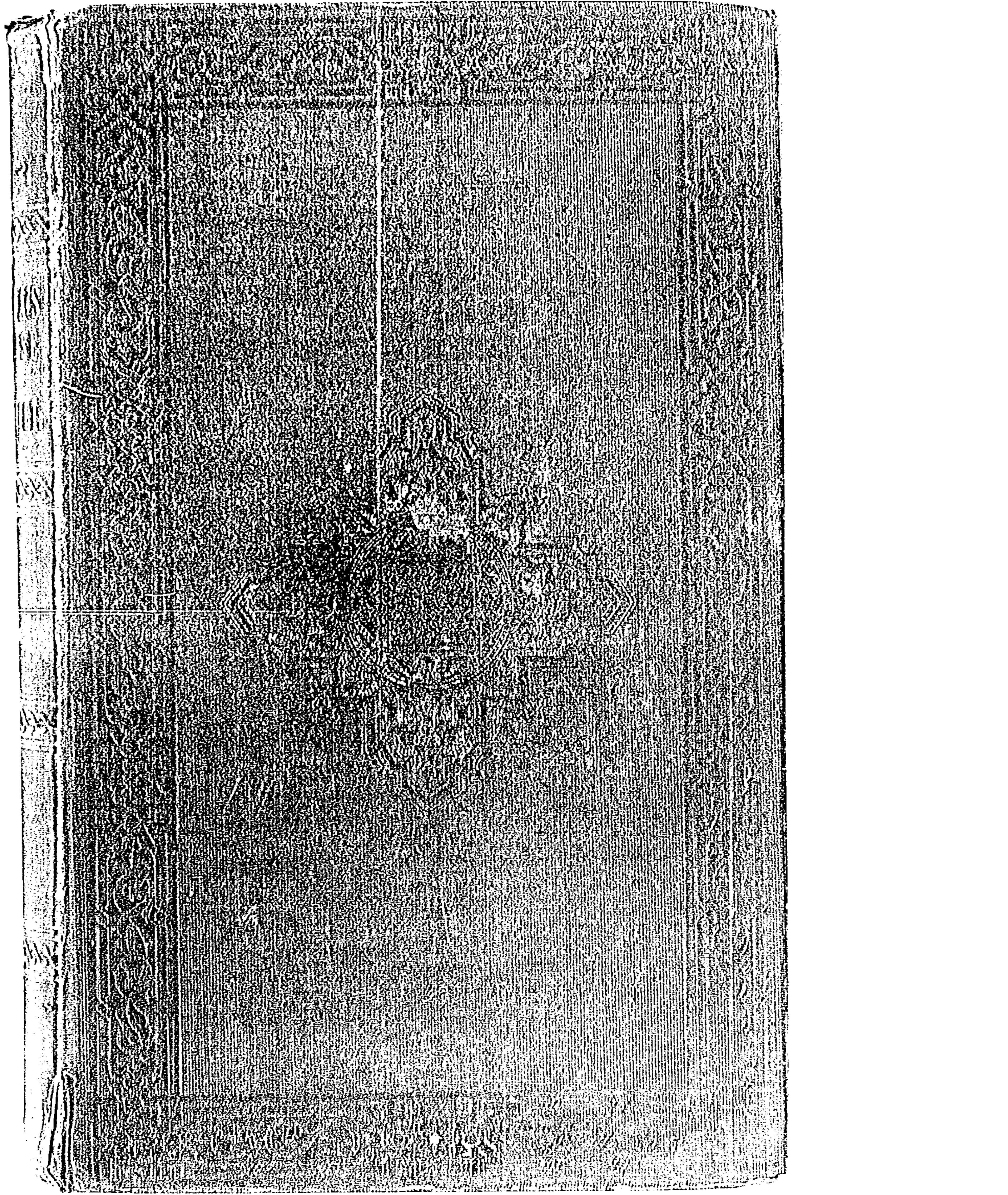


A

TREATISE

ON

FOOD AND DIET:

WITH

OBSERVATIONS ON THE

DIETETICAL REGIMEN

SUITED FOR

DISORDERED STATES OF THE DIGESTIVE ORGANS;

AND AN

Account of the Dietaries

OF SOME OF THE

PRINCIPAL METROPOLITAN AND OTHER ESTABLISHMENTS

FOR

PAUPERS, LUNATICS, CRIMINALS, CHILDREN, THE SICK, &c.

BY

JONATHAN PEREIRA, M.D. F.R.S. & L.S.

LICENTIATE OF THE ROYAL COLLEGE OF PHYSICIANS IN LONDON;
MEMBER OF THE ROYAL COLLEGE OF SURGEONS;
FELLOW OF THE ROYAL MEDICAL AND CHIRURGICAL SOCIETY;
CORRESPONDING MEMBER OF THE SOCIETY OF PHARMACY OF PARIS;
HONORARY MEMBER OF THE PHARMACEUTICAL SOCIETY OF GREAT BRITAIN;
EXAMINER IN MATERIA MEDICA AND PHARMACY TO THE UNIVERSITY OF LONDON;
AND ASSISTANT PHYSICIAN TO, AND LECTURER ON MATERIA MEDICA AT, THE LONDON HOSPITAL.

LONDON:

LONGMAN, BROWN, GREEN, AND LONGMANS,

PATERNOSTER ROW.

1843.

WILSON AND OGILVY, SKINNER STREET, SNOWHILL, LONDON.

PREFACE.

The idea of the present treatise occurred to the author during the preparation of another work, when he repeatedly experienced the want of a detailed and individual account of alimentary substances.

His original intention was to have treated the subject in the same full and systematic manner that he has elsewhere done the articles of the Materia Medica; and he had, in fact, begun to collect materials for a work on this plan. But he soon found that the subject was too extensive to be treated in such a way; within, at least, reasonable limits. He was, therefore, compelled to abandon, though with considerable reluctance, his original design, and to substitute for it the present work, in which he has excluded all Natural Historical details; preferring this course to that of giving a mere sketch or epitome of the subject.

The present treatise on Diet differs from its predecessors in several particulars, some of which it may not be useless to point out.

In the first place, it contains a tolerably full account of the chemical elements of food,—a subject which has always appeared to the author of considerable importance, and to which the recent researches and conclusions of Boussingault, Liebig, and Dumas have given additional interest. It is one, however, which preceding dietetical writers have altogether passed over, or only incidentally alluded to; and in no work, with which he is acquainted, has it been systematically treated.

Another peculiarity of the present work is the increased space devoted to the consideration of alimentary principles, the number of which the author, for reasons he has elsewhere assigned, has considered it proper to augment.

The plan of separately considering *Alimentary Principles* and *Compound Aliments*, adopted from Tiedemann*, he considers to be greatly superior to the ordinary method of treating these subjects, and which consists in the arrangement of foods according to the proximate or immediate principle predominating in their composition. Such a classification is open to the glaring and obvious objection, that most of the foods in ordinary use consist of several alimentary principles. Thus, *butchers' meat* consists of fibrine, albumen, gelatine, and fat; *bread*, of starch, gluten, gum, and sugar; *milk*, of caseine, butter, and sugar. Now, to arrange meat among fibrinous, bread among starchy, and milk among caseous, foods, is to overlook the other important

* *Untersuchungen über das Nahrungs Bedürfniss den Nahrungs-Trieb und die Nahrungs-Mittel des Menschen.* Darmstadt, 1836.

constituents of these substances, and to give a very imperfect view of their alimentary properties.

The author did not venture, without considerable hesitation and doubt as to its propriety, to deviate from Dr. Prout's beautifully simple and generally admitted classification of alimentary principles, into the *aqueous*, the *saccharine*, the *albuminous*, and the *oleaginous*. After mature consideration, however, he satisfied himself of the impossibility of reducing all nutritive principles to these four heads. Common salt, for example, which a recent writer* justly observes "can by no means be considered only as a luxury, but as a substance as essential to life as nitrogenous or non-nitrogenous food and water" can be referred to no one of these four classes. Moreover, lemon juice, which constitutes one of our most valuable antiscorbutic foods, does not owe its efficiency to water, sugar, albumen, or oil. Furthermore, to call gum, starch, and acetic acid, *saccharine* substances,—gelatine an *albuminous* one,—or alcohol an *oleaginous* one, is to assign new meanings to common and familiar terms. Gelatine and albumen are not mutually convertible into each other by any known chemical process, nor can oil be transformed into alcohol, or, *vice versâ*, alcohol into oil. For these reasons, therefore, the author has ventured to adopt a new and enlarged arrangement of alimentary principles, which he now submits to the notice of his professional brethren.

* *On Gravel, Calculus, and Gout*, by H. Bence Jones, M.A. p. 46. London, 1842.

Considerable pains have been taken in the preparation of Tables representing the proportion of some of the chemical elements, and of the alimentary principles, contained in different foods; and the author believes they will be found as complete and accurate as the present state of our knowledge admits.

Another peculiar feature of this treatise is the chapter on Dietaries, which has been rendered necessary by the discussions which have been going on, for many months past, in the public journals and elsewhere, respecting the amount of food proper to be supplied to paupers, prisoners, and others. The subject has in this way forced itself on the attention of all grades of society; and professional men and others must have long felt the want of a work giving an account of the dietaries in use in various Public Establishments in this country, as well as in the Navy and Army. The author greatly regrets that the necessarily limited extent of the present treatise has precluded him from entering into a variety of interesting details connected with this subject.

47, Finsbury Square, London.
June 13, 1843.

CONTENTS.

CHAP. II.—OF ALIMENTARY PRINCIPLES.

PART II.—OF DIET.

CHAP. V.—ON THE DIETETICAL REGIMEN SUITED FOR DISORDERED STATES OF THE DIGESTIVE ORGANS.

CORRIGENDA ET ERRATA.

The reader is requested to correct with the pen the following typographical errors:—

Page.	Line.	
8	13	*for* "77·75," *read* "77·50."
25	20	*for* "12C + 17 Water + 5O," *read* "12C + 8·5 Water + 11O."
25	27	*after* "interest," *insert* "as oxygen."
61	5	*for* "refining," *read* "preparing raw."
61	23-4	It should have been stated, that the "bones of the sheep's feet" and "ox's head" had been digested in muriatic acid.
66	13 from bottom,	*for* "ovalbumine," *read* "ovalbumen."
138	24	*for* "peas," *read* "pears."
231	24	*for* "31," *read* "21."
242	4	*omit* the words "alimentary qualities of the."
368	last line,	*omit* the word "On."

ON

FOOD AND DIET.

PART I.—OF FOODS.

THE substances employed by man as food consist of certain compound bodies termed *Alimentary Principles*, which, by their mixture or union, constitute our ordinary foods: these, for the sake of distinction, I shall denominate *Compound Aliments.*

Thus meat (a compound aliment) consists principally of fibrine, albumen, gelatine, hæmatosin, fat, and water (alimentary principles). Wheat (a compound aliment) is composed of starch, gluten, sugar, and gum (alimentary principles).

Alimentary principles are themselves compound substances. They consist of two, three, four, or more, *simple* or *undecompounded bodies*, usually denominated *elements.* These are the *Chemical Elements*, or *Elementary Constituents of Foods.*

Thus fibrine (an alimentary principle) is composed of carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulphur (chemical elements). Gum (an alimentary principle) consists of carbon, hydrogen, and oxygen (chemical elements).

I propose, therefore, to consider successively—

1. The Chemical Elements of Foods.
2. Alimentary Principles.
3. Compound Aliments.

Chap. I.—*Of the Chemical Elements of Foods.*

Those bodies from which chemists have hitherto failed to extract other substances of entirely different properties, are denominated *Simple* or *Undecompounded Bodies*, or *Chemical Elements.*

At the present time, fifty-five* such bodies are known. Arranged alphabetically, they are as follows:—

CHEMICAL ELEMENTS.

	Equivalent or Combining Proportion. (Hydrogen=1)	*Symbol.*
1. Aluminum	10	Al
2. Antimony (*Stibium*) .	65	An *or* Sb
3. Arsenicum .	38	Ar *or* As
4. Barium . .	69	Ba
5. Bismuth . .	72	Bi
6. Boron . . .	10	Bo
7. Bromine . .	78	Br
8. Cadmium . .	56	Cd
9. Calcium . .	20	Ca
10. Carbon . .	6	C
11. Cerium . .	46	Ce
12. Chlorine . .	36	Cl
13. Chromium .	28	Cr
14. Cobalt . . .	30	Co
15. Columbium (*Tantalum*)	185	Ta
16. Copper (*Cuprum*) . .	32	Cu
17. Flucrine. . .	19	F
18. Glucinum . .	27	G
19. Gold (*Aurum*)	200	Au
20. Hydrogen . .	1	H
21. Iodine . . .	126	I
22. Iridium . .	98	Ir
23. Iron (*Ferrum*)	28	Fe
24. Lanthanium .	?	La
25. Lead (*Plumbum*) . .	104	Pl
26. Lithium . .	8	Li
27. Magnesium .	12	Ma
28. Manganese .	28	Mn

	Equivalent or Combining Proportion. (Hydrogen=1)	*Symbol.*
29. Mercury (*Hydrargyrum*)	202	Hg
30. Molybdenum	48	Mo
31. Nickel . . .	29	Ni
32. Nitrogen . .	14	N
33. Osmium . .	100	Os
34. Oxygen . .	8	O
35. Palladium .	54	Pd
36. Phosphorus .	16	P
37. Platinum . .	99	Pl
38. Potassium (*Kalium*)	40	K
39. Rhodium . .	52	R
40. Selenium . .	40	Se
41. Silicon. . .	8	Si
42. Silver (*Argentum*) .	108	Ag
43. Sodium (*Natrium*) .	24	N
44. Strontium .	44	Sr
45. Sulphur . .	16	S
46. Tellurium .	64	Te
47. Thorium . .	60	Th
48. Tin (*Stannum*)	58	Sn
49. Titanium . .	24	Ti
50. Tungsten (*Wolfram*)	95	W
51. Uranium . .	68	U
52. Vanadium .	217	V
53. Yttrium . .	32	Y
54. Zinc . . .	32	Zn
55. Zirconium .	33	Zr

* A fifty-sixth element, called *Didym*, has been recently announced. It is a metal which is found along with Cerium and Lanthanium (Poggendorff's *Annalen der Physik und Chemie*, vol. xlvi. No. 7, p. 503).

As far as we have at present ascertained, these are the substances which constitute the elements of all known bodies (mineral and organised).

It has long been suspected that many of these supposed elementary bodies are themselves compounded*. The suspicion has arisen from the analogies which exist between some of the undecompounded substances (especially the metals); as well as from the difficulty of accounting for the presence of several of the so-called elements found in organised beings. But though it may be well founded, yet chemists have agreed to call those substances *simple* or *elementary* which have hitherto resisted every attempt to resolve them into other and simpler parts; and, therefore, when the phrase *element* or *simple body* is used, we merely mean a substance which no one, as yet, has been able to decompose.

Of the fifty-five above-mentioned elementary substances, there have been found in Organised Bodies about nineteen only; these are arranged alphabetically in the following table:—

CHEMICAL ELEMENTS OF ORGANISED OR LIVING BODIES.

1. Carbon	6. Sulphur	11. Fluorine	16. Iron
2. Hydrogen	7. Silicon	12. Potassium	17. Manganese
3. Oxygen	8. Chlorine	13. Sodium	18. Aluminum
4. Nitrogen	9. Iodine	14. Calcium	19. Copper ?
5. Phosphorus	10. Bromine	15. Magnesium	

* Some interesting observations on this subject will be found in Sir H. Davy's *Elements of Chemical Philosophy*, p. 478, et seq. London, 1812.—See also Berzelius's *Traité de Chimie*, t. ii. p. 268. Paris, 1830. Very recently it has been asserted that carbon is convertible into silicon (Dr. Sam. H. Brown, *Transactions of the Royal Society of Edin-*

Though I have included *Copper* as an element of organised bodies, in consequence of its having been found in them by several chemists*, it is, probably, only an accidental constituent. *Gold* †, and, more recently, *Lead* ‡ and *Arsenicum* §, have been declared to be constituents of organised bodies; but there is reason, I think, to suspect some error in the observations.

A living body has no power of forming elements, or of converting one elementary substance into another ‖;

---

burgh, for 1841); but the assertion has not been corroborated by subsequent experiments.

* Copper has been detected in plants by Bischoff (De Candolle, *Physiologie Végétale*, t. i. p. 389), Meissner (*Ann. de Chim. et de Phys.* t. iv. p. 106), and by Sarzeau (*Ann. de Chim. et de Phys.* t. xlix. p. 334). The last mentioned chemist also found it in the blood of animals.

† Several distinguished chemists have asserted the existence of gold in vegetables (Chaptal, *Elements of Chemistry*, vol. ii. p. 442).

‡ According to Devergie (*Journal de Chimie Médicale*, t. iv. 2^le^ Série, p. 591, 1838), lead and copper are constituents of the bodies of man and other animals.

§ Orfila (*Journ. de Chim. Méd.* t. v. 2^le^ Sér. p. 632, 1839) asserts, that arsenicum is a constituent of the bones of man and other animals. But Dr. G. O. Rees (*Guy's Hospital Reports*, No. xii.), Messrs. Danger and Flandrin, and the Commissioners appointed by the French Academy of Sciences (*Journal de Pharmacie*, t. xxiv. p. 428, Juillet, 1841), have repeated his experiments without detecting it.

‖ Dr. Prout (*Phil. Trans.* 1822, p. 377) asserts, that the lime found in the skeleton of the chick when it quits the shell, did not pre-exist in the recent egg; so that the only possible sources whence it could be derived are the shell and transmutation from other substances supposed to be elementary. But as the membrane in contact with the shell is never vascular, and as both the albumen and yolk contain, at the end of incubation, a considerable quantity of earthy matter, which it is to be supposed would have been appropriated to the bone in preference to that derived from a remote source, Dr. Prout doubts whether the origin or source of the lime is referable to the shell. Indeed, it is tolerably clear, that he believes in the capability of the vital energies to effect the transmutation of some of the so-called elements; and

and it therefore follows that the elements of which the body of an animal is composed must be the elements of its food.

The essential constituents of the human body are thirteen; and the same, therefore, must be the elements of our food*.

CHEMICAL ELEMENTS OF THE FOOD OF MAN.

1. Carbon	5. Phosphorus	8. Chlorine	11. Potassium
2. Hydrogen	6. Sulphur	9. Sodium	12. Magnesium
3. Oxygen	7. Iron	10. Calcium	13. Fluorine
4. Nitrogen			

---

in a more recent work (*On the Nature and Treatment of Stomach and Urinary Diseases*, p. xxxvi. 3rd edit. 1840), he expresses himself more decidedly on this point. "Some imagine," he observes, "that the mineral incidental principles of organised beings are generated during the vital process; while others maintain that they are derived *ab externo*. My belief is, that, under certain extraordinary circumstances, the vital agents *can* form what we now consider as elements; but that, in ordinary, such elements are chiefly derived *ab externo*, in conjunction with the alimentary principles;" and in another part of the same work (p. xxix.), he speaks of the assimilating organs being able, under extraordinary circumstances, "to decompose principles which are still considered as elementary; nay, to *form* azote or carbon."

These opinions, however well founded, in no way affect the accuracy of the proposition which I have above laid down in the text; for Dr. Prout himself, in his Bridgewater Treatise (*Chemistry, Meteorology, and the Function of Digestion considered with reference to Natural Theology*, p. 431, 1834) lays down a similar one. "No organic agent," he says, "has the power either of *creating* material elements, or of *changing* one such element into another." His opinions merely affect the question of the elementary nature of some of the substances which chemists have not hitherto been able to decompose. At p. 432 of the last quoted work, he observes, that "while it is thus denied that organised beings possess the power, either to create or change, in the strict acceptance of these terms; it has been admitted to be exceedingly probable, that the organic agent is, within certain limits, qualified to compose and decompose many substances which are now viewed as elements; and that the organic agent does thus apparently form and transmute these imagined elements."

* Traces of manganese have been detected in the blood; but I have not included this metal as an essential constituent of the human system.

These substances I now proceed to notice individually.

1. CARBON.—In the pure and crystallized state, carbon constitutes the *diamond*, a substance which Sir D. Brewster * suspects to be of vegetable origin. In its more familiar but impure forms, carbon constitutes *plumbago* (graphite or black-lead) and *charcoal* (animal and vegetable). The last-mentioned substance is always contaminated with various earthy bodies derived from the organic matter from which the charcoal was made. Thus *animal charcoal* obtained from bones, and known as *bone black*, contains only ten per cent. of carbon.

COMPOSITION OF BONE BLACK.

Carbon	10·0
Phosphate of Lime . . . . } Carbonate of Lime . . . . }	88·0
Carburet or Silicet of Iron	2·0
Sulphuret of Calcium, or Iron . . .	*traces*
Animal Charcoal or Bone Black † . .	100·0

Vegetable Charcoal, obtained from wood, contains a much larger proportion of carbon.

In some countries, siliceous and aluminous substances are eaten, but they can scarcely be denominated aliments; and I have not, therefore, inserted silicon and aluminum among the elements of the food of man. "The negroes of Guinea, the Javanese, the New Caledonians, and many South American tribes, eat clay as a luxury" (Elliotson's *Human Physiology*, p. 63, 1840). The Otomacks, a savage race on the banks of the Orinoco, appease their hunger for two or three months, according to Humboldt, by distending their stomachs with clay. The *fossil farina*, which, according to Stanislas Julien (*Comptes Rendus*, 1841, 2 Semest. p. 358), is used in China, in times of great scarcity, as a food, contains 13·2 per cent. of organic matter (Payen, *Ibid.* p. 480), and may, therefore, possess some slightly nutritive qualities.

* *Edinburgh Philosophical Journal*, vol. iii. p. 98; and *Philosophical Magazine*, vol. i. p. 147. 1827.

† Dumas, *Traité de Chimie appliqué aux Arts*, t. i. p. 450.

COMPOSITION OF VEGETABLE CHARCOAL.

	Thorn.	Poplar.	Maple.	Ash.	Aspen.	Spindle.
Carbon	88·0	85·6	85·2	83·2	82·0	82·8
Volatile matter . . .	9·6	13·4	13·8	15·0	15·0	15·6
Calcined ashes	2·4	1·0	1·0	1·8	3·0	1·6
Vegetable Charcoal * . .	100·0	100·0	100·0	100·0	100·0	100·0

Carbon is an essential constituent of every living or organised tissue, both vegetable and animal. It is, therefore, a necessary ingredient of food; and nature has accordingly supplied it in the aliment which she has provided for all living beings in the early stage of their existence. Thus it is an element of the organic substances composing seeds, and from which the embryo plant derives its first nutriment. The yolk of eggs (the food of the embryo chick), and milk, on which young mammals subsist during the first period of their existence after birth, also contain it.

The quantity of it which is contained in different foods is as follows:—

QUANTITY OF CARBON IN FOODS.

1.—*Alimentary Principles.*

a. NON-NITROGENISED:

		Per-centage, by weight, of Carbon.	Authority.†
Saccharine	Anhydrous Cane Sugar . .	47.05	Peligot.
	Sugar Candy	42.1	
	Sugar of Milk	40.0	Prout & Liebig.
	Grape Sugar (from Honey) .	36.36	Prout.
Amylaceous	Wheat Starch	37.5	Ditto.
	Ditto, dried at 350° Fahr. .	44.0	Ditto.
	Arrow Root	36.4	Ditto.
	Ditto, highly dried at 212° Fahr.	44.4	Ditto.
Mucilaginous	Gum Arabic	36.3	Ditto.
	Ditto, dried at 212° Fahr. .	41.4	Ditto.
	Ditto, dried at 240° Fahr. .	45.1	Mulder.

* Berthier, *Traité des Essais par la voie sèche*, t. i. p. 286.

† The analyses of Liebig, Scherer, Jones, Playfair, and Bœckmann, alluded to in this table, are taken from Liebig's *Animal Chemistry*,

Vegetable Jelly	Pectine (from Sweet Apples)	45.198	Mulder.
	Ditto (from Sour Apples) .	45.853	Fremy.
	Ditto (in Pectinate of Lead)	43.5	
Acidulous .	Acetic Acid (anhydrous) .	47.06	
	Citric Acid (hypothetical or dry)	43.63	
	Ditto (commercial crystals) .	34.29	
	Tartaric Acid (anhydrous) .	36.36	
Alcoholic . .	Alcohol	52.18	
Oleaginous .	Butter	65.6	Bérard.
	Mutton Fat	78.996	Chevreul.
	Hog's Lard	79.098	Ditto.
	Olive Oil	77.75	Calculated from Saussure.

b. NITROGENISED:

Proteine Compounds .	Animal Albumen (from Eggs)	55.000	Scherer.
	——— Fibrine	55.002	Ditto.
	———Caseine(from fresh Milk)	54.825	Ditto.
	Vegetable Albumen(from Wheat)	55.01	Jones.
	——— Fibrine	54.617	Scherer.
	——— Caseine	54.138	Ditto.
	Gluten (from Wheat) . . .	55.22	Jones.
Gelatinous .	Tendons of Calves' Feet . .	50.960	Scherer.
	Isinglass	50.557	Ditto.
	Cartilages of Calves' ribs (chondrine)	50.895	Ditto.

2.—*Compound Aliments.*

a. VEGETABLE:

Wheat (dried *in vacuo* at 230° Fahr.)	46.1	Boussingault.
Oats (ditto)	50.7	Ditto.
Rye (ditto)	46.2	Ditto.
Potatoes	12.2598	Ditto.
Ditto (dried *in vacuo* at 230° Fahr.)	44.0	Ditto.
Turnips	3.217	Ditto.
Ditto (dried *in vacuo* at 230° Fahr.)	42.9	Ditto.
Jerusalem Artichoke (ditto)	43.3	Ditto.
Peas	35.743	Playfair.
Ditto (dried *in vacuo* at 230° Fahr.)	46.5	Boussingault.
Lentils	37.38	Playfair.
Beans	38.24	Ditto.
Fresh Bread	30.15	Liebig.
Black Bread (dried at 210°)	45.41	Bœckmann.

(London, 1842). Those of Boussingault, are taken from his papers in the *Annales de Chimie et de Physique* (t. lxiii., lxvii., lxix., and lxxi.)—The results of Mulder's analysis of pectine, I have taken from the *Pharmaceutisches Central-Blatt für* 1838 (p. 338); those of Fremy's analysis of the same substance from the *Journal de Pharmacie* (t. xxvi. p. 373). Prout's experiments were published in the *Philosophical Transactions,* for 1827. I have taken the results of Bérard's and Chevreul's analyses from L. Gmelin's *Handbuch der theoretischen Chemie* (vol. ii. p. 439.)

b. ANIMAL:

Ox Blood	10.392	Playfair and Bœckmann.
Ditto (dried)	51.96	
Fresh Meat (devoid of fat)	13.6	Liebig.
Ditto (with ⅛th fat and cellular tissue) . .	21.75	Ditto.
Dry muscular Flesh (Beef)	51.89	Bœckmann.
Roasted Flesh (Roe Deer)	52.60	Ditto.
Ditto (Beef)	52.59	Playfair.
Ditto (Veal)	52.52	Ditto.
Soup of the House of Arrest at Giessen . .	0.46848	Liebig.

The quantity of carbon consumed, in the form of food, by different individuals and at different times, is subject to very considerable variation. Age, sex, peculiarities (individual or national), temperature and density of the air, occupation (laborious or inactive), and amount of clothing, are among the circumstances which produce these diversities.

"From the accurate determination of the quantity of carbon daily taken into the system in the food, as well as of that proportion of it which passes out of the body in the fæces and urine, unburned—that is, in some form in which it is not combined with oxygen—it appears that an adult, taking moderate exercise, consumes 13$\frac{9}{10}$ oz. [Hessian=15$\frac{3}{10}$ oz. avoirdupois] of carbon daily *."

Liebig's statement is based on observations made on the average daily consumption of food by from 27 to 30 soldiers, of the Body Guard of the Grand Duke of Hesse Darmstadt in barracks, for a month, or by 855 men for one day. I have drawn up the following table from his statements, and converted the Hessian weights into avoirdupois weights.

* Liebig, *Animal Chemistry, or Organic Chemistry in its Applications to Physiology and Pathology,* edited by Dr. W. Gregory, p. 14. Lond. 1842.

Kinds of Food.	Avoirdupois weight of Food.			Avoirdupois weight of Carbon.		
	lbs.	oz.	grs.	lbs.	oz.	grs.
Ordinary meat containing ⅙ of fat and cellular tissue	306	4	186	66	9	397½
Fat or Lard	3	13	304½	3	1	156 1/16
Lentils	3	10	412	11	10	131 2/15
Peas	12	12	161			
Beans	15	0	76			
Potatoes	1093	2	357	133	5	374 8/15
Bread	1923	9	214½	603	15	300½
Total for 855 men for one day	3358	5	398¼	818	11	46
Average for one man for one day	3	14	370½	0	15	140

In addition to the above, the 855 men consumed,

	lbs.	oz.	grs.
Of Green Vegetables (Cabbages, Greens, Turnips, &c.)	192	15	15
Of Sourkrout	110	2	325
Of Onions, Leeks, Celery, &c.	26	11	203½
Total for 855 men for one day	326	6	55
Average for one man for one day	0	6	63½

It also appears, from an approximate report of the serjeant-major, that each soldier consumed daily, on an average, out of the barracks, the following quantities of other foods :—

Sausages	3 3/10 oz.	Avoirdupois weight.
Butter	¼ oz. & 33¼ grs.	
Beer	½ pint	
Brandy	1/16 pint	

So that we may fairly assume, that each of these soldiers consumed daily about one pound (avoirdupois) of carbon. Now if we suppose that while under experiment he neither gained nor lost in weight, what, it may be asked, became of the carbon thus taken in the form of food?

I shall assume, with Liebig, that the carbon of the

green vegetables, sourkrout, and onions, was equal to that of the fæces and the urine, and shall exclude from our calculation the carbon of the small quantity of food (sausages, butter, beer, and brandy) taken in the alehouse. We have, therefore, to account for the disposal of 15 ozs. 140 grs. avoirdupois (=6702½ grs. troy) of carbon; nearly the whole of which quantity must have been thrown out of the system by the lungs and the skin in the form of carbonic acid.

Now, 6 grs. of carbon combine with 16 grs. of oxygen, and form 22 grs. of carbonic acid. Hence 6702½ grs. troy of carbon require 17,840 grs. of oxygen gas to yield 24,542½ grs. of carbonic acid; and this quantity of oxygen must, therefore, be derived from the air, either by the lungs or skin, or by both. But oxygen is also consumed in the system in the oxidation of hydrogen, sulphur, and phosphorus, and this quantity also must be derived from the same source (the atmosphere) and by the same means.

The quantity of oxygen consumed, and of carbonic acid produced, in respiration, by an adult man, in twenty-four hours, has been variously estimated as follows :—

Consumption of Oxygen and Production of Carbonic Acid in Respiration by an Adult Man in 24 hours

	Oxygen consumed.				Carbonic Acid produced.			Carbon contained in the Carbonic Acid.
	Cubic In.		Grs.		Cubic In.		Grs.	Grs.
Lavoisier & Seguin	46037	or	15661		14930	or	8584	2820 (French)
Menzies	51480	or	17625		——		——	—— (English)
Davy	45504	or	15751		31680	or	17811	4853 (ditto)
Allen & Pepys . .	39600	or	13464		39600	or	18612	5148 (ditto)
Coathupe . . .	——		——		17856		——	2616 (ditto)

It is obvious that the highest of these estimates is below the quantity of oxygen required to oxidate the carbon consumed by the Darmstadt soldiers. But in drawing any conclusions as to the absolute amount of oxygen consumed in respiration, we must not omit to consider the numerous circumstances which interfere with the results, and render it difficult, if not impossible, to obtain a correct estimate. The management of the apparatus, the nicety of the manipulation, the degree of muscular exertion employed, the quantity and quality of the food consumed by the individual experimented on, the state of the system, and various other circumstances, concur in affecting the results.

Moreover, it is probable that the skin produces on the air changes analogous to those effected by the lungs: that is, it absorbs oxygen, and evolves carbonic acid.*

Furthermore, if the amount of carbonaceous food be less than that supplied to the Darmstadt soldiers, it is obvious that less oxygen will be required to oxidise the carbon. Now, according to Liebig, "prisoners in the Bridewell at Marienschloss (a prison where labour is enforced) do not consume more than 10.5 oz. [Hessian = $11\frac{568}{1000}$ avoirdupois] of carbon daily; those in the House of Arrest at Giessen, who are deprived of all exercise, consume only 9 oz.† [Hessian = $9\frac{9}{10}$ avoirdupois]; and in a family well

* See Bostock's *Elementary System of Physiology*, vol. ii. p. 237, *et seq.* Lond. 1826.

† At p. 36 of the English translation of Liebig's *Animal Chemistry*, it is stated that 8·5 oz. of carbon are consumed: but at p. 293, the translator has given reasons for believing that the quantity should be 9 oz.

known to me, consisting of nine individuals, five adults, and four children of different ages, the average daily consumption of carbon for each is not more that 9.5 oz. [Hessian = $10\frac{45}{100}$ avoirdupois] of carbon. We may safely assume, as an approximation, that the quantities of oxygen consumed in these different cases are in the ratio of these numbers."

Ten ounces avoirdupois or 4375 grs. troy of carbon combine with 11666·6 grs. troy of oxygen, and thereby form 16041·6 grs. of carbonic acid.

By the union of carbon with oxygen, in whatever part of the system this is effected, heat must be evolved. At least, in all other cases, the formation of carbonic acid is attended with the evolution of heat; and we have a right, therefore, to assume, that the same takes place within the body. We are, in fact, acquainted with no conceivable reason why it should be otherwise. Now, according to Despretz *, one pound of pure charcoal evolves, by its combustion in oxygen gas, sufficient heat to raise the temperature of 78lbs. of water from 32° Fahr. to 212° Fahr.; and this must be about the amount evolved in the case of the Darmstadt soldiers, independently of the heat produced by the union of oxygen with hydrogen hereafter to be noticed.

It appears to me that we have a sufficient explanation of animal temperature in the chemical changes just referred to. Indeed, it cannot be doubted that a large proportion, if not the whole, of the heat evolved by animals, is produced by chemical action. But it is

* Graham, *Elements of Chemistry*, p. 250.

scarcely to be expected that experiments can be so nicely and delicately performed as to demonstrate in a precise manner the truth of this chemical theory of animal heat: for while, on the one hand, considerable difficulty is experienced in determining the actual quantity of combustible matter oxidated in the system, it is almost impossible, on the other, to estimate, with absolute nicety, the amount of heat actually imparted by a living animal to surrounding bodies. The results of our experiments, therefore, can only furnish, at the most, approximations to the truth *.

Liebig has endeavoured to show, that by the conversion of starch or sugar into fat, oxygen is supplied to the system; and that by the union of this disengaged oxygen with carbon (from the bile, for example) heat is developed. Suppose 1 equivalent of carbonic acid CO_2, and 7 equivalents of oxygen, O_7, to be abstracted from 1 equivalent of starch, $C_{12}\ H_{10}\ O_{10}$, we have, in the residue, the empirical formula for fat, $C_{11}\ H_{10}\ O$.

RELATIVE COMPOSITION OF STARCH AND FAT.

1 eq. Starch . .	$C_{12}\ H_{10}\ O_{10}$	1 eq. Fat	$C_{11}\ H_{10}\ O$
		1 eq. Carbonic Acid	$C\ \ O_2$
		7 eq. Oxygen . .	O_7
			$C_{12}\ H_{10}\ O_{10}$

The oxygen thus presumed to be separated from the starch, can only be disengaged in the form of either carbonic acid or water, or of both; therefore it must have combined with carbon or hydrogen, or both.

* Despretz observes, that in none of his experiments did respiration produce less than $\frac{7}{10}$ths, nor more than $\frac{9}{10}$ths of the whole heat emitted by the animal (*Ann. de Chimie et Physiq.* t. xxvi. p. 361, 1824). See also Dulong's paper in the *Mem. de l'Acad. Royale des Sciences*, t. xviii. p. 327, 1842.

Now, Liebig has adduced several reasons for presuming that heat must attend the formation of carbonic acid under these circumstances. "Thus," says this distinguished chemist, "in the formation of fat, the vital force possesses a means of counteracting a deficiency in the supply of oxygen, and consequently in that of the heat indispensable for the vital process."

In the natural and healthy condition of the system, the food supplies the necessary carbon for the support of animal heat, but when food is withheld, the fat of the body is consumed; its carbon being converted into carbonic acid, its hydrogen into water. Experience has satisfactorily shown that the heat of the blood is the same in all climates and in all conditions of atmospheric temperature. Now it follows that a larger quantity of combustible matter is required in cold climates and cold weather, for keeping up this temperature, than in hot climates and warm weather; since a greater amount of heat must be given off to surrounding media in the former than in the latter. Hence the necessity for a more liberal supply of food in cold weather. "He who is well fed," observes Sir John Ross,* "resists cold better than the man who is stinted, while the starvation from cold follows but too soon a starvation in food. This, doubtless, explains in a great measure the resisting powers of the natives of these frozen climates; their consumption of food, it is familiar, being enormous, and often incredible."†

* *Narrative of a Second Voyage in Search of a North west Passage*, page 200. London, 1835.

† Most persons are familiar with the accounts which have been published respecting the gormandizing powers of the natives of the Arctic Regions. Captain Sir W. E. Parry (*Second Voyage for the Discovery of*

Moreover, it is obvious that the foods which, theoretically, appear to be best suited for the inhabitants of these colder climates, are those which contain the largest amount of carbon and hydrogen, viz., the fats and oils, which contain from 66 to 80 per cent. of carbon. The celebrated traveller just quoted, further remarks, "that in every expedition or voyage to a polar region, at least if a winter residence is contemplated, the quantity of food should be increased, be that as inconvenient as it may. It would be very

the North-west Passage, p. 413, Lond. 1824) states that, as a matter of curiosity, he one day tried how much food an Esquimaux lad, scarcely full grown, would consume, if freely supplied. "The under-mentioned articles were weighed before being given to him; he was twenty hours in getting through them, and certainly did not consider the quantity extraordinary."

	lbs.	oz.
Sea-horse flesh, hard frozen	4	4
ditto boiled . .	4	4
Bread and bread-dust . .	1	12
Total .	10	4

The fluids were in fair proportion, viz.:—

Rich gravy soup	1¼ pint.
Raw spirits . .	3 wine glasses.
Strong grog . .	1 tumbler.
Water	1 gallon 1 pint.

Sir John Ross (*Narrative*, p. 448, 1835) says, that an Esquimaux "perhaps eats twenty pounds of flesh and oil" daily.

But the most marvellous account of gormandizing powers is that published by Captain Cochrane (*Narrative of a Pedestrian Journey through Russia and Siberian Tartary*, vol. i. p. 255, 3d edit. 1825). He says, that the Russian Admiral Saritcheff was told that one of the Yakuti consumed in twenty-four hours "the hind quarter of a large ox, twenty pounds of fat, and a proportionate quantity of melted butter for his drink." The Admiral, to test the truth of the statement, gave him "a thick porridge of rice boiled down with three pounds of butter, weighing together twenty-eight pounds, and although the glutton had already breakfasted, yet did he sit down to it with great eagerness, and consumed the whole without stirring from the spot: and, except that his stomach betrayed more than an ordinary fulness, he shewed no sign of inconvenience or injury"!! Captain Cochrane also states (p. 352), that a good calf, weighing about two hundred pounds, "may serve four or five good Yakuti for a single meal." In another place (p. 255) the same traveller observes, that he has repeatedly seen a Yakut or Tongouse devour forty pounds of meat a day; and, he adds, "I have seen three of these gluttons consume a rein-deer at one meal."

desirable indeed, if the men could acquire the taste for Greenland food, since all experience has shewn that the large use of oil and fat meats is the true secret of life in these frozen countries, and that the natives cannot subsist without it, becoming diseased, and dying, with a more meagre diet."

The effect of cold in augmenting, and of heat in diminishing the appetite for food, is well known. I will not, however, go the length of Liebig in asserting, that if we were to go naked, as the Indians, or if in hunting or fishing we were exposed to the same degree of cold as the Samoyedes, we should be able to consume the half of a calf, besides a dozen of candles *. For though it must be admitted that the inhabitant of a frozen region requires more abundant food than he who lives in a temperate climate, yet I feel that it is an error to ascribe the voracity and gormandizing powers of some of the natives of the colder regions to the influence of cold only. The Hottentots and the Bushmen [Bosjesmans]† of Southern Africa, in-

* *Annalen der Chemie und Pharmacie*, vol. xli. Liebig, or his translator, seems to have had some misgivings about the "*half of a calf*," since, in the English translation, I find "*10lbs of flesh*" substituted.

† Barrow (*Account of Travels into the Interior of Southern Africa*, vol. i. p. 152. 1801) says that the Hottentots are "the greatest gluttons upon the face of the earth. Ten of our Hottentots," he adds, "ate a middling-sized ox, all but the two hind legs, in three days; but they had very little sleep during the time, and had fasted the two preceding days. With them the word is to eat or to sleep. When they cannot indulge in the gratification of the one, they generally find immediate relief in flying to the other."

The same authority, when speaking of the Bosjesmans (*op. cit.* p. 288) says that they are equally filthy and gluttonous with the voracious vultures. "The three who accompanied us to our waggons had a sheep given to them about five in the evening, which was entirely consumed dulge, as is well known, in beastly gluttony, yet this cannot be the effect of the temperature of their climate; while "the inhabitants of the Alpine regions of Southern Europe demand no such extravagance of food, nor are even the people of Lapland and the northern extremity of Norway conspicuous for such eating; as is not less true of the Icelanders*." Instead, therefore, of ascribing the gluttony of the inhabitants of frozen regions solely to the low temperature to which they are exposed, I consider it to be in part the result of an instinct or propensity exercised by some portion of the brain. Phrenologists place *alimentiveness*, or the *organ of the propensity to eat and drink*, "at the base of the middle lobe of the brain, adjoining and immediately below the situation occupied by the organ of destructiveness in carnivorous animals†." But while I entertain no doubt of the existence of such a propensity, I do not wish to offer any opinion as to the precise seat of it within the skull. To varying degrees in the power and activity of this propensity I ascribe the greater or less fondness for good living evinced by different individuals. It is well known that some persons are notorious, among their friends and acquaintances, for their gormandizing propensity, while others are commonly reputed as being little eaters.

by them before the noon of the following day. They continued, however, to eat all night, without sleep and without intermission, till they had finished the whole animal. After this, their lank bellies were distended to such a degree that they looked less like human creatures than before."

* Sir J. Ross, *op. supra cit.* p. 447.

† *A System of Phrenology, by George Combe*, p. 230, 4th ed. Edinb. 1836.

Similar differences are observed between different nations. "The great difference which exists between the French and Germans, in the organs of alimentiveness, accounts for the difference between the two nations in sobriety. After the Spaniards, no nation in Europe is more sober than the French; while the Germans are essentially great feeders. Among a pretty considerable number of German, Spanish, and French soldiers, who were in the same hospital at Caen, I have observed," says Dr. Vimont, "that a remarkable difference existed among them in regard to the faculty in question. A light soup, some fruit, or a little meat, were sufficient for the Spaniards; the repast of the French consisted of three-fourths of the portion; while the Germans swallowed the whole allowance, and continually complained that they did not receive enough of meat and potatoes. Every time I happened to pass the wards where the Germans were placed, I was certain to be assailed by the words *flesh, flesh, sir!*" *

Much less heat is evolved when there is a deficiency of food. "During the whole of our march," observes Sir John Franklin,† "we experienced, that no quantity of clothing could keep us warm while we fasted, but on those occasions on which we were enabled to go to bed with full stomachs, we passed the night in a warm and comfortable manner." In tropical climates, and even in cooler regions during the summer, a

* Dr. Vimont, quoted by Mr. G. Combe, in his *System of Phrenology*, p. 765.

† *Narrative of a Journey to the Shores of the Polar Sea, in the years* 1819 *to* 1822, p. 424. London, 1823.

smaller quantity of food suffices to keep up the temperature of the body, and under the same circumstances substances containing a less proportion of carbon are better adapted for the preservation of health.

The frequency of diseases of the liver, in hot seasons and tropical climates, is ascribed by Liebig to the accumulation of carbon in the system. "In our climate," he observes *, "hepatic diseases, or those arising from excess of carbon, prevail in summer; in winter, pulmonic diseases, or those arising from excess of oxygen, are more frequent."

When the external temperature is high, less carbon is requisite to support the natural heat of the body, and in consequence of the air being expanded, we inhale, at each inspiration, less oxygen by weight than in colder climates and seasons. If, therefore, we continue to consume large quantities of food, there will be an excess of carbonaceous matter in the system.

The influence of external temperature, excess of food, and want of exercise, on the condition of the liver, is well shewn in the goose. The celebrated *pâtés de foies gras*, prepared at Strasburg, are made of the livers of geese, artificially enlarged "by the cruel process of shutting the birds up in coops, within a room heated to a very high temperature, and stuffing them constantly with food †."

In tropical climates and in hot seasons the system requires a smaller quantity, and a less carbonaceous

* *Animal Chemistry*, p. 24.
† Murray's *Hand-Book for Travellers on the Continent: being a Guide through Holland, Belgium, Prussia, and Northern Germany*, p. 448. Lond. 1836.

quality, of food than in colder countries and cold seasons; and the frequent occurrence of hepatic disease among Europeans, who reside in tropical countries, is probably in part owing to their continued employment of a dietetical system fitted for colder climates.

2. Hydrogen.—Hydrogen, like carbon, is an essential constituent of every organised tissue; and is, in consequence, a necessary ingredient of the food of every living being, both vegetable and animal. The nutritive principles of seeds, the albumen and oil of eggs, and the sugar, the butter and caseine of milk, therefore, contain it.

Considered with respect to the quantity of hydrogen which they contain, alimentary principles may be arranged in three groups: the first containing those substances whose oxygen and hydrogen are in the same relative proportion as in water; the second, including those whose oxygen is to the hydrogen in a less proportion than in water, or which contain an excess of hydrogen; and the third, comprehending those whose oxygen is to the hydrogen in a proportion greater than is necessary to form water, or which possess an excess of oxygen.

RELATIVE QUANTITY OF HYDROGEN AND OXYGEN IN ALIMENTARY PRINCIPLES.

Group 1.—Principles whose oxygen and hydrogen are in the same ratio as in water.	Group 2.—Principles containing an excess of hydrogen.	Group 3.—Principles containing an excess of oxygen.
Acetic Acid	Oil	Pectine
Starch	Alcohol	Citric Acid
Sugar	Malic Acid	Tartaric Acid
Gum	Fibrine } Animal and Vegetable	
	Albumen } Animal and Vegetable	
	Caseine } Animal and Vegetable	
	Gluten	
	Gelatine	

Group 1. *Alimentary principles whose oxygen and hydrogen are in the same ratio as in water.* The substances of this group may be regarded as *hydrates of carbon*, since they consist of carbon and water (or its elements). Their composition is as follows:—

HYDRATES OF CARBON.

Acetic Acid	12 C + 9 Water
Starch	12 C + 10 Water
Cane Sugar	12 C + 10 Water + 1 Water
Gum	12 C + 10 Water + 1 Water
Sugar of Milk	12 C + 10 Water + 2 Water
Grape Sugar	12 C + 10 Water + 4 Water

It is obvious that these foods can yield carbon only to be oxidated in the system, since the hydrogen is already in combination with oxygen. This, therefore, is a sufficient explanation of the fact mentioned by Liebig, that the graminivorous animals expire a volume of carbonic acid equal to that of the oxygen inspired; in other words, there is no loss of oxygen, since one volume of carbonic acid gas contains a volume of oxygen.

2 eq. Oxygen =16	1 eq. Carbon =6	=	1 eq. Carbonic Acid =22

In a state of nature, a large proportion of the food of these animals consists of principles (starch, sugar, and gum) whose hydrogen is saturated with oxygen. In no other way can we account for the fact just referred to; for, as Liebig correctly observes, "at the temperature of the body, the affinity of hydrogen for oxygen far surpasses that of carbon for the same element," and, therefore, the return of an equal volume of

carbonic acid by expiration is an evidence that there was a want of hydrogen for the oxygen to combine with.

Group 2. *Alimentary principles, whose oxygen is to the hydrogen in a less proportion than in water, or which contain an excess of hydrogen.*—This group includes both nitrogenised and non-nitrogenised food. If we suppose the oxygen of these principles to be combined with hydrogen in the ratio to form water, there will remain, for each, an excess of hydrogen; the amount of which, however, varies in different substances. The following table, constructed on this view, shows the excess of hydrogen which each principle contains, the amount of carbon in each being calculated to be the same:—

ALIMENTARY PRINCIPLES CONTAINING EXCESS OF HYDROGEN.

Malic Acid (anhydrous)	=48 C + 18	Water + 6	H
Fat (Lard)	=48 C + 4.5	" + 38.5	H
Alcohol	=48 C + 24	" + 48	H
Proteine	=48 C + 14	" + 22	H + 6 N
Albumen	=48 C + 14	" + 22	H + 6 N + *S* + *P* *
Fibrine	=48 C + 14	" + 22	H + 6 N + 2 *S* + *P*
Caseine	=48 C + 14	" + 22	H + 6 N + *S*
Gelatinous tissues, tendons . . .	=48 C + 18	" + 23	H + 7.5 N
Chondrine	=48 C + 20	" + 20	H + 6 N

The ultimate changes which these constituents of food undergo in the system, are the conversion of the carbon into carbonic acid, and the hydrogen into water. "It signifies nothing," says Liebig, "what

* The letters *S* and *P* are not intended to express the absolute number of equivalents of sulphur and phosphorus, but only the relative proportions of these two elements to each other.

intermediate forms food may assume, what changes it may undergo in the body, the last change is uniformly the conversion of its carbon into carbonic acid, and of its hydrogen into water. The unassimilated hydrogen of the food, along with the unburned or unoxidised carbon, is expelled in the urine or in the solid excrements."

By the union of hydrogen with oxygen, and the consequent formation of water, a considerable degree of heat is developed. According to Despretz *, 1 lb. of hydrogen yields, by combustion with oxygen, sufficient heat to raise the temperature of 236.4 lbs. of water from 32° Fahr. to 212° Fahr.; weight for weight, therefore, hydrogen greatly exceeds carbon in its calorific power.

Part of the heat developed in carnivorous animals must arise from the oxidation of hydrogen; for, in the first place, hydrogen, (as of the fat) disappears from the system, and there is no other mode by which it can have done so except by union with oxygen, and its consequent conversion into water. In the second place, of the atmospheric oxygen taken into the lungs during inspiration, the whole is not found, in the inspired air, in union with carbon, nearly every experimenter having detected a loss †.

Bostock ‡ calculates that 45,000 cubic inches of

* Graham, *Elements of Chemistry*, p. 250.

† Messrs. Allen and Pepys (*Phil. Trans.* 1809, p. 404) ascribed the slight loss observed in their researches to some accidental circumstance, and inferred, therefore, that the oxygen which disappears is exactly replaced by an equal volume of carbonic acid.

‡ *Elementary System of Physiology*, vol. ii. p. 110. Lond. 1826.

oxygen gas are consumed in respiration by a man, under ordinary circumstances, in twenty-four hours; but that of this quantity only about 40,000 cubic inches are found in the expired air in combination with carbon. The remaining 5000 cubic inches must, therefore, be employed in the oxidation of other combustible matters (principally hydrogen) in the system.

Group 3. *Alimentary principles, whose oxygen is to the hydrogen in a proportion greater than is necessary to form water.*—None of the substances of this group, which includes pectine (vegetable jelly) and some vegetable acids, are nitrogenised. The following table represents the composition of these principles, on the supposition that the hydrogen is combined with oxygen, in the ratio to form water, the calculation being made for the same amount of carbon in each.:—

ALIMENTARY PRINCIPLES CONTAINING AN EXCESS OF OXYGEN.

Pectine	=12 C+17 Water+5 O
Citric Acid (dry) . .	=12 C+ 5 " +6 O
Tartaric Acid (dry) .	=12 C+ 6 " +9 O

All the hydrogen and part of the carbon of these principles are, therefore, in combination with oxygen.

3. Oxygen.—Of all undecompounded or elementary substances, none presents, to my mind, so much interest—a principle which constitutes not less than three-fourths of the known terraqueous globe *—

* The following calculations support the above statement:—Oxygen is a constituent of the *Atmosphere*, of the *Water*, and of the *Mineral Crust* of the globe. It constitutes $\frac{23}{100}$ by weight of the air, $\frac{8}{9}$ of the aqueous vapour, and $\frac{16}{22}$ of the carbonic acid of the atmosphere. Water, which covers $\frac{3}{4}$ of the globe, at an average depth of about three miles, contains $\frac{8}{9}$ of its weight of oxygen. Silica, carbonate of lime, and

which is concerned in almost every change that occurs among natural bodies—and which is so mysteriously connected with life, that without its never-ceasing influence all vital phenomena would speedily cease! As the continuance of the flame of a candle or lamp depends on the due supply of oxygen to the fat or the oil, and as, in the voltaic apparatus, an electric current is excited by the oxidisement of a metal, so animal life seems to be inseparably connected with the influence of oxygen on the organism. Interrupt the influence of oxygen and the flame is extinguished, the electric current is stopped, and all vital phenomena cease. In all three processes, matter (oil, zinc, organic substances) is destroyed or consumed by the oxygen. So that though oxygen be essential to life—though it be *vital air*—yet its ultimate effect is destructive; just as, in the lamp, it is the cause of the flame, but consumes the oil. "Man, and every other animal, are exposed at every period of their lives to the unceasing and destructive action of the atmosphere; with every breath he expires a part of his body, every moment of his life he produces carbonic acid, the carbon of which his food must replace."

Oxygen is a necessary ingredient of our food. The relative proportions of oxygen and hydrogen in different foods have been already alluded to (p. 21). The following table, taken from Liebig, gives the

alumina, the three most abundant constituents of the strata of the earth, contain nearly half their weight of oxygen. Mr. De la Beche (*Researches in Theoretical Geology*, p. 8.) calculates that silica alone constitutes 45 per cent. of the mineral crust of the globe, and of this one-half is oxygen.

relative proportions of carbon and oxygen in several alimentary principles:—

RELATIVE PROPORTIONS OF CARBON AND OXYGEN IN ALIMENTARY PRINCIPLES.

In Fats (on an average) .	120 equivalents	of Carbon	10 eq.	of Oxygen
In Fibrine, Albumen, and Caseine	120	"	36	"
In Starch	120	"	100	"
In Cane Sugar	120	"	110	"
In Gum	120	"	110	"
In Sugar of Milk . . .	120	"	120	"
In Grape Sugar	120	"	140	"

As the carbon and hydrogen of the food are ultimately, for the most part, thrown out of the system in combination with oxygen — that is, in the form of carbonic acid and water—it follows that those foods which contain a small proportion of oxygen only must consume a greater amount of atmospheric oxygen than those which possess a larger quantity of this element. It cannot be doubted, therefore, that the quality of the food must affect the activity of the function of respiration. This is quite in accordance with the results of experience. Mr. Spalding * a diver, found that he consumed more atmospheric oxygen in his diving-bell, when he had used a diet of animal food, or drank spirituous liquors; and experience, therefore, had taught him that vegetable food, and water for drink, were best adapted for the performance of the duties of his business. Dr. Fyfe † also found that the consumption of oxygen was greatly reduced by the employment of vegetable diet,

* See Dr. John Murray's *System of Materia Medica and Pharmacy*, vol. i. p. 509, 5th ed. Edinb. 1828.

† Quoted by Dr. Bostock, in his *Elementary System of Physiology*, vol. ii. p. 90. Lond. 1826.

though he differed from Mr. Spalding in his account of the effect of alcohol on the respiratory function.

The influence exercised by matters taken into the stomach on the process of respiration, is well illustrated in the case of the vegetable salts of potash or soda. If the acetate, citrate, or tartrate of either of these alkalies be swallowed, the salt suffers partial decomposition in its passage through the system. Its base can be detected in the urine; but its acid has disappeared, and is replaced by carbonic acid. To effect this change, a considerable quantity of oxygen must be consumed. In the case of acetate of potash, no less than eight equivalents of oxygen are required to convert the carbon of every atom of acetic acid into carbonic acid.

CONVERSION OF ACETIC ACID INTO CARBONIC ACID AND WATER.

1 eq. Acetic Acid	$C_4 O_3 H_3$	4 eq. Carbonic Acid	$C_4 O_8$
8 eq. Oxygen	— O_8 —	3 eq. Water . .	— $O_3 H_3$
Total . . .	$C_4 O_{11} H_3$	Total . . .	$C_4 O_{11} H_3$

When we take an ordinary effervescing draught composed of tartaric acid and bicarbonate of soda, there is developed, by their mutual reaction, tartrate of soda, which, in its passage through the system, suffers decomposition. Its tartaric acid disappears, and is converted into carbonic acid and water by means of oxygen.

CONVERSION OF TARTARIC ACID INTO CARBONIC ACID AND WATER.

1 eq. Tartaric Acid	$C_4 O_5 H_2$	4 eq. Carbonic Acid	$C_4 O_8$ —
5 eq. Oxygen . .	— O_5 —	2 eq. Water . . .	— $O_2 H_2$
Total	$C_4 O_{10} H_2$	Total	$C_4 O_{10} H_2$

Now the eight equivalents of oxygen in the first case, and the five equivalents in the latter instance, must be derived either from the organism or from the atmosphere. But, as Liebig justly observes, there is no evidence presented by the organism in itself that any of its constituents have yielded so large a quantity of oxygen; and we have a right, therefore, to infer that it must have been derived from the air; and that these salts, in their passage through the lungs, appropriate to themselves the necessary amount of oxygen. But do they appropriate that which, if they were not present, would be otherwise employed in the organism? Or do they consume an extra quantity of oxygen? We have no precise data on which we can satisfactorily answer this question. Liebig asserts, that they must consume a part of the oxygen, which would otherwise unite with the constituents of the blood; and "the immediate consequence," he observes, "of this must be the formation of arterial blood in less quantity; or, in other words, the process of respiration must be retarded." But it appears to me, that Liebig's conclusion is by no means a necessary one, and that on this, as on several other occasions, he has decided somewhat hastily, and written much too positively. I have already shown that the amount of oxygen, consumed by respiration, is modified by the quality of the food; and it is by no means improbable, therefore, that the passage of the above-mentioned salts through the lungs may occasion a temporary augmented consumption of oxygen; but the evidence for or against this notion is yet to be adduced.

4. NITROGEN *or* AZOTE.—Nitrogen is distinguished

from the three preceding substances, by the indifference which it manifests to enter into chemical combination with other bodies. It is an essential constituent of every animal tissue. Fat and water are non-nitrogenised components of the animal body, but they are not organised or living substances. It is obvious, therefore, that for the development, growth, nutrition, and renovation of living animal parts, nitrogen is essential; and accordingly we find, that nature has supplied it in the food which she has furnished for the nourishment of the young animal; it being a constituent of the albumen of the yolk of the egg (the food of the embryo chick), and of the caseine of the milk (the aliment of the young mammal).

A large number of vegetable and animal substances used as food contains no nitrogen. The following table shows the per-centage quantity of this element in various foods:

QUANTITY OF NITROGEN IN CERTAIN FOODS.

1. *In Alimentary Principles.*

		Per-Centage of Nitrogen.	Authority.
Proteine Compounds.	Animal Albumen (of eggs)	15.920	Scherer.
	Vegetable Albumen (of wheat)	15.920	Jones.
	Animal fibrine	15.817	Scherer.
	Vegetable fibrine	15.809	Ditto.
	Animal caseine	15.724	Ditto.
	Vegetable caseine	15.672	Ditto.
	Gluten	15.98	Jones.
Gelatinous.	Tendons of calves' feet	18.470	Scherer.
	Isinglass	18.790	Ditto.
	Cartilage of calves' ribs (chondrine)	14.908	Ditto.

2. *Compound Aliments.*

Wheat (dried *in vacuo* at 230° Fahr.)	2.3	Boussingault.
Rye (ditto)	1.7	Ditto.
Oats (ditto)	2.2	Ditto.
Barley (dried at 212°)	2.02	Ditto.
Rice (ditto)	1.39	Ditto.
Indian Corn or Maize (ditto)	2.0	Ditto.
Peas (dried *in vacuo* at 230° Fahr.)	4.2	Ditto.

Horse beans (dried at 212° Fahr.)	5.5	Boussingault.
White haricots (ditto)	4.3	Ditto.
Lentils (ditto)	4.4	Ditto.
Potatoes (fresh)	0.37	Ditto.
Ditto (dried at 212° Fahr.)	1.80	Ditto.
Ditto kept 10 months	0.28	Ditto.
Ditto (dried at 212° Fahr.)	1.18	Ditto.
Jerusalem artichokes (dried *in vacuo* at 230° Fah.)	1.6	Ditto.
White garden cabbage	0.28	Ditto.
Ditto (dried at 212° Fahr.)	3.70	Ditto.
Carrot (dried at 212° Fahr.)	2.40	Ditto.
Turnips	0.17	Ditto.
Ditto (dried at 212° Fahr.)	2.20	Ditto.
Dried ox blood	15.08	Bœckmann.
Dried muscular flesh (beef)	15.05	Ditto.
Roasted flesh (roe deer)	15.23	Ditto.
Ditto (beef)	15.214	Playfair.
Ditto (veal)	14.70	Ditto.

Several circumstances have induced recent writers to conclude that *nitrogenised foods* are alone capable of conversion into blood, and of forming organised tissues; that, in fact, they only are the foods properly so called. Hence Liebig has denominated them the *plastic elements of nutrition.* The *non-nitrogenised foods*, it is said, are incapable of transformation into blood, and are, therefore, unfitted for forming organised or living tissues. They are, nevertheless, essential to health; and Liebig asserts that their function is to support the process of respiration (by yielding carbon and hydrogen, the oxidation of which is attended with the development of heat), and some of them, he states, contribute to the formation of fat. These non-nitrogenised foods he calls *elements of respiration.*

Nitrogenised Foods, or Plastic Elements of Nutrition.	*Non-nitrogenised Foods, or Elements of Respiration.*	
Vegetable Fibrine	Fat	Pectine
——— Albumen	Starch	Bassorine
——— Caseine	Gum	Wine
Animal Flesh	Cane Sugar	Beer
——— Blood	Grape Sugar	Spirits
	Sugar of Milk	

I propose now to state briefly those circumstances which have been adduced in favour of the opinion, that nitrogenised foods alone nourish the tissues; offering, as I proceed, short commentaries on them.

1. The first argument is, that *as the animal tissues contain nitrogen as one of their essential constituents, and as this element cannot be created in the system, it must be derived from either the food or the atmosphere; but as it is not absorbed from the atmosphere in the vital process, it must be obtained from the food.*

It appears to me, that if it can be demonstrated that "no nitrogen is absorbed from the atmosphere," the most important fact in favour of nitrogenised food is obtained. But has this been satisfactorily done? I think not. Numerous researches have been undertaken by different persons to determine this point, but the results have been most discordant. Some of the experimenters have declared that the nitrogen of the air is passive in respiration; some have asserted that nitrogen is generated in the lungs; some that it is absorbed; others that it is both absorbed and exhaled—under certain circumstances absorption being most active, under others exhalation. What conclusions, then, it may be asked, have cautious, unbiassed, and well-informed physiologists drawn from these discrepant assertions? Müller, one of Liebig's countrymen, and the most distinguished physiologist of the age, observes that "The conclusion to be deduced from all these experiments seems to be, that during respiration nitrogen is both absorbed and exhaled by the blood."* Dr.

* Baly's Translation of Müller's *Elements of Physiology*, vol. i. p. 310. Lond. 1838.

Carpenter * concludes his account of the chemical phenomena of respiration with the following observation:—"Thus, there will be a continual exosmose of carbonic acid and nitrogen, and a continual endosmose of oxygen and nitrogen; and the relative quantities of these gases exhaled and absorbed will be subject to continual variation from secondary causes." Lastly, Dr. Bostock † observes, that "It is probable that the blood, as it passes through the lungs, both absorbs and exhales nitrogen, the proportion which these operations bear to each other being very variable, and depending upon certain states of the system, or upon the operation of external agents."

Thus, then, it appears that some of the best systematic physiological writers admit the absorption of nitrogen; and it is, therefore, somewhat remarkable that both Liebig and Dumas ‡ should make such positive and unqualified denials of it, without adducing some new facts in proof of the accuracy of their own views. Their opinions must, I presume, be founded on the experiments of Dulong § and Despretz. ‖ The first

* *Principles of Human Physiology*, p. 438. London, 1842.

† *Elementary System of Physiology*, vol. ii. p. 143. 1826.

‡ "Animals constantly exhale nitrogen," says M. Dumas (*Essai de Statique Chimique des Etres Organisés*, p. 36, 2[me]. ed. 1842). "I insist on this point," he adds, "in order to dispel one of those illusions, which, in my opinion, are among the most obnoxious to your studies. Some observers have admitted, in respiration, an absorption of nitrogen; but this is never observed except under circumstances which render it more than doubtful. The constant phenomenon is the exhalation of this gas, as Despretz has very correctly stated."

§ *Mémoire sur la Chaleur Animale*, read to the Academy of Sciences at Paris in 1822, but published in the 18th vol. of the *Mémoires* of the Academy in 1842.

‖ *Annales de Chimie et de Physique*, t. xxvi. p. 337. 1824.

of these philosophers has given an account of 17 experiments made on animals. In 14 cases he found that nitrogen was exhaled, in one that it was absorbed, in one that it underwent no change, and in one the result is not stated. Dulong, however, seemed to think that further experiments were required to verify these results; for he observes, that "the exhalation of nitrogen by the pulmonary surface was a phenomenon too remarkable to be passed over without an attempt being made to verify it in an indubitable manner; and I propose," he adds, "to make some special experiments for this purpose." With regard to Despretz's experiments, it is deserving of especial notice, that whenever his conclusions militate against the opinions of Liebig and Dumas, they offer sundry objections to his experiments and conclusions; but where the results of his investigations coincide with their opinions, no objections are made to his experiments.*

That animals frequently, if not generally, exhale nitrogen, can scarcely be denied; but the question is, whether, when animals are supplied with food which contains a quantity of nitrogen insufficient for the wants of the system, nitrogen may not then be absorbed by the lungs? This question, it appears to me, remains yet to be solved; and I am not, therefore,

* Liebig (*Animal Chemistry*, p. 37,) and Dumas (*op. supra cit.* p. 42, 85, *et seq.*) The first of these chemists concludes his objections to Despretz's experiments in these words:—"We can hardly be at a loss what value we ought to attach to the conclusions drawn from such experiments as those above described. These experiments, and the conclusions deduced from them, in short, are incapable of furnishing the smallest support to the opinion," &c. &c.

disposed to adopt Liebig's unqualified assertion that "no nitrogen is absorbed from the atmosphere;" the more especially as it is in opposition to the experiments of Priestley, Davy, Cuvier, Pfaff, Henderson, Spallanzani, Edwards, and others, and to the generally received opinions of physiologists. It appears to me to be completely begging the question. The establishment or rejection of the theory of nitrogenised foods is most essentially affected by the present argument; for should it be shown that nitrogen is absorbed by the lungs, we have then another source for the nitrogen of the tissues; while, on the other hand, if nitrogen be not absorbed, the tissues can obtain this element from the food only.*

But there is another source of nitrogen which has not been hitherto noticed,—I mean the ammonia of the atmosphere. Liebig has demonstrated the existence of this substance in the air, and has assigned strong reasons for believing that plants derive the nitrogen of

* Dr. Prout (*On the Nature and Treatment of Stomach and Urinary Diseases*, p. xxvi., 3rd ed. Lond. 1840) considers that both sugar and fat are convertible into nitrogenised animal substances. "That the oleaginous principle," he observes, "may be converted into most, if not all, the matters necessary for the existence of animal bodies, seems to be proved by the well-known fact, that the life of an animal may be prolonged by the appropriation of the oleaginous and other matters contained within its own body." In a foot note (p. xxvii.) he adds, "The azote may, in some instances, be derived from the air, or *generated.* But my belief is, that, under ordinary circumstances, the azote is principally furnished by a highly azotised substance (organised urea?) secreted from the blood, either into the stomach or duodenum, or into both these localities; and that the portion of the blood thus deprived of its azote is separated from the general mass of blood by the liver, as one of the constituents of the bile, which secretion, as a whole, is remarkably deficient in azote."

their nitrogenised principles from it. The ammonia of the inspired air may, therefore, be one of the sources from whence animals derive a part, small though it be, of the nitrogen of their system.

2. *The second argument is, that non-nitrogenised foods alone are incapable of supporting animal life.*

It has been found, by experiments on animals, that gum, sugar, starch, or butter, cannot alone preserve the health and life of animals. Magendie * found that dogs fed exclusively on sugar and water died in from thirty-one to thirty-four days; and similar results were obtained with butter and with gum. Tiedemann and Gmelin † have confirmed Magendie's statements. They found that geese fed on sugar and water, or gum and water, or starch and water, died in from sixteen to twenty-four days.

Magendie also states, in confirmation of the above, that in 1793, five sailors, on board the wreck of a vessel from Hamburgh, had subsisted for nine days on sugar and a small quantity of rum, and that they were found by a French vessel in a most debilitated state (the youngest excepted). The three oldest died shortly afterwards. He further adds, that an eccentric individual in Paris had subsisted for nearly a month on potatoes ‡ and water. At the end of this time he was extremely feeble, and passed an extraordinary quantity of urine; but by the use of nitrogenised

* *Ann. de Chim. et de Physique*, t. iii. p. 66. 1816.

† Quoted by Müller.

‡ Ten thousand parts of potatoes contain, according to Boussingault, only thirty-seven parts of nitrogen.

food he recovered in a few weeks. Sir Christopher Wren* also states, "that it was of late years found, that the blacks, who feed only on potatoes, were apt to die of the dropsy; and, therefore, the planters had found it necessary to allow them milk and bread, which prevented it." And he further observes, "that in Ireland, where the people feed much on potatoes, they help themselves, by drinking milk soured, to make the potatoes digest the better."

This second argument has not, however, much weight; since it is well known that an exclusive diet of nitrogenised alimentary principles (gluten excepted) is also incapable of supporting animal life. Fibrine, albumen, or gelatine, taken separately, does not support life: even the artificial mixture of these principles is insufficient to preserve life—for dogs thus fed, ultimately die with all the signs of complete inanition. While, on the other hand, a diet of muscular flesh, or of raw bones, or of gluten exclusively, is capable of complete and prolonged nutrition †.

It has been said, however, that both gum and sugar are capable of maintaining human existence. The asserted power of gum to support life rests principally on a story, told by Hasselquist ‡, of a caravan of more than one thousand persons, travelling from Abyssinia to Cairo, and whose provision being exhausted, supported themselves for two months on the gum they

* Birch's *History of the Royal Society of London*, vol. iv. p. 93.

† See the *Report of the Gelatine Committee*, in the *Comptes Rendus des Séances de l'Académie des Sciences*, No. V. Août, 1841.

‡ *Voyages and Travels in the Levant*, p. 298. Lond. 1766.

were carrying as merchandize. But there are no details given to satisfy us of the accuracy of the conclusion which has been drawn from it. Altogether the case is not one to be relied on. Of the use of gum by the Moors, Negroes, and Hottentots, we have but little detailed and satisfactory information.

The evidence of the nutritive property of sugar will be hereafter stated; but I may here mention that it applies principally to the use of this substance in an impure state, in which it contains nitrogenous matter *. Moreover, it is probable that nitrogenised food is, in general, used in combination with sugar.

3. The third argument is, that *the food of all animals, herbivorous and carnivorous, contains nitrogenised matters, identical in composition with the principal constituents of the blood and organised tissues of the animal body; and, therefore, the carbon of gum, sugar, and starch, and the carbon and hydrogen of the fats and oils, are not required for the production of blood.*

One of the most surprising facts for which we are indebted to the school of Giessen is, that vegetables contain organic principles identical in composition with animal fibrine, albumen, and caseine. "They are not merely similar," observes Liebig, "but absolutely identical, not only in having the same proportion of carbon, hydrogen, oxygen, and nitrogen, which

* An amusing illustration of this has been furnished by Liebig with respect to the saccharine juice of Maple trees, which he found to emit so much ammonia when mixed with lime, that suspicion was at first excited that some malicious wag had introduced urine into it; and, accordingly, the vessels, which hung upon the trees in order to collect the juice, were watched with great attention.

the animal principles contain, but also in possessing the same relative amount of sulphur, phosphorus, and phosphate of lime."

Fibrine, albumen, and caseine, both animal and vegetable, dissolve in a solution of caustic potash. If, to the resulting liquid, acetic acid be added, the same precipitate is obtained, whichever of the above three principles has been employed. The substance thus precipitated has been called, by its discoverer, Mulder, *proteine* (from πρωτεύω—*I hold the first place*). Its formula, according to Liebig, is $C_{48}\ H_{36}\ N_6\ O_{14}$*. Fibrine, albumen, and caseine, are compounds of proteine and sulphur, and, in the case of the two first of these bodies, of phosphorus also.

ANIMAL.		VEGETABLE.	
Fibrine .	=*Proteine* + S + Ph.	Fibrine .	=*Proteine* + S + Ph.
Albumen .	=*Proteine* + S^2 + Ph.	Albumen .	=*Proteine* + S^2 + Ph.
Caseine .	=*Proteine* + S	Caseine .	=*Proteine* + S

"Vegetable fibrine and animal fibrine, vegetable albumen and animal albumen, hardly differ," says Liebig, "even in form; if these principles be wanting in the food, the nutrition of the animal is arrested; and when they are present, the graminivorous animal obtains in its food the very same principles, on the presence of which the nutrition of the carnivora entirely depends."

* Dumas (*Essai de Statique Chimique des etres organisés*, p. 56., 2me ed. 1842.) gives the following as the formula for fibrine, albumen, and caseum: $C^{48}\ H^{39}\ N^6\ O^{15}$. This is equal to 48 eq. Carbon, 6 eq. Ammonium, and 15 eq. Water: he also states that the analyses made in Liebig's laboratory agree best with the following: $C^{48}\ H^{36}\ N^6\ O^{15}$, which is equal to 48 eq. Carbon, 3 eq. Ammonium, 3 eq. Ammonia, and 15 eq. Water.

4. The fourth argument is, that *the quantity of nitrogenised food, which herbivorous animals consume, is amply sufficient for the growth and development of their organs, and for the supply of waste.*

We are indebted to Boussingault * for the demonstration of the truth of this statement, in the case of the cow and the horse. The following table is taken from his memoir: the numbers represent French grammes [1 gramme=15.434 grs. troy.]

* *Ann. de Chim. et de Physique*, t. lxxi.

FOOD CONSUMED BY, AND EXCRETIONS OF, A HORSE IN TWENTY-FOUR HOURS.

FOOD CONSUMED BY A HORSE IN TWENTY-FOUR HOURS.								EXCRETIONS OF A HORSE IN TWENTY-FOUR HOURS.							
ARTICLES OF FOOD.	Weight in Fresh State.	Weight in Dry State.	Carbon.	Hydrogen.	Nitrogen.	Oxygen.	Salts and Earthy Matters.	EXCRETIONS.	Weight in Fresh State.	Weight in Dry State.	Carbon.	Hydrogen.	Nitrogen.	Oxygen.	Salts and Earthy Matters.
Hay . . .	7500	6465	2961.0	323.2	97.0	2502.0	581.8	Urine . .	1330	302	108.7	11.5	37.8	34.1	109.9
Oats . . .	2270	1927	977.0	123.3	42.4	707.2	77.1	Excrements	14250	3525	1364.2*	179.8	77.6	1328.9	574.6
Water . .	16000	..	..	..	..	..	13.3								
Total . .	25770	8392	3938.0	446.5	139.4	3209.2	672.2	Total . .	15580	3827	1472.9	191.3	115.4	1363.0	684.5
Deduct Excretions	15580	3827	1472.9	191.3	115.4	1363.0	684.5								
Excess of Food	10190	4565	2465.1	255.2	24.0	1846.2	..								
Excess of Excretions	..	..	.	..	..	..	12.3								

* In Boussingault's table the quantity of carbon contained in the excrements is stated to be 1364·4. This, however, is an error (as may be seen by referring to p. 134 of the 71st vol. of the *Annales de Chimie et Physique*).

Now it appears from this table, that after deducting the nitrogen of the urine and excrements from that contained in the food, the surplus quantity is 24 grammes ($370\frac{416}{1000}$ grs. troy); and if we assume that ordinary blood contains 80 per cent of water, and that the dry residue (20 per cent.) contains 15.07 per cent. of nitrogen, it follows that $370\frac{416}{1000}$ grs. troy of nitrogen are sufficient to form $2457\frac{9694}{10000}$ grs. troy of dried blood, or $12289\frac{847}{1000}$ grs. troy (equal to 1lb. 12ozs. 40grs. avoirdupois) of ordinary blood: in other words, about 1¾lb. avoirdupois of blood may be formed daily from the above quantity of food.

Moreover, 100 parts of dried blood contain 51.96 of carbon, and, therefore, $2457\frac{9694}{10000}$ grs. troy contain about 1277 grs. troy of carbon. If, therefore, we abstract the latter quantity from $38046\frac{4444}{10000}$ grs. troy (=2465.1 grammes), the residual carbon in Boussingault's table, we have $36369\frac{1935}{10000}$ grs. troy (5lbs. 3ozs. 56½grs. avoirdupois) of carbon to be thrown out of the system by the lungs and skin in the form of carbonic acid. Now Boussingault calculates that a horse expires daily 28078grs. troy (about 4lbs. avoirdupois) of carbon.

I have thus endeavoured to lay before my readers the opinions recently advanced with respect to the uses of nitrogenised and non-nitrogenised foods in the animal economy. These opinions may be thus briefly stated:—

1. Nitrogenised foods are alone capable of conversion into blood, and of forming organised tissues.

2. Nitrogenised foods which contain proteine, as albumen, fibrine, caseine, and gluten, alone form the albuminous and fibrinous tissues.

3. Gelatine is incapable of conversion into blood; but it may perhaps serve for the nutrition of the gelatinous tissues (cellular tissue, membrane, and cartilage).

4. Non-nitrogenised foods support the process of respiration by yielding carbon, and, in some cases, hydrogen, to be burnt in the lungs, and thereby to keep up the animal temperature.

5. Some of the non-nitrogenised foods contribute to the formation of fat, the carbon and hydrogen of which are ultimately burnt in the lungs, and thereby develope heat.

6. With the exception of the substance of cellular tissue, of membranes, and of the brain and nerves, all the organic materials of which the animal body is composed are derived from vegetables, which alone possess the property of producing compounds of proteine.

The evidence hitherto adduced, in favour of these opinions, I have already briefly noticed and criticised. I propose now to state a few circumstances which appear to me to raise some difficulties or objections to the unqualified admission of the opinions above referred to.

1. When benzoic acid, a non-nitrogenous substance, is taken into the stomach, it appears in the urine in the form of hippuric acid. For this fact we are indebted to Dr. Alexander Ure. This hippuric acid is probably formed by the elements of the benzoic acid, with the addition of those of lactate of urea.

1 eq. Urea . . .	C^2	N^2	H^4	O^2	2 eq. crystallised Hippuric Acid } C^{36} N^2 H^{19} O^{12}
1 eq. Lactic Acid	C^6	—	H^4	O^4	
1 eq. Benzoic Acid	C^{28}	—	H^{10}	O^6	
Total . .	C^{36}	N^2	H^{18}	O^{12}	

It cannot, therefore, be doubted, "that a non-azotised substance, taken in the food, can take a share, by means of its elements, in the act of transformation of the animal tissues, and in the formation of a secretion." Consequently, the possibility of the conversion of non-nitrogenised foods into nitrogenised constituents of the animal body does not appear by any means improbable.

2. Liebig's explanation of the uses of nitrogenised and non-nitrogenised foods does not account for the fact stated by the Commissioners of the French Academy,* that while fibrine, albumen, and gelatine, taken together or separately, are incapable of supporting animal life, gluten from wheat or maize is alone sufficient to satisfy complete and prolonged nutrition. As fibrine, albumen, and gluten, are said to be identical in composition, their nutritive powers ought to be equal.†

3. According to Liebig and Dumas, sugar is an element of respiration. Now as it can only reach the lungs by means of the blood, traces of it ought to be found in this fluid: yet it does not appear that sugar is a constituent of healthy blood. At least it has not hitherto been found in it, though $\frac{1}{10000}$th part of sugar added to blood can be readily detected.‡ This circumstance, therefore, seems rather to shew that sugar undergoes some complete change in its nature previous to its passage into the blood. Several facts favour this opinion. In the first place,—of the foods (viz. yolk of eggs, and milk), supplied by nature for the early stages of animal existence, sugar is found only in that food (milk) which undergoes digestion before its application to the purposes of the economy. Secondly, in diabetes, the digestive powers are greatly impaired, and saccharine assimilation is suspended. Sugar is then detected in the blood. Now it cannot be said that its presence is owing to any defect in the respiratory process, since fatty matter appears to suffer the ordinary changes in the pulmonary organs.

* *Comptes Rendus*, Août 1842.

† Tiedemann and Gmelin found it impossible to sustain the life of geese by means of boiled white of egg. "This," says Liebig, (*Animal Chemistry*, p. 106) "may be easily explained, when we reflect that a graminivorous animal, especially when deprived of free motion, cannot obtain, from the transformation or waste of the tissues alone, enough of carbon for the respiratory process. 2lbs. [Hessian] of albumen contain only 3½ oz. [Hessian] of carbon, of which, among the last products of transformation, a fourth part is given off in the form of uric acid.

‡ Trommer (*Pharmaceutisches Central-Blatt für* 1841, p. 764.)

4. According to Dr. Prout,* the contents of the stomachs of animals fed on vegetable substances, even when fully digested, and about to pass the pylorus, exhibit no traces of an albuminous principle; while the chymous mass of animals fed on animal food contains albumen.

COMPOSITION OF THE CHYMOUS MASS FROM THE DUODENUM OF THE DOG.

	Vegetable Food.	Animal Food.
Water	86·5	80·0
Chyme, &c.	6·0	15·8
Albuminous Matter	—	1·3
Biliary Principle	1·6	1·7
Vegetable Gluten?	5·0	—
Saline Matters	0·7	0·7
Insoluble Residuum	0.2	0·5
	100·0	100·0

* *Annals of Philosophy*, vol. xiii. 1819.

It would appear, therefore, that albumen is formed subsequently to the passage of the chyme into the duodenum. Now this is in complete contradiction to Liebig's statement, that albumen pre-exists in the vegetable food of the herbivora, and is not formed in the animal economy.* Dr. Prout's statement harmonizes well with another fact well known to physiologists, namely, the non-existence of fibrine in the contents of the duodenum, though, according to Liebig, this principle also pre-exists in the food of animals, and is not formed by them. It has even been said that the chyle contains no fibrine until after its passage through the mesenteric glands.†

5. If the nitrogenised substances requisite for the nutrition of the animal body exist ready formed in plants, the necessity of more complex organs of digestion for the herbivora than for the carnivora is not very obvious. Liebig‡ thinks that it "is rather owing to the difficulty of rendering soluble and available for the vital processes certain non-azotised compounds (gum? amylaceous fibre?) than to any thing in the change or transformation of vegetable fibrine, albumen, and caseine, into blood; since, for this latter purpose, the less complex digestive apparatus of the

* I have already (p. 35) noticed Dr. Prout's suggestion of the possible secretion of nitrogenised matter by the duodenum, for the purpose of converting non-nitrogenised foods into the nitrogenised constituents of the body.

† Gulliver (English Translation of Gerber's Anatomy, p. 94) says he has seen a distinct clot in the chyle of the afferent lacteals. In this case, therefore, fibrine must have been present.

‡ *Animal Chemistry*, p. 165.

carnivora is amply sufficient." But this suggestion is not a very satisfactory one. Gummy and amylaceous substances are eaten, and, apparently, digested, by some animals which are essentially carnivorous in the structure of their alimentary canal. Moreover, as the leading distinction in the food of the herbivora and carnivora consists in the use, by the former, of substances containing vegetable fibrine, albumen, and caseine, while the latter employ animal fibrine, albumen, and caseine,—it appears more natural to connect the peculiarity in the structure of the digestive organs with the nitrogenised, than with the non-nitrogenised, food.

6. No plausible explanation has hitherto been offered, by Liebig, or others, of the necessity for the variation of diet, and for the use of succulent vegetables or fruits, which experience has shewn to be necessary for the preservation of human health and life. Liebig has shewn that food must contain both a plastic element of nutrition and an element of respiration; but it is well known that a diet (as of salt meat and biscuit), which fulfils both of these conditions, is not always sufficient to preserve health and life.

It cannot be a matter of doubt that non-nitrogenised substances are intended by nature to constitute part of the food of man and other animals, but especially of the herbivora, since we find them in the aliments supplied by nature for animals during the first period of their existence. Thus, in the yolk of egg (the food of the embryo chick) we find fixed oil,—and in milk we have sugar and butter, both non-nitrogenous principles. If to these proofs we further add the fondness of animals for non-nitrogenised substances, the craving, nay almost insatiable desire, for them, manifested by individuals who are deprived of them, and the fact before mentioned, that nitrogenised food alone cannot support life, not a doubt can remain in our minds that these principles are essential to health and life.

In commencing our enquiry, then, into the particular purpose they serve in the animal economy, I would observe, in the first place, that with the exception of fat, none of them are constituents of the animal system; nor in a state of health are they found in the blood* or the excretions. It is obvious, therefore, that they must suffer some change or transformation in the organism. Now they all consist of carbon, hydrogen, and oxygen. In starch, sugar, and gum, the hydrogen and oxygen are exactly in the ratio to form water. Do they, therefore, contribute carbon, and in some cases, hydrogen also, to assist in the formation of blood? Liebig asserts they do not, for he observes that as the nitrogenised principles used as food contain exactly the "amount of carbon [and hydrogen] which is required for the production of fibrine and albumen," it follows that the carbon of gum, sugar, and starch, and the carbon and hydrogen of butter and other fats, cannot "be employed in the production of blood." If the nitrogenised principles contained less carbon than albumen and fibrine, then starch, sugar, gum, and fat, might give up some carbon to compen-

* "Hitherto grape sugar has not been detected in the blood, though $\frac{1}{10000}$ part of it, added to blood, can be readily detected" (Trommer, *Pharmaceutisches Central-Blatt für* 1841, p. 764).

sate the difference. He, therefore, concludes, that these bodies yield their carbon, and, when their hydrogen is in excess to their oxygen, part of their hydrogen also, to form, with atmospheric oxygen, carbonic acid and water, and, therefore, to develope heat. They serve to protect the organism from the action of the oxygen, which, in the absence of food, consumes the tissues. "If," says Liebig, "we observe a man or other animal in sickness, or at any time when the body is not supplied with nourishment to compensate for the continual loss, we find him to become lean; the fat is the first to disappear, it vanishes through the skin and lungs in the form of carbonic acid and water, as none of it can be found in the fæces or urine: it resists the action of the atmosphere on the body, and is a protection to the organs. But the action of the atmosphere does not end with the loss of fat: every soluble substance of the body enters into combination with the oxygen of the air. The influence of the oxygen of the atmosphere is the cause of death in most chronic diseases; from want of carbon to resist its action, that of the nerves and brain is used. In a normal state of health and nutrition, the carbon of the carbonic acid must have another source." Thus, then, it would appear that nitrogenised aliments alone are assimilated: the non-nitrogenous ones are burnt in the lungs.

But it may be asked, why, if both sugar and fat serve merely for combustion in the lungs, are both of these principles contained in the milk, since, theoretically, one of them would appear to be sufficient? Moreover, if sugar be burnt in the lungs, is it not remarkable that, as I have already stated (p. 48), it has not, in the healthy system, been detected while in its passage from the digestive organs to the lungs? Surely some traces of it ought to be recognizable in the blood? Hitherto, however, none have been found. Does not this fact seem to shew that it undergoes some transmutation during digestion, different to that which fatty substances suffer? The yolk of the egg serves directly for the nourishment of the embryo chick, but it contains one non-nitrogenised organic principle (oil) only. But milk, which also serves for animal food, contains two (butter and sugar). Now milk requires to be digested before it can be assimilated: whereas yolk of egg does not,—in fact, it serves for food before the digestive organs are developed. This fact, therefore, favours the notion that sugar is in some way connected with the digestive process.

Alcohol is classed among the elements of respiration; and it cannot be doubted that it undergoes some change in the animal economy. When taken into the stomach it is absorbed, and gets into the circulating mass. Now, how does it get out of the system? Certainly not by the bowels, urine, or skin. A portion of it escapes by the lungs, and is recognizable by its odour in the breath; but the quantity in this way thrown out of the system is comparatively small, and is certainly quite disproportionate to that often swallowed. Moreover, it is principally when the quantity taken is very large that it is most recognizable in the breath;—when, in fact, the function of respiration is very imperfectly performed. What, then, becomes of it? By itself it cannot form tissues, since it is

deficient in some of their essential ingredients, namely, nitrogen, sulphur, and phosphorus; and there is no reason to suppose that it contributes, even in part, to the renovation of tissues. Liebig's suggestion, that it is burnt in the lungs, and thereby converted into carbonic acid and water, appears to me a very plausible one. Now, to convert it into these substances, it merely requires oxygen.

CONVERSION OF ALCOHOL INTO CARBONIC ACID AND WATER.

Alcohol . . .	$C^4 H^6 O^2$	Carbonic Acid .	$C^4 — O^8$
Oxygen . . .	$— — O^{12}$	Water	$— H^6 O^6$
Total . . .	$C^4 H^6 O^{14}$	Total . . .	$C^4 H^6 O^{14}$

By its oxidation in the lungs it must evolve caloric, and thus, when used in moderation, it serves to support the temperature of the body. This use of it in the animal system appears to have been quite overlooked by the *Temperance* and *Tee-total Societies.*

Alcohol, therefore, is a fuel in the animal economy, by the combustion of which caloric is evolved. Common experience favours this view. Coachmen and others take it in cold weather to keep them warm, and it is familiarly used to prevent what is commonly called "catching cold." In cases of extreme suffering and exhaustion from excessive exertion and privation of food, the cautious and moderate dietetical use of spirit has, on many occasions, proved invaluable. In Captain Bligh's account* of the sufferings of himself and companions, in consequence of the mutiny of the crew of the Bounty, he observes, "The little rum we

* *Voyage to the South Seas* in 1787-9, p. 190. Lond. 1792.

had was of great service: when our nights were particularly distressing, I generally served a tea-spoonful or two to each person: and it was joyful tidings when they heard of my intentions." It is said, that the inhabitants of colder climates take more spirit than others, and with less injury. Liebig accounts for this by saying that they inhale a more condensed air, that is, they take in more oxygen at every inspiration; combustion is more rapid in them, and thus the elements of the alcohol are more speedily got rid of*.

I trust that in offering these remarks on the effects of alcohol, I may not be misunderstood. I do not wish to cast any reflections on the Societies before referred to, whose motives I highly esteem, and whose objects I would gladly promote. Though alcohol evolves heat in burning, it is an obnoxious fuel. Its volatility, and the facility with which it permeates membranes and tissues, enable it to be rapidly absorbed; and when it gets into the blood it exerts a most injurious operation, before it is burnt in the lungs, on the brain and the liver†. Though by its combustion heat is evolved, yet, under ordinary circumstances, there are other better, safer, and less injurious combustibles to be burned in the vital lamp.

Some of these non-nitrogenised foods serve another

* The Highlanders, who it is well known are immoderate drinkers, pretend that spirit does not intoxicate in the Hills as it would do in the Low Country. (See *Letters from a Gentleman in the North of Scotland to his Friend in London*, vol. ii. p. 161, 5th Ed. Lond. 1818).

† Alcohol acts on the stomach before it is absorbed. Its operation on the brain and liver are probably referable to its topical action on these organs after it gets into the blood; for it has been detected both in the brain and liver of those who have died under its influence. (See my *Elements of Materia Medica*, vol. i. p. 359, 2d edit.)

purpose in the animal economy—*they contribute to the formation of fat.* When the quantity of these foods taken into the stomach is great, that is, out of proportion to the quantity of oxygen absorbed by the lungs, fat is, under some circumstances, formed. Sugar, starch, and gum, become, by the loss of part of their oxygen, fat; for the relative proportion of their carbon and hydrogen is almost identical with that of fat.

RELATIVE PROPORTIONS OF CARBON AND HYDROGEN IN SOME NON-NITROGENISED PRINCIPLES.

Starch contains . .	79	Carbon	to	10·99	Hydrogen
Sugar	79	—	"	11·80	—
Gum	79	—	"	11·80	—
Mutton fat	79	—	"	11·1	—
Human fat	79	—	"	11·4	—
Hog's lard	79	—	"	11·7	—

Some facts adduced by Liebig are almost conclusive that starch and sugar may become converted into fat in the animal economy. A lean goose, weighing 4lbs. gained, in thirty-six days, during which it was fed with 24lbs. of maize, 5lbs. in weight, and yielded 3½lbs. of fat. Now this fat could not have been contained in the food ready formed, because maize does not contain the thousandth part of its weight of fat, or of any substances resembling fat. A certain number of bees, the weight of which was exactly known, were fed with pure honey devoid of wax. They yielded one part of wax for every twenty parts of honey consumed, without any change being perceptible in their health or in their weight. I agree with Liebig, that with these facts before us, " it is impossible any longer to entertain doubt as to the formation of fat from sugar in the animal body*."

* The mode of promoting obesity, practised in certain parts of the

Now, alcohol is an element of respiration. Does it form fat? I think not. In the first place, its carbon and hydrogen are not in the ratio of those of fat, for it contains 79 parts of Carbon to 19·74 of Hydrogen. Secondly, we do not find that spirit-drinkers are fat; but, on the contrary, emaciated. Hogarth, in his *Beer Alley* and *Gin Lane*, has ludicrously though faithfully represented the differences in the appearance of beer topers and spirit tipplers. The first are plump, rubicund, and bloated; the latter are pale, tottering, emaciated, and miserable.

But, it may be asked, what is the use of fat in the animal economy? It is a reservoir of food. During long fasting and hybernation it is absorbed and consumed. It is the food apparently on which the animal, at these times, exists. Is it then capable of renovating the tissues; and, if so, where does it derive the necessary quantity of nitrogen? Liebig asserts that it does not renovate. It merely yields, he says, carbon and hydrogen to be burnt in the lungs, by which the animal temperature is supported without the living organs being oxidised and destroyed. Dr. Prout, on the other hand, as I have already stated (p. 35), believes that fat may be converted into most,

world, lends support to the above statements. If "we can trust to the reports of physicians who have resided in the East," says Liebig, "the Turkish women, in their diet of rice, and in the frequent use of enemata of strong soup, have united the conditions necessary for the formation both of cellular tissue and fat." M. Caullet de Vaumoral, quoted by Mrs. Walker (*Female Beauty*, p. 171. Lond. 1837), states that in the Bey's Seraglio at Tripoli, women are fattened against a certain day by means of repose and baths, assisted by a diet of Turkish flour, mixed with honey. Fifteen days, he says, were sufficient for the purpose.

if not all, the matters necessary for the existence of animal bodies.

Nutritive equivalents.—Several writers have endeavoured to form a scale of nutritive equivalents, the value of which, if accurate, will be universally admitted. Boussingault has suggested one, founded on the quantity of nitrogen contained in foods.

BOUSSINGAULT'S SCALE OF NUTRITIVE EQUIVALENTS.

Substances.	Equivts.	Substances.	Equivts.
Wheat-flour	100	White haricots . . .	56
Wheat.	107	Lentils	57
Barley-meal	119	White garden cabbage .	810
Barley	130	Ditto, dried at 212° . .	83
Oats	117	Potatoes	613
Rye	111	Ditto, kept 10 months .	894
Rice	177	Ditto, dried at 212° . .	126
Buck-wheat	108	Carrot.	757
Maize, or Indian corn .	138	Ditto, dried at 212° . .	95
Horse-beans	44	Jerusalem artichoke . .	539
Peas	67	Turnips	1335

It will be observed, that in this table 44 parts of horse-beans, or 67 of peas, are represented as being equal in nutritive power to 100 parts of wheat-flour. Surely, this cannot be correct? Liebig admits, that though lentils, beans, and peas, surpass all other vegetable food in the quantity of nitrogen they contain, yet that they possess but small value as articles of nourishment, because they are deficient in the component parts of the bones (subphosphate of lime and magnesia); they satisfy the appetite without increasing the strength. If this explanation be correct, it suggests the use of bone-ashes with either horse-beans or peas, as constituting a most nutritive and economical food.

It may be objected that all nitrogenised vegetable principles are not nutritive, for the most powerful of the vegetable poisons, as the vegetable alkalies, are nitrogenised *; and, therefore, the presence of such substances would lower the nutritive equivalent. Moreover, rain water contains ammonia, which being contained in the vegetable juices, would lead to an erroneous estimate of the nutritive value of many plants. Boussingault has met the first of these objections by observing, that these violent poisons are not found in appreciable quantity in alimentary plants; and, therefore, a vegetable substance which has been accepted as animal nourishment may be inferred to be devoid of any hurtful principle.

But this assertion must be received with considerable limitation. The *solanina* of potatoes, the *sulphosinapisin* of white mustard, and the *myronic acid* of black mustard, are nitrogenised, though not nutritive, principles, which occur in substances used as food, and

* Liebig asserts that all the [vegetable] poisons contain nitrogen. But *anthiarin*, the active principle of the Upas poison, is devoid of it. Moreover, *elaterin* is a non-nitrogenised principle. Furthermore, no ratio can be observed between the proportion of nitrogen and the physiological effect of the vegetable nitrogenised substances. Thus, *solanina* contains 1·64, picrotoxine 1·3, morphia about 5, strychnia about 8, quina 8·64, and caffeine 28·78, per cent. of nitrogen; yet solanina is a poison, caffeine not so. Lastly, the difference between the per centage composition of quina and strychnia is too slight to admit of safe conclusions being drawn as to the cause of the difference of operation of those two bodies.

Carbon	74·08	76·08
Hydrogen	7·40	6·63
Nitrogen	8·64	8·07
Oxygen	9·88	9·22
	100·00	100·00

whose presence must erroneously lower the nutritive equivalent; that is, raise the estimated nutritive value of the substances in which they are respectively contained. And if we were to apply Boussingault's principle to animal substances, we should in the outset meet a difficulty, in the case of gelatine*, which contains a larger amount of nitrogen than either flesh or blood, but which, according to Liebig, is capable of nourishing the gelatinous tissues only.

But, notwithstanding these and other drawbacks to its accuracy, this mode of forming a scale of nutritive equivalents is of great interest and value, on account of the extreme difficulty of arriving at correct results by practical methods.

5. Phosphorus.—This is a constituent of both animals and vegetables. It is an essential ingredient of albumen and fibrine, and of all tissues composed of those principles. Nervous matter also contains it. Its existence in the brain has been long known. In 1834, Couerbe† advanced an absurd notion, that the

* The reader is referred to the *Comptes Rendus des Séances de l'Académie des Sciences*, Août, 1841, for the *Report made by the Gelatine Committee.* This report is the result of ten years' labour. The reporter (M. Magendie) shows that though raw bones are capable of effecting the complete and prolonged nutrition of dogs, yet that there is no process known for extracting from bones an aliment which, either alone, or mixed with other substances, can be substituted for meat. He also infers that—as gelatine, albumen, or fibrine, separately or artificially combined, are incapable of permanently nourishing; while flesh, which consists of gelatine, albumen, fibrine, fat, salts, &c. combined according to laws of organic nature, suffices, even in small quantity, for complete and prolonged nutrition—it is the "organic condition" which forms such an important element in this process.

† *Ann. de Chim. et de Physique*, p. 190. 1834.

healthy or morbid conditions of the mental faculties were connected with variations in the amount of this substance in the cerebral matter. "In the brains of sane men," says he, "I have found from 2 to 2·5 per cent. of phosphorus; in those of idiots only 1 or 1·5; while in those of madmen there are from 3 to 4·5 per cent.!" It is scarcely necessary to say, that the accuracy of this assertion has been disproved; and Lassaigne* fixes the amount of phosphorus in the brains of madmen at from 1·93 to 1·97 per cent.

The bones also contain phosphorus, which exists in them in combination with oxygen and lime principally, constituting a sub-phosphate of lime (*bone ash*).

Phosphorus is also a constituent of the sexual apparatus. It is found in the spermatic fluid, and in the ovary.

As it is thus a necessary ingredient of the animal body, it must, of course, be an element of the food of animals. Thus it is a constituent of the yolk of eggs, the food of the embryo chick. "One great use of the yolk," says Dr. Prout,† "evidently is to furnish the phosphorus, entering as phosphoric acid, into the skeleton of the animal." In milk, (the aliment of young mammals) it is also a constant ingredient, existing as sub-phosphate of lime.

It is a constituent of the blood, the flesh, and the bones of animals employed by man as food. In the bones it exists, as I have just stated, in the form of

* *Journ. de Chim. Méd.* t. 1er, IIe Série, p. 344. 1835.
† *Phil. Trans.* for 1822, p. 388-9.

subphosphate of lime, which salt is also found in the blood and flesh. But fibrine and albumen, both of them constituents of blood and flesh, contain phosphorus. In what state, it may be asked, does it exist in these organic principles? When separated by an alkali (potash), it is found as phosphorus or phosphoric acid. Now it has been supposed that the oxygen of this acid was derived from the potash, the potassium of which combined with the sulphur found in both fibrine and albumen. But caseine yields equally sulphuret of potassium when treated with caustic potash, although it contains no phosphorus to abstract the oxygen. Hence, then, it is not known precisely in what form phosphorus exists in fibrine and albumen. Fishes are especially rich in phosphoric matter; a fact which explains the circumstance related by Dumas*, of the evolution of phosphuretted hydrogen in the purification of spirit which had been used for preserving fish. I have frequently recognised a powerful phosphoric odour in the breath of patients. I have noticed that it occurs after certain kinds of foods, as lobster and crab. I have also met with it after the use of some Indian condiments.

Phosphorus is a constituent of most vegetable substances, being found in the ashes of plants, principally in the form of an earthy phosphate (lime or magnesia). "The soil in which plants grow furnishes them with phosphoric acid, and they in turn yield it to animals, to be used in the formation of their bones, and of those constituents of the brain which contain phos-

* *Traité de Chimie appliquée aux Arts*, t. i. p. 266.

phorus. Much more phosphorus is thus afforded to the body than it requires, when flesh, bread, fruit, and husks of grain, are used for food, and this excess is eliminated in the urine and the solid excrements. We may form an idea of the quantity of phosphate of magnesia contained in grain, when we consider that the concretions in the cæcum of horses consist of phosphate of magnesia and ammonia, which must have been obtained from the hay and oats consumed as food."* The concretions (*hippolithi*) here referred to sometimes attain the size of a child's head. Several of this magnitude are contained in the Anatomical Museum of the London Hospital. I have one weighing between five and six pounds. Ammoniacal phosphate of magnesia "is an invariable constituent of the seeds of all the grasses. It is contained in the outer horny husk, and is introduced into bread along with the flour, and also into beer. The bran of flour contains the greatest quantity of it." "When ammonia is mixed with beer, the same salt separates as a white precipitate†."

"The small quantity of phosphates which the seeds of the lentils, beans, and peas, contain, must be the cause of their small value as articles of nourishment, since they surpass all other vegetable food in the quantity of nitrogen which enters into their composition. But as the component parts of the bones

* Liebig, *Chemistry in its Application to Agriculture and Physiology*, p. 145.

† *Op. supra cit.* p. 92.

(phosphate of lime and magnesia) are absent, they satisfy the appetite without increasing the strength*."

Unrefined sugar contains an earthy phosphate; for the crust, which is deposited in the boilers used for refining sugar, contains, according to Avequin†, no less than 92·43 per cent. of sub-phosphate of lime. "Phosphate of magnesia and ammonia forms the principal inorganic constituent of the potatoe‡."

The following table shows the quantity of phosphorus contained in some alimentary substances :—

QUANTITY OF PHOSPHORUS IN CERTAIN FOODS.

1000 Parts.	Quantity of Phosphorus.	Authority §.
Fibrine (dried) . . . . } Albumen of eggs (dried) . . . }	4·3 to 3·2	Mulder ‖.
Albumen of serum of blood (dried)	3·3	Mulder.
Vegetable fibrine . . . . . } ——— albumen . . . . . }	as animal fibrine and albumen	Liebig.
Cerebric acid (in brain)	9	Fremy ¶.
Oleophosphoric acid (in brain) . .	12 to 19	Ditto.
Caseine	13·2	Berzelius **.
Bones of Sheep's feet	27·3	French Commis^{on}. ††
——— Ox's head	72·	Ditto.
Milk	0·56	Berzelius.
Blood (average)	0·143	Denis ‡‡.
Potatoes (dried)	2·5	Einhoff ‖‖.

* Ibid. p. 147.

† *Journal de Pharmacie*, t. xxvii. p. 15.

‡ Liebig, *op. supra cit.* p. 205.

§ Several of the authorities quoted in this table merely state the quantity of phosphates present; I have, therefore, calculated the quantity of phosphorus present on the assumption that 100 parts of the earthy phosphates are equal to 22 parts of phosphorus.

‖ *Pharmaceutisches Central-Blatt für* 1838, p. 885.

¶ *Journal de Pharmacie*, t. xxvii. p. 453, 1841.

** *Traité de Chimie*, t. vii. p. 606.

†† *Comptes Rendus des Séances de l'Academie des Sciences*, Août, 1841.

‡‡ *Essai sur l'Application de la Chimie à l'Etude physiologique du Sang de l'Homme*, p. 211—244.

‖‖ Thomson's *Chemistry of Organic Bodies—Vegetables*, p. 840.

1000 Parts.	Quantity of Phosphorus.	Authority.
Wheat	from 0·792 to 1·98	Hermbstaedt*.
Rye	1·32 to 9·196	
Barley	0·22 to 1·32	
Oats	0·352 to 1·32	
Rice	0·286 to 0·88	
Garlic	0.242	

6. SULPHUR. — Sulphur is a constituent of both animals and vegetables. Fibrine and albumen, and all tissues composed of these substances, contain it. A solution of flesh in liquor potassæ contains sulphuret of potassium; and if hydrochloric acid be added to it, sulphuretted hydrogen is evolved, and is detected by its staining paper moistened with a solution of sugar of lead. The discoloration which a silver spoon suffers by being used in eating eggs, depends on the formation of sulphuret of silver. It is probable, therefore, that the sulphur of both fibrine and albumen is uncombined with oxgen. If some white of egg, boiled hard, be decomposed by heat, it evolves hydrosulphuret of ammonia, which discolours paper moistened with sugar of lead. Caseine also contains sulphur, as do likewise hair and bones. The efficacy of a mixture of finely powdered litharge (oxide of lead) and lime *(hair dye)* in staining the hair, depends on the formation of the black sulphuret of lead. The lime serves to form, in the first place, a sulphuret of calcium with the sulphur of the hair. The lead afterwards unites with the sulphur. Animal

* *Anleitung zur chemischen Zergliederung der Vegetabilien überhaupt und der Getreidearten insbesondere.* Leipzig, 1831. The nature of the manure modifies the quantity of earthy phosphates found in corn.

charcoal *(bone black)* evolves sulphuretted hydrogen, when treated with hydrochloric acid, showing that sulphur was a constituent of bones.

The existence of sulphur in so many animal substances, serves to explain the evolution of sulphuretted hydrogen and hydrosulphuret of ammonia, by putrifying animal substances; excrement, for example. Indeed, so much sulphur is obtained in this way, that some geologists have considered it to be a source of, at least part of, the native sulphur of the mineral kingdom *. That sulphuretted hydrogen is evolved in privies is proved by its darkening the white paint, and by its blackening silver articles (watches, coin, spoons, &c.) which have accidentally fallen into the night soil. Game, when very high, will sometimes discolour the silver fork used in eating it.

Sulphur is thrown out of the system in various excretions. Thus, the urine contains sulphates, in part formed by the action of the oxygen of the arterial blood on the sulphur of the metamorphosed tissues. In the saliva there is found an alkaline sulphocyanide; and in consequence of the presence of this salt, the saliva possesses the property of reddening the sesquisalts of iron. The sulphuretted hydrogen

* Brocchi, quoted by Leonhard in his *Handbuch der Oryktognosie*, p. 599, Heidelberg, 1826. When the gate St. Antoine at Paris was pulled down in 1778, there were found in the ditches of that place, where many years (300?) previously excrement had been deposited, grains and crystals of sulphur deposited on lime. (Fougeroux de Bondarey, *Mem. de l'Academie Royale des Sciences*, Anneé 1780, p. 105.) It is stated in the *Athenæum*, (Dec. 1, 1838, p. 860), that Maravigno "disputes the assertions of Prof. Gemellaro, who pretends that sulphur owes its origin to the decomposition of mollusca."

found in the alimentary canal is perhaps often produced by the action of decomposing organic matters on sulphates *.

Metallic matter kept in the mouth becomes discoloured by the action of sulphur on it. Thus the gold plates used to support artificial teeth, and the amalgam of silver, sometimes employed to fill the hollows of decayed teeth, become incrusted with a film of metallic sulphuret. Moreover, the leaden blue line, which borders the edges of the gums attached to the necks of the teeth, in persons whose constitutions are under the influence of lead†, is probably sulphuret of lead.

* An eminent chemical philosopher tells me that he is always much troubled with the evolution of this gas after the use of sulphate of magnesia (Epsom salts.) That organic matter, in a state of decomposition, possesses the power of decomposing sulphates, is now fully established. Many years since, my friend, Mr. Pepys, (*Trans. of the Geological Society*, vol. i. p. 399) shewed that by the mutual action of animal matter, and a solution of sulphate of iron, the latter is de-oxidated, sulphur, sulphuret of iron, and black oxide of iron, being formed. My friend, Professor Daniell, (*Lond. Edinb. and Dub. Phil. Mag.*, July, 1841) has also shewn that alkaline sulphates are decomposed by decomposing organic matters. From his statements it appears that the waters upon the western coast of Africa, to an extent of 40,000 square miles, are impregnated with sulphuretted hydrogen, to an amount, in some places, exceeding that of some of the most celebrated sulphur springs in the world; and he suggests that the existence of this deleterious gas in the atmosphere, which must necessarily accompany its solution in the waters, may be connected with the awful miasma which has hitherto proved fatal to the explorers and settlers of the deadly shores of Africa, as well as of other places. The origin of the sulphuretted hydrogen of sea and some other waters, has been ascribed by Dr. Marcet (*Phil. Trans.*, 1819, p. 195), Mr. Malcolmson (*Trans. of the Geological Society*, 2nd Ser., vol. v., p. 564, Lond. 1840), Dr. A. Fontan (*Ann. de Chim. et de Physique*, July 1840), and Professor Daniell, to the decomposition of sulphates contained in the water, by putrifying vegetable matter.

† See Dr. Burton's paper on this subject, in the *Medico-Chirurgical Transactions*, 2nd Series, vol. v. p. 63. 1840.

The system derives its sulphur from animal, vegetable, and mineral substances, used as food. Thus flesh, eggs, and milk, contain it. Vegetable fibrine (as of corn), vegetable albumen (as of almonds, nuts, cauliflowers, asparagus, and turnips), and vegetable caseine (as of peas and beans), contain it. Lastly, sulphur, in the form of sulphate of lime, is a constituent of common and spring water.

Celery, rice, hops, ginger, and many other vegetable substances, contain sulphur. Though most culinary vegetables contain sulphur, yet in the *Cruciferæ* it is especially abundant. Asafœtida, which contains sulphur, is sometimes used as a condiment; and is considered by some oriental nations as *"food for the gods."* *

An infusion of *white* mustard strikes a blood-red colour with the persalts of iron, owing to the presence of sulphosinapisine. By this character white mustard is readily distinguished from black mustard. Both kinds of mustard-flour charred in a tube evolve a sulphuretted vapour, which blackens paper moistened with a solution of acetate of lead. In the same way sulphur may be detected in cabbage, potatoes, and many other vegetable foods. If peas or almonds be boiled in a solution of caustic potash, and then hydrochloric acid be added, the evolved vapour blackens paper moistened with a solution of lead, thus showing that these seeds contained sulphur.

* See my *Elements of Materia Medica*, vol. ii. p. 1456, et seq. 2d edit. Also Burnes's *Travels*, vol. i. p. 143; and vol. ii. p. 243.

The quantity of sulphur contained in various alimentary substances is as follows *:—

TABLE OF THE QUANTITY OF SULPHUR IN SOME ALIMENTARY SUBSTANCES.

1000 *Parts of*	*Quantity of Sulphur.*	*Authority.*
Fibrine / Albumen of eggs (*oralbumen*)	From 3·6 to 3·8	Mulder.
Albumen of blood (*seralbumen*)	6·8	Ditto.
Caseine	3·6	Ditto.
Vegetable fibrine / —— albumen / —— caseine	as animal fibrine, albumen, and caseine	Liebig.
Volatile oil of black mustard	204·8	
Sulphosinapisine (in white mustard)	96·57	
Asafœtida	20·0	Ure †.

These are some only of the substances from which the sulphur of our system is derived. Others have been already referred to.

8. Iron.—Iron is a constituent of most, if not all, organised beings; and is found in the ashes of both animals and vegetables. The quantity which they contain is, however, small, and has not been accurately ascertained. Moreover, we are unacquainted with the precise state in which it exists in living beings.

* According to Mulder (*Pharmaceutisches Central-Blatt für* 1838, p. 885), the formula for fibrine and ovalbumine is C^{800} H^{620} N^{100} O^{240} P^{2} S^{2}; while that for seralbumen is C^{800} H^{620} N^{100} O^{240} P^{2} S^{4}. But Liebig (*Animal Chemistry*, p. 124) justly observes, that "Every attempt to give the true absolute amount of the atoms in fibrine and albumen in a rational formula, in which the sulphur and phosphorus are taken, not in fractions, but in entire equivalents, must be fruitless, because we are absolutely unable to determine with perfect accuracy the exceedingly minute quantities of sulphur and phosphorus in such compounds; and because a variation in the sulphur or phosphorus, smaller in extent than the usual limits of errors of observation, will affect the number of atoms of carbon, hydrogen, or oxygen, to the extent of 10 atoms or more."

† *Pharmaceutical Journal*, vol. i. p. 461.

This metal is an essential constituent of the blood corpuscles, though, according to the recent researches of Scherer, it is neither essential to hæmatosin, nor necessary to the colour of the blood. But the well-known beneficial influence of chalybeates in the disease called Anæmia, in which the blood is found to contain a smaller quantity of iron than in a state of health, favours the notion that the proper colour of this fluid is in some way connected with the amount of iron contained in it; for one of the most characteristic symptoms of this malady is an absence of the natural vermilion tint of the complexion.

According to Denis,* 1000 parts of the blood corpuscles yield 2 parts of per- or sesquioxide of iron. But as the relative proportions of serum and blood corpuscles are subject to considerable variation, it follows that the quantity of iron contained in a given weight of blood cannot be constant. Moreover, it is probable that the proportion of this metal in the blood corpuscles may not be uniform.

The quantity of sesquioxide of iron obtained from 1000 parts of blood, varies, according to the authority† just quoted, from 0.128 to 0.346 parts. In pale, relaxed individuals, of a lymphatic temperament, in those who have been badly fed, or have been subjected to frequent bleedings, or who are labouring under anæmia, the blood yields the smaller proportion of sesquioxide above referred to. But the blood of strong

* *Essai sur l'Application de la Chimie à l'Etude Physiologique du Sang de l'Homme*, p. 205, Paris, 1838.

† *Op. supra cit.* pp. 211—244.

and vigorous subjects, of persons of a sanguine temperament, and of those who are well fed, furnishes a much greater proportion of iron. Liebig * assumes the existence of a much larger quantity of sesquioxide of iron in the blood than is stated by Denis in the work already quoted.† "According to the researches of Denis, Richardson, and Nasse, (Handworterbuch der Physiologie, vol. i. p. 138)" says Liebig, "10,000 parts of blood contain 8 parts of peroxide of iron." Now 8 parts of peroxide are equal to 5$\frac{6}{10}$ths parts of the pure metal.

Liebig regards the compound of iron in the blood as an oxidized one. In the arterial blood, it is saturated with oxygen (*hydrated sesquioxide*); but during its passage through the capillaries it loses part of its oxygen ‡, and becomes protoxide of iron, which combines with carbonic acid, one of the products of the oxidation of the metamorphosed tissues, and forms *carbonate of the protoxide of iron*, which exists in venous blood. This, in the lungs, absorbs the same amount of oxygen it had lost, and gives out its acquired carbonic acid. But the fact, that for every volume of oxygen absorbed by carbonate of the prot-

* *Animal Chemistry*, p. 273.

† In a work published by Denis in 1830, and entitled *Recherches Experimentales sur le Sang Humain*, the mean quantity of iron in 1000 parts of blood is said to be 0.9, but in his more recent work, from which the statement in the text has been taken, he states (p. 193) he has substituted Lecanu's method of determining the proportion of iron, as being infinitely more exact than his own.

‡ The facility with which, under certain circumstances, the sesquioxide of iron loses part of its oxygen, has been recently applied by Sir J. F. Herschel in the production of photographic pictures, termed *Ferrotypes*.

oxide of iron no less than four volumes of carbonic acid are evolved, appears to me to present some difficulties to its admission.

QUANTITY OF OXYGEN ABSORBED, AND CARBONIC ACID EVOLVED, BY CARBONATE OF THE PROTOXIDE OF IRON.

4 eq. of Carbonate of Protoxide of Iron	232	4 vols. or eq. Carbonic Acid evolved	88
1 vol. or 2 eq. of Oxygen absorbed	16	4 eq. Sesquioxide of Iron formed	160
	248		248

Now it has already been stated (pp. 11 and 24) that in the process of respiration, the quantity, by volume, of carbonic acid expired, is not equal to that of the oxygen which has disappeared.

If we assume that the venous blood contains protoxide of iron, a portion only of which is in combination with carbonic acid, this difficulty may be obviated.

QUANTITY OF OXYGEN ABSORBED, AND CARBONIC ACID EVOLVED, BY PROTOXIDE AND CARBONATE OF THE PROTOXIDE OF IRON.

1 equivalent Carbonate of Protoxide of Iron	58	1 equivalent or vol. of Carbonic Acid evolved	22
3 equivalents of Protoxide of Iron	108	4 equivalents of Sesquioxide of Iron	160
1 vol. or 2 equivalents of Oxygen absorbed	16		182
	182		

"The frightful effects of sulphuretted hydrogen and of prussic acid, which, when inspired, put a stop to all the phenomena of motion in a few seconds, are explained in a natural manner by the well-known action of these compounds on those of iron, when alkalies are present; and free alkali is never absent in the blood" (Liebig).

Iron is a constituent of the hair. Black hair contains most of this metal; white hair the least *.

Iron has been found by Braconnot in the gastric juice of dogs †. It has likewise been detected in the chyle ‡. These facts, then, explain how this metal gets into the blood.

Most articles of food contain iron. It is a constituent of the blood found in meat. Veal must contain less of it than beef, since calves are usually bled copiously previous to death, by which an anæmic state is induced. In the yellow fat of the yolk of egg this metal may be detected (Liebig). Milk likewise contains iron, according to Berzelius, in the state of phosphate. Traces of iron have been detected in most vegetable foods. Mustard, cabbage, potatoes, peas, and cucumbers, may be mentioned as examples.

9. Chlorine.—This elementary substance is a constituent of the blood, the gastric juice, and several of the excretions, as the urine, saliva, tears, and fæces. In the blood and the excretions it exists in combination with sodium, while in the gastric juice it is found combined with hydrogen, and thereby constituting hydrochloric acid.

As the chlorine of the blood is constantly being consumed in the formation of the gastric juice and secretions, it requires to be frequently renewed. Hence it is an indispensable constituent of our food; and is taken into the system in the form

* Vauquelin, *Ann. de Chim.* lviii. p. 41.
† *Ann. de Chim. et de Physiq.* lix. p. 249.
‡ Denis, *Recherches Expérimentales*, p. 328. 1830.

of chloride of sodium or common salt, which contains 60 per cent. of chlorine. To the embryo chick nature has supplied it in both the white and the yolk of egg, while the young mammal finds it in its mother's milk. The appetite which all animals evince for common salt shews that it is an agent indispensable for their health. Its uses will be hereafter pointed out *.

* One of the most important uses of chloride of sodium (common salt) is the formation of hydrochloric acid, an essential ingredient of the gastric juice. By what particular agency, whether by electricity or affinity, this decomposition is effected, we are unable to determine precisely, but that the hydrochloric acid of this juice derives its chlorine from the chloride of sodium, can scarcely be doubted. Its hydrogen is probably derived from water, the oxygen of which at the same time unites with the sodium to form soda.

The gastric juice consists essentially of *water*, *gastric mucus*, and *hydrochloric acid*. As mucus is a fluid secretion of all the mucous membranes, while the mucus of the gastric membrane alone yields, with water and hydrochloric acid, a digestive liquor, it is probable that the mucus of the stomach contains some peculiar organic principle, not hitherto isolated, on which its peculiar properties depend. To this principle, the term *pepsin* (from πεπτο, *I digest*) has been applied. An artificial digestive liquor is readily prepared by macerating the lining membrane of the fourth stomach of the calf in water, to which a few drops of hydrochloric acid have been added. If small cubes of white of egg, boiled hard, be macerated in this liquor, their more superficial parts become translucent, and their edges and angles rounded. Very gradually they are dissolved, presenting during the process the appearance of a cube of soap, dissolving in water, and having a gelatiniform character. The yolk of egg yields a turbid liquor, owing to the presence of fat globules. A piece of cooked beef-steak becomes pulpy at the surface, and gradually dissolves.

These changes are produced neither by an infusion of the stomach, nor by diluted hydrochloric acid employed separately; but by the two conjointly they are readily effected.

Now, Liebig asserts, "that the substance which is present in the gastric juice in a state of change is a product of the transformation of the stomach itself;" and he goes on to state, that "the fresh lining membrane of the stomach of a calf, digested with weak muriatic acid, gives to this fluid no power of dissolving boiled flesh or coagulated

10. Sodium. Sodium is a constituent of the blood, the animal tissues, and the secretions. Owing to its presence, the ashes of animal substances (feathers,

white of egg; but if previously allowed to dry, or if left for a time in water, it then yields to water, acidulated with muriatic acid, a substance in minute quantity, the decomposition of which is already commenced, and is completed in the solution."

But several circumstances appear to me to be opposed to this view. The fact ascertained by Schwann, that the solvent principle of the digestive fluid can be precipitated from its neutral solution by acetate of lead, and be obtained again in an active state from the precipitate by means of sulphuretted hydrogen, is apparently inconsistent with Liebig's idea, that this principle is matter in a state of decomposition or transformation. Moreover, if the essential part of the gastric juice —that by which digestion is effected—be a mere transformation of the stomach, how is it that other parts of analogous structure and composition do not suffer the same transformation? I have tried to obtain a digestive liquor from the second stomach of the calf, and from the bladder, but in vain. How is it this fancied transformation goes on, during life, only when solicited to do so by the presence of aliment or by mechanical irritation? Dr. Beaumont ascertained that pure gastric juice will keep for many months without becoming fetid: a fact scarcely explicable on the hypothesis that its activity depends on a principle in a state of decomposition. I find that while acidulated infusions of the second stomach of the calf, and of the bladder, soon become putrid and fetid, that of the fourth stomach remains remarkably free from unpleasant smell for several weeks. Lastly, I find, contrary to Liebig's statement, that a digestive liquor can be prepared from the fresh undried fourth stomach of a calf.

I cannot agree with Liebig, that digestion is a process analogous to fermentation; that, in fact, it is nothing more than the transformation of food, effected by the contact of matter in a state of decomposition. If it were, a small quantity of gastric juice ought to be capable of effecting the digestion of an unlimited quantity of food. Now, the experiments of Dr. Beaumont on the natural gastric juice, and of Schwann on the artificial digestive liquor, prove that this is not the case. Both found that only a certain amount of food could be digested with a given quantity of gastric juice; and Dr. Beaumont observes, that "when the juice becomes saturated it refuses to dissolve more; and if an excess of food have been taken, the residue remains in the stomach, or passes into the bowels in a crude state." Now, this fact is quite inconsistent with the fermentation theory.

bristles, hairs, flesh, &c.) possess the property of communicating a yellow tinge to flame.

This metal is taken into the system, principally in the form of chloride, which contains 40 per cent. of the metal. This salt is used at our table as a condiment, and is a constituent of most animal foods. Thus it is contained in both the white and the yolk of egg, in milk, and in flesh. It is not an ordinary constituent of plants, unless they grow in the neighbourhood of the sea or other salt water. Minute quantities of it are found in most of our common waters.

Sodium is expelled from the system both in the form of chloride and of oxysalt. In the urine of flesh-eating animals it exists in the form of sulphate and phosphate of soda.

11. Calcium.—This metal is a component part of all animals. In the higher classes it exists principally in the form of subphosphate of lime. Thus, the bones of the vertebrata contain this salt mixed with a small portion of carbonate of lime. But the shells and crusts of invertebrated animals, as lobsters, oysters, &c., consist of carbonate principally, but mixed with a little subphosphate of lime. Muscles, nervous matter, the liver, the thyroid gland, and, indeed, all the animal solids, as well as the blood, contain calcium in the form of subphosphate of lime.

Calcium is a constituent of the white, the yolk, and the shell of eggs; and it is probable that the calcium found in the skeleton of the chick, when it quits the shell, was derived from one or more of these sources.*

* This, however, is denied by Dr. Prout (*Phil. Trans.* 1822, p. 399). "I think I can venture to assert," says he, "after the most patient and

It is likewise a constituent of milk, and from this source the young mammal derives the requisite subphosphate of lime for deposition in his bones.

We derive the calcium of our system from the animal, vegetable, and mineral substances which we consume as food. Thus bones, flesh, viscera, blood, and milk of animals, yield us this metal. To these sources must be added eggs, as above mentioned. Most vegetables also contain it. Thus subphosphate of lime is found in cereal grains, onions and garlic; the oxalate exists in the stalks of garden rhubarb used for making tarts and puddings; the tartrate is found in grapes; gum and unrefined sugar yield ashes containing calcium. Another source of calcium is common water (well and river water), which usually contains both bicarbonate and sulphate of lime.

"The Chinese," says Mr. Medhurst *, "use great quantities of gypsum [sulphate of lime], which they mix with pulse, in order to form a jelly, of which they are very fond."

In some conditions of system a morbid appetite for calcareous substances exists. "Physicians," says Liebig, "are well acquainted with the fact, that children who are not well supplied with a sufficient quantity of lime in their food, eat that which they

attentive investigation, that it [the lime of the skeleton of the chick] does *not pre-exist in the recent egg;* certainly not, at least in any known state. The only possible sources, therefore, whence it can be derived, are from the shell, or transmutation from other principles." I have before (p. 4) noticed Dr. Prout's opinions as to the origin of the lime of the chick when it leaves the shell.

* *China, its State and Prospects,* p. 38. Lond. 1838.

collect from the walls of houses, with the same appetite that they have for their meals." Such cases are, according to my experience, very rare; and there is no evidence to prove Liebig's assertion, that in these cases the food was deficient in its ordinary proportion of lime.

12. MAGNESIUM. Small quantities of this metal are found in the blood, teeth, bones, nervous matter, thyroid gland, and other parts of the body. It exists in combination with oxygen and phosphoric acid, and often with ammonia also. (See *Phosphorus*).

It is a constituent of both vegetable and animal foods. Thus it is found in cereal grains, potatoes, flesh of animals, milk, eggs, &c.

13. POTASSIUM. Minute traces of potassium exist in blood, the solids, and several of the secretions of animals.

Liebig * states, that "without an abundant supply of potash, the production of milk becomes impossible;" but I know not on what authority he makes this statement, for Schwartz † found only seven parts of chloride of potassium (equivalent to 3·68 parts of potassium) in 10,000 parts of human milk—a quantity apparently too minute to be of much importance.

Potassium is a constituent of both animal and vegetable food. Most plants which grow inland contain it; thus, it is found in grapes and potatoes. Its presence may be readily detected: burn a grape stalk in the candle—the minute ash obtained at the point

* *Animal Chemistry,* p. 164.

† Gmelin, *Handbuch der theoretischen Chemie,* vol. ii. p. 1403.

of the burnt stalk will, if introduced into the outer or almost colourless cone of the flame, communicate a violet tint; thus demonstrating the presence of potassium or potash.

Nitrate of potash is sometimes used in the preparation of salted meats. This, therefore, is another source of potassium in the system. Moreover, common salt contains minute traces of this metal.

14. FLUORINE.—Berzelius detected minute quantities of fluoride of calcium in the bones and teeth of animals; but, more recently, Dr. G. O. Rees failed to detect it. If fluorine be a normal constituent of the body, it is doubtless introduced into the system in the small portions of the bones of animals occasionally swallowed with their flesh, for it cannot be derived from plants, since it has never been detected in these bodies. It is remarkable, however, that fluoride of calcium is abundant in fossilized bones, and in the human bones found at Pompeii and Herculaneum.

CHAP. II.—*Of Alimentary Principles.*

Two or more of the undecompounded bodies, described in the last chapter, form, by their union with each other, certain compound substances, termed *Alimentary Principles*, or *Simple Aliments;* and, by the combination or mixture of the latter, our ordinary foods, called Compound Aliments, are formed.

Some alimentary principles contain two elements only, as Water. Others contain three, as Sugar and Fat. Proteine is formed of four elements, while Fibrine and Albumen contain six.

Some alimentary principles, as Water and Common Salt, are derived from the Mineral Kingdom: others are obtained from the Organised Kingdom.

Dr. Prout * arranges alimentary principles in four great classes or groups, viz., the *aqueous*, the *saccharine*, the *oleaginous*, and the *albuminous*. The types of these groups are found in milk, the only article of food actually furnished and intended by nature as food for animals. Thus this secretion contains water, sugar, butter, and caseum (an albuminous substance).

This arrangement is a very excellent one; but several reasons induce me to adopt another. Milk

* *On the Nature and Treatment of Stomach and Urinary Diseases*, p. vi., Lond. 1840.

holds in solution saline matter, which is also an essential article of food to the adult animal, and hence I shall admit another class under the name of the *saline* aliments.

Moreover, both chemical and physiological considerations induce me to separate gelatine from albuminous principles, and, therefore, it will be necessary to have a separate group for *gelatinous* principles. Furthermore, it appears to me to be desirable to have distinct classes for gum, sugar, starch, vegetable jelly, alcohol, and vegetable acids. Hence I admit the following classes of alimentary principles:—

CLASSES OF ALIMENTARY PRINCIPLES.

1. The Aqueous.	7. The Acidulous.
2. The Mucilaginous or Gummy.	8. The Alcoholic.
3. The Saccharine.	9. The Oily or Fatty.
4. The Amylaceous.	10. The Proteinaceous †.
5. The Ligneous.	11. The Gelatinous.
6. The Pectinaceous *.	12. The Saline.

1. THE AQUEOUS ALIMENTARY PRINCIPLE.

Water is essential to the performance of all vital processes in the higher classes of living beings; Mosses, and some of the infusorial animals, may, it is said, be deprived of moisture without having their vitality destroyed ‡. But with these exceptions moisture seems essential to vital manifestations. This connection between vitality and moisture led the ancients

* *Pectinaceous*, from *pectin*, vegetable jelly.

† *Proteinaceous*, from *proteine*, the organic constituent of fibrine, albumen, and caseine.

‡ Needham, Baker, Spallanzani, and Fontana, quoted by Tiedemann in his *Traité Complet de Physiologie de l'Homme*, p. 116.

to suppose that water was the parent of every thing possessed of life *.

A very large proportion of the human body is aqueous. The blood contains about 80 per cent., the flesh about 74 per cent. of water. So that we may safely assume that the entire human machine contains nearly 75 per cent. or three-fourths of its weight of water. But as by evaporation, as well as by the processes of secretion and exhalation, as also perhaps by decomposition, part of this fluid is wasted or consumed, the necessity of the use of water as a drink becomes obvious. In fact, it is more necessary to our existence than solid food; and in this point of view it holds an intermediate rank between air and solid food, being less essential than the first, but more so than the last.

The water contained in the system is derived from the aqueous drinks which we consume, as well as from the moisture contained in most of the solid substances employed as food. "Water," says Dr. Prout †, "enters into the composition of most organised bodies, in two separate forms; that is, water may constitute an *essential* element of a substance—as of sugar, starch, albumen, &c. in their *driest* states; in which case the water cannot be separated, without destroying the *hydrated* compound. Or water may constitute an

* This notion is said to have been derived from a statement made by Moses (*Genesis*, ch. i. ver. 2). It is taught in the Koran (Sale's *Koran*, vol. ii. p. 155), and has been embraced by Milton (*Paradise Lost*, Book vii. line 234).

† *On the Nature and Treatment of Stomach and Urinary Diseases*, p. xix. Lond. 1840.

accidental ingredient of a substance — as of sugar, starch, albumen, &c. in their *moist* states; in which case, more or less of the water may frequently be removed without destroying the essential properties of the compound."

The following table shews the quantity of accidental water, or that which can be removed by drying, without injury to the compound, in various articles of food:—

QUANTITY OF WATER IN 100 PARTS OF THE FOLLOWING FOODS.

	Water.	*Authority.*
Gum Arabic	17.6	Guerin.
Sugar Candy	10.53	Peligot.
Arrow-root (by drying at 212° Fahr.)	18.2	Prout.
Wheat (by drying at 230° Fahr.)	14.5	Boussingault.
Rye (ditto)	16.6	Ditto.
Oats (ditto)	20.8	Ditto.
Barley (ditto at 212° Fahr.)	13.2	Ditto.
Maize (ditto)	18.0	Ditto.
Peas	16	Playfair.
Beans	14.11	Ditto.
Lentils	15.9	Ditto.
Potatoes (dried at 230° Fahr.)	75.9	Boussingault.
Turnips (ditto)	92.5	Ditto,
Carrots (ditto at 212° Fahr.)	87.6	Ditto.
Beet-root (ditto at 230° Fahr.)	87.8	Ditto.
Jerusalem Artichoke (ditto)	79.2	Ditto.
Cabbage, White (ditto at 212° Fahr.)	92.3	Ditto.
Black Bread	31.4 to 33	Bœckmann.
Beef Tea	98.4375	Christison.
Blood	80	Liebig.
Fresh Meat	74.8 to 75	Bœckmann.
Muscle of Beef	74	Brande.
Ditto	77.5	Schlossberger.
Ditto of Veal	75	Brande.
Ditto	79.7 to 78.2	Schlossberger.
Ditto Mutton	71	Brande.
Ditto Pork	76	Ditto.
Ditto	78.3	Schlossberger.
Ditto Roe Deer	76.9	Ditto.
Ditto Chicken	73	Brande.
Ditto	77.3	Schlossberger.
Ditto Pigeon	76	Ditto.
Ditto Cod	79	Brande.
Ditto Haddock	82	Ditto.

	Water.	*Authority.*
Muscle of Sole	79	Brande.
Ditto Carp	80.1	Schlossberger.
Ditto Trout	80.5	Ditto.
Calf's Sweetbread (Thymus)	70	Morin.
Ox's Liver (Parenchyma of)	68.64	Braconnot.
Egg (white of)	85	Gmelin.
Ditto (yolk of)	53·77	Prout.
Milk, Cows'	87.02	O. Henry and Chevallier.
—— Asses'	91.65	
—— Human	87.98	
—— Goats'	86.80	
—— Ewes'	85.62	

Water is probably the natural drink of all adults. It serves several important purposes in the animal economy: firstly, it repairs the loss of the aqueous part of the blood, caused by evaporation and the action of the secreting and exhaling organs; secondly, it is a solvent of various alimentary substances, and, therefore, assists the stomach in the act of digestion, though, if taken in very large quantities, it may have an opposite effect, by diluting the gastric juice; thirdly, it is probably a nutritive agent, — that is, it assists in the formation of the solid parts of the body. From the latter opinion, which I hold with Count Rumford *, many, however, will be disposed to dissent.

It has not, indeed, been actually demonstrated that water is decomposed in the animal system, or, in other words, that it yields up its elements to assist in the formation of organised tissues; yet such an occurrence is by no means improbable. It appears, from Liebig's

* *Essays*, vol. i. p. 194, 5th ed. 1800.

observations *, that the hydrogen of vegetable tissues is derived from water; and it is not probable that the higher orders of the organised kingdom should be deficient in a power possessed by the lower orders. Dr. Prout † appears to admit the existence of this power, but thinks that it is rarely exercised by animals. "There is reason to believe," he says, "that the decomposition of water either takes place when in a state of combination with other principles, or during the act of its separation or combination with such principles; and that water, as water, is rarely decomposed by the animal economy."

The water which constitutes an essential part of the blood and of the living tissues, assists in several ways in carrying on the vital processes. "In the blood," says Dr. Prout ‡, "the solid organised particles are transported from one place to another; are arranged in the place desired; and are again finally removed and expelled from the body, chiefly by the agency of the water present." It is from water that the tissues derive their properties of extensibility and flexibility. Lastly, this fluid contributes to most of the transformations which occur within the body. As a solvent, it serves not only to aid digestion, as already noticed, but also to effect other changes. Thus, it is probable that the conversion of uric acid into urea, by the action of oxygen, is

* *Chemistry in its Application to Agriculture and Physiology*, p. 63, in 2d ed. 1842.

† *Op. supra cit.* p. 8.

‡ *On the Nature and Treatment of Stomach and Urinary Diseases*, p. 7.

effected by the agency of water, which holds the acid in solution; for in animals, which drink much water, no uric acid, but urea only, is found in the urine *; while in birds, which seldom drink, and in snakes, uric acid predominates.

CONVERSION OF URIC ACID INTO UREA.

1 eq. Uric Acid	C^{10}	N^4	H^4	O^6	2 eq. Urea .	C^4	N^4	H^8	O^4
4 eq. Water .	—	—	H^4	O^4	6 eq. Carbonic Acid .	C^6	—	—	O^{12}
6 eq. Oxygen .	—	—	—	O^6					
Total . .	C^{10}	N^4	H^8	O^{16}	Total . .	C^{10}	N^4	H^8	O^{16}

In some cases, water combines chemically with substances to which, therefore, it contributes both its elements. Thus the conversion of either cane sugar (C^{12} *Aqua*^{11}), or starch (C^{12} *Aqua*^{10}), into either sugar of milk (C^{12} *Aqua*^{12}), or diabetic sugar (grape sugar C^{12} *Aqua*^{14}), can be effected only by the addition of water. So also the hydrochloric acid of the gastric juice and the soda of the blood and bile, are derived from common salt (chloride of sodium) by the aid of water.

CONVERSION OF CHLORIDE OF SODIUM INTO HYDROCHLORIC ACID AND SODA.

1 eq. Chloride of Sodium	Cl	Na	—	—	1 eq. Hydrochloric Acid	Cl	—	H	—
1 eq. Water	—	—	H	O	1 eq. Soda	—	Na	—	O
Total	Cl	Na	H	O	Total	Cl	Na	H	O

Water, considered as a dietetical remedy, may be regarded under a twofold point of view;—first, with

* Liebig's *Animal Chemistry*, p. 139.

respect to its *quantity;* secondly, in reference to its *quality*.

In some maladies, as fevers and acute inflammatory diseases, an almost unlimited use of aqueous fluids is admitted under the various names of *slops, diluents, thin diet, fever diet, broth diet,* &c. They quench thirst, lessen the stimulating quality and augment the fluidity of the blood, by increasing the proportion of its aqueous part, and promote the action of the secreting organs. Moreover, it is probable that they may promote the conversion of uric acid into urea, as above referred to. Furthermore, they are sometimes useful by lessening the irritating contents of the alimentary canal.

But in some maladies it is necessary to restrict the quantity of fluids taken; in other words, to employ what is called a *dry* diet. Thus, we employ this regimen when our object is to keep down the volume of the circulating fluid (as in valvular diseases of the heart), or to prevent thinness of the blood (as in aneurism of any of the great vessels, when our only hope of cure depends on the coagulation and deposition of fibrine within the aneurismal sac), or when we are desirous of repressing excessive secretion (as of urine, in diabetes).

Attention to the *quality* as well as to the quantity of the water employed, as a drink, is also important; not only for the palliation and cure of some maladies, but also as a prophylactic means. Now, considered with regard to quality, the waters furnished us by nature are conveniently divisible into three classes; viz. 1st. Common waters, or those employed as drinks, or for

dressing food, or for other purposes of domestic economy. 2dly, Sea water, or the water of the ocean. 3dly, Mineral waters, or those waters which belong to neither of the preceding classes, and which possess some peculiar properties derived from the presence of one or more mineral substances.

From any of these waters, though usually from those of the first class, we obtain distilled water, which is sometimes used for dietetical and remedial purposes. These different kinds of water require separate consideration.

1. COMMON WATERS.—Under this head are included the waters commonly known as *rain, spring, river, well* or *pump, lake,* and *marsh waters.*

a. Rain Water.—This is the purest of all natural waters. Its purity, however, is subject to some variation. Thus, when collected in large towns or cities, it is less pure than when obtained in the country: moreover, it is usually loaded with impurities at the commencement of a shower, but after some hours of continuous rain it becomes nearly pure; for the first water which falls brings down the various foreign matters suspended in the atmosphere. Air is a constant constituent of rain water. Carbonate of ammonia is another ingredient. It is derived from the putrefaction of nitrogenous substances. When several hundred pounds of rain water "were distilled in a copper still, and the first two or three pounds evaporated with the addition of a little muriatic acid, a very distinct crystallization of sal-ammoniac was obtained: the crystals had always a brown or yellow colour *." "It is

* *Organic Chemistry in its Application to Agriculture and Physiology;* edited by Lyon Playfair Ph. D. p. 75. Lond. 1842.

worthy of observation," says Liebig, "that the ammonia contained in rain and snow water possesses an offensive smell of perspiration and animal excrements,—a fact which leaves no doubt respecting its origin." It is owing to the presence of carbonate of ammonia that rain water owes its *softer* feel than pure distilled water. According to Liebig, it is the atmospheric ammonia which furnishes the nitrogen of plants. The traces of nitric acid which have been detected in the air are referable to the oxidation of the constituents of ammonia; and not to the direct union of the oxygen and free nitrogen of the atmosphere. A carbonaceous (sooty) substance, and traces of sulphates, chlorides, and calcareous matter, are the usual impurities of the first rain water of a shower. Carbonate of lime, and, according to Bergmann, chloride of calcium, are constituents of rain water. Zimmermann found oxide of iron and chloride of potassium; but Kastner could discover no trace of iron in it, though he found in dew, meteoric iron and nickel. Brandes detected various other inorganic substances, viz. chloride of sodium (in greatest quantity), chloride of magnesium, sulphate and carbonate of magnesia, and sulphate of lime. He likewise mentions oxide of manganese. The putrefaction to which rain water is subject, shews that some organic matter is present. The term *pyrrhin* (from πυῤῥός, red) has been applied by Zimmermann to an atmospheric organic substance which reddens solutions of silver. Whenever rain water is collected near large towns, it should be boiled and strained before use. As it contains less saline impregnation than other kinds of natural waters, it is more apt to become contami-

nated with lead from roofs, gutters, cisterns, and water pipes.

Snow Water is destitute of air and other gaseous matters found in rain; and hence fish cannot live in it. According to Liebig, it contains ammonia. It has long been a popular, but erroneous opinion, that it was injurious to the health, and had a tendency to produce bronchocele. But this malady "occurs at Sumatra, where ice and snow are never seen; while, on the contrary, the disease is quite unknown in Chili and Thibet, although the rivers of these countries are chiefly supplied by the melting of the snow with which the mountains are covered*." Snow does not quench thirst; on the contrary, it augments it; and the natives of the Arctic regions "prefer enduring the utmost extremity of this feeling, rather than attempt to remove it by eating of snow†." When melted, however, it proves as efficacious as other kinds of water.

b. Spring Water.—This is rain water, which, having percolated through the earth, reappears at the surface of some declivity. During its passage, it almost always takes up some soluble matters, which of course vary according to the nature of the soil. Its constituents are similar to those of well water, presently to be noticed.

c. River Water.—This is a mixture of rain and spring water. When deprived of the matters which

* Paris, *Pharmacologia*, 6th ed. vol. i. p. 79.

† Captain Ross's *Narrative of a Second Voyage in Search of a North-west Passage; and of a Residence in the Arctic Regions during the years* 1829, 1830, 1831, 1832, *and* 1833, p. 366. Lond. 1835.

it frequently holds in suspension, its purity is usually considerable. The following are the solid constituents of the waters of the Thames and Colne, at different localities, according to the analyses of Mr. R. Phillips *.

QUANTITY OF WATER.	THAMES WATER.			COLNE WATER.		
1 Gallon = 10lbs. Avoirdup., at 62° F. or 70000 grs. Avoirdup.	*Brentford* Source of the Grand Junction Water Works Company.	*Barnes.* Source of the West Middlesex Water Works Company.	*Chelsea.* Source of the Chelsea Water Works Company.	*Otterpool.* Spring near Bushey.	*Main Spring* in the valley that supplies the Colne.	*Colne* Itself.
	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.
Carbonate of Lime	16·000	16·900	16·500	18·800	19·300	18·100
Sulphate of Lime........ } Chloride of Sodium...... }	3·400	1·700	2·900	2·500	2·500	3·200
Oxide of Iron............ Silica .... Magnesia .... Carbonaceous matter....	Very minute portions.	Ditto.	Ditto.	Ditto.	Ditto.	Ditto.
Solid matter held in solution	19·400	18·600	19·400	21·300	21·800	21·300
Mechanical Impurity......	0·368	0·369	0·238	0·185	0·262	0·126
Total Solid matter....	19·768	18·969	19·638	21·485	22·062	21·426

No notice is taken in these analyses of the gaseous constituents (air and carbonic acid) of river water.

The carbonate of lime is held in solution by carbonic acid, forming bicarbonate of lime. By boiling, this acid is expelled, and the carbonate of lime is precipitated on the sides of the vessel, constituting the *fur* of the tea-kettle and the *crust* of boilers.

Decomposing organic matter, in suspension or solution, is found in every river water in a greater or less proportion. Ordinarily the quantity is insufficient to act injuriously; but it cannot be doubted that water, strongly contaminated with it, must be deleterious.

* *Report from the Select Committee of the House of Lords, appointed to inquire into the Supply of Water to the Metropolis,* p. 91, 1840.—See also Dr. Bostock's analysis, in the *Report of the Commissioners appointed to inquire into the State of the Supply of Water in the Metropolis,* 1828.

Where, however, the quantity present is insufficient to produce any immediately obvious effects, it is by no means easy to procure decisive evidence of its influence on the system. In those cases in which its operation has been unequivocally recognised, it has manifested itself by the production of dysentery *.

* At the Nottingham Assizes in July, 1836, it was proved at a trial (Jackson *versus* Hall), on which I was a witness, that dysentery, in an aggravated form, was caused in cattle by the use of water contaminated with putrescent vegetable matter, produced by the refuse of a starch manufactory. The fish (perch, gudgeon, pike, roach, and dace) and frogs in the pond, through which the brook ran, were destroyed. All the animals (cows, calves, and horses,) which drank of this water, became seriously ill, and in eight years the plaintiff lost 24 cows and 9 calves, all of a disease (dysentery) accompanied by nearly the same symptoms. It was also shewn that the animals sometimes refused to drink the water; that the mortality was in proportion to the quantity of starch made at different times; and that, subsequently, when the putrescent matter was not allowed to pass into the brook, but was conveyed to a river at some distance, the fish and frogs began to return, and the mortality ceased among the cattle. The symptoms of illness in the cows were as follows: the animals at first got thin, had a rough, staring coat, and gave less milk (from two to three quarts less every day); they then became purged, passed blood with the fæces, and at length died emaciated and exhausted. On a post-mortem examination, the intestinal canal, throughout its whole length, was found inflamed and ulcerated. The water, which I examined, was loaded with putrescent matter, and contained chloride of calcium (derived from the chloride of lime employed in bleaching the starch). Traces of free sulphuric acid were occasionally found by one witness.

"Dr. M. Barry affirms that the troops were frequently liable to dysentery, while they occupied the old barracks at Cork; but he has heard that it has been of rare occurrence in the new barracks. Several years ago, when the disease raged violently in the old barracks (now the depôt for convicts), the care of the sick was, in the absence of the regimental surgeon, entrusted to the late Mr. Bell, surgeon, in Cork. At the period in question, the troops were supplied with water from the river Lee, which, in passing through the city, is rendered unfit for drinking, by the influx of the contents of the sewers from the houses, and likewise is brackish from the tide, which ascends into their chan-

Its influence in a milder form is attended with slight relaxation of bowels. "The beneficial effects derived from care as to the qualities of water," says Mr. Chadwick *, "is now proved in the navy, where fatal dysentery formerly prevailed to an immense extent, in consequence of the impure and putrid state of the supplies; and care is now generally exercised on the subject by the medical officers of the army."

The decomposing organic matter above referred to, consists principally of the exuviæ of animal and vegetable substances †. The water of some of the wells of

nels. Mr. Bell, suspecting that the water might have caused the dysentery, upon assuming the care of the sick, had a number of water-carts engaged to bring water for the troops, from a spring called the Lady's Well, at the same time that they were no longer permitted to drink the water from the river. From this simple, but judicious arrangement, the dysentery very shortly disappeared among the troops." (Dr. Cheyne, *On Dysentery, in the Dublin Hospital Reports*, vol. iii. p. 11).

* *Report to her Majesty's Principal Secretary of State for the Home Department, from the Poor-Law Commissioners, on an Inquiry into the Sanatory Condition of the Labouring Population of Great Britain*, p. 78. 1842.

† "In addition to its saline or natural impurities, the well water of London is sometimes contaminated by organic matters, the source of which, especially in the pump-water of churchyards, is sufficiently obvious; and such is usually the place selected for the parish pump. This disgusting source of water should be avoided; and the disgraceful system of burying the dead in the streets of the metropolis should be authoritatively discontinued. Of this nuisance, abundant instances occur to every one who walks about London; the churchyard of St. Clement's, in the Strand, is a fair specimen, and there are many infinitely worse. In these, the same graves are repeatedly opened, and the coffins thrust in one upon another, according to the most inexplicable system; and it is beneath this superstratum that the waters of the adjacent wells flow, in some instances, perhaps, deep enough to avoid direct contamination, but never free from the suspicion of the oozings of the vicinity." (Brande's *Dictionary of Materia Medica and Practical Pharmacy*, p. 81. 1839). In the *Report on the Health of Towns (Effect of Interment of Bodies)*;

the metropolis are occasionally contaminated with the odour and flavour of gas-tar. I have myself found this to be the case in a well water obtained near the London Hospital.

The quantity of organic matter contained in common water has not been accurately determined. Dr. Lambe * states, that from 30 gallons of Thames water, collected at London, he procured 28 grains of a carbonaceous substance. But from Thames water taken out of the river at Windsor, the quantity was considerably less. From six gallons of water he did not procure one grain of this charcoally matter.

Thames water, when carried to sea in casks, soon becomes putrid and offensive, and evolves inflammable

dated 14th June, 1842 (327), it is stated that this pump has been obliged to be shut up, as the water was found unfit for use. In the same work, Dr. Copland, in his evidence before the Committee of the House of Commons, states, that water which percolates through soil abounding in animal matter becomes injurious to the health of the individuals using it. This fact, he says, "has been proved on many occasions, and especially in warm climates; and several very remarkable facts illustrative of it occurred in the Peninsular campaign. It was found, for instance, at Cuidad Rodrigo, where, as Sir James Macgregor states, in his account of the health of the army, there were 20,000 dead bodies put into the ground within the space of two or three months, that this circumstance appeared to influence the health of the troops, inasmuch as for some months afterwards all those exposed to the emanations from the soil, as well as obliged to drink the water from the sunk wells, were affected by malignant and low fevers, and by dysenteries, or fevers frequently putting on a dysenteric character. The digestive operations are affected by water abounding with putrid animal matter; so that burying in large towns affects the health of individuals, in the first place, by emanations into the atmosphere, and, in the second place, by poisoning the water percolating through that soil."

* *An Investigation of the Properties of the Thames Water.* Lond. 1828.

vapour *. This is owing to the presence of decomposing organic matter. If, however, the water in this fetid state be racked off into larger vessels, and exposed to the air, a slimy deposit is formed, and the water becomes clear, sweet, and palatable.

I have already had occasion to refer to the evolution of sulphuretted hydrogen gas from waters containing both sulphates and decomposing organic matter †.

Living beings (animals and vegetables) constitute another class of impurities of river water. But the public has formed a very erroneous notion of the extent and nature of this source of impurity, in consequence of the public exhibition in London of aquatic animals, by means of the solar and oxyhydrogen microscopes. The animals used on these occasions are collected in stagnant pools in the neighbourhood of the metropolis, and are not found in the water usually supplied for domestic use.

Recent microscopic investigations have shown that animals are liable to both vegetable and animal parasites (*entophyta* and *entozoa.*) Thus, goldfish often become covered with a white efflorescence, and, in consequence, languish and die. When examined by a microscope, this efflorescence is found to be a cryptogamic plant, and to consist of articulated, cellular tubes, some of which are filled with granules, and one or two nuclei. A similar growth sometimes occurs on efts (Triton cristata),

* A similar change is reported to have occurred to water collected at St. Jago (see *Phil. Trans.* No. 268, p. 738, vol. 22. 1701).

† See p. 64.

by which the tails of these animals are gradually destroyed. Now it is by no means improbable that disease may be induced in a somewhat similar way in the human subject, by the use of water containing the shreds or filaments of cryptogamic plants. This suspicion is strengthened by the case, related by Dr. A. Farre *, of a woman who passed, by the bowels, substances having the ordinary appearance of shreds of false membrane, but consisting entirely of confervoid filaments, probably belonging to the genus Oscillatoria. The patient drank the ordinary water which supplies London, and it is not improbable, therefore, she may have in this way imbibed the reproductive sporules. In the same way, aquatic animals of various species may be occasionally swallowed. When the French army entered upon the deserts which separate Egypt from Syria, the soldiers, pressed by thirst, threw themselves on their faces, and drank greedily of the muddy water, and which, unknown to them, contained leeches (*Sanguisuga ægyptiaca*), having the form of a horse-hair, and the length of a few lines only. Many of them felt immediately stings or prickling pains in the posterior fauces, followed by frequent coughs, glairy spots, slightly tinged with blood, and a disposition to vomit, with a difficulty of swallowing, laborious respiration, and sharp pains in the chest, loss of appetite and rest, attended with great uneasiness and agitation. On pressing down the tongue of the individual first attacked, a leech was discovered, which was with difficulty removed by the

* *Microscopic Journal*, vol. ii. p. 189.

forceps. Little or no hemorrhage followed, and the patient recovered. Those which had attached themselves to the posterior fauces, were removed by the use of gargles composed of vinegar and salt-water.

d. Well Water.—This is water obtained by sinking wells*. As it is commonly raised by means of a pump, it is frequently called *pump water*. The constituents of ordinary well water are similar to those of river water above mentioned; but the earthy salts (especially the bicarbonate and sulphate of lime) are found in much larger quantity. It usually decomposes and curdles soap, and is then denominated *hard water*, to distinguish it from river and other waters, which are readily miscible with soap, and which are termed *soft waters*. The hardness of water depends on certain earthy salts, the most common of which is sulphate of lime. By the mutual action of this salt and soap, double decomposition is effected: the sulphuric

* Artesian Wells are vertical cylindrical borings in the earth, through which water rises, by hydrostatic pressure, either to the surface (*spouting* or *overflowing wells*), or to a height convenient for the operation of a pump. (For a description of the mode of boring, and of the tools used, see Ure's *Dictionary of Arts, Manufactures, and Mines*, p. 57, Lond. 1839. In the *Penny Cyclopædia*, art. *Artesian Wells*, is a popular and interesting account of these wells). They have been denominated Artesian, from a notion that they were first made in the district of Artois, in France. It is probable, however, that they were known to the ancients, for a notice of them is said to occur in Olympiodorus (Passy, *Description Géologique du Département de la Seine Inférieure*, p. 292. Rouen, 1832). Proposals have been made for supplying London with water by these wells; which would derive their water from the stratum of sand and plastic clay, placed between the London clay and the chalk basin. But it does not appear that a sufficient supply could be obtained in this way. (See an interesting account of Artesian Wells, by Mr. Webster, in the *Athenæum* for 1839, p. 131. Also, *Transactions of the Institution of Civil Engineers*, vol. iii. part iii.)

acid unites with the alkali of the soap, setting free the fatty acids, which unite with the lime to form an insoluble earthy soap. Hard water is a less perfect solvent of organic matter than soft water; hence, in the preparation of infusions and decoctions, and for many economical purposes, as for tea-making and brewing, it is inferior to soft water; and, for the same reason, it is improper as a drink in dyspeptic affections. Moreover, it proves injurious in urinary deposits. The unfavourable effects of hard waters on the animal system are especially manifested in horses. "Hard water, drawn fresh from the well," observes Mr. Youatt*, "will assuredly make the coat of a horse, unaccustomed to it, stare, and it will not unfrequently gripe and otherwise injure him. Instinct, or experience, has made even the horse himself conscious of this; for he will never drink hard water if he has access to soft: he will leave the most transparent and pure [?] water of the well for a river, although the water may be turbid, and even for the muddiest pool†."

Mr. Chadwick‡ observes that "water containing animal matter, which is the most feared, appears to be less frequently injurious than that which is the clearest—namely, spring water; from the latter being oftener impregnated with mineral substances." Satis-

* *The Horse*, p. 359. Lond. 1831.

† "Some trainers have so much fear of hard or strange water, that they carry with them to the different courses the water that the animal has been accustomed to drink, and that they know agrees with it."

‡ *Report to her Majesty's Principal Secretary of State for the Home Department, from the Poor-Law Commissioners, on an Inquiry into the Sanatory Condition of the Labouring Population of Great Britain*, p. 77. 1842.

factory and unequivocal evidence, however, of the nature of the injurious action of the saline ingredients of common waters, is not readily obtained, but the most obvious and frequent effect is diarrhœa *.

Though the purest waters are the most wholesome, yet very pure water is possessed of one very dangerous quality; viz. that of rapidly corroding lead, and thereby acquiring an impregnation of this metal. Distilled water has no action on lead, provided the air be excluded, but, when this is admitted, a thin white crust † of carbonate and hydrate of the oxide of lead is speedily formed. Now, it is very remarkable that the neutral salts usually found in spring water, impair the corrosive action of water and air, and thus exercise a protecting influence. To the presence of saline matter, therefore, is to be ascribed

* Sulphate of lime or gypsum is the ordinary constituent of hard waters. Dioscorides (lib. v. cap. 134) describes it as possessing an astringent property, and, when drank, destroying life; and Pliny (lib. xxxvi. cap. 59) states, that C. Proculeius killed himself by taking it. From the few observations respecting it which have been published (see Wibmer, *Die Wirkung der Arzneimittel und Gifte*, vol. ii. p. 11), it appears that it acts on the system as an astringent, causing constipation and disordered digestion. Parent du Chatelet (quoted by Mr. Chadwick) ascribes to it a purgative quality; and refers the chronic diarrhœa, so often observed in the hospital of Salpêtrière and the prison of St.-Lazarus, to the "very great proportion of sulphate of lime and other purgative salts" contained in the water with which both these establishments are supplied.

† Dr. Christison (*Transactions of the Royal Society of Edinburgh*, vol. xv. part ii. 1842), made three analyses of this crust, and found that it consisted of Oxide of Lead, Carbonic Acid, and Water, in proportions which nearly correspond to the formula $3 PbO + 2 CO^2 + Aq.$; that is, a compound of three equivalents Oxide of Lead, two of Carbonic Acid, and one of Water; or rather, a compound of two equivalents of Carbonate of Lead in union with one equivalent of Hydrated Oxide of Lead $= 2 (PbO + CO^2) + (PbO + Aq.)$

the comparative infrequency of the plumbeous impregnation of water kept in leaden cisterns or transmitted through leaden pipes. All salts do not possess an equally protective influence, the carbonates and sulphates being most, the chlorides (muriates) the least, energetic of those saline substances commonly met with in spring waters*. Rain and other pure kinds of water which contain but minute portions of these protecting salts, readily acquire an impregnation of lead from roofs, gutters, cisterns, or pipes, made of this metal. "There is another way in which lead is occasionally acted upon by water, and to which attention was first directed by Dr. Paris: it is in consequence of galvanic action, and in cases where iron and lead are in metallic contact, as often happens in the employment of iron bars to strengthen and support leaden cisterns, and in the introduction of iron pumps under similar circumstances; in these cases, though the lead is rendered electro-negative, and so far protected from acid reaction, it becomes more susceptible of, and exposed to, the agency of electro-positive elements, among which are alkalis and alkaline earths, and these exert considerable solvent power over it. So that all such combinations of lead and iron, zinc, &c.

* My friend, Professor Daniell, informs me that he has found lead in the well water obtained at Norwood. The water is very hard (that is, holds a large quantity of sulphate of lime in solution) and contains much free carbonic acid. It is the latter ingredient, apparently, which holds the lead in solution, for, by boiling, the whole of the lead is precipitated. The water is raised from the well by a leaden pump, to which is attached a few feet of leaden pipe. Professor Daniell's attention was directed to the subject in consequence of the occurrence of several cases of lead colic in the neighbourhood of his residence at Norwood. (See also *Pharmaceutical Journal*, Nov. 1, 1842.)

should be cautiously avoided. Lastly, there is another source of contamination of water by lead, which is this; leaden cisterns have often leaden covers, and the water, spontaneously evaporating from the cistern, is condensed (now in the form of *pure* or *distilled* water) upon the lid, upon which it exerts its usual energetic action, and drops back into the body of the cistern, contaminated by lead: so that wood, not leaded, should be used in all cases for covering leaden reservoirs*."

Water impregnated with lead, in the way above alluded to, possesses the following properties:—By exposure to the air it becomes covered with a thin white film, and the vessel in which it is contained becomes lined with a thin white incrustation of a pearly lustre. This crust, dissolved in acetic acid, yields a solution which is rendered blackish brown by sulphuretted hydrogen, and yellow by either iodide of potassium or bichromate of potash.

The continued use of water containing lead gives rise to *lead* or *painter's colic*, which is accompanied by a narrow leaden blue line on the edges of the gums attached to the necks of two or more (usually incisor) teeth of either jaw (see p. 64). If the cause of the malady be not discovered, and the water not discontinued, *palsy* usually succeeds colic †.

The following conclusions, drawn by Dr. Christison ‡, as to the employment of lead-pipes for conducting

* Brande's *Dictionary of Materia Medica and Practical Pharmacy*, p. 80. Lond. 1839.

† See my *Elements of Materia Medica*, p. 793, vol. i. 2d edit.

‡ *Trans. of the Royal Society of Edinburgh*, vol. xv. part ii. p. 271.

water, are of considerable importance, and, therefore, deserve especial attention.

"1. Lead-pipes ought not to be used for the purpose, at least where the distance is considerable, without a careful examination of the water to be transmitted.

"2. The risk of a dangerous impregnation with lead is greatest in the instance of the purest waters.

"3. Water, which tarnishes polished lead when left at rest upon it in a glass vessel for a few hours, cannot be safely transmitted through lead-pipes without certain precautions*.

"4. Water, which contains less than about an 8000th of salts in solution, cannot be safely conducted in lead-pipes without certain precautions.

"5. Even this proportion will prove insufficient to prevent corrosion, unless a considerable part of the saline matter consist of carbonates and sulphates, especially the former.

"6. So large a proportion as a 4000th, probably even a considerably larger proportion, will be insufficient, if the salts in solution be in a great measure muriates.

"7. It is, I conceive, right to add, that in all cases, even though the composition of the water seems to bring it within the conditions of safety now stated, an attentive examination should be made of the water after it has been running for a few days through the pipes. For it is not improbable that other circum-

* "Conversely, it is probable, though not yet proved, that if polished lead remain untarnished, or nearly so, for twenty-four hours in a glass of water, the water may be safely conducted through lead-pipes."

stances, besides those hitherto ascertained, may regulate the preventive influence of the neutral salts.

"8. When the water is judged to be of a kind which is likely to attack lead-pipes, or when it actually flows through them impregnated with lead, a remedy may be found, either in leaving the pipes full of the water and at rest for three or four months, or by substituting for the water a weak solution of phosphate of soda, in the proportion of about a 25,000th part*."

e. Lake Water.—This is a collection of rain, spring, and river water, usually contaminated with putrefying organic matter.

f. Marsh Water.—This is analogous to Lake water, except that it is altogether stagnant, and is more loaded with putrescent matter. The sulphates in sea and other waters are decomposed by putrefying vegetable matter, with the evolution of sulphuretted hydrogen; hence the intolerable stench from marshy and swampy grounds liable to occasional inundations from the sea.

Tests of the usual Impurities in Common Water.—The following are the tests by which the presence of the ordinary constituents or impurities of common waters may be ascertained:—

1. Ebullition.—By boiling, Air and Carbonic Acid gas are expelled, while Carbonate of Lime (which has been held in solution by the carbonic acid) is deposited. The latter constitutes the fur or crust which lines tea-kettles and boilers.

2. Protosulphate of Iron.—If a crystal of this salt be introduced into a phial filled with the water to be examined, and the phial be well

* The object of this is to form, while the water is at rest, a fine film of mixed carbonate and phosphate of lead, which shall adhere so firmly as not to be swept away when the water is allowed to flow, and which will serve as a lining to prevent the contact of the running water with the metal.

corked, a yellowish-brown precipitate (sesquioxide of iron) will be deposited in a few days, if Oxygen gas be contained in the water.

3. Litmus.—Infusion of litmus or syrup of violets is reddened by a free Acid.

4. Lime Water.—This is a test for Carbonic Acid, with which it causes a white precipitate (carbonate of lime) if employed before the water is boiled.

5. Chloride of Barium.—A solution of this salt usually yields, with well-water, a white precipitate insoluble in nitric acid. This indicates the presence of Sulphuric Acid (which, in common water, is combined with lime).

6. Oxalate of Ammonia.—If this salt yield a white precipitate, it indicates the presence of Lime (carbonate and sulphate).

7. Nitrate of Silver.—If this occasion a precipitate insoluble in nitric acid, the presence of Chlorine may be inferred.

8. Phosphate of Soda.—If the lime contained in common water be removed by ebullition and oxalic acid, and to the strained and transparent water, Ammonia and Phosphate of Soda be added, any Magnesia present will, in the course of a few hours, be precipitated in the form of the white ammoniacal phosphate of magnesia.

9. Tincture of Galls.—This is used as a test for Iron, with solutions of which it forms an inky liquor (tannate and gallate of iron). If the test produce this effect on the water before, but not after, boiling, the iron is in the state of Carbonate: if after as well as before, in that of Sulphate. *Tea* may be substituted for galls, to which its effects and indications are similar. *Ferrocyanide of Potassium* yields, with solutions of the sesquisalts of iron, a blue precipitate, and with the protosalts a white precipitate, which becomes blue by exposure to the air.

10. Hydrosulphuric Acid *(Sulphuretted Hydrogen)*.—This yields a dark (brown or black) precipitate (a metallic sulphuret) with water containing Iron or Lead in solution.

11. Evaporation and Ignition.—If the water be evaporated to dryness, and ignited in a glass tube, the presence of organic matter may be inferred by the odour and smoke evolved, as well as by the charring. Another mode of detecting organic matter is by adding nitrate (or acetate) of lead to the suspected water, and collecting and igniting the precipitate; when globules of metallic lead are obtained if organic matter be present*. The putrefaction of water is another proof of the presence of this matter. Nitrate of silver has been before mentioned as a test†.

* See Dr. Lambe's *Investigation of the Properties of Thames Water*, p. 11. 1828.—Also Clement, *Ann. de Chim. et Phys.* t. iv. p. 232.

† See p. 86. Also Davy, in Jameson's *Journal*, Dec. 1828, p. 128; and my *Elements of Materia Medica*, pp. 257, 258, 259, and 689.

Purification of Common Water.—By *filtration* water may be deprived of living beings and of all suspended impurities. But substances in solution are not got rid of by this proceeding. *Ebullition* destroys the vitality of either animals or vegetables; expels air or carbonic acid; and causes the precipitation of carbonate of lime. Subsequent filtration may be advantageously combined. *Distillation,* when properly conducted, is the most effectual method of purifying water. But distilled water, is, in general, contaminated by traces of organic matter (see *Distilled Water*). The addition of *chemical agents* to water is another mode which has been proposed and practised for freeing water from some of its impurities. Alum is oftentimes used by common people to cleanse muddy water. Two or three grains are sufficient for a quart of water. The alum decomposes the carbonate of lime: sulphate of lime is formed in solution, and the alumina precipitates in flocks carrying with it mechanical impurities. It is obvious that this agent adds nothing to the chemical purity of the water, but by converting the carbonate into sulphate of lime augments its hardness. Caustic alkalies added to lime saturate the excess of carbonic acid, and throw down the carbonate of lime, having an alkaline carbonate in solution. A patent has recently been taken out, by Professor Clark *, of Aberdeen, for the

* See *Repertory of Patent Inventions,* for October 1841. Also, *A New Process for Purifying the Waters supplied to the Metropolis by the existing Water Companies: rendering each Water much softer, preventing a fur on boiling, separating vegetating and colouring matter, destroying numerous water-insects, and withdrawing from solution large quantities of solid*

purification of waters. The patent process consists in the addition of lime to the water. The lime unites with the excess of carbonic acid in the water, and forms carbonate of lime (chalk), which precipitates along with the carbonate of lime held previously in solution in the water. The effect of this process is similar to that of ebullition*. It has no effect on the gypsum of common water, and, therefore, can have little or no influence in rendering hard water soft.

matter not separable by mere filtration. By Thomas Clark, Professor of Chemistry in the University of Aberdeen, 2d ed. Lond. 1841.

* The patentee asserts that his process renders water much softer, and calculates that if his patent were adopted, £63,000 would annually be saved to the metropolis by the diminished consumption of soap and soda. Unfortunately for this calculation, it does not appear that the patent process has much, if any, effect in lessening the hardness of water, since the lime used merely acts on the bicarbonate of lime held in solution in the water. Now this salt, it appears, scarcely affects soap, and, therefore, does not give to water its property of hardness. Dupasquier (*Des Eaux de Source et des Eaux de Rivière,* p. 105, Paris and Lyons, 1840) observes, that "It is generally supposed that all calcareous salts equally decompose soap; but though this is true for the sulphate and other calcareous salts directly soluble in water, as chloride of calcium and nitrate of lime, it does not hold good with regard to the carbonate, which is held in solution by an excess of carbonic acid. Numerous experiments have satisfied me," he adds, "that the latter salt has only a slight action on soap, and cannot, in the proportions in which it exists in potable waters, decompose it, by giving rise to the formation of a clotty precipitate, as we observe with sulphate and nitrate of lime and chloride of calcium. If a reason for this interesting fact be required, I should say that the non-decompositon of the soap is owing to the excess of carbonic acid, which prevents the reaction of the calcareous carbonate on the oleate and stearate of soda of the soap. This fact completely explains why the waters of the Roye, the Ronzier, the Fontaine, and the Neuville, which, at their source, contain a considerable quantity of carbonate, but extremely little sulphate of lime and chloride of calcium, dissolve soap without curdling it." Dupasquier then proceeds to detail a series of experiments in support of the above statements.

Alkaline carbonates soften water, decompose all the earthy salts (calcareous and magnesian carbonates, sulphates, and chlorides), and precipitate the earthy matters. They leave, however, in solution, an alkaline salt, but which does not communicate to water the property of hardness.

2. SEA WATER.—Under this head are included the waters of the ocean, and of those lakes, called inland seas, which possess a similar composition. The Dead Sea, however, differs exceedingly in its nature from sea water, and may properly be ranked amongst mineral waters.

The quantity of solid matter varies considerably in the waters of different seas, as the following statement from Pfaff * proves:—

10,000 parts of Water of		Solid Constituents.
The Mediterranean Sea		410 grs.
English Channel		380 „
German Ocean	At the Island of Föhr	345 „
	„ „ Norderney	342 „
	In the Frith of Forth	312 „
	At Ritzebüttel	312 „
Baltic Sea	At Apenrade, in Sleswick	216 „
	At Kiel, in Holstein	200 „
	At Doberan, in Mecklenburg	168 „
	At Travemünde	167 „
	At Zoppot, in Mecklenburg	76 „
	At Carlshamm	66 „

We shall not be far from the truth if we assume that the average quantity of saline matter is 3½ per cent.; and the density about 1·0274.

The composition of sea water varies in different localities, as the following analyses † show:—

* Schwartz's *Allgemeine und specielle Heilquellenlehre*, 2te Abt. S. 186. Leipzig, 1839.

† *Lond. and Edin. Phil. Mag.* vol. xv. p. 51, July 1839. Also, Graham's *Elements of Chemistry*, vol. i. p. 266.

Sea Water.	*Of the English Channel,* (SCHWEITZER.) Grains.		*Mediterranean.* (LAURENS.) Grains.
Water	964·74372		959·26
Chloride of Sodium	27·05948		27·22
„ „ Potassium	0·76552		0·01
„ „ Magnesium	3·66658		6·14
Bromide of Magnesium	0·02929		—
Sulphate of Magnesia	2·29578		7·02
„ „ Lime	1·40662		0·15
Carbonate of Lime	0·03301	and Magnesia	0·20
	1000·00000		00·00

Iodine has been found in the Mediterranean Sea by Balard.

Sea water, taken internally, excites thirst, readily nauseates, and, in full doses, occasions vomiting and purging. The repeated use of it, in moderate doses, has been found beneficial, on account of its alterative and resolvent operation in scrofulous affections, especially glandular enlargements and mesenteric diseases. Its topical action is more stimulant than common water. It is used as an embrocation in chronic diseases of the joints. Employed as a bath, it more speedily and certainly causes the reaction and glow; and, consequently, the sea-water bath may be used for a longer period, without causing exhaustion, than the common water-bath. It is a popular opinion, which is perhaps well founded, that patients are less likely to take cold after the use of salt water, as a bath, than after the employment of common water*.

3. MINERAL WATERS.—These are waters which be-

* On the medicinal properties of sea water, consult Logan's *Observations on the Effects of Sea Water in Scurvy and Scrophula*, Lond. 1770; and Dr. R. White, on *The Use and Abuse of Sea Water*, Lond. 1775.

long to neither of the preceding classes. In consequence of their peculiar, sensible, and chemical properties, they are not applicable as drinks, or for the general purposes of domestic economy.

Those mineral waters whose predominating active principle is iron, are called *Chalybeate* or *Ferruginous*. They are of two kinds; some contain carbonate of the protoxide of iron, and are called *Carbonated Chalybeates*, as those of Tunbridge Wells; while others contain sulphate of iron, and are termed *Sulphated Chalybeates*; as the Sand Rock Spring, Isle of Wight.

Some mineral waters are impregnated with sulphuretted hydrogen, and have, in consequence, the odour of rotten eggs. These are called *Sulphureous* or *Hepatic waters*. The Harrowgate waters are of this kind.

Those mineral waters which are brisk and sparkling, and have an acidulous taste, contain carbonic acid, and are called *Carbonated* or *Acidulous* waters; as those of Selters and Pyrmont.

The last class of mineral waters is that called *Saline*. It includes the *Purging Saline* (as of Cheltenham), the *Brine* (as of Cheshire), the *Calcareous* (as of Bath and Bristol), the *Alkaline* (as of Malvern and Teplitz), and the *Siliceous* (as of Geyser, and Reikum in Iceland).

As none of these mineral waters are employed for dietetical purposes, they do not require further notice here*.

* Further details concerning them will be found in my *Elements of Materia Medica*, vol. i. 2d ed.

4. Distilled Water.—When it has been carefully prepared and preserved, this water is nearly pure. Its taste is flat, mawkish, and by no means agreeable, in consequence of the absence of air and carbonic acid. It is unaffected by solutions of acetate of lead, nitrate of silver, oxalate of ammonia, chloride of barium, or soap. It usually contains traces of organic matter.

Dr. Wm. Heberden * suggests its dietetical employment as a substitute for common water, where this was bad and productive of diseases. But the greatest advocate for its use, in modern times, is Dr. Lambe †, who, regarding the presence of decomposing organic matter, in common waters, as noxious, and as the prolific source of many constitutional diseases, proposed distillation as the most certain mode of getting rid of it. But while, on the one hand, neither the public nor the profession has adopted his opinion of the injurious qualities of common water,—on the other hand, the difficulties and expense of procuring a sufficient supply of distilled water offer a serious, if not fatal impediment to its extended and general use. Moreover, it is well known that distilled water, as ordinarily met with, contains traces of organic matter.

In some calculous affections, as the oxalate of lime diathesis, the employment of distilled water is one of the remedial means which have been suggested.

The distillation of water at sea, for the use of

* *Remarks on the Pump Water of London*, in the *Medical Transactions published by the College of Physicians in London*, vol. i.

† *Reports of the Effects of a peculiar Regimen on Scirrhous Tumours and Cancerous Ulcers.* 1809.—*Additional Reports on the Effects of a peculiar Regimen.* 1815.

mariners, is an old suggestion. The proposition seems a very feasible one, as it may be effected at a moderate expense, and all danger of distress from want of water thereby avoided. Coulier * has more recently insisted on the advantages to be obtained by the use of distilled water on ship-board, as well as in other places where serious maladies have been ascribed to the use of impure water.

2. THE MUCILAGINOUS OR GUMMY ALIMENTARY PRINCIPLE.

(Mucilaginosa. Gummata.)

The organisable principle termed *gum* exists almost universally in plants, and appears to hold the same position in the vegetable economy that albumen does in the animal. It is found in great abundance in some plants, from which it frequently exudes spontaneously, and concretes on the stem in the form of tears. In this way are obtained *Gum Arabic, Gum Senegal, East Indian, Barbary,* and *Cape Gums, Gum Tragacanth,* the *Gum of Cherry* and *Plum-trees,* and *Gum Bassora.*

The following table shews the quantity of gummy matter contained in various vegetable substances used as food:—

QUANTITY OF GUM CONTAINED IN 100 PARTS OF THE FOLLOWING FOODS.

	Gum.	Authority.
Barley-meal	4·62	Einhof.
Oatmeal	2·5	Vogel.
Wheat-flour	2·8 to 5·8	Vauquelin.
Wheat-bread	18·0	Vogel.
Rye-meal	11·09	Einhof.
Maize	2·283	Bizio.
Rice	0·1 to 0·71	Braconnot.
Peas	6·37	Einhof.
Garden Bean (*Vicia Faba*)	4·61	Ditto.
Kidney Bean (*Phaseolus vulgaris*)	19·37	Ditto.
Potatoes	3·3 to 4·1	Ditto.
Cabbage	2·89	Schrader.
Sweet Almonds	3·0	Boullay.
Green Gage (ripe)	4·85	Berard.
Pears (ripe and fresh)	3·17	Ditto.
Gooseberries (ripe)	0·78	Ditto.
Cherries (ripe)	3·23	Ditto.
Apricot (ripe)	4·85	Ditto.
Peach (ripe)	5·12	Ditto.
Linseed	5·2	Meyer.
Marshmallow-root	35·64	Buchner.

* *Comptes Rendus,* 1841, p. 968.

The gummy matters of different plants differ one from another in several of their properties. Some are soluble in water (*soluble gum*); others, however, merely swell up, and do not completely dissolve in this liquid (*insoluble gum*). The following table shews the relative proportion of soluble and insoluble gummy matters contained in certain mucilaginous alimentary substances:—

PROXIMATE COMPOSITION OF SOME MUCILAGINOUS ALIMENTARY PRINCIPLES.

100 Parts	Soluble Gum.	Insoluble Gum.	Water.	Ashes.
Gum Arabic	79·40	—	17·60	3·0
„ Senegal	81.10	—	16·10	2·8
„ Cherry-tree	87·30	—	11·20	1·5
„ Apricot-tree	89·85	—	6·82	3·33
„ Plum-tree	82·83	—	15·15	2·02
„ Peach-tree	82·60	—	14·21	3·19
„ Almond-tree	83·24	—	13·79	2·97
„ Bassora	11·20	61·31	21·89	5·60
„ Tragacanth	53·30	33·10	11·10	2·50
Mucilage of Linseed	52·70	29·89	10·30	7·11

Gum consists of carbon and the elements of water.

COMPOSITION OF GUM.

100 Parts	Carbon.	Water.	Authority.
Gum Arabic	36·3	63·7	Prout.
Ditto, dried at 212°	41·4	58·6	Prout.
Ditto, dried *in vacuo*	42·682	50·944 *Oxyg.* + 6·374 *Hydr.*	Berzelius.
Ditto, dried at 324·5	45 10	48·8 „ + 6·1 „	Mulder.

The atomic formula which agrees with Berzelius's analysis is C^{12} + $Aqua^{11}$: whereas Mulder's analysis gives C^{12} + $Aqua^{10}$ as the formula.

Some mucilaginous substances yield nitrogen; but it is doubtful whether this is contained in the mucilage itself or in some foreign matter. From mucilage of linseed, Guerin procured 7·27 per cent. of nitrogen.

Gum is usually considered to possess nutritive properties, but to be somewhat difficult of digestion, and, therefore, apt to disagree with dyspeptics. According to Liebig, it is merely an element of respiration (see pp. 31, 36, 37, and 38). "From the chemical properties and analogies of this principle," says Dr. Prout *, "it is probable that it is neither converted (at least so readily) into sugar nor oxalic acid as farinaceous matters." May it not be advantageously substituted for sugar and amylaceous substances, in diabetes?

Gum is sometimes employed, as a dietetical agent, by invalids. It is useful as a demulcent or sheathing agent in inflammatory affections of the mucous membranes. Gum Arabic is slowly dissolved in the mouth to allay troublesome cough and irritation of the throat. It is also used in irritation of the intestinal canal, and of the urinary organs. It may be taken dissolved in milk.

The preparations of gum in use are, Gum Water, Mucilage, Gum Lozenges, and Gum Pastes (*Pâtes*).

1. *Gum Water.*—Take of Gum Arabic from half an ounce to an ounce. Wash it in cold water to remove

* *On the Nature and Treatment of Stomach and Urinary Diseases*, p. 299. 1840.

any bitter matter, and then dissolve it, by maceration, in two pints of cold water. When made with either powdered gum or hot water, the flavour of the solution is less agreeable. Gum water is employed as a demulcent drink in colds and coughs, and in inflammatory affections of the alimentary canal and urinary organs.

2. *Mucilage.*—Take of Gum Arabic nine ounces; wash it with a little cold water, tie it up in a linen bag, and macerate it in one pint of cold water, occasionally squeezing it gently. Its uses are similar to those of gum water. It is sometimes employed as a vehicle for the exhibition of medicinal powders.

3. *Gum Arabic Lozenges.*—Gum Arabic is a constituent of most kinds of lozenges, but of one kind (gum lozenges), it is the essential ingredient; the other constituents being sugar and starch. These are employed as an agreeable pectoral, to allay the tickling in the throat which provokes coughing.

4. *Gum Pastes* (Pâtes).—These consist essentially of gum and sugar, to which some medicinal substance is sometimes added. They are transparent or opaque. The *Pâte de Jujubes* is a transparent gum paste, coloured either pink or yellow. It should be flavoured with a decoction of jujubes (the fruits of *Zizyphus vulgaris*). It is a popular remedy to allay teasing coughs. The *Pâte de Gomme Arabique* or *Gum Paste,* commonly called *Pâte de Guimauve* or *Marshmallow Paste,* consists of gum, sugar, and white of eggs, flavoured with orange-flower water. Formerly an infusion of marshmallow root was used in its preparation. It is opaque, and is employed as a pectoral.

3. THE SACCHARINE ALIMENTARY PRINCIPLE.

(Saccharina.)

Saccharine matter exists in both vegetables and animals. In the former it is very generally distributed. The following table shows the quantity of it which is contained in various alimentary substances.

QUANTITY OF SACCHARINE MATTER CONTAINED IN 100 PARTS OF THE FOLLOWING FOODS.

	Sugar.	*Authority.*
Barley-meal	5·21	Einhof.
Oat-meal (including bitter matter)	8·25	Vogel.
Wheat-flour	4·2 to 8·48	Vauquelin.
Wheat-bread	3·6	Vogel.
Rye-meal	3·28	Einhof.
Maize	1·45	Gorham.
Rice	0·05 to 0·29	Braconnot.
Peas	2·0	Einhof.
Sweet Almonds	6·0	Boullay.
Figs	62·5	Bley.
Green Gage (ripe)	11·61	Berard.
Tamarinds	12·5	Vauquelin.
Pears (ripe and fresh)	6·45	Berard.
Ditto (kept for some time)	11·52	Ditto.
Gooseberries (ripe)	6·24	Ditto.
Cherries (ripe)	18·12	Ditto.
Apricot (ripe)	11·61	Ditto.
Peach (ripe)	16·48	Ditto.
Melon	1·5	Payen.
Expressed Carrot juice evaporated to dryness	93·71	Wackenroder.
Beet-root	5 to 9	Payen.
Ditto	5·8 to 10	Pelouze.
Cow's Milk	4·77	O. Henry and Chevallier.
Ass's Milk	6·08	
Woman's Milk	6·50	
Goat's Milk	5·28	
Ewe's Milk	5·00	

The substances to which I apply the term saccharine are not uniform in their properties; but differ more or less from each other in their susceptibility of undergoing the process of vinous fermentation, in their crystallisability, solubility, and composition.

TABLE OF SACCHARINE MATTERS.

Saccharine Matters susceptible of Vinous Fermentation (Sugars properly so called).	*Saccharine Matters unsusceptible of Vinous Fermentation.*
1. CRYSTALLISABLE. This division includes three kinds of Sugar: a. *Common Sugar*, comprehending Cane, Maple, and Beet-root Sugar, whose formula is C^{12} *Aqua*^{11}. b. *Sugar of Milk* or *Lactine*, composed of C^{12} *Aqua*^{12}. c. *Granular Sugar* or *Glucose*, including the Sugar of Fruits (as of Grapes), and Diabetic Sugar, whose formula is C^{12} *Aqua*^{14}. 2. UNCRYSTALLISABLE. This division comprehends the liquid or mucous sugars, as Treacle.	1. CRYSTALLISABLE. This division includes *Mannite* (and *Canellin?*) whose formula, according to Liebig, is $C^6 H^7 O^6$. 2. UNCRYSTALLISABLE. This division comprehends at least two kinds of sugar. a. *Glycyrrhizin* or *Liquorice Sugar.* b. *Glycerine, Hydrated Oxide of Glycerule*, or *Sweet Principle of Oils*, whose formula is $C^6 H^7 O^5$ + *Aqua*.

The following table shows the relative proportions of carbon and water (or its elements) contained in several varieties of saccharine matters, according to Dr. Prout * :—

COMPOSITION OF SACCHARINE SUBSTANCES.

100 Parts.	*Carbon.*	*Water.*
Pure Sugar Candy	42·85	57·15
Impure ditto	41·5 to 42·5	58·5 to 57·5
East India ditto	41·9	58·1
English refined	41·5 to 42·5	58·5 to 57·5
East India refined	42·2	57·8
Maple	42·1	57·9
Beet-root	42·1	57·9
East India moist	40·88	59·12
Diabetic	36 to 40?	64 to 60?
Of Narbonne Honey	36·36	63·63
Of Starch	36·2	63·8
Of Milk	40·0	60·0

* *Phil. Trans.* for 1827, p. 355.

Those varieties which contain the smallest quantity of water, Dr. Prout terms *strong* or *high;* while such as contain the largest proportions, he denominates *weak* or *low*. Thus sugar-candy is a high or strong sugar, —sugar of starch a weak or low one.

Sugar is usually regarded as a nutritious substance, but Liebig declares that it is merely an element of respiration, as I have already stated. (See pp. 31, 35 foot-note, 36, 37, 38, 44, 48, and 53). Many insects (especially the *Lepidoptera*, *Hymenoptera*, and *Diptera*) feed on sugar or saccharine liquids. During the sugar season of the West India Islands "every negro on the plantations, and every animal, even the dogs, grow fat *." The injurious effects which have been ascribed to sugar are more imaginary than real; for some individuals have consumed large quantities of it, for a long series of years, without suffering any ill consequences therefrom. We are told that Henry Duke of Beaufort, who died about 1702, ate nearly a pound of sugar daily for 40 years. He died of fever in the 70th year of his age. He was never troubled with cough, his teeth were firm, and all his viscera were found, after death, quite sound †.

The fondness of children for saccharine substances may be regarded as a natural instinct; since nature, by placing it in milk, evidently intended it to form a part of their nourishment during the first period of their existence. Instead, therefore, of repressing this

* Dr. Wright, *Medicinal Plants of Jamaica.*

† See Dr. Slare's *Vindication of Sugar*, p. 59. Lond. 1715.

appetite for sugar it ought rather to be gratified in moderation. The popular notion of its having a tendency to injure the teeth is totally unfounded. "It has been alleged," says Dr. Wright, "that the eating of sugar spoils the colour of, and corrupts, the teeth: this, however, proves to be a mistake, for no people on the earth have finer teeth than the negroes in Jamaica." It is probable, therefore, that this erroneous notion has been propagated by frugal housewives in order to deter children from indulging in an expensive luxury.

Sugar is readily digested by the healthy stomach; though, in some dyspeptic individuals, it is apt to give rise to flatulency and preternatural acidity of stomach. In these cases it probably yields lactic acid *. "In certain diseases," says Liebig †, "there

* Anhydrous lactic acid (in lactate of zinc) consists of $C^6 H^5 O^5$. Hence one equivalent of crystallized Cane Sugar ($C^{12} H^{11} O^{11}$) contains the elements of two equivalents of lactic acid 2 ($C^6 H^5 O^5$) *plus* one equivalent of water. But when lactic acid is formed out of sugar, there are also produced mannite and mucilage (hence the process is termed the *viscous* or *mucilaginous fermentation*), while gas is evolved. Now, two equivalents of mannite 2 ($C^6 H^7 O^6$) are equal to one equivalent of granular sugar ($C^{12} H^{11} O^{11}$) *minus* two equivalents of oxygen. Consequently one equivalent of lactic acid ($C^6 H^5 O^5$) and one equivalent of mannite ($C^6 H^7 O^6$) are equal to one equivalent of sugar of milk *minus* one equivalent of oxygen.

1 eq. Lactic Acid .	$C^6 H^5 O^5$	1 eq. Sugar of Milk	$C^{12} H^{12} O^{12}$
1 eq. Mannite . .	$C^6 H^7 O^6$	Abstract . . .	— — O
Total .	$C^{12} H^{12} O^{11}$	Residue .	$C^{12} H^{12} O^{11}$

Liebig suggests that lactic acid and mannite may, therefore, be formed by the deoxidation of sugar,—part of the oxygen of which is consumed in the oxidation of the elements of the nitrogenised substances present in the fermenting liquids.

† *Animal Chemistry*, pp. 111—112.

are produced from the starch, sugar, &c. of the food, lactic acid and mucilage. These are the very same products which are produced out of sugar by means of membrane in a state of decomposition out of the body; but in a normal state of health, no lactic acid is formed in the stomach."

In diabetes, the power of assimilating saccharine matter is in a great measure, if not wholly, lost; and hence, therefore, the dietetical employment of sugar and sweet foods, in this malady, is highly improper. In the oxalate of lime diathesis, likewise, these foods are objectionable. "I have seen repeated cases," says Dr. Prout, "in which the too free use, or rather abuse, of sugar, has given occasion to the oxalic acid form of dyspepsia; and sooner or later, under favourable circumstances, to the formation of an oxalate of lime calculus." In the phosphatic diathesis, the copious use of unrefined sugar is objectionable, on account of the lime contained in it.

The varieties and preparations of sugar used for dietetical purposes are very numerous. The following are all which it is necessary to notice:—

1. *Purified or Refined Sugar.*—This is met with in the shops either in conical loaves (*Loaf Sugar*), or truncated cones called lumps (*Lump Sugar*), of various sizes and degrees of purity. Small lumps are called *Titlers*. The finest refined sugar is perfectly white, and is termed *double refined;* the inferior kind has a slightly yellowish tint, and is called *single refined.* Both varieties are compact, porous, friable, and made up of small crystalline grains.

2. *Brown Sugar* * occurs in commerce in the form of a coarse powder, composed of shining crystalline grains. It is more or less damp and sticky, and has a peculiar smell and a very sweet taste. Its colour is brownish yellow, but varies considerably in intensity. *Muscovado* or *raw sugar*, sometimes termed *Foot Sugar*, has the deepest colour, and is intermixed with lumps. *Bastard* is a finer kind prepared from molasses, and the green syrups.

Raw sugar contains several impurities from which it may be freed by the process of refining. Its colour is owing to the presence of *uncrystallisable sugar* (treacle). In an aqueous solution of raw sugar *lime* is detected by oxalic acid. By keeping, it is well known that a strong raw sugar becomes weak, that is, soft, clammy, and gummy. This change Professor Daniell † ascribes to the action of the lime. *Subphosphate of lime* is another constituent of raw sugar ‡. *Glutinous* and *gummy matters*, and traces of *tannic acid*, are also present in raw sugar. The *crystal sugar* brought from Demerara (and St. Vincent's?) is the

* Brown sugar is extensively adulterated with sugar prepared from potato-starch, as well as with that made from sago-flour. Potato sugar is manufactured at Stratford, in Essex. It is clammy, and wants that sparkling crystalline appearance possessed by West Indian sugar, is much less sweet than the latter, and possesses a bitter somewhat unpleasant taste. Trommer (*Pharm. Central-Blatt für* 1841, p. 762—4) and more recently Krantz (*Annals of Chymistry*, Nov. 11, 1842) have pointed out the means of detecting sugar of starch in cane sugar.

† *Quarterly Journal of Science*, vol. vi. p. 38.

‡ Avequin (*Journal de Pharmacie*, tom. xxvii. p. 15) states that the crust, which deposits in the boilers during the manufacture of raw sugar, contains, after it has been calcined to destroy the saccharine and other vegetable matters, in 100 parts, *subphosphate of lime* 92·43, *lime*, in part carbonated, 1·35, *silica* 4·7, and *phosphate of copper* 1·41.

finest and purest kind of the coloured sugars which are imported. Its colour is pale yellow, and its crystals are larger and more brilliant than the preceding varieties. It is used for sweetening coffee. On account of the before-mentioned impurities, unrefined sugar is an improper article of diet for those afflicted with calculous disorders.

3. *Sugar Candy.*—This is crystallised cane-sugar. It is prepared from concentrated syrup. The crystals deposit themselves, as the liquid cools, on the sides of the vessel and on strings stretched across. The form of the crystals is an oblique rhombic prism. Three kinds of candy are sold—the *white*, the *brown*, and the *pink*. Powdered candy is used to sweeten coffee.

4. *Aqueous Solutions of Sugar.*—*Sugar water* is frequently used at the table on the continent. *Syrup* is prepared by dissolving two pounds and a half of sugar in a wine-pint of water, by the aid of a gentle heat. If necessary, it may be clarified by white of egg. It is used for sweetening.

5. *Boiled Sugars.*—If a small quantity of water be added to sugar, the mixture heated till the sugar dissolves, and the solution boiled to drive off part of the water, the tendency of the sugar to crystallise is diminished, or, in some cases, totally destroyed. To promote this effect, confectioners sometimes add a small portion of cream of tartar to the solution while boiling. Sugar, thus altered by heat, and sometimes variously flavoured, constitutes several preparations sold by the confectioner. *Barley Sugar* and *Acidulated Drops* are prepared in this way from white

sugar;—powdered tartaric acid being added to the sugar while soft, when the drops are prepared. *Hardbake* and *Toffee* are made by a similar process from brown sugar. Toffee differs from Hardbake in containing butter. The ornamental sugar-pieces or *caramel*-tops with which pastry-cooks decorate their tarts, &c. are prepared in the same way. If the boiled and yet soft sugar be rapidly and repeatedly extended, and pulled over a hook, it becomes opaque and white, and then constitutes *Pulled Sugar* or *Penides.* Pulled sugar, variously flavoured and coloured, is sold in several forms by the preparers of hard confectionary.

6. *Molasses and Treacle.*—The brown, saccharine, viscid fluid, which drains from raw sugar when placed in hogsheads, is called *Molasses,* and is used in the preparation of brown sugar. It is imported from the West Indies in casks. Closely allied to this is *Treacle*—a viscid, dark-brown, uncrystallisable syrup, which drains from the moulds in which refined sugar concretes. These liquids result from an alteration effected in crystallisable sugar, and do not exist in the sugar cane. Both of them contain free acid.

7. *Burnt Sugar.*—When sufficiently heated, sugar becomes brown, evolves a remarkable odour, loses its sweet taste, and acquires bitterness: in this state it is called *Caramel* or *Burnt Sugar,* and is sold, when dissolved in water, as a colouring matter, under the name of *Essentia Bina* or *Browning.* It is used to colour soups and sauces. The high coloured brandies and dark brown sherries are said sometimes to owe part of their colour to this liquor. The brewer, it is reported, occasionally makes use of it to colour his beer.

8. *Hard Confectionary.*—Sugar constitutes the base

of an almost innumerable variety of hard confectionary, sold under the names of *Lozenges, Brilliants, Pipe, Rock, Comfits, Nonpareils,* &c. Besides sugar, these preparations contain some flavouring ingredient, often flour or gum, to give them cohesiveness, and frequently colouring matter*. Caraway fruits, almonds, and pine seeds, constitute the nuclei of some of these preparations.

9. *Liquorice Sugar.*—An aqueous extract of the root of liquorice (*Glycyrrhiza*) is extensively imported under the names of *Liquorice Juice*, or, according to the countries from whence it is brought, of *Spanish* or *Italian Juice. Solazzi Juice* is most esteemed. The Spanish extract is prepared in Catalonia, from the common liquorice plant (*Glycyrrhiza glabra*), but the Italian extract, obtained in Calabria, is procured from *G. echinata*. Extract of liquorice is imported in cylindrical or flattened rolls, of five or six inches long, and about one inch in diameter, enveloped in bay-leaves. Its principal constituent is *Glycyrrhizin*, or *Liquorice Sugar*, mixed with some foreign matters. If the foreign extract be dissolved in water, and the solution filtered and evaporated, we obtain *Refined Liquorice;* but the *Pipe Refined Liquorice* of the shops is a very adulterated article. The *Pontefract Lozenges* are made of refined liquorice, and are much esteemed. The *Liquorice Lozenges* are officinal in the Edinburgh Pharmacopœia, and are directed to be prepared of

* Cochineal and indigo, employed to colour respectively red and blue, are harmless. But, in order to meet the demands of their customers, confectioners are necessitated to use other colouring ingredients, of a less innocent nature, to give several admired tints (yellow and green) to their goods.

extract of liquorice, gum, and sugar. There is also another liquorice lozenge sold in the shops, under the name of *Quintessence of Liquorice.* Extract of liquorice is used as a flavouring ingredient. Slowly dissolved in the mouth, it is taken to appease tickling cough, and to allay irritation of the fauces.

10. *Preserves, &c.*—In addition to its dietetical and condimentary uses, sugar is extensively employed, in domestic economy, as an antiseptic; that is, to prevent the decomposition or putrefaction of organic substances. A variety of fruits, as well as some roots, stems, and even leaves, are in this way preserved, some in the moist state (as *Fruits in Syrup*, and *Preserved Ginger*) others in the dry state (as *Candied Angelica, Candied Citron, Orange, and Lemon Peels, and Crystallised Fruits*). In these cases sugar acts by excluding air, or by absorbing moisture, or in both of these ways. In some instances, perhaps, its efficacy may be of another kind, as when it promotes the solidification of vegetable jelly. (See *The Pectinaceous Alimentary Principle.*) "Latterly," says Berzelius (*Traité de Chimie*, t. v., p. 243), "sugar has begun to be more generally employed than formerly for the preservation of meat, in consequence of a much smaller quantity of it being required for preventing putrefaction, than of salt, while it renders the meat neither less savoury nor less nutritive. Fish, when gutted, may be equally well preserved by spreading powdered sugar inside them."

4. THE AMYLACEOUS ALIMENTARY PRINCIPLE.

(Farinaceous or Starchy Substances.)

This principle is peculiar to plants, from which it is obtained under the various names of *Amylum,** *Starch*, *Fecula*, or *Farinaceous Matter*. It is very generally distributed in the vegetable kingdom, existing in both cryptogamic and flowering (endogenous and exogenous) plants, and being found in thallus, roots, stems, tubercles, fruits, and seeds.

The following table gives an approximative idea of the quantity of starch contained in different parts of plants.

QUANTITY OF STARCH IN 100 PARTS OF THE FOLLOWING VEGETABLE ORGANS.

		Starch.	*Authority.*
1. *Thallus.*	Iceland Moss	44·6 †	Berzelius.
2. *Roots.*	Janipha Manihot or Tapioca plant (var. red)	13·5	De Candolle.
	Ditto (var. green)	11·5	Ditto.
	Ipomœa Batatas	7·5	Ricord.
	Ditto (var. red)	13·3	O. Henry.
3. *Tubercles.*	Potatoe (var. kidney)	9·1 ‡	Einhof.
	Ditto (var. red)	15·0 §	Ditto.
	Ditto (var. Shaw)	18·8 ‖	Vauquelin.
	Ditto (var. Champion)	15·9 ¶	Ditto.
	Ditto (var. Chair rouge)	12·2 **	Ditto.
	Ditto (var. L'Orpheline	24·4 ††	Ditto.
	Ditto (var. Captain Hart)	15	Skrimshire.
4. *Rhizomes.*	Maranta arundinacea or Arrow-root plant	12·5	De Candolle.
	Ditto	26·0	Benzon.
	Canna coccinea	12·5	De Candolle.
	—— indica	3·3	Ditto.
	Ginger	13·0	Ditto.
	Ditto	19·75	Bucholz.
	Turmeric	26·0	De Candolle.
	Dioscorea sativa, or the Yam	12·5	Ditto.
	Ditto	22·66	Süersen.

* The Greeks called it ἄμυλον (from α negative, and μύλος *a mill*) because it was not prepared by grinding in a mill. (See Pliny, *Hist. Nat.* lib. xviii. cap. 17. ed. Valp.)

† Besides 36·2 parts of amylaceous fibre.

‡ In addition to 8·8 parts of amylaceous fibre.

§ Also 7·0 parts of amylaceous fibre.

‖ In addition to 5·1 parts of amylaceous fibre.

¶ Besides 4·9 parts of amylaceous fibre.

** And 10·2 parts of amylaceous fibre.

†† Also 6·2 parts of amylaceous fibre.

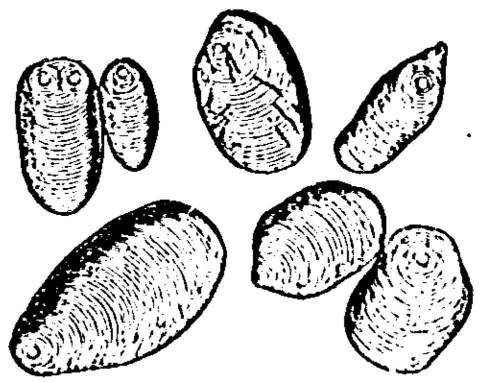
		Starch.	*Authority.*
5. *Pericarps.*	Artocarpus incisa, or Bread-fruit	3·2	De Candolle.*
	—— integrifolia, or Jak-fruit	6·2	Ditto.
6. *Seeds.*	Barley-meal	67·18	Einhof.
	Oatmeal	59.0	Vogel.
	Wheat-flour	56·5 to 72	Vauquelin.
	Wheat-bread	53·5	Vogel.
	Rye-meal	61·07	Einhof.
	Maize	80·92	Bizio.
	Rice (*Piedmont*)	82·8	Braconnot.
	Ditto (*Carolina*)	85·07	Ditto.
	Peas	32·45	Einhof.
	Garden Bean (*Vicia Faba*)	34·17	Ditto.
	Kidney Bean (*Phaseolus vulgaris*)	35·94	Ditto.

The amylaceous substances are organised. Examined by a microscope they are seen to consist of small grains, which are usually rounded, or elliptical, flask-shaped or mullar-shaped, or polyhedral. The polyhedral form probably arises from the mutual compression of numerous grains in the same or neighbouring cells. On some part of the surface of each grain is a circular spot, called the *hilum:* very rarely, two or even three of these spots are observed on the same grain. According to Raspail, the hilum is the spot where the starch-grain was adherent to the vegetable cell in which these grains are contained. The hilum usually cracks in a linear or stellate manner. Starch grains have a laminated texture: that is, they consist of a series of concentric layers or membranes, the outermost of which is the thickest or firmest. To these layers is owing the appearance of concentric rings or rugæ which starch grains present on their surface, and which are most evident in grains of Tous les Mois and of Potato Starch.

* *Physiologie Végétale*, vol. i. See also some experiments on the quantity of starch in various plants, by Dr. Clark, in the *Medical Facts and Observations*, vol. vii. 1797.

MICROSCOPIC APPEARANCE OF STARCH GRAINS.

(Drawn to one scale.)



Grains of Tous les Mois or Canna Starch.

Grains of Potato Starch.

a, Normal starch particle (Fritzsche).
b, Irregular ditto.
c, *d*, Particles each having two hila.
e, *f*, *g*, Particles broken by pressure and water; the internal matter remains solid (Payen).

Grains of West-Indian Arrow-Root.

Grains of Sago Meal.

Entire Grains of Tapioca.

Grains of Tahiti Arrow-Root, or Otaheite Salep.

Grains of East-Indian Arrow-Root.

Grains of Wheat-starch.
a, A particle seen edgeways.

Grains of Portland Arrow-Root.

The organic principle of which starch-grains are composed is called *amidon* or *amylon*. This substance consists of carbon and water (or its elements).

COMPOSITION OF STARCH.

	Carbon.	*Water.*	*Authority.*
Fine Wheat Starch	37·5	62·5	
Ditto, dried at 212°	42·8	57·2	Prout.
Ditto, highly dried at 350° . .	44·0	56·0	Prout.
Arrow-root	36·4	63·6	Prout.
Ditto, dried at 212°	42·8	57·2	Prout.
Ditto, highly dried at 212° . .	44·4	55·6	Prout.

The formula which agrees with Prout's third analysis of Arrow-root is C^{12} + *Aqua*^{10}.

The starchy matter (called *Lichenin* or *Feculoid*) of Iceland Moss consists, according to Guerin-Varry, of $C^{10}\ H^{11}\ O^{10}$. If the analysis be correct, this variety of starch contains excess of hydrogen.

To render amylaceous matter digestible, it requires to be cooked in order to break or split the grains *; for, of the different laminæ of which each grain con-

* "Fecula," says Raspail (*Chim. Organique*), "is not actually nutritive to man until it has been boiled [or otherwise cooked]. The heat of the stomach is not sufficient to burst all the grains of the feculent mass which is subjected to the rapid action of this organ. The stomach of graminivorous animals and birds seems to possess, in this respect, a particular power; for they use feculent substances as food in a raw state. Nevertheless, recent experiments prove the advantage that results from boiling the potatoes and partially fermenting the farina which are given them for food. At all events, it is certain, that bruised grain is much more nutritive for them than that which is entire; for a large proportion of the latter passes through the intestines perfectly unaffected as when it was swallowed."

Braconnot (*Journ. de Chim. Méd.* t. iii. 2e Sér. p. 428—430) found unbroken starch grains in the excrement of a slug; the temperature of sists, the outer ones are the most cohesive, and present the greatest resistance to the digestive power of the stomach, while the internal ones are the least so. Hence farinaceous substances are boiled in milk or water,—or they are panified with gluten, by which the grains are completely broken up—or they are made into puddings and tarts.

When cooked, it is usually regarded as a mild, slightly nutritious, easily digestible article of food. Directly or indirectly, observes Dr. Prout *, " it forms a constituent of the food of most of the higher animals, as well as of man. It differs, therefore, from sugar, in being a *necessary* article of food, without which animals could not exist; while sugar is not. Hence a much larger quantity of amylaceous matter than of sugar can be taken; and what is a still more decisive fact, the use of this larger quantity of amylaceous matter may be persisted in for an unlimited period, which, it appears, is not the case with a large portion of sugar."

By digestion, starch becomes converted into gum and sugar; the latter probably becomes absorbed. This conversion is effected, according to Leuchs, by the action of the saliva †.

this cold-blooded mollusk being insufficient to crack the grains. Unbroken grains, he states, are also found in the excrements of hot-blooded animals fed on raw potatoes. Hence, he adds, the potatoes employed for feeding cattle should be boiled; since, independently of the accidents which may arise from the use of them in the raw state, a considerable quantity of alimentary matter is lost by the employment of these tubercles in the unboiled state.

* *On the Nature and Treatment of Stomach and Urinary Diseases*, p. x. Lond. 1840.

† Müller's *Physiology*, by Baly, vol. i. p. 548.

The exterior laminæ of the starch-grain are thicker, more cohesive, and less readily digested, than the inner ones. Leeuwenhoek * observed that the excrements of birds fed on the cereal grains contained a considerable quantity of these exterior laminæ, but without the interior matter; and from this he inferred that the latter only was the nutritive portion of starch.

According to Liebig (see *ante*, p. 31), starch being a non-nitrogenised food †, is an element of respiration, and is incapable of transformation into blood or organised tissues. He, therefore, regards it as an element of respiration, and as contributing to the formation of fat (see *ante*, p. 53). " Children fed upon arrow-root, salep, or indeed any kind of amylaceous food, which does not contain ingredients fitted for the formation of bones and muscles, become fat, and acquire much *embonpoint*; their limbs appear full, but they do not acquire strength, nor are their organs properly developed ‡."

The times required for the digestion of some amylaceous matters, are, according to Dr. Beaumont §, as follows :—

* Quoted by Guibourt (*Hist. Abrég. des Drogues simples*, t. ii. p. 447. 3me ed.)

† Jacquelain (*Ann. de Chim. et de Physique*, t. lxxiii. p. 167—207) states, that both starch and its granules contain from 0·24 to 0·31 per cent. of nitrogen.

‡ Liebig, *Chemistry in its Application to Agriculture and Physiology*, p. 128-9, foot note, 2d ed. 1842. Very recently, Dumas (*Annals of Chymistry*, Nov. 11, 1842) has denied that animals have the power of forming fat; and he asserts that the fat of animals is derived immediately from the fatty substances contained in the food on which the animals feed.

§ *Experiments and Observations on the Gastric Juice and the Physiology of Digestion.* By W. Beaumont, M.D. Reprinted from the Plattsburg edition, with notes by Dr. Combe. Edinb. 1838.

DIGESTIBILITY OF AMYLACEOUS MATTER.

	Time required for Stomachal Digestion.
Sago boiled	1 hour.
Tapioca boiled	2 hours.

It is doubtful whether tapioca is uniformly more difficult of digestion than sago.

Farinaceous food is, perhaps, the least irritating of all kinds of aliments. It is, therefore, well adapted for the use of persons affected with morbidly sensible conditions of the primæ viæ. It will sometimes remain on the stomach when every other kind of nutriment is immediately rejected. Being totally devoid of all stimulating properties, it is a useful and valuable article of food in febrile and inflammatory diseases.

The following are the varieties of amylaceous matter in common use for dietetical purposes:—

1. *Sago.*—This is obtained from the interior tissue (commonly termed medulla or pith) of the stems of various species of palms, especially those of the genera Sagus and Saguerus. It is manufactured in the Moluccas, and is imported into this country from Singapore. Three kinds of it are met with—namely, Sago-meal, Pearl Sago, and Common Sago. *Sago-meal* (called also *Sago-flour* or *Sago-powder*) is a whitish powder, which is now, or very recently was, extensively used in the manufacture of a saccharine substance, called *Sago-sugar* (see p. 117). *Pearl-sago* consists of small pinkish or yellowish grains, about the size of a pin's head. It is the kind in general use for domestic purposes. *Common* or *Brown Sago* occurs in grains varying in size from that of grains of pearl-barley to that of peas. Its colour is brownish

white; each grain being whitish on one part of its surface, and brownish on another. Of these three varieties of sago, one only, namely pearl-sago, swells up in cold water, and yields an infusion which becomes blue on the addition of iodine. This arises from its having been subjected to heat in the process of manufacturing it, whereby its grains have become ruptured. All the kinds of sago contain colouring matter, which renders them inferior to those amylaceous substances (*e.x.* West Indian arrow-root and tapioca) which are perfectly white. By bleaching, however, pearl-sago may be rendered perfectly white. *Bleached Pearl-sago* resembles an imitation sago manufactured in France from potato-starch. The microscope readily distinguishes *Potato-sago* from the genuine sago.

Sago is nutritive, and easy of digestion. It is an important article of food in some parts of the East. "The Malay sago-palm," says Dr. Roxburgh, "is the tree the pith of which is the staff of life to the inhabitants of the Moluccas." In England, *Sago puddings* (made like tapioca puddings) are occasionally brought to the table. But the principal use of sago is to yield a light, nutritious, easily digestible, and non-irritating article of food for the invalid, in febrile and inflammatory cases. *Sago milk* is prepared by soaking an ounce of sago in a pint of cold water for an hour, pouring off this water, and adding a pint and a half of good milk, and boiling slowly until the sago is well incorporated with the milk (Dr. A. T. Thomson*). Sugar, an aromatic

* *The Domestic Management of the Sick Room.* Lond. 1841.

(as nutmeg), and a little white wine, are occasionally added for flavouring, when their use are not contraindicated. In cases where milk is apt to disagree with the patient, *Sago gruel* (Sago mucilage) may be substituted for sago milk. It is prepared by macerating an ounce (or a table-spoonful) of sago in a pint of water, on the hob or hot-plate, for two hours, then boiling for fifteen minutes, assiduously stirring during the boiling (Dr. A. T. Thomson). Sugar, lemon juice, an aromatic (as nutmeg or ginger), and white wine, are occasionally permitted for flavouring. Sago gruel containing all these ingredients is called, by Dr. A. T. Thomson, *Sago posset*.

Dr. Christison states that sago has come into use, in this country, for feeding domestic animals, and especially the horse.

2. *Tapioca.*—The tuberous root of the poisonous plant *Janipha Manihot* yields a large quantity of amylaceous matter, which is imported into this country from the Brazils. When it comes over in the form of a white powder it is called *Brazilian Arrow-root*, *Tapioca-meal*, *Mandiocca*, *Moussache* or *Cipipa*. But it is usually met with in the shops in the form of irregular small lumps, and in this state is called *Tapioca*. It has acquired this form in consequence of having been dried on hot plates. The heat used in its preparation breaks the starch globules, and renders them partially soluble in cold water. Hence an infusion of tapioca in cold water yields, after filtration, a blue colour with iodine. In boiling water, tapioca becomes tremulous, gelatiniform, transparent, and viscous.

In its nutritious qualities tapioca agrees with sago,

than which it is much purer, being free from colouring matter. It also yields a more consistent jelly than some other kinds of starch. It is principally employed as an agreeable light nourishment for invalids, as well as for children. "No amylaceous substance," says Dr. Christison, "is so much relished by infants about the time of weaning; and in them it is less apt to become sour during digestion, than any other farinaceous food, even arrow-root not excepted." *Tapioca gruel* (Tapioca mucilage) and *Tapioca milk* are made in the same way as sago gruel and sago milk; but tapioca, being more soluble than sago, requires only half the time for its maceration and boiling (Dr. A. T. Thomson). *Tapioca pudding* for invalids is prepared by beating the yolks of two eggs, and half an ounce of sugar, together, and stirring the mixture into a pint of tapioca milk.

Cassava-bread or *Cassada-bread* is made thus: the roots of the Janipha Manihot are washed and scraped clean; then grated into a tub or trough, and afterwards subjected to pressure in a hair bag. It is then dried, and constitutes *Cassava powder*, or *Farine de Manioc*. When made into cakes and dried or baked, it forms *Cassava bread*, used as a wholesome bread in Brazil, Guiana, Jamaica, &c.

3. *Arrow-root; West Indian Arrow-root.* This is a very pure white amylaceous powder, obtained from the roots (tubers) of the *Maranta arundinacea*. It is brought from most of the West India islands, but that from Bermuda (*Bermuda Arrow-root*) is most esteemed. It makes a tolerably strong jelly,—stronger than that from wheat-starch,—and is free from colour-

ing matter, and also from any unpleasant flavour and odour. On these accounts it is greatly in request. Dr. Prout regards it as a low variety of starch, analogous to the low sugar of honey; while wheat-starch he considers to be the most perfect form of starch, analogous to sugar-candy. It is employed as a nutritious, easily digested, agreeable, non-irritating diet for invalids and infants. *Arrow-root pudding* is prepared like tapioca pudding (see p. 131.) *Arrow-root gruel* and *Arrow-root milk* are made like the corresponding preparations of sago. *Arrow-root Blanc-mange* (Arrow-root jelly), contains three times as much arrow-root as the arrow-root gruel. A moderate quantity of milk being added, the whole is boiled down to a proper consistence, poured into a shape to cool and set; and afterwards turned out (Dr. A. T. Thomson).

4. *Tous-les-Mois; Canna Starch.*—Within the last few years considerable quantities of an amylaceous matter has been imported from St. Kitt's, under the name of *Tous-les-mois*, or *Starch of the Canna coccinea.* It is said to be prepared by a tedious and troublesome process from the rhizome of the above mentioned species of Canna; but it is very doubtful whether it really be obtained from the Canna coccinea of botanists. Its grains are larger than those of any other starch; and indeed are almost visible to the naked eye. Their tegument, according to Guibourt, is very thin. It is a very excellent kind of starch, equal perhaps to any, and superior to several, of the amylaceous matters in ordinary use. It yields a fine jelly, and is devoid of colouring matter and of any disagreeable flavour or odour. It is very soluble, and very readily digested. It is used for invalids and infants; and may be administered in the same forms as Arrow-root.

5. *Potato Starch.*—This kind of amylaceous matter is imported from France and Guernsey, and is also manufactured in this country. It is frequently sold under the names of *Potato-flour* or *English Arrow-root.* Its grains are somewhat smaller than those of Tous-les-mois. An imitation sago *(Potato-sago)* is made of it, as I have already mentioned (see p. 129); and sometimes, it is stated, potato-starch is substituted for arrow-root. It is most extensively consumed in the manufacture of *Potato-sugar* (see p. 117). In its general dietetical properties, potato-starch agrees very much with the other amylaceous substances above mentioned. It does not, however, yield so firm a jelly; and, according to Dr. Christison, is more apt to cause acidity, especially in infants, than arrow-root. It is used by the cook in the preparation of soufflés, and sometimes, as a substitute for wheat-flour, for thickening gravies, sauces, &c., on account of its being both cheap and tasteless.

6. *Tahiti Arrow-root; Otaheite Salep; Arrow-root prepared by the Native Converts at the Missionary Stations in the South Sea Islands.*—This is a white amylaceous powder obtained at Tahiti (Otaheite) from the *Tacca pinnatifida.* It has been introduced as a substitute for the West Indian arrow-root, on the ground of its purity, superior quality, and lower price (1s. 8d. per lb.); but the specimens which I have met with had a musty odour.

7. *East Indian Arrow-root.*—Under this name two kinds of an amylaceous powder are imported from Calcutta; one white, the other pale buff-coloured. To the microscope both kinds present the same appearance, from which it is probable that they are obtained from the same or some neighbouring plant, but with unequal degrees of care. As the grains very much resemble in form those obtained from the rhizomes of ginger and turmeric, there can be but little doubt that this fecula is procured from some scitamineous plant. Now, it appears from the statements of Drs. Roxburgh and Ainslie, that an amylaceous matter called *Tickor* or *Tikhur* * is obtained in India from the tuberous roots of three species of *Curcuma*, viz. *C. angustifolia*, *C. rubescens*, and *C. leucorrhiza*. This is identical, probably, with our East Indian Arrow-root. In Travancore it forms a large part of the diet of the inhabitants. It is employed by Europeans as a substitute for the West Indian arrow-root.

8. *Portland Arrow-root; Portland Sago.*—This is a white amylaceous powder obtained in the island of Portland, from the underground tubers of *Arum maculatum*, or *Wake Robin*, and used as a substitute for West Indian arrow-root.

9. *Rice Starch.*—Mr. O. Jones has recently taken out a patent for the preparation of starch from rice by means of a weak solution of caustic alkali. In another patent an alkaline salt is substituted for the caustic alkali.

* Dr. Royle (*Illustrations of the Botany, &c. of the Himalayan Mountains*, p. 359,) says that an excellent starch, called *Tikkur*, is made at Patna and Boglipore from the tubers of *Batatas edulis*.

10. *Lichenin* or *Feculoid.*—This is the name applied to the starchy matter found in the thallus of the foliaceous lichens. As, however, it is not sold in the separate state, it will be described hereafter (see *Iceland Moss*, or *Cetraria islandica*).

I have not included the substance called *Salep* among the amylaceous substances, though it is closely allied to them. It is the prepared and dried tuberous or palmate roots of several orchideous plants, and is sometimes sold in the state of powder. *Indigenous Salep* is procured from *Orchis mascula*, *O. latifolia*, and other native plants of this order. It has been recommended by Dr. Thomas Percival as furnishing a cheap, wholesome, and most nutritious article of diet; and he adds that it "is said to contain the greatest quantity of vegetable nourishment in the smallest bulk." *Oriental Salep* is imported from India in the form of ovate tubers. When ground to powder, these constitute the salep powder sold at Butler's, in Covent Garden Market. Dr. Royle states that the salep of Cachmere is obtained from a species of *Eulophia*.

5. THE LIGNEOUS ALIMENTARY PRINCIPLE.

(Lignine; Woody Fibre.)

The substance commonly called lignine constitutes the basis of all vegetable tissues (woody fibre, vessels, ducts, and cellular tissue). It is obtained by submitting vegetables to the successive action of ether, alcohol, water, diluted acids, and diluted alkalies, to extract all the matters soluble in these liquids. Lignine, therefore, is insoluble in all these solvents.

QUANTITY OF LIGNINE CONTAINED IN 100 PARTS OF THE FOLLOWING ALIMENTARY SUBSTANCES.

	Lignine.		*Authority.*
Rice	4·8		Braconnot.
Barley	18·75	(husk)	Einhof.
Oats	34	(bran)	Vogel.
Rye	24·2	(husk)	Einhof.
Apricots (ripe)	1·86		Bérard.
Green Gages (ripe)	1·11		Ditto.
Peaches (ripe)	1·21		Ditto.
Gooseberries (ripe)	8·01		Ditto.
Cherries (ripe)	1.12		Ditto.
Pears (ripe)	2·19		Ditto.
Sweet Almonds	9·0	(and seed coats)	Boullay.
Peas	21·88	(amylaceous fibre)	Einhof.
Garden Bean (*Vicia Faba*)	25·94	(ditto & membrane)	Ditto.
Kidney Bean (*Phaseolus vulgaris*)	18·57	(ditto)	Ditto.
Potatoes	4·3 to 10·5	(amylaceous fibre)	Vauquelin.
Cocoa-nut kernel	14·95		Bizio.

The substance called by Einhof *amylaceous fibre* is probably woody fibre, with some intermixed amylaceous matter.

According to Dr. Prout's experiments, the composition of lignine is probably similar in all plants *.

COMPOSITION OF LIGNINE.

	Carbon.	*Water.*
Lignine from Box	42·7	57·3
Ditto ditto, dried	50·0	50·0
Ditto from Willow	42·6	57·4
Ditto ditto, dried	49·8	50·2

The formula for lignine which agrees with these analyses is C^{12} + *Aqua*^{8} or $C^{12}\ H^{8}\ O^{8}$.

* According to the Rev. J. B. Reade (*Lond. and Edin. Phil. Mag.* vol. xi. p. 421), a very remarkable difference exists between the chemical composition of cellular membrane and of spiral vessels in the same plant. But his "results are in many respects so remarkably at variance with all that we are as yet acquainted with respecting similar subjects, that we must at the outset doubt their correctness." (Meyen's *Report on the Progress of Vegetable Physiology during the year* 1837. Translated by Wm. Francis. Lond. 1839.)

According to Payen *, the substance called lignine consists of two organic principles. One of these is the true or primitive tissue of the wood, or, in other words, the membrane or fibre of which the vegetable tissues are built up; this he calls *cellulose*. It is isomeric with starch, and, therefore, consists of $C^{12}\ H^{10}\ O^{10}$. The other, called *pure lignine*, is a secretion, and fills the cells. Its composition is $C^{35}\ H^{24}\ O^{20}$.

Though I have placed ligneous matter among the alimentary principles, yet I confess I am by no means satisfied that it is capable of yielding nutriment to man. Dr. Prout †, whose example I have followed in calling it an alimentary principle, observes that it forms the appropriate food of numerous insects and of some of the lower animals, but of few of the higher classes of animals. The reason of this is probably to be sought for in their not being furnished with organs proper for comminuting and reducing it; for when lignin is comminuted and reduced by artificial processes, it is said to form a substance analogous to the amylaceous principle, and to be highly nutritious."

This statement of the nutritious property of lignine when minutely pulverised, is made on the authority of Professor Autenrieth ‡, of Tubingen, who states, that when wood is deprived of every thing soluble, reduced to powder, repeatedly subjected to the heat of an oven, and then ground in the manner of corn, it yields, boiled with water, a flour, which forms a jelly, like that of

* *Ann. des Scien. Nat.* 2nde Sér. Botanique. 1838.

† *On the Nature and Treatment of Stomach and Urinary Diseases*, p. xi. 1840.

‡ *Phil. Trans.* 1827, p. 355.—Also, *The Scots Mag.* vol. lxxx. p. 313.

wheat-starch, and, when fermented with leaven, makes a perfectly uniform and spongy bread; and Linnæus * states that the Laplanders eat bark-bread (*barkbröd*), prepared from the bark of *Pinus sylvestris* †, during a great part of the winter, and sometimes even during the whole year.

But admitting the accuracy of these facts, it by no means follows that lignine is nutritive; because in the autumn, after the formation of wood has ceased, starch is formed, and is diffused through every part of the plant by the autumnal sap ‡. "According to the observations of M. Heyer, the starch thus deposited in the body of the tree can be recognised in its known form by the aid of a good microscope. The barks of several aspens and pine-trees contain so much of this substance, that it can be extracted from them as from potatoes by trituration with water §." So that starch may, in reality, be the nutritive principle of the wood-bread and bark-bread above referred to.

The ligneous matter of our ordinary vegetable foods is indigestible, and is evacuated with the fæces, of which it makes a part. The skin of potatoes, the husk of the grape, the peel and core of apples and peas, the skin and stones of drupes (as plums, peaches, &c.), the skin or seed-coats of the kernels of nuts, the membrane covering beans and peas, the

* *Flora Lapponica.*

† See Von Buch, in *The Scots Magazine*, vol. lxxx. p. 315. Edinb. 1817.

‡ Hartig, in *Erdmann und Schweigger-Seidel's Journal.* 1835.

§ Liebig, *Chemistry in its Application to Agriculture and Physiology*, p. 119, 2d ed. 1842.

husk of gooseberries, the peel of cucumbers, melons, &c., the husk or bran of corn, &c., are all indigestible, and incapable of being assimilated. But though insoluble and unassimilable, ligneous matter is not quite useless. It serves as a mechanical stimulus to the bowels, the action of which it promotes. "Of the numerous shapes assumed by lignin," says Dr. Prout *, "the best adapted for excremental purposes is undoubtedly the external covering of the seeds of the *cerealia*, and particularly of wheat. Bread, therefore, made with undressed flour, or even with an extra quantity of bran, is the best form in which farinaceous and excremental matters can be usually taken; not only in diabetes, but in most of the other varieties of dyspepsia accompanied by obstinate constipation. This is a remedy the efficacy of which has been long known and admitted; yet, strange to say, the generality of mankind choose to consult their taste rather than their reason; and by officiously separating what nature has beneficently combined, entail upon themselves much discomfort and misery. In stating above, that *most* individuals subject to constipation obtain relief by the use of brown bread, I wished to imply that there are some exceptions; and that not only among the various forms of dyspepsia, but even in diabetes. In such instances, the mucous membrane of the stomach and intestines is often so irritable, that the mechanical excitement produced by furfuraceous matters cannot be borne; and in a few of such instances, (not in all,) the second

* *Op. supra cit.* p. 300.

great class of excremental matters, those, namely, consisting of the green matter of the leaves of plants, is, in general, little acted on by the stomachs of the higher animals; and hence may, in most cases, safely form a portion of the food of diabetic individuals."

Fungin, or the fleshy part of mushrooms, is closely allied to lignine, of which, perhaps, it is only a variety. It is the substance which remains after mushrooms have been deprived of every thing soluble in water, alcohol, and a weak alkaline solution. From Braconnot's * experiments it would appear to be highly nitrogenous, but those of Vauquelin †, who probably obtained fungin in a purer form and freer from foreign nitrogenous substances, do not confirm Braconnot's statement, but seem to show that fungin contains but little nitrogen. Müller ‡ considers fungin to be one of the simple nutritive substances.

6. THE PECTINACEOUS ALIMENTARY PRINCIPLE.

(Vegetable Jelly.)

Jelly is of two kinds—animal and vegetable. The first has for its base animal gelatine, and will be described hereafter (see *The Gelatinous Alimentary Principle*). The second has for its base starch, pectine, or pectic acid. Starch has been already noticed (see *The Amylaceous Alimentary Principle*); and I now proceed to examine the dietetical properties of pectine and pectic acid, both of which substances I include under the denomination of the Pectinaceous Alimentary Principle.

* *Ann. Chim.* lxxix.
† Ibid. lxxxv.
‡ *Elements of Physiology*, Baly's Translation, p. 478.

Pectine (so called from πηκτὶς, *coagulum*) and *Pectic acid* are both vegeto-gelatinous matters. One or both of them are most extensively distributed in the vegetable kingdom. Most pulpy fruits contain vegetable jelly; as Currants (red, white, and black), Apples (both sweet and sour), Pears, Quinces, Plums, Apricots, the Cucurbitaceous fruits (as Melon), Gooseberries, Blackberries, Raspberries, Strawberries, Bilberries, Mulberries, Cherries, Love-apples, Oranges, Lemons, Guava, and Tamarinds. The Jerusalem Artichoke and the Onion also yield it. It is likewise obtained from the Carrot, Turnip, Celery, Beet, and many other roots. Hitherto the quantity procurable from different plants has not been ascertained.

In the dried state, pectine and pectic acid closely resemble each other; but the former is distinguished from the latter by several characters. Pectine dissolves in cold water, yielding a thick solution which does not redden litmus paper; whereas pectic acid reddens litmus, and is scarcely soluble in water. Dissolved in solution of ammonia, pectine yields no precipitate on the addition of an acid; whereas pectic acid, treated in the same way, yields a gelatinous precipitate. Very small quantities of the fixed alkalies or alkaline earths convert pectine into pectic acid.

Pectine has been analysed by Mulder * and Fremy †.

COMPOSITION OF PECTINE.

100 *Parts*	*Carbon.*	*Hydrogen.*	*Oxygen.*	*Authority.*
Pectine from sweet apples . .	45·198	5·352	49·45	Mulder.
Ditto from sour apples . .	45·853	5·479	48·668	Mulder.
Ditto in pectinate of lead .	45·608	5·370	49·022	Mulder.
Ditto in ditto	43·5	5·2	51·4	Fremy.

* *Pharmaceutisches Central-Blatt für* 1838, p. 337.
† *Journal de Pharmacie*, t. xxvi. p. 368. 1840.

Fremy gives as the formula for pectine $C^{24} H^{17} O^{23}$. Both Fremy and Mulder agree that pectine and pectic acid are identical in composition: the latter chemist gives $C^{12} H^{8} O^{10}$ as the formula for pectic acid; while Regnault * gives $C^{11} H^{7} O^{10}$. According to Fremy the saturating power of pectic acid is double that of pectine: pectic acid combining with two atoms, pectine with one atom of a base.

By boiling with an acid solution (as of malic acid) both pectine and pectic acid are converted into metapectic acid, which is very soluble in water.

According to Fremy unripe fruits contain a very small portion only of pectine; but when the fruit becomes ripe, pectine is formed by the action of the vegetable acids of the fruit on a pulpy matter. These acids are contained in cells, from which they do not escape until the period of ripening, when the cells are transparent, distended, and permeable. By subjecting fruit to heat the cells burst and allow the acid to escape, and in this way the formation of pectine is promoted.

The same chemist has also shown that under the influence of vegetable albumen contained in fruits, pectine is convertible into pectic acid. This fact explains why an impure aqueous solution of pectine gelatinizes by keeping: the pectine is changed by vegetable albumen into pectic acid. It explains also why the juice of a fruit by prolonged ebullition often loses its power of gelatinizing; since the matter destined to form the jelly has been coagulated or destroyed. Moreover, under the influence of heat, the malic or other vege-

* *Journal de Pharmacie*, t. xxiv. p. 201. 1838.

table acid of the juice may convert the pectine or pectic acid into metapectic acid, which is very soluble in water, and does not possess the property of gelatinizing.

Sugar promotes the solidification of both pectine and pectic acid. If sugar be dissolved in a solution of pectine, an imperfect jelly is formed, which finally may be drawn out in threads. It also promotes the gelatinization of pectic acid, a property which the confectioner takes advantage of, in the preparation of the jellies of currants, apples, cherries, gooseberries, &c.

The dietetical properties of vegetable jelly have been but imperfectly examined. We believe it to be slightly nutritive, and readily digestible. Analogy leads us to suppose that its alimentary properties are similar to those of gum; from which, however, it differs somewhat in composition: — gum being composed of carbon and water (or its elements), while both pectine and pectic acid consist of carbon and water (or its elements), *plus* oxygen (see p. 25). Both of these vegeto-gelatinous principles being deficient in nitrogen, are considered by Liebig (see *ante*, p. 31) to be mere elements of respiration. But on account of the excess (in relation to the hydrogen) of oxygen which they contain, it is possible that their copious use would diminish the activity of the function of respiration (see *ante*, p. 27). Most fruits have more or less tendency to promote alvine evacuations: whether or not this is ascribable to the vegeto-gelatinous principles which they contain, or to some other constituent, has not been ascertained. Braconnot* has sug-

* *Ann. Chim. et Phys.* t. xxviii. and xxxx.

gested the preparation of jellies with pectic acid, to which various flavouring ingredients may be added. "I dissolved," says he, "in warm water, one part of pectate of potash prepared from turnips, and then added sugar to the solution. On the addition of an infinitely small quantity of acid, the whole became, in a few minutes, a mass of trembling jelly, weighing 300 parts." Such a jelly, however, must contain so small a quantity of solid matter, that, instead of nourishing, its great value would be in deceiving morbid appetites.

1. *Fruit Jellies.*—A variety of vegetable jellies are prepared by the confectioner. Those in greatest request are *Currant (red* and *black), Apple, Strawberry,* and *Raspberry Jellies.* To some jellies the term *Marmalade* is applied. Thus *Quince Marmalade* (formerly contained in the Edinburgh Pharmacopœia), prepared with strained quince juice and sugar, is in fact a jelly.

Fruit jellies owe part of whatever nutritive properties they possess, to sugar, and frequently to animal gelatine. The sugar used in their preparation promotes the solidification of, and likewise preserves, the vegetable jelly, which, though apt to become mouldy, does not become sour. Isinglass is frequently added to communicate firmness or stiffness. Fruit jellies form very agreeable cooling articles of food in febrile and inflammatory complaints. They are frequently used by invalids to moisten the mouth and fauces, and to allay thirst. They are esteemed antiscorbutic.

When dissolved in water they form an agreeable drink. An extemporaneous *Raspberry Vinegar* is made by dissolving half a pint of raspberry jelly in a

pint of vinegar. This, when diluted with water, (forming *Raspberry-Vinegar Water*) affords a pleasant cooling beverage for allaying thirst in fevers, colds, and inflammatory maladies.

2. *Jams, &c.*—These being mixtures of vegetable pulps with sugar, are in fact *Conserves.* Those in most demand are *Raspberry, Strawberry, Currant, (red* and *black) Apricot, Green Gage, Gooseberry,* and *Pine Apple Jams.* Closely allied to these are the *Fruit-Cheeses,* as *Damson Cheese, Green Gage Cheese, Bullace Cheese, &c.* Some of the *Marmalades* are more allied to jams than to jellies. Thus *Orange* or *Scotch Marmalade* is prepared with Seville Oranges and Sugar, to which Apple liquor, and sometimes a little Balsam of Tolu, are added for flavouring.

These preparations are very similar in their effects and uses to the fruit jellies above mentioned, from which they principally differ in containing a quantity of insoluble, and, therefore, indigestible ligneous matters (as vegetable membrane, cellular tissue, and sometimes seeds), which, in the healthy state of the system, contribute by their mechanical stimulus to promote the action of the bowels; but, in irritable conditions of the alimentary canal, sometimes prove injurious.

3. *Carrageenin.*—The mucilaginous or vegeto-gelatinous substance which I have elsewhere * denominated Carrageenin, is contained in *Chondrus crispus,* and other allied sea weeds, which are sold in the shops under the name of Carrageen, Pearl, or Irish Moss.

* See my *Elements of Materia Medica,* vol. ii. p. 874, 2d ed. 1842.

It is perhaps more closely allied to pectin than to any other vegetable principle.

Its composition, according to Mulder *, is Carbon 45·17, Hydrogen 4·88, and Oxygen 49·95. Its formula, therefore, is $C^{12} H^{8} O^{10}$. So that, like pectine, carageenin contains excess of oxygen. A solution and jelly of it are in use. (See *Chondrus crispus.*)

7. THE ACIDULOUS ALIMENTARY PRINCIPLE.

I have admitted the existence of an acidulous alimentary principle for two reasons.

The *first* is, that vegetable acid constitutes one of the ingredients of our foods. This statement holds good for ancient as well as for modern times,—and both for barbarous and civilised nations. Fruits and succulent herbs, in both of which vegetable acid exists, have always been employed as food. Moreover, acetic acid, obtained by the acetous fermentation of wine, was in very early use. Moses,† who lived 1490 years before Christ, speaks of vinegar of wine being used as a drink. "Vinegar, either by accident or design," says Dr. Prout, ‡ "has been employed by mankind in all ages, in greater or less quantity, as an aliment; that is, substances naturally containing it in small quantity have been employed as aliments; or it has been formed artificially from certain bodies, with the view to alimentary purposes."

The *second* reason is, that the employment of vegetable acid, as an aliment, is necessary for the preservation of health. At least, it seems pretty clearly established that the "complete and prolonged abstinence from succulent vegetables or fruits, or their preserved juices, as articles of food,"* is a cause of scurvy; and various "circumstances render it probable that the anti-scorbutic virtue [of succulent vegetables or fruits] depends on the organic acids, or on some salt that enters the system only in combination with such acids. The latter supposition is the more probable, because the acids, pure, have much less efficacy in preventing scurvy than the vegetable juices from which they are derived. Lemon-juice evaporated to the consistence of syrup, as originally recommended by Dr. Lind, was found very inferior to the fresh fruit; and the crystallised acid, after being extensively tried, was renounced in favour of the juice preserved simply by the addition of a certain proportion of spirit †."

But in admitting that the dietetical use of vegetable acid is necessary to health, it must not be assumed that all vegetable acids, which can be taken as food, are equally efficacious; for experience has proved that this is not the case. Thus, though we admit that lemon-juice is a valuable anti-scorbutic, we cannot make the same statement of vinegar; the united observations of Drs. Lind, Gilbert Blane, and Trotter, having shown that the liberal use of vinegar by sailors did not prevent the appearance, nor check the progress, of scurvy.

* *Pharmaceutisches Central-Blatt für* 1838, p. 500.
† *Numbers*, ch. vi. v. 3.
‡ *On the Nature and Treatment of Stomach and Urinary Diseases*, p. ix. 3d ed. 1840.

* Dr. Budd, *Lectures on the Disorders resulting from Defective Nutriment*, in *The London Medical Gazette*, July 22, 1842, p. 633.
† Dr. Budd, *loc. cit.* p. 716.

Water sharpened with the vegetable acids oftentimes proves a most refreshing beverage, allaying thirst, and moderating excessive heat. When taken in the free state these acids suffer no appreciable chemical change in the system, except that of combining with a base; for Drs. Wöhler and Stehberger * detected oxalic, tartaric, and gallic acids, in combination with bases, in the urine of persons to whom these acids had been administered in the free state. Now, inasmuch as the chyle and blood are always alkaline, it follows that these acids must have entered into combination with bases before they entered the circulation. It is probable, therefore, that the bile furnishes the basic matter for neutralising the acids previous to their absorption. It is remarkable, however, that the tartrates, citrates, malates, and acetates of potash and soda, taken into the stomach, suffer decomposition in the system, and are converted into carbonates of their respective bases. This fact, first noticed by Sir Gilbert Blane, but confirmed by Drs. Wöhler and Stehberger, has been already adverted to, and the changes which the vegetable acids suffer, explained. (See *ante*, pp. 28 and 29.)

I now proceed to make a few remarks on those organic acids which are most frequently used for dietetical purposes.

1. *Acetic Acid* or *The Acid of Vinegar.*—To this substance Pyroligneous Acid, Vinegar, Sour Beer, and Sour Wine, owe entirely or principally their acid properties. Anhydrous or real acetic acid, as it exists in some acetates, has the following composition,

* See my *Elements of Materia Medica*, vol. i. p. 109, 2nd ed.

$C^4 H^3 O^3$. *Glacial* or *Crystallisable Acetic Acid*, the strongest procurable, contains one equivalent of water. Its formula is $C^4 H^3 O^3 + Aqua$.

Pyroligneous Acid, called also *Wood Vinegar*, or *White Vinegar*, is obtained by the distillation of wood. When pure it consists of acetic acid and water only.

The *Common Vinegar* of the shops is procured by subjecting an infusion of malt, or of a mixture of malt and raw barley, to the acetous fermentation. Hence it is commonly termed *Malt Vinegar*. It has a yellowish red colour and an agreeable acid taste, which it owes principally to acetic acid, but in part also to sulphuric acid, and a peculiar refreshing, pleasant odour, which it derives from acetic acid and acetic ether. The makers of it sell four vinegars, of different degrees of strength, which they distinguish as Nos. 18, 20, 22, and 24. The vinegar distinguished as No. 24, or *Proof Vinegar*, is the strongest that is made. It is almost too strong for ordinary use at the table, but is employed for pickling and preserving meat, fish, and game; whence it has received its name of *Strongest Pickling Vinegar*. The vinegar known as No. 22 is adapted for the table, and for pickling most vegetables, whence it is frequently called *Best Pickling Vinegar*. Malt vinegar has the following composition:—

COMPOSITION OF MALT VINEGAR.

Acetic Acid.
Acetic Ether.
Colouring Matter.
Peculiar Mucilaginous Matter.
Alcohol (a small portion).
Sulphuric Acid ($\frac{1}{1000}$ part).
Water.

Malt Vinegar *.

* Vinegar is very liable to undergo decomposition: it becomes

Vinegar makers are allowed by law to add the above mentioned quantity of sulphuric acid.

Wine Vinegar, also called *French Vinegar*, is obtained from wines of inferior quality. It is of two kinds, *white* and *red*. *White Wine Vinegar* is usually preferred, as it keeps better. That which is made at Orleans is considered to be the best. The constituents of wine vinegar are very similar to those of malt vinegar. It contains a small quantity of bitartrate and sulphate of potash. Wine vinegar may be distinguished from malt vinegar by ammonia, which occasions in the former a purplish precipitate, but not in the latter.

Distilled Vinegar is usually imitated in the shops by diluted pyroligneous acid; but this imitation has not so fragrant an odour as the genuine article.

The following table shews the proportion of acetic acid in the preceding preparations:—

TABLE SHEWING THE QUANTITY OF ACETIC ACID IN SEVERAL ACETOUS COMPOUNDS.

100 *Parts*	*Anhydrous Acid.*
Pyroligneous Acid (Acetic Acid of the London Pharmacopœia)	30·8
Malt Vinegar (No. 24, or Proof Vinegar)	4·6
Wine Vinegar	5·36
Distilled Vinegar of the London Pharmacopœia	3·07

turbid, loses its acidity, acquires an unpleasant odour, and deposits a slippery gelatiniform substance. The mucilaginous coat or skin which forms on the surface of vinegar, and is called the *Mother of Vinegar*, consists of myriads of exceedingly minute vegetables having a spheroidal form. The surface of vinegar is frequently covered by mouldiness, which, when examined by the microscope, is seen to consist of minute fungi, called by botanists *Mucor Mucedo*. The microscopic animals called *Vinegar Eels* (*Anguillula Aceti*), are generated and nourished in vinegar. They may be destroyed by submitting the liquid, in which they are contained, to heat. Vinegar is also infested by a small fly (*Musca cellaris*).

Vinegar is used at the table as a condiment, on account of its agreeable flavour and refreshing odour. It is employed either alone or with pickles. When taken in small quantities it is quite wholesome, allaying thirst and checking preternatural heat. Small quantities do not appear to act injuriously on the stomach; nay, a considerable quantity has been taken at one time with impunity. Dr. Christison knew a case in which eight ounces were swallowed without injury. But the habitual use of it is injurious, and, by disturbing the function of the stomach, may give rise to wasting *. "Every one knows," says Giacomini, "that when habitually taken, it produces leanness, from a sort of languor of the digestive process."

2. *Citric Acid; Concrete Acid of Lemons.*—This acid, in the free state and combined with little or no malic acid, is a constituent of the juice of the Lemon, the Orange (bitter and sweet), the Lime, the Citron,

* It is in repute with young ladies for diminishing obesity. But the following case, from Portal, quoted by Giacomini, shews the ill consequences of employing it for this purpose:—"A few years ago, a young lady, in easy circumstances, enjoyed good health; she was very plump, had a good appetite, and a complexion blooming with roses and lilies. She began to look upon her plumpness with suspicion; for her mother was very fat, and she was afraid of becoming like her. Accordingly, she consulted a woman, who advised her to drink a small glass of vinegar daily: the young lady followed her advice, and her plumpness diminished. She was delighted with the success of the remedy, and continued it for more than a month. She began to have a cough; but it was dry at its commencement, and was considered as a slight cold, which would go off. Meantime, from dry it became moist; a slow fever came on, and a difficulty of breathing; her body became lean, and wasted away; night-sweats, swelling of the feet and of the legs, succeeded, and a diarrhœa terminated her life. On examination, all the lobes of the lungs were found filled with tubercles, and somewhat resembling a bunch of grapes."

the Shaddock, and other fruits of the genus Citrus, all of which owe their sourness to this acid. The Cranberry and the fruit of the Dog-rose likewise contain it. Mixed with an equal quantity of malic acid, it is found in the Gooseberry, the Red Currant, the Strawberry, the Raspberry, the Cherry, and the Bilberry. Mixed with both malic and tartaric acids, it exists in the pulp of the Tamarind.

The composition of citric acid is as follows:—

FORMULÆ OF CITRIC ACID.

Hypothetical or dry Citric Acid as it exists in some citrates	$C^{12} H^5 O^{11}$
Citric Acid crystallised by cooling a solution saturated at 212°	$C^{12} H^5 O^{11} + Aqua^4$
Commercial crystals of Citric Acid	$C^{12} H^5 O^{11} + Aqua^5$

Citric acid is employed as a substitute for lemon and lime juice in the preparation of refreshing and cooling beverages.

Artificial Lemon Juice is prepared by dissolving nine drachms and twelve grains of crystallised citric acid in a wine-pint of water, and flavouring with a drop of essence of lemon dissolved in a tea-spoonful of spirit. This preparation is less apt to undergo decomposition than the genuine juice, for which the artificial compound may be substituted in the preparation of agreeable and refrigerant drinks.

The effervescing powder sold under the name of *Lemon and Kali* should consist of powdered white sugar two parts, dried and powdered citric acid one part, and powdered bicarbonate of potash one part and a quarter. But as citric acid is slightly deliquescent, this preparation does not keep well, and is apt to form a hard mass. Hence *Concrete Acidulated*

Alkali (hereafter to be described) is frequently substituted for it.

3. *Tartaric Acid* or *Crystallised Acid of Tartar.*—This acid, in the free state, exists in Tamarinds, Grapes, and the Pine-apple. Bitartrate of potash, also called Cream of Tartar, is found in Tamarinds, Grapes, and Mulberries. During the fermentation of wine, this salt, in combination with colouring and extractive matters, is deposited on the sides of the cask, and is termed *Crude Tartar* or *Argol.* A further deposition also takes place after bottling, and is then called the *Crust.*

The formula for anhydrous tartaric acid is $C^4 H^2 O^5$, or double this, viz. $C^8 H^4 O^{10}$. The crystallised acid, therefore, is either $C^4 H^2 O^5 + Aqua$, or $C^8 H^4 O^{10} + Aqua^2$.

Tartaric acid is employed as a cheap substitute for citric acid or lemon juice. Besides cheapness, it has another advantage over citric acid, viz. its not being deliquescent when exposed to the air. But in flavour it is decidedly inferior to citric acid.

A variety of effervescing powders, prepared with tartaric acid and sesquicarbonate (bicarbonate) of soda, are kept in the shops. The *Concrete Acidulated Alkali,* before referred to, is prepared by intimately mixing one part of powdered tartaric acid, one part of bicarbonate of soda, and two parts of powdered white sugar. This powder is flavoured with essence of lemon, in the proportion of fifty drops to one pound of the mixture. A tea-spoonful of this is taken in a little water contained in a tumbler.—The *Soda Powders* of the shops consist of thirty grains of bicarbonate of soda, contained in a blue paper, and twenty-five grains of powdered tartaric acid, in a white paper. When taken, they should be dissolved in half a pint of water.—*Ginger-beer Powders* are made in the same way as soda powders, except that five grains of powdered ginger and a drachm of white sugar are mixed with the bicarbonate of soda. All these preparations furnish us with an extemporaneous *Effervescing Saline Draught*, containing tartrate of soda, and the flavour of which is much improved by adding to the water, before dissolving the acid or mixed powder, two or three drachms of syrup and half a drachm of tincture of orange peel.

Seidlitz Powders consist of two drachms of tartarised soda and two scruples of bicarbonate of soda, contained in a blue paper, and half a drachm of powdered tartaric acid in a white paper. These are to be taken, dissolved in half a pint of water, while the liquid is in a state of effervescence. They form an agreeable and mild aperient.

Cream of tartar is frequently substituted for tartaric acid, in the preparation of cooling drinks. The liquid called *Imperial* is of this kind. It is formed by dissolving one drachm or a drachm and a half of cream of tartar in a pint of boiling water, and flavouring with lemon-peel and sugar. When cold, the solution may be taken *ad libitum*, as a refrigerant beverage in febrile complaints, especially where it is desirable to promote the secretion of urine.

All the above effervescing compounds, as well as imperial, are injurious to patients troubled with white sand (phosphatic deposits) in the urine; in consequence of the alkaline tartrate being converted into an alkaline carbonate (see pp. 28 and 29), which passes out of the system in the urine, and promotes the deposition of the earthy phosphates.

Acidulated Drops or *Lozenges*, consist of barley-sugar sharpened with tartaric acid, as I have before stated (see pp. 118, 119). They are useful in coughs and sore-throats, but are commonly taken, on account of their agreeable flavour, as articles of confectionary.

4. *Malic Acid*, or *Acid of Apples.*—This acid is very extensively distributed in the vegetable kingdom. It exists in the free state in Apples, Pears, Quinces, Plums, Apricots, Peaches, Cherries, Gooseberries, Currants, Strawberries, Raspberries, Blackberries, Pine-apples, Barberries, Elderberries, Grapes, Love-apples, Tamarinds, and several other fruits. It is usually accompanied by citric acid. Wine, Cider, and Perry, likewise contain it. The formula for the hydrated acid is $C^8 H^4 O^8 + Aqua^2$. Its dietetical properties are analogous to citric acid; but it is not employed in the separate state.

5. *Oxalic Acid.*—This exists in a considerable number of plants. Those which it is necessary here to refer to, as being employed at the table, are the Garden Rhubarb, whose leafstalks are used in tarts and puddings; Common Sorrel, which is sometimes taken as a potherb and salad; and Common Woodsorrel, which is occasionally eaten as an antiscorbutic. The crystallised acid of the shops is obtained by the action of nitric acid on sugar, or molasses. Its formula is $C^2 O^3 + Aqua^3$. In large doses and in a concentrated form, it is an energetic poison; but in small quantities and largely diluted, it may be used without injury.

In this country it is never taken internally. In France, however, it is sometimes employed in the preparation of acidulous drinks (called *lemonades*), in the proportion of twelve or fifteen grains of acid to a quart of water; but it is much safer to use tartaric acid. Lozenges containing this acid have been prepared under the name of *Tablettes d'Acide Oxalique*, or *Pastilles pour la soif*; but they present no advantage over the ordinary acidulated drops.

Quadroxalate of Potash, sold in the shops as *Salt of Sorrel*, has also been employed in the preparation of refrigerant drinks and lozenges.

6. *Lactic Acid*, or *Milk Acid*.—This acid exists in sour milk. It is also formed when various vegetable substances become sour—as when oatmeal is left in a large quantity of water. Its composition and formation out of sugar have been already adverted to (see p. 115). "This acid," says Dr. Prout, "like the acetic acid, is probably, under certain circumstances, capable of becoming an aliment; but as it is often found unchanged and even developed in the stomach, and, indeed, in almost all parts of the animal system, it is probably less digestible, and, therefore, less adapted as an aliment, than the acetic acid." Under the erroneous idea that lactic acid was one of the agents by which aliments are dissolved in the stomach, *lactic acid lemonade*, and *lactic acid lozenges*, have been employed in dyspepsia arising from simple debility of the digestive organs.

7. *Tannic Acid*.—This, though a constituent of some articles employed at the table, as Tea, can scarcely be considered alimentary.

8. THE ALCOHOLIC ALIMENTARY PRINCIPLE.

The reasons for believing that under some circumstances alcohol is an alimentary principle, have been already stated (See pp. 50, 51, 52, and 54).

The formula for pure or anhydrous alcohol (sp. gr. 0·7947 at 60° F.) is $C^4 H^6 O^2$. Spirit of Wine consists of alcohol and water. Rectified spirit of wine (sp. gr. 0·835 to 840) contains about 90 per cent. of alcohol.

Alcohol is a product of the vinous fermentation. It is, therefore, a constituent of Wines, Cyder, Perry, and Malt liquors (Beer, Ale, and Porter), and of Ardent Spirits obtained by distillation from vinous liquids. The following are the quantities of alcohol contained in various Wines, Spirits, and Malt Liquors, according to the best authorities.

TABLE *of the proportion of* ALCOHOL (sp. gr. 0·825, at 6° F.), *by measure, contained in* 100 *parts of Wine, Spirits, Malt Liquors, &c.* *

	Brandc.	*Others.*
1. Lissa	*A.* 25·41	15·90 *P.*
2. Raisin	*A.* 25·12	
3. Marsala	*A.* 25·09	18·40 *P.*
4. Port	*A.* 22·96	20·64 *P.*
5. Madeira	*A.* 22·27	21·20 *P.*
6. Currant	20·55	
7. Sherry	*A.* 19·17	23·80 *P.*
8. Teneriffe	19·79	
9. Colares	19·75	
10. Lachryma Christi	19·70	
11. Constantia, white	19·75 }	14·50 *P.*
12. Constantia, red	18·92 }	
13. Lisbon	18·94	
14. Malaga	18·94	
15. Bucellas	18·49	
16. Red Madeira	*A.* 20·35	
17. Cape Muschat	18·25	

[*carried over*]

* *A.* means average, *F.* Julia-Fontenelle, *P.* Prout.

	Brande.	Others.
18. Cape Madeira	A. 20·51	
19. Grape Wine	18·11	
20. Calcavella	A. 18·65	
21. Vidonia	19·25	
22. Alba Flora	17·26	
23. Malaga	17·26	
24. White Hermitage	17·43	
25. Rousillon	A. 18·13	
26. Claret	A. 15·10	
27. Zante	17·05	
28. Malmsey-Madeira	16·40	
29. Lunel	15·52	18·01 F.
30. Sheraaz	15·52	
31. Syracuse	15·28	30·00 P.
32. Sauterne	14·22	
33. Burgundy	A. 14·57	12·16 P.
34. Hock	A. 12·08	
35. Nice	14·63	
36. Barsac	13·86	
37. Tent	13·30	
38. Champagne	A. 12·61	12·20 F.
39. Red Hermitage	12·32	
40. Vin de Grave	13·94	
41. Frontignac (Rivesalte)	12·79	
42. Côte Rôtie	12·32	
43. Gooseberry	A. 11·84	
44. Orange	11·26	
45. Tokay	9·88	
46. Elder	8·79	
47. Cider, highest average	9·87	
Ditto, lowest ditto	5·21	
48. Perry, average of four samples	7·26	
49. Mead	7·32	
50. Ale (Burton)	8·88	
London (Edinburgh)	6·20	
Ditto (Dorchester)	5·56	
Average	6·87	
51. Brown Stout	6·80	
52. London Porter (average)	4·20	
53. Ditto Small Beer	1·28	
54. Brandy	53·39	
55. Rum	53·68	
56. Gin	57·60	
57. Scotch Whiskey	54·32	
58. Irish ditto	53·90	

According to the more recent experiments of Dr. Christison, the quantity of alcohol in wines has been somewhat overrated. The following are his results:—

	Alcohol (0·7939) per cent. by weight.	Proof Spirit per cent. by volume.
Port — Weakest	14·97	30·56
Port — Mean of 7 wines	16·20	33·91
Port — Strongest	17·10	37·27
Port — White	14·97	31·31
Sherry — Weakest	13·98	30·84
Sherry — Mean of 13 wines, excluding those very long kept in cask	15·37	33·59
Sherry — Strongest	16·17	35·12
Sherry — Mean of 9 wines very long kept in cask in the East Indies	14·72	32·30
Sherry — Madre da Xeres	16·90	37·06
Madeira, all long in cask in East Indies — Strongest	16·90	36·81
Madeira, all long in cask in East Indies — Weakest	14·09	30·86
Teneriffe, long in cask at Calcutta	13·84	30·21
Cercial	15·45	33·65
Dry Lisbon	16·14	34·71
Shiraz	12·95	28·30
Amontillado	12·63	27·60
Claret, a first growth of 1811	7·72	16·95
Chateau-Latour, first growth 1825	7.78	17·06
Rosan, second growth 1825	7·61	16·74
Ordinary Claret, a superior "vin ordinaire"	8·99	18·96
Rivesaltes	9·31	22·35
Malmsey	12·86	28·37
Rüdesheimer, superior quality	8·40	18·44
Ditto inferior quality	6·90	15·19
Hambacher, superior quality	7·35	16·15
Edinburgh Ale, unbottled	7·35	16·15
Same Ale, 2 years bottled	5·70	12·60
London Porter, 4 months in bottle	5·36	11·91

Dr. Christison states that by keeping wines, as Sherry and Madeira, in casks, for a moderate term of years, the quantity of alcohol increases; but after a certain time it decreases; and it is probable that at the period when wines begin to lose alcohol they cease to improve in flavour.

The value of ardent spirits is, of course, proportionate to the quantity of alcohol contained therein; and, therefore, a ready mode of estimating this is most desirable. The alcoholometrical method usually adopted consists in determining the sp. gr. of the liquid by an instrument called the *hydrometer* (from ὕδωρ, *water*; and μετρέω, *I measure*). That employed in this country, in the collection of the duties on spirits, is called *Sikes's hydrometer*. Spirit having the sp. gr. 0·920, at 60° F., is called *proof spirit*; that which is heavier is said to be *under proof*, while that which is lighter is called *over proof**. The origin of these terms is as follows:—Formerly a very rude mode of ascertaining the strength of spirits was practised, called the *proof*: the spirit was poured upon gunpowder, in a dish, and inflamed. If at the end of the combustion the gunpowder took fire, the spirit was said to be *above* or *over proof*; but if the spirit contained much water, the powder was rendered so moist that it did not take fire: in this case the spirit was declared to be *below* or *under proof*. As spirit of different strengths will or will not inflame gunpowder, according to the quantity of spirit employed, it became necessary to fix the legal value of proof spirits: this has been done, and proof spirit (*Spiritus tenuior*) is defined, by act of parliament, to be such, that at the temperature of 51° F., thirteen volumes of it weigh exactly as much as twelve volumes of water. According to this definition the sp. gr. at 60° F. is 0·920, and spirit of this strength consists of

	By Weight.	*Sp. Gr.*
Alcohol	49	0·791
Water	51	1·000
Proof spirit	100	0·920

* Spirit, which is of the strength of 43 *per cent. over proof* at the least, is recognised by the legislature (6 Geo. 4. cap. 80, Sects. 101 and 114) as *spirits of wine*. All spirit under this strength is known in trade as *plain spirit*. Distillers are not permitted (Ibid. Sect. 81) to send out spirits at any other strengths than 25 or 11 *per cent. above*, or 10 *per cent. below proof*. Raw corn spirit, therefore, is sold at 25 or 11 per cent. above proof. *Compounded spirits* (as *Gin*) are not allowed (Ibid. Sect. 124) to be kept or sent out stronger than 17 *per cent. under proof*; but Gin, as sold by the rectifier, is usually 22 *per cent. under proof*. *Foreign or Colonial spirits* (not being compounded colonial spirits) must not be kept or sent out of less strength than 17 *per cent. under proof* (Ibid. Sect. 130). Rum and Brandy, as commonly sold, are 10 *per cent. under proof*.

Spirit is employed by the cook and confectioner, as a preservative agent. Thus Brandy is used to preserve several kinds of fruit*. Its efficacy is imperfectly understood. It acts, in part at least, by excluding air (oxygen) and water, the two powerful promoters of fermentation and putrefaction.

1. *Brandy; Eau-de-vie.*—This is an ardent spirit obtained by the distillation of wine. Its constituents are alcohol, water, volatile oil, a minute portion of acetic acid, œnanthic ether, colouring matter, and tannin. The latter is said to be derived from the cask in which the spirit has been preserved. The most celebrated of the French Brandies are those of Cognac and Armagnac. *Pale brandy* has a very slight brownish yellow tint, derived from the cask. The *high coloured brandy* usually found in the shops of this country is artificially coloured. When fresh imported the alcoholic strength of brandy is usually above proof; but by keeping it diminishes. A sample of pale brandy,

* Cherries and plums shrivel when preserved in syrup, but remain plump in brandy: in the first case, exosmosis preponderates, because the syrup is denser than the juice of the fruit; in the second, endosmosis, because the juice is denser than the brandy: the separating membrane is the skin or epicarp of the fruit.

in bond, supplied me by Mr. Gassiot, of Mark Lane, I found to be 1·5 over proof, and a coloured brandy 2·2 over proof. But I am informed that 10 per cent. under proof is the strength of brandy as usually sold. *British brandy* is extensively manufactured and sold as foreign brandy.

From other ardent spirits in ordinary use, brandy is distinguished by its cordial and stomachic properties. It is, therefore, often resorted to as a domestic remedy to relieve spasmodic pains and flatulency, to check vomiting, especially sea-sickness, and to give temporary relief in some cases of indigestion, attended with pain after taking food. A little warm brandy and water with nutmeg is often a very efficacious remedy for slight cases of diarrhœa unaccompanied with inflammatory symptoms.

Burnt brandy is a popular remedy for diarrhœa.

In the London Pharmacopœia there is, under the name of *Brandy Mixture* (Mistura Spiritûs Vini Gallici), an imitation of *Egg-Flip*, and as it is a valuable stimulant and restorative it deserves a place here. It consists of brandy, cinnamon water, of each four fluidounces [a gill], the yolks of two eggs, white sugar half an ounce, and oil of cinnamon two drops. From one to three table-spoonfuls are given, as a dose, in extreme exhaustion from flooding or other hemorrhages, and in the latter stages of low fevers.

2. *Rum.*—This is ardent spirit, obtained both in the West and East Indies, by distillation from the fermented skimmings of the sugar boiler, molasses, the washings of the boilers, and the lees or spent wash of former distillations, called *dunder*. It is im-

ported into this country in puncheons. In some parts of the West India Islands it is customary to put slices of pine-apples in the puncheons of rum; hence the designation of *pine-apple rum*. *Jamaica rum* is more highly esteemed than the *Leeward Islands rum*. The peculiar flavour of rum depends on volatile oil.

The general effects and uses of rum are similar to those of brandy. But rum is considered more heating, and more disposed to cause sweating, than the other kinds of ardent spirit, to which it has been popularly thought preferable in slight colds, long-standing coughs, and rheumatism *. Of its great value in cases of extreme suffering and exhaustion, from excessive fatigue and privation of food, I have already furnished evidence (see pp. 51, 52).

3. *Gin.*—Gin is an ardent spirit prepared from corn spirit, and flavoured with Juniper, Sweet Flag, &c. It is not allowed to be sent out stronger than 17 per cent. under proof, but is usually sold to the trade at 22 per cent. under proof. The retail dealer always further reduces its strength, and flavours it with sugar.

On account of the oil of juniper which it holds in solution, gin is more powerfully diuretic than either brandy or rum; and hence it is a more popular diuretic in dropsical and other affections where an augmen-

* "They talk of a common experiment here [Jamaica], that any animal's liver put into Rum grows soft, and not so in Brandy, whence they argue this last less wholesome than that; but their Experiment, if true, proves no such thing. I think it may be said to have all the good and bad qualities of Brandy, or any fermented or vinous spirit" (Sir Hans Sloane's *Jamaica*, vol. i. p. xxx. Lond. 1707).

tation of the renal secretion is considered desirable. Moreover, it is frequently used, in preference to other ardent spirits, to promote menstruation. At the London Hospital, it is frequently administered medicinally, as a substitute for brandy, to patients who have been accustomed to it, and whose maladies require the use of some alcoholic stimulant.

4. *Whisky.*—This is a corn spirit, and agrees in most of its properties with gin; from which it differs in its peculiar smoky flavour and odour: these it acquires from the malt, which is dried by turf fires. But the smell of burned turf, called peat-reek in Scotland, "which was originally prized as a criterion of whisky made from pure malt, moderately fermented and distilled with peculiar care, has of late years lost its value, since the artifice of impregnating bad raw grain whisky with peat-smoke has been extensively practised" (Ure *). The peculiar flavour of whisky is owing "to a volatile oil which exists in the barley from which the spirits have been made" (Thomson †). Highland whisky is sometimes sold 11 per cent. over proof. The greater reputation of the Highland over Lowland whisky has been ascribed to the use of porter-yeast by the Lowland distillers, which is said to deteriorate the flavour.

5. *Arrack* or *Rack.*—This is a spirit obtained from different sources in various parts of the East. In Batavia it is procured by distillation from fermented infusions of rice, whence it has been termed *Rice*

* *Dictionary of Arts, Manufactures, and Mines*, p. 399. Lond. 1839.
† *Chemistry of Organic Bodies—Vegetables*, p. 481.

Spirit. In Ceylon, it is obtained by distillation from fermented cocoa-nut toddy (by some called *Palm Wine*). Pine-apples, steeped in it, impart a most exquisite flavour to the spirit; and, by age, it becomes a delicious liqueur, which is unrivalled in the world for making nectarial punch. Arrack is said to be distinguished from the other ardent spirits by its stimulating and narcotic properties. It is sometimes used in this country to impart an agreeable flavour to punch. A *mock arrack* is made by dissolving twenty grains of benzoic acid in two pints of rum.

6. *Liqueurs* and *Compounds.*—By spirit dealers, British compounded spirits are denominated *Compounds*, while Foreign compounded spirits are called *Liqueurs*. Both classes of liquors consist of spirits sweetened and otherwise flavoured.

A great variety of *Liqueurs* is imported. In France they are called *Ratafias* *, and some of them also *Crèmes*. *Kirschenwasser* or *Kirschwasser* (literally *Cherry-water*) is obtained by distillation from the fermented juice of a black cherry (*Cerasus avium macrocarpa*, De Cand.) cultivated in Switzerland and in some parts of France (in the Vosges and the Forêt-Noire). *Maraschino di Zara* is procured in Dalmatia from a peculiar variety of cherry, called *Marasquin* (*Cerasus Caproniana* var. « *Montmorencyana*, De Cand.?) *Curaçoa* is prepared by digesting bitter

* *Ratafia*, like the verb *ratify*, is derived from the Latin words *ratum* and *fio*, to make firm, or to confirm. By Ratafia, therefore, was originally meant a liquid drank at the ratification, confirmation, or settlement of an agreement or bargain. The practice of drinking on these occasions is by no means of modern origin.

orange-peel (or orange-berries), cloves, and cinnamon, in old brandy, to which sugar dissolved in water is subsequently added *.

The following list of *Compounds* or *British Liqueurs* usually kept at the gin-shops of this metropolis has been furnished me by the proprietor of one of these establishments:—

COMPOUNDS, OR BRITISH LIQUEURS.

	Under Proof.		*Under Proof.*
Gin	17	Tent	64
Gin	22	Aniseed	„
Mint (*Peppermint*)	64	Caraway	„
Cloves	„	Lovage	„
Bitters	„	Usquebaugh (*seldom asked for*)	„
Raspberry	„	Orange Cordial (*ditto*)	„
Noyeau	„	Citron Cordial (*ditto*)	„
Cinnamon	„	Rum Shrub	„

Those marked at 64 under proof, though usually permitted to the retailers at that strength, are usually much nearer 80 under proof.

9. THE OILY ALIMENTARY PRINCIPLE.
(Oleaginous Aliments.)

The substances usually denominated oils are of two kinds, *fixed* and *volatile*. The first cannot be distilled with water, and when dropped on paper communicate to it a permanently greasy stain. The second are volatile, and communicate to paper a stain, which can be removed by moderate warmth.

1. OF THE FIXED OILS.—Under this head are included all fatty substances employed as food, whether

* Formulæ for the preparation of the above and other Liqueurs (*Ratafias*) are given in MM. Henry and Guibourt's *Pharmacopée Raisonnée.*

obtained from animals or vegetables. To this, therefore, belong the substances popularly known as *Fat, Suet, Tallow, Lard* or *Axunge, Marrow, Grease, Butter, Blubber,* and *Fixed Oil.*

The vegetable fixed oils reside principally in the seed; either in the embryo itself, as in Almonds, Rape-seed, Mustard-seed, Filberts, Walnuts, Earth-nuts, and Linseed;—or in the perisperm or albumen which surrounds the embryo, as in the Cocoa-nut, Poppy-seed, and Nutmeg. The pericarp or fruit-coats rarely contain fixed oil. Olives, however, constitute a remarkable exception to this statement.

In animals, fat is lodged in the cells of what is called adipose tissue—a structure analogous to, if, indeed, it be not identical with, common cellular membrane. A stratum of this tissue, of variable thickness, lies beneath the skin. A considerable accumulation of it, containing a very firm kind of fat, exists in the neighbourhood of the kidneys. In the omentum (popularly called the caul), the orbits, and various other parts of the animal body, depositions of fat take place.

The quantity of oil or fat procurable from different vegetable and animal substances is as follows:—

QUANTITY OF OIL OR FAT YIELDED BY 100 PARTS BY WEIGHT OF THE FOLLOWING ALIMENTARY SUBSTANCES:—

	Oil or Fat.	*Authority.*
a. VEGETABLES.		
Filberts	60	Schübler.
Olives (including pericarp, stone, and seed)	32	Sieuve.
Olive-seeds	54	Ditto.
Walnuts	50	Schübler.
Earth-nut (*Arachis hypogæa*)	47	Payen and Henry fils.

	Oil or Fat.	*Authority.*
Cocoa nut (nucleus or fleshy part)	47	Buchner.
Almonds	46	Schübler.
White Mustard	36	Ditto.
Plums	33	Ditto.
Linseed	22	Ditto.
Black Mustard	18	Ditto.
Grape-stones (seeds)	11·4 to 18·5	Julia-Fontenelle.
Maize	9	Dumas and Payen.
Dates (fleshy part of the fruit)	0·2	Reinsch.
b. ANIMAL.		
Yolk of Eggs	28·75	Prout.
Ordinary Meat	14·3 (*including cellular tissue*)	Liebig.
Caviare (fresh unpressed)	4·3	John.
Liver of the Ox (parenchyma of)	3 89	Braconnot.
Milk, Cows'	3·13	O. Henry and Chevallier.
„ Women's	3·55	
„ Asses'	0·11	
„ Goats'	3·32	
„ Ewes'	4·20	
Bones of Sheep's feet	5·55	French Gelatine Commission.
„ „ Ox-head	11·54	

The elementary constituents of the fatty substances are Carbon, Hydrogen, and Oxygen, to which, in some instances, Saussure adds Nitrogen.

ULTIMATE COMPOSITION OF SOME FIXED OILS OR FATS.

	Carbon.	*Hydrogen.*	*Oxygen.*	*Nitrogen.*	*Authority.*
Almond Oil	77·403	11·481	10·828	0·288	Saussure.
Olive Oil (*liquid part or oleine*)	76·036	11·545	12·068	0·353	Ditto.
Ditto (*solid part or margarine*)	82·170	11·232	6·302	0·296	Ditto.
Walnut Oil	79·774	10·570	9·122	0·543	Ditto.
Train Oil	76·1	12·4	11·5	0	Bérard.
Butter	65·6	17·6	16·8	0	Ditto.
Hog's Lard	79·098	11·146	9·756	0	Chevreul.
Mutton Suet	78·996	11·700	9·304	0	Ditto.

The fixed oils or fats employed as aliments are mixtures or compounds of two, three, or more neutral, fatty, saponifiable principles, viz., *Stearine, Margarine, Oleine, Butyrine, Caprine, Capröine, Hircine*, and *Phocenine*. Each of these fatty principles is convertible,

by a caustic alkali, into a fatty acid, a saccharine substance called *glycerine*, or the *oxide of glycerule* (see p. 113), and water. They are probably, therefore, hydrated salts of glycerine.

1. Stearine (*Stearate of Glycerine*)	yields	Stearic acid	+ Glycerine.
2. Margarine (*Margarate of Glycerine*)	„	Margaric acid	+ Glycerine.
3. Oleine (*Oleate of Glycerine*)	„	Oleic acid	+ Glycerine.
4. Butyrine (*Butyrate of Glycerine*)	„	Butyric acid	+ Glycerine.
5. Caprine (*Caprate of Glycerine*)	„	Capric acid	+ Glycerine.
6. Capröine (*Capröate of Glycerine*)	„	Capröic acid	+ Glycerine.
7. Hircine (*Hircate of Glycerine*)	„	Hircic acid	+ Glycerine.
8. Phocenine (*Phocenate of Glycerine*)	„	Phocenic acid	+ Glycerine.

Stearic, margaric, and oleic acids, are without smell, and as they cannot be distilled with water, are called fixed acids. The other acids are odorous, volatile, and acrid. The peculiar smell, which most fats have, is due to one or more of these volatile oily acids.

The fixed oils and fats are difficult and slow of digestion; more so than any other alimentary principles. This fact has long been familiar to dyspeptics; but it has of late years been confirmed in a very satisfactory manner, by the experiments of Dr. Beaumont*, made on a Canadian who had a permanent artificial opening in the stomach, produced by a gun-shot wound at about two inches below the left nipple. By means of this aperture, Dr. Beaumont was enabled to introduce into the stomach various articles of diet, and from time to time to withdraw them, in order to examine the changes they underwent. He was also able to extract the gastric juice, and to perform various

* *Experiments and Observations on the Gastric Juice, and the Physiology of Digestion*, by Wm. Beaumont, M.D. Reprinted from the Plattsburgh edition by Andrew Combe, M.D. Edinb. 1838.

experiments on its digestive powers. He found that this secretion had a very slow and feeble action on fatty matters, whether contained in the stomach or otherwise.

The mean time required for the chymification of fatty substances is, according to Dr. Beaumont's experiments, as follows:—

Articles of Diet.	Mean time of the Chymification.					
	In Stomach.			In Phials.		
	Preparation.	H.	M.	Preparation.	H.	M.
Butter	Melted	3	30			
Mutton Suet . . .	Boiled	4	30	Divided	10	0
Beef Suet (fresh) .	Boiled	5	30	Entire piece	12	0
Olive Oil	—	—		Raw	60	0

The first change which the animal fat suffers when swallowed, consists in its conversion into liquid oil by the warmth of the stomach. Very gradually this oil is converted into a creamy-looking chyme, containing myriads of oily globules, visible to the eye when aided by a microscope; so that the oil is, in fact, not in solution, but, like the butter in milk, or the oil in an emulsion, is held in suspension merely. Hence oils or fats, if swallowed in the form of an emulsion or milk, are more readily digested than if taken in the raw or undivided state.

I have repeatedly subjected fatty substances to the action of an artificial digestive liquor *, which readily dissolved coagulated white of egg or beef-steak. In

* See p. 71, foot-note, for the mode of preparing this liquor.

no case, however, have I been able to get the fat or oil in solution. When yolk of egg boiled hard was submitted to its influence, the albuminous matter was readily dissolved, but not so the yellow fat of the yolk, which was merely diffused through the liquor, rendering it creamy or yellowish white, and opaque.

Thus minutely divided, and perhaps otherwise somewhat changed, fat or fixed oil becomes absorbed by the chyliferous vessels; for it is well known that the opacity of the chyle depends entirely or principally on the presence of myriads of minute oily globules, which readily dissolve in ether.

The chymification of fatty substances is assisted by the presence of bile in the stomach. "Bile," says Dr. Beaumont, "is seldom found in the stomach, except under peculiar circumstances. I have observed," he adds, "that when the use of fat or oily food has been persevered in for some time, there is generally the presence of bile in the gastric fluids." The popular notion that oily or fatty foods "cause bile" in the stomach, is not, therefore, so groundless as medical men have generally supposed. From Dr. Beaumont's observations and experiments, it appears that oil is slowly, and with great difficulty, acted on by the gastric juice; but that the admixture of bile greatly accelerates chymification. Perhaps the alkaline property of the bile partly contributes to this effect.

In many dyspeptic individuals fat does not become properly chymified. It floats on the contents of the stomach in the form of an oily pellicle, becoming odorous, and sometimes highly rancid, and, in this state, excites heartburn, most disagreeable nausea, and eructations, or at times actual vomiting. It appears to me that the greater tendency which some oily substances have than others to disturb the stomach, depends on the greater facility with which they evolve volatile fatty acids, which are for the most part exceedingly acrid and irritating. The unpleasant and distressing feelings excited in many dyspeptics by the ingestion of mutton fat, butter, and fish-oils, are in this way readily accounted for; since all these substances contain each one or more volatile acids to which they respectively owe their odour. Thus mutton fat contains hircic acid; butter no less than three volatile fatty acids, viz. butyric, capric, and capröic acids; while train oil contains phocenic acid.

Fats, by exposure to the air, become rancid, and in this state are exceedingly obnoxious to the digestive organs. Their injurious qualities depend in part on the presence of volatile acids, and in part also on other volatile but non-acid substances. The following table shews the differences in composition between fresh and rancid lard:—

COMPOSITION OF FRESH AND RANCID LARD.

Fresh Lard.	*Rancid Lard,*
Stearine.	Stearine [Margarine ?] and Oleine.
Margarine.	Volatile non-acid matter, having a rancid odour.
Oleine.	Caproic (?) acid.
	Another volatile acid.
	Oleic, margaric, and perhaps stearic acids.
	Yellow colouring matter.
	Non-acid non-volatile matter, soluble in water.

The influence of heat on fatty substances effects various chemical changes in them, whereby they are

rendered more difficult of digestion, and more obnoxious to the stomach. Hence those culinary operations in which fat or oil is subjected to high temperatures, are objectionable for the preparation of foods for persons with weak stomachs. On this account, dyspeptics should be prohibited from employing foods prepared by frying; as in this operation the heat is usually applied by the intermedium of boiling oil or fat. Fixed oils give off, while boiling, carbonic acid, a little inflammable vapour, and an acrid volatile oil called *Acroleine* or *Acroleon* *, while the fatty acids of the oils are, in part, set free. It has always appeared to me that cooked butter proves more obnoxious to the stomach than cooked olive oil. This I ascribe to the facility with which, under the influence of heat, the acrid volatile acids of butter are set free.

The fat of salt-pork and of bacon is less injurious to some dyspeptics than fresh animal fats. A somewhat similar observation has been made by others. "There is one form of impaired digestion," says Dr. Combe †, "in which the fat of bacon is digested with perfect ease, where many other apparently more appropriate articles of food oppress the stomach for hours." This must depend on some change effected in the fat by the process of curing it, for, in the cases which have

* Acroleine is probably generated by the decomposition of the glycerine. Its vapour most powerfully affects the eyes. I have known a whole class of medical students obliged to leave the lecture-room to avoid the irritating effects of acroleine vapour developed during the distillation of a couple of ounces of olive oil.

† See the foot-note at p. 87 of his edition of Dr. Beaumont's *Experiments*.

fallen under my observation, the fat of salt-pork or of bacon was the only kind of fat which did not disturb the digestive organs. Dr. Combe, however, suggests that it may depend on the presence of bile in the stomach. On this explanation, however, other fats should be equally digestible, which, according to my experiments, they are not.

Fixed oil or fat is more difficult of digestion, and more obnoxious to the stomach, than any other alimentary principle. Indeed, in some more or less obvious or concealed form, I believe it will be found the offending ingredient in nine-tenths of the dishes which disturb weak stomachs. Many dyspeptics who have most religiously avoided the use of oil or fat in its obvious or ordinary state (as *fat meat*, *marrow*, *butter*, and *oil*), unwittingly employ it in some more concealed form, and, as I have frequently witnessed, have suffered therefrom. Such individuals should eschew the *yolk of egg*, *livers* (of quadrupeds, poultry, and fish), and *brains*, all of which abound in oily matter. *Milk*, and especially *cream*, disagree with many persons, or, as they term it, "lie heavy at the stomach," in consequence of the butter they contain. *Rich cheese* likewise contains butter, and on that account is apt to disturb the stomach. *Fried dishes* of all kinds are abominations to the dyspeptic, on account of the oil or fat used in their preparation. *Melted butter*, *buttered toast*, *butter-cakes*, *pastry*, *marrow-puddings*, and *suet-puddings*, are, for the like reason, obnoxious to the stomach. Several kinds of *fish*, as *salmon*, *herrings*, *sprats*, and *eels*, abound in oil, and on this account form objectionable foods for the dyspeptic. Moreover, the mode of cooking (frying) some fishes, and the condiment (melted butter) used with them, often render this kind of animal food injurious. The *oily seeds*, as *nuts*, *walnuts*, and *cocoa-nuts*, are very indigestible. *Chocolate* prepared from the oily seeds of the *Theobroma Cacao* is, therefore, not a fit article of food for a delicate stomach. *Hashes*, *stews*, and *broths*, frequently prove injurious, from the oil or fat contained in them. In preparing broths for such persons, therefore, the fat should be carefully removed by skimming.

Oleaginous aliments have been until very recently regarded as highly nutritious; though alone, it is well known that they are incapable of supporting life. But Liebig asserts that, like other non-nitrogenised foods, they are incapable of transformation into food, and are, therefore, unfitted for forming organised or living tissues, and that they merely serve for supporting the process of respiration. I have, however, already fully discussed Liebig's opinions on this subject in a former part of this work (see pp. 31—54), to which, therefore, I must refer the reader for further information. I have likewise noticed the importance of the fatty foods in enabling the inhabitants of frozen regions to resist the effects of extreme cold (see pp. 15—20).

In the Report made to the French Academy of Sciences, in the name of the Gelatine Commission *, it is stated that animals fed on fatty substances (fresh butter, lard, and the fat which surrounds the bullock's

* *Comptes Rendus*, Août 1841.

heart), refuse, after some time, to take this food, and ultimately die of inanition*. During life, they exhaled a strong fatty odour, and though dying of inanition, were in a remarkable state of *embonpoint*. On a post-mortem examination, all the tissues and organs were found infiltrated with fat, and the liver was in the state called by anatomists *fatty*.

In the preceding part (p. 53) of this work I have mentioned the facts adduced by Liebig, to prove that fat may be formed in the animal body from starch and sugar. Very recently, however, MM. Dumas and Payen † have denied the correctness of Liebig's conclusion; and have related some experiments which have led them to infer that animals derive their fat from plants. Maize, they state, contains 9 per cent. of a yellow oil; so that the goose referred to by Liebig (see *ante*, p. 53), in eating 24 lbs. of maize received 2·16 lbs. of fatty matter. "It is not astonishing, therefore, that the animal should yield 3½ lbs., when we reckon that which it contained originally."

Hitherto I have not alluded to the ulterior changes which the fixed oils or fats suffer in the animal economy. On this point, physiology is very barren

* To the general statement in the text two exceptions were reported by the Commissioners. One dog ate daily 125 grammes [1929¼ troy grs.] of the fat which surrounds the bullock's heart, and at the end of a twelvemonth was in perfect health. Another dog took 190 grammes [2932⅓ troy grs.] daily, and was in perfect health at the end of six months' trial. But as this kind of fat contains cellular tissue and fragments of muscular fibre, both nitrogenous substances, these results do not invalidate the general statement made in the text, and which is founded on the results obtained by feeding animals on pure fat.

† *Comptes Rendus*, Oct. 24, 1842. Also, *Annals of Chymistry*, Nov. 11, 1842.

in facts. I have already stated (see p. 170) that the chyle contains, floating in it, globules of oil visible by the aid of a microscope. In the blood, however, the oil or fat* does not exist in a free state, but is intimately combined with some of the other constituents of the serum; while its properties are different from those of the chyle-oil. It has, therefore, undergone some important modifications.

From the blood, the adipose and nervous tissues must derive their oily or fatty constituents. The peculiar fatty matters of the brain pre-exist in the blood.

Obesity and leanness depend, the one on excessive, the other on deficient, quantity of oleaginous matters in the system. Dr. Prout also very properly refers gall-stones, which consist of a fatty matter called cholesterine, to the mal-assimilation of the oleaginous principle.

Oleaginous foods often agree so remarkably well with diabetic patients, "that some have gone so far as to propose them as remedies. When freely taken, they usually cause a flow of saliva, and thus diminish the urgent thirst. When they agree, also, they give a sensation of satisfaction and support to the stomach, which other alimentary substances do not. Perhaps butter is the most agreeable form in which they can be taken, and this, under proper circumstances, may be taken freely. When oleaginous matters disagree, as

* Chemists have detected in the blood the following fatty substances: — *Cholesterine*, *Oleic* and *Margaric Acids*, *Serolin*, and *Cerebrote* (Cerebric Acid).

is sometimes the case, they should be carefully shunned *."

1. *Olive Oil; Sweet Oil.*—This is obtained by expression from olives. In France, the finest oil is procured by bruising them in the mill immediately they are gathered, and submitting the paste to pressure. The first product, termed *Virgin Oil* (*Huile Vierge*), is greenish, and is much sought after by connoisseurs, for its superior flavour. *Provence Oil*, the produce of Aix (*Huile d'Aix en Provence*), is one of the most esteemed kinds. *Florence Oil* is a fine kind of olive oil imported from Leghorn in flasks surrounded by a kind of network, formed by the leaves of a monocotyledonous plant. These are the kinds of olive oil in most frequent use at the table for salads (hence they are called *Salad Oils*). *Lucca Oil* is imported in jars holding nineteen gallons each. *Genoa Oil* is a fine kind. *Gallipoli Oil* is imported in casks: it constitutes the largest portion of the olive oil brought to England. *Sicily Oil* is of inferior quality. *Spanish Oil* is the worst. The foot deposited by olive oil is used for oiling machinery, under the name of *Droppings of Sweet Oil*.

Olive Oil consists of *Oleine* and *Margarine*. In cold weather, the latter constituent congeals in the form of white or yellowish globules. The following table shows the relative proportion of oleine and margarine in olive and almond oils:—

	Oleine.	*Margarine.*
Olive Oil	72	28
Almond Oil	76	24

* Dr. Prout, *op. supra cit.* p. 43, foot-note.

As olive oil contains somewhat more margarine than almond oil does, it is more apt to congeal in cold weather.

In England, the dietetical uses of olive oil are comparatively limited; being principally confined to its mixture with salads. It is also employed in frying fish. In Spain, and some other countries, it is frequently employed as a substitute for butter. Taken in large quantities, it acts as a mild laxative.

The difficult digestibility of oil has been already adverted to (see p. 169). Some writers on dietetics are of opinion that, taken as a condiment, with salad, it promotes the digestibility of the latter. But I do not coincide with them. The statement itself is, *à priori*, improbable, while the facts adduced in support of it are insufficient to prove it. Raw oil, as taken with salad, is less likely to disturb the stomach than the same or other oily or fatty substances when cooked; for while, on the one hand, the freshest and sweetest oil is generally selected for employment at the table in the raw state, so, on the other, oil which has been subjected to heat, as in various culinary operations, is rendered more difficult of digestion (see p. 172). Fresh olive oil I believe to be less obnoxious to the stomach than some other oily or fatty substances, and which I ascribe to its not containing any free volatile acid (see p. 171).

2. *Butter.*—As usually met with, this substance contains about one-sixth of its weight of butter-milk *.

* Thomson's *Chemistry of Animal Bodies*, p. 430. 1843.

Cow's butter, according to Bromeis *, has the following composition:—

COMPOSITION OF BUTTER.

Margarate of glycerine [*Margarine*]	68
Butyroleate of glycerine [*Oleine*]	30
Butyrate [*Butyrine*], capröate [*Capröine*], and caprate of glycerine [*Caprine*]	2
Butter	100

The same authority gives the following as the formulæ for the fatty acids of butter:—

COMPOSITION OF THE FATTY ACIDS OF BUTTER.

Margaric Acid	$C^{34}H^{33}O^{3}$
Butyroleic Acid	$C^{34}H^{30}O^{4}$
Butyric Acid	$C^{8}H^{6}O^{3}$
Capröic Acid	$C^{12}H^{9}O^{3}$
Capric Acid	$C^{18}H^{14}O^{3}$

The acid called by Bromeis *butyroleic acid* was obtained from the oil (*oleine* of Chevreul) which he had extracted from butter by pressure.

Butter is employed rather as a condiment than as a direct alimentary matter. Its dietetical properties I have already noticed (pp. 171 and 174). Its odour depends on the volatile fatty acids: to the facility with which these are set free, I have before ascribed its greater tendency to disorder the stomach than some other fats. When rendered rancid by keeping, or empyreumatic by heat, it is exceedingly injurious to the dyspeptic (pp. 172-174).

In the Report of the Gelatine Commission of the

* *Journal de Pharmacie*, 3me Sér. t. ii. Août 1842.

French Academy of Sciences, it is stated that a dog, fed on fresh butter only, continued to eat it irregularly for 68 days. "He died subsequently of inanition, although in a remarkable state of *embonpoint*. During the whole of the experiment he exhaled a strong odour of butyric acid, his hair felt greasy, and his skin was unctuous and covered with a fatty layer. At the autopsy all the tissues and organs were found infiltrated with fat. The liver was in the state called, in pathological anatomy, *fatty*. By analysis, a very large quantity of stearine [margarine?], but little or no oleine, was found in it. Into this organ, therefore, there had been a kind of infiltration of fat."

3. *Marrow.*—This is the fatty matter contained in the interior of the cylindrical bones. Berzelius analysed beef-marrow, and found its constituents to be as follows:—

COMPOSITION OF BEEF MARROW.

Medullary fat	96
Skins and bloodvessels	1
Watery liquids contained in these bodies	3
Beef marrow	100

"The constituent parts of these liquids do not differ from the matters which cold water extracts from beef."

Marrow is deprived of the skins, vessels, &c. by melting it, and straining through a linen cloth.

"The marrow of large bones," says Berzelius, "is absolutely of the same nature as the other fat of the same animal. The difference of flavour which exists between the marrow of boiled bones and ordinary melted fat depends on foreign matters derived from the liquids which circulate in the cellular tissue by which the fat is surrounded, and especially by an extractiform substance which is insoluble in alcohol."

The proportions of solid and liquid fats contained in marrow are, according to Braconnot, as follows:—

	Solid Fat. (Stearine.)	Liquid Fat. (Oleine.)
Beef marrow	76	24
Mutton marrow	26	74

In its dietetical properties, marrow agrees with other oily or fatty substances. *Beef marrow* is the only variety used at the table. It is never eaten raw. It is frequently employed as a substitute for suet in the making of puddings.

4. *Animal Fats.*—Under this head are included the oils or fats contained in the adipose tissue of animals: when separated from vessels and skins by melting and straining, they are said to be *rendered down.* By subjecting animal fats to pressure, Braconnot procured the following proportions of stearine and oleine from them:—

100 Parts.	Solid Fat. (Stearine, &c.)	Liquid Fat. (Oleine.)
Hog's lard	38	62
Goose fat	32	68
Duck fat	28	72
Turkey fat	26	74

Hog's lard contains, besides Stearine and Oleine, some Margarine (see p. 172, where also is stated the composition of rancid lard). Mutton Suet consists of Stearine, Margarine, Oleine, Hircine, and Hircic Acid (see p. 171). Whale oil, obtained, by boiling, from the blubber of whales, consists principally of Oleine with some Phocenine, and usually a little Phocenic acid, to which it owes its odour. It also contains a solid crystallisable fat.

The digestibility of animal fats has already been adverted to (see p. 169-170), as well as the injurious influence of heat on them (see p. 172). I have likewise noticed the fact that some kinds of cured fats (as salt-pork and bacon) are less indigestible, by some stomachs, than other forms of fat (see p. 173).

The incapability of pure animal fats to effect prolonged nutrition has likewise been stated (see pp. 36 and 175). Magendie* reports that many animals which at first ate lard with pleasure, subsequently refused to touch it. After a shorter or longer use of it they all died. The autopsy of one of these animals shewed, as in the case of the animal who died when kept exclusively on a diet of butter, "a general atrophy of the organs, but a great abundance of fat, particularly under the skin, where it formed a layer of more than one centimetre [0·39371 of an English inch] in thickness."

"We tried," continues Magendie, "whether, by mixing a certain portion of bread with the lard, we could ameliorate its effects. We made a paste composed of

Lard	120	Grammes.
White bread	250	Ditto.

But the animal who was submitted to this nourishment refused it after a few days' use of it."

Six dogs were fed exclusively on the fat which surrounds the heart of the ox. This fat contained some nitrogenous matter in the form of cellular tissue, and some small parcels of muscular fibres. Four of the

* *Comptes Rendus,* Août 1841.

animals refused to eat it after using it for seven days, and died in from 10 to 35 days." The two other animals continued to take it, and were nourished by it, as I have already stated (see p. 176, foot-note).

The animal fats are sometimes used by the cook, as preservative agents for various foods. Thus plums and damsons, when boiled, are covered with suet, in order to preserve them; potted meats with butter; &c. The antiseptic virtue depends, in these cases, on the exclusion of atmospheric air; the oxygen of which is a powerful accelerator of fermentation and putrefaction.

2. Of the Volatile or Essential Oils. — As volatile oil is a constituent of several substances employed at the table, either as aliments or condiments, I have thought it advisable to notice it here; — the more especially as Dr. Prout includes it among oleaginous aliments.

The *labiate plants* used in cookery, under the name of *sweet* or *savory herbs*, such as Mint, Marjoram, Savory, Sage, and Thyme, owe their peculiar odour and flavour to volatile oil lodged in small receptacles contained in the leaves. The fruits and leaves of several *umbelliferous plants* employed for flavouring, as Caraway, Anise, Fennel, and Parsley, likewise contain volatile oil, to which they owe their agreeable flavour. In the case of the umbelliferous fruits, the oil is contained in tubes or vessels, called *vittæ*, situated in the pericarpial coat of the fruit. The *cruciferous* or *siliquose condiments*, such as Mustard, Horse-radish, and Water Cresses, yield an acrid volatile oil, to which hey owe their pungency. The *alliaceous condiments*, Garlic, Onions, Eschalots, and Leeks, likewise owe

their peculiar flavour to volatile oil. The *spices*, as Cinnamon, Nutmeg, Mace, Cloves, Allspice, Pepper, and Ginger, owe their strong but grateful odour and taste to volatile oil. Lastly, the *bitter-almond flavour*, obtained, not only from Bitter-Almonds, but also from the leaves of the Peach and the Cherry-Laurel, resides in a volatile oil.

The *volatile oils* of many of the preceding substances are prepared and sold. But in flavour and odour they are generally inferior to the substances from which they are obtained; as the act of distillation, by which they are procured, usually diminishes more or less their agreeable qualities. Dissolved in rectified spirit of wine, in the proportion of one part of oil to eight parts of spirit, they form the liquids commonly sold as *Essences* for flavouring, &c.

The relish for flavouring or seasoning ingredients, manifested, in a greater or less degree, by almost every person, would lead us to suppose that these substances serve some useful purpose in the animal economy, beyond that of merely gratifying the palate. At present, however, we have no evidence to prove that they do. They stimulate, but do not seem to nourish. The volatile oil which they contain is absorbed, but is subsequently thrown out of the system, still possessing its characteristic odour. A portion of it may, perhaps, under some circumstances, be burnt in the lungs, and in this way produce heat.

10. The Proteinaceous Alimentary Principle.

(Albuminous Substances.)

Several organic principles, both animal and vegetable, which are employed as aliments, contain as their basis, or at least yield, the substance called by Mulder *Proteine*, and which I have before noticed (see p. 39). They may, therefore, be regarded as modifications of one another, or of proteine, and I have accordingly included them in one group, under the name of the proteinaceous alimentary principle.

This group corresponds very nearly with that called by Dr. Prout the *Albuminous Alimentary Principle*. It differs, however, in not comprehending gelatinous substances, which, for reasons hereafter to be stated, I have thought it advisable to form into a distinct group.

Proteine has been analysed by its discoverer, Mulder, and also by Scherer.

ANALYSES OF PROTEINE.

MULDER.

	From Fibrine.	*From Ovalbumen.*	*From Vegetable Albumen.*
Carbon . .	55·44	55·30	54·99
Hydrogen .	6·95	6·94	6·87
Nitrogen .	16·05	16·02	15·66
Oxygen .	21·56	21·74	22·48
Proteine .	100·00	100·00	100·00

SCHERER.

	From Fibrine.	*From Albumen.*	*From Crystalline Lens.*
Carbon . .	54·848	55·160	55·300
Hydrogen .	6·959	7·055	6·940
Nitrogen .	15·847	15·966	16·216
Oxygen .	22·346	21·819	21·544
Proteine .	100·000	100·000	100·000

Mulder and Liebig have deduced the following formulæ for the representation of the composition of proteine:—

MULDER.

	Atoms.	*Eq. Wt.*	*Per Cent.*
Carbon	40	240	54·93
Hydrogen	31	31	7·09
Nitrogen	5	70	16·02
Oxygen	12	96	21·96
Proteine	1	437	100·00

LIEBIG.

	Atoms.	*Eq. Wt.*	*Per Cent.*
Carbon	48	288	55·38
Hydrogen	36	36	6·92
Nitrogen	6	84	16·16
Oxygen	14	112	21·54
Proteine	1	520	100·00

These formulæ differ considerably from each other, yet agree very closely with the experimental results. They are good illustrations of the difficulty of determining the atomic constitution of complicated organic substances.

Proteine does not exist, as such, in organised beings. Combined with small quantities of mineral or organised substances (sulphur, phosphorus, potash, soda, common salt, and phosphate of lime), it constitutes fibrine, albumen, and caseine, both animal and vegetable.

The composition of Fibrine, Albumen, and Caseine, is, according to Mulder *, as follows:—

COMPOSITION OF PROTEINACEOUS COMPOUNDS.

	Fibrine.	*Ovalbumen.*	*Seralbumen.*	*Caseine.*
Proteine . . .	99·31	99·19	98·99	99·64
Sulphur . .	0·33	0·43	0·33	0·36
Phosphorus .	0·36	0·38	0·68	0·00
	100·00 [*Salts*]	100·00 [*Salts*]	100·00 [*Salts*]	100·00 [*Salts*].

* Mulder's formulæ for fibrine and albumen I have before stated (p. 66, foot-note).

Fibrine, albumen, and caseine, contain, besides Proteine, Sulphur, and Phosphorus, a quantity of *saline matter* (not included in the above analyses), and hence, when burned, they leave ashes (composed principally of phosphate of lime and alkaline salts). The following are the proportions of ashes obtained by Scherer and Jones:—

QUANTITY OF ASHES YIELDED BY FIBRINE, ALBUMEN, AND CASEINE.

100 *Parts.*	*Ashes.*	*Authority.*
Fibrine	1·3 to 2·3	Scherer.
Seralbumen	1·265 to 2·1	Ditto.
Ovalbumen (white of egg) . .	2·0	Ditto.
Albumen of the yolk of egg . .	4·8	Jones.
Albumen of Calf's brain . . .	2·8	Ditto.
Caseine*	1·5 to 10·0	Scherer.
Zieger	2·0	Ditto.

The dietetical properties of pure proteine have not yet been ascertained. The proteinaceous compounds constitute the plastic elements of nutrition (see p. 31). According to Liebig, they are produced by vegetables only, and cannot be formed by animals, "although the animal organism possesses the power of converting one modification of proteine into another, fibrine into albumen, or *vice versâ*, or both into caseine, &c. In this point of view, the vegetable forms of proteine, vegetable albumen, fibrine, and caseine, become signally important, as the only sources of proteine for animal life, and consequently of nutrition, strictly so called—that is, the growth in mass of the animal body†."

* The ashes of caseine consist chiefly of phosphate of lime and potash (Liebig).

† Turner's *Chemistry*, 7th ed. p. 1185. 1842.

The brain and nervous matter (which is quite similar to brain) are distinct from all other animal tissues, and, according to Liebig, are formed, in the animal body exclusively, "from compounds of proteine, either by the loss of some azotised compounds, or by the addition of highly carbonised products, such as fat*."

Proteinaceous aliments are obtained from both animals and vegetables, and it will, therefore, be convenient to consider them under two distinct subgroups; notwithstanding that Liebig states, as I have before observed (see pp. 38-39), that animal and vegetable fibrine, animal and vegetable albumen, and animal and vegetable caseine, are respectively identical in every particular.

1. ANIMAL PROTEINACEOUS PRINCIPLES.—This subgroup comprehends Fibrine, Albumen, and Caseine (see p. 39).

a. Fibrine; Animal Fibrine.—The fibrine is contained in solution in the circulating blood, but coagulates when this fluid is drawn from the body, forming, with the colouring particles, the *clot* or *crassamentum*. In the solid state it constitutes the basis of muscular fibre. It forms, therefore, the principal constituent of the fleshy or lean parts of animals. It is also found in some other animal tissues.

QUANTITY OF FIBRINE IN ANIMAL SUBSTANCES.

100 *Parts.*	*Fibrine.*	*Authority.*
Blood of the Hog . .	0·46	Andral, Gavarret, and Delafond.
" " Ox . .	0·37	
" " Sheep .	0·3	

* Ibid. p. 1197.

100 *Parts.*	*Fibrine.*		*Authority.*
Beef (muscle of)	20·0	*including albumen*	Brande.
Veal (ditto)	19·0	*ditto*	Ditto.
Mutton (ditto)	22	*ditto*	Ditto.
Pork (ditto)	19	*ditto*	Ditto.
Chicken (ditto)	20	*ditto*	Ditto.
Cod (ditto)	14	*ditto*	Ditto.
Haddock (ditto)	13	*ditto*	Ditto.
Sole (ditto)	15	*ditto*	Ditto.
Calf's Sweetbread (Thymus)	8	. . .	Morin.

Fibrine (as beef-steak, &c.) is readily soluble in the artificial digestive liquid already described (see p. 71, foot-note). It is also speedily dissolved in the living stomach; and is generally considered, even by dyspeptics, as being easy of digestion.

It is an important element of nutrition, and yields fibrine, albumen, and caseine, as well as the tissues composed of these substances. Alone, however, it is incapable of supporting life, except for a very limited period. Magendie* mentions, as a most singular and surprising circumstance, that animals who took regularly for two months from 500 grammes [1 lb. 4 oz. 37 grs. troy] to 1000 grammes [2 lbs. 8 oz. 74 grs. troy] of fibrine daily, died of inanition; and on a post-mortem examination, it was found that the blood had almost entirely disappeared. "Notwithstanding," says Magendie, "the care we took to collect it [the blood], a few minutes after death, scarcely a gramme [15·444 grs. troy] of fibrine could be obtained."

b. Albumen; Animal Albumen.—This substance constitutes the most important part of animal foods. The albumen, both of the egg (*ovalbumen*) and of the

* *Comptes Rendus*, Août 1841.

serum of the blood (*seralbumen*), is liquid. But the albumen of flesh, glands, and viscera of animals, is solid. The quantity of albumen contained in several aliments is as follows:—

QUANTITY OF ALBUMEN IN ANIMAL SUBSTANCES.

100 *Parts.*	*Albumen.*	*Authority.*
Blood of the Ox	18·6	Mean quantity of blood-corpuscles and solid contents of the serum, according to MM. Andral, Gavarrel, and Delafond.
" " Hog (English breed)	18·58	
" " Goat	19·28	
" " Sheep (Merino)	18·35	
" " Ditto (Dishley breed)	18·74	
East Indian Isinglass	7·2 to 13·5	E. Solly, jun.
Egg, white of	15·5	Bostock.
" yolk of	17·47	Prout.
Liver of Ox, parenchyma of	20·19	Braconnot.
Sweetbread (Thymus) of Calf	14·00	Morin.
Caviare, fresh unpressed	31·00	John.
Muscle of Beef	2·2	Soluble Albumen and Hæmatosine, according to Schlossberger.
" " Veal	3·2 to 2·6	
" " Pork	2·6	
" " Roe Deer	2·3	
" " Pigeon	4·5	
" " Chicken	3·0	
" " Carp	5·2	
" " Trout	4·4	

I have included the *blood corpuscles* among the albuminous constituents of some of the preceding alimentary substances, since albumen is their principal constituent*.

Albumen is highly nutritious, and, when either raw or lightly boiled, is easy of digestion; but when

* According to Denis (*Essai sur l'Application de la Chimie à l'Etude Physiologique du Sang de l'Homme*, p. 205, 1838), the blood corpuscles have the following composition:—

Envelopes	Colouring matters (*Hæmatosine*)	1·8
	Peroxide of Iron	0·2
Central nucleus (*albuminous matters*)		98·0
Blood Corpuscles		100·0

boiled hard, or especially when fried, its digestibility is considerably impaired (see *Eggs*). The gastric juice has the property of coagulating liquid albumen, and afterwards of dissolving the coagula which are formed. The influence of an artificial gastric juice on cubes of coagulated albumen (white of egg), I have already mentioned (see p. 71, foot-note).

"Albumen," says Liebig*, "must be considered as the true starting point of all the animal tissues. This appears from the phenomena of incubation, where all the tissues are derived from the albumen of the white and of the yolk, which contain albumen also, with the aid only of the air, of the oily matter of the yolk, and of a certain proportion of iron, also found in the yolk." Out of this albumen, therefore, must be formed flesh, blood, membrane and cellular tissue, blood-vessels, feathers, claws, &c.

Notwithstanding this, however, animals cannot subsist solely on albumen (see p. 44, foot-note). After a few days' use of it they refuse to take it, preferring to suffer the most violent pangs of hunger rather than eat it; and ultimately they die of inanition. It has been justly observed by Magendie†, that white of eggs combines a number of conditions favourable to digestion. "It is alkaline, contains saline matters, and especially common salt in very large proportion: the animal matter which it contains is the same as that found in the chyle and in the blood: it is liquid, but is coagulated by the acids of the stomach, forming flocculi

* Turner's *Chemistry*, 7th ed. p. 1187.
† *Comptes Rendus*, Août 1841.

having but little cohesion. Lastly, white of egg contains some organised membranes, which may perform, in digestion, some useful and perhaps indispensable function. But notwithstanding all these good reasons, albumen is refused by animals."

Albumen (as the white or glaire of eggs) is used by the cook and confectioner as a clarifying or clearing agent for syrups, jellies, &c. Its efficacy depends on its coagulation, by which it entangles in its meshes the impurities, with which it either rises to the surface or precipitates. When the liquid to be clarified does not spontaneously coagulate the albumen, it is necessary to apply heat.

c. Animal Caseine; Caseum; Lactalbumen; Curd.—This is the coagulable matter of milk, and is closely allied to albumen, of which it may be regarded as a modification. Liquid caseine, unlike liquid albumen, does not coagulate by heat, though when milk is heated in an open vessel an insoluble pellicle forms on it, owing to the action of the atmospheric oxygen. "The ashes of soluble caseine," says Liebig*, "are very strongly alkaline; and there is reason to believe that the potash found in the ashes had served, by combining with the caseine, to render it soluble."

The quantity of caseine contained in different kinds of milk is as follows:—

QUANTITY OF CASEINE IN MILK.

100 *Parts.*	*Caseine.*	*Authority.*
Cow's milk	4·48	O. Henry and Chevallier.
Ditto fed on hay	3·0	Boussingault and Le Bel.
Ditto „ turnips	3·0	
Ditto „ clover	4·0	
Ditto „ potatoes and hay .	15·1	
Ditto „ ditto	3·3	

* Turner's *Chemistry*, 7th ed. p. 1190.

100 *Parts.*	*Caseine.*	*Authority.*
Ewe's milk	4·50	O. Henry and Chevallier.
Goat's milk	4·02	Ditto.
Asses' milk	1·82	Ditto.
Woman's milk	1·52	Ditto.

Mulder * has shewn that caseine, like albumen and fibrine, is a proteinaceous substance. It differs, however, from the two last-mentioned principles, in containing no phosphorus (see p. 30 and 187). When coagulated by rennet and afterwards burnt, it yields 6 per cent. of phosphate of lime and a half per cent. of caustic lime †.

Coagulated caseine, deprived of whey by pressure, and usually mixed with more or less of butter, constitutes *cheese;* the richness of which is in proportion to the quantity of butter present. Rich cheese, when toasted, undergoes a kind of semifusion, and becomes soft and viscid. The poorer cheeses, or those which contain very little butter, are better adapted for keeping. When toasted they shrivel like horn. *Stilton Cheese* is prepared from milk to which cream is added. *Cheshire* and the best *Gloucester Cheeses* are made from unskimmed milk. *Suffolk* and *Parmesan Cheeses* are prepared from skim-milk. Annotta is often employed, as a colouring agent, in the preparation of cheese. Salt is used to preserve it, as well as to improve the flavour and add to the weight.

When long kept, cheese undergoes a series of peculiar changes. According to Chevreul ‡, its odour

* *Pharmaceutisches Central-Blatt für* 1839, p. 244.
† Berzelius, *Traité de Chimie,* t. vii. p. 603.
‡ *Ann. de Chim. et de Phys.* xxiii. p. 29.

depends on the developement of the fatty acids of butter; and, when the fermentation is prolonged, to the alteration of the capric acid. *Roquefort Cheese* owes its odour to the latter circumstance. By the decomposition of moist cheese, there is developed a solid substance, which Braconnot * called *aposepedin* (from *απω*, *from*, and *σηπεδὼν*, *putrefaction*, because it is the produce of putrefaction), but which Proust † had previously denominated *caseic oxide.* This last-mentioned chemist also mentions *caseic acid* as a constituent of cheese; but Braconnot states that the substance to which Proust gave this name is a compound or mixture of no less than nine substances, viz. free acetic acid, aposepedine, animal matter soluble in water and insoluble in rectified spirit (osmazome), animal matter soluble in water and alcohol, yellow acrid oil, brown slightly sapid oil, acetate of potash, chloride of potassium, and traces of acetate of ammonia. From 750 parts of cheese, Braconnot obtained 36 parts of fatty matter, composed of margarate of lime 14·92, margaric acid 2·57, oleic acid retaining margaric acid and a brown animal matter 18·51. The piquant flavour of old cheese depends on oleic acid and an acrid oily matter.

Cheese is subject to the attacks of both animals and vegetables. The Fly called *Musca (Tephritis) putris* deposits its leaping larvæ or maggots (called *hoppers* or *jumpers*) on cheese. The *Cheese-mite (Acarus domesticus)* is another animal of frequent occurrence.

* *Ann. de Chim. et de Physique,* xxxvi. p. 159.
† Ibid. x. p. 39.

The *Mould* of cheese is composed of minute fungi. *Blue Mould* is the *Aspergillus glaucus* of Berkeley *: while *Red Cheese-mould* is the *Sporendonema Casei* of the same authority.

Liquid caseine, as it exists in milk, is coagulated in the stomach by the gastric secretion †, and the coagula thus formed are subsequently redissolved ‡. In this form, caseine is easy of digestion. Cheese, however, is digested with difficulty, especially by dyspeptics §.

* Smith's *English Flora*, Vol. v. Part ii. *Fungi*, by the Rev. M. J. Berkeley. Lond. 1836.

† "The action of the digestive principle on caseine deserves a more particular consideration. Berzelius had already pointed out that the rennet of the calf has the property of coagulating milk, even after all traces of acidity have been removed by washing. It is known, too, that the coagulation of the caseine produced by rennet is peculiar; inasmuch as the curds are insoluble in water and in an additional quantity of acid. Now Schwann has shown that this property of coagulating the caseine is possessed by the artificial digestive fluid, even when neutralised. On the addition of a very small quantity of the acid fluid to milk, and the application of heat, the coagulated caseine soon separates: of the neutral fluid, more than 0·42 per cent. are necessary; 0.83 is sufficient. The power of the artificial digestive fluid to coagulate milk is destroyed by the boiling temperature; it cannot, therefore, be the saline ingredients which produce the coagulation. This peculiar action of the digestive principle on milk renders the latter fluid a test for its presence. Schwann has in this way proved that the digestive principle which we are here considering, really exists in the stomach. He divided the stomach of a rabbit, which had died immediately after birth, into two portions; boiled one, and then added to each some milk. On the application of a gentle heat, the milk coagulated in the portion which had not been boiled, while in the other it remained unchanged" (Müller's *Physiology*, by Baly, vol. i. p. 547).

‡ According to Schwann, caseine dissolves in the acid of the gastric juice; whereas albumen requires the presence of pepsine to effect its solution.

§ "By many," says Dr. Dunglison (*Elements of Hygiène*, p. 278, Philadelphia, 1835) "cheese is supposed to be an excellent condiment, and, accordingly, it is often systematically taken at the end of dinner as a *digestive*, in accordance with the old proverb:—

'Cheese is a surly elf,
Digesting all things but itself.'

In the toasted state it is still more obnoxious to the stomach *.

The time required for the chymification of cheese is, according to Dr. Beaumont's experiments, as follows:—

Articles of Diet.	Mean time of the Chymification.					
	In Stomach.			In Phials.		
	Preparation.	H.	M.	Preparation.	H.	M.
Cheese, old, strong .	Raw . . .	3	30	Masticated	7	15
,, ,, ,,	..	..		Entire pure	18	0
,, new, mild .	..	..		Divided . .	8	30

Caseine is highly nutritious, constituting a plastic element of nutrition (see p. 31), by which, in the young mammal, the developement of the tissues is effected.

"The young animal," says Liebig †, "receives, in the form of caseine, which is distinguished from fibrine and albumen by its great solubility, and by not coagulating when heated, the chief constituent of the mother's blood. To convert caseine into blood no

* "With respect to cheese," says Dr. Cullen (*Materia Medica*, p. 331) "there is yet one particular to be mentioned, and which is to remark, that it is often ate after having been toasted—that is, heated over the fire to a considerable degree; whereby a portion of its oil is separated, whilst the other parts are united more closely together. I know many persons who seem to digest this food pretty well; but it is certainly not easily digested by weak stomachs: and for those who can be hurt by indigestion, or heated by a heavy supper, it is a very improper diet."

† *Animal Chemistry*, p. 52.

foreign substance is required, and in the conversion of the mother's blood into caseine, no elements of the constituents of the blood have been separated. When chemically examined, caseine is found to contain a much larger proportion of the earth of bones than blood does, and that in a very soluble form, capable of reaching every part of the body. Thus, even in the earliest period of its life, the developement of the organs, in which vitality resides, is, in the carnivorous animal, dependent on the supply of a substance, identical in organic composition with the chief constituents of its blood."

2. Vegetable Proteinaceous Principles.—According to Liebig, vegetables contain proximate principles, which are not only similar to, but absolutely identical with, the fibrine, albumen, and caseine of animals; and he, therefore, denominates them respectively vegetable fibrine, vegetable albumen, and vegetable caseine.

There is also a fourth proteinaceous vegetable principle called glutine, or pure gluten.

The composition of these substances may be assumed identical, for their analyses do not differ more than two analyses of the same substances differ from each other.

COMPOSITION OF VEGETABLE FIBRINE.

	Obtained from Wheat-Gluten.			*From Rye Meal.*
	Scherer.	*Scherer.*	*Jones.*	*Scherer.*
Carbon . .	53·064	54·603	53·83	54·617
Hydrogen .	7·132	7·302	7·02	7·491
Nitrogen . .	15·359	15·810	15·58	15·809
Oxygen . / Sulphur . / Phosphorus	24·445	22·285	23·56	22·083
	100·000	100·000	100·00	100·000

COMPOSITION OF VEGETABLE ALBUMEN, CASEINE, AND GLUTEN.

	Vegetable Albumen from Rye. (*Jones.*)	*Vegetable Caseine.* (*Scherer.*)	*Pure Gluten.* (*Jones.*)
Carbon	54·74	54·138	55·22
Hydrogen . . .	7·77	7·156	7·42
Nitrogen . . .	15·85	15·672	15·98
Oxygen, &c. . .	21·64	23·034	21·38
	100·00	100·000	100·00

No experiments have been made on the nutritive powers of these principles in the separate state; but they are doubtless equal to those of the same principles procured from animals (see pp. 38-39).

"How beautifully and admirably simple," says Liebig, "appears the process of nutrition in animals, the formation of their organs in which vitality chiefly resides! Those vegetable principles which, in animals, are used to form blood, contain the chief constituents of blood, fibrine and albumen, ready formed, as far as regards their composition. All plants, besides, contain a certain quantity of iron, which reappears in the colouring matter of the blood. Vegetable fibrine and animal fibrine, vegetable albumen and animal albumen, hardly differ, even in form; if these principles be wanting in the food, the nutrition of the animal is arrested; and when they are present, the graminivorous animal obtains in its food the very same principles on the presence of which the nutrition of the carnivora entirely depends. Vegetables produce in their organism the blood of all animals, for the carnivora, in consuming the blood and flesh of the graminivora, consume, strictly speaking, only the vegetable principles which have served for the nutrition of the latter. Vegetable fibrine and albumen take the same form in the stomach of the graminivorous animal as animal fibrine and albumen do in that of the carnivorous animal."

a. Vegetable Fibrine.—This principle is most abundant in the seeds of the cereal grasses, as Wheat*, Rye, Barley, Oats, Maize, and Rice. It exists also in Buckwheat. The Juice of Grapes is especially rich in it. It is also found in the newly-expressed juices of most vegetables, as of Carrots, Turnips, and Beet-root, from which it coagulates spontaneously on standing. It is a constituent of the raw gluten obtained from the dough of wheaten flour. From both vegetable albumen and vegetable caseine, it differs in being insoluble in water. Moreover, it does not dissolve in ammonia.

b. Vegetable Albumen.—This, like vegetable fibrine, is a constituent of the seeds of the Cereal Grasses, as of Wheat. In the preparation of raw gluten from wheaten dough, it is washed away along with the starch. It is found in great abundance in the Oily Seeds, as Almonds, Nuts, &c. Most Vegetable Juices contain a considerable quantity of it. Thus the juices of Carrots, Turnips, Cabbages, Cauliflowers, Asparagus, and other cultivated nutritious vegetables, after being separated from the coagulum of fibrine, which spontaneously forms in them, yield by boiling a second coagulum of vegetable albumen.

This principle differs from vegetable fibrine in being soluble in water, and from vegetable caseine in coagulating when heated.

* The vegetable fibrine of wheat is identical with the *zymome* of Taddei, and with the *vegetable albumen* of Berzelius.

c. Vegetable Caseine.—This is chiefly found in Leguminous Seeds, as Beans, Peas, Lentils; and has in consequence, been termed *Legumine.* The oily seeds, such as Almonds, Nuts, &c., also contain it along with albumen. It exists, perhaps, in solution in grape juice, and in other vegetable juices which yield very little vegetable albumen on being heated. It differs from vegetable fibrine in being soluble in water: and from vegetable albumen in not coagulating when its aqueous solution is heated.

d. Pure Gluten.—By washing wheaten dough with a stream of water, the gum, sugar, starch, and vegetable albumen, are removed; while a ductile, tenacious, elastic, grey mass is left, which is usually denominated *gluten.* I shall distinguish it as *raw, impure,* or *common gluten.* It is sometimes called *Beccaria's gluten.* It is a mixture of several organic principles.

When raw gluten is boiled in alcohol, it is resolved into two portions, one soluble, the other insoluble in this liquid. The insoluble portion is Liebig's *vegetable fibrine.* It is identical with what Taddei called *zymome* (from ζύμη, *ferment*), and which Berzelius describes as *vegetable albumen.* The soluble portion is that which Jones (quoted by Liebig) analysed as *pure gluten,* and which Taddei called *gliadine* (from γλία, *glue*). It probably consists of at least two substances; one which deposits as the hot alcoholic solution cools, and which has been termed *mucine*; the other remains in solution in the cold liquor, and has been called *glutine.*

The quantity of *pure gluten* (glutine and mucine) contained in different alimentary substances, has not been accurately determined. According to Saussure *, raw gluten has the following composition:—

COMPOSITION OF RAW GLUTEN.

Glutine	20
Vegetable albumen [vegetable fibrine of Liebig]	72
Mucine	4
Oily matter	3·7
Starch (accidental)	small quantity.
Raw Gluten	99·7

The quantity of *raw gluten* contained in various alimentary substances is as follows:—

QUANTITY OF GLUTINOUS MATTER CONTAINED IN SEVERAL ALIMENTARY SUBSTANCES.

100 *Parts.*	*Glutinous Matter.*	*Authority.*
Wheat, Middlesex (average crop)	19·0	Davy.
" Spring	24·0	Ditto.
" Mildewed of 1806	3·2	Ditto.
" Blighted of 1804	13·0	Ditto.
" Thick-skinned Sicilian of 1810	23·0	Ditto.
" Thin-skinned Sicilian of 1810	23·9	Ditto.
" from Poland	20·0	Ditto.
" North American	22·5	Ditto.
" of the neighbourhood of Paris	9·2†	Boussingault.
" cultivated in soil manured with ox-blood	34 24	Hermbstaedt.
" Ditto " with human fæces	33·94	Ditto.
" Ditto " with sheep's dung	32·9	Ditto.
" Ditto " with goat's dung	32·88	Ditto.
" Ditto " with human urine	35·1	Ditto.
" Ditto " with horse-dung	13·68	Ditto.
" Ditto " with pigeon's dung	12·2	Ditto.
" Ditto " with cow-dung	11·96	Ditto.

* *Bibliothèque Universelle.* Sciences et Arts, t. liii. p. 260. 1833.

† Mechanical analysis gave Boussingault only 9·2 per cent. of raw gluten; but the quantity of nitrogen contained in the same wheat indicated 14·4 per cent. of raw gluten. The difference (5·2 per cent.) he ascribes to the vegetable albumen and gluten carried away by washing in the mechanical analysis (*Ann. de Chim. et de Phys.* t. lxv. p. 308-9).

100 *Parts.*	*Glutinous Matter.*	*Authority.*
Wheat Ditto " with vegetable humus	9·6	Hermbstaedt.
" Ditto, not manured	9·2	Ditto.
Wheat	12·5	Proust.
" Bavarian	24·0	Vogel.
Barley, Norfolk	6 0	Davy.
" grown in soil manured with horse-dung	5·7	Hermbstaedt.
Oats from Scotland	8·7	Davy.
" grown in soil manured with horse-dung	4·0	Hermbstaedt.
Rye from Yorkshire	10·9	Davy.
" grown in soil manured with horse-dung	7.98	Hermbstaedt.
Rice, Carolina	3·60	Braconnot.
" Piedmont	3·60	Ditto.
Maize	(*zeïne*) 3·0	Gorham.
"	(*ditto*) 5·758	Bizio.
Beans, common	10·3	Davy.
Pease, dry	3·5	Davy.
Potatoes	4 to 3	Davy.
Beet, red	1·3	Davy.
Turnips, common	0·1	Davy.
Cabbage	0·8	Davy.

From Schwann's experiments it appears that gluten dissolves in the acid of the gastric secretion; for when it was digested separately with dilute acid and dilute digestive fluid, no difference could be perceived in the change which it underwent in the two fluids. Tincture of iodine threw down a precipitate in the solution of gluten in the dilute acid, but produced no change of colour *.

Gluten is easy of digestion; at least substances (as the preparations of wheat) which contain it in the largest quantity, are readily digested even by invalids and dyspeptics.

Gluten is highly nutritious, and alone is capable of the prolonged nutrition of animals. "Gluten," says Magendie †, "obtained either from wheat or maize,

* Muller's *Physiology*, Baly's Translation, vol. i. p. 547.

† *Rapport fait à l'Académie des Sciences au nom de la Commission dite de la Gélatine.* *Comptes Rendus*, Août 1841.

presented a phenomenon which we had not observed in our experiments with organic immediate principles, which, in every instance, excited greater or less aversion in the animals obliged to subsist on it solely.

" Gluten, notwithstanding that its odour is savourless, and sometimes somewhat nauseous, while its taste has nothing agreeable, was taken without difficulty from the first day, and the animals continued to use it without distaste for three months uninterruptedly. The dose was 120 to 150 grammes [1852 to 2315 grs. troy] daily, and the animals preserved all the characters of excellent health. This fact appeared the more remarkable to us, as it was in opposition to the law which seemed to result from very numerous facts before stated, namely, that an alimentary substance, especially if it were an isolated immediate principle, is not fitted for supporting life beyond a very limited period.

" Here, however, is a substance heretofore considered as an immediate azotised principle which, without any preparation or seasoning, excited neither repugnance nor disgust, and which alone nourished completely and for a long period."

Magendie subsequently observes that gluten ought not to be considered as an immediate principle. " That which we employed," he adds, " undoubtedly contained some traces of fecula. Exclusive of this, we know that it may be resolved into two distinct substances; one of an albuminous nature, the other called glaïadine. This latter is likewise separable into gluten properly so called, gum, and mucilage."

" Our dogs, therefore," he continues, " eat much gluten, combined with a little albumen, gum, mucilage, fecula, and even sugar arising from the fecula. This aliment, simple in appearance, was then, in reality, very compounded."

" It is the presence of gluten in wheaten flour that renders it pre-eminently nutritious, and its viscidity or tenacity confers upon that species of flour its peculiar excellence for the manufacture of *macaroni*, *vermicelli*, and similar pastes, which are made by a kind of wire-drawing, and for which the wheat of the south of Europe (more abundant in gluten than our own) is particularly adapted. The superiority of wheaten over other bread depends upon the greater tenacity of its *dough*, which, in *panary fermentation*, is puffed up by the evolved carbonic acid, and retained in its vesicular texture, so as to form a very light loaf*."

Gluten being nutritious and unobjectionable as an article of food in diabetes, has been recently used in the preparation of what has been called *gluten bread*, for the use of diabetic patients †.

11. THE GELATINOUS ALIMENTARY PRINCIPLE.

Dr. Prout § comprehends gelatine among albuminous aliments. He considers it to be a modification of albumen, or " as the least perfect kind of albuminous matter existing in animal bodies."

But gelatine and albumen, and the proteinaceous and albuminous tissues respectively differ in their

* Brande's *Manual of Chemistry*, p. 1091, 5th ed. 1841.

† See the article *Bread*.

§ *On the Nature and Treatment of Stomach and Urinary Diseases*, pp. xii. and xiii. 3rd ed. 1840.

chemical properties and composition. And though it is probable that, in the animal system, gelatinous tissues are formed out of proteine compounds, chemists have hitherto totally failed to convert albumen into gelatine, or, *vice versâ*, to change gelatine into albumen. Moreover, as the composition of proteine compounds is identical with that of the flesh and blood of animals, while that of the gelatinous tissues is not, it follows that the nutritive qualities of the proteinaceous and gelatinous tissues cannot be identical. For these reasons I have thought it desirable to separate gelatinous aliments from albuminous ones.

Albuminous or proteinaceous tissues are insoluble in water, and by boiling become hard. Gelatinous tissues, on the other hand, yield, by boiling, a substance called *gelatine*, which is soluble, and forms with water a tremulous mass, termed *jelly* (*animal jelly*). The quantity of gelatinous matter obtained from different alimentary substances is as follows:—

QUANTITY OF GELATINOUS MATTER OBTAINED FROM ALIMENTARY SUBSTANCES.

100 *Parts.*	*Gelatine.*		*Authority.*
Isinglass (East Indian)	86·5 to 92·8	. . . .	E. Solly., jun.
" (good quality)	70·0	. . . .	John.
Muscle of Beef	6·0	. . . .	Brande.
" Veal	6·0		
" Mutton	7·0		
" Pork	5·0		
" Chicken	7·0		
" Cod	7·0		
" Haddock	5·0		
" Sole	6·0		
Caviare, fresh unpressed	0·5	(including some salts)	John.
Sweetbread (Thymus) of Calf	6·0	. . . .	Morin.

100 *Parts.*	*Gelatine.*		*Authority.*
Antlers of Stag (Hartshorn)	27·0	(Cartilage)	Merat-Guillot.
Bones, spongy portions	39	(ditto)	D'Arcet.
Bones of Sheep (Ileum)	43·3 to 47.2	. . . .	Dr. T. Thomson.
" of Ox (Ileum)	48·5		
" of Haddock (Vertebræ)	39·49		

Under the name of gelatine are included several substances which differ more or less from each other, but which agree in most of their principal characters. Two of these have been distinguished by distinct names, viz., *Collin* or *Colla* and *Chondrin*.

α. *Collin*, Thomson; *Colla*, Müller; *Common Gelatine.*—This is obtained from Isinglass, Skins, Tendons, Cartilage of bone after ossification has taken place, Cellular Tissue, and the Serous Membranes. It is distinguished from chondrin by not being precipitated from its aqueous solution by muriatic acid, acetic acid, acetate of lead, alum, sulphate of alumina, or sulphate of the sesquioxide of iron. *Glue*, *Size*, and *Isinglass Jelly*, are examples of collin.

β. *Chondrin*, Müller.—This is obtained from the Cornea, the Spongy Cartilages, the Permanent Cartilages, Cartilage of bone before ossification, the Unossified Cartilages of the Cartilaginous fishes, and the Bony Crusts of the Armadillo. It is distinguished from collin by being precipitated from its aqueous solution by muriatic acid, acetic acid, acetate of lead, alum, sulphate of alumina, and sulphate of the sesquioxide of iron.

γ. *Gelatine from Elastic Tissues.*—The gelatine obtained from the Elastic Tissues, as the Inner Arterial Coat, the Ligaments of the Larynx, &c., is identical with neither collin nor chondrine, though it approximates nearer to the latter. Its aqueous solution is rendered turbid by acetic acid and acetate of lead, and is precipitated by alum and sulphate of alumina, but does not form a precipitate with sulphate of the sesquioxide of iron.

δ. *Gelatine altered by heat.*—When gelatine is submitted to prolonged ebullition, or to a temperature exceeding 220° F., it undergoes important changes. It evolves ammonia, becomes syrupy, loses its characteristic property of forming with water a jelly, and very speedily undergoes putrefaction. Thus altered, it has a disagreeable flavour. Its nutritive properties are greatly deteriorated, if not altogether destroyed. It is less digestible, and readily deranges the functions of the digestive organs.

The ultimate composition of gelatinous substances is as follows:—

COMPOSITION OF GELATINOUS SUBSTANCES.

	Tissues yielding Collin.		*Collin.*	*Tissues yielding Chondrin.*
	Isinglass. (*Scherer.*)	*Tendons of Calf's Foot.* (*Scherer.*)	*Hartshorn Jelly.* (*Mulder.*)	*Cartilages of Calf's Ribs.* (*Scherer.*)
Carbon	50·557	50·960	50·048	50·895
Hydrogen	6·903	7·188	6·643	6·962
Nitrogen	18·790	18·320	18·388	14·908
Oxygen	23·750	23·532	24·921	27·235
	100·000	100·000	100·000	100·000

From the researches of Mulder and Scherer, Liebig has deduced the following empirical formulæ of the composition of various organic substances.

COMPOSITION OF ORGANIC TISSUES.

Albumen	$C^{48} N^6 H^{36} O^{14} + P + S$*
Fibrine	$C^{48} N^6 H^{36} O^{14} + P + 2 S$
Caseine	$C^{48} N^6 H^{36} O^{14} + S$
Gelatinous tissues, tendons	$C^{48} N^{7\cdot5} H^{41} O^{18}$
Chondrine	$C^{48} N^6 H^{40} O$
Hair, horn	$C^{48} N^7 H^{39} O^{17}$
Arterial membrane	$C^{48} N^6 H^{38} O^{16}$

"The composition of these formulæ shews that when proteine passes into chondrine (the substance of the cartilages of the ribs), the elements of water, with oxygen, have been added to it; while in the formation of the serous membranes, nitrogen also has entered into combination.

"If we represent the formulæ of proteine $C^{48} N^6 H^{36} O^{14}$ by Pr, then nitrogen, hydrogen, and oxygen, have been added to it in the form of known compounds, and in the following proportions, in forming the gelatinous tissues, hair, horn, arterial membrane, &c."

	Proteine.		*Ammonia.*		*Water.*		*Oxygen.*
Fibrine	Pr						
Albumen	Pr			+	2 HO		
Chondrine	Pr			+	4 HO	+	2 O
Hair, horn	Pr	+	NH^3			+	3 O
Gelatinous tissues	2 Pr	+	3 NH^3	+	HO	+	7 O

According to Schwann, the artificial digestive liquor (described at p. 71, foot-note) produced no other change upon gelatine than what simple acidified water equally produced. His statements are confirmed by Dr. Beaumont's experiments †.

* "The quantities of sulphur and phosphorus here expressed by S and P are not equivalents, but only give the relative proportions of these two elements to each other, as found by analysis."

† *Op. supra cit.* pp. 237-238.

The digestibility of the different varieties and forms of gelatinous matter is not uniform. *Calf's-foot jelly*, when fresh prepared, I believe to be readily digested even by invalids and dyspeptics, with whom I have rarely found it disagree. I am confirmed in this opinion by the experiments of Dr. Beaumont *.

Isinglass jelly, when fresh prepared from isinglass of good quality, and also *Hartshorn jelly*, are probably equally easy of digestion.

But other forms of gelatinous matter are more difficult of digestion, and some are very apt to derange the functions of the digestive organs. Thus *very hard gelatinous tissues*, as *tendons*, require a larger quantity of gastric juice and a longer time for their complete digestion †. *Gelatinous liquids*, when very weak, or which are obtained by means of a high temperature or

* The experiments of Dr. Beaumont, above referred to, were made on the Canadian whose case I have already noticed (see p. 169). The following are the notes of one experiment:—

" Experiment 41.—At 1 o'clock, P.M., he ate eight ounces of *Calf's-foot jelly*, and nothing else.

" In twenty minutes, examined stomach, and took out a portion of its contents, consisting of gastric juice, combined with the jelly, nearly all of it in a fluid form; a few particles only of entire jelly, suspended in the fluids, with a few small yellowish-white coagula floating near the surface, could be perceived.

" At 2 o'clock examined again, extracted a little fluid, but found no appearance of jelly.

" *Remarks*.—The operation of gastric juice on gelatine is very difficult to be detected. Unlike albumen, it is unsusceptible of coagulation; and it is probable that the gastric juice acts upon it in its soft solid state. This was disposed of in a short period. It was, however, but a small quantity, and was much sooner digested than a full meal would have been. From various trials, I am disposed to think that gelatine, if not in too concrete a state, is a very digestible article of diet."

† Beaumont, *op. supra cit.* p. 194-5.

prolonged ebullition, or which are procured from tissues containing fat or other matters apt to become rancid, readily disturb the functions of the stomach and intestines. The injurious effects of gelatine which has been altered by heat, I have already had occasion to mention (see p. 208). *Soups, hashes*, and *stews*, all of which contain gelatine, are obnoxious to the digestive organs of dyspeptics and invalids, partly perhaps on account of the changes effected in the gelatinous matter by heat, but principally from the presence of fatty and other substances difficult of digestion (see p. 175).

It is customary with writers on dietetics to declare all gelatinous substances difficult of digestion: but such assertions are, in my opinion, far too sweeping. They can apply only to certain kinds of gelatinous foods; and not to some of the simplest and purest forms of gelatine, such as plain calf's-foot jelly.

The times required for the digestion of various substances, as ascertained by Dr. Beaumont, are as follows:—

DIGESTION OF GELATINOUS SUBSTANCES.

Articles of Diet.	Mean time of Chymification.					
	In Stomach.			In Phials.		
	Preparation.	H.	M.	Preparation.	H.	M.
Calf's-foot Jelly (*Exp.* 41)	Boiled	1	0			
Isinglass Jelly (*Exp.* 64)	Boiled	1	0			
Gelatine	Boiled	2	30	Boiled	4	45
Aponeurosis	Boiled	3	0	Boiled	6	30
Cartilage	Boiled	4	15	—	—	
Cartilage	—	—		Divided	12	0
Tendon	Boiled	5	30	Masticated	12	45
Tendon of young beef	—	—		Entire piece	24	0
Bone, beef, solid . . .	—	—		Entire piece	80	0
„ hog's, solid . .	—	—		Entire piece	80	0

A gelatinous substance, though possessing some degree of nutritive power, cannot alone sustain animal life; but, when taken in conjunction with other alimentary substances, takes part in the nutrition of the body. Different gelatinous substances, however, are unequally nutritive. Thus gelatine is less nutritive than the bone which yields it.

The French Gelatine Commission found that dogs fed solely on raw bones and water for three months, continued in perfect health, and lost none of their weight by the use of this kind of food. Now as by boiling in water the cartilaginous tissue of bone is resolved into gelatine principally, it follows that a gelatinous tissue (that is, a tissue which by boiling is resolved into gelatine) contributes to the nutrition of the body; though it cannot be said to be the exclusive agent in this process, since bones contain other alimentary principles (such as fatty and albuminous matters) besides the earthy salts and the substance which is resolvable into gelatine.

The same experimenters found that the nutritive quality of bones is deteriorated, or even destroyed, by boiling them, by digesting them in hydrochloric acid, and especially by resolving their cartilaginous tissue into gelatine. Thus the very same kind of bones which in the raw state effected nutrition, failed to support animal life after they had been boiled; for dogs which had been fed on them died at the end of two months, with all the signs of inanition, and with a considerable diminution of their weight.

An exclusive diet of beef tendon and water is incapable of effecting perfect nutrition. A dog ate the tendons for eighteen days, and then manifested dislike to them; but he continued to take them for five days longer, when he refused them. He had now lost considerably in weight, and manifested other signs of inanition.

Gelatine extracted from bones was refused by dogs, —by some from the first, by others after once or twice using it. They preferred enduring the pangs of hunger to eating it; though it was tried in various forms, namely, both in the dry and humid states, and as a tremulous jelly. Seasoned gelatine prepared for the use of man, and which had a very agreeable flavour, was eaten for a few days, and then refused; the animals dying of starvation on the twentieth day. These experiments, therefore, are tolerably conclusive that animals cannot be nourished on gelatine exclusively. M. Donné tried its effects on himself. He took daily from 20 to 50 grammes [from 308½ grs. to 771¾ grs. troy] of dry gelatine (in the form of a sugared and aromatised jelly, with either lemon or some spirit), and from 85 to 100 grammes [from 1312 grs. troy to 1543½ grs. troy] of bread. At the expiration of six days he had lost two pounds in weight, and during the whole time was tormented with hunger, and suffered with extreme faintness, which was only alleviated after dining in his usual way.

These experiments do not, however, go the length of proving that gelatine, taken in conjunction with other alimentary substances, does not assist in nutrition. The every-day experience of the physician would negative such an inference. Moreover, the investigations of MM. Edwards and Balzac favour the notion that gelatine taken with other kinds of food assists the nutrition of the body.

Liebig has recently suggested that the nourishing powers of gelatine are confined to the gelatinous tissues: for, as proteine cannot be obtained from gelatine, the latter can serve neither for the formation of blood nor for the reproduction and growth of albuminous and fibrinous tissues. It is, therefore, probable, he thinks, "that gelatine, when taken in the dissolved state, is again converted, in the body, into cellular tissue, membrane, and cartilage. And when the powers of nutrition in the whole body are affected by a change of the health, then, even should the power of forming blood remain the same, the organic force by which the constituents of the blood are transformed into cellular tissue and membranes must necessarily be enfeebled by sickness. In the sick man, the intensity of the vital force, its powers to produce metamorphoses, must be diminished as well in the stomach as in all other parts of the body. In this condition, the uniform experience of practical physicians shews that gelatinous matters in a dissolved state exercise a most decided influence on the state of the health. Given in a form adapted for assimilation, they serve to husband the vital force, just as may be done, in the case of the stomach, by due preparation of the food in general."

These opinions, however ingenious and plausible, require to be confirmed by facts; for at present they are rather to be regarded as unsupported hypotheses. Even should they be eventually admitted as true, they

offer no explanation of many of the curious and interesting circumstances respecting the alimentary properties of gelatinous substances, which have been recently reported by the French Gelatine Commission.

As gelatine is convertible into a kind of sugar (*gelatine sugar* or *glycicoll* $C^8 H^7 N^2 O^5 + 2 HO$) by a process similar to that by which starch may be so converted, it is probably a less appropriate alimentary principle for diabetic patients than proteinaceous (albuminous) substances.

Besides its use as an alimentary substance, gelatine (in the form of isinglass principally) is employed as a clarifying, clearing, or fining agent, for coffee, wines, beer, &c. Some of the constituents of these liquors unite with the gelatine and form insoluble compounds, which precipitate and carry with them the matters which rendered the liquor turbid.

A few only of the gelatinous substances in use as food will require separate notice.

1. *Isinglass.*—This is procured from the *air-bag* or *swimming-bladder*, sometimes termed the *sound*, of various fishes. The finest kinds are procured from different species of *Acipenser* (*Sturgeons*), and are imported from Russia and Siberia. But other genera of fishes, as *Silurus, Morrhua, Gadus, Otolithus, Lota*, and *Polynemus*, also yield it. Sometimes the bag is dried unopened, as in the case of the *purse, pipe*, and *lump* isinglasses of the shops. At other times it is laid open, and submitted to some preparation; being either dried unfolded, as in the *leaf* and *honeycomb* isinglasses; or folded, as in the *staple* (*long* and *short*) and *book* isinglasses; or rolled out, as in the *ribbon*

isinglass. When it arrives in this country it is *picked* or *cut*. Formerly it was picked into shreds by women and children, but is now usually cut by machines worked by steam. The Russian and Siberian isinglasses (the kinds which from their purity and ready solubility are best adapted for domestic use), are carefully prepared by washing them with warm water to remove any adhering blood, cut open longitudinally, exposed to the air, with the inner, delicate, silvery membrane upwards. When dried, this fine membrane* is removed by beating and rubbing, and the swimming bladder is then made into various forms.

For the following table of the varieties of isinglass at the present time known in the London markets, I am indebted to Mr. James Metcalfe, wholesale dealer in isinglass, of No. 20, Artillery Place, Finsbury Square, London. I have thought it desirable to have the prices annexed in order to show the relative commercial value of the different kinds.

* It is usually stated that the innermost membrane of the swimming bladder is that which yields gelatine by boiling: but I have elsewhere shown this to be an error (see my *Elements of Materia Medica*, pp. 1859 and 1861, vol. ii. ed. 2d, 1842). The innermost membrane of cod sounds and of the Hudson's Bay and East Indian isinglasses, is insoluble in water. If the Siberian purse isinglass be carefully examined, the bag will be found to have been deprived of its innermost lining.

VARIETIES OF ISINGLASS.

Country.	*Place of Produce.*	*Place of Export.*	*Name and Character.*	*Prices Per lb. English.*		*Remarks.*
				s. d.	*s. d.*	
Russian Empire	The Oural (Ural)	St. Petersburg	LONG STAPLE URAL 1st & 2nd	14 6	13 6	
	The Irtysch and Obi	”	SHORT ditto PATRIARCH	..	none	Very choice; dear.
	Oural and tributaries	”	Ditto ditto 1st and 2nd	14 6	13 0	
			BOOK			
	Astrakhan	”	THIN LEAF 1st & 2nd	14 6	to 9 6	These are the sorts which yield the cut.
	The Volga and tributaries....	”	BELUGA 1st & 2nd	14 6	10 6	
			Cut by machine or hand	16 0 14 6	13 6 to 9 6	
			Pickings (the brown ends)....	8 0	..	Refuse of the above.
	Tributaries of Black Sea	Odessa	SISANE LEAF	3 6	..	Seldom imported.
	Tcherkaskoy ..	Taganrog	KROSKI or KROSKY	6 0	..	Seldom inquired for.
	The Don and tributaries......	”	SAMOVEY LEAF 1st & 2nd	3 9	3 3	Used for finings.
	Ditto	”	Ditto BOOK 1st & 2nd	4 0	3 6	In great demand.
		”	Ditto SHORT STAPLE............	5 6	..	Seldom imported.
	The Irtysch and Obi	St. Petersburg	SIBERIAN PURSE	8 6	7 6	In good esteem.
North America	Hudson's Bay and rivers	Hudson's Bay	PURSE	8 6	6 0	A thin insoluble membrane lining the inside.
	United States ..	New York....	RIBBON..........	No price	..	Not in use.
South America	The Brazils	Maranham & Para	PIPE BRAZIL ..	5 0 4 0	3 0	In general demand.
			LUMP ditto	0 4 0	3 3	
			HONEYCOMB ditto	3 6	2 0	Not in much repute.
			CUT BRASIL ..	7 6 6 6	6 0	Used perhaps for mixing.
East Indies	Bay of Bengal..	Calcutta	PURSE .... LEAF	4 6	4 0	Objected to on account of the fishy smell and imperfect solubility. When carefully prepared may equal the Brazilian kind.
			PICKED........	4 0	3 6	
Philippine Islands	Manilla	....	MANILLA THIN CAKE........	4 0	3 6	Quality assimilating to Samovey.

Isinglass has been analysed by both John and Mr. E. Solly, jun. Their results are subjoined :—

COMPOSITION OF ISINGLASS.

John.		*Mr. E. Solly, jun.*
Gelatine	70·0	Gelatine.
Osmazome [?]	16·0	Albumen.
Membrane insoluble in boiling water	2·5	Saline and earthy substances (small quantity).
Free acids and salts	4·0	Osmazome.
Water	7·5	Odorous oil (a minute trace).
Isinglass of good quality	100·0	East India Isinglass.

The relative proportions of gelatine and albumen in three specimens of East Indian isinglass were, according to Mr. E. Solly, jun. as follows :—

Isinglass.	*Soluble Gelatine.*	*Insoluble Albumen.*
100	86·5	13·5
100	90·9	9·1
100	92·8	7·2

When isinglass is reduced to small shreds (*picked* or *cut isinglass*) it is scarcely possible to distinguish by the age, some of the inferior from the finer kinds. The best criteria are its whiteness, freedom from unpleasant odour, and its complete solubility in water.

Isinglass is a very pure form of gelatine, and is employed in the preparation of jellies, blanc-mange, &c. It is frequently added to fruit jellies (see p. 144), to give them firmness or stiffness. Dissolved in milk, and flavoured with sugar, lemon, and some aromatic, it is frequently taken in the liquid state by convalescents with advantage, when recovering from the effects of extreme debility (as that brought on by hemorrhage); but this form of exhibition does not suit all stomachs.

Isinglass is also used in domestic economy as a clarifying, clearing, or fining agent for coffee, wine,

beer, &c. For this purpose it is extensively used by brewers *, who employ principally the Brazilian variety.

---

* Mr. Metcalfe, who supplied me with the table of isinglass already given (p. 217), has kindly furnished me with the following information as to the mode of preparing and using isinglass for beer-finings.

"I herewith beg to hand you such particulars as have come under my own observation as to the method generally adopted by brewers in their mode of preparing isinglass for beer-finings, and the way in which it is customarily applied. Firstly, with regard to the more insoluble sorts, such as the Lump Brazilian and common Book Glasses, as much should be put in a cask as it is likely will be required for three months' consumption; to this should be added just sufficient of strong sours to cover the isinglass, and as it swells above the liquor fresh sours of the first strength should be added daily, covering the isinglass to the depth of about 3 inches in the liquor after it has done swelling. It is a practice with some brewers to add a small quantity of pyroligneous acid to cut or dissolve it the more quickly, though if the first sours are good, and care is taken that the fresh, added from time to time during the process of swelling, is of equal strength, the pyroligneous acid may be advantageously dispensed with: care should be taken not to add more sours than is just necessary. In this state they should be well stirred up frequently with a stiff birch-broom, or some similar instrument, which materially assists the cutting or dissolving. The liquor should be used in a cold state, or at a very moderate heat, as by using it hot it would form a jelly, and be perfectly useless as finings. It having become thoroughly dissolved or cut by the cold sours, it may be kept for any length of time by being frequently well stirred up as above described.

In applying it for use, a proportionate quantity should be taken to the beer requiring fining, and pressed through a horse-hair sieve into as much mild beer as will reduce it to the consistency of thin treacle; of this about one pint is enough to fine a barrel (36 gals.), unless the beer is what is termed stubborn, when it will take sometimes double the quantity. One pound of good Brazilian isinglass, if treated in this manner, will make 15 gallons of strong finings. The liquid finings having been thus prepared, about one pint should be whisked up with about a gallon of the beer from each barrel intended to fine, and then poured in through the bung-hole of the cask. Under some circumstances a small quantity of strong infusion of hops, added after the finings, will cause a perfect precipitation of all the impurities in the beer, and leave it thoroughly cleansed and bright after standing a

2. *Cod Sounds.*—These are analogous to isinglass, being prepared from the swimming bladder of the Common Cod (*Morrhua vulgaris*). In the dried state they are brought from Scotland, and are used as a substitute for isinglass. They are, however, usually preserved soft by salting, and dressed for the table. The glue obtained by boiling the cod sounds does not gelatinize, but dries into a hard brown substance, which may be employed to glue pieces of wood together *.

3. *Dry and Hard Gelatine.*—This is a pure kind of glue prepared for dietetical use. *Nelson's Patent Opaque Gelatine* (called, in the specification of the patent †, *gelatine of the first quality*) is prepared, by preference, from " the cuttings of the hides of beasts or of the skins of calves," " freed from hair, flesh, and fat." It is sold in the form of cuttings. I have been furnished with a similar kind of gelatine, prepared by another maker, under the name of *Pale Gelatine English Machine cut.* A third kind of gelatine is met with in the shops, under the name of *French Gelatine* or *Grenetine* ‡. It occurs in sheets,

few hours. The only advantages gained by using the more expensive qualities of isinglass are, that the process of cutting or dissolving is less tedious, the fine Long Staple, Siberian Purse, and Astrakhan Pickings, not requiring above 48 hours for preparing, and that a milder Alegar will answer the purpose of cutting it; it may also possess some advantages in purity, for fine ales. Its mode of application should be similar to that given for the Brazilian and Book."

* Thomson's *Animal Chemistry*, p. 216.

† For the specification, see *The Mechanic and Chemist* for 1840.

‡ The word Grenetine is derived from *Grenet*, the name of the first manufacturer who supplied a white, transparent, and very pure gelatine for sale. Grenetine is now made by M. Grenet fils, of Rouen.

or thin plates or cakes, marked by the nets in which it has been dried. White grenetine of the first quality is transparent, inodorous, tasteless, and almost colourless. Coloured grenetine is rose-red, yellow, blue, or green. Grenetine is extracted from bones, either by the prolonged action of boiling water under pressure, or by first digesting the bones in dilute hydrochloric acid, and afterwards submitting them to the action of boiling water *.

These different kinds of gelatine are employed in the preparation of jellies, blanc-manges, soups, gravies, &c. as substitutes for isinglass and calves' feet, to which I consider them inferior in nutritive power and digestibility. For it is well known that gelatinous substances, when subjected to the prolonged action of water and heat, suffer changes in their chemical properties; and the French Gelatine Commission has shewn that the nutritive qualities of at least one gelatinous tissue (bone) are diminished or even destroyed by submitting it either to decoction in water or to the action of hydrochloric acid, or by resolving it into gelatine. It is not, therefore, too much to assume that the different operations to which the gelatinous tissues, used in the preparation of gelatine, are subjected, must deteriorate the dietetical qualities of the product. Moreover, a knowledge of the substances from which commercial gelatine is procured, is not calculated to create an appetite for foods obtained from such sources.

4. *Hartshorn.*—Shavings or raspings of the antlers

* Lecanu, *Cours Complet de Pharmacie*, t. i. p. 451. 1842.

of the stag, commonly called *hartshorn shavings*, are employed in the preparation of jellies and gelatinous solutions. Their composition is as follows :—

COMPOSITION OF HARTSHORN.

Soluble cartilage	27·0
Subphosphate of lime	57·5
Carbonate of lime	1·0
Water and loss	14·5
Total	100·0

By boiling, the cartilage is resolved into gelatine; and the decoction, if sufficiently concentrated, gelatinizes on cooling. Bones cannot be substituted for hartshorn, on account of the fat they contain. *Decoction of Hartshorn* is prepared by boiling one ounce of the shavings in four pints of water, down to two pints. When sweetened, it is sometimes taken as a mild demulcent and emollient drink, in intestinal and pulmonary irritation. An elegant *Hartshorn Jelly* is prepared by boiling down half a pound of the shavings in three quarts of water to one quart, and adding to the strained liquor an ounce of Seville orange or of lemon juice, a quarter of a pint of mountain wine, and half a pound of fine sugar; and boiling down the mixture to a due consistence *. It is sometimes used, as a grateful kind of aliment, by invalids and convalescents.

5. Several gelatinous tissues, besides those already noticed, are employed in the preparation of jellies and gelatinous liquids (as soups). Thus a jelly is obtained from *Calves' Feet;* and *Calves' Heads* are used in the preparation of mock-turtle soup. These sub-

* Lewis's *Materia Medica.*

stances yield, by boiling, an oily or fatty matter, as well as gelatine. *Cows' Heels, Sheeps' Trotters,* and *Petit-toes* (sucking pigs' feet) abound in gelatinous tissues, for which they are principally employed as aliments.

12. THE SALINE ALIMENTARY PRINCIPLE.

Saline matters are essential constituents of the blood, of the organised tissues, and of the secretions. They are, therefore, necessary components of our food; for without them health and vitality cannot be maintained.

The alimentary salts, which, on account of their occurring more frequently and largely in the system, may be regarded as of the most importance in a dietetical point of view, are Common Salt and the Earthy Phosphates. Ferruginous compounds (salts?), and probably salts of Potash, are also indispensable ingredients of our food.

1. *Common Salt* (*Chloride of Sodium*).—Though salt is a constituent of most of our foods and drinks, we do not, in this way, obtain a sufficient supply of it to satisfy the wants of the system; and nature has accordingly furnished us with an appetite for it. The salt, therefore, which we consume at our table as a condiment, in reality serves other and far more important purposes in the animal economy, than that of merely gratifying the palate. It is a necessary article of food, being essential for the preservation of health and the maintenance of life.

It forms an essential constituent of blood, which fluid doubtless owes many of its important qualities to it. Thus it probably contributes to keep the blood corpuscles unchanged; for when these are put into water a powerful and rapid endosmose takes place, in consequence of which they swell up and assume a globular form; whereas in a weak solution of salt they remain unchanged. In malignant cholera, and some other diseases in which there is a deficiency of the saline ingredients of the blood, this fluid has a very dark or even black appearance; whence it has been assumed by some writers that the red colour of the blood is dependent on the presence of its saline ingredients. From the salt of the blood, aided by water, the gastric juice derives its hydrochloric acid, and the blood and the bile their soda (see p. 71, foot-note, and p. 83). The soda, which exists in the blood in combination with albumen, passes out of the system in union with organic matter ($C^{70} H^{66} N^2 O^{22}$) represented by *choleic acid:* in other words, bile contains the elements of chloleate of soda, though not necessarily arranged as such. Lastly, "the soda, which has been used in the vital processes, and any excess of soda, must be expelled in the form of salt, after being separated from the blood by the kidney" (Liebig).

It has been calculated that the average annual consumption of salt by an adult amounts to 16lbs.; equal to about 5 ounces per week.

The salt consumed in this country is obtained principally from fossil or rock salt, and by the evaporation of the water of brine springs. The salt districts are Northwich, Middlewich, and Nantwich, in Cheshire; Shirleywich, in Staffordshire; and Droitwich, in Worcestershire. Salt is also procured in Durham.

In some parts of England, as at Lymington in Hampshire, and some parts of Scotland, salt is procured by the evaporation of sea-water.

The small-grained salt is formed by the strongest heat, and constitutes the *butter, stoved, lump,* and *basket salt* of commerce; while the larger crystals, forming the *bay* and *fishery salts,* are formed at a lower temperature. For table use, for salting butter, and for various domestic purposes, the small-grained salt is preferred. It is also employed for making the pickle for *striking* the meat, which is the first part of the process in curing fish and preserving animal flesh. The coarse or large-grained salt is preferred for the packing and preservation of fish and other provisions. For these purposes it is greatly superior to the small-grained salt: hence it is technically termed a *stronger* salt. Its superiority depends, not on any difference in its chemical composition, but on its greater cohesiveness and hardness of texture, whereby it dissolves much less readily.

Common salt, or chloride of sodium, formerly called *muriate of soda,* has the following composition:—

COMPOSITION OF CHLORIDE OF SODIUM.

1 equivalent of Chlorine	36	or per cent. . . .	60
1 equivalent of Sodium	24	or per cent. . . .	40
1 equivalent of Chloride of Sodium	60	or Chloride of Sodium	100

A little water is frequently lodged (mechanically) between the plates of the crystals.

Common salt, as found in commerce, is not absolutely pure; being contaminated with some other salts. The following table shews the composition of several varieties of salt, according to the analyses of Dr. Henry:—

COMPOSITION OF VARIOUS KINDS OF SALT (HENRY).

1000 *Parts by Weight consist of*

	Kind of Salt.	Pure Muriate of Soda.	Muriate of Lime.	Muriate of Magnesia.	Total Earthy Muriates.	Sulphate of Lime.	Sulphate of Magnesia.	Total Sulphates.	Insoluble Matter.	Total Impurity.
For. Bay Salt.	St. Ube's	960	trace	3	3	23½	4½	28	9	40
	St. Martin's	959½	do.	3½	3½	19	6	25	12	40½
	Oleron	964¼	do.	2	2	19½	4¼	23¾	10	35¾
Brit. Salt fr. Sea-water.	Scotch (common)	935½	—	28	28	15	17½	32½	4	64½
	Scotch (Sunday)	971	—	11¼	11¼	12	4½	16½	1	29
	Lymington (common)	937	—	11	11	15	35	50	2	63
	Ditto (cat)	988	—	5	5	1	5	6	1	12
Cheshire Salt.	Crushed rock	983¼	0·1/10	0·3/10	0.¼	6½	—	6½	10	16¾
	Fishery	986	0·¼	0·¾	1	11½	—	11½	1	13½
	Common	983½	0·¼	0.¾	1	14½	—	14½	1	16½
	Stoved	982½	0.¼	0.¾	1	15¼	—	15¼	1	17¼

Besides its use at the table as a flavouring or seasoning agent, salt is extensively employed in the preservation and curing of alimentary substances.

Its antiseptic power is by no means well understood. It is usual to ascribe it to the desiccating influence of the salt, but the explanation is not a satisfactory one. A dry bladder, says Liebig, remains more or less dry in a saturated solution of common salt. The solution runs off its surface in the same manner that water runs from a plate of glass besmeared with tallow. "Fresh flesh, over which salt has been strewed, is found, after 24 hours, swimming in brine, although not a drop of water has been added. The water has been yielded by muscular fibre itself, and having dissolved the salt in immediate contact with it, and thereby lost the power of penetrating animal substances, it has on this account separated from the flesh. The water still retained by the flesh contains a proportionally small quantity of salt, having that degree of dilution at which a saline fluid is capable of penetrating animal substances. This property of animal tissues is taken advantage of in domestic economy for the purpose of removing so much water from meat that a sufficient quantity is not left to enable it to enter into putrefaction *."

But the fact, that a dilute aqueous solution of salt possesses antiseptic properties, appears to me to render Liebig's explanation inadmissible; and we are compelled, therefore, to admit that the preservative power depends either on the chemical combination of the salt with the organic tissues †, or on occult causes more or less analogous to those which prevent the development of the volatile oils of black mustard and bitter almonds, when in contact with mineral acids and salts.

2. *Earthy Phosphates.*—These are almost universal constituents of the ashes of animal tissues. From their constant presence, we cannot suppose them to be

* Liebig, *Chemistry in its Application to Agriculture and Physiology*, 2d ed. p. 356—7. 1842.

† The conservative efficacy of bichloride of mercury, sulphate of copper, and some other metallic salts, depends on the union of these substances with the animal matter; and the formation of compounds which are not subject to the putrefactive process. Chemists, however, have hitherto refused to admit that common salt, nitrate of potash, and some alkaline salts, owe their antiseptic efficacy to the exercise of a chemical influence. But an argument in favour of this view may be derived from the well-known reddening effect produced by saltpetre (nitrate of potash) on beef, during the process of curing. Moreover, the augmented firmness or hardness of fibre, possessed by old salted meats, is, I suspect, an evidence of chemical action.

accidental: we have a right to infer that they are in some way necessary to vitality.

Phosphoric acid and lime combine together in several proportions. Of these combinations two have been found in the human solids and fluids. The *bone subphosphate of lime* ($8\,CaO + 6\,PO^{2.5}$) is by far the most frequently met with calcareous phosphate. It constitutes the principal part of the earthy matter of bones, and is probably the calcareous phosphate usually found in the ashes of animal tissues. According to Dr. Wollaston *, it exists in ossifications of arteries, veins, valves of the heart, bronchiæ, and tendinous portion of the diaphragm, as well as in the tartar of the teeth. According to the same authority, the *neutral phosphate of lime* ($CaO + PO^{2.5}$) exists in the urine, from which it is sometimes deposited in a pulverulent form. The phosphate of lime calculus, prostatic calculi, and pineal concretions, also contain the neutral phosphate.

Phosphate of magnesia, though of very frequent occurrence, is found in the animal solids and fluids in very small quantities only. Sometimes it exists in combination with ammonia (*ammoniacal phosphate of magnesia*).

The system obtains its supply of earthy phosphates from both vegetable and animal foods (see pp. 59-61, and 73-74). Corn, potatoes, milk, and the flesh and blood of animals, furnish us with more than the wants of the system require, and the excess is eliminated in the secretions.

* *Phil. Trans.* for 1797.

QUANTITY OF EARTHY PHOSPHATES IN FOODS.

100 Parts.	*Earthy Phosphates.*	*Authority.*
Wheat	from 0·36 to 0·9	Hermbstaedt.
Rye	0·6 to 4·18	Hermbstaedt.
Barley	0·1 to 0·6	Hermbstaedt.
Oats	0·16 to 0·6	Hermbstaedt.
Rice	0·4	Braconnot.
Garlic	1.1	Cadet.
Caseine	6·0	Berzelius.
Milk	0·1975	Schwartz.
Blood	0·03	Denis.
Bones (ileum) of sheep	50·58	Thomson.
" (ileum) of ox	45·2	Thomson.
" (vertebræ) of haddock	56·08	Thomson.
Muscular flesh of ox	traces	Schlossberger.
" " calf	0·1	Schlossberger.
" " pig	traces	Schlossberger.
" " roe	0·4	Schlossberger.
" " chicken	0 6	Schlossberger.
" " trout	2·2	Schlossberger.

The amount of earthy phosphates in several foods which contain these salts, has not been ascertained.

3. *Potash Salts.*—Minute quantities of potash salts exist in the ashes of blood and several of the animal tissues. They are derived from both animal and vegetable foods (see pp. 75 and 193).

4. *Ferruginous Compounds.*—The existence of iron in the animal system, and the sources of it, have been already noticed (see pp. 66-70). The precise state in which this metal exists in, and is introduced into, the system, has not been made out. In some cases it is supposed to be in the form of a phosphate.

Chap. III.—*Of Compound Aliments.*

The foods which consist of two or more alimentary principles, may be conveniently termed *Compound Aliments.* These it is customary to divide into *Solid Foods* or *Aliments Proper, Liquid Foods* or *Drinks,* and *Seasoning Agents* or *Condiments.* This division, though by no means accurate, is both familiar and convenient; and I shall, therefore, adopt it.

1. SOLID ALIMENTS, OR ALIMENTS PROPER.

Man obtains his food from both the animal and vegetable kingdoms. This is almost universally the case, and is a strong confirmation of the correctness of the inference drawn by the anatomist from the structure of the entire human digestive apparatus, that man is omnivorous. "It is quite certain," says Dr. Carpenter*, "that the most perfect physical development, and the greatest intellectual vigour, are to be found amongst those races in which this [a mixed] diet is the prevalent habit." Yet a modern writer †, who eloquently and ably advocates the exclusive use of vegetable food, declares that "the adherence to the use of animal food is no more than a persistence in the gross customs of savage life; and evinces an insensibility to the progress of reason, and to the operation of intellectual improvement." !!

* *Principles of Human Physiology,* p. 349. 1842.

† Dr. Lambe, *Additional Reports on the Effects of a Peculiar Regimen,* p. 243. 1815.

SECT. 1.—ANIMAL FOODS.

Exclusive of water and saline matters, we obtain, from animal foods, Proteinaceous, Gelatinous, and Fatty alimentary principles; to which must be added, in the case of milk, Sugar.

These are derived from flesh, blood, viscera, bones, cartilages, ligaments, cellular tissue, the milk of the mammals, and the eggs of some of the oviparous animals.

The proximate composition of the muscular flesh of different animals has been examined by Mr. Brande* and more recently by Schlossberger†: their results are as follows:—

COMPOSITION OF MUSCLE, ACCORDING TO MR. BRANDE.

100 *Parts Muscle of*	*Water.*	*Albumen or Fibrine.*	*Gelatine.*	*Total of Nutritive Matter.*
Beef	74	20	6	26
Veal	75	19	6	25
Mutton	71	22	7	29
Pork	76	19	5	24
Chicken	73	20	7	27
Cod	79	14	7	21
Haddock	82	13	5	18
Sole	79	15	6	31

COMPOSITION OF MUSCULAR FLESH, ACCORDING TO SCHLOSSBERGER.

	Ox.	*Calf.*	*Pig.*	*Roe.*	*Pigeon.*	*Chicken.*	*Carp.*	*Trout.*
Flesh.—Vessels, nerves, and cellular tissue.... ..	17·5	15—16·2	16·8	18·0	17·0	16·5	12·0	11·1
Soluble albumen and hematosine..................	2·2	3·2 — 2·6	2·4	2·3	4.5	3·0	5·2	4·4
Alcoholic extract with salts	1·5	1·1 — 1·4	1·7 }	2·4	1·0	1·4	1·0	1·6
Watery extract with salts ..	1·3	1·0 — 1·6	0·8 }		1·5	1·2	1·7	0·2
Phosphate of lime containing albumen	traces	0·1—traces	traces	0·4	—	0 6	—	2·2
Water and loss..	77·5	79.7 —78·2	78·3	76·9	76·0	77·3	80·1	80·5
	100·0	100·0—100·0	100·0	100·0	100·0	100·0	100·0	100·0

* *Manual of Chemistry.*

† *Pharmaceutisches Central-Blatt,* 1842, p. 41.

A very large number of animals is used, in different parts of the world, as food. In this work, however, I purpose speaking of those only which are employed in this country *.

CLASS I. MAMMALIA.—MAMMALS.

In this country, the mammals, employed by man as food, are, the Ox, the Sheep, the Hog, the Deer, the Rabbit, and the Hare.

These animals furnish their Bones, Cartilages, Tendons, Aponeuroses, Ligaments, Cellular Tissue, Fat, Muscles or Flesh, Viscera, Blood, and Milk, as alimentary substances.

1. *Bones.*—The bones of the ox and sheep are those principally which serve for alimentary purposes. Their composition, exclusive of the marrow (see p. 181) which they contain, is as follows:—

COMPOSITION OF BONE (THOMSON).

	Ox.	*Sheep.*	
	Ilium or Haunch-bone.	*Ilium.*	*Tibia.*
Cartilage	48·5	43·30 – 47·20	51·97
Phosphate of lime	45·2	50·58 – 46·35	40·42
Carbonate of lime	6·1	4·49 – 4·83	7·03
Magnesia	0·24	0·86 – 0·64	0·22
Soda	0·20	0·31 – 2·09	0·19
Potash	0·11	0·19 – 0·25	traces
	100·35	99·73 – 101·41	99·83

By digesting bones in hydrochloric acid they are deprived of part of their earthy salts. They are then semi-transparent, flexible, and elastic; and have a fatty smell and an acid state. In this state they are known in France under the name of *Alimentary gelatine.* Their composition is as follows:—

* For an account of other animals used as food, the reader is referred to the article *Aliment*, in the *Encyclopædia Metropolitana*, and Lardner's *Cabinet Cyclopædia, Domestic Economy*, vol. ii. by Mr. Donovan.

COMPOSITION OF BONES WHICH HAVE BEEN DIGESTED IN HYDROCHLORIC ACID.

	Sheep's feet bones.	*Ox-head bones.*
Water	47·22	22·87
Fat	5·55	11·54
Matter which may be transformed into gelatine	17·30	27·99
Earthy phosphates and other salts	12·42	32·77
Insoluble animal matter	17·51	4·83
	100·00	100·00

The cartilage of bone, after ossification has taken place, is resolved by boiling into collin or common gelatine (see p. 207). Hence bones are employed in domestic economy for the preparation of soups. But the quantity of gelatine extractable from bones by the ordinary mode of boiling, is comparatively small. To increase it, Papin * proposed to expose them to the action of water and steam under pressure. By this means he declared that he could make the oldest and hardest cow as tender and well flavoured as the finest meat!!

At the commencement of the French revolution, the attention of every one in France was directed to the improvement of the food for the poor and for the army. All were agreed in employing for this purpose bones. The government, led away by the enthusiastic reports of scientific men (Proust, d'Arcet, Pelletier, Cadet de Vaux, &c.), issued a public instruction, declaring that "a bone is a tablet of soup formed by nature: a pound of bone gives as much soup as six pounds of meat: bone soup, in a dietetical point of

* *A New Digester, or Engine for Softening Bones*, 4to. Lond. 1681. —*A Continuation of the New Digester of Bones*, 4to. Lond. 1687.

view, is preferable to meat soup." It need scarcely be stated that these inflated expressions were gross exaggerations. It is obvious, as Magendie has justly observed, that in this hyperbolic language the terms *jelly* (gelatine) and *nutritive matter* were considered synonymous. The favourable report made by the Faculty of Medicine, on the nutritive and easily digestible properties of gelatine, induced the French *administration des hospices*, in 1824, to introduce its employment into the public hospitals of Paris; and for this purpose, in many of these establishments d'Arcet's apparatus for obtaining a solution of gelatine from bones, by the aid of steam, was fitted up. In most, if not in all, its employment was, however, soon abandoned. At the Hôtel-Dieu its use was abolished in consequence of the unfavourable report given of its properties by the medical officers of that institution. The report concludes with the following summary:—

1. The soup made with the gelatinous solution is of bad quality.
2. It is more liable to putrefaction than soup prepared by the old method.
3. Its taste is disagreeable, and even disgusting.
4. It is less digestible than common soup, and may even derange the functions of the digestive organs.
5. It contains a smaller quantity of nutritive matter than common soup.
6. Its nutritive matter is inferior to that contained in common soup.

This report, which is dated November 8th, 1831, is signed by MM. Petit, Recamier, Caillard, the Baron Dupuytren, Breschet, Guéneau de Mussy, Honoré Husson, Sanson, Magendie, Bally, Henry, Duval, and Gendrin.

The nutritive qualities of bone, as well as of bone-gelatine, have been already noticed (see pp. 212-213). The time required for the chymification of bone contained in a phial has likewise been stated (see p. 211).

2. *Cartilages, Tendons, Aponeuroses, and Ligaments.*—The cartilage of unossified parts, by boiling, yields chondrine. Tendons (popularly called *sinews*), the aponeuroses, and most of the ligaments, by long boiling, yield collin. All these, therefore, are gelatinous tissues, and have been before noticed (see pp. 207-212). The *ligament nuchæ* (commonly termed *packwax*) of ruminants differs, however, from ordinary ligament. Though it yields a little gelatine to water, it does not soften or dissolve by long boiling.

3. *Cellular Tissue.*—This, by boiling in water, becomes soft, and is ultimately converted into collin. It, therefore, belongs to the gelatinous substances (see p. 207).

4. *Fat.*—The fat of mammals is lodged in the cells of the adipose tissue, which probably is only a modification of, if, indeed, it be not identical with, the common cellular tissue. The animal fats have already been described (see p. 167, et seq.)

5. *Muscles* or *Flesh.*—The flesh of mammals consists principally and essentially of the muscles, intermixed, however, with tendons, aponeuroses, fasciæ, nerves, vessels, cellular tissue, blood, serum, and fat. That part of the flesh which consists of muscle without the fatty and other matters is called the *lean.*

The chemical constituents of flesh are the following:—

CONSTITUENTS OF FLESH.

Water.	Osmazome.
Fibrine.	Fatty matter.
Albumen.	Creatine.
Gelatinous matter.	Peculiar nervous matter.
Hematosine.	Salts.

Osmazome (from ὀσμή, *a smell*, and ζωμός, *broth* or *soup*,) is an alcoholic extract obtained from the flesh, brain, and other parts of animals. It has a reddish brown colour, and the smell and taste of soup. It is generally mixed with lactic acid, the lactates, and common salt. To this principle, broths and soups owe their flavour and smell, and part of their nutritive qualities.

The substance called, by its discoverer, Chevreul *, *creatine* (from κρέας, *flesh*), is a nitrogenous, crystallisable substance, insoluble in alcohol.

Liebig † calculates that ordinary meat, as bought from the butcher, contains about one-seventh of its weight of fat and cellular tissue; and that meat devoid of fat contains, on the average, 74 per cent. water, and 26 dry water; the latter of which contains 13·6 parts of carbon. On these assumptions, therefore, 100 parts of ordinary butcher's meat has the following composition :—

COMPOSITION OF ORDINARY BUTCHER'S MEAT.

Meat devoid of fat	85·7	Water	63·418
		Dry matter containing 11·6552 parts of carbon	22·282
Fat, cellular tissue, &c.			14·300
Ordinary Butcher's meat			100·000

The following are analyses of the muscular flesh of the ox :—

* *Journal de Chimie Méd.* t. viii. p. 548.

† *Animal Chemistry*, p. 286.

COMPOSITION OF BEEF FLESH.

		Lean of Beef. (Berzelius.)	*Heart of an Ox.* (Braconnot.)
Muscular fibre, vessels, and nerves	15·8	17·70	18·196
Cellular tissue convertible into gelatine by boiling	1·9		
Soluble albumen and colouring matter		2·20	2·733
Phosphate of lime and albumen		0·08	
Alcoholic extract with salts (osmazome)		1·80	1·566
Aqueous extract with salts		1·05	. . . .
Lactate and phosphate of potash, and common salt		. . .	0·465
Water		77·17	77·036
		100·00	100·000

The analyses of Brande and Schlossberger have been already given (p. 231).

The *fibrine* of the muscular flesh of different animals is very uniform in its chemical properties, and appears to be identical in its composition. The flesh of the mammalia of the chase is of a darker colour, and is sometimes called *black meat;* while that of the rabbit, after boiling, is pale, and may be termed *white meat.* The quantity of *blood* in the flesh of animals augments with their age. Schlossberger found it to be inversely to that of the water, but directly to that of the fibrine. To augment the whiteness of veal, it is said that butchers sometimes repeatedly bleed calves, by which an anæmic state is induced. Young meats yield, by boiling, a larger amount of *gelatine* than old meats. Every one is probably familiar with the fact that the gravy of lamb more readily gelatinizes when cold than that of mutton. The *osmazome* augments with the age of the animal. The flesh of wild animals, as the stag and the roe, contains a very small quantity of *fat*, compared with that of the well-fed domesticated animals, as the sheep and hog.

The ultimate composition of flesh is identical with that of blood. "The analyses of Playfair and Boeckmann," says Liebig, "give for flesh (fibrine, albumen, cellular tissue, and nerves) and for blood, as the most exact expression for their numerical results, one and the same formula, namely, $C^{48} N^{6} H^{39} O^{15}$. This may be called the empirical formula of blood." Moreover, it appears that roasting and boiling alter in no way the composition of animal food.

ULTIMATE COMPOSITION OF FLESH AND BLOOD.

			Roasted Flesh.		
	Ox Blood. (Playfair.)	*Dry Beef Muscle.* (Playfair.)	*Beef.* (Playfair.)	*Veal.* (Playfair.)	*Roe Deer.* (Boeckmann.)
Carbon . .	51·95	51·83	52·590	52·52	52·60
Hydrogen .	7·17	7·57	7·886	7·87	7·45
Nitrogen .	15·07	15·01	15·214	14·70	15·23
Oxygen . .	21·39	21·37	24·310	24·91	24·72
Ashes . .	4·42	4·23			
	100·00	100·00	100·000	100·00	100·00

The tenderness of flesh is influenced by a variety of circumstances; as age, sex, leanness or fatness, mode of slaughtering, and incipient decomposition. Thus the flesh of young animals is more tender than that of old ones. That of the entire male adult is coarser and tougher than that of the female. The meat of the bull and of the cow are familiar illustrations of this. The flesh of castrated animals is not only more delicate, more tender, and finer grained, but has a more agreeable odour and flavour than that of the uncastrated animal; and a similar improvement in the flesh of the female is effected by the operation of spaying. The

flesh of lean animals is generally firmer than that of plump ones, in which the fibres are penetrated with fat. The mode of preparation for slaughter affects the tenderness of the meat. Hunting, baiting, fighting, and whipping animals just before death, augments the tenderness of their flesh. With the exception of the first one, these barbarous and cruel practices are now justly exploded in the most civilized countries of the world. Another circumstance which promotes the tenderness of meat is incipient decomposition; hence the flesh of most animals is kept for some time after death.

With regard to digestibility, Dr. Beaumont* found that digestion is facilitated by minuteness of division and tenderness of fibre; and retarded by opposite qualities. "Chymification," he observes, "is most readily effected on solid food, or rather on a soft solid, which is easily divisible into shreds or small particles. Such is particularly the character of venison, which is ascertained to be one of the most digestible substances. The qualities of looseness of texture and susceptibility of division belong to most of those wild meats and game which are generally acknowledged to be easy of digestion. Beef and mutton, of a certain age, possess similar qualities."

As young meats are more tender than old meats, and as tenderness of fibre facilitates digestion, it might be expected that the flesh of young animals would be more digestible than that of old ones; and this inference is favoured by the experiments of Dr.

* *Op. ante cit.* pp. 36 and 142.

Beaumont, who found that roasted sucking-pig was more speedily digested than broiled pork-steak, and boiled fresh lamb sooner than boiled fresh mutton: though, on the other hand, veal proved less digestible than beef.

DIGESTIBILITY OF MEATS.

Articles of Diet.	Mean Time of Chymification. In Stomach. Preparation.	H.	M.	In Phials. Preparation.	H.	M.
Venison steak	Broiled	1	35			
Pig, sucking	Roasted	2	30			
Lamb, fresh	Broiled	2	30			
Beef, with salt only	Boiled	2	45		9	30
„ fresh, lean, raw	Roasted	3	0	Roasted		
„ steak	Broiled	3	0	Masticated	8	15
Pork, recently salted	Raw	3	0	Raw	8	30
„ „ „	Stewed	3	0			
Mutton, fresh	Broiled	3	0	Masticated	6	45
„ „	Boiled	3	0			
Pork, recently salted	Broiled	3	15			
Pork-steak	Broiled	3	15			
Mutton, fresh	Roasted	3	15			
Beef, fresh, lean, dry	Roasted	3	30	Roasted	7	45
„ with mustard, &c.	Boiled	3	30			
„ „ „	Fried	4	0		12	30
Veal, fresh	Broiled	4	0			
Beef, old, hard, salted	Boiled	4	15			
Pork, recently salted	Fried	4	15			
Veal, fresh	Fried	4	30			
Pork, fat and lean	Roasted	5	15			

Notwithstanding the preceding facts, experience seems to shew that young meats frequently prove less digestible than old ones. Dr. Cullen *, after stating that young meat is universally more soluble than old, adds: "There is, however, a difficulty which occurs

* *A Treatise on the Materia Medica*, vol. i. p. 358.

here. Although from their texture young meats are more soluble than old, and appear to be so in decoctions with water, yet in some stomachs the young meats are more slowly digested than old; and thus in some persons veal is more slowly digested than beef, and lamb than mutton."

Animal flesh is a plastic element of nutrition (see p. 31). Being identical, in composition, with our own flesh and blood, it requires neither addition nor subtraction to render it nourishing; but in order that it may reach the different organs, it is necessary that it should be reduced to a liquid form (blood).

"Muscular flesh," says Magendie *, "in which gelatine, albumen, and fibrine, are combined according to the laws of organic nature, and where they are associated with other matters, such as fats, salts, &c., suffices, even in very small quantity, for complete and prolonged nutrition." Dogs fed solely for 120 days on raw meat from sheeps' heads preserved their health and weight during this period; the daily consumption never exceeding 300 grammes [= 4630½ grs. troy], and often being less than this quantity. But 1000 grammes [= 15434 grs. troy] of isolated fibrine, with the addition of some hundreds of grammes of gelatine and albumen, were insufficient to support life. "What, then," exclaims Magendie, "is the peculiar principle which renders meat so perfect an aliment? Is it the odorous and sapid matter, which has this function, as seems probable? Do the salts, the trace of iron, the

* *Rapport fait à l'Académie des Sciences au nom de la Commission dite de la Gélatine. Comptes Rendus*, Août, 1841.

fatty matters, and the lactic acid, contribute to the nutritive effect, notwithstanding that they constitute so minute a portion of meat?"

The alimentary qualities of the meats of different species of mammals are unequally digestible and nutritive: but the digestibility of the same kind of meat is by no means uniform in different individuals. Venison, as I have already stated, is easy of digestion; but it is generally considered to be more stimulating than other meats (*e.g.* mutton); and, therefore, less fitted for convalescents. Occasionally mutton disagrees with certain individuals *. I know a gentleman who has repeatedly had an attack of indigestion after the use of roast mutton; but I have reason to suppose that it was caused by the mutton fat, and probably, therefore, depended on the hircic acid (see p. 172).

4. *Viscera.*—The brain, the tongue, the heart, the thymus, the liver, the kidneys, and the alimentary canal of quadrupeds, are employed as food.

The following are the mean times of chymification of some of these, according to Dr. Beaumont's experiments:—

* Dr. Prout (*On the Nature and Treatment of Stomach and Urinary Diseases*, p. xxx. 3d ed.) knew an individual on whom mutton acted as a poison. He "could not eat mutton in any form. The peculiarity was supposed to be owing to caprice, and the mutton was repeatedly disguised, and given unknown to the individual; but uniformly with the same result of producing violent vomiting and diarrhœa. And from the severity of the effects, which were, in fact, those of a virulent poison, there can be little doubt that if the use of mutton had been persisted in, it would soon have destroyed the life of the individual."

Articles of Diet.	*Mean Time of Chymification.*					
	In Stomach.			*In Phials.*		
	Preparation.	*H.*	*M.*	*Preparation.*	*H.*	*M.*
Tripe, soused	Boiled	1	0			
Brains, ox's	Boiled	1	45	Boiled	4	30
Liver, ox's, fresh . .	Broiled	2	0	Cut fine	6	30
Spinal marrow, ox's .	Boiled	2	40	Boiled	5	25
Heart, animal . . .	Fried	4	0	Entire piece	13	30

a. The *brain* contains about 80 per cent. of water. Its other constituents are albumen and fatty matters. The principal fat is cerebric acid. It exists free or combined with soda and phosphate of lime.

COMPOSITION OF CEREBRIC ACID.

Carbon	66·7
Hydrogen	10·6
Nitrogen	2·3
Phosphorus	0·9
Oxygen	19·5
	100·0

It differs, therefore, from ordinary fats in containing nitrogen and phosphorus. From the proteine compounds it differs in containing so small a proportion of nitrogen (see p. 189).

The other cerebral fats are oleophosphoric acid (which contains about 2 per cent. of phosphorus, and probably consists of oleine and phosphorus), oleine, margarine, small quantities of oleic and margaric acids, and cholesterine.

In composition, then, brain may be regarded as intermediate between ordinary fat and the proteinaceous substances. It appears, from Dr. Beaumont's experiments (see p. 242), to be somewhat more digestible than common fat.

b. and *c.*—The *tongue* and *heart* of mammals are muscular organs (see p. 237 for the composition of the heart of the ox), and in their dietetical properties agree with the flesh of these animals.

d. The *thymus* of the calf is employed as food, under the name of *sweetbread.* Its composition, according to Morin*, is as follows:—

COMPOSITION OF CALF'S SWEETBREAD.

Albumen	14·00
Osmazome	1·65
Gelatine	6·00
Peculiar animal fat	0·30
Margaric acid	0·05
Fibrine	8·00
Water	70·00
Thymus or Sweetbread	100·00

A fresh sweetbread, when plainly cooked (by boiling) and moderately seasoned, forms a very agreeable and suitable dish for the convalescent; but when highly dressed, is improper both for dyspeptics and invalids.

e. The *liver* of the ox has been analysed by Braconnot†, who found its composition to be as follows:—

COMPOSITION OF THE LIVER OF THE OX.

Vascular and cutaneous tissues	18·94
Parenchyma (*i. e.* soluble parts)	81·06
Liver	100·00

* *Journ. de Chim. Méd.* t. iii. p. 450.
† *Ann. de Chimie et de Physique,* t. x. p. 189.

The parenchyma consisted of the following substances:—

Brown oil, containing phosphorus	3·89
White fatty flocculi	?
Nitrogenous matter	6·07
Albumen	20·19
Blood	?
Salts	1·21
Water	68·64
Parenchyma of the liver	100·00

On account of the oily matter which it contains, the liver of quadrupeds is not an appropriate food for invalids, or for those whose stomachs are weak. Moreover, the ordinary mode of cooking it (frying) renders it still more inappropriate.

f. The *kidneys.*—From Berzelius's experiments it appears that the solid part of the kidney is neither fibrine nor cellular tissue, but approaches nearer to the substance of which the fibrous coat of the arteries consists (see p. 209). The liquid portion of the kidney contains albumen and lactic acid. Berzelius could detect no urea in it. But the urinous odour which a cooked kidney presents is a sufficient evidence that it contains some of the essential constituents of this secretion. Dr. T. Thomson * states that urea has been detected in the kidney.

g. Alimentary Canal.—The stomachs of ruminants when prepared as food constitute *tripe.* Its principal organic constituents are albumen and fibrine. "Few things," says Dr. A. T. Thomson †, "are more readily

* *Animal Chemistry,* p. 330.
† *The Domestic Management of the Sick Room,* p. 433.

digested than tripe, when it is properly cooked. After partially boiling, in the usual manner, and also some onions in two waters, both should be slowly boiled together, until the tripe is very soft and tender. A sufficient quantity of salt, and a pinch or a few grains of cayenne pepper, may be added." Dr. Beaumont's experiment, before quoted (see p. 243), also shews the ready digestibility of tripe.

5. *Blood.*—Blood forms a greater or less constituent of the flesh and viscera of quadrupeds, notwithstanding that in the ordinary mode of slaughtering these animals they are deprived of the greater part of their circulating fluid *. Among civilized nations, the pig is the only animal whose blood furnishes a distinct article of food. Mixed with fat and aromatics, and inclosed in the prepared intestines, the blood of this animal constitutes the *sausages* sold in the shops under the name of *black puddings*.

The following table shows the mean composition of the blood of several animals employed as food, according to the analyses of MM. Andral, Gavarret, and Delafond †.

* Some animals are bled to death; others, after being knocked down, have the vessels of their neck divided. By the Mosaic law the Jews are expressly forbidden to eat the blood of any beast or bird, or to partake of the flesh of any beast or bird, whose throat has not been cut in order to drain off its blood. They are not to eat of any creature that dies of itself (*Leviticus*, chapters 7, 11, and 17). "Previously to boiling any meat they are required to let it lie half an hour in water and an hour in salt, and then to rinse off the salt with clean water. This is designed to draw out any remaining blood." (Allen, *Modern Judaism*, p. 420-21, 2d ed. 1830.)

† *Annales de Chimie et de Physique*, 3e série, t. v.

MEAN COMPOSITION OF THE BLOOD OF THE OX, THE SHEEP, AND THE PIG.

Constituents.	*Oxen.*	*Sheep.*		*Pigs of from 2 to 6 months old. English Breed.*
		Merino.	*Dishley Breed.*	
Fibrine	3·7	3·0	2·6	4·6
Corpuscles	99·7	101·1	95·0	105·7
Solid matters of the serum	86·3	82·4	92·4	80·1
Water	810·3	813·5	810·0	809·6
	1000·0	1000·0	1000·0	1000·0

The composition and alimentary properties of *fibrine* have already been stated (see pp. 187-189). I have also given the composition of the *blood corpuscles* according to Denis (see p. 191, foot-note). Their alimentary properties are similar to those of albumen and other proteinaceous substances.

The solid matters of the serum of the blood consist of albumen (see pp. 187-193), which constitutes more than $\frac{1}{10}$ of their weight, of fatty matters (see p. 177, foot-note), of, according to Denis, two colouring matters (yellow biliary matter and traces of a blue substance), and, lastly, various salts (viz. alkaline chlorides, alkaline carbonate, phosphate, and sulphate, carbonates of lime and magnesia, and phosphates of lime and magnesia).

The nutritive quality of blood is equal to that of flesh, with which it is identical in composition (see p. 238).

6. *Milk.*—On account of its liquidity milk ought, perhaps, to be placed amongst Drinks; but inasmuch as it contains, in solution and suspension, a large

quantity of alimentary matter; as it constitutes the sole food of mammals during a certain period of their life, after birth; and, lastly, as it yields some solid alimentary substances (butter, cheese, and sugar of milk), it will be, on the whole, most convenient to notice it here.

Milk, or, to be more precise in our description, *Cow's Milk*, is an opaque, white emulsive liquid, with a bland, sweetish taste, a faint peculiar odour, and a specific gravity of about 1·030: the latter property, however, is subject to considerable variation. When recently drawn from the animal it is slightly alkaline (see p. 193). Subjected to a microscopical examination, it is observed to consist of myriads of excessively minute globular particles floating in a serous liquid. These particles are *butter*. They instantly disappear, by solution, on the addition of a drop of caustic alkali; and they may be separated by filtration,—the filtered liquor being transparent. Being specifically lighter than the liquor in which they are suspended, they readily separate by standing. They rise to the surface, carrying with them some caseine, and retaining some of the serum, thus forming *cream*. The milk from which the cream is separated is termed *skimmed milk*.

Milk has been the subject of repeated chemical investigation. The following is the composition of several kinds of milk, according to the very elaborate experiments of MM. O. Henri and Chevallier * published in 1839.

* *Journal de Pharmacie*, t. xxv. p. 340.

Constituents.	Milk of the Cow.	Ass.	Woman.	Goat.	Ewe.
Caseine	4·48	1·82	1·52	4·02	4·50
Butter	3·13	0·11	3·55	3·32	4·20
Sugar of Milk	4·77	6·08	6·50	5·28	5·00
Various Salts	0·60	0·34	0·45	0·58	0·68
Water	87·02	91·65	87·98	86·80	85·62
Total	100·00	100·00	100·00	100·00	100·00
Solid substances	12·98	8·35	13·00*	13·20	14·38

But the relative proportions of the constituents of milk vary with the quality of the food, the age of the animal, and the period after parturition. The following table, taken from the memoir of the last mentioned chemists, shows the influence of food.

COMPOSITION OF COW'S MILK.

	Kind of Food. Carrots.	Beet.
Caseine	4·20	3·75
Butter	3·08	2·75
Sugar of Milk	5·30	5·95
Salts	0·75	0·68
Water	86·67	86·87
Total	100·00	100·00
Solid substances	13·33	13·13

MM. Boussingault and Le Bel † have also made a series of experiments to determine the effect of various kinds of food upon the quantity and quality of the milk given by cows. Some of their results have been before noticed (see *ante*, p. 193).

I have already considered the composition and alimentary qualities of butter (pp. 168-181), and of caseine (pp. 187, 188, 193-198.)

* According to the preceding data the quantity of solid substances in woman's milk is 12·02; but 13·00 is given in the memoir quoted, and I have no means of discovering where the error exists.

† *Ann. de Chim. et de Physique*, t. lxxi. p. 65.

Sugar of Milk, in its nutritive qualities, is similar to saccharine substances in general, and which have been already stated (see pp. 112-121). In its chemical properties it is allied to gum. Its alimentary uses are precisely similar to those of whey. Dissolved in skimmed cow's milk, I have occasionally employed it in consumptive cases, where unskimmed milk disagreed with the stomach. The homœopathists use it as the vehicle (*excipiens* vel *constituens*) for the exhibition, in a pilular (globular) form, of small doses of their remedies; as they object to the use of common sugar, for this purpose, on account of the lime which it contains.

The *saline constituents* of milk have been slightly alluded to (see p. 103). According to Schwartz * the following is the composition of the ashes of cow's milk.

COMPOSITION OF THE ASHES OF 100 PARTS OF COW'S MILK.

Soda (in milk combined with lactic acid)	0·0115
Chloride of potassium	0·1350
Phosphate of soda	0·0225
Phosphate of lime	0·1805
Phosphate of magnesia	0·0170
Phosphate of iron	0·0032
	0·3697

But according to Berzelius the lactic acid is combined with potash.

Cream of cow's milk has a variable specific gravity: perhaps the average is 1·2044. According to the

* Gmelin, *Handbuch der theoretischen Chemie*, vol. 2, p. 1404.

analysis of Berzelius, it has the following composition:

COMPOSITION OF CREAM OF COW'S MILK.

Butter	4·5
Caseine or curd	3·5
Whey	92·0
	100·0

The upper stratum of cream is richer in butter, the lowest in caseine. By agitation, as in the process called *churning*, the fatty globules unite to form *butter:* the residue, called *butter-milk*, consists of caseine, serum (whey), and a little butter.

Skimmed milk, like cream, has a variable specific gravity: perhaps the average is 1·0348. If left to itself, it readily acquires acid properties; white coagula, commonly called *curds*, separate from it. If an acid or rennet (the infusion of the fourth or true stomach of the calf) be added to skimmed milk, this change is immediately produced. The curd separated by rennet is the *caseine*. But after rennet has ceased to produce any more coagula, acetic acid will cause a further quantity to be formed. The curd thus subsequently separated by the acid is known by the various names of *zieger*, *serai*, *ricotta*, and *bracotte*. It is probably nothing else than uncoagulated caseine united to acetic acid. The *whey* left after the separation of the caseine and zieger, yields, on evaporation, *sugar of milk*, one or more nitrogenous substances (*osmazome*), *lactic acid*, and *salts*.

The following table shews the composition of several domestic preparations of milk:—

COMPOSITION OF MILK.

				CONSTITUENTS.
MILK	Cream …	Butter ….	solid fat ……………	1. *Margarine.*
			liquid fat ……………	2. *Butyroleine.* 3. *Butyrine.* 4. *Caproïne.* 5. *Caprine.*
		Butter-milk	caseum. serum or whey.	
	Skimmed milk ..	Matters coagulable ..	by rennet ……………	6. *Caseine.*
			not by rennet, but by acetic acid ……………	7. *Zieger* or *Seral.*
		Whey or serum……	saccharine matter ……	8. *Sugar of Milk.*
			azotized matter ……	9. *Osmazome.*
			salts: soluble in alcohol ..	10. *Alkaline and earthy lactates and phosphates.*
			salts: soluble in water, not in alcohol ……	11. *Alkaline sulphate and phosphates.*
			salts: insoluble in water ..	12. *Earthy and ferruginous phosphates.*

The morbid changes produced in the quality of the milk by diseased conditions of the cows, have recently attracted considerable attention in Paris, owing to the prevalence of a malady, called the *cocote*, among the cows in that capital *. Those which have been recognised are want of homogeneousness, imperfect mobility or liquidity, capability of becoming thick or viscid on the addition of ammonia, and the presentation of, when examined by the microscope, certain globules (agglutinated, tuberculated or mulberry-like, mucous or pus globules) not found in healthy milk †. Labillardière ‡ states that the milk of a cow, affected with a kind of tubercular phthisis (*pommelière*) contained seven times more phosphate of lime than usual; and Dupuy also §

* See *Journal de Pharmacie*, vol. xxv. p. 301-318.

† *Recherches microscopiques sur divers laits obtenus de vaches plus ou moins affectées de la Maladie qui a régné pendant l'Hiver de* 1828 *à* 1839, *et designée vulgairement sous la dénomination de Cocote*, par M. Turpin, in the *Mémoires de l'Académie Royale des Sciences de l'Institut*, t. xvii. Paris, 1840.

‡ *Dict. Mat. Méd.* iv. 23.

§ Quoted by Andral, *Treat. on Path. Anatomy*, Engl. Transl. vol. i. p. 675.

speaks of the large quantity of calcareous matter in the milk of cows, in whose lungs abundant deposits of the same substance were found.

Good milk is quite liquid and homogeneous; not viscid; and, when examined by the microscope, is found to contain only spherical transparent globules, soluble in alkalies and ether. Moreover, good milk yields a flocculent precipitate with acetic acid, but is not coagulated by heat. The relative quantity of cream, which it affords, is estimated by a glass tube divided into 100 parts. Such an instrument is called a *lactometer*. The thickness of the layer of cream which, in a few hours, forms at the top of the milk, may be easily read off. I have repeatedly submitted the milk supplied to me by a respectable dealer in this metropolis, to examination by the lactometer, but the results have been very unsatisfactory, as the quantity of cream which I procured varied from 5 to 23 per cent by measure. I subjoin a few results obtained in November 1840:—

QUANTITY OF CREAM IN COW'S MILK.

100 Parts by measure of Milk.	*Quantity of Cream by measure.*
1840, November 6,—Morning	$11\frac{1}{2}$
" Afternoon	5
" 7,—Morning	10
" Afternoon	$16\frac{1}{2}$
" 8,	$10\frac{1}{3}$
" 10,	8
" 17,	23
" 18,	23

The milk yielded by an Alderney cow, belonging to a gentleman in the neighbourhood of Whitechapel, yielded $17\frac{1}{2}$ per cent. (by measure) of cream.

The following table of the quantity of cream contained in the milk supplied by contract to the London Hospital, has been kindly furnished me by Mr. Macmeikan, the apothecary to that establishment. The specific gravity was, for convenience, taken by the urinometer.

SPECIFIC GRAVITY AND PROPORTION OF CREAM ON MILK SUPPLIED TO THE LONDON HOSPITAL.

Date.	*Specific Gravity.*	*Cream.*	*Temperature.*
1842.			
Sept. 12 . .	1·023	9	—
13 . .	1·030	5	—
14 . .	1·026	5	—
15 . .	1·025	5	—
16 . .	1·030	5	62
17 . .	1·026	4½	62
18 . .	1·030	5½	62
19 . .	1·027	5½	63
20 . .	1·026	5½	61
21 . .	1·026	5	60
22 . .	1·026	5	62
23 . .	1·027	5½	62
24 . .	1·026	5	—
25 . .	1·027	4½	—
26 . .	1·025	4½	64
27 . .	1·028	4½	64
28 . .	1·028	5	—
29 . .	1·027	5	—
Oct. 1 . .	1·030	5	—
2 . .	1·027	7	—
3 . .	1·028	6	—
4 . .	1·027	7	—
5 . .	1·030	7	—
6 . .	1·027	7	—
7 . .	1·029	7½	—
8 . .	1·028	7	—
26 days.	Average sp. gr. } $1{\cdot}027\frac{1}{26}$	Average quantity of cream } $5\frac{10}{232}$	

Donné* says ordinary cow's milk should furnish

* *Conseils aux Mères sur la Manière d'Elever les Enfans nouveau-nés.* 1842.

12 to 15 per cent. of cream,— woman's milk, of good quality, 3 per cent.,—and ass's milk from 1 to 2 per cent.

The influence which many medicines, taken by the parent, have over the offspring, is a circumstance known to every nurse, though Cullen denies it. We can modify the *colour* of the milk by mixing saffron or madder with the food; the *odour* may be affected by various cruciferous and alliaceous plants; the *taste* may be altered by the use of bitters, as wormwood; and lastly, the *medicinal effect* may be also influenced. Children may be salivated by sucking nurses under the influence of mercury, or purged by the exhibition of drastics, or narcotised by the administration of opiates to the nurse. These facts are so familiar to every one, that further evidence of them is scarcely requisite. Mental emotions also affect the quality of the milk. Thus the action of the bowels of the child are frequently disordered in consequence of some sudden emotion on the part of the mother.

The quality of the milk is also affected by the state of health of the female supplying it. I have already mentioned the effect of tubercular disease of the lungs in increasing the quantity of phosphate of lime in the milk (see p. 252). This subject is one of the greatest moment, not only in reference to the frequency of disease in cows, and, therefore, to the possible morbific character of their milk, but also in reference to the milk of the human subject. I think, with these facts before us, it would be highly improper to allow a female, with any trace or suspicion of tuberculous disease, to suckle. Not that a few grains, more or less, of phosphate of lime in the milk, can probably do any injury to the child; but the fact once established, that the milk may be thus altered by disease, leads to the suspicion that some other substances, not yet recognised by their physical or chemical characters, may be in the milk of diseased nurses, and which may have an injurious influence on the child; and the suspicion does not confine itself to those affected with tuberculous diseases: other hereditary or constitutional affections may also be attended with altered conditions of the milk. This suspicion is strengthened by the common observation that the milk of different nurses does not equally suit the same child; nor that of the same nurse, different children.

Milk being furnished by nature as the only food for the young mammal, during a certain period of his existence, contains all the elements necessary for the nutrition and growth of the body.

Out of the caseine of milk are formed the albumen and fibrine of the blood, and the proteinaceous and gelatinous tissues (see p. 147). The butter serves for the formation of fat, and contributes, with the sugar, to support the animal heat by yielding carbon and hydrogen to be burnt in the lungs. The earthy salts are necessary for the developement of the osseous system; the iron is required for the blood corpuscles and the hair; while the alkaline chloride furnishes the hydrochloric acid of the gastric juice.

Milk is in general readily digested by children, unless it contain too large a quantity of nutritious matter*,

* See Payen, *Journ. de Chim. Méd.* t. iv. p. 118. Also Donné, *Conseils aux Mères sur la Manière d'Elever les Enfans nouveau-nés.* 1842.

when it is apt to induce various disorders of the digestive organs (vomiting, griping, &c.) It frequently disagrees with adults. With some it proves heavy and difficult of digestion, owing to its oily constituent (butter). With such, ass's milk (which contains very little butter), or skimmed cow's milk usually agrees. The following table of the digestibility of milk, &c. is taken from Dr. Beaumont's work :—

Articles of Diet.	*Mean Time of Chymification.*					
	In Stomach.			*In Phials.*		
	Preparation.	*H.*	*M.*	*Preparation.*	*H.*	*M.*
Milk	Boiled	2	0	Boiled	4	15
Milk	Raw	2	15	Raw	4	45
Butter	Melted	3	30	—	—	
Cream	—	—		Raw	25	30

Pure milk injected into the veins exerts no deleterious effects except in the horse *.

Milk is a very useful and valuable article of food as well for the adult as for the child,—and for healthy individuals as for invalids and convalescents. The principal drawback to its employment, in many cases, is the difficult digestibility of its fatty constituent (butter). Under the name of *Milk Diet* it is extensively employed, in conjunction with farinaceous substances and light puddings, with great benefit in many maladies. (See the article *Milk Diet*, in a subsequent part of this work.)

Whey is an excellent diluent and nutritive. It may

* Donné, *Comptes Rendus*, 1841.

be used in febrile and inflammatory complaints. It is usually prepared by means of rennet *; and when thus procured may be denominated *Rennet Whey*, in order to distinguish it from whey prepared by other methods. *White Wine Whey*, taken warm and combined with a sudorific regimen, acts powerfully on the skin, and is a valuable domestic remedy in slight colds and febrile disorders. *Cream of Tartar Whey* is prepared by adding a quarter of an ounce of cream of tartar (bitartrate of potash) to a pint of milk. It may be diluted with water, and taken in febrile and dropsical complaints. It is refrigerant and diuretic. *Alum Whey* is made by boiling a quarter of an ounce of powdered alum with a pint of milk; then straining. It may be flavoured with sugar and nutmeg. This is a pleasant mode of exhibiting alum, and may be beneficially resorted to in disorders requiring the use of this astringent, as in lead colic, hemorrhages, and colliquative sweating. The dose is a wine-glassful. *Tamarind Whey* is prepared by boiling an ounce of tamarind pulp with a pint of milk, and then straining. It is refrigerant, slightly laxative, and nutritive,

* The term *Rennet*, or *Runnet*, is applied to the stomach of a sucking animal (as of the calf) preserved by means of salt. These terms are also applied to the liquid obtained by macerating this stomach in water. It is the gastric juice which is the effective agent in coagulating or curdling milk (see pp. 71, and 196). According to Deschamps (*Journ. de Pharm.* vol. xxvi. p. 412), liquid rennet contains *hydrochloric acid* (in great quantity), *butyric, caproïc, capric*, and *lactic acids, sal ammoniac, chloride of sodium* (independently of that which has been added), *magnesia* (not as ammoniacal phosphate), *soda* (probably with the magnesia, as lactate), traces of a *sulphate, phosphate of lime*, and a peculiar matter which he calls *chymosine* (from χυμὸς, *chyme*, χύμωσις, *chymification*).

and may be exhibited in febrile disorders. *Mustard Whey* is prepared by boiling together half an ounce of bruised mustard seeds and one pint of milk, until the milk is curdled: then strain, to separate the whey. "This whey has been found to be a useful drink in dropsy: it stimulates the kidneys; and, consequently, augments the urinary secretion. It may be taken in a tea-cupful at a time *."

Milk and lime-water forms a very useful remedy in some irritable conditions of stomach arising from uterine and other maladies. It oftentimes proves a most effectual remedy for obstinate vomiting. I have likewise found it highly serviceable in the climacteric disease, or, what is technically known as "a breaking up of the constitution." It nourishes, while it checks sickness and relaxation of bowels. One part of lime water may be taken with one, two, or three parts of milk according to circumstances. The milk completely covers the offensive taste of the lime water.

Whey possesses slightly nutritive qualities: these it derives from the sugar of milk which it contains. It is devoid of all stimulating properties with reference either to the vascular or nervous systems. It, therefore, forms a very agreeable and excellent diluent and slight nutrient in febrile and inflammatory complaints; and is well adapted for catarrhal and pulmonary affections, especially incipient phthisis, hæmoptysis, atrophy, scrofula, and chronic disorders of the liver, and other digestive organs. It very gently promotes

* Dr. A. T. Thomson, *The Domestic Management of the Sick Room*, p. 420.

the action of the secreting organs, and in this way may prove useful in congestion of the liver and of other abdominal viscera. In various parts of Switzerland and Germany there are special establishments for the cure of chronic disorders by the use of pure or aromatised whey (*Molkencuren; Cures de Petit Lait*). The whey is obtained from the milk of the cow, the goat, or the ass; and is used as a drink, as a lavement, or as a bath. Its use is often associated with that of mineral waters; as at Salzbrunn, Reinerz, Kreuth, Gaiss, Weissbad, and many other continental watering places.

Butter-milk, when made from whole milk, differs from this in the absence of butter. As it contains the caseine, the sugar, and the salts of milk, it must possess nutritive qualities. It is extensively used as an article of food by the lower classes in Ireland. It forms a very agreeable cooling beverage in febrile and inflammatory cases. As "it cannot be procured in London and other large towns, and not always in the country, the method of making it in small quantities, daily, should be understood. It is readily prepared by putting a quart of new milk into a bottle which will hold a gallon, corking the bottle, and covering it with a towel in such a manner, that, by drawing alternately each end of the towel, the bottle can be rolled upon a table. This movement should be continued until such time as all the butter is separated, which is known by its appearing in clots or masses swimming in the milk. During the rolling, it is necessary to open the bottle occasionally to admit fresh air into it, as that is essential for the formation of butter. When the process is finished, all the butter should be carefully separated from the butter-milk *." This may be drank *ad libitum*.

The preparations of milk known as *Corstorphin Cream, Devonshire Cream*, or *Clotted Cream*, consist of cream and the coagulated curd. They are nutritive and delicious substances, but apt to disagree with dyspeptics on account of the butter which they contain.

Having noticed the leading alimentary properties of milk, and its most frequently used preparations, it may be proper now to say a few words on the distinctive properties of the different milks in most frequent use.

It will be seen by reference to p. 249, that *Ewes' milk* contains the largest amount of nutritive matter (caseine and butter); but on this account is less easy of digestion, and, therefore, unfitted for dyspeptics. Next to this is *Goats' milk*, concerning which the same remarks may be made. It is said to be useful in checking obstinate diarrhœa. *Ass's milk* is the least nutritive, but the most easy of digestion. With the exception of woman's milk, it is the richest in sugar of milk. In the convalescence from acute maladies, in consumptive cases, and chronic diseases of the digestive organs, it is a most valuable aliment. Its medicinal value seems to depend on the small quantity of butter and large quantity of sugar of milk which it contains. An *artificial ass's milk* may be prepared by

* Dr. A. T. Thomson, *The Domestic Management of the Sick Room.*

dissolving a couple of ounces of sugar of milk in a pint of skimmed cow's milk. *Cow's milk* is intermediate, in nutritive and digestible properties, between goat's milk and ass's milk. Donné * says that it is the only milk which is either very feebly alkaline, often neutral, and sometimes slightly acid. The milk of the ass and the woman are always very obviously alkaline. He thinks that the cause of this peculiarity of cow's milk is referable to the fact that this milk is, to a certain extent, an artificial production: that is, it is furnished by the animal long after the time of suckling its offspring, and it is well known that the milk varies in its qualities at different periods after the parturition of the animal.

CLASS II. AVES.—BIRDS.

This class of animals, like the preceding one, furnishes a very safe aliment to man, for none of the species are poisonous; and, accordingly, a very large number are employed as food. My remarks, however, will be directed to those in most frequent use in this country;—principally to the Common Fowl, the Pheasant, the Partridge, the Pigeon, the Duck, and the Goose.

The flesh, viscera, and eggs of birds, are used as food.

1. *Flesh.*—The composition of the muscular flesh of birds, according to the analyses of Mr. Brande and Schlossberger, has been already stated (see p. 231). "The flesh of birds," says the late Dr. Duncan, jun.* "differs very much in its sensible properties, not only in different kinds, but even in the different muscles of the same bird. The pectoral muscles which move the wings are drier and more tender than those which move the legs. The tendons of the legs are also very strong, and at a certain age become bony; but the flesh of the legs, when sufficiently tender, either from the bird being young, or from long keeping, or sufficient cookery, is more juicy and savoury than that of the wings. Of a few birds, especially the woodcock and snipe, the legs are at all times preferred to the breast. In the black-cock, the outer layer of the pectoral muscle is of a dark-brown colour, while the inner is white. A similar difference is observed in many other birds, and perhaps it is general in a slight degree. The muscular organs of birds differ from those of quadrupeds in their flesh never being marbled, or having fat mixed with the muscular fibres."

* *Comptes Rendus*, 1841, p. 1064; also *Conseils aux Mères*, 1842.

The muscles of those parts of the body most frequently exercised become firmer, harder, and tougher than those which are more rarely used. "That exercise produces strength and firmness of fibre," says Dr. Kitchener †, "is excellently well exemplified in the woodcock and partridge. The former flies most—the latter walks;—the wing of the woodcock is al-

* Supplement to the *Encyclopædia Britannica*, art. *Food.*
† *Cook's Oracle.*

ways very tough, — of the partridge very tender: hence the old doggrel distich,—

> 'If the Partridge had but the Woodcock's thigh,
> He'd be the best bird that e'er doth fly.'

The breast of all birds is the most juicy and nutritious part."

Castration improves the flesh of birds for the table, rendering it more tender and savoury. Of this we have an illustration in the capon (the castrated cock). Spaying exercises a similar influence over the female bird; as in the poulard (the spayed hen).

The flesh of the older and larger birds is in general coarser than that of the younger and smaller animals.

Though great diversity exists in the flesh of different orders of birds, yet no accurate distribution of those animals, founded on the kind of flesh, can be made, because, though the extremes are well marked, they run insensibly into each other. The usual division is into four classes, as follows:

a. The *White-fleshed*, as the common fowl and the turkey. The meat of these animals is white, contains but little osmazome, when good is generally liked, and when young is exceedingly tender. Chicken flesh is, in general, easily digested. Dr. Beaumont * states that it is more difficult of digestion than beef. He says, that the texture of the chicken being closer than that of beef, the gastric juice does not insinuate itself into the interstices of the muscular fibre so

* *Op. supra cit.* p. 122.

readily as into beef, but operates entirely upon the outer surface, which it dissolves, as a piece of gum arabic is dissolved in the mouth, until the last particle is dissolved.

Chicken flesh is nutritious, and is, perhaps, the least stimulating of animal foods. It is often retained on the stomach of invalids when other meats would be immediately rejected. Chicken broth is well adapted for irritable stomachs.

b. The *Dark-fleshed Game*, as the grouse, and the black-cock. The flesh of the wild gallinaceous birds is darker coloured, firmer, richer in osmazome, somewhat less digestible, and more stimulating, than that of the chicken. When sufficiently kept it acquires a peculiar odour, called *fumet*, and an aromatic bitter taste, most sensible in the back. In this condition it is said to be *ripe* or *high*, and is much esteemed as a luxury.

c. The *Aquatic* (including swimmers and waders), as the goose and the duck. The flesh of water fowl is mostly firm, penetrated with fat (which often acquires a rancid and fishy taste), and is more difficult of digestion. It forms, therefore, a less appropriate aliment for invalids.

d. The *Rapacious*, as the hawk and the owl. None of these are eaten, partly, perhaps, from prejudice, and partly because those which touch carrion acquire a cadaverous smell.

The following table contains Dr. Beaumont's results respecting the digestibility of the flesh of birds.

DIGESTIBILITY OF THE FLESH OF BIRDS.

Articles of Diet.	*Mean Time of Chymification.*			
	In Stomach.		*In Phials.*	
	Preparation.	*H. M.*	*Preparation.*	*H. M.*
Turkey, wild	Roasted	2·18		
„ domestic . . .	Boiled	2·25		
„ „	Roasted	2·30		
Goose, wild	Roasted	2·30		
Chicken, full grown . .	Fricasseed	2·45		
Fowls, domestic . . .	Boiled.	4·0	Masticated	6·30
„ „	Roasted	4·0		
Ducks, domestic . . .	Roasted	4·0		
„ „	Roasted	4·30		

2. *Viscera.*—Some of the viscera of birds are employed as aliment. They constitute part of what is called, in the case of the goose and duck, *giblets.*

a. The *brains* of birds are eaten at the table. In their chemical properties they resemble calves' brains. John says the cerebrum contains a larger quantity of fat (part of which is crystallisable) than the brain of the calf: the cerebellum of birds contains less water and no crystallisable fat.

b. Gizzard.—This is the muscular or pyloric portion of the stomach. It consists of a very dense and firm muscular or fleshy texture, lined by a thick, hard, fibrous or tendinous membrane. On account of its density and hardness of texture, it is very slowly digested; and hence is not adapted for persons with weak stomachs. Dr. Beaumont found that the gizzard of a chicken, introduced into the stomach of the Canadian, was not completely dissolved at the end of five hours,—the residuum, consisting principally of tendinous fascia, weighed seven and a half grans.

c. Intestine.—In the woodcock, the intestine (called the *trail*) is, by epicures, considered a *bonne bouche.*

d. Liver.—The liver of most birds is a favourite morsel. Its peculiar flavour it owes to the bile which it contains. Its oily constituent would seem to render it difficult of digestion; but Dr. Beaumont found that it was almost as completely dissolved in the same time as the breast of a fricasseed chicken.

I have already (p. 20) referred to the morbidly enlarged liver of the goose*, employed in the preparation of the celebrated *Pâtés de Foies gras de Strasbourg.* The principal agents in inducing it are external heat, obscurity, inactivity, and cramming the animals with food†. At Alsace, a trough in front of the animal is always kept "full of water, in which some pieces of wood charcoal‡ are left to steep" (Sonnini). In this way the liver becomes enormously enlarged, and oftentimes weighs one or two pounds;

* These livers were highly esteemed by the Romans, who effected their enlargement by cramming the animals as in modern times. Pliny (*Hist. Nat.* lib. x. cap. 27, ed. Valp.) tells us, that the honour of the discovery was contested for by Scipio Metellus and M. Seius.

† The ordinary method of producing the disease at Strasburgh, I have before noticed (p. 20). For further details, the reader is referred to Sonnini (*Nouv. Dict. d'Hist. Nat.* art. *Oie*), and to the article *Food,* in the *Supplement* to the *Encyclopædia Britannica.*

‡ Liebig (*Chemistry in its Application to Agriculture and Physiology,* p. 133, 2d ed. 1842) observes, that "it is well known that charcoal powder produces such an excessive growth of the liver of a goose as at length causes the death of the animal." But there is no valid reason for supposing that charcoal has any thing to do with the effect in question: indeed it does not appear that this substance is used at Strasburgh; for Tiedemann (*Untersuchungen ü. das Nahrungs-Bedurfniss, den Nahrungs-Trieb und die Nahrungs-Mittel des Menschen,* p. 127, 1836), after describing the mode adopted in that city, adds, "In other places charcoal powder is mixed with the drink."

while the animal is excellent for the table, and furnishes, during roasting, from three to five pounds of fat. The change thus induced in the liver is that known to pathologists by the name of *fatty degeneration* *, in which the liver is very rich in a phosphoric oil. It is obvious, therefore, that these diseased livers must be difficult of digestion, and unfit for persons with delicate stomachs. Dr. Prout † has endeavoured to deter indolent and dyspeptic individuals from partaking of them, by suggesting that they "cannot be supposed, in all instances, to assimilate them; and consequently run considerable risk in inoculating and converting their own livers, or other organs, into a similar mass of disease."

3. *Fat.*—The composition of the fat of the goose, the duck, and the turkey, has been already stated (see p. 182). Goose Grease, when spoiled (by keeping?) has produced symptoms of poisoning ‡.

4. *Eggs.*—Both the white or glaire, and the yolk of eggs, are employed as food.

a. White or Glaire of Eggs.—This is also termed

* Cruveilhier, *Dict. de Méd. et de Chir. prat.* t. viii. p. 326.—An analysis of a fatty liver has been published by Vauquelin (quoted by Mr. W. J. E. Wilson, in the *Cyclopædia of Anatomy*, art. *Liver*), "from which the quantity of oily matter present may be fairly estimated thus:—in 100 parts he found,

Oil	45
Parenchyma	19
Water	36
	100."

† *On the Nature and Treatment of Stomach and Urinary Diseases*, p. 244. 1840.

‡ Christison, *Treatise on Poisons*, p. 593, 3d ed.

the *Albumen of Eggs*, or *Ovalbumen*. Its composition, according to Dr. Bostock, is as follows:—

COMPOSITION OF WHITE OF EGG.

Water	80·0
Albumen	15·5
Uncoagulable matter [mucus]	4·5
	100·0

Couerbe has extracted from the white of egg a peculiar non-nitrogenous principle, which he first called *albuminin*, but afterwards, *oonin*.

The composition and dietetical uses of the white of egg have been previously stated (see pp. 186-188 and 190-193).

b. The *Yolk of egg* is a kind of yellow emulsion, consisting of oil suspended in water by means of albumen, and inclosed in a sac called the yolk bag. Its composition, according to Dr. Prout, is as follows:—

COMPOSITION OF YOLK OF EGG.

Water	53·78
Albumen	17·47
Yellow oil	28·75
	100·00

According to Planche, the oil of yolk of eggs consists of stearine 10, oleine 90. Liebig states that cholesterine and iron may be detected in the yellow oil of the yolk.

The albumen of the yolk is identical in its nature with that of the white. Dr. Prout ascertained by combustion the relative proportions of the fixed constituents of the white and yolk of three eggs. Assuming the weight of each egg to be 1000 grs. the proportions of the mineral substances were as follows:—

FIXED CONSTITUENTS OF EGGS.

	White of Egg.			*Yolk of Egg.*		
	No. 1.	*No. 2.*	*No. 3.*	*No. 1.*	*No. 2.*	*No. 3.*
Sulphuric acid	0·29	0·15	0·18	0·21	0·06	0·19
Phosphoric acid . . .	0·45	0·46	0·48	3·56	3·50	4·00
Chlorine	0·94	0·93	0·87	0·39	0·28	0·44
Potash, soda, and their carbonates	2·92	2·93	2·72	0·59	0·27	0·51
Lime, magnesia, and their carbonates . .	0·30	0·25	0·32	0·68	0·61	0·67
	4·90	4·72	4·57	5·34	4·72	5·81

Dr. Prout's observations on the supposed production of lime during the incubation of the egg have been before noticed (see pp. 4 and 5, foot-note).

Fresh or newly laid eggs, when lightly cooked, as when poached or very slightly boiled, are nutritive, and moderately easy of digestion. Dr. Pearson * has justly observed that, in general, the lightest as well as the simplest mode of preparing eggs for the table is to boil them only as long as is necessary to coagulate slightly the greater part of the white, without depriving the yolk of its fluidity. Raw eggs are said to be gently laxative, and were formerly in repute in cases of jaundice and obstructed liver. When boiled hard, and especially when fried in butter, oil, or fat, they are less readily soluble in the gastric juice, and are commonly very difficult of digestion. Cooked in this way they prove injurious to persons whose stomachs are delicate, giving rise to various disorders of the digestive organs. These observations also apply to omelettes,

* *A Practical Synopsis of the Materia Alimentaria.* 1808.

pancakes, fritters, and other dishes made with eggs and cooked by frying. Yet there are "instances of labouring people, and persons who use violent exercise, with whom eggs, hardened by boiling or frying, agree better than in the soft or liquid state" (Pearson). These, however, are exceptions to the general rule.

The following are the mean times of the digestion of eggs, as observed by Dr. Beaumont:—

DIGESTIBILITY OF EGGS.

Articles of Diet.	*Mean Time of Chymification.*					
	In Stomach.			*In Phials.*		
	Preparation.	*H.*	*M.*	*Preparation.*	*H.*	*M.*
Eggs, whipped	Raw	1	30	Whipped	4	0
" fresh	Raw	2	0	Raw	4	15
" "	Roasted	2	15	—		—
" "	Soft boiled	3	0	Soft boiled	6	30
" "	Hard boiled	3	30	Hard boiled	8	0
" "	Fried	3	30	—		—

The raw yolk of egg is often taken whipped up in tea, as an agreeable and easily digestible aliment. Mixed with sugar, brandy, and a little cinnamon, it forms an exceedingly valuable restorative and stimulant (see *Brandy Mixture*, p. 162). Wine is sometimes substituted for brandy. *Flip* is prepared with hot ale, eggs, nutmeg or ginger, and some ardent spirit (rum or brandy).

CLASS III. REPTILIA.—REPTILES.

The number of reptiles employed by man as food is small; indeed, the Green or Edible Turtle is the only one used in this country. The flesh of some of them, however, forms a delicious and wholesome aliment. When cooked, it resembles somewhat that of chicken or veal, is pale, aqueous, soft, rich in gelatine, poor in fibrine, and contains little or no osmazome. It is easily digestible and nutritive, and, by decoction, yields highly restorative broths, which have been much valued in consumptive and other maladies. The eggs of several are eaten as agreeable and nutritive articles of food.

The Green, or Edible Turtle, above referred to, is greatly prized by the epicure. In the markets of Jamaica it is bought and sold like beef*. To the tropical navigator it is highly important as forming a valuable article of food. The female with egg is most esteemed. In this country the principal use of the turtle is for the preparation of soup. An imitation (called mock-turtle) is prepared with the integuments (scalp) of the calf's head. The large shield of the turtle's back (*dorsal shield*) is called by naturalists the *Carapace*, by cooks the *Callipash* (*Callapash* or *Calipash*); while the shield of the belly (*ventral* or *sternal shield*) is denominated by naturalists the *Plastron*, by cooks the *Callipee* (*Calipee* or *Callepee*). When these two shields have been removed from the animal, preparatory to dressing, they are scalded, to enable the cook to separate the scales † or shell. They are then boiled until the bones can be

* Dr. P. Browne's *History of Jamaica*, p. 465.

† The scales of the dorsal shield are used for veneering ladies' work-boxes, and for other purposes.

separated, the liquor being kept as a kind of stock. The softer parts of the shields (thus deprived of their bones) as well as portions of the fins, are, when cold, cut into square or oblong pieces, which constitute the favourite glutinous or gelatinous morsels in turtle soup; and which by turtle-eaters are often erroneously supposed to be green fat. They considerably resemble the pieces of the scalp of the calf contained in mock-turtle. The pieces from the callipash are dark-coloured externally, and are sometimes called *black* or *green meat*: while those from the callipee are white externally. "The callepee, or under part of the breast or belly, baked," says Sir Hans Sloane*, "is reckoned the best piece." The *flesh* of the turtle is sometimes dressed at taverns, in London, as a steak: but it is more commonly used in the preparation of soup. By boiling it becomes white, like veal or chicken. Besides contributing to flavour the stock, it is cut in small pieces and put into the soup. The *viscera* of the turtle are not used, in London, as food. But Sir Hans Sloane says that "the livers are counted delicacies. Those who feed much on them," he adds, "sweat out a yellow serum, especially under the armpits." The *fatty tissue* (*green fat*) of the turtle is of a greenish yellow colour, and on this account the animal has been termed the *green* turtle. The lard or fat, when melted out of the tissue in which it is naturally contained, is of a warm yellow colour, and resembles, both in appearance and taste, marrow. It communicates a yellow tinge to the sweat of those

* *Jamaica*, vol. i.

who feed on it; "whence," says Sir Hans Sloane, "their shirts are yellow, their skin and face of the same colour, and their shirts under their armpits stained prodigiously. This, I believe," he adds, "may be one of the reasons of the complexion of our European inhabitants, which is changed, in some time, from white to that of a yellowish colour, and which proceeds from this, as well as the jaundice, which is common, sea air, &c. The fat is used in the preparation of the soup; but many of the turtles used in soup, in London, contain very little fat. The green fat is said to communicate a green colour to the urine. Turtle is highly nutritious, and, probably, when plainly cooked, is easy of digestion; but when taken in the form of the highly esteemed "turtle soup," is very apt to disagree with dyspeptics. "Turtle," says Dr. P. Browne*, "is delicate, tender food, while young; but, as it grows old, it grows more tough and gristly, and is not so agreeable to the stomach in those warm countries [Jamaica]; the juices, however, are generally reckoned great restoratives."

CLASS IV. PISCES.—FISHES.

This class of animals yields an almost endless variety of food for man. It furnishes a much greater number of edible genera and species than any other class. From it, some nations derive their chief sustenance. The inhabitants of the most northern parts of Europe, Asia, and America, where but few ali-

* *The Civil and Natural History of Jamaica.*

mentary plants are found, are compelled to live almost exclusively on fish.

In ancient times, fish formed the chief or sole nutriment of certain people, who were in consequence called *Ichthyophagi* (from ἰχθὺς, *a fish*, and φάγω, *I eat*). Herodotus* says that there were three tribes of Babylonians whose food was fish. They prepared it thus: having dried it in the sun, they beat it very small in a mortar, and afterwards sifted it through a piece of fine cloth; they then formed it into cakes, or baked it as bread. In another place† he states, that with a considerable part of the Egyptians, fish constituted the principal article of food; they dried it in the sun, and ate it without any other preparation.

Some of the smaller and more delicate fishes are eaten whole, as the White Bait‡. Some are eaten

* *Clio*, cc.

† *Euterpe*, xcii.

‡ White Bait, formerly supposed to be the fry of some other fish, as the Shad, but now universally admitted to be a distinct species (*Clupea alba*), is found in immense shoals, during the summer season, in the Thames, in the neighbourhood of Blackwall and Greenwich, to which places the London admirers of this delicacy repair to enjoy their favourite dish; the fish-dinners of these places being proverbially excellent. Having had an opportunity of seeing the mode of cooking this fish, as practised at Lovegrove's, at Blackwall, the following notice of the process may not, perhaps, be uninteresting:—

I was informed that the fish should be cooked within an hour after being caught, or they are apt to cling together. Those which I saw cooked were contained in water in a pan, from which they were from time to time removed, as required, by a skimmer. They were then thrown on a stratum of flour contained in a large napkin, in which they were shaken until completely enveloped with flour. In this state they were placed in a cullender, and all the superfluous flour removed by sifting. They were now thrown into hot melted lard, contained in a copper cauldron or stew-vessel placed over a charcoal fire.

whole, with the exception of the head. The skin, the flesh, and the viscera only, of others, are eaten.

1. *Integument.*—The corium or true skin of fishes, as of many higher animals, is a gelatinous tissue (see p. 207); but varies considerably in thickness in different species. On account of their gelatinous nature, the skins of some fishes are used as food, and employed for various purposes in the arts. Thus, by boiling, the skin of the Turbot and Ling becomes pulpy and gelatinous, and forms a rich and favourite nutriment; and various parts about the jowl of the Cod are much esteemed by epicures, on account of their gelatinous quality. Sole skins, when clean, sweet, and well prepared, are used as a substitute for isinglass in fining (see pp. 215, 218-219). Dr. Fleming says that the skin of the Cod is employed for the same purpose. Eel skins are used in the preparation of size.

2. *Flesh.*—The great bulk of the soft parts of fishes consists of voluntary muscles forming the *flesh*, which are disposed upon the sides of the spinal column,—in four series on either side. They are soft, pellucid, and but little permeated with blood.

The composition of the flesh of the Cod, Haddock, Sole, Carp, and Trout, has already been stated (see p. 231). It will be seen, by reference to the analyses of

A kind of ebullition immediately commenced, and in about two minutes they were removed by a tin skimmer, thrown into a cullender to drain, and served up by placing them on a fish-drainer in a dish. At table they are flavoured with cayenne and lemon juice, and eaten with brown-bread and butter;—iced punch being the favourite accompanying beverage.

Brande and Schlossberger, that fish-flesh contains more water than the flesh of either quadrupeds or birds.

In many fishes the flesh is mixed with, or covered by, oily or fatty matter, as in the Salmon, the Herring, the Pilchard, the Sprat, and the Eel. This is more abundant in the thinner or abdominal parts than in the thicker or dorsal portions. Hence the thinnest part of salmon is preferred by epicures. After spawning, the quantity of this oil is greatly diminished. But in the Cod, the fish of the Ray-kind, and some others, the liver is the only organ which contains fat; the flesh being quite devoid of it.

The flesh of the Smelt has been analysed by Morin*, who found its composition to be as follows:—

COMPOSITION OF THE FLESH OF THE SMELT.

Yellow phosphoric oil.	Salts—viz. sal ammoniac, phosphates of potash, lime, iron, and magnesia; chloride of potassium, carbonate of lime, and lactate of soda.
Fibrine.	Water.
Albumen.	
Gelatine.	
Osmazome.	
Mucus.	

In the Cod and many other fishes, the muscles are arranged in more or less wedge-shaped masses, called *flakes*, which, after cooking, readily separate from each other, owing partly to the contraction of the muscular fibre, and partly to the solution of the interposed ligamentous or tendinous matter. The white curdy matter observed between the flakes of boiled fresh fish

* *Journal de Pharmacie*, t. viii. p. 61.

is a film of albumen produced by the coagulation of the serous juices intervening between the muscular layers.

In the flat or eel-shaped fishes, the flesh has rather a fibrous than a flaky arrangement.

The flesh of the Whiting, the Cod, the Haddock, the Sole, the Plaice, the Flounder, the Turbot, and many other species, is white: hence they are termed *White-fish.* The flesh of these fishes, when in season, becomes white and opaque by boiling; but, when the animal is out of condition, it remains semi-transparent and bluish after being sufficiently cooked.

The flesh of some species is coloured: thus that of the Salmon is pale-red. The higher the colour, the more highly the flesh of these fishes is esteemed.

The flesh of the male fish, called the *melter* or *soft-roed,* is in general considered to be superior to that of the female, called the *hard-roed*: at least this is certainly the case with the Salmon and the Herring.

The flesh of fish is in the greatest perfection for food at the period of the ripening of the milt and the roe. It is then said to be *in season.* At this time, the flesh, especially of the thinner or abdominal part, of many fishes, as of the Salmon and Herring, abounds in oily matter, and possesses, in the highest degree, flavour and richness. But after the fish has deposited its spawn, the flesh becomes soft, flabby, and inferior in flavour, owing to the disappearance of the oil or fat which has been consumed in the function of reproduction. "The superiority of *deep-sea* herrings over those caught near the shore and in bays, arises," says

Dr. Fleming *, "from this circumstance. The former are fat, while the latter have either recently spawned, or are nearly ready for spawning, and, consequently, lean."

The digestibility of fish varies considerably in different species. The oily fishes are always more difficult of digestion; and, in consequence, are unfit for the use of invalids. Melted butter, lobster-sauce, shrimp-sauce, and egg-sauce, are very indigestible additions to fish: they are exceedingly obnoxious to the stomach, and should be excluded from the table of the invalid (see p. 174). The digestibility of fish is also injured by frying them (see p. 173).

The following are the mean times of digestion of several kinds of fish, according to Dr. Beaumont's experiments:—

DIGESTIBILITY OF FISH.

Articles of Diet.	*Mean Time of Chymification.*					
	In Stomach.			*In Phials.*		
	Preparation.	*H.*	*M.*	*Preparation.*	*H.*	*M.*
Trout, Salmon, fresh	Boiled	1	30	Boiled	3	30
" " "	Fried	1	30	—		—
Codfish, cured dry	Boiled	2	0	Boiled	5	0
Flounder, fresh	Fried	3	30	—		—
Catfish, fresh	Fried	3	30	—		—
Salmon, salted	Boiled	4	0	Boiled	7	45

The Whiting, the Haddock, the Sole, the Plaice, the Flounder, the Cod, and the Turbot, are devoid of

* *Philosophy of Zoology*, vol. ii. p. 373.

oil or fat (except in their livers); and, therefore, belong to the more easily digestible fish. They are also less stimulating to the system. On these accounts they are preferred to other species for the use of invalids. The Whiting and the Haddock are the most delicate and tender; the Turbot and Cod the least so. The Whiting, sometimes called "the chicken of the sea," stands pre-eminent among them for its tenderness, delicacy, easy digestibility, and purity of flavour. The Haddock is very similar to the whiting, but has a firmer texture, and is inferior in flavour and digestibility. The Cod, when in good condition, yields an excellent food, but it is denser, less delicate, and probably somewhat less easy of digestion, than either the whiting or haddock. Crimped cod is firmer, keeps longer, and has a better flavour, than that which is not crimped. The Dogger-Bank Cod is more flaky than the Scotch Cod, which is stringy or woolly *. Among flat fish, the Sole is distinguished for its tenderness, delicacy, and easy digestibility. The Flounder † and the Plaice, especially when small, are tender and delicate. The Turbot for flavour is

* There are two well-marked varieties of the Cod, which are known respectively as *Dogger-Bank* and *Scotch Cod.* The first has a sharp nose, elongated before the eye, and the body of a very dark-brown colour: the second has a round blunt nose, short and wide before the eyes, and the body of a light yellowish ash-green colour. (See Yarrell's *British Fishes*).

† Dr. A. T. Thomson (*Domestic Management of the Sick Room*, p. 434,) gives, under the head of "Cookery for the Convalescent," the following directions for the preparation of *Water-Souchy.*—"Take two small Thames flounders, boil them in a quart of water to one-third, long enough to reduce the fish almost to a pulp. Strain the liquor through a sieve, and, having cut the fins off four other small flounders,

justly regarded as "the prince of flat fish," but it is richer and less digestible than the flat fish just mentioned. The gelatinous skin is especially unfit for delicate stomachs. The Brill, though an excellent fish, is inferior in flavour to the turbot, for which, however, it is sometimes substituted.

Salmon, Eels, Herrings, Pilchards, and Sprats *, abound in oil, and are, in consequence, difficult of digestion, very apt to disturb the stomach, and exceedingly injurious to the dyspeptic. Moreover, they prove stimulant to the general system. The thirst, and uneasy feeling at the stomach, frequently experienced after the use of the richer species of fish, have led to the employment of spirit to this kind of food. Hence the vulgar proverb that "*Brandy is Latin for Fish.*"

The flesh of fish is less satisfying to the appetite than the flesh of either quadrupeds or birds. As it contains a larger proportion of water (see p. 231,) it is obviously less nourishing †. A fish diet, therefore,

put them into the above-mentioned liquor, with a sufficient quantity of salt, a few grains of cayenne pepper, and a small quantity of chopped parsley; and boil just long enough to render the fish proper to be eaten. The fish and the sauce should be eaten together.—If flounders are not in season, soles or whitings, or small haddocks, may be prepared in the same manner.—I know few dishes which are so much relished as this is by convalescents from fever. I have heard invalids ask for it daily for ten or more days.—In advanced convalescence, the yolk of one or two eggs may be beaten up with a little soft water, and added to the strained liquor before the fish is put into it."

* In the *Standard* of Feb. 9, 1842, is a notice of an inquest held on the body of a person whose death was caused by the use of sprats.

† Haller (*Elem. Phys.*, xix.) found himself weakened by a fish diet; and he states that persons are generally debilitated by Lent diet. Pechlin (*Observat. physico-medicæ.* Hamburgi, 1691, p. 513), also states

is less substantial than either butcher's meat or poultry. Medicinally, we employ it, when the digestive powers are unable to assimilate stronger kinds of aliments, or when it is considered desirable to avoid the stimulus which butchers' meat communicates to the system. "The jockeys who *waste themselves* at Newmarket, in order to reduce their weight, are never allowed meat, when fish can be obtained *."

It is an ancient and popular notion that the frequent employment of fish is favourable to the powers of generation; and that those who live principally on this kind of food are unusually prolific †. These effects have been ascribed to the oil contained in fishes, the phosphorus of which possesses aphrodisiac properties. That the frequent use of those fish which abound in phosphoric oil may have an exciting effect on persons previously unaccustomed to this kind of diet, I am neither prepared to admit nor to deny. But there is, I think, sufficient evidence to prove that the

that a mechanic nourished merely by fish had less muscular power than one who lived on the flesh of warm-blooded animals. Dr. Cullen (*Mat. Med.* vol. i. p. 390), however, maintained that the nutritive powers of fish are nearly, if not quite, equal to those of meat; and in support of his opinion he states that he has known "several instances of persons who felt no weakness from a Lent diet, when a great deal of fish was taken;" and he further observes that there are "several instances of villages inhabited almost only by fishers, and who, therefore, live very much upon this sort of aliment, but in whom no diminution of health or vigour appears." His evidence, however, is by no means satisfactory. But to avoid the fallacies attendant on appeals to experience, I have relied, in the text, on the chemical composition of fish, as an evidence of their inferior nutritive power.

* *A Treatise on Diet*, p. 210-211, 5th ed. 1837.

† Montesquieu (*Œuvres Completes*, t. 51-2, 1767), mentions, as instances in point, the Japanese and Chinese.

ichthyophagous people are not more prolific than others. "In Greenland, and among the Esquimaux," says Foster *, "where the natives live chiefly upon fish, seals, and oily animal substances, the women seldom bear children oftener than three or four times: five or six births are reckoned a very extraordinary instance. The Pesserais, whom we saw, had not above two or three children belonging to each family, though their common food consisted of muscles, fish, and seal flesh. The New Zealanders absolutely feed on fish, and yet no more than three or four children were found in the most prolific families; which seems strongly to indicate that feeding on fish by no means contributes to the increase of numbers in a nation."

Another ill effect ascribed to fish diet is the production or augmentation of skin diseases, especially leprosy and elephantiasis. This notion is a very ancient one, and probably has some foundation in fact. It is not improbable that it was, in part at least, the origin of the prohibition from eating fish, under which the Egyptians laboured †; as well as of the Mosaic law, that fish without fins and scales must not be eaten ‡.

Some species of fish, especially in tropical climates, possess poisonous properties, either at all times or at certain seasons; or to all persons or only to particular individuals. The subject, however, is veiled in great

* *Observations made during a Voyage Round the World*, p. 315. Lond. 1778.

† Herodotus (*Euterpe*, xxxvii.) Perhaps the supposed aphrodisiac effect of fish may have been one of the causes of the prohibition.

‡ *Leviticus*, ch. xi. verse ix—xii.

obscurity. Sometimes the symptoms are allied to those of cholera. An eruption (often resembling nettle-rash), and various nervous symptoms (as trembling or convulsive twitches of the limbs, paralysis, and stupor), are occasionally observed. These poisonous effects have been variously ascribed to the aliment on which the fish have fed,—to disease in the fish, to the putrefaction of the fish, and to the idiosyncrasy of the patient: but none of these hypotheses are satisfactory.

"For dietetical uses, fishes have frequently to undergo some sort of preparation, varying according to the situation, the necessities, or the taste of the consumers. When circumstances permit, they are in general used in a *fresh* state; and in large cities, where the supply must be brought from a distance, various expedients are resorted to, to prevent the progress of putrefaction. By far the best contrivance for this purpose is the well-boat, in which fish may be brought to the place of sale even in a living state. Placing the fish in boxes, and packing with ice, is another method, and has been extensively employed, particularly in the supply of the capital with salmon.

"In many maritime districts, where fish can be got in abundance, a species of refinement in taste, or at least a departure from the simplicity of nature, prevails, to gratify which, the fish are kept for some days, until they begin to putrefy. When used in this state they are far from disagreeable, unless to the organs of smell. Such fish are termed by the Zetlanders *blawn-fish*.

"Where fish are to be procured only at certain seasons of the year, various methods have been devised to preserve them during the periods of scarcity. The simplest of these processes is to *dry* them in the sun. They are then used either raw or boiled, and not unfrequently, in some of the poorer districts of the north of Europe, they are ground into powder, to be afterwards formed into bread.

"But by far the most successful method of preserving fish, and the one in daily use, is by means of salt. For this purpose they are packed with salt in barrels, as soon after being taken as possible. In this manner are herrings, pilchards, cod, and salmon preserved, as well as many other kinds of esculent fish.

"The fish, in many instances, after having been salted in vessels constructed for the purpose, are exposed to the air on a gravelly beach, or in a house, and dried. Cod, ling, and tusk, so prepared, are termed, in Scotland, *salt-fish*. Salmon in this state is called *kipper*; and haddocks are usually denominated by the name of the place where they have been cured.

"After being steeped in salt, herrings are, in many places, hung up in houses made for the purpose, and dried with the smoke of wood. In this state they are sent to market, under the name of *red-herrings*.

"Although salt is generally employed in the preservation of fish, whether intended to be kept moist or to be dried, vinegar in certain cases is added. It is used, in this country at least, chiefly for the salmon sent from the remote districts to the London market. It can only, however, be employed in the preservation of those fish to which this acid is served as a sauce*."

* Fleming's *Philosophy of Zoology*, vol. ii. p. 371-2.

By drying, salting, smoking, and pickling, the digestibility of fish is greatly impaired; though, in some cases, their savoury, stimulating, and even nutritive qualities, may be augmented. *Dried, salted, smoked*, and *pickled fish*, therefore, are totally unfit for dyspeptics and invalids. By drying, part of the water is got rid of, and thereby the relative proportion of solid or nutritive matter is augmented: but the fish is more difficult of digestion. Salt-fish excites thirst and feverish symptoms. Smoked-fish, as smoked-sprats, sometimes prove injurious. "Putrid pickled salmon * has occasioned death in this country; and I may mention," says Dr. Christison †, "that I have known most violent diarrhœa occasioned in two instances by a very small portion of the oily matter about the fins of Kipper or smoked salmon, so that I have no doubt a moderate quantity would produce very serious effects."

3. *Viscera.*—Several of the viscera of fishes are used as aliments; as the Liver, the Swimming Bladder, the Roe or Ovary, and the Milt or Testicle.

a. The *Liver.*—The livers of fishes always abound in oil. In the Cod, the Whiting, the flat fish, and some others, this is the only organ which contains oil. Though the livers of some fishes, as the Cod and

* "The three *indispensable marks* of the goodness of *Pickled* Salmon are, 1st. The brightness of the scales, and their sticking fast to the skin; 2ndly. The firmness of the flesh; and, 3rdly. Its fine pale-red rose colour:—without these it is not fit to eat, and was stale either before it was pickled, or has been kept too long after" (Dr. Kitchener, *Cook's Oracle*).

† *Treatise on Poisons*, p. 593. 3rd ed.

Barbot, are much admired as articles of food, yet they are not adapted for invalids and dyspeptics, on account of their fatty nature. The oil obtained from the liver of the Cod (*Cod oil*) is celebrated in obstinate rheumatic, gouty, and scrofulous maladies, as well as in chronic skin diseases. Dr. Ure * has suggested the adoption of cod livers as a diet for patients who are recommended to take the oil, which, on account of its nauseous flavour, is very objectionable. In order to prevent the loss of oil during the process of cooking, "he recommends the livers to be immersed entire in boiling water, to which a sufficient quantity of salt has been added, to raise the boiling point about 220° F. The sudden application of this high temperature coagulates the albumen of the liver, and prevents the escape of the oil. When the liver is cut, the oil exudes, and mashed potato may be used as a vehicle."

The constituents of cod-liver oil are stated to be as follows:—

COMPOSITION OF COD-LIVER OIL.

Fatty matter (oleic and margaric acids combined with glycerine.)	Chlorides of calcium and sodium.
Resin.	Sulphate of potash.
Gelatine.	Iodide of copper.
Colouring matter.	Bromide of potassium.

The two last ingredients were detected by Herberger; but Dr. Ure has recently stated † that he could not detect iodine in the cod-liver oil sold in London.

b. The Swimming Bladder.—This organ is a gela-

* *Pharmaceutical Journal*, vol. ii. p. 361.

† *Ibid.* p. 459.

tinous tissue, and has already been considered (see pp. 215—220). It constitutes the well-known Isinglass and Sound.

c. The *Roe* or *Ovary*, commonly called the *Hard Roe*, of many fishes is eaten. That of the Carp, Pike, Perch, Salmon, Trout, and many other fishes, furnishes a much esteemed and nourishing aliment. The roe of the Barbel, and of some others, has at times proved injurious; giving rise to nausea, vomiting, and purging.

The roe has been analysed by several chemists: that of the Pike by Vauquelin*, of the Trout and Carp by Morin †, and of the Barbel by Dulong d'Astafort ‡. Their results shew that the roes of different fishes have a similar composition and bear a striking analogy to the eggs of birds.

COMPOSITION OF THE ROE OF FISHES.

	Pike.	*Trout.*	*Carp.*	*Barbel.*
Albumen	+	+	+	+
Osmazome	0	+	+	+
Gelatine	+	+	+	+
Oil	+	+	+	+
Phosphorus	+	+	+	+
Sal-Ammoniac	+	+	0	+
Chloride of Sodium	+	0	0	+
Chloride of Potassium	+	+	+	+
Phosphate of Potash	+	+	0	+
,, of Lime	+	+	+	+
,, of Magnesia	+	0	0	0
Sulphate of Potash	+	0	0	0
Carbonate of Soda	0	+	+	0
,, of Potash	0	+	0	0
,, of Lime	0	+	+	0
An organic salt with base of potash	0	0	0	+

* *Journal de Pharmacie*, t. iii. p. 385.
† Ibid. t. ix. p. 203.
‡ Ibid. t. xiii. p. 521.

The purgative property, said to be possessed by the roe both of the Pike and the Barbel, is ascribed to the oil, which possesses acrid properties.

The substance called *Caviare** is the roe of several species of Acipenser (Sturgeons), preserved by salting. The best is that prepared on the shores of the Caspian. The following is the composition of Caviare:—

COMPOSITION OF CAVIARE.

Yellow odorous fatty oil	4·3
Soluble albumen	6·2
Insoluble albumen	24·8
Chloride of sodium and sulphate of soda	6·7
Gelatine, with some salts	0·5
Water	57·5
Fresh unpressed Caviare	100·0

Caviare is difficult of digestion, and apt to excite nausea. Very little of it is used in this country; but considerable quantities of it are exported from Russia to Italy. It is extensively employed in Russia and other places on fast-days; and is eaten raw with toasted bread, or with vinegar and oil, or with lemon juice.

4. *Milt* or *Testicle*.—This is usually called the *Soft Roe*. Messrs. Fourcroy and Vauquelin analysed the

* Several kinds of Caviare are met with in Russia. The worst sort is the *common pressed caviare* (*pajusnaja ikra*). A better sort is that called *grained caviare* (*sernistaia ikra*). The cleanest and best sort *bag-pressed caviare* (*Meschechaja ikra*). In some parts of Russia a reddish kind of caviare (*Krasnaja ikra*) is prepared from the roes of the white salmon and pike. (For further information consult Brandt and Ratzeburg's *Medicinische Zoologie*; and Tooke's *View of the Russian Empire*, vol. iii, p. 467—469).

milt of the Carp; and John, that of the Tench. The milt of the Carp consisted of 75 parts water and 25 parts of dry residuum.

COMPOSITION OF THE MILT OF THE TENCH.

White Fat.
Osmazome.
Animal Jelly.
Insoluble Albumen.
Phosphates of ammonia, lime, magnesia, and potash or soda.
Water.

It appears from Fourcroy and Vauquelin's experiments that phosphorus (not as phosphoric acid) exists in the milt.

The milt of the Cod is used as a garnish, and is eaten at the table; but, on account of its fatty constituent, is not adapted for delicate stomachs. That of the Herring is also employed as food. The latter (*testes harengi*) has been recommended by Ritter, Neumann, Frank, Siemerling, and Hufeland, as a remedy for obstinate cough, hoarseness, and phthisis laryngea. It is to be taken in the morning fasting. Its efficacy (?) has been ascribed to the common salt which it contains.

CLASS V. CRUSTACEA.—CRUSTACEANS.

Many of the species of this class are esculent; and some of them form highly esteemed articles of food. Those in use in this country are the Common Lobster (*Astacus marinus*), the Thorny Lobster, better known as the Common Sea Crawfish (*Palinurus vulgaris*), the River Crawfish (*Astacus fluviatilis*), the Large Edible or Black-clawed Crab (*Cancer Pagurus*), the Common or Small Edible Crab (*Cancer Mænas*),

the Prawn (*Palæmon serratus*), and the Shrimp (*Crangon vulgaris*).

These Crustaceans have "a white firm flesh, which contains much gelatine. In the membrane, which encloses the calcareous shell, is found a resinous substance, which, in the living animals, is of a brownish-green colour, but becomes red by boiling. From this matter proceeds the peculiar odour and taste of these animals. The flesh is difficult of digestion; the broth is stimulant. In febrile and inflammatory complaints, their use is injurious *."

The colouring matter of the shells of the crustaceans, above referred to, has been termed *Cancrin*. Its composition is as follows:—

COMPOSITION OF CANCRIN OR COLOURING MATTER OF CRUSTACEANS.

16 atoms of Carbon . .	96	or per cent. . . .	68·08
13 atoms of Hydrogen .	13	. . . .	9·22
4 atoms of Oxygen . .	32	. . . .	22·70
1 atom of Cancrin . .	141	. . . .	100·00

Both the Crab and the Lobster excite, in some constitutions, Urticaria or nettle-rash, and even colic. Neither of them are easily digestible; so that, though they form very agreeable and moderately nutritive articles of food, they are not appropriate substances for dyspeptics or invalids.

The parts of Crustaceans employed as food are the muscles and some of the viscera. The branchiæ or gills are commonly known under the name of *dead men's fingers*. The muscles (*flesh*) of the lobster and

* Tiedemann, *Untersuchungen über Nahrungs-Bedürfniss*, &c.

crab are principally confined to the parts moving the tail and limbs. Their alimentary properties are very similar to those of fishes.

Both lobsters and crabs are apt to disagree with some persons; and to give rise to a sensation of heaviness at the epigastrium, nausea, depression, giddiness, and nettle-rash. Cullen mentions violent colic as also having been produced in several instances. These effects appear to depend on some peculiar susceptibility (idiosyncrasy) of particular persons. In some parts of the world poisonous crustaceans are found.

The *Lobster* is found in considerable abundance on the rocky coasts of various parts of England and Scotland. The males are preferred, especially in winter, for eating: they are distinguished by the narrowness of their tails, and by "their having a strong spine upon the centre of each of the transverse processes beneath the tail, which support the four middle plates of their tails." The females (called hen-lobsters) are preferred for making sauce on account of the coral (*ovary*) and spawn (*ova* or *eggs*): the former, when boiled, is bright red, and is useful for garnishing; the latter serves to communicate both colour and flavour. They are known by their broader tail and smaller claws. The muscles (*flesh* or *meat*) of the lobster reside principally in the tail and claws: those of the claws being more tender, delicate, and easily digestible. It is a popular notion that a part of the body of the lobster, called "*the old lady in her arm-chair*," proves injurious when eaten. This part is the bony teeth of the stomach, and, being indigestible, should not be eaten. The bag, in which "the old lady" is contained, is the stomach. The flavour

of the lobster is generally considered to be superior in both purity and delicacy to that of the other crustaceans. But, on account of its difficult digestibility, as well as of its occasional ill effects, before referred to (see p. 292), it does not form a fit aliment for invalids and dyspeptics. "As found in the London market," says Dr. Paris, lobsters "are generally underboiled, with a view to their better keeping; and in that case they are highly indigestible." The injurious effects of lobster sauce have been already alluded to (see p. 279).

The *Sea Crawfish* is frequently used as a substitute for the lobster, with which it agrees in its general alimentary properties. But it is usually thought to be inferior in delicacy of flavour and tenderness.

Of the *Crab* the same remarks may be made. The muscles or *flesh* (contained in the claws) is much less apt to disturb the stomach than the viscera (*liver, testicles, ovaries*, &c.), which constitute the soft contents of the shell.

Prawns and *Shrimps* are almost universal favourites on account of their delicious flavour. They are generally and correctly regarded as being easier of digestion than the preceding crustaceans.

CLASS VI. MOLLUSCA.—MOLLUSKS.

In this country a few species only of this class are used as food. Among the *bivalves*, the principal are the Oyster, the Mussel, the Cockle, and the Scallop: among *univalves*, we have the Periwinkle, the Limpet, and the Whelk. To these, as well as to the Crustaceans (Lobsters, Crabs, &c.), the term *Shell Fish* is usually applied.

Some of the edible mollusks are principally and extensively used by the poor; but the Oyster constitutes a favourite article of food to all classes.

Molluscous foods are not without danger; since Mussels, and even Oysters, occasionally give rise to deleterious effects.

The *Oyster* holds the most distinguished place amongst the foods of this class. It was greatly admired by the luxurious Romans, who highly esteemed the Oysters of Britain. They are found on various parts of our coast, and are caught by dredging. But, in order to improve their flavour and size, or, as it is termed, to *fatten* them, they are not immediately consumed, but are laid in beds in creeks along shore, where they rapidly improve. Colchester and other places of Essex are the nurseries or feeding grounds for the metropolis.

The flesh, and the liquor or water, of the oyster have been analysed by Pasquier *.

COMPOSITION OF THE OYSTER.

Flesh.		*Liquor or Water.*
Fibrine, Albumen, Gelatine, Osmazome, Mucus	12·6	Osmazome.
Water	87·4	Albumen.
	100·0	Chloride of sodium.
		Sulphate of lime.
		Sulphate of magnesia.
		Chloride of magnesium.
		Water.

By incineration the organic matters yielded 1·84 of a white ash, containing phosphate of lime and the same salts as the liquor contained.

* Mérat and De Lens, *Dict. de Mat. Méd.* t. v.; and Gmelin, *Handb. d. Chemie*, vol. ii. p. 1478.

The oyster furnishes a delicious and favourite article of food. It is more digestible in the raw state than when cooked (by roasting, scolloping, or stewing); for the heat employed coagulates and hardens the albumen, and corrugates the fibrine, which are then less easily soluble in the gastric juice; and the heated butter, generally used as an accompaniment, adds still more to the indigestibility of the oyster. The following are the mean times of digestion of oysters, according to the experiments of Dr. Beaumont:—

DIGESTIBILITY OF OYSTERS.

Articles of Diet.	*Mean Time of Chymification.*					
	In Stomach.			*In Phials.*		
	Preparation.	*H.*	*M.*	*Preparation.*	*H.*	*M.*
Oysters, fresh	Raw	2	55	Raw, entire	7	30
" "	Roasted	3	15			
" "	Stewed	3	30	Stewed	8	25

As far as my own personal observation extends, the finest raw oysters of the London market, usually called *natives*, rarely disagree even with convalescents and dyspeptics; and Dr. Cullen declares oysters to be easy of digestion. But the experience of some other physicians is very different to this. In the raw state, says Dr. Pearson *, " they agree very well with strong stomachs, but by no means so with persons who are subject to indigestion; and dyspeptic and gouty

* *A Practical Synopsis of the Materia Alimentaria and Materia Medica*, p. 55. 1808.

persons, who have ventured to swallow them in this state, have often been violently disordered by them. Such persons, if they eat them at all, should have them well stewed and seasoned with some aromatic. But even in that state they should be eaten rather sparingly in the instances above mentioned." Dr. Paris * also observes, that "when eaten cold, they are frequently distressing to weak stomachs, and require the aid of pepper as a stimulant; and, since they are usually swallowed without mastication, the stomach has an additional labour to perform, in order to reduce them into chyme." In reply to this last statement, however, it may be observed, that Dr. Beaumont found that an entire raw oyster was chymified, in a phial, in 7½ hours,—while masticated beef-steak required 8¼ hours.

It cannot be doubted that oysters disagree with some constitutions; and that occasionally they have appeared to possess noxious properties. But considering the enormous consumption of these animals, their supposed deleterious effects are exceedingly rare †. The late Dr. Clarke ‡ has related some re-

* *Treatise on Diet.*

† Some cases of supposed deleterious properties acquired by oysters are referred to by Dr. Christison (*Treatise on Poisons*), as having occurred in the years 1816-19 at Havre and Dunkirk. But it is by no means clear that the diseases which prevailed at these places originated from the use of oysters. MM. Vauquelin and Chaussier, who were appointed to inquire into these cases, denied that they were caused by oysters, since many persons were attacked who had not eaten them. (See Mérat and De Lens, *Dict. de Mat. Méd.* vol. v. p. 123).

‡ *Transactions of the London College of Physicians*, vol. v. p. 109.

markable cases, in which convulsions, followed in two cases by death, occurred in women who had taken oysters soon after their delivery. But we are not authorised in adopting his conclusion, that fresh healthy oysters are apt to occasion apoplexy and convulsions in puerperal women. The fact that the symptoms did not come on until the day after the oysters were taken, is against such an assumption.

The green colour, which certain parts of the oyster sometimes assume, has been ascribed by some to marine Ulvæ, on which the animal has fed,—by others, to the absorption of a green-coloured microscopical animalcule (called *Vibrio ostrearius*). Very recently, Valenciennes * has shewn that the green colouring matter is a peculiar organic substance, derived perhaps from a peculiar state of the bile of the animal. The popular notion that the colour is produced by coppery beds, on which the animal is supposed to have laid, is totally unfounded †.

It is a popular notion that the oyster possesses aphrodisiac properties, derived from the phosphorus which it contains; but it has not yet been shewn that oysters contain more phosphorus than the flesh of other animals.

As 100 parts of the flesh of the oyster contain only about 12·6 parts of solid matter, while 100 parts of

* *Comptes Rendus*, t. xii. p. 345. Février 1841.

† "I am acquainted with a lady," says Dr. Paris (*Treatise on Diet*, p. 8. 5th ed.), "who is constantly made sick by eating a green oyster; the cause of which may be traced to an erroneous impression she received with respect to the colouring matter being cupreous."

butchers' meat contain, on the average, about 25 parts, it is obvious that oysters must be less nutritive than butchers' meat.

When eaten raw it is customary to swallow the oyster entire; but for stewing or making sauce they are deprived of the *beard* (the branchiæ or gills *). The indigestible nature of oyster sauce has been alluded to.

Oysters have been employed as medicinal agents in phthisis (in which disease they have been vaunted as a specific), in chronic affections of the digestive organs, in scrofula, and several other complaints. They are useful as nutrients in the stage of convalescence of many disorders, but I am unacquainted with any evidence of their curative powers beyond this.

The *Mussel* is used as food by the lower classes principally. Its flesh is yellowish and difficult of digestion. Dr. Paris † states that the common people, in eating mussels, take out a dark part (the heart), which is

* "We cannot walk the streets without noticing that, in the fish-shops, the oysters are laid with their flat sides uppermost; they would die were it otherwise. The animal breathes and feeds by opening its shell, and thereby receiving a new portion of water into the concavity of its under-shell; and if it did not thus open its shell, the water would neither be propelled through its branchiæ or respiratory apparatus, nor sifted for its food. It is in this manner that they lie in their native beds: were they on their flat surface, no food could be gathered, as it were, in their cup; and if exposed by the retreating tide, the opening of the shell would allow the water to escape, and leave them dry—thus depriving them of respiration as well as food." (Sir Charles Bell's notes to Paley's *Natural Theology*, vol. ii. p. 220-1). The same author also observes, that "in confirmation of these remarks, the geologist, when he sees those shells in beds of diluvium, can determine whether the oysters were overwhelmed in their native beds, or were rolled away and scattered as shells merely."

† *Treatise on Diet.*

erroneously supposed to be poisonous. Under some circumstances mussels acquire deleterious qualities, and occasionally prove fatal. The symptoms which they give rise to, however, are by no means uniform. At one time they are those of irritation of the alimentary canal; but "much more commonly the local effects have been trifling, and the prominent symptoms have been almost entirely indirect, and chiefly nervous. Two affections of this kind have been noticed. One is an eruptive disease, resembling nettle-rash, and accompanied with violent asthma; the other, a comatose or paralytic disorder of a very peculiar description *." The presence of copper, a putrid condition of the mussels, idiosyncrasy on the part of the sufferers, a morbid condition of the mussels, and the poisonous quality of their food (medusæ or starfish), have, at different times, been supposed to be the source of the deleterious effects; but at present the cause is involved in considerable obscurity.

Cockles, Scallops, Periwinkles, Limpets, and *Whelks*, are of inferior moment as aliments. They are principally used by the poorer inhabitants on the coast, and are not adapted for persons of delicate stomachs. *Snails* are employed in some countries as food. In this country the *Great* or *Vineyard Snail* (*Helix pomatia*) is a popular remedy for emaciation with hectic fever and phthisis, on account of its nourishing qualities. Figuier † says, its medicinal property resides in an oil, which he calls *Helicine*.

* Dr. Christison, *Treatise on Poisons.*

† *Journal de Pharmacie*, t. xxvi. p. 113.

Diseased and Decayed Animal Substances.—On several occasions (pp. 252, 255, 268, 283, 284, 286, 289, 291, 292, 296, 297, and 299) I have incidentally alluded to the deleterious qualities sometimes acquired by certain animal foods. It deserves, however, to be specially noticed, with regard to animal foods in general, that when obtained from animals affected with disease at the time of their death, they are always dangerous, and have in some cases proved fatal*.

Moreover, Animal foods, even if procured from perfectly healthy individuals, sometimes suffer a peculiar kind of decay or putrefaction, by which they acquire poisonous properties. Thus, *Sausages* made of the flesh, viscera, or blood of animals, and cured by smoking, have sometimes acquired, by keeping, highly deleterious qualities, which, in many cases, has been attended with fatal results. Buchner ascribes the effects to the presence of a peculiar fatty acid, which has been termed *botulinic acid* (*Wurst-fett-saüre*). *Bacon*, probably other kinds of cured meat, *Ham-pie*, *Cheese*, *Milk*, *Goose-grease* (see p. 268), *Smoked Sprats*, *Pickled Salmon*, *Kipper* or *Smoked Salmon* (see p. 286), and the decayed flesh of quadrupeds (as veal and beef) have also at times produced effects analogous to those caused by the sausages above alluded to†.

The cause of the poisonous quality of those animal foods is involved in complete obscurity. Liebig‡ has

* Tiedemann, *Untersuchungen über das Nahrungs-Bedürfniss*, &c. pp. 119-120; also, *Lond. Med. Gazette*, Oct. 21, 1842.

† For further details consult Dr. Christison's *Treatise on Poisons*; Tiedemann, *op. supra cit.*; and Buchner's *Tokicologie*.

‡ *Chemistry in its Application to Agriculture and Physiology*, pp. 368-369. 2d edit. 1842.

offered an ingenious but gratuitous hypothesis concerning it. The sausages, he says, are in a peculiar state of putrefaction; and in this condition "exercise an action upon the organism, in consequence of the stomach, and other parts with which they come in contact, not having the power to arrest their decomposition; and entering the blood in some way or other, while still possessing their whole power, they impart their peculiar action to the constituents of that fluid."

The subject of *fish-poison* * has been already noticed (see pp. 283, 284, 286, 291, 292, 297, and 299).

* In connection with the above subject, I subjoin the following table, taken from the *Times* newspaper of April 14, 1842:—

Annual Return of Fish seized at Billingsgate (being unfit to be used as human food), from the 1st *of January*, 1841, *to the* 1st *of January*, 1842.

Salmon	136	Salt-fish	86
Turbots	185	Smelts	1,100
Cod	1,295	Mullets	61
Haddocks	28,611	Hallibuts	24
Scate	287	Trout	224
Gurnets	5,700	Lings	14
Mackarel	39,520	Dories	13
Soles	9,790	Dried Haddock	324
Maids	7,372	Roach and Dace	300
Plaice	50,085	Tench	82
Herrings	27,720	Pickled Herrings	2,800
Whitings	1,706		
Brills	222		5,028
			172,629
	172,629	Total	177,657

Sprats	36 bushels.	Oysters	51 bushels.
Pickled Salmon	3 kits.	Shrimps	12 bushels.
Eels	1,232 lbs.	Lobsters	2,819
Winkles	50 bushels.	Crabs	2,332
Whelks	38 bushels.	Crawfish	122
Mussels	22 bushels.		

Total number of Fish seized and condemned:—

In tale	177,657
Sprats	36 bushels.
Pickled Salmon	3 kits.
Eels	1,232 lbs.
Shell-fish in tale	5,774
Shell-fish	173 bushels.

SECT. II.—VEGETABLE FOODS.

The aliments obtained from the Vegetable kingdom greatly exceed in number and variety those procured from Animals; and it is not very easy to adopt a classification which shall be at the same time accurate and practical.

The Natural-history method which I have elsewhere* adopted for the Vegetable and Animal Materia Medica, and which I have followed to a certain extent in the present work, in noticing animal aliments, does not appear to me to be sufficiently practical, for my present purpose, to be exclusively adopted. Nor can we adopt a chemical classification, since most of the substances which we have to notice owe their dietetical properties to more than one proximate principle, and oftentimes to several.

On the whole, then, I believe the arrangement of Tiedemann† to be the most appropriate for my present purpose, and I shall therefore adopt it. It is founded partly on Natural History, partly on the Vegetable organs which are used as food. The following table presents a general view of the classes and orders:—

CLASSIFICATION OF VEGETABLE ALIMENTS.

I. *Aliments derived from Flowering Plants.*

1. Seeds.
2. Fleshy Fruits.
3. Roots, Subterraneous Stems, and Tubers.
4. Buds and Young Shoots.

* *Elements of Materia Medica.*

† *Untersuchungen über das Nahrungs-Bedürfniss, den Nahrungs-Trieb und die Nahrungs-Mittel.* 1836.

5. Leaves, Leaf-stalks, and Flowers.
6. Receptacles and Bracts.
7. Stems.

II. *Aliments derived from Flowerless Plants.*

1. Ferns.
2. Lichens.
3. Algæ, or Sea-weeds.
4. Fungi, or Mushrooms.

CLASS I. ALIMENTS DERIVED FROM FLOWERING PLANTS.

The *Flowering Plants* are also called by botanists *Phenogamous* or *Vascular plants.* They are *Phanerogamia,* the *Cotyledoneæ,* or *Embryonatæ* of some authors.

ORDER I. SEMINA OR SEEDS.

The seeds employed as food are of two kinds, *farinaceous* and *oleaginous.*

1. MEALY OR FARINACEOUS SEEDS.—This division includes the alimentary seeds of the Cerealia, Polygonaceæ, Chenopodiaceæ, Leguminosæ, and Cupuliferæ.

a. Cereal Grains or *Corn.*—These are the seeds of certain grasses, which, on account of their comparatively much larger size, are preferred, for dietetical purposes, to other grass seeds. Those commonly employed are Wheat, Oats, Barley, Rye, Rice, Maize or Indian Corn, Millet, and Sorghum, Durra or Guinea Corn.

The fruit of the grasses is one-seeded, and is called a *caryopsis.* Its endocarpium adheres inseparably to the integuments of the seed. The seed, exclusive of its *coats*, consists of a farinaceous *albumen*, on the outer side and at the base of which lies the *embryo*. In a dietetical point of view the albumen is the most important part of the seed.

The proximate constituents of the Cereal grains are as follows :—

PROXIMATE PRINCIPLES OF CORN.

Starch.
Vegetable albumen.
Vegetable Fibrine. ⎫
Glutine. ⎬ Raw or
Mucine. ⎬ Ordinary Gluten.
Oily Matter. ⎭
Sugar.
Gum.
Earthy Phosphates.
Ligneous Matter (bran, husk, &c.)
Water.

A *bitter principle* and *resin* have been found in some kinds of corn. The dietetical properties, and the proportions, of the alimentary principles found in corn have been already stated.

The ultimate composition of several kinds of corn is, according to Boussingault *, as follows :—

ULTIMATE COMPOSITION OF CORN DRIED AT 230° F.

	Wheat.	*Rye.*	*Oats.*
Carbon	46·1	46·2	50·7
Hydrogen	5·8	5·6	6·4
Oxygen	43·4	44·2	36·7
Nitrogen	2·3	1·7	2·2
Ashes	2·4	2·3	4·0
Total	100·0	100·0	100·0

* *Mémoires de l'Académie Royale des Sciences de l'Institut de France*, t. xviii. p. 345. 1842.

The Cereal grains and the farinaceous foods obtained therefrom, are, when sufficiently and plainly cooked, nutritive, and readily digestible. Their *nitrogenised constituents*, or, in the language of Liebig, their *plastic elements of nutrition*, are, vegetable albumen, vegetable fibrine, glutine, and mucine; while their *non-nitrogenised constituents*, or the *elements of respiration*, are, starch (principally), sugar, and gum.

The following table, drawn up from Dr. Beaumont's work, shows the mean-time of chymification of several kinds of food, composed wholly, or partially, of the cereal grains :—

DIGESTIBILITY OF THE CEREAL GRAINS.

Articles of Diet.	*Mean Time of Chymification.*					
	In Stomach.			*In Phials.*		
	Preparation.	*H.*	*M.*	*Preparation.*	*H.*	*M.*
Rice	Boiled	1	0			
Barley Soup	Boiled	1	30			
Barley	Boiled	2	0			
Cake, Sponge	Baked	2	30	Broken	6	15
Custard	Baked	2	45	Baked	6	30
Dumpling, Apple . . .	Boiled	3	0			
Cake, Corn	Baked	3	0			
Bread, Corn	Baked	3	15			
Bread, Wheat, fresh . .	Baked	3	30	Masticated	4	30

1. *Wheat.*—The grains of several species of *Triticum* are employed as food under the name of Wheat; viz. *Triticum vulgare*, *turgidum*, *polonicum*, *Spelta*, and *monococcum*. In this country, the first species is that which is principally cultivated. The flour

obtained from Lammas Wheat (*Triticum vulgare*, variety *hybernum*) has the following composition :—

COMPOSITION OF WHEATEN FLOUR.

	French Wheat.	*Odessa Hard Wheat.*	*Odessa Soft Wheat.*	*Ditto.*	*Ditto.*	*Flour of Paris Bakers.*	*Ditto, of good quality used in public establishments.*	*Ditto, inferior kind.*
Starch ..	71·49	56·5	62·00	70·84	72·00	72·8	71·2	67·78
Gluten .	10·96	14·55	12·00	12·10	7·30	10·2	10·3	9·02
Sugar ..	4·72	8·48	7·56	4·90	5·42	4·2	4·8	4·80
Gum....	3·32	4·90	5·80	4·60	3·30	2·8	3·6	4·60
Bran....	..	2·30	1·20	..	..	..	..	2·00
Water ..	10·00	12·00	10·00	8·00	12·00	10·0	8·0	12·00
	100·49	98·73	98·56	100·44	100·02	100·0	97·9	100·20

The quantity of gluten contained in wheat is subject to very considerable variation, as will be obvious by reference to the table at pp. 202-3. " In general," says Sir H. Davy *, " the wheat of warm climates abounds more in gluten and in insoluble parts; and it is of greater specific gravity, harder, and more difficult to grind. The wheat of the South of Europe, in consequence of the larger quantity of gluten it contains, is peculiarly fitted for making macaroni, and other preparations of flour, in which a glutinous quality is considered as an excellence."—" In the South of Europe," the same authority adds, " hard or thin-skinned wheat is in higher estimation than soft or thick-skinned wheat; the reason of which is obvious, from the larger quantity of gluten and nutritive matter it contains †."

I am informed by Mr. Hards, miller, of Dartford,

* *Elements of Agricultural Chemistry*, p. 130-131. 4th ed. 1827.
† Ibid. p. 138-9.

that the following are the products obtained by grinding one quarter or eight bushels of wheat:—

PRODUCE OF 1 QUARTER OF WHEAT WEIGHING 504 lbs.

Flour	392 lbs.
Biscuit or fine middlings	10
Toppings or specks	8
Best pollard, Turkey pollard, or twenty-penny .	15
Fine pollard	18
Bran and coarse pollard	50
Loss, sustained by evaporation, and waste in grinding, dressing, &c.	11
	504 lbs.

Owing to the larger quantity of gluten which it contains (see pp. 202 and 203), wheat is more nutritive than the other cereal grains; and its nutritive equivalent, founded on the quantity of its nitrogen, is, therefore, less than these (see p. 55). It yields the finest, whitest, lightest, and most digestible kind of bread; the greater lightness of which depends on the toughness of its dough; which retaining the evolved carbonic acid, swells up during fermentation, and thus acquires a vesicular or cellular character. This lightness or sponginess contributes to the digestibility of bread; since the gastric juice more easily permeates and acts on it when it has this loose texture.

Semolina, Soujee, and *Mannacroup,* are granular preparations of wheat, deprived of bran. A manufacturer * of these substances informs me that they are prepared from the best Kentish wheat. They possess all the nutritive qualities of wheat, and are very agreeable, light, nutritive articles of food, well fitted for invalids and children.

* Mr. Walter Levy, of No. 2, White's Row, Spitalfields, London.

Macaroni, *Vermicelli*, and *Cagliari Paste*, are prepared from wheat. They are imported from Genoa and Naples, and are manufactured in London by Mr. Walter Levy, who prepares them from a paste made from semolina. Macaroni and vermicelli have their well-known forms given to them by forcing the tenacious paste through a number of holes in a metallic plate. Three varieties of macaroni are kept in the shops, the *pipe*, the *celery*, and the *ribbon* macaroni. The Cagliari paste is sold in the form of stars, rings, fleurs de lis, Maltese crosses, &c. The nutritive qualities of all these preparations are identical with those of wheat; and when plainly cooked, as by boiling, they are easily digestible. Boiled in beef-tea they form a nutritious kind of soup (*Macaroni* or *Vermicelli Soup*), for invalids. Or they may be made into puddings. Dr. A. T. Thomson * gives the following directions for the preparation of *Macaroni* or *Vermicelli Pudding*:— "Take two ounces of macaroni or vermicelli, a pint of milk, and two fluid-ounces (four table-spoonfuls) of cinnamon water; simmer until the macaroni or vermicelli is tender. Next, beat up three yolks of eggs and the white of one egg, one ounce of sugar, one drop of the oil of bitter almonds, and a glass of raisin wine, in half a pint of milk; and add the mixture to the macaroni or vermicelli. Bake in a slow oven."

Some of the powders sold under the name of *Farinaceous Foods* for infants † consist wholly or

* *The Domestic Management of the Sick-Room.*

† Bright's *Nutritious Farina* is Potato-starch (see Potatoes).

partially of wheaten flour, with which, therefore, they agree in nutritive qualities. *Hards's Farinaceous Food* is prepared, as Mr. Hards positively assures me, from the finest wheat only. Judging from its colour, smell, and microscopic appearance, it must have been submitted to some heating process (baking?), by which its properties are modified. It is a deservedly esteemed aliment for infants. *Densham's Farinaceous Food* is a mixture of three parts wheat-flour and one part barley-meal *. It is an excellent preparation.

Bread is the most important article of food prepared from the flour or meal of wheat. It is of two kinds; fermented or leavened, and unfermented or unleavened.

a. *Fermented* or *Leavened Wheat-Bread*.—This is the ordinary *Loaf Bread*. Wheaten flour, salt, water, and either yeast † or leaven (old dough already in a state of fermentation) are the ingredients from which it

* Mr. Hooper, chemist, of Pall Mall, who prepares Densham's farinaceous food, has kindly furnished me with the method of preparing it:—Three parts of the best wheat-flour and one part of the best barley-meal are intimately mixed, and the mixture being placed in tins lined with paper, is submitted to a heat of about 200° F. in a baker's oven, for three hours. The time generally chosen is between ten o'clock A.M. and two o'clock P.M., when the oven has cooled considerably. The mixture should not be browned by the process, as it then acquires a pea-flavour. It loses, by heating, from 25 to 30 per cent. in weight, owing to evaporation; and acquires an improved flavour. In this state it keeps well, without becoming sour or musty, and makes excellent puddings.

The barley used in preparing this food is intended to prevent the supposed constipating effects of the wheat.

† Ale and table-beer yeast answer perfectly well. An artificial yeast, prepared by fermenting a wort made of malt, is sometimes employed. Lately, German yeast has been extensively used. It is a friable soft solid, which, when examined by the microscope, appears to consist wholly of yeast globules (*Torula Cerevisiæ*).

is prepared. Bakers generally employ, in addition, potatoes and alum. The yeast or leaven causes the sugar of the flour to undergo the vinous fermentation, by which carbonic acid gas and alcohol * are formed. It is not improbable that the fermentation is promoted by the starch, a proportion of which may, perhaps, yield an additional quantity of sugar. The carbonic acid is prevented from escaping by the tenacity of the dough, which, becoming distended with gas, swells up and acquires a vesicular texture, forming a kind of spongy mass †. In this way, therefore, are produced the vesicles or eyes which give to ordinary loaf-bread its well-known lightness and elasticity. In well-baked bread these vesicles are stratified in layers which are perpendicular to the crust; forming thus what bakers term *piled* or *flaky* bread. The tenacity of the dough, on which the vesicular structure of the bread depends, is owing to the gluten.

* The alcohol is dissipated by the heat of the oven. A few years ago a patent was taken out by Mr. Hicks for collecting the alcohol during the baking process; and above £20,000 were expended in the establishment of a manufactory for bread and spirit; but, as a commercial speculation, the scheme failed. The bread prepared under the patent was baked in pans, and was generally considered to be less agreeable than the ordinary loaf-bread.

† In the ordinary mode of bread making, the baker mixes together water, a little flour, yeast, and potatoes, and sets the mixture aside for six or eight hours, to undergo fermentation. The fermented mixture is, "in the language of the bakehouse, the *sponge;* its formation and abandonment to spontaneous decomposition is termed *setting* the sponge; and according to the relation which the amount of water in the sponge bears to the whole quantity to be used in the dough, it is called *quarter*, *half*, or *whole* sponge." (Dr. Colquhoun, *Annals of Philosophy*, N.S. vol. xii. p. 165. 1826.)

If the vinous fermentation be not checked in due time by baking, the dough becomes sour, owing, probably, to the formation of both acetic and lactic acids.

On weighing bread, when taken from the oven, it is found to be from 28 to 34 per cent. heavier than the flour used in its preparation. "In the formation of wheaten bread," says Sir H. Davy*, "more than one-quarter of the elements of water combine with the flour; more water is consolidated in the formation of bread from barley, and still more in that from oats; but the gluten in wheat being in much larger quantity than in other grain, seems to form a combination with the starch and water, which renders wheaten bread more digestible than other species of bread."

The common salt used in bread-making serves principally to flavour; but it also improves the colour of, and gives stiffness to, the dough.

Notwithstanding that the law prohibits, under a penalty, the use of alum by bakers, it is very frequently employed under the name of "*stuff*." It augments the whiteness and firmness of bread made from inferior kinds of flour, and, by the latter effect, renders the bread less liable to crumble when cut, while it enables the baker to separate the loaves more readily after their removal from the oven. Whatever doubts may be entertained as to the ill effects of alum on the healthy stomach, none can exist as to its injurious influence in cases of dyspepsia. Bread which contains alum is objectionable, not merely on

* *Elements of Agricultural Chemistry*, 4th ed. p. 127. 1827.

account of its containing this salt, but because it is generally made from inferior flour, which, when mixed with yeast and water, and formed into dough, quickly passes through the stage of vinous fermentation, and becomes acid.

Potatoes are very commonly used in bread-making. They assist fermentation in the manufacture of bread, and render the product lighter. As they contain less gluten, they are, of course, less nutritive than wheat flour; but in other respects their use is unobjectionable, and the law imposes no penalty on the baker for employing them.

The following is Vogel's analysis of wheaten bread:—

COMPOSITION OF 100 PARTS OF WHEATEN BREAD (MADE WITH WHEAT-FLOUR, DISTILLED WATER, AND YEAST, BUT WITHOUT SALT).

Starch	53·5
Torrefied or gummy starch	18·0
Sugar	3·6
Gluten combined with a little starch	20·75
	95·85

Exclusive of carbonic acid, chloride of calcium, and chloride of magnesium.

From this it appears that a portion of the starch is gummified (converted into *dextrine*) by the process of panification. Moreover, as the quantity of sugar in the baked loaf is nearly equal to that of the flour, it is probable that a certain portion of saccharine matter is formed at the expense of the starch. The gluten does not appear to have suffered much change in its amount; but in some of its qualities (tenacity and elasticity) it has undergone considerable alteration. If a piece of bread be "placed in a lukewarm decoction of malt,

the starch and the substance called dextrine are seen to dissolve like sugar in water, and, at last, nothing remains except the gluten, in the form of a spongy mass, the minute pores of which can be seen only by a microscope *."

Liebig † states that 100 parts of fresh bread contain, on an average, 30·15 parts of carbon; and though this statement is meant to apply to rye-bread (*Schwartzbröd* or *black bread*), it is probably equally applicable to wheaten bread.

Notwithstanding that bread is denominated the *staff of life*, alone it does not appear to be capable of supporting prolonged human existence. Boussingault ‡ came to this conclusion from observing the small quantity of nitrogen which it contains; and the Reports of the Inspectors of Prisons, on the effects of a diet of bread and water, favour this notion.

The *fine bread* prepared from flour only is the most nutritive and digestible. *Brown bread*, made from wheaten meal, which contains bran, is laxative, as I have already stated (see p. 139), and is used by persons troubled with habitual constipation, as well as by those labouring under diabetes. *Hot rolls* are indigestible, and unfit for dyspeptics and invalids. Indeed, all kinds of *new bread* are injurious. Rolls, both English and French, are made with a much larger proportion of yeast than is employed for ordinary bread.

* Liebig's *Chemistry in its Application to Agriculture and Physiology*, 2d ed. pp. 38, 39. 1842.
† *Animal Chemistry*, p. 287.
‡ *Ann. de Chim. et Phys.* t. lxviii.

The different kinds of *fancy breads* are less adapted for the use of invalids and of those who suffer with a tender stomach, than the common loaf-bread. Bread which has been submitted to compression by the hydraulic press becomes dry and hard, and may be kept for an almost indefinite period. When used, this *compressed bread* requires to be granulated like semolina*.

Very recently, Bouchardat† has suggested the use of what he calls *gluten bread*, by diabetic patients. It is bread made of wheat dough deprived of the chief portion of its starch. It is impossible to eat bread made of gluten only, on account of its hardness and toughness. Hence one-fifth of the normal quantity of starch is allowed to remain in; and in this form the bread is tolerably light, edible, and moderately agreeable ‡. But though the substitution of this bread for ordinary loaf-bread is attended with a diminution of the quantity of sugar contained in the urine, yet the remedy is a mere palliative, and has no curative tendency. I have tried it in one case only, and that for about ten days, when the patient (a medical man) finding himself not improved by it, ceased its use. In a case related by Dr. Budd §, the general symptoms of diabetes appeared to be relieved by its use.

Rusks and *Tops and Bottoms* belong to the class of fermented breads. Both are made with wheat flour,

* See Laignel, *Comptes Rendus*, 1841, 1er Sem. p. 25.
† *Comptes Rendus*, Nov. 1841, p. 942.
‡ Gluten bread is prepared and sold by Mr. Bullock, chemist, of Conduit Street, London.
§ *Lond. Medical Gazette*, April 22, 1842.

butter, sugar, milk, and a considerable quantity of yeast, to give them lightness. Notwithstanding that they are frequently employed as infants' food, it is obvious that they are objectionable, on the double ground of containing butter and of being fermented.

β. *Unfermented or unleavened bread.*—There are two principal kinds of unfermented bread, the one heavy and compact, the other light and elastic.

Of the *heavy and compact unfermented bread* we have an excellent example in the *common sea biscuit*, called *ship bread*, which is hard, compact, heavy, and difficult either to cut or chew. That made at the Government Victualling Establishment at Weevil, near Portsmouth, is composed of wheaten meal (containing a certain proportion of bran) and water only. It must be very obvious that this very cohesive, firm, and compact bread, must be slowly digested, as the gastric juice cannot so speedily and readily permeate it as the light and elastic kinds of bread. It requires, therefore, a very perfect mastication and insalivation.

Notwithstanding this objection, biscuit sometimes agrees better with the dyspeptic than fermented bread. In such cases the biscuits prepared by Mr. Dodson, on the patent unfermented principle, deserve a trial. *Biscuit powder* is frequently used for infants' food, and is, of course, free from the objection raised to the whole biscuit; the cohesiveness of which has been overcome by grinding. It is generally prepared for use by the aid of hot water, which likewise tends to obviate the foregoing objection. It is greatly superior to rusks and to tops and bottoms.

The *Captains' biscuits* sold in the shops are professedly unfermented, and made of wheaten flour and water, with a small portion of butter. Milk is sometimes used instead of water. It is reported that some biscuit-bakers employ a little yeast, to render the product somewhat less dense. The *meal biscuit* is prepared with wheaten-meal, which contains a portion of bran. The common *buttered biscuit* is rendered somewhat light by a little yeast; and contains, as its name indicates, butter. *Abernethy's biscuits* are variously made by different bakers: yeast is generally used in their preparation. They contain caraway-seeds. The small square *York biscuit* is prepared with wheaten flour, butter, milk, and sugar, but without yeast. Of course those biscuits which contain butter * are more objectionable for dyspeptics than plain biscuits.

Of the *light and elastic* (*spongy*) *unfermented breads*, there are several kinds. They owe their lightness to a cellular or vesicular texture (similar to that of ordinary fermented bread) produced by a gaseous or volatile body, not developed by fermentation, but otherwise set free in the dough, and, being expanded by the heat of the oven, distends the dough. The *Patent Unfermented Bread* obtains its lightness from carbonic acid developed within the dough by the action of hydrochloric (muriatic) acid, sometimes called spirits of salts, on the sesquicarbonate of soda. *Gingerbread* is also rendered light by carbonic acid gas; but the latter is obtained by the mutual action which takes place between carbonate of potash and treacle †.

* The difficult digestibility of butter, and its injurious effects on dyspeptics, have been already alluded to (see pp. 172, 174, and 179).

† The ingredients used in the manufacture of gingerbread are *flour*,

I have tasted some excellent Gingerbread and Gingerbread Nuts made by Mr. Dodson, by the patent unfermented process, without either alum or potashes. *Several kinds of light biscuits* owe their lightness to sesquicarbonate of ammonia (volatile or smelling salts) which is dissolved in the water used in the formation of the dough. In the oven, the heat converts the ammoniacal salt into vapour, which distends the dough. When the whole salt has been nearly evaporated, the texture of the dough has become sufficiently stiff and dry to prevent the mass shrinking to its former dimensions. Biscuits thus prepared are *porous*, but have not the *piled* texture of ordinary fermented bread. As examples of unfermented biscuits, in the manufacture of which sesquicarbonate of ammonia is used, I may mention Cracknells, and the Victoria and Clarence Biscuits. Cracknells are prepared with wheaten flour, a small quantity of sugar, a

treacle, *butter*, *common potashes*, and *alum*. "After the butter is melted, and the potashes and alum are dissolved in a little warm water, these three ingredients, along with the treacle, are poured among the flour which is to form the basis of the bread. The whole is then thoroughly incorporated together, by mixture and kneading, into a stiff dough." This dough, "however thoroughly kneaded, almost invariably requires to stand over for the space of from three or four to eight or ten days, before it arrives at that state which is best adapted for its rising to the fullest extent, and becoming duly gasified in the oven." The alum is the least essential ingredient; "although it is useful in having a decided tendency to make the bread lighter and crisper, and in accelerating the tardy period at which the dough is in the most advantageous condition for being baked." (Dr. Colquhoun, *Annals of Philosophy*, N. S. vol. xii. p. 271. 1826).

Treacle contains free *glucic* and *melassic acids*, which, by their action on the carbonate of potash, set carbonic acid free. It is not improbable that, during the rising of the gingerbread dough, more glucic acid may be formed by the action of the potashes on the saccharine matter.

little milk, butter, eggs, and the sesquicarbonate of ammonia. The curl of the oak-leaved cracknells is produced by the latter salt. The Victoria Biscuit contains, besides the smelling salt, flour, eggs, sugar, milk, and butter. The Clarence Biscuit contains some eggs, and a few caraway seeds.

The *Patent Unfermented Bread* deserves a more extended notice. Many years since it was stated in the Supplement to the Encyclopædia Britannica (art. *Baking*,) that if, instead of the ordinary dose of common salt being mixed with the dough in the usual way, we substitute carbonate of soda and muriatic acid in due proportion, and knead them as rapidly as possible with the dough, it will rise immediately, fully as much, if not more, than dough mixed with yeast, and, when baked, will constitute a very light and excellent bread.

By the mutual action of the muriatic acid and carbonate of soda we obtain common salt (chloride of sodium), water, and carbonic acid gas. The latter ingredient being set free distends the dough and gives it a vesicular character. In this way the bread is rendered light without the destruction of any of the nutritive ingredients of the flour; and without the risk of the production of acetous fermentation, or of the decomposition of the gluten. Dr. Colquhoun tried this plan; and though he used an unnecessarily large quantity of the carbonate and acid, the bread which he obtained, proved, as he says, "doughy and sad, possessed but a few diminutive vesicles, and was never piled." His failure arose, I suspect, from setting aside the dough for twenty minutes before putting it in the oven; whereas it cannot be too quickly heated.

In 1836, Dr. Whiting * took out a patent for rendering bread, cakes, light biscuits, and such like farinaceous foods, cellular, light (spongy), without the aid of fermentation. His process is essentially that just described. The proportions of the ingredients which he directs to be used are as follows:—

Wheaten Flour . . .	7 lbs.
Carbonate of soda .	350 grs. to 500 grs.
Water	2¼ pints.
Muriatic acid .	from 420 to 560, or as much as may be sufficient.

Mr. Dodson, of 98, Blackman Street, Southwark, having purchased the patent of Dr. Whiting, prepares bread (white and brown), biscuits, biscuit-powder, and cakes, according to the unfermented process. The bread appears to me to be made of excellent flour, and though it is scarcely so light as the ordinary loaf bread, its flavour is very agreeable. It resembles home-made bread rather than baker's bread, and keeps well without becoming sour or mouldy. I greatly prefer the brown to the white unfermented bread.

A most delicious unfermented bread, equal in lightness to any bread prepared by the fermented process, was made, in my presence, by the cook of Mr. John Savory, of New Bond Street, according to the following formula †:—

* *Repertory of Patent Inventions*, N.S. vol. vii. p. 267. 1837.

† This formula differs somewhat from that published by Mr. Deane (*Pharmaceutical Journal*, vol. i. p. 492), for making what he terms "Pharmaceutical Bread."

Flour, 1 lb.
Sesquicarbonate of soda, 40 grains.
Cold water, half a pint, or as much as may be sufficient.
Muriatic acid of the shops, 50 minims [drops].
Powdered white sugar, a tea-spoonful.

Intimately mix the sesquicarbonate of soda and the sugar with the flour, in a large basin, by means of a wooden spoon. Then gradually add the water, with which the acid has been previously mixed, stirring constantly, so as to form an intimate mixture very speedily. Divide into two loaves, and put into a quick oven immediately.—If any soda should escape the action of the acid it causes a yellow spot, which, however, is more unsightly than detrimental. The sugar can be omitted if thought desirable.

The unfermented bread possesses several advantages, besides those already specified (see p. 318), over the ordinary fermented bread. In its manufacture both time and trouble are saved; and all risk of vitiating the bread by the use of inferior yeast, or by carrying the fermentation too far, thereby avoided. It is well adapted for the use of invalids and dyspeptics, with whom the ordinary fermented bread disagrees. In urinary maladies, likewise, it deserves a trial. In its porosity and lightness it is superior to biscuits (see p. 315), since it is more speedily permeated, and more readily acted on, by the gastric juice.

Mouldy bread (that is, bread covered with *Mucor Mucedo*, and other allied fungi) has on several occasions proved injurious *. Colic, headache, great thirst,

* See Chevallier's paper in the *Journ. de Chim. Méd.* t. vii. p. 122. 1831. The author refers to Barruel's observations, and also quotes some cases published by Westerhoff in 1826.

dry tongue, frequent pulse, and stupor, have been induced by it. Wheat is liable to several disorders * produced by the attack of certain fungi and animals, and probably in these states is more or less deleterious to health, independent of losing, partially or entirely, its nutritive qualities.

Cakes, of which the *Plum-cake* may be taken as the type, may be regarded as a rich variety of bread; though in common parlance they are considered distinct from this. They are composed of wheaten flour, butter or lard, eggs, sugar, raisins (the larger kind as well as the small Corinthian raisin, popularly called the currant), frequently almonds, &c. They form a most indigestible kind of food, totally unfit for children, invalids, and dyspeptics. Their indigestible quality is principally derived from the butter or lard which they contain (see p. 174).

* The Rev. Professor Henslow, in his *Report on the Diseases of Wheat* (published in the *Journal of the Royal Agricultural Society of England*, vol. ii.), states that he has examined wheat infested by five species of parasitic fungi; by the Ergot; by the little animalcule (*Vibrio Tritici*), which produces the Earcockle, Purples, or Peppercorn; and the fly called the Wheat Midge (*Cecidomyia Tritici*). The five fungi referred to are:—

1st. The Bunt, Smut-balls, or Pepperbrand (*Uredo Caries*, De Cand.; *Uredo fœtida*, Bauer).

2d. The Smut or Dust Brand (*Uredo Segetum*).

3dly and 4thly. The Rust, Red-rag, Red-robin, or Red-gum (*Uredo rubigo* and *Uredo linearis*).

5thly. The Mildew (*Puccinia graminis*).

Mr. Quekett and others have, I think, satisfactorily shown the Ergot to be a disease induced by the attack of a fungus, which Mr. Quekett has denominated the *Ergotætia abortifaciens*. (See *Trans. of the Linn. Society*, vol. xviii.; also my *Elements of Materia Medica*, vol. ii. p. 913, 2d ed.)

Mr. Dodson prepares cakes (plain, currant, sultana, or fig) by the unfermented patent process, without butter. They are, therefore, free from the objections raised to ordinary cakes.

The action of heat on the butter or lard used in the manufacture of *pastry* (*baked paste*), renders this compound highly injurious to the dyspeptic, who should, therefore, most carefully avoid its use. "All pastry is an abomination," justly observes Dr. Paris *. "I verily believe," he adds, "that one half, at least, of the cases of indigestion which occur, after dinner-parties, may be traced to this cause." I have already (p. 172-3) pointed out the injurious influence of heat on oily and fatty substances, especially butter.

The same authority correctly adds, that "the most digestible *pudding* is that made with bread, or biscuit and boiled flour: *batter* pudding is not so easily digested; and *suet* pudding is to be considered as the most mischievous to invalids in the whole catalogue. *Pancake* is objectionable, on account of the process of frying imparting a greasiness, to which the dyspeptic stomach is not often reconciled."

The following is a formula for a *boiled bread-pudding*, adapted for the convalescent †:—"Grate half a pound of stale bread, pour over it a pint of hot milk, and leave the mixture to soak for an hour in a covered basin; then beat it up with the contents of two eggs. Put the whole into a covered basin, just large enough to hold it, which must be tied

* *Treatise on Diet*, 5th ed.

† See Dr. A. T. Thomson's *Domestic Management of the Sick-Room*.

in a cloth, and placed in boiling water for half an hour. It may be eaten with salt or with sugar; and, if wine be allowed, it may be flavoured with sherry."

Panada is prepared as follows:—Place some very thin slices of crumb of bread in a saucepan, and add rather more water than will cover them. Boil until the bread becomes pulpy, then strain off the superfluous water, and beat up the bread until it becomes of the consistence of gruel; then add white sugar, and, when permitted, a little sherry wine. This forms a very agreeable aliment for the sick.

2. *Oats.*—The Oat cultivated in this country is the *Avena sativa* or *Common Oat*. When the grains are deprived of their integuments they are called *groats* or *grits*; and these, when crushed, are denominated *Embden groats*, and when ground into flour, *prepared groats*. *Oatmeal* is prepared by grinding the kiln-dried seeds deprived of their husk and outer skin. It is not so white as wheaten flour, and has a somewhat bitterish taste.

The following is the composition of oats, according to Vogel:—

COMPOSITION OF OATS.

The Entire Seeds.		*Dried Oatmeal.*	
Meal	66	Starch	59·00
Husk	34	Bitter matter and sugar	8·25
	100	Gray albuminous matter	4·30
		Fatty oil	2·00
		Gum	2·50
		Husk, mixture, and loss	23·95
			100·00

But Oatmeal yielded Dr. Christison the following results:—

COMPOSITION OF OATMEAL.

Starch	72·8
Saccharo-mucilaginous extract	5·8
Albumen	3·2
Oleo-resinous matter	0·3
Lignin (bran)	11·3
Moisture	6·6
	100·0

Oats are generally considered somewhat less nutritive than wheat. But from Boussingault's ultimate analysis, already referred to (see p. 304), the quantity of nitrogen yielded by them is nearly equal to that obtained from wheat; and, accordingly, the nutritive equivalent for oats, according to this chemist, differs but little from that of wheat (see p. 55). Oatmeal, says Dr. Cullen*, " is especially the food of the people of Scotland, and was formerly that of the northern parts of England; counties which have always produced as healthy and as vigorous a race of men as any other in Europe."

Oats are apt to disagree with some dyspeptics; or, in popular language, they are liable to become acescent on the stomach.

Unfermented oat-bread, in those unaccustomed to it, is apt to occasion dyspepsia, with heartburn, and was formerly thought to have a tendency to produce skin diseases, but without just grounds. *Gruel* is a mild, nutritious, and, in most cases, an easily digested article of food, in chronic diseases and in the convalescence from acute maladies. In some irritable conditions of the stomach it is occasionally retained when many other foods are rejected. Yet it is less demulcent than barley-water. " Unless gruel be very thin," says Dr. A. T. Thomson, " it can scarcely be regarded as a diluent; and when thick, it is too heating an aliment for patients labouring under febrile symptoms." On account of the nitrogenous principle which it contains, it is of course more nourishing than the starchy preparations (arrow-root, tapioca, sago, &c.) frequently employed in the sick-chamber. It is prepared from either groats or oatmeal. It may be sweetened, acidulated with a little lemon-juice, or aromatised with a very small portion of some spice. Butter, which is frequently added, is objectionable in dyspeptic and other cases where the stomach is tender.

* *Materia Medica*, vol. i. p. 278.

Oatmeal Porridge or *Stir-about* is a moderately consistent mixture, composed of oatmeal and water, and prepared by boiling. It is sometimes eaten with milk as a moderately nutritive diet. When mixed with the thin liquor of boiled meat, or the water in which cabbage or kale has been boiled, it is called *beef-brose*, or *kale-brose*.

The husk and some adhering starch separated from oats in the manufacture of oatmeal are sold in Scotland " under the inconsistent name of *Seeds**." These, " if infused in hot water and allowed to become sourish in this state, yield, on expression, a mucilaginous liquid, which, on being sufficiently concentrated, forms a firm jelly, known by the name of *Sowins*." Dr. A. T. Thomson † gives the following directions for the preparation of " *Flummery* or *Sowans*":—

* Dr. Christison, *Dispensatory*.
† *Domestic Management of the Sick-Room*.

Take a quart or any quantity of groats, or of oatmeal; rub the groats or the meal for a considerable time, with two quarts of hot water, and leave the mixture for several days at rest, until it becomes sour; then add another quart of hot water, and strain through a hair sieve. Leave the strained fluid at rest until it deposits a white sediment, which is the starch of the oats; lastly, pour off the supernatant water, and wash the sediment with cold water. The washed sediment may be either boiled with fresh water, stirring the whole time it is boiling, until it forms a mucilage or jelly; or it may be dried, and, afterwards, prepared in the same manner as arrow-root mucilage *.—Flummery is light, moderately nutritious, and very digestible; it is, consequently, well adapted for early convalescence. It may be eaten with milk or wine, or lemon-juice and sugar."

"A diet of oats," says Dr. Christison, "has the credit of tending to keep the bowels open; and I have seen it apparently have this effect in several instances of habitual constipation, when taken at breakfast in the form of porridge. In cases of dyspepsia associated with acidity of stomach, it is on the contrary in general a noxious article of food; and some dyspeptics among the working classes recover entirely on abandoning it for a time. A curious, though now rare, consequence of its long habitual use as food, is the formation of intestinal concretions composed of phosphate of lime, agglutinating animal matter, and

* "Flummery should not be made in a metallic vessel."

the small stiff silky-like bristles which may be seen at one end of the inner integument of the oat-seed. This affection must have been common in Scotland during the last century, as Dr. Monro Secundus, collected forty-one specimens, still in the anatomical museum of this University. But it is now far less frequent, probably in consequence of the oats being more thoroughly cleared of their investing membranes before being ground into meal. I have had occasion to examine one specimen only, which was removed from the rectum by Mr. Liston in a case of recto-vesical fistula."

3. *Barley.*—Several species of Barley are cultivated in this country, viz. *Hordeum distichon*, the Common Long-eared Barley; *Hordeum vulgare*, the Spring Barley; *Hordeum hexastichon*, Winter Barley; and *Hordeum Zeocitron*, Sprat or Battledore Barley. The grains, when deprived of their husk by a mill, form *Scotch, hulled*, or *pot barley*. When all the integuments of the grains are removed, and the seeds are rounded and polished, they constitute *pearl barley*. The farina obtained by grinding pearl barley to powder is called *patent barley*.

The following is the composition of barley according to Einhof:—

COMPOSITION OF BARLEY.

The Ripe Seeds.		*Barley-meal.*	
Meal	70·05	Starch	67·18
Husk	18·75	Fibrous matter (gluten, starch, and lignin)	7·29
Moisture	11·20	Gum	4·62
	100·00	Sugar	5·21
		Gluten	3·52
		Albumen	1·15
		Phosphate of lime with albumen	0·24
		Moisture	9·37
		Loss	1·42
			100·00

The husk of barley is slightly acrid. Deprived of this, as in Scotch and pearl barley, the seeds are highly nutritious. They are considered to be more laxative than the other cereal grains. The quantity of gluten which they yield, is, however, considerably less than that obtained from wheat (see p. 203); and as they contain less nitrogen, their nutritive equivalent is less than that of wheat (see p. 55). Count Rumford,* however, regarded *barley-meal*, when used for soup, as three or four times as nutritious as wheaten flour. It is a constituent of *Densham's farinaceous food* (see p. 309), being used, on account of its laxative operation, to counteract the supposed constipating effect of wheat. *Barley bread* is somewhat more difficult of digestion than wheaten bread. *Barley water* is a light, mild, emollient demulcent liquid, which is slightly nutritive, and very easy of digestion. It forms an excellent diluent beverage in febrile and inflammatory cases, especially maladies of the chest, bowels, and urinary organs. It is prepared as follows:—Take two ounces and a half of pearl barley; first wash away, with water, the foreign matters adhering to the seeds; then add half a pint of water, and boil for a little while. This liquid being then thrown away, pour on them four pints (imperial) of boiling water; boil down to two pints, and strain. It is frequently flavoured with sugar, and sometimes with slices of lemon-peel. *Compound barley water* is prepared by boiling together two pints of barley water, a pint of water, two ounces and a half of sliced figs,

* *Essay on Feeding the Poor.*

half an ounce of liquorice root, sliced and bruised, and two ounces and a half of raisins. They are boiled down to two pints, and strained. This decoction is emollient, demulcent, and slightly aperient.

Malt.—This is barley which has been made to germinate by moisture and warmth, and afterwards dried, by which the vitality of the seed is destroyed. By this process a peculiar nitrogenous principle, called *diastase*, is produced. This, though it does not constitute more than 1-500th part of the malt, serves to effect the conversion of the starch of the seed into dextrine and grape sugar, preliminary to the operation of brewing. The colour of the malt varies according to the heat employed in drying it: *pale* or *amber malt* yields a fermentable infusion: *brown* or *blown malt* is not fermentable, but is used to communicate flavour; while *roasted* or *high-dried malt*, which has been scorched, is employed for colouring. The infusion or decoction of malt (called *sweet-wort*), contains saccharine matter, starch, glutinous matter, and mucilage. It is nutritious and laxative, and has been used as an antiscorbutic and tonic. Macbride recommended it in scurvy, but it is apt to increase the diarrhœa. As a tonic, it has been used in scrofulous affections, purulent discharges—as from the kidneys, lungs, &c., and in pulmonary consumption. The *decoction* is prepared by boiling three ounces of malt in a quart of water. This quantity may be taken daily.

4. *Rye.*—The cultivated or common rye is the *Secale cereale* of botanists. Though in common use among the northern inhabitants of Europe, it is rarely employed as food in England.

COMPOSITION OF RYE.

The Entire Seeds.		*Rye-Meal.*	
Husk	24·2	Starch	61·07
Pure Meal	65·6	Gum	11·09
Moisture	10·2	Gluten	9·48
		Albumen	3·28
	100·0	Saccharine matter	3·28
		Husk	6·38
		Undetermined acid & loss	5·42
			100 00

It contains less gluten than wheat (see p. 203), and yields less nitrogen (see pp. 304 and 55): hence it is inferior in nutritive properties to the latter.

Rye-bread, called in Germany *Schwartzbrot*, or *Black Bread*, has, according to Bœckmann, the following composition :—

COMPOSITION OF RYE BREAD.

	1	2
Water	33	31·418
Dry matter	67	68·592
	100	100·000

	1	2
Carbon	45·09	45·41
Hydrogen	6·54	6·45
Nitrogen, Oxygen	45·12	44·89
Ashes	3·25	3·25
Dry matter	100·00	100·00

From these analyses Liebig calculates that 100 parts of fresh bread contain on an average 30·15 parts of carbon.

In those unaccustomed to it, rye bread is apt to occasion diarrhœa, which Dr. Cullen ascribes to its readily becoming acescent.

Rye-pottage is said to be a useful article of diet in consumptive cases.

Rye is exceedingly subject to the attack of the *Ergot;* and to the use of ergotised rye a disease termed *Ergotism* has been ascribed. It assumes two

forms, one called *convulsive*,—the other, *gangrenous ergotism*. In the former, convulsion, in the latter gangrene of the extremities, constitutes the most marked character.*

5. *Rice*.—This is the well-known grain of *Oryza sativa*. Whilst in the husk it is called *paddy* (*padi* or *paddie*) by the Malays, *bras* when deprived of the husk, and *nasi* after it has been boiled. It is extensively raised in India, China, and most other Eastern countries; in the West Indies, Central America, and the United States; and in some of the Southern countries of Europe. The kinds most esteemed in this country are the Carolina and Patna rice.

The composition of Carolina and Piedmont rice is, according to Braconnot, as follows :—

COMPOSITION OF RICE.

	Carolina Rice.	*Piedmont Rice.*
Starch	85·07	83·80
Parenchyma (woody fibre)	4·80	4·80
Glutinous matter	3·60	3·60
Rancid, colourless, tallowy oil	0·13	0·25
Uncrystallizable sugar	0·29	0 05
Gum	0·71	0·10
Phosphate of lime	0·40	0·40
Water	5·00	7·00
Acetic acid, phosphate of potash, chloride of potassium, and vegetable salts of potash and lime	traces	traces
	100·00	100·00

In the manufacture of rice starch by Mr. Orlando Jones's patent process, Patna rice is digested in a weak

* For further details, as well as for references, respecting ergot of rye, see my *Elements of Materia Medica*.

solution of caustic alkali (soda), by which the *gluten*, as it is technically called, is dissolved and removed. The insoluble matter consists of *starch*, and a white substance termed by Mr. Jones, *fibre*. The last-mentioned substance appears, when examined by the microscope, to consist chiefly of starch grains, but in drying it does not split into prismatic columnar masses,—in the language of the starch-maker, it does not *race*,—and, therefore, is not fit for commerce. Mr. Jones informs me, that in manufacturing rice starch on the large scale, Patna rice, dried at from 160° to 180° F., for several days, yields 80 per cent. of *marketable starch*,* and 8·2 per cent. of *fibre;* the remaining 11·8 per cent. being made up of gluten, gruff or bran, and a small quantity of light starch, carried off in suspension by the alkaline solution.†

If the alkaline solution of glutinous matter be carefully neutralized by an acid, the gluten is precipitated. I have received from Mr. Jones a quantity of this precipitate. It had a creamy consistence, an agreeable smell, and a bland taste, somewhat like pap. When heated it separates into two parts,—a coagulum or curd,

* According to Vogel, a dried rice yielded him 96 per cent. of starch.

† Vauquelin (*Mémoires du Museum d'Histoire Naturelle*, t. iii. p. 229, 1817) says that rice contains scarcely an appreciable quantity of gluten. Braconnot, however, in his analyses, obtained 3·6 per cent. of gluten. It is probable that the 11·8 per cent. loss of weight, experienced by digesting rice in a weak alkaline solution, is ascribable, not merely to gluten, and the other substances named in the text, but also to gum, sugar, and water, contained in the grain. But even assuming this to be the case, I suspect that both Vauquelin and Braconnot have underrated the glutinous or nitrogenous matter contained in rice. My suspicion does not rest merely on Mr. Jones's results, but also on Boussingault's statement of the quantity of nitrogen contained in rice.

and a serous or aqueous substance. By keeping it curdled, and subsequently underwent a peculiar kind of fermentation, evolving a smell somewhat like sour yeast. When fresh, it appeared to me well adapted for use as food; and I have a diabetic patient, in the London Hospital, now trying its effects. He uses it in the form of a baked pudding containing eggs. The only other vegetable food which he is permitted to take is cabbage. He has, however, a plentiful allowance of meat, cheese, milk, &c. On this regimen the quantity of urine passed in twenty-four hours has been reduced, in about ten days, from 11 pints to 3½. Its sp. gr., however, is but little changed.

The granule of rice starch is excessively small. According to Vauquelin this starch begins to dissolve in water when this liquid has attained a temperature of from 122° F. to 132° F. The same authority states that an infusion of rice contains a little phosphate of lime, which is held in solution by the starch. Vogel obtained 1·05 per cent. of oil from dried rice.

"Rice," says Marsden *, "is the grand material of food, on which an hundred million of the inhabitants of the earth subsist, and although chiefly confined by nature to the regions included between, and bordering on the tropics, its cultivation is probably more extensive than that of wheat, which the Europeans are wont to consider as the universal staff of life."

Rice, though nutritious, is less so than wheat: this is proved by chemical analysis, which shews the much smaller proportion of glutinous or nitrogenous matter

* *History of Sumatra*, p. 65, 3d ed. 1811.

found in the former than in the latter grain. "Rice," says Boussingault *, "is held up as a most nutritive food. But though I have lived long in countries which produce it, I am far from considering it as a substantial nourishment. I have always seen it, in ordinary use, replace bread; and when it has not been associated with meat, it has been employed with milk."

Rice is less laxative than the other cereal grains. Indeed, it is generally believed to possess a binding or constipating quality; and, in consequence, is frequently prescribed by medical men as a light, digestible, uninjurious article of food in diarrhœa and dysentery.

Various ill effects, such as disordered vision, &c., have been ascribed to its use †; but, as I believe, unjustly so. Neither does there appear to me to be any real foundation for the assertions of Dr. Tytler ‡, that malignant cholera (which he calls the *morbus oryzeus*, or *rice disease*) is induced by it.

Rice is employed as a nutriment in a variety of forms. *Mucilage of Rice*, obtained by boiling well-washed rice in water, contains both starch and phosphate of lime in solution. It is used as a demulcent in diarrhœa. *Rice-milk*, *rice-pudding*, &c., are other preparations of rice employed by invalids. *Rice-cakes* contain, besides flour, eggs, and sugar, about one-third of their weight of rice.

* *Ann. Chim. et Phys.* lxvii. p. 413.

† Bontius, *Account of the Diseases, Natural History, &c. of the East Indies*, translated into English, 1769. Also, Bricheteau, in Tortuelle's *Elém. d'Hygiène*, 4^me éd.

‡ *Lancet*, 1833-34, vol. i.

6. *Maize* or *Indian Corn*.—This is the produce of the plant called by botanists the *Zea Mays*. Its composition, according to the analyses of Dr. Gorham and Bizio, is as follows:—

COMPOSITION OF MAIZE OR INDIAN CORN.

1. *Dr. Gorham's Analysis.*

	Common State.	*Dried.*
Starch *	77·0	84·599
Zeïne	3·0	3·296
Albumen	2·5	2·747
Gummy matter	1·75	1·922
Saccharine matter	1·45	1·593
Extractive matter	0·8	0·879
Cuticle and ligneous fibre	3·0	3·296
Phosphate, carbonate, and sulphate of lime, and loss	1·5	1·648
Water	9·0	0
	100·0	99·98

2. *Bizio's Analysis.*

Starch		80·920
Zeïne	Fatty oil	1·152
	Gliadine	2·499
	Zimome	2·107
Zimome		0 945
Fatty oil		0·323
Extractive matter and sugar		1·987
Gum		2·283
Hordein		7·710
Acetic acid, salts, and loss		0·074
		100 000

MM. Dumas and Payen procured 9 per cent. of yellow oil from maize †; but Liebig ‡ was able to obtain only 4·25 per cent. This oil consists, according to Fresenius, of *carbon* 79·68, *hydrogen* 11·53, and *oxygen* 8·79.

* The substance sold, under the name of *Indian Corn Starch*, in the London shops, is Potato Starch.

† See *ante*, p. 176.

‡ *Annalen der Chemie und Pharmacie*, Bd. xlv. S. 126. 1843.

In America, Asia, and some parts of Europe, maize is extensively used for human existence. "Like the farina of the wheat," says Dr. Dunglison*, "it is formed into bread, alone or with various additions,—as milk, eggs, &c. It is a wholesome and nutritious aliment, but with those who are unaccustomed to its use it is apt to produce diarrhœa; in consequence, probably, of the presence of the husk, with which it is always more or less mixed, in the state in which it is brought to market. It is on this account that it has been regarded as a bread but little adapted for those liable to, or labouring under, bowel affections, or in times when a choleric predisposition exists." The same author further adds †, that "the young grains, constituting the 'roasting ears,' make a delicious vegetable, ready for the table, too, after the season for green peas has gone by. When very young, corn in this state is in its most digestible condition, the husk being comparatively tender; but when old, a considerable part of the grain withstands the digestive operation, and passes through the bowels unchanged. It need hardly, therefore, be added, that where bowel affections are rife, this vegetable ought to be used with caution. Corn meal, mixed with cheese, and baked into a kind of pudding, forms the dish which the Italians call *polenta* ‡."

b. Leguminous Seeds.—Of the Leguminous Seeds

* *Elements of Hygiène*, p. 289. 1835

† Ibid. p. 294.

‡ The substance sold in the London shops under the name of *Polenta* is the meal of Indian corn.

the best known in this country are Peas and Beans; but on the continent, and in eastern countries, Lentils are in common use. Their composition, as determined by Einhof, is as follows :—

COMPOSITION OF LEGUMINOUS SEEDS.

	Peas (*Pisum sativum*).	*Garden Bean** (*Vicia Faba*).	*Kidney Bean†* (*Phaseolus vulgaris*).	*Lentils* (*Ervum Lens*).
Starch	32·45	34·17	35·94	32·81
Amylaceous fibre	21·88	15·89	11·07	18·75
Legumine (*Caseine*)	14·56	10·86	20·81	37·32
Gum	6·37	4·61	19·37	5·99
Albumen	1·72	0·81	1·35	1·15
Sweet Extractive matter	2·11	3·54	3·41	3·12
Membrane	—	10 05	7·50	—
Water	14·06	15·63	(dried)	
Salts	6·56	3·46	0·55	0·57
Loss	0·29	0·98	—	0·29
	100·00	100·00	100·00	100·00

Peas, Beans, and Lentils, have been submitted to ultimate analysis by Boussingault‡ and by Playfair.§

ULTIMATE COMPOSITION OF LEGUMINOUS SEEDS.

	Peas. *Playfair.*	*Peas* (dried in vacuo at 230° F.) *Boussingault.*	*Beans.* *Playfair.*	*Lentils.* *Playfair.*
Carbon	35·743	46·5	38·24	37·38
Hydrogen	5·401	6·2	5·84	5·54
Nitrogen } Oxygen }	39·366	40·0 / 4·2	38·10	37·98
Ashes	3·440	3·1	3·71	3·20
Water	16·000	0·0	14·11	15·90
	100·000	100·0	100·00	100·00

* This species is commonly known as *broad bean*, or *Windsor bean*.

† The *common dwarf kidney bean*, the *haricot* of the French, is commonly termed *French bean*. It is a distinct species from the *scarlet bean* (*Phaseolus multiflorus*).

‡ *Mémoires de l'Académie Royale des Sciences*, t. xviii. p. 345. 1824.

§ Liebig's *Animal Chemistry*.

Liebig assumes, that the average amount of carbon in peas, beans, and lentils, in the state in which they are used, is 37 per cent.; an assumption sufficiently near the truth for all practical purposes.

The quantity of nitrogen contained in these leguminous seeds is larger than that found in the cereal grains; so that if the nutritive quality of vegetables was in proportion to the nitrogen which they contain, these seeds would be more nutritive than wheat; and, accordingly, in Boussingault's scale of nutritive equivalents, their nutritive equivalent is lower, or, in other words, their nutritive quality is assumed to be higher than that of wheat (see *ante*, p. 55). For

44 parts of horse beans, or 56 parts of white haricots, or 57 parts of lentils, or 67 parts of peas,	are said to be equivalent to	100 parts of wheat-flour.

Experience, however, by no means confirms these theoretical conclusions; and Liebig, therefore, offers the following explanation of the want of relation between their nutritive quality and the proportion of nitrogen which they contain. "The small quantity of phosphates which the seeds of the lentils, beans, and peas contain," says Liebig *, "must be the cause of their small value as articles of nourishment, since they surpass all other vegetable food in the quantity of nitrogen which enters into their composition. But as the component parts of the bones (phosphate of lime and magnesia) are absent, they satisfy the appetite without increasing the strength."

* *Chemistry in its Application to Agriculture and Physiology*, p. 147, 3d ed.

I have already (see p. 55) remarked, that were this hypothesis correct, the addition of bone-ashes (earthy phosphates) ought to add greatly to the nutritive powers of the leguminous seeds, and would, in fact, render them much more nutritious than the cereal grains.

Peas and beans are very apt to occasion flatulence, and even colic; and their difficult digestibility augments with their age; for when very young they are sweet, and more digestible, but less nourishing. They are usually regarded as being stimulating or heating *, and, on that account, unfit for febrile and inflammatory cases.

c. Seeds of Cupuliferæ.—The principal cupuliferous seed used in this country as food is the Chestnut (*Castanea vesca*). It possesses considerable nutritive power, and in Lombardy is used as food by the lower classes. Its sweetness, especially when roasted, indicates the presence of sugar. No oil can be obtained from it by pressure. In the raw state, it is very difficult of digestion: it requires to be cooked (roasted) to split the starch grains which it contains, and thereby to render them readily digestible. Dyspeptics should carefully avoid chestnuts, even in the cooked state.

2. Oily Seeds.—To this division belong the Almond, the Walnut, the Hazel nut, the Cashew-nut, the Pistachio-nut, the Stone-Pine-nut (Pignoli-Pine), and the Cocoa-nut. These contain vegetable albumen and caseine, on which their nutritive qualities

* Beans are believed, by veterinarians, to possess a stimulating influence over the horse.

principally depend. They also contain a quantity of fixed oil, which renders them very difficult of digestion; and unfit for dyspeptics and others who have a delicate stomach.

The *Almond* (both sweet and bitter) is the produce of the *Amygdalus communis.*

BOULLAY AND VOGEL'S ANALYSES OF SWEET AND BITTER ALMONDS.

Boullay's Analysis.		*Vogel's Analysis.*	
Fixed oil	54·0	Volatile oil and hydrocyanic acid	*Quantity undetermined.*
Emulsion	24·0	Fixed oil	28·0
Liquid sugar	6·0	Emulsin	30·0
Gum	3·0	Liquid sugar	6·5
Seed-coats	5·0	Gum	3·0
Woody fibre	4·0	Seed-coats	8·5
Water	3·5	Woody fibre	5·0
Acetic acid and loss	0·5	Loss	19·0
Sweet almonds	100·0	Bitter almonds	100·0

Sweet almonds are nutritive and emollient, but, on account of their fixed oil, difficult of digestion, at least when taken in large quantities, or by persons whose digestive powers are weak. When rancid they are still more apt to disorder the stomach. The husk or pellicle of the almond has been known to occasion nausea, uneasiness in the stomach and bowels, increased heat, œdematous swelling of the face, followed by nettle-rash. Dr. Winterbottom * suffered twice in this way from the use of unblanched sweet almonds; but blanched almonds caused him no inconvenience. Almonds are employed as a dessert, and in puddings,

* *Medical Facts and Observations,* vol. v. p. 60.

cakes, &c. For table use they should always be blanched, on account of the injurious qualities of the husk.

Bitter almonds are more or less poisonous to all classes of animals. They contain neither volatile oil nor prussic acid,* though they yield both these substances when submitted to distillation with water; but they contain a peculiar crystallizable principle, called *Amygdalin,* whose composition is $C^{40} H^{27} N O^{22}$. Now, when bitter almond cake is submitted to distillation, with water, the amygdalin suffers decomposition by the united agencies of the emulsin (of the seed) and the water, and yields hydrocyanic acid, volatile oil of bitter almonds, sugar, formic acid, and water.

PRODUCTS OF THE DECOMPOSITION OF AMYGDALIN BY EMULSIN.

	Atoms of *Carbon*	*Hydrogen*	*Nitrogen*	*Oxygen*
1 atom of Hydrocyanic Acid	2	1	1	0
2 atoms Volatile Oil of Bitter Almonds	28	12	0	4
1 atom of Sugar	6	5	0	5
2 atoms of Formic Acid	4	2	0	6
7 atoms of Water	0	7	0	7
1 atom of Amygdalin	40	27	1	22

When bitter almonds are chewed, the moisture of the mouth and the emulsin of the seeds effect the decomposition of the amygdalin, and the formation of prussic acid and volatile oil; and the poisonous operation of the seeds depends on the prussic acid. The smaller animals, as dogs, pigeons, &c. are readily

* For the facts in proof of the accuracy of this statement, see my *Elements of Materia Medica,* vol. ii., p. 1535.

destroyed by them. One drachm has killed a pigeon, and twenty seeds have destroyed a dog. On man they frequently prove injurious even in small doses, while, in large ones, they are highly deleterious. In some persons, nausea, vomiting, and purging, are readily caused by them. On the late Dr. Gregory* they produced first sickness, generally tremors, then vomiting, next a hot fit, with an eruption of nettle-rash, particularly on the upper part of the body. At the same time the face and head swelled very much, and there was a general feeling like intoxication. The symptoms lasted only a few hours. The rash did not alternately appear and disappear, as in common nettle-rash.

When eaten in large quantities, bitter almonds have caused serious and even fatal consequences. Pierer states that three children, having taken some of these seeds, were attacked in a few minutes with nausea, vomiting, loss of consciousness and of speech, and convulsions; and Mr. Kennedy has noticed the case of a stout labourer who died after the use of a large quantity of them. These, and other observations referred to by Wibmer, Cullen, and others, prove that the poisonous effects of the bitter almond are similar to those of prussic acid, on the developement of which, in fact, their activity depends. *Macaroons* and *Ratafia* cakes, as well as *Noyau*, which owe their peculiar flavour to these

* Dr. Christison's *Treatise on Poisons*.

seeds, likewise prove injurious when taken in large quantities.

The *volatile oil of bitter almonds* (frequently sold in the shops as *essence of bitter almonds*) is a most potent poison, being in general four times as powerful as the prussic acid kept in chemists' shops. A single drop of it will kill a cat in a few minutes. Sir Benjamin Brodie happening to touch his tongue with a probe which had been dipped in it, suffered, almost instantaneously, an indescribable sensation at the pit of the stomach, feebleness of the limbs, and loss of power over the muscles. These effects were, however, quite transient. A few years ago, a lady, in Aldersgate-Street, London, was accidentally killed by it. She sent to a chemist's shop for *beech* nut oil, to destroy worms, and the person in the shop, mistaking the inquiry for *peach* nut oil, served her with oil of bitter almonds, of which she took half an ounce, by which she lost her life. An hypochondriacal gentleman, 48 years old, swallowed about two teaspoonfuls of the oil, and in a few minutes after was found by his servant lying in bed, with his features spasmodically contracted, his eyes fixed, staring, and turned upwards, and his chest heaving convulsively and hurriedly. A physician, who entered the room twenty minutes after the draught had been taken, found him quite insensible, the pupils immoveable, the breathing stertorous and slow, the pulse feeble, and only thirty in a minute, and the breath exhaling strongly the odour of bitter almonds. Death ensued ten minutes afterwards. With these facts before us, it is, I conceive, highly improper for ignorant persons to employ it; yet it is extensively used by cooks and confectioners for flavouring!

ORDER II. FLESHY FRUITS.

A very considerable number of fleshy or succulent fruits are employed as food. Of these, however, it is intended to notice only such as are in most frequent use in this country.

1. Drupaceous or Stone Fruits. — These are called by botanists *Drupes*. They contain one or two seeds (popularly termed the *kernels*) contained in a bony endocarp, commonly called the *stone*, on the outside of which is a soft fleshy mesocarp or sarcocarp (usually known as the *pulp* or *flesh* of the fruit), which is covered by the membranous epicarp (generally denominated the *skin*).

From the *Almond tribe* are obtained several drupes in common use in this country. Such are the Peach, the Nectarine, the Apricot, the Plum, and the Cherry. They are usually regarded as difficult of digestion; and the popular opinion is probably the correct one, for Dr. Beaumont found that from six to ten hours were required for the artificial digestion of peaches. They are sometimes eaten with the view to open the bowels. When taken too freely they are apt to disorder the digestive organs, and to occasion griping and relaxation.

The following is the composition of several of these fruits, according to Berard *.

* *Ann. de Chimie et de Physique.* 1821.

COMPOSITION OF DRUPACEOUS FRUITS OF THE ALMOND TRIBE.

	Apricot.		*Green-gage (Reine Claude).*		*Peach (d'Ete).*		*Cherries (Royales).*	
	Unripe.	*Ripe.*	*Unripe.*	*Ripe.*	*Unripe.*	*Ripe.*	*Unripe.*	*Ripe.*
Nitrogenous matter	0·76	0·17	0·45	0·28	0·41	0·93	0·21	0·57
Colouring matter..	0·04	0·10	0·03	0·08	0·27	"	0·05	"
Lignine	3·61	1·86	1·26	1·11	3·01	1·21	2·44	1·12
Gum..............	4·10	5·12	5·53	2·06	4·22	4·85	6·01	3·23
Sugar	traces	16·48	17·71	24·81	0·63	11·61	1·12	18·12
Malic acid	2·70	1·80	0·45	0·56	1·07	1·10	1·75	2·01
Lime..............	very small quantity	very small quantity	traces	traces	0·08	0·06	0·14	0·10
Water	89·39	74·87	74·57	71·10	90·31	80·24	88·28	74·85
	100·60	100·40	100·00	100·00	100·00	100·00	100·00	100·00

In these analyses, however, no mention is made of vegetable jelly (pectine or pectic acid), which, as I have before stated (see p. 141), is always a constituent of these fruits; but it is probable that, in the above table, it is included under the denomination of gum.

The highly palatable flesh of the *Peach* is slightly nutritious from the nitrogenous matter, sugar, gum, and pectine, which it contains, while the malic acid renders it cooling. Both in the fresh and preserved state it is employed as a delicious dessert. Its use is objectionable in gouty persons, and in those whose bowels are easily disordered. When stewed with sugar it may be given as a mild laxative to convalescents.

The *Nectarine* differs from the Peach in having a smooth skin. This trivial distinction has led many botanists to regard it as a distinct species.

Gardeners cultivate several hundred sorts of the *Plum* (*Prunus domestica*). De Candolle admits the following as distinct varieties.

α. *Armenioïdes*, including the *Mirabelle Plum.*
β. *Claudiana*, including the *Green Gage.*
γ. *Myrobalana*, including the *Myrobalan Plum.*
δ. *Damascena*, including the *Damask Plum.*
ε. *Turonensis*, including the *Orleans Plum.*
ζ. *Juliana*, including the *Officinal Prune.*
η. *Catharinea*, including the *St. Catharine Plum.*
θ. *Aubertiana*, including the *Magnum Bonum*, or *Mogul Plum.*
ι. *Pruneolina*, including the *Damson.*

Dried plums, called *prunes*, are prepared in warm countries by drying the plums on hurdles by solar heat; but in colder climates artificial heat is employed. In France both methods are adopted; the fruit being exposed to the heat of an oven, and to that of the sun, on alternate days. *Table prunes* are prepared from the larger kinds of plum,—as the Saint Catherine and the Reine-Claude (Green Gage): *Medicinal Prunes* from the Saint Julien. The former has an agreeable, very sweet taste; the latter are somewhat austere. They are principally imported from Bourdeaux. The edible part is the *pulp*.

Fresh ripe plums, taken in moderate quantity, are wholesome and nutritive; but when eaten freely are apt to disorder the bowels; an effect more readily excited by the unripe fruit. The medicinal prune is slightly laxative. The finer kinds of plums are employed at the table as a delicious dessert: the inferior qualities are used in pies, tarts, conserves, and sweetmeats. The larger prunes are eaten at table as a dessert. The medicinal prunes form an agreeable and mild laxative for children, and during convalescence from febrile and inflammatory disorders.

The *Cherry* possesses dietetical properties similar to those of the plum. In the unripe state it readily disorders the bowels.

The stones of all these drupaceous fruits should not be swallowed, as they are apt to cause intestinal obstruction. I have known fatal enteritic inflammation produced by the accumulation of cherry-stones in the appendix cæci. The kernels or seeds yield, like the almond, prussic acid.

The *Olive* is a drupaceous fruit, which when ripe is remarkable for its sarcocarp abounding in a bland fixed oil (see *Olive Oil*, p. 178). *Olives farcies à l'huile* are sometimes imported. The *preserved* or *pickled olives*, admired, by most persons, as a dessert, are the green unripe fruit, deprived of part of their bitterness by soaking them in water, and then preserved in an aromatised solution of salt. Several varieties are met with in commerce, but the most common is the *small French olive* and the *large Spanish olive*. *Olives à la picholine* have been soaked in a solution of lime or alkali. Pickled olives are employed at the table to excite the appetite for, as well as to improve the flavour of, wine. They are also used in some sauces.

The *Date* is a drupaceous fruit, of vast importance in the East, for a considerable portion of the inhabitants of Egypt, Arabia, and Persia, subsist in great part on it. It is the produce of the date palm, or *Phœnix dactylifera* of botanists. Dates have been recently analysed by Reinsch *, who gives the following as their constituents:—

* *Pharmaceutisches Central-Blatt für* 1840, p. 400.

COMPOSITION OF DATES.

Flesh.		*Kernel.*	
Uncrystallizable sugar	58·0	Fibre	39·6
Pectin	8·9	Gummy matter	36·4
Pectinaceous gum	3·4	Gum and mucus	2·5
Bassorine	4·1	Epidermis (albumen)	0·6
Fatty oil	0·2	An astringent acid (catechuic?)	7·1
Wax	0·1	Stearine	0·5
Fibre, with traces of colouring matter and tannic acid	2·3	Oleine	0·3
Water	24·0	Water	13·0
	101·0		100·0

It is obvious from this analysis that sugar is the leading alimentary constituent of this fruit. In this country dates are used principally as condiments.

2. Pomaceous Fruits or Apples.—These are the produce of the sub-order *Pomeæ* of Rosaceous plants. The edible or pulpy portion of the fruit is the sarcocarp or fleshy mesocarp, which is covered on the outside by a membranous epicarp (commonly called the *peel* or *skin*), and lined on the inner side by a cartilaginous endocarp (the *core*) inclosing the seed. Apples, Pears, and Quinces, are familiar examples of this division of fruits. The following are the results of Berard's analysis of the Jargonelle pear.

COMPOSITION OF JARGONELLE (CUISSE-MADAME).

	Unripe.	*Ripe.*	*Rotten.*
Nitrogenous matter	0·08	0·21	0·301
Colouring matter	0·08	0·01	resin soluble in alcohol 0·058
Lignine	3·80	2·19	2·534
Gum	3·17	2·07	3·400
Sugar	6·45	11·52	11·417
Malic acid	0·11	0·08	0·786
Lime	0·03	0·04	traces
Water	86·28	83·88	81·500
	100·00	100·00	99·99

No mention is here made of vegetable jelly (pectine or pectic acid) which the author included, I presume, under the head of gum.

Apples and *Pears* are very agreeable fruits, but they are not in general regarded as easy of digestion; and apples, being of a much firmer texture, are believed to be more slowly digested than pears. "In the case of a dyspeptic stomach," says Dr. Cullen, "I have known apples, a long time after they had been taken down, brought up again by eructation in the same masses they had been swallowed, and that even after two days." Dr. Beaumont's experiments, however, by no means confirm ordinary experience, for they appear to show that apples, even when raw, are readily digestible.

DIGESTIBILITY OF APPLES.

Articles of Diet.	*Mean Time of Chymification.*					
	In Stomach.			*In Phials.*		
	Preparation.	*H.*	*M.*	*Preparation.*	*H.*	*M.*
Apples, sweet, mellow,	Raw	1	30	Masticated	6	45
" sour, mellow,	"	2	0	Masticated	8	30
" sour, hard	"	2	50	Entire pieces	18	0
Apple dumpling	Boiled	3	0			

Both apples and pears are occasionally eaten to move the bowels. *Roasted apples* are much easier of digestion than raw apples. They gently promote relaxation of bowels; and are, therefore, used by persons troubled with habitual constipation.

The *Quince* is not eatable in its raw state; but stewed in pies or tarts, along with apples, it is much esteemed. The expressed juice is cooling and astringent. An excellent marmalade (see p. 144) and syrup are prepared from the quince by the confectioner. Quince seeds abound in mucilage.

3. Baccate or Berried Fruits. *Berries.*—To this division belong the Currant, the Gooseberry, the Cranberry, the Elderberry, and the Grape; the eatable part of which is the pulp. The epicarp (commonly called *skin* or *husk*) and the seeds are indigestible, and should not be swallowed. The pulp, when freely eaten, slightly relaxes the bowels. In the unripe states these fruits readily disorder the alimentary canal, and occasion griping.

The juice of *Red Currants* has, according to Proust, the following composition:—

COMPOSITION OF RED CURRANT JUICE.

Citric Acid,
Malic Acid,
Sugar,
Vegetable Jelly,
Gum,
Extractive.

These fruits are very agreeable and cooling, and are eaten both raw and in tarts. A jelly and a jam are prepared from them (see pp. 144, 145).

The constituents of *Black Currants* are similar to those of red currants, with the addition of a *peculiar volatile principle* and *a violet-colouring matter.* A jelly (see p. 144), a jam (see p. 145), a paste, and *fruit lozenges,* are made from them. These different preparations are employed in febrile and inflammatory cases, and are in particular request in hoarseness and affections of the throat.

Gooseberries have been analysed by Berard. Their composition is as follows:—

COMPOSITION OF GOOSEBERRIES.

	Unripe.	Ripe.
Nitrogenous matter	1·07	0·86
Colouring matter	0·03	"
Lignine and seeds	8·45	8·01
Gum	1·36	0·78
Sugar	0·52	6·24
Malic acid	1·80	2·41
Citric acid	0·12	0·31
Lime	0·24	0·29
Water	86·41	81·10
	100·00	100·00

In their general properties they agree with currants. Their husks are indigestible, and should not be swallowed. In the unripe state, gooseberries are apt to gripe, and otherwise disturb the bowels.

The *Cranberry* is usually eaten when baked; and in this way proves an agreeable, and, in general, harmless fruit.

The juice of the *Elderberry* contains malic acid, a little citric acid, sugar, pectin, and colouring matter. The inspissated juice, (*elder rob*) diluted with water, forms a cooling beverage in febrile and inflammatory disorders. The berries are principally employed in the preparation of elder wine.

The *Grape* is one of the most valuable and esteemed of fruits. Considered with regard to shape and colour, the different varieties may be thus arranged:—

1. *Round, dark-red, purple, or black grapes.*—This division includes a considerable number of sorts. The grapes from which port wine* is procured belong to

* In September, 1842, my friend Mr. Gassiot, of the firm of Martinez,

this division. The *black Muscardine*, common on dwelling-houses about London, come under this head. The most remarkable variety of this division is the *black Corinthian grape*, which, when dried, constitutes the *currant* of the grocer. This was formerly produced at Corinth (whence its name), but it is now grown at Zante, Cephalonia, Patras, &c. At Zante the grapes are gathered in August, disposed in couches on the ground to dry, cleaned, and laid up in magazines (called *seraglios*), where they eventually adhere so firmly as to require digging out. They require

---

Gassiot, and Co., of Mark Lane, London, showed me sixteen sorts of grapes which had been sent by their agent at Oporto as the grapes yielding port wine. They were all round, dark, and rather small. Those numbered "2" and "16" were the largest berries, and also formed the largest bunches; while "7" and "14" were the smallest. I subjoin the list of grapes, with the names and remarks, as sent by Messrs. Martinez and Gassiot's Oporto agent :—

" LIST OF THE GRAPES, AS SHIPPED.

No. 1.	*Tinta Francisca*	Dark coloured wine.
2.	*Touriga*	Full bodied.
3.	*Tinta amarella* }	Good.
7.	" *Cão* . . }	
4.	" *grossa*	Give abundance, but not of the best.
5.	*Bastardo*	Rich.
6.	*Alvarelhão*	Good flavour, but little colour.
8.	*Negrão.*	
9.	*Mourisco preto*	Body and flavour.
10.	*Castillôa.*	
11.	*Souzão*	Gives the darkest coloured, but in general bad wine.
12.	*Donzelinho do Castello* . . .	Very little colour, and not the best wine.
13.	*Tinta da Lameira*	Colour and flavour.
14.	*Bastardeira*	Good wine.
15.	*Moretto.*	
16.	*Noveira*	Gives abundance of wine, but of the worst quality: has the name of the '*Poor Man's Wine.*'"

eight, ten, or fourteen days for drying. For exportation they are trod in barrels. They form one of the constituents of the well-known national dish, *plum pudding*.

2. *Oval, dark-red, purple, or black grapes.*—To this division belong the *black* and *purple Hamburgh grapes*.

3. *Round and white grapes.*—Of this there are several sorts.

4. *Oval and white grapes.*—The *Portugal grape* comes under this division. It is imported, packed in saw-dust, and contained in earthen jars, from Portugal and Spain. The berries are large, fleshy, sweet, and slightly acidulous. They keep a long time after they have ripened.

5. *Red, rose-coloured, grayish, or striped grapes.*—Of this there are several sorts.

The juice of both unripe and ripe grapes has been examined by several chemists. The following are the most important results :—

COMPOSITION OF GRAPE JUICE.

Juice of the Unripe Grape.		*Juice of the Ripe Grape.*	
Proust.	*Geiger.*	*Proust.*	*Bérard.*
Extractive. Malic acid, a little. Citric acid, much. Bitartrate of potash. Sulphate of potash. Sulphate of lime.	1. *Deposit from the juice.* { Wax. Chlorophylle. Tannin. Glutinous matter. 2. *Filtered juice.* { Tannin. Extractive. Sugar (uncrystallizable). Gallic acid. Tartaric acid (free) about 1·12 per cent. Malic acid (free) about 2·19 per cent. Bitartrate of potash. Malate, phosphate, sulphate, and muriate of lime.	Extractive. Sugar (granular and uncrystallizable). Gum. Glutinous matter. Malic acid, a little. Citric acid, a little (tartaric, *Braconnot*). Bitartrate of potash.	Odorous matter. Sugar. Gum. Glutinous matter. Malic acid. Malate of lime. Bitartrate of potash. Supertartrate of lime.
Unripe Grape juice.	Juice of White Grape of good quality.	Ripe Grape juice.	Ripe Grape juice.

The composition of *grape sugar* (called also *granular sugar* or *glucose*) has been already stated (see p. 113). The *bitartrate of potash* contained in grape juice deposits, along with colouring and other matters, from wine, and forms what are termed *crude tartar* or *argol*, and the *crust of wine*. Crude tartar, when purified and deprived of colouring matter, constitutes *cream of tartar*, from which *tartaric acid* is obtained (see p. 153).

Grapes when dried are called *Raisins*. In Granada the finest kinds of raisins, viz. the *Muscatels* and the *Blooms*, are sun-dried; while the *Lexias* (so called from the liquor in which they are immersed), are dipped in a mixture of water, ashes, and oil, and afterwards sun-dried. By this treatment the juice exudes and candies on the fruit. The raisins of Valentia are prepared by steeping them in boiling water, to which a lye of vine stems has been added. The alkaline solution serves to remove the waxy coat which checks the drying of the berry. The varieties of raisins known in the market are distinguished partly from their place of growth, as *Valentias* and *Smyrnas;* partly from the variety of grape from which they are prepared, as *Sultanas*, *Blooms*, and *Muscatels;* and partly from the mode of curing them, as *Raisins of the Sun*. Muscatels are the finest: Sultanas are stoneless. The raisins of Malaga are of three kinds: 1st, *Muscatels;* 2dly, *Sun* or *Bloom Raisins;* and 3dly, *Lexia Raisins*.

The *small or Corinthian raisins* (called, by grocers, *currants*) have been already noticed (see p. 352).

Fresh grapes, when ripe, are wholesome, nutritious, refrigerant, and, when taken freely, diuretic and laxative; but the skin and the seeds are indigestible, and should be rejected. In the alvine discharges of children who have eaten plum pudding, the currants (black Corinthian raisin) will be found almost entirely undigested. "I think we may assert," says Dr. Cullen, "that grapes which contain a large quantity of sugar, are, if taken without their husks, the safest and most nutritive of summer fruits." They are used at table as a dessert, and in febrile and inflammatory complaints as a very agreeable fruit, which allays thirst, and checks febrile heat. In the inflammatory form of dyspepsia (called by Sir James Clark and others gastritic dyspepsia), and in pulmonary affections, ripe grapes are eaten in considerable quantities, in Switzerland and other parts of the continent, occasionally with considerable benefit, and forming what is called the "*Cure de Raisins*." It deserves consideration how far the bitartrate of potash, contained in grapes, may contribute to the beneficial effect. For this salt, like the other vegetable alkaline salts, is converted, in the system, into an alkaline carbonate at the expense of atmospheric oxygen (see pp. 28-29). In tubercular phthisis the system manifests no want, but rather redundancy, of oxygen. May not the bitartrate, in such cases, prove useful by appropriating to itself a portion of oxygen? If so, in bronchitis with a purple tint the same treatment would prove injurious, as there is a manifest deficiency of oxygen in the system.

Raisins are somewhat more nutritive and less refrigerant then fresh grapes; for they abound more in sugar and less in acid. If eaten freely they are apt to disorder the digestive organs and cause flatulence. They are employed at the table as a dessert, and are used in various articles of pastry.

4. THE ORANGE OR AURANTIACEOUS FRUITS. — These fruits, called by botanists the *Hesperidium* or *Aurantium*, are the produce of the genus *Citrus*: they are the Orange, the Lemon, the Lime, the Citron, and the Shaddock. Their rind is leathery or spongy: the external portion, called *flavedo* or *zeste*, is yellow, and contains a volatile oil lodged in rounded or vesicular receptacles. The acid juice of the fruit is lodged in small pulpy bags, which are readily separated from each other.

Lemons are imported from Spain, Portugal, Italy, and the Azores. Their *rind* contains a volatile oil (*essence of lemons*), a bitter principle (*aurantiin*), and a peculiar crystalline substance (*hesperidin*). It is a grateful aromatic and stomachic, and is used as a flavouring substance. *Candied lemon peel* is an agreeable stomachic, and is employed as a dessert, and in confectionery. *Lemon Juice* is a slightly turbid, very sour liquid, with a grateful flavour. Owing to the mucilaginous matter which it contains, it readily becomes mouldy, and suffers decomposition. Its constituents, according to Proust, are as follows:—

COMPOSITION OF LEMON JUICE.

Citric acid.
Malic acid.
Gum.
Bitter extractive.
Water.

The relative proportions of these ingredients vary somewhat according to the degree of ripeness of the fruit. One fluidounce (two table-spoonfuls) of good juice is equal to thirty-two grains of crystallized citric acid, and saturates about 45½ grs. of bicarbonate of potash. Lemon juice furnishes a most agreeable and refreshing beverage, and proves refrigerant and antiscorbutic. It may be either added to barley water, or mixed with sugar and water to form *Lemonade* *. The latter may be extemporaneously made, by adding two lemons sliced, and two ounces of sugar, to two pints of boiling water, and digesting until cold. A somewhat similar beverage has been denominated *King's Cup*. These acidulated drinks are exceedingly useful for allaying thirst, and as refrigerants in febrile and inflammatory complaints, and in hemorrhages. In the latter maladies *iced lemonade* is to be preferred. When there is nausea or a tendency to sickness, *effervescent lemonade* is useful.

Lemon juice has long been justly regarded as a valuable antiscorbutic; but on account of the difficulty of preserving it, a solution of crystallized citric acid is often substituted. Experience, however, has proved that it is inferior to the recent juice. Even the con-

* "Lemonade, as a beverage in putrid diseases, was first introduced by the French physicians in the beginning of the seventeenth century; and about the year 1660, an Italian, from Florence, having learnt the process of freezing confectionary, conceived the happy idea of converting such beverage into ice. This found a ready sale, and was the occasion of so great an increase in the number of sellers of lemonade, that in the year 1676 the *Limonadiers* of Paris were formed into a company, and received a patent from government." (Dr. Paris, *Pharmacologia*).

centrated juice is not equal to the fresh fruit. Hence Sir Gilbert Blane suggested that the juice should be preserved by the addition of a little spirit, without the employment of heat; and this plan is usually followed.

Lemon juice is not an infallible specific for scurvy, as Sir Gilbert Blane and some others have supposed; for occasionally the malady rages despite of the copious use of it *.

* The following extract from Dr. Johnson's *Medico-Chirurgical Review*, for 1824, serves to illustrate the statement in the text :—

" *Lemon Juice in Scurvy.*—It has long been known to many intelligent observers that salt provisions are not the only cause of scurvy, and that lemon juice is by no means an infallible cure for the disease, however induced, notwithstanding the evidence of Sir Gilbert Blane, so positively advanced to the contrary. In support of our position, we shall here bring forward an abstract from an official document of unquestionable authenticity and recent occurrence.

In the year 1822, his Majesty's ship Leander sailed from Trincomalee for the Cape of Good Hope, taking on board the mechanics of the Dock Yard establishment, then reduced on the island. There were also embarked twenty-six invalids, and all the sick that could be removed from the hospital. These invalids and sick were principally affected with chronic hepatitis, dysentery, and phthisis pulmonalis, all of which (even some who were expectorating large quantities of purulent matter) recovered on the passage to the Cape. This good fortune was counterbalanced by scurvy, which broke out among the crew, and in spite of large quantities of lemon-juice plentifully administered, in conjunction with every other antiscorbutic which the ship could produce, spread to an alarming extent, and in one case proved fatal. Had they not reached the Cape at the time they did, the Leander would have presented as deplorable a spectacle as the Anson [Centurion], at Juan Fernandez, notwithstanding the supposed infallible specific, *lemon juice*, which, in no instance, on board the Leander, had the slightest effect in even checking the ravages of the scurvy. Immediately the ship reached the Cape, and the crew got plenty of *animal* food in conjunction with vegetables, they rapidly recovered (see Mr. Bampfield's remarks on the subject, in his valuable work on Tropical Dysentery). Specimens of the lemon-juice used were transmitted to the Victualling Board, and carefully analysed in London. It was found to be perfectly good."

The properties and uses of the *Lime* are similar to those of the Lemon. Lime juice contains the same ingredients as lemon juice, but in somewhat different proportions.

The *Common* or *Sweet Orange* is a most delicious fruit. Its juice has the following composition :—

COMPOSITION OF ORANGE JUICE.

Citric Acid.
Malic Acid.
Mucilage.
Albumen.
Sugar.
Citrate of Lime.
Water.

The proportions, however, vary with the degree of ripeness of the fruit. The juice of the ripe orange is a refreshing and grateful beverage, and is extensively used at the table. In febrile and inflammatory complaints it is a valuable refrigerant; allaying thirst and diminishing preternatural heat. The orange, when unripe, is very apt to cause griping; but when quite ripe, is rarely inadmissible: the seeds (called pips) and rind, however, should be rejected. Orange peel is used as a flavouring agent. It is an agreeable stomachic.

The *Citron* is seldom brought to the table in the raw state, but it yields some excellent preserves and sweetmeats. The juice is employed to flavour punch and negus. It forms, with sugar and water, a refreshing refrigerant beverage. *Candied Citron peel* is a favourite condiment and sweetmeat.

The *Seville Orange* has a rough, sour, and somewhat bitter juice, which is used by the cook to flavour jellies, and for other purposes. The peel of the Seville orange, and also the small dried green fruits (*Orangettes* or *Curaçoa Oranges*) of both the Seville and Sweet oranges, are employed for flavouring the liqueur termed *Curaçoa* (p. 165) and other substances. *Candied orange peel* is used as a condiment.

5. CUCURBITACEOUS FRUITS; PEPONES; GOURDS.—Those cucurbitaceous fruits which are employed for alimentary purposes contain a pulpy, aqueous, sweet or somewhat acidulous, refreshing flesh, which, though agreeable to the palate, is difficult of digestion, and when eaten freely, relaxes the bowels, and sometimes occasions griping pain. It yields but little nutritive matter, and readily disagrees with the dyspeptic. Pepper is eaten with several of them with the view of assisting their digestion, and preventing any injurious effect on the stomach.

The *Cucumber* is the most commonly employed, and, therefore, the best known fruit of this order. Its constituents, according to John, are as follows :—

COMPOSITION OF THE GREEN CUCUMBER.

The Peeled Fruit.		*The Fresh Peel.*	
Sugar and extractive	1·66	Solid matters (similar to those of the peeled fruit, but containing much fungus-like matter)	15
Chlorophylle	0·04	Water	85
Odorous matter	?		100
Fungus-like membrane (lignin ?) with phosphate of lime	0·53		
Soluble albumen	0·13		
Mucus with free phosphoric acid, an ammoniacal salt, malate, phosphate, sulphate, and muriate of potash, and phosphate of lime and iron	0·50		
Water	97·14		
	100·00		

In its raw state the cucumber is slowly, and with difficulty, digested, and is usually eaten with condiments (pepper, vinegar, and oil) as a salad; but its employment should be carefully avoided by dyspeptics. When stewed it forms a light and wholesome food. Young cucumbers (called *gherkins*), as well as the full-grown fruits, are eaten as condiments, when pickled.

The *Melon*, when in perfection, is a very delicious fruit. The *Cantaloupe* variety was examined by Payen,* who obtained the following results :—

COMPOSITION OF THE CANTALOUPE MELON.

				Flesh of the Melon.	
100 parts of Melon.	*Flesh*	Juice . . . . / Do. in the pulp .	46·29	Crystallizable sugar	1·5
		Fibrous pulp, washed & dried	0·57	Pectic acid	traces
	Internal portion	Juice around the seeds	6·97	Uncrystallizable sugar, Vegetable albumen, Mucilage, Free acid, Saponifiable fat, Nitrogenous matter, Colouring matter, Aromatic matter, Starch, Lignin, Salts, Water	98·5
		Fresh seeds	1·54		
		Fibres	0·19		
	Rind		44·44		
			100·00		100·0

The melon, like other cucurbitaceous fruits, is very apt to disagree with delicate stomachs, and, to obviate this, is usually eaten with salt and pepper, and sometimes with sugar.

The *Water Melon* possesses similar properties to the melon. The *Vegetable Marrow*, when cooked by

* *Journal de Chimie Méd.* t. iii. p. 15. 1827.

boiling, forms a very agreeable and wholesome article of food. The *Pumpkin* (*Pompion*) agrees with the other cucurbitaceous fruits in its alimentary qualities.

6. Leguminous Fruits; *Legumes* or *Pods*.—The pulpy mesocarp or sarcocarp of the *Tamarind* possesses alimentary properties. Its composition, according to Vauquelin, is as follows:—

COMPOSITION OF TAMARINDS.

Citric acid	9·40
Tartaric acid	1·55
Malic acid	0·45
Bitartrate of potash	3·25
Sugar	12·5
Gum	4·7
Vegetable jelly (pectine)	6·25
Parenchyma (lignine)	34·35
Water	27·55
	100·00

Tamarind pulp is slightly nutritive. It allays thirst, diminishes febrile heat, and when eaten freely proves laxative. It is adapted for febrile and inflammatory cases; and is sometimes employed to form whey (see *Tamarind Whey*, p. 258). The East Indian tamarind has a much longer pod than the West Indian fruit.

The unripe pods of *Phaseolus vulgaris* (*Kidney bean* or *Haricot*), commonly called *French beans*, form, when boiled, a favourite dish; though their nutritive properties are but slight. They are also eaten as a pickle. *Scarlet beans* (the unripe pods of *Phaseolus multiflorus*), when boiled, are also brought to table, and greatly resemble the French bean, to which they are preferred by many.

7. Syconus.—The *Fig* is a familiar illustration of the collective fruit called by botanists the Syconus.

It consists of a pulpy or fleshy pear-shaped receptacle, within which are many seed-like bodies, which are the fruits (*achenia*) properly so called. In the green or unripe state figs contain an acrid bitter juice; but as they ripen, this disappears, and is replaced by sugar; and in this state they form an agreeable and wholesome food. The figs, which are imported, have been dried in the sun or in ovens, are compressed, covered with a whitish saccharine efflorescence, and have an agreeable though peculiar odour, and sweet taste. In this state if freely eaten they are apt to produce disorder of the stomach and bowels, and occasion flatulence, griping, and slight relaxation of bowels, especially in children. Their composition is as follows:—

COMPOSITION OF FIGS.

Granular sugar (glucose)	62·5
Fatty matter	0·9
Extractive with chloride of calcium	0·4
Gum with phosphoric acid	5·2
Woody fibre and achenia	15·0
Water	16·0
	100·0

In eastern countries figs are eaten as food; but here they are taken as a dessert principally. A roasted or boiled fig is a popular poultice for gum-boils.

8. Sorosis.—The *Mulberry* belongs to this order of fruits. It consists of the female flowers, become fleshy and grown together, and inclosing a dry membranous pericarp. Its constituents are as follows:—

CONSTITUENTS OF MULBERRIES.

Colouring matter.
Pectine.
Bitartrate of potash.
Sugar.
Woody fibre.
Water.

Mulberries possess very slightly nutritive qualities They check thirst, relieve febrile heat, and, when eaten freely, gently relax the bowels.

The *Pine-apple*,—the most delicious of fruits,—is, like the mulberry, composed of ovaria and floral envelopes, which have become fleshy and grown together. It is a native of South America and of some of the West India islands, and is now naturalized in several of the hotter parts of Asia and Africa. Its juice was examined by Adet, who states its constituents to be as follows:—

CONSTITUENTS OF THE JUICE OF THE PINE-APPLE.

Peculiar Aroma.
Sugar.
Gum.
Malic Acid.
Citric and Tartaric Acids.
Water.

"Ripe pine-apples," says Dr. Wright*, "are amongst the finest of our fruits in the West Indies, and are relished by all ranks of people, especially sick of acute diseases, dysenteries, &c. They have a detersive quality, and are better fitted to cleanse the mouth and gums than any gargle whatever. Besides being eaten raw, they are often candied with sugar, and sent home as presents." The same authority adds that they are made into tarts and pickles. I have before stated (see p. 163) they are used for flavouring rum.

9. ETÆRIO.—To this order of fruits belong the Strawberry, the Raspberry, and the Blackberry.

* *Medicinal Plants of Jamaica.*

In the *Strawberry*, the seed-like pericarps are dry, but are placed upon a fleshy or pulpy receptacle, which forms the juicy or succulent part of the fruit. The strawberry constitutes one of the most delicious of our summer fruits. The following are the constituents of it:—

CONSTITUENTS OF THE STRAWBERRY.

Peculiar volatile Aroma.
Sugar.
Mucilage.
Pectine.
Citric Acid } equal parts of each.
Malic Acid }
Woody fibre.
Pericarps.
Water.

Strawberries contain a very small portion only of nutritive matter. They are employed as a very admired dessert, and also in the preparation of jellies and jams (see pp. 144-145). The grains or seed-like pericarps are not digestible, and, it is stated, are apt to excite intestinal irritation. The late Dr. Armstrong entertained a very strong opinion of the injurious effects of these grains, and, on one occasion, in which I met him in consultation, he directed the patient to suck strawberries through muslin, in order to prevent the grains being swallowed. The cream frequently taken with strawberries is objectionable for dyspeptics.

The *Raspberry* differs in several respects from the strawberry. The pericarps (sometimes called *drupes*) are succulent instead of dry; while the receptacle, which in the strawberry is juicy, is in the raspberry dry and spongy. In 1838 this fruit was analysed by Bley, who found its constituents to be as follows:—

CONSTITUENTS OF THE RASPBERRY.

Volatile oil.
Citric acid.
Malic acid.
Crystallizable, fermentable sugar.
Red colouring matter.
Mucus.
Woody fibre.

It is obvious, however, that he has omitted *pectine*, which is a well-known constituent of raspberries. The ashes contained carbonate, phosphate, and muriate of potash, carbonate and phosphate of lime and magnesia, silica, and oxide of iron.

The raspberry is an agreeable acidulous fruit, containing very little nourishment, but rarely disturbing the stomach. If eaten freely it promotes the action of the bowels. Besides being used at the table as a dessert, it is employed in the preparation of jellies, jams, raspberry vinegar (see pp. 144 and 145), and creams. The latter preparation is an objectionable one for dyspeptics.

ORDER III.—ROOTS, SUBTERRANEOUS STEMS, AND TUBERS.

This order includes the Turnip, the Carrot, the Parsnip, the Beet, the Potato, and the Jerusalem Artichoke.

Before proceeding to notice them individually, it may be advantageous to give a tabular view of their relative digestibility, according to Dr. Beaumont's experiments:—

RELATIVE DIGESTIBILITY OF TURNIPS, PARSNIPS, POTATOES, CARROTS, AND BEETS.

Articles of Diet.	*Mean Time of Chymification.*					
	In Stomach.			*In Phials.*		
	Preparation.	*H.*	*M.*	*Preparation.*	*H.*	*M.*
Parsnips	Boiled	2	30	Mashed	6	45
Potatoes, Irish . . .	Roasted	2	30			
„ „ . . .	Baked	2	30			
Carrot, orange . . .	Boiled	3	15	Mashed	6	15
Turnips, flat	Boiled	3	30			
Potatoes, Irish . . .	Boiled	3	30	Mashed	8	30
Beets	Boiled	3	45			
Parsnips	Boiled			Entire piece	13	15
Parsnips	Raw			Entire piece	18	0
Carrot, orange . . .				Entire piece	12	30
„ „	Raw			Entire piece	17	15
Potatoes, Irish . . .				Entire piece	14	0

The Cruciferous or Siliquose root called the *Turnip*, is, on account of the large proportion of water of which it is made up, but slightly nutritive. By drying it *in vacuo*, at 230° F., Boussingault* found the relative proportion of solid and liquid matters which it contains to be as follows:—

QUANTITY OF SOLID MATTER IN TURNIPS.

Water	92·5
Solid matter	7·5
Turnips	100·0

The same chemist submitted the solid or dried matter of turnips to ultimate analysis, and obtained the following results:—

* *Mémoires de l'Académie Royale des Sciences*, t. xviii. 1842.

ULTIMATE COMPOSITION OF THE DRIED TURNIP.

Carbon	42·9
Hydrogen	5·5
Oxygen	42·3
Nitrogen	1·7
Ashes	7·6
Dried Turnip	100·0

The juice of the turnip contains two nitrogenous constituents, viz. vegetable fibrine and vegetable albumen. The first coagulates spontaneously on standing,—the second is afterwards coagulated by heat.

The turnip, though very slightly nutritive, is in general easily digested; and though by some it is reputed flatulent, I have never seen it prove so when it has been well boiled.

The *Carrot* and *Parsnip* are Umbelliferous roots in common use. They contain vegetable fibrine, vegetable albumen, sugar, and volatile oil. The following are the constituents of the expressed and dried juice of the carrot:—

EXPRESSED AND DRIED JUICE OF THE CARROT.

Fixed oil, with some volatile oil	1·0
Red crystalline neutral substance (*carotin*)	0·34
Uncrystallizable sugar, with some starch and malic acid	93·71
Albumen	4·35
Ashes (alumina, lime, and iron)	0·60
	100·00

Both the carrot and the parsnip are highly nutritive; but the volatile oil which they contain renders their flavour unpleasant to many, and causes them to be apt to disagree with some dyspeptics.

The *Beet-root* is the produce of a Chenepodiaceous plant, and is used both as a garnish and a salad. On

The *Jerusalem Artichoke* is the tuber of the *Helianthus tuberosus*. It is in use, on the continent, as a substitute for the potato, to which it is inferior in nutritive power as well as in flavour. In taste it somewhat resembles the bottom of the Garden Artichoke (*Cynara Scolymus*).

The *Potato** (*Solanum tuberosum*), next to the Cerealia, is the most important and valuable of the esculent vegetables. For its introduction into England, from America, we are indebted to Sir Walter Raleigh.

The part of the plant which is used as food is the *tuber* attached to the subterranean stem, of which, in fact, it may be regarded as a part in a state of excessive development. It is provided with a number of buds, commonly called *eyes*, which, with contiguous portions of the potatoes, are used, under the name of *sets*, for multiplying the species.

When examined by the microscope the tissue of the potato is found to consist of a mass of cells, between and within which is an albuminous liquor. Each cell also contains about ten or twelve starch grains.

Potatoes have been repeatedly subjected to chemical examination; but the most important investigations

* This plant is sometimes confounded by writers with the *Batatas edulis*, the *Convolvulus Batatas* of most botanists, whose tuberous roots are called *Sweet Potatoes*, *Spanish Potatoes*, or *Batatas*. The latter constitute the *Potatoes* of Shakespeare, as well as of some other authors. When boiled or baked they form a wholesome farinaceous food, which, however, is slightly laxative, and, according to many writers, aphrodisiac.

are those of Einhof, Lampadius, Vauquelin, Otto, Baup, Michaelis, and Boussingault. The last-mentioned chemist submitted the potato to ultimate analysis,* and obtained the following results:—

ULTIMATE ANALYSIS OF THE POTATO.

Water	75·9	Carbon	44·0
Solid matter dried at 230° F. *in vacuo*	24·1	Hydrogen	5·8
	100·0	Oxygen	44·7
		Nitrogen	1·5
		Ashes	4·0
		Solid matter dried at 230° F. *in vacuo*	100·0

So that 100 parts of the Potato, in its ordinary state, contain the following substances:—

Water			75·9
Carbon	10·604	Solid matter dried at 230° F. *in vacuo*	24·1
Hydrogen	1·3978		
Oxygen	10·7727		
Nitrogen	0·3615		
Ashes	0·9640		
			100·0

From this analysis we learn that the proportion of nitrogen contained in the potato is very small; but it is still smaller in potatoes that have been kept for some time.

100 *parts of*	*Moisture.*	*Nitrogen in dried substance.*	*Nitrogen in undried substance.*
Potato, fresh	79·4	1·80	0·37
Ditto, kept 10 months	76·8	1·18	0·28

From these statements it follows, that if nitrogenised

* *Mémoires de l'Académie des Sciences de l'Institut de France*, t. xviii. 1842, p. 345.

principles alone contribute to the nutrition of the body, the nutritive power of the potato must be very low; or, in other words, its nutritive equivalent must be very high (see p. 55); and accordingly both Boussingault and Liebig have endeavoured to show that this is really the case. Two milch cows, says Boussingault*, were fed with a quantity of potatoes according to my equivalents. They always consumed their rations, and had they been fed with less would have been insufficiently nourished. A horse may be kept alive by feeding it with potatoes, observes Liebig †, but life thus supported is a gradual starvation; the animal increases neither in size nor strength, and sinks under every exertion.

If we assume that all the nitrogenised principles of the potato are alimentary, it follows that butcher's meat is about 10·4 times as nutritive as the potato. But solanine, and probably other constituents of the potato, are nitrogenised though not alimentary principles; and we may, therefore, estimate 1 lb. of butcher's meat as being equal, in nutritive power, to 10½ lbs. of potatoes.

In the year 1840 some experiments were made on the effects of different diets, on the prisoners confined in the Glasgow Bridewell; and the following extract from the report ‡ of the inspectors of prisons, de-

* *Ann. de Chim. et de Phys.* t. 67, p. 410, et seq.

† *Chemistry in its Application to Agriculture and Physiology*, p. 82, 2d ed. 1842.

‡ *Fifth Report of the Inspectors of Prisons.* IV. *Scotland, Northumberland, and Durham*, pp. viii.—xi.

serves to be noticed here in connection with the preceding observations on the nutritive powers of potatoes.

"*Eighth Diet.*—Cost, including cooking, 1¾d.
Breakfast.—2 lbs. of potatoes boiled.
Dinner.—3 lbs. of potatoes boiled.
Supper.—1 lb. of potatoes boiled.

A class of ten young men and boys was put on this diet. All had been in confinement for short periods only, and all were employed at light work, teazing hair. At the beginning of the experiment eight were in good health, and two in indifferent health; at the end, the eight continued in good health, and the two who had been in indifferent health had improved. There was, on an average, a gain in weight of nearly 3¼ lbs. per prisoner, the greatest gain being 8¾ lbs., by a young man, whose health had been indifferent at the beginning of the experiment. Only two prisoners lost at all in weight, and the quantity in each case was trifling. The prisoners all expressed themselves quite satisfied with this diet, and regretted the change back again to the ordinary diet."

Now the quantity of nitrogen, contained in the six pounds of potato allowed to each of these prisoners, was equal to that contained in somewhat more than nine ounces of butcher's meat.

The proximate principles of the potato are *water*, *starchy matter* (starch grains and amylaceous fibre), *ligneous matter*, *proteinaceous principles* (vegetable fibrine, vegetable albumen, and gluten), *fat*, *gum*, *asparagine*, *extractive*, *vegetable acids*, *salts*, and occasionally *solanina*.

The following is a recent analysis, by Michaelis, of a red variety of potato, which was suspected to possess injurious properties.

PROXIMATE COMPOSITION OF THE POTATO.

Water	66·875
Starch and amylaceous fibre	30·469
Albumen	0·503
Gluten	0·055
Fat	0·056
Gum	0·020
Asparagin	0·063
Extractive	0·921
Chloride of potassium	0·176
Silicate, phosphate, and citrate of iron, manganese, alumina, soda, potash, and lime (of these potash and citric acid are the prevailing ingredients)	0·815
Free citric acid	0·047
	100·000

I have already given some account of *Potato Starch* (see p. 133), as well as figures representing its microscopic appearance (see p. 124). The quantity obtained from potatoes is subject to considerable diversity (see p. 122); and varies not only with the sort of potato used but also with the season.

QUANTITY OF STARCH YIELDED BY 100 lbs. OF POTATOES AT DIFFERENT SEASONS.

In August, about	10 lbs.
In September	14½
In October	14¾
In November	17
In March	17
In April	13¾
In May	10

From this it will be seen that the quantity of starch is at its maximum in the winter season. In the spring vegetation becomes active, and the buds begin to grow at the expense of the starch contained in the tuber. Hence at this season potatoes are less mealy, and, in consequence, less esteemed for the table.

Potato starch agrees with the other amylaceous substances in its alimentary and dietetical properties (see pp. 125-121, and 133). Being devoid of nitrogen it is of course inferior in nutritive power to the flour or meal of the cereal grains, which contain vegetable fibrine, vegetable albumen, and gluten. But being readily soluble in boiling water, it yields several agreeable articles of food. It is sold in the shops under the name of *Potato Flour* or *English Arrowroot*. *Bright's Nutritious Farina*, sold for invalids and infants, is a carefully prepared potato starch slightly scented. The substance sold as *Indian Corn Starch* is potato starch coloured blue. *Bright's Universal Sanative Breakfast Beverage* appears to be a mixture of potato starch and chocolate.

The presence of *Citric acid* in the potato deserves to be especially noticed, since on it probably depends, in a great measure, the antiscorbutic property of this tuber. Baup* says that the potato yields sufficient citric acid to admit of its being employed for the preparation of this acid, for commercial purposes.

Solanina, a vegetable alkali possessing powerfully narcotic properties, has been detected by Otto in the buds and underground shoots of the potato. "If potatoes are grown where they are not supplied with earth, the magazine of inorganic bases, (in cellars, for example), a true alkali, called solanin, of very poisonous nature, is formed in the sprouts which extend towards the light, while not the smallest trace of such a substance can be discovered in the roots,

* *Pharmaceutisches Central-Blatt für* 1836, p. 47.

herbs, blossoms, or fruits of potatoes grown in the field.*" The most delicate test of solanina is, according to Otto, iodine. If small pieces of this be added to a weak solution of solanina (as the sulphate), they become surrounded by a brown syrupy fluid. A watery solution of iodine also forms, with a very weak solution of solanina, a brownish colour†. Michaelis‡, however, declares that the colour thus produced depends not on the solanina, but on the fatty acid of an alkaline [basic] calcareous soap contained in the potato. Solanina or other noxious principle, if present at all, must be contained in extremely small quantity in the potato, or must be destroyed or removed by cooling, since notwithstanding the universal employment of this vegetable, poisonous effects from it are never heard of; or if they occur must be exceedingly rare. Nauche asserts that the infusion or decoction of potatoes promotes the renal and biliary secretions, and slightly affects the nervous system. If the observation be correct, it would follow that the water, in which potatoes are boiled, extracts or destroys some noxious matter; and as both baked and roasted potatoes are likewise wholesome, it follows that heat alone is capable of destroying the noxious principle of the potato.

When potatoes are boiled in water the albumen of the liquor contained in the cells and intercellular spaces is coagulated, and the starch grains absorb the

* Otto, quoted by Liebig, *Chemistry in its Application to Agriculture*, p. 100. 2d edit.

† Otto, *Pharmaceutisches Central-Blatt für* 1834, pp. 458-459

‡ Ibid, *für* 1838, p. 379.

watery portion of it, swell up, and distend the cells in which they are contained. The coagulated albumen forms irregular fibres between the starch grains, and probably, also, covers them with a thin film of albumen. Lastly, the cells, in which the starch grains are contained, separate from each other. Potatoes in which these changes are complete are called *mealy*, while those in which they are only partially effected are called *watery*, *doughy*, or *waxy*. Potatoes, unlike potato starch, do not yield, by boiling, a mucilage or jelly. This arises probably from the starch grains being enveloped by a coating of coagulated albumen, as well by the membrane of the cell in which the grains are contained.

Potatoes, when in good condition and cooked by boiling, form a nutritious and easily digestible article of food. From an experiment made on the prisoners in the Glasgow Bridewell, it would appear that baked potatoes are less nourishing than boiled ones. The following is an extract, from the report of the Inspectors, bearing on the point * :—

"*First Diet.*—Cost, including cooking, 2¾d.

Breakfast.—8 ozs. oatmeal, made into porridge, with a pint of buttermilk.

Dinner.—3 lbs. of boiled potatoes with salt.

Supper.—5 ozs. of oatmeal made into porridge, with half a pint of buttermilk.

Ten prisoners were put on this diet (five men and five boys), all under sentences of confinement for two months, and all employed at light work (picking hair and cotton). At the beginning of the experiment eight were in good health and two in indifferent health; at the end all were in good health, and they had on an average gained more than 4 lbs. each in weight, only one prisoner (a man) having lost in weight. The greatest gain was 9 lbs. 4 ozs., and was made by one of the men. The prisoner who was reduced in weight had lost 5 lbs. 2 ozs."

The *second diet* was similar to the first, except that a third of a pint of skimmed milk was substituted at breakfast for a pint of buttermilk. Five young men and five women, some of whom had been in prison for several months, were put on this diet. All were in good health at the beginning of the experiment, and all in good health at the end. On an average each prisoner had gained rather more than 4 lbs. in weight.

"*Third diet.*—Cost, including cooking, 2¾d. This diet was the same as the first, except that the potatoes were baked instead of boiled. Three young men, two boys, and five young women, were put upon this diet. Most of them had been in confinement about five months. The men and boys and two of the women were employed in weaving, and the other three women in winding and twisting. All were in good health, both at the beginning and at the end of the experiment. There was, however, an average loss of 1½ lb. in weight, the greatest loss being 10 lbs. (by a man), who had been in prison nearly five months, and the greatest gain 6¼ lbs. by a woman, who had been in prison about eight weeks. The prisoners all disliked the baked potatoes."

* *Fifth Report of the Inspectors of Prisons.* IV. *Scotland, Northumberland, and Durham*, pp. viii.—xi.

In order to render potatoes more palatable they are usually boiled only so far as to make them soft without affecting their shape; and probably in this state they contain a larger amount of nutritive matter than if longer boiled. It can scarcely, however, be doubted that they must be more readily permeated by the gastric juice, and, therefore, more easily digested, if boiled until they begin to break down, or are so softened as to be readily mashed.

Hard and waxy potatoes must, for the same reason, be less digestible than mealy ones; and new potatoes being less mealy are less easily digested than old ones.

The influence of a freezing temperature on the potato is remarkable. The effect is mechanical; the watery juice, contained in the cells and intercellular spaces, expands in the act of freezing, and by this means ruptures and isolates the cells, and destroys the organization of the tuber. It does not appear, however, that any chemical change is produced in the first instance either on the starch or the other constituents, for Girardin * obtained the same proportions of water, fecula, woody fibre, albumen, sugar, and saline matters, from frosted, as from unfrosted potatoes. But it is obvious that when the organization and life of the potato is destroyed, decomposition must soon succeed; though even then the fecula or starch seems but little altered.

I have already slightly alluded to the antiscorbutic property of the potato, and which I have in part ascribed to the contained citric acid. The importance of the subject demands a more specific reference to it. Sir Gilbert Blane † mentions that raw potatoes sliced, with vinegar, had been found beneficial in scurvy. Much more recently, M. Julia Fontanelle ‡ gave a brief sketch of its antiscorbutic effects on sailors, many of whom, he states, declared themselves to have been cured of the scurvy by the long-continued use of potatoes very slightly baked under the ashes, and eaten without salt. Nauche § also testifies to the antiscorbutic properties of this vegetable; which he used in the form of de-

* *Journal de Pharmacie*, t. xxiv. p. 301. 1838.
† *Diseases of the Fleet*. 1781.
‡ *Journal de Chimie Médicale*, t. ii. p. 129. 1826.
§ Ibid. t. vii. p. 374.

coction. Mr. Dalton * and Mr. Berncastle † have recommended the use of potatoes as a preventive of scurvy in ships making long voyages. Dr. Baly ‡, Physician to the General Penitentiary at Milbank, has published some interesting observations on the antiscorbutic quality of the potato; and he declares that its efficacy is not, as some had supposed, impaired by a boiling heat, but "*as ordinarily cooked, it is an admirable preservative against the scurvy*." In 1840 he found that scurvy was a disease of rather frequent occurrence amongst the military prisoners, whilst amongst the convicts it was never seen. The exemption of the latter he found could only be attributed to their weekly diet containing 5 lbs. of potatoes and an onion. The military prisoners, therefore, were allowed two lbs. of potatoes weekly during the first three months of their imprisonment, three lbs. during the second three months, and four lbs. after the expiration of six months. "This addition to the dietary of the military prisoners was made in January, 1842, and not a single case of scurvy has since occurred." Dr. Baly has also shown, from the Reports of the Inspectors of Prisons, that in those prisons where scurvy has prevailed, the diet of the prisoners, though often abundant in other respects, has contained no potatoes, or only a very small quantity; and that in several prisons the appearance of the disease has wholly ceased on the addition of a few pounds of potatoes being made to the weekly dietary.

* *Lancet*, Sept. 4, 1842.
† Ibid. Sept. 23, 1842.
‡ *London Medical Gazette*, Feb. 10, 1843.

These facts, then, are of high importance, inasmuch as the potato is a cheap and readily accessible preventive of scurvy—a disease which the excellent reports of the prison inspectors have shown to be of frequent occurrence in this country.

ORDER IV.—BUDS AND YOUNG SHOOTS.

Onions, Leeks, Garlic, and *Shallots,* though usually ranked among roots (bulbous roots), are in reality buds, formed at or beneath the ground, and whose scales are thick and fleshy. They owe their peculiar odour and flavour, as well as their pungent and stimulating qualities, to an acrid volatile oil which contains sulphur. This oil becomes absorbed, quickens the circulation, and occasions thirst. Passing out of the system by the different excreting organs it communicates its peculiar smell to the secretions. Hence the well-known odour of the breath after eating onions or garlic. The following are the constituents of onions, according to Fourcroy and Vauquelin :—

COMPOSITION OF THE ONION.

Acrid volatile oil.
Uncrystallizable sugar.
Gum.
Vegetable albumen.
Woody fibre.
Acetic and phosphoric acids.
Phosphate and carbonate of lime.
Water.

Garlic, Leeks, and Shallots, have a similar composition.

If the volatile oil be dissipated by boiling, these bulbs no longer possess any acrid or stimulating qualities. They then form mild and easily digestible aliments; whereas in the raw state, that is, with the

oil, they are pungent, acrid, difficultly digestible, stimulating substances.

The young shoots of *Asparagus officinale* form a delicious article of food, known at table as *Asparagus.* Their constituents are as follows :—

COMPOSITION OF ASPARAGUS.

Asparagine (Asparamide).
Gum.
Uncrystallizable sugar.
Vegetable albumen.
Resin.
Woody fibre.
Acetate, malate, phosphate, and muriate of potash and lime.
Iron.

Asparagine is a crystalline substance whose formula is $C^8 H^8 N^2 O^6 + Aq^2$. Liebig regards it as a nutritive agent (see *Theine*).

Asparagus is a wholesome, very agreeable, light kind of aliment, which acts as a mild diuretic, and communicates a peculiar and unpleasant odour to the urine. It was formerly charged with causing bloody urine and accelerating the fits of the gout, but there does not appear to be any ground for such an accusation. It is usually brought to table with toasted bread and melted butter, and is sometimes eaten in soup.

ORDER V.—LEAVES AND LEAFSTALKS.

The green colour of foliaceous parts depends on the presence of green globules contained in the cells of the leaf. These globules consist of a substance called *chlorophylle,* which, in its properties, is intermediate between resin and fat. It does not appear to possess any alimentary properties.

"The green matter of plants," says Dr. Prout*,

* *On the Nature and Treatment of Stomach and Urinary Diseases,* p. 300, 3d ed. 1840.

"is in general little acted on by the stomachs of the higher animals; and hence may, in most cases, safely form the portion of the food of diabetic individuals, as first, I believe, recommended by Dr. B. G. Babington; though on very different principles. In many cases of common dyspepsia, also, more especially connected with derangements of the lower intestines, and with irritable states of the mucous membrane, the green matter of plants contributes, as above mentioned, to the action of the bowels by its excremental properties. In dyspeptic affections, however, more immediately connected with the stomach, it is apt to disagree, by producing acidity and flatulence, and their consequences; and as such forms of dyspepsia are by far the most common, herbaceous vegetable matters in general are much less suited for dyspeptic individuals than farinaceous."

The *Cabbage Tribe* includes the Cabbage (both white and red), the Savoy, Greens, the Cauliflower, and Broccoli. The parts used are the leaves, and, in the case of the two last-mentioned substances, the young and compact flowering heads.

These vegetables by drying lose more than 90 per cent. of water. The dried residue is remarkably rich in nitrogen as well as in sulphur.

100 *parts of*	*Water lost by drying at 212° F.*	*Nitrogen in the dried residue.*	*Nitrogen in the undried plant.*
Cabbage	92·3	3·7	0·28

According to Boussingault,* from whom these data

* *Ann. de Chim. et Phys.*

are taken, 810 parts of fresh cabbage, or 83 parts of dried cabbage, are equal, in nutritive power, to 100 parts of wheat (see p. 55).

The following are the results of Dr. Beaumont's experiments on the digestibility of the cabbage:—

DIGESTIBILITY OF CABBAGE.

Articles of Diet.	*Mean Time of Chymification.*			
	In Stomach.		*In Phials.*	
	Preparation.	*H. M.*	*Preparation.*	*H. M.*
Cabbage with vinegar .	Raw	2 0	Shaved	10 15
Cabbage head	Raw	2 20	Masticated	12 30
Cabbage	Boiled	4 30	Boiled	20 0

The Cabbage has been analysed by Schrader*; the Cauliflower by Trommsdorff.†

Cabbage.		*Cauliflower.*
Extractive	2·34	Colouring matter.
Gummy extractive . . .	2·89	Mucilage.
Resin	0·05	Resin.
Vegetable albumen . . .	0·29	Vegetable albumen (about 0·5 per cent.)
Green fecula	0·63	Chlorophylle.
Water with acetic acid, sulphate and nitrate of potash, chloride of potassium, malate and phosphate of lime, phosphate of magnesia, iron and manganese . .	93·80	Fatty matter.
		Pectic acid (a product?).
		Woody fibre (about 1·8 per cent.)
		Silica.
		Water (rather more than 90 per cent.)
	100·00	Malate of ammonia, malate of lime, free malic acid, acetate of potash, phosphate of lime, chloride of calcium, and sulphate of potash.

Sourkrout or *Sauerkraut.* — Sauerkraut is prepared by the fermentation of cabbage. The plants

* Schweigger's *Journ. für Chem.* Bd. v. S. 19. 1812.
† *Pharmaceutisches Central-Blatt für* 1832, p. 97.

are collected from the fields in autumn, divided, the stalks removed, and the leaves cut by machine or hand into slices, a layer of which is placed into a vat, alternating with a layer of salt, until the vessel is filled, when it is subjected to the pressure of heavy weights placed on the whole. At the end of six weeks (more or less, according to the temperature), when the acetous fermentation is completed, it is considered fit for use. The method of cooking it in Germany is to stew it simply in its own liquor, with bacon, pork, or other fat meat. Dill, caraway seeds, and other carminatives, are sometimes added.

Sauerkraut is not fitted for persons troubled with acidity of stomach. It has a slightly relaxing effect on the bowels. As an antiscorbutic it has long been celebrated, and was highly spoken of by Capt. Cook.

Turnip tops are frequently boiled and used as greens, but they are very apt to disorder the bowels. The same remarks likewise apply to *Spinage.*

The herbaceous part of the *Water Cress,* the seed leaves of *White Mustard* and of *Common Cress,* and the leaves of *Lettuce* and *Endive,* are eaten raw, under the name of Salads (*Acetaria*), with the addition of vinegar, oil, salt, and sometimes mustard. They of course yield very little nourishment. The three first-named plants probably owe their pungency to a minute portion of sulphuretted volatile oil, analogous to that found in horse-radish.

Lettuce leaves are used at table as a salad. They usually abound in a cooling, bland, pellucid juice; but the more advanced plant contains a bitter, milky juice, which has a slight tendency to promote sleep.

Hence lettuce leaves are eaten at supper by those troubled with watchfulness. Galen, in his old age, obtained relief in this way. It is prudent, however, to avoid the use of this salad when any tendency to apoplexy manifests itself. The inspissated milky juice of the lettuce is called *Lactucarium,* or *Lettuce Opium,* and is employed medicinally as an anodyne, sedative, and soporific. Mr. Loudon enumerates no less than fourteen varieties of the lettuce, which are cultivated by gardeners for the table. Of these, seven are *Cabbage lettuces,* and seven *Cos lettuces.*

The stalks of *Rhubarb* leaves are used, when peeled, for making pies, tarts, and puddings, in the manner of apples and gooseberries. Most species of Rheum may serve for this purpose; but Rheum Rhaponticum and Rheum hybridum are the kinds usually cultivated. Rheum palmatum and Rheum Emodi yield excellent tart rhubarb. Lassaigne found in the stalks of Rheum Rhaponticum oxalic and malic acids. The presence of oxalates makes this food highly objectionable where there is a tendency to oxalate of lime calculi. "I have seen," observes Dr. Prout, "well-marked instances in which an oxalate of lime nephritic attack has followed the free use of rhubarb (in the shape of tarts, &c.), particularly when the patient has been in the habit, at the same time, of drinking *hard water.*"

ORDER VI.—RECEPTACLES AND BRACTS.

Of this order it will be necessary to notice one vegetable only, namely, the Garden Artichoke (*Cynara Scolymus*), whose flower-heads are used before the expansion of the flowers. The parts of these heads, which are eaten, are—1st, the fleshy receptacle, usually called the *bottom*, deprived of the thistles and seed down, vulgarly termed the *choke;* and, 2dly, the *talus*, or base of the involucral scales. These contain a sweet saccharine and mucilaginous juice with starchy matter, and they form a bland readily digestible article of food; but the melted butter, with which they are usually eaten, renders them objectionable for dyspeptics and others with delicate stomachs.

ORDER VII.—STEMS.

From the stems of several Cycadaceæ, as well as from some Palms, is obtained a farinaceous substance, which is employed, in the East, as an article of food. Sago (see p. 128) is procured from this source.

CLASS II. ALIMENTS DERIVED FROM FLOWERLESS PLANTS.

ORDER I.—FERNS.

From the tuberous rhizomes of ferns is obtained, in some of the Polynesian islands, as well as in some other parts of the world, a farinaceous or ligneous matter, which is employed by the natives as a nutritive substance. The rhizomes are cooked by baking or roasting. In general, however, they are only resorted to in times of scarcity, when other and more palatable food cannot be obtained.*

* Ellis, *Polynesian Researches*, vol. i. p. 363; Bennett, *Narrative of a Whaling Voyage*, vol. ii. p. 394. 1840.—Dieffenbach (*Travels in New Zealand*, vol. ii. 1843) says, that the "*korau* or *mamako*, the pulpous stem of a tree-fern (*Cyathea medullaris*), is an excellent vegetable;" and, he adds, "it is prepared by being cooked a whole night in a native oven."

ORDER II.—LICHENS.

Many lichens contain a starchy or amylaceous matter, called *lichenin* or *feculoid* (see p. 135), to which they owe their alimentary qualities. But it is usually accompanied with a *bitter principle*, which gives them an unpleasant flavour, and renders them apt to disorder the bowels. To separate the latter substance they require to be soaked in a cold weak alkaline solution, and then washed with cold water.

Several species of *Gyrophora*, as *G. proboscidea β arctica*, *G. hyperborea*, *G. pennsylvanica*, and *G. Muhlenbergii*, are employed by the hunters of the Arctic regions of America as articles of food, under the name of *Tripe de Roche*. All four species were eaten by Captain Franklin and his companions, in 1821, when suffering great privations in America; and to its use may their preservation be in part ascribed.* But not having the means of extracting the bitter principle, these lichens proved noxious to several of the party, producing severe bowel complaints.

Iceland Moss (*Cetraria Islandica*) is extensively used in this country, but principally as a medicine. Its composition, according to Berzelius, is as follows:—

* *Narrative of a Journey to the Shores of the Polar Sea*. 1823.

COMPOSITION OF ICELAND MOSS.

Starchy matter (*lichenin*)	44·6
Bitter principle (*cetrarin*)	3·0
Uncrystallizable sugar	3·6
Chlorophylle	1·6
Extractive matter	7·0
Gum	3·7
Bilichenates of potash and lime with phosphate of lime	1·9
Amylaceous fibre	36·2
	101·6

Like the other lichens, it must be deprived of its bitter matter before it is fit for use. One part of subcarbonate of potash (*salt of tartar*) dissolved in water and rendered caustic by an equal weight of lime, is sufficient to extract the bitter principle out of twenty parts of Iceland moss; but for this purpose the plant must be soaked in the solution for ten or fourteen days. Thus deprived of its bitterness, Iceland moss may be used as food by boiling it in water or milk, and flavouring with sugar, lemon, wine, or spices. A concentrated decoction gelatinizes on cooling.

A *decoction* of Iceland moss, made with the unprepared plant, and, therefore, containing the bitter principle, is used as a demulcent tonic in consumptive cases. It is prepared by boiling down five drachms of the moss and a pint and a half of water, to one pint. The dose is from two table-spoonfuls to a wine-glassful.

ORDER III.—ALGÆ OR SEA WEEDS.

Several species of the inarticulated Algæ are occasionally employed in some parts of the British islands as articles of food. Some of them abound in a mucilaginous or vegeto-gelatinous substance, to which they in part owe their dietetical uses. Starch, and, in some cases, sugar, are also alimentary principles of some of the Algæ.

Laver (*Porphyra laciniata* and *vulgaris*) is sold in the London shops. When boiled or stewed for several hours, until reduced to a pulpy substance, it is brought to table as a luxury, under the name of *Marine Sauce*, *Sloke*, or *Slouk**. In its absence, *Green Laver* (*Ulva latissima*) is sometimes substituted for it.

Carrageen or *Irish Moss*, called also *Pearl Moss* (*Chondrus crispus*), is extensively used, partly as a domestic remedy and partly as a nutritive substance. Its composition is as follows:—

COMPOSITION OF CARRAGEENIN.

Vegetable jelly (Carrageenin)	79·1
Mucus	9·5
Resin	0·7
Fat and free acid	traces
Water } Salts }	10·7
	100·0

The salts contain chlorine, iodine, bromine, sodium, magnesium, potassium, and calcium.

The substance which I have elsewhere† denominated *Carrageenin* (see p. 145), approximates to the mucilage of quince seed in composition. Mulder‡ found it to consist of *carbon* 45·17, *hydrogen* 4·88, and *oxygen* 49·95.

* The Hon. W. H. Harvey's *Manual of the British Algæ*. 1841.
† See my *Elements of Materia Medica*, vol. ii. p. 874, 2d ed.
‡ *Pharmaceutisches Central Blatt für* 1838.

Carrageenin possesses slight nutritive qualities. In the form of decoction, it is employed as a popular remedy for consumption, scrofula, &c. A very concentrated decoction gelatinizes on cooling, and the jelly thus prepared is used, by careful housekeepers, in the preparation of blanc-mange, jellies, white soup, &c.; but it is a wretched substitute for gelatine (isinglass or calves' feet). It has a fishy or sea-weed flavour, especially when it has been kept for some days.

Ceylon or *Jafna Moss* (*Gracilaria lichenoides*) is a whitish filamentous sea weed brought from India. Its composition is as follows:—

COMPOSITION OF CEYLON MOSS.

Vegetable jelly	54·5
True starch	15·0
Ligneous fibre	18·0
Gum	4·0
Sulphate and muriate of soda	6·5
Sulphate and phosphate of lime	1·0
Wax, iron, and loss	1·0
	100·0

By boiling in water it yields a liquid which gelatinizes on cooling. The decoction or jelly forms an agreeable, light, nourishing article of food for invalids and children.

ORDER IV.—FUNGI OR MUSHROOMS.

Though a considerable number of species of fungi are edible—in fact, several form delicious articles of food—a small number only are in common use in this country. This has arisen, in great measure, from the difficulty experienced by the public in discriminating wholesome from poisonous species. Nay, it would

appear that the same species is under some circumstances edible, under others deleterious. This, if true, is a very proper ground for distrust. "So strongly did the late Professor L. C. Richard feel the prudence of this, that although no one was better acquainted with the distinctions of fungi, he would never eat any, except such as had been raised in gardens in mushroom beds *." The edible species in most common use in this country are, 1st. *Agaricus campestris* (*Common Field* or *Cultivated Mushroom*), which, in the adult state, is employed in the preparation of ketchup, and is eaten fresh, either stewed or broiled: the young or button mushroom is pickled. 2dly. *Morchella esculenta* (*Common Morel*), employed to flavour gravies, ragouts, &c. 3dly. *Tuber cibarium* (*Common Truffle*), a subterraneous fungus, used for seasoning. No less than thirty-three species of fungi are eaten in Russia †.

The supposed alimentary principle of mushrooms is *fungin*, already described (see p. 140), to which must, in some cases, be added *mannite*. But it appears to me by no means clearly made out that these vegetables possess much nutritive power ‡. They are certainly difficult of digestion, and on certain constitutions act very injuriously. Invalids, dyspeptics, and others with delicate stomachs, will act prudently in avoiding the use of this doubtful order of foods.

* Lindley, *Natural System of Botany*, 2d ed. p. 442.

† Dr. (now Sir G.) Lefevre, *London Medical Gazette*, vol. xxiii. p. 414.

‡ "We do not believe," says the eccentric Dr. Kitchener, in his *Cook's Oracle*, "that mushrooms are nutritive."

2. LIQUID ALIMENTS OR DRINKS.

The basis of all drinks is water, which I have already considered among alimentary principles (see p. 78). I have now to notice the compounded liquid aliments, or those composed of water combined with some other substance. These I shall arrange in six orders, as follows:—

1. Mucilaginous, farinaceous, or saccharine drinks.
2. Aromatic or astringent drinks.
3. Acidulous drinks.
4. Animal broths, or drinks containing gelatine and osmazome.
5. Emulsive or milky drinks.
6. Alcoholic and other intoxicating drinks.

ORDER I.—MUCILAGINOUS, FARINACEOUS, OR SACCHARINE DRINKS.

These drinks differ but little from common water. They are very slightly nutritive, and are employed as demulcents and diluents. They include the liquids popularly known in the sick chamber as *slops*, and which on the continent are called *tisans*. They are well adapted for febrile and inflammatory maladies, especially when combined with an affection of the mucous membrane of the alimentary canal.

One of the simplest of the drinks of this order is *Toast Water*, which is prepared by infusing toasted bread or biscuit in water. By this means the water is rendered much more palatable and agreeable, by the empyreumatic or aromatic and gummy or starchy matter which the toast communicates to it. It is a very wholesome and useful drink.

The other drinks of this order have been already considered. (See *Gum Water*, p. 110, *Sugar Water*,

p. 118, *Sago Gruel*, p. 130, *Tapioca Gruel*, p. 131, *Arrow-root Gruel*, p. 132, *Common or Oat Gruel*, p. 324, *Barley Water*, p. 328, *Compound Barley Water*, p. 328, and *Mucilage of Rice*, p. 334).

ORDER II.—AROMATIC OR ASTRINGENT DRINKS.

Under this order are included Tea, Coffee, Chicory, Chocolate, and Cocoa.

1. TEA.—The shrub or shrubs from which Tea is procured are closely allied to the well-known Camellia Japonica. Two kinds, known respectively as the *Thea viridis* and *Thea Bohea*, are cultivated in the botanical gardens of this country; the first is commonly said to yield *Green Tea*, the latter *Black Tea*. Though their general characters and appearance give the idea of their being distinct species, yet by some botanists they are considered to be mere varieties. Thus De Candolle refers them to one species, under the name of *Thea Chinensis*.

Great discrepancy of opinion exists amongst writers as to whether the green and black teas of commerce are the produce of one or of two species. Some writers contend for one species; "the green and black, with all the diversities of each, being mere varieties produced by a difference in the culture, qualities of soil, age of the crop when taken up, and the modes of preparation for the market *." Others, however, assert the existence of two distinct species. Thus Mr. Reeves †, whose opinions are entitled to great weight, expresses his surprise "that any person who has

* Robinson's *Descriptive Account of Asam*. 1841.
† Loudon's *Gardener's Magazine*, vol. ix. p. 713.

been in China, or, indeed, any one who has seen the difference in the colour of the infusions of black and green tea, could suppose for a moment that they were the produce of the same plant, differing only in the mode of curing; particularly as they do not grow in the neighbourhood of each other."

The principal varieties of *Black Teas* are, Bohea, Congou, Campoi, Souchong, Caper, and Pekoe. The last-mentioned one is the best. It is prepared from the unexpanded leaf-bud. Bohea is the lower grade of black tea. To the *Green Teas* belong Twankay, Hyson-skin, Hyson, Imperial, and Gunpowder. "The gunpowder here stands in the place of the pekoe, being composed of the unopened buds of the spring crop. Imperial, hyson, and young hyson, consist of the second and third crops. The light and inferior leaves, separated from the hyson by a winnowing machine, constitute hyson-skin.*"

The latest analysis of tea is that of Mulder.†

COMPOSITION OF TEA.

	CHINESE.		JAVANESE.	
	Hyson.	*Congou.*	*Hyson.*	*Congou.*
Volatile oil	0·79	0·60	0·98	0·65
Chlorophylle	2·22	1·84	3·24	1·28
Wax	0·28	0·00	0·32	0·00
Resin	2·22	3·64	1·64	2·44
Gum	8·56	7·28	12·20	11·08
Tannin	17·80	12·88	17·56	14·80
Theine	0·43	0·46	0·60	0·65
Extractive	22·80	19·88	21·68	18·64
Apotheme		1·48		1·64
Ext. obtained by hydrochloric acid	23·60	19·12	20·36	18·24
Albumen	3·00	2·80	3·64	1·28
Fibrous matter	17.08	28·32	18·20	27·00
	98·78	98·30	100·42	97·70
Salts included in the above	5·56	5·24	4·76	5·36

* M'Culloch's *Dictionary of Commerce.*

† *Pharmaceutisches Central-Blatt für* 1838, p. 403.

According to this analysis, green tea contains more *tannin* than black tea. This accords with every-day experience, as well as with the experiments of Mr. Brande;* but it is opposed to the results obtained by Sir H. Davy† and Frank,‡ both of whom state that black tea is the most astringent. It is probable, therefore, that the amount of tannin in different teas is subject to variation.

The substance called *Theine,* or *Theina,* is a crystalline salifiable base, discovered some years since by Oudry§, and since found to be identical with caffeine, obtained from coffee. Its formula is $C^8 H^5 N^2 O^2$. It exists in tea, in combination with tannic acid. Hot water extracts the tannate of theina as well as free tannic acid; but by cooling, both of these substances almost entirely precipitate. According to Mulder, theina is not to be regarded as the principle which confers on tea its peculiar or characteristic properties. Its action on the system is not very obvious. He gave half a grain to a rabbit; the animal ate but little the next day, and aborted the day after. Liebig‖ has suggested that it may contribute to the formation of bile. "Without entering minutely into the medicinal action of caffeine (theine)," he observes, "it will surely appear a most striking fact, even if we were to deny its influence on the process of secretion, that this substance, with the addition of oxygen and the elements

* *Quarterly Journal,* vol. xii. p. 201.

† *Philosophical Transactions* for 1803, p. 268.

‡ Gmelin, *Handbuch der Chemie,* vol. ii. p. 1252.

§ Thomson, *Organic Chemistry,* p. 295.

‖ *Animal Chemistry,* p. 179, et seq.

of water, can yield taurine, the nitrogenised compound peculiar to bile:—

1 atom Caffeine or Theine	=	$C^8 N^2 H^5 O^2$
9 atoms Water	=	$H^9 O^9$
9 atoms Oxygen . . .	=	O^9
		$C^8 N^2 H^{14} O^{20}$
= 2 atoms Taurine . . .		$2 (C^4 N H^7 O^{10})$"

The same authority adds, that "$2\frac{8}{10}$ths grains of caffeine [theine] can give to an ounce of bile the nitrogen it contains in the form of taurine. If an infusion of tea contain no more than the $\frac{1}{10}$th of a grain of caffeine [theine], still, if it contribute in point of fact to the formation of bile, the action even of such a quantity cannot be looked upon as a nullity. Neither can it be denied that, in the case of an excess of non-azotised food and a deficiency of motion, which is required to cause the change of matter in the tissues, and thus to yield the nitrogenised product which enters into the composition of bile, that in such a condition the health may be benefited by the use of compounds which are capable of supplying the place of the nitrogenised product produced in the healthy state of the body, and essential to the production of an important element of respiration. In a chemical sense—and it is this alone which the preceding remarks are intended to shew—caffeine or theine, asparagine, and theobromine, are, in virtue of their composition, better adapted to this purpose than all other nitrogenised vegetable products. The action of these substances, in ordinary circumstances, is not obvious, but it unquestionably exists." These views, though quite hypothetical, are highly ingenious and interesting.

The peculiar flavour of tea depends on the *volatile oil* which is lighter than water, and has a lemon yellow colour, and the taste and smell of tea. Alone it acts as a narcotic, but in combination with tannin, as a diuretic and diaphoretic. It is extracted from tea by hot water, in which, however, it is not always equally soluble, its solubility being modified by the other constituents.

The following is the composition of the *ashes* of black tea:—

ASHES OF CONGO TEA.

	Chinese.		*Javanese.*
Potash, sulphate, phosphate, and muriate of potash	2·84	—	3·40
Oxide of iron, carbonate, sulphate, and phosphate of lime, and carbonate of magnesia	1·72	—	1·64
Hypermanganate of potash	traces	—	0
Silica	0·68	—	0·32
	5·24		5·36

Notwithstanding the extensive employment of tea in this country, it is no easy matter to ascertain its precise effects on the constitution. Its astringency, proved by its chemical properties, depends on the presence of tannin. Of this quality we may beneficially avail ourselves in some cases of poisoning, as by poisonous mushrooms, by opium or laudanum, or by any other vegetable substance containing a vegetable alkali, with which tannin combines. Schwann * found that tannin throws down a precipitate from the artificial digestive liquids, and renders this fluid inert. Does the copious use of strong tea, therefore, immediately after a meal, impede the process of digestion?

* Quoted by Muller, in his *Elements of Physiology*: see Baly's translation, p. 546.

The peculiar influence of tea, especially of the green variety, over the nervous system, depends on the volatile oil above referred to. This influence is analogous, in some respects, to that of foxglove; for both green tea and foxglove occasion watchfulness, and act as sedatives on the heart and blood-vessels. These effects of tea are familiar to most persons. It is a common practice with those who desire nocturnal study to use tea; and on the same principle it may be employed as an antisoporific to counteract the effects of opium and intoxicating liquors, and to relieve the stupor of fever. As a diluent and sedative it is well adapted for febrile and inflammatory disorders, and most persons can bear testimony to its good effects in these cases. To its sedative influence also should be ascribed the relief of headache sometimes experienced by the use of strong tea. In colds, catarrhs, and slight rheumatic cases, warm tea is used as a diluent, diaphoretic, and diuretic.

Strong green tea produces on some constitutions, usually those popularly known as nervous, very severe effects. It gives rise to tremor, anxiety, sleeplessness, and most distressing feelings. On others, however, none of these symptoms are manifested. Part of the ill effects sometimes ascribed to tea may be owing to the use of so much aqueous liquid,—to the temperature of the liquid,—to milk and sugar used with it,—or to the action of the tannin on the digestive liquid. But independently of these, tea possesses a specific and marked influence over the functions of the brain not referrible to any of the circumstances just alluded to.

Weak tea rarely disagrees with the invalid, and is admissible in a variety of maladies, in most of which it proves refreshing and agreeable. It is well adapted for febrile and inflammatory complaints; and is particularly valuable when we are desirous of checking sleep. Moreover, if the suggestions of Liebig, before noticed, be correct, tea is by no means to be considered as a mere diluent, but as possessing nutritive powers of no mean kind.

2. Coffee.—The Coffee plant (*Coffea arabica*) is a native of Arabia felix and Ethiopia, but is extensively cultivated in Asia and America. It is an evergreen shrub, from fifteen to twenty feet high, and bears an oval, succulent, blackish red or purplish two-seeded berry. The seeds are enclosed in a membranous coat (endocarp), called by some botanists a parchment-like putamen. Occasionally they are imported with this coat remaining on them, and in this state they form what is called in commerce *coffee in the husk*. In general, however, they are met with without this coat, and in this state are called simply *coffee*, or *raw coffee*. They then consist of a horny, yellow, bluish or greenish albumen, which is convex on one side, but flat on the other side, with a longitudinal furrow. At one end of the seed is the embryo, with its cordiform cotyledons.

The varieties of coffee are distinguished in commerce according to their places of growth; but considered with reference to their physical properties, they are characterized by colour (yellow, bluish, or greenish) and size (the smallest seeds being about three lines long and two broad, the largest five lines long and two lines and a half broad). *Arabian* or *Mocha Coffee* is small and dark yellow. *Java* and *East India* (Malabar) kinds are larger and paler yellow. The *Ceylon* is more analogous to the *West India* kinds (Jamaica, Berbice, Demerara, Dominica, Barbadoes, &c.), which, as well as the *Brazilian*, have a bluish or greenish grey tint.

Roasted Coffee is, when ground, extensively adulterated with chicory. To detect the adulteration, shake the suspected coffee with cold water in a wine-glass: if it be pure coffee, it will swim, and scarcely communicate any colour to the fluid. Chicory, on the other hand, sinks, and communicates a deep red tint to the water. The microscope serves also to detect the adulteration; fragments of dotted ducts being found when chicory is present, but not when the coffee is pure. The presence of *roasted corn* may be detected by the blue colour produced on the addition of a solution of iodine to the cold decoction.

Coffee has been the subject of repeated chemical investigation; but a good analysis of it is still a desideratum.

The following probably are the constituents of raw coffee:—

COMPOSITION OF RAW COFFEE.

Caffeic acid.
Tanno-caffeic acid (Gallic acid of some ?)
Caffeine.
Wax.
Fixed oil.
Resin.
Gum.
Extractive.
Albumen.
Lignin.
Sulphur (*Robiquet*).
Lime and Magnesia.
Iron.

Caffeic acid is a white powder insoluble in alcohol, but soluble in water. Its characteristic property is, that when heated it emits an odour precisely similar to that of roasted coffee; so that the aroma of roasted coffee must depend on the decomposition by heat of this acid*. Zenneck†, it is true, denies this, and asserts that the aromatic principle is neither acid nor alkaline; but he admits that alkalies render it odourless, while the subsequent addition of an acid causes the smell to reappear; a fact strongly confirmatory of its acid nature. Pfaff‡ analysed this acid, and found it to consist of *carbon* 29·1, *hydrogen* 6·9, and *oxygen* 6·4.

Tanno-caffeic acid is a dark brown extractiform substance, whose solution yields a green colour with the salts of the peroxide of iron, but no precipitate with a solution of isinglass. In these properties it resembles *catechine* (catechuic acid).

Caffeine is identical with Theine, already described (see p. 395).

By roasting, coffee suffers some remarkable and well-known changes in its sensible properties; but, in a chemical point of view, the precise nature of these changes is by no means well determined. The aroma is, as I have already stated, ascribed by Pfaff to the effect of heat on the caffeic acid.

The infusion or decoction of coffee forms a well-known favourite beverage. Like tea, it diminishes the disposition to sleep, and hence is often resorted to

* Pfaff, *Pharmaceutisches Central-Blatt. für* 1831, pp. 423 & 441.
† Ibid. p. 444.
‡ Ibid. p. 443.

by those who desire nocturnal study. It may also be used to counteract the stupor induced by opium, alcoholic liquors, and other narcotics. In some constitutions it acts on the bowels as a mild laxative. I have known several persons on whom it has this effect; yet it is usually described as producing constipation. Employed moderately, I believe it to be a wholesome and slightly nutritive beverage. I have already (see p. 395 *et seq.*) explained Liebig's hypothesis of the nutritive agency of caffeine (theine). The immoderate use of coffee is said to produce various nervous disorders, such as anxiety, tremor, disordered vision, palpitation, and feverishness.

Coffee is occasionally useful in the sick chamber. It relieves some forms of headache, especially those denominated nervous, and which are unaccompanied with sanguineous congestion. It likewise proves beneficial in some cases of spasmodic asthma.

Dunn's Essence of Coffee is prepared by subjecting moistened roasted coffee to pressure.

3. CHICORY or SUCCORY.—The substance sold in the shops under the name of chicory is the roasted root of the *Cichorium Intybus* (Wild Succory, or Wild Endive), an indigenous syngenesious plant, extensively cultivated in Holland, Belgium, and Germany, from whence it is largely imported. The root is cut, dried, roasted like coffee in heated iron cylinders which are kept revolving, and then ground in mills. The powder is employed by grocers and others to adulterate coffee (see p. 400). Its infusion or decoction forms a perfectly wholesome beverage, but which wants the fine flavour for which genuine

coffee is renowned. I have been informed, however, that some persons prefer the flavour of a mixture of coffee and chicory to that of unmixed coffee. Chicory is frequently adulterated. A grinder of the article tells me that roasted peas and beans, damaged corn, and coffee husks, are used as sophistications, and that Venetian red or Armenian bole is employed as a colouring agent.

4. CHOCOLATE.—This is prepared from the seeds of the *Theobroma Cacao*, a native of the West Indies and of Continental America. The kernels of the seeds have, according to Lampadius,* the following composition:—

COMPOSITION OF THE KERNELS OF CACAO SEEDS.

Fat or oil (*butter of cacao*)	53·10
Albuminous brown substance	16·70
Starch	10.91
Mucilage or gum	7·75
Red colouring matter	2·01
Lignine	0·90
Water	5·20
Loss (from adhesion of mucilage to the filter)	3·43
	100·00

The fat or oil, called *butter of cacao*, is, therefore, the principal ingredient of the seeds. It is a white solid substance, has a chocolate flavour, and is chiefly composed of oleine and stearine; but, unlike most other fats, is not apt to become rancid.

More recently, a nitrogenised crystalline principle, called *theobromine*, has been discovered in these seeds. Its formula is $C^9 H^5 N^3 O^2$, or $C^{18} H^{10} N^6 O^4$. It is very similar to caffeine.

* Quoted in Dulk's *Preussische Pharmakopöe.*

The husks consist principally of *lignine*, but they yield by boiling a *brownish mucilaginous extract*.

Chocolate is prepared by roasting the seeds, and depriving them of their husks, which constitute about 23 per cent. of the whole. The kernels of the roasted seeds constitute what is called *Nib Cocoa*. They are ground in a mill, whose sole rests on a heated iron plate, by which they are made into a brown pasty mass, which, when sweetened with some saccharine matter, flavoured with either vanilla or cinnamon, and placed in proper moulds, constitutes *Chocolate*. In a large manufactory of this substance in London, honey is employed as a sweetener, and a portion of starchy matter (sago flour or potato starch) is added, in order to give the chocolate a thickening quality. Most of the chocolate made at this establishment consists merely of the decorticated roasted seeds, sago flour, and honey, without any other flavouring ingredient.

Chocolate furnishes a moderately nourishing and very agreeable beverage. On hypothetical grounds, Liebig has suggested that the *theobromine* may contribute to the formation of the nitrogenised principle of the bile and urine; for with the addition of the elements of water and of a certain quantity of oxygen, it yields the elements of taurine and urea.

1 at. theobromine,	$C^{18} N^{6} H^{10} O^{4}$	=	4 at. taurine . .	$C^{16} N^{4} H^{28} O^{40}$
22 at. water . . .	$H^{22} O^{22}$		1 at. urea . . .	$C^{2} N^{2} H^{4} O^{2}$
16 at. oxygen . .	O^{16}			
	$C^{18} N^{6} H^{32} O^{42}$			$C^{18} N^{6} H^{32} O^{42}$

Chocolate, though devoid of the disagreeable qualities frequently evinced by tea and coffee, of disturbing the nervous functions, yet is difficult of

digestion, on account of the large quantity of oil which it contains, and is, therefore, very apt to disturb the stomach of dyspeptics and of others troubled with a delicate stomach.

5. COCOA.—Under this name is sold in the shops another preparation of the seeds of the *Theobroma Cacao*. It is prepared by grinding the entire roasted seeds (kernels and husks), sometimes mixed with sago meal or potato starch. I suspect that, besides the entire seeds, the husks separated in the manufacture of chocolate are also intermixed. It is somewhat less oily than chocolate, and being rather astringent, is adapted for persons with relaxed bowels.

ORDER III.—ACIDULOUS DRINKS.

These drinks consist of water, as their basis, and an acid, which is usually a vegetable one.

α. A considerable number of acidulous drinks are prepared with the juices of fruits. Of these *Lemonade*, already noticed (see p. 357), is the most familiar example.

β. Acidulous drinks are also prepared by dissolving vegetable acids or acidulous salts in water, and variously flavouring the liquid. *Raspberry-vinegar water* (see p. 145) and *Imperial* (see p. 154) are drinks of this kind.

The general effects of these acidulous drinks have been already explained (see p. 148). They allay thirst, both as well by the acid as the water which they contain. They form cooling, refreshing, antiscorbutic drinks, and are well adapted for hot seasons and for febrile and inflammatory cases.

γ. Decoctions of fruits likewise form acidulous drinks. They promote the secretions of the alimentary canal, and act as laxatives. *Apple Tea*, a liquid of this kind, is prepared by boiling an apple in half a pint of water, and adding sugar to the decanted liquor.

δ. The carbonated or effervescent drinks belong to this order. They owe their briskness and sparkling quality to carbonic acid gas, which has been either forced into the liquid by pressure, or developed in it after the corking of the bottle.

The *Bottle Soda Water* of the shops is, in general, merely a solution of carbonic acid gas in water; and might, therefore, be more properly denominated *Carbonic acid Water*. *Webb's Soda Water* is an exception to this statement, as, in the preparation of it, 15 grains of crystallized carbonate of soda are added to every 10 fluidounces of water; and, in consequence, it effervesces on the addition of an acid, after the escape of the free carbonic acid. The quantity of gas contained in these effervescing waters depends on the pressure employed in their preparation. At the ordinary temperature and pressure of the atmosphere, water absorbs its own volume of carbonic acid gas, and acquires a specific gravity of 1·0018. By doubling the pressure, it takes up two volumes of gas, by trebling it three volumes, and so on. Mr. Webb informs me, that a pressure of eleven atmospheres is used in the preparation of his soda water. Water thus charged with carbonic acid forms a refreshing cooling beverage. It acts both as a diaphoretic and diuretic, and is a most valuable agent for checking nausea and vomiting. When it contains bicarbonate of soda in

solution, it proves antacid, and is a most valuable beverage for persons afflicted with calculi in the bladder. The facts adduced by M. Chevallier* appear to me to be conclusive that bicarbonate of soda promotes the solution of uric acid in the bladder, and that it assists in breaking up and dividing other calculi (the phosphates).

Ginger beer is a well-known popular and agreeable beverage. A very superior preparation of this kind is made as follows: — Take of White Sugar 20lbs., Lemon or Lime Juice 18oz., Honey 1lb., Ginger, bruised, 22oz., Water 18 gallons. Boil the ginger in three gallons of water for half an hour; then add the sugar, the juice, and the honey, with the remainder of the water, and strain through a cloth. When cold, add the White of one Egg and half an ounce of Essence of Lemons. After it has stood for four days, let it be bottled. This preparation will keep for many months.

Several other effervescing or carbonated drinks have already been noticed—(see *Lemon and Kali*, p. 152; *Concrete Acidulated Alkali*, p. 153; *Soda Powders*, p. 153; *Ginger Beer Powders*, p. 154; *Effervescing Saline Draught*, p. 154, and *Seidlitz Powders*, p. 154). They are prepared with a vegetable acid (citric or tartaric) and an alkaline carbonate. Hence there is formed, in their manufacture, a vegetable alkaline salt (citrate or tartrate), the general effects of which on the system have been already noticed (see pp. 28 and 29).

* *London Medical Gazette*, vol. xx. p. 542.

ORDER IV.—DRINKS CONTAINING GELATINE AND OSMAZOME.

(Broths and Soups.)

These are essentially decoctions of animal flesh (meat); though frequently vegetables are also used in their preparation.

The composition of the flesh of various species of animals has been already stated (see pp. 231, 236, and 237); but the changes which it suffers in the operation of boiling are by no means well ascertained. The fibrine of the meat is rendered harder, but being insoluble in water, contributes nothing to this liquid. The albumen of meat is partly solid, partly liquid; the latter is coagulated by the boiling water. By the united agency of water and heat a portion of albumen—or at least a nitrogenous matter—is rendered soluble, and therefore is contained in the broth. The hematosin (see pp. 191 and 247), or colouring matter of the blood, dissolves in, and communicates a red colour to, cold water: but, as soon as the water becomes sufficiently heated, the hematosin coagulates, and forms brown flocculi, which float on the top of the liquor, and constitute part of what is called the scum. The cellular tissue, the bones, the aponeuroses, and the tendons, yield, by boiling in water, gelatine. The fatty matters melt, and, except when they are contained in closed cells, escaping from the meat, float on the top of the broth. The nervous or cerebral fatty matter (see p. 243), which principally constitutes the pulp of the nerves, is softened by the heat, and is in part carried off during the process. The

odour which it evolves when heated is recognised both in the broth and the boiled meat.

During the ebullition there are obtained, by unknown reactions, other products; viz. 1stly, *creatine* (see p. 236), 2dly, *osmazome* (see p. 236), or the extractive matter on which the odour and flavour of broth principally depend; 3dly, ammonia; 4thly, a sulphuretted compound (sulphuretted hydrogen?), which blackens paper moistened with a solution of acetate of lead; 5thly, a volatile acid, analogous to acetic acid; 6thly, an odorous volatile acid, similar to butyric acid. The three last-mentioned substances are partially or wholly volatilized.

Thus, then, the following are the constituents of broth and boiled meat:—

Broth.	*Boiled meat.*
Gelatine.	Fibrine.
Albuminous matter.	Albumen (coagulated).
Creatine.	Gelatinous cellular tissue.
Extractive matters (*osmazome*).	Fat.
Lactic acid.	Nervous matter.
Salts.	Water.
A little fatty matter.	
Saccharine matter.	
Water.	

Besides meat, it is customary to employ vegetables (as turnips, carrots, onions, &c.) in the preparation of broths. These communicate colouring and mucilaginous matters, sugar, nitrogenized matter, volatile oils and salts. All the cruciferous plants, as turnips and cabbages, yield a sulphuretted and nitrogenized principle. Onions and leeks furnish an acrid volatile oil: the sweet herbs an aromatic oil.

The following table, drawn up from Chevreul's results, shows the quantity of alimentary matter contained in broth:—

Substances used in the preparation of broth.		*Products.*	
Beef	1·433	Broth . 4 litres	(= $8\frac{44}{100}$ wine pints)
Bone	0·430	Boiled meat	0·858
Common salt	0·040	Bone	0·392
Water	5000·000	Vegetables	0·340
Turnips, Carrots, Onions (burnt)	0·331		

The specific gravity of the broth was 1·0136. One litre (= $2\frac{113}{1000}$ wine pints) contained—

Water			985·600
Organic matters			16·917
Salts	soluble	Potash, Soda, Chlorine, Phosphoric acid, Sulphuric acid	10·721
	insoluble	Phosphate magnesia, " lime, Oxide copper	8·539
			1013·6

Magendie * states that 1 litre (= $2\frac{113}{1000}$ wine pints) of the broth, which is very carefully prepared by the "Compagnie hollandaise" in Paris, contains from 24 to 25 grammes (= 370·416 to 385·85 troy grains) of dry matter, of which from 8 to 10 grammes (= 123·472 to 154·34 troy grains) are saline substances. It is obvious from these statements that the actual amount of nutritive matter in broths is very small.

Beef Tea, Mutton, Veal, and Chicken Broths, are the lightest forms of animal food, and are employed by invalids and convalescents. *Beef Tea* is a light and pleasant article of diet. *Mutton Broth* is apt to disagree with persons having delicate stomachs, especially if the fat be not skimmed from it. It is

* *Comptes Rendus*, 1841, t. xiii.

frequently given to promote the operation of purgative medicine. *Chicken Broth*, of all the animal decoctions, is the least disposed to disturb the stomach. It is especially adapted for invalids with great irritability of stomach. *Veal Broth* is less frequently used. When prepared from a knuckle of veal, and sufficiently concentrated, it gelatinizes on cooling.

ORDER V.—EMULSIVE OR MILKY DRINKS.

These liquids hold in suspension an oily or fatty substance in a finely divided state.

Animal Milk, the principal and most important drink of this order, has been already fully considered (see p. 247, *et seq.*)

Almond Milk is an emulsive liquid used as a drink. It is prepared as follows:—Take of Sweet Almonds, blanched, half an ounce, Powdered Gum Arabic a drachm, White Sugar two drachms, and Water six ounces and a half. Beat the almonds with the sugar and water, and then gradually add the water. Almond milk agrees with animal milk in many of its properties. It contains in solution caseine, sugar, and gum, and retains in suspension a fixed oil. It forms a very agreeable demulcent drink in colds, coughs, and inflammatory affections of the bowels and urinary organs.

Orgeat, Syrup of Orgeat, or *Syrup of Almonds*, is thus prepared:—Take of Sweet Almonds a pound; Bitter Almonds four ounces; Water three wine pints; and Sugar six pounds. Blanch the almonds, and beat them in a mortar to a fine paste, adding three fluidounces of the water and a pound of the sugar.

Mix the paste thoroughly with the remainder of the water, strain with strong expression, add the remainder of the sugar to the strained liquor, and dissolve it with the aid of a gentle heat. Strain the syrup through the linen, and, having allowed it to cool, put it into bottles, which must be well stopped, and kept in a cool place.—In most recipes for it, about an ounce of Powdered Gum is directed to be used, and about half a pint of Orange Flower Water: but the latter, as found in the shops, is frequently contaminated with lead. Orgeat is demulcent and slightly narcotic, owing to the presence of prussic acid (derived from the bitter almonds). It is used to flavour drinks for invalids, and to allay troublesome coughs. The dose of it is from one to two table-spoonfuls.

The *Milk of the Cocoa Nut* is an albuminous liquid, closely allied to vegetable emulsions, though it is devoid of oily matter. It holds in solution a proteine compound (vegetable caseine?), sugar, gum, and some salts. It is, therefore, slightly nutritive.

ORDER VI.—ALCOHOLIC AND OTHER INTOXICATING DRINKS.

I have already fully considered the dietetical properties of Alcohol and of the different kinds of Ardent Spirit in ordinary use in this country (see pp. 50 to 54, and 157 to 166). Of alcoholic drinks, therefore, Malt Liquor and Wine alone remain for consideration.

1. MALT LIQUOR OR BEER.—Under this head are included *Ale*, *Stout*, *Porter*, and the weaker kinds of beer commonly known as *Table* or *Small Beer*. All these are fermented infusions of malt flavoured with hops.

The densities of different kinds of beer are, according to Mr. Richardson, as follows:—

DENSITY OF BEER.

Kinds of Beer.	*Excess in pounds per Barrel over a Barrel of Water.*	*Specific Gravity.*
Burton Ale, 1st sort . .	40 to 43	1·111 to 1·120
———— 2d sort . .	35 to 40	1·097 to 1·111
———— 3d sort . .	28 to 33	1·077 to 1·092
Common Ale	25 to 27	1·070 to 1·073
Ditto, ditto	21	1·058
Porter, common sort . .	18	1·050
Ditto, double	20	1·055
Ditto, brown stout . .	23	1·064
Ditto, best brown stout .	26	1·072
Common table beer . .	6	1·014
Good table beer	12 to 14	1·033 to 1·039

The following are the principal constituents of beer:—

COMPOSITION OF BEER.

Alcohol.
Starch sugar.
Dextrine (starch gum).
Extractive and bitter matter.
Fatty matters.
Aromatic matters.
Glutinous matters.
Lactic acid.
Carbonic acid.
Salts.
Water

1. *Alcohol.*—The quantity of spirit contained in different kinds of beer, according to the experiments of Brande and Christison, has been already stated (see pp. 158 and 159). We may safely assume, with Dr. Ure*, that the amount of spirit, "in *common*

* *Dictionary of Arts*, p. 105.—For further information respecting the quantity of alcohol in beer, the reader is referred to Accum's *Treatise on Adulterations of Food*, and to the writings of Leo (*Pharmaceutisches Central-Blatt. für* 1833, p. 413), Schrader, Wackenroder, and Lampadius (Ibid. *für* 1834, p. 99, et seq.)

strong ale or *beer*, is about 4 per cent., or four measures of spirits, specific gravity 0·825, in 100 measures of the liquor. The *best brown stout porter* contains 6 per cent., the *strongest ale* even 8 per cent.; but *common beer* only one."

2. *Carbonic Acid.*—The quantity of free carbonic acid in beer is subject to considerable variation, as the following table, taken from Dumas *, shews :—

QUANTITY OF CARBONIC ACID IN BEER.

	Carbonic Acid per cent. in Volumes.
Not frothy	2
Beading, not frothy	3
Yielding a little scum, not frothy .	4
Very slight froth	8
Slight froth	11
Moderate froth	15
Rather strong froth	20 to 22
Strong froth, much scum	25 to 26

3. *Extract.*—By evaporation we obtain the soluble but fixed and nutritive constituents of beer, in the form of an extract, which consists of starch-sugar, dextrine, lactic acid, different salts, the extractive and aromatic parts of the hop, gluten, and fatty matters. The quantity of extract yielded by beer is subject to considerable variation. It depends not only on the strength of the wort, but on the length of the fermentation and the age of the beer. An imperial pint of good porter yields in general about one ounce and a half of extract.

The following is the composition of six varieties of beer, according to Wackenroder † :—

* *Traité de Chimie*, t. vi. 1843.
† *Pharmaceutisches Central-Blatt für* 1834, p. 100.

COMPOSITION OF BEER.

CONSTITUENTS.	Of Lichtenhain. sp. gr. 1·0098.	Of Ilmenau. Felsenkellerbier.	Of Jena. Erlanger Bier. sp. gr. 1·0179.	Of Weimar. Bamberger Bier.	Of Upper Weimar.	Of Jena. Stadt-Doppelbier. sp. gr. 1·0215.
Absolute alcohol	3·168	3·096	3·018	2·834	2·567	2·080
Albumen coagulated by heat ..	0·018	0·079	0,015	0·030	0·020	0·028
Solid extract	4·485	7·072	6·144	6·349	7·316	7·153
Water .... Carbonic acid .. Acetic acid...... }	92·299	89·753	90.793	90.787	90·097	90·739
Total	100·000	100·000	100·000	100·000	100·000	100·000
Soluble salts; viz. phosphate of potash, more or less chloride of potassium and sulphate of potash, with some intermixed phosphates of lime and magnesia.......................	0·078	0·107	0·118	0·101	0·107	0·085
Insoluble substances; viz. phosphates of lime and magnesia, with some silica..	0·162	0·104	0.071	0·076	0·196	0·103

Considered dietetically, beer possesses a three-fold property:—it quenches thirst; it stimulates, cheers, and, if taken in sufficient quantity, intoxicates; and, lastly, it nourishes or strengthens. Its power of appeasing thirst depends on the aqueous ingredient which it contains, assisted somewhat by its acidulous constituent. Its stimulating, cheering, or intoxicating power, is derived either wholly, or principally, from the alcohol which it contains. Lastly, its nutritive or strengthening quality is derived from the sugar, dextrine, and other substances contained in the extract. Moreover, the bitter principle of hops confers on beer tonic properties.

From these combined qualities beer proves a refreshing and salubrious drink (always presuming that it is used in moderation), and an agreeable and valuable stimulus and support to those who have to undergo much bodily fatigue. When Dr. Franklin* asserted that a penny loaf and a pint of water yielded more nourishment than a pint of beer, it is obvious that he regarded beer merely as a nutrient, and overlooked its stimulating and cheering qualities, of which bread and water are totally devoid.

It is a popular notion, which has, perhaps, some foundation in fact, that beer has a tendency to promote corpulency. This cannot be the effect of the alcohol which it contains, since it is well known that confirmed spirit-drinkers are usually slender, or even emaciated (see p. 54).

Considered dietetically, beer differs from wine, in containing less alcohol, but more nutritive matter; and, in addition, a bitter tonic extractive derived from the hop.

The practice of taking a moderate quantity of mild malt liquor, of sound quality, at dinner, is, in general, not only unobjectionable, but beneficial. It is especially suited for those who lead an active life, and are engaged in laborious pursuits. For the sedentary and inactive it is less fitted. In the convalescence after lingering diseases, it often proves a most valuable restorative; but in delicate conditions of the stomach, and in relaxation of the bowels, its use should be prohibited. With bilious and dyspeptic individuals it frequently disagrees, and by such, therefore, should be avoided. In plethoric constitutions, especially when there is a tendency to apoplexy, it is objectionable. In some persons it is apt to produce headache, and by such it should be, either used sparingly, or totally abstained from.

* *Select Works*, by W. T. Franklin, vol. i. p. 36. Lond. 1818.

There are considerable differences in the dietetical properties of different kinds of malt liquors, to which it is necessary to make allusion.

Ale is prepared with pale malt, and on this account is much lighter coloured than Porter and Stout. The strongest kinds of ale are richer in alcohol, sugar, and gum, than any other kind of malt liquor: but though they thus contain a larger amount of nutritive matter, they are not fitted for ordinary use, on account of their intoxicating and stupefying qualities, and are especially to be avoided in diabetic and dyspeptic cases. On some persons they act as purgatives. The *Pale Ale*, prepared for the India market, and, therefore, commonly known as the *Indian Pale Ale*,* is free from these objections. It is carefully fermented, so as to be devoid of all sweetness, or, in other words, to be *dry;* and it contains double the usual quantity of hops: it forms, therefore, a most valuable restorative beverage for invalids and convalescents. It is taken with benefit by many persons on whom other kinds of ale act injuriously. For ordinary use at table, the weaker kinds of ale, popularly known as *Table Ale*, are to be preferred.

Porter is prepared from a mixture of pale and high-dried or charred malts; the pale kind being used to

* "The beer which the English send to the Indies," says Dumas, "is more highly charged with the essential oil [of hops]."

give body or strength—the dark kind to communicate colour.* Moreover, a larger amount of hops is used in the preparation of porter than of the ordinary kinds of beer. Porter is much better adapted for table use than strong ale. It agrees with many individuals on whom the latter liquid acts injuriously. When new, as generally prepared at the present day, it is called *mild;* by keeping, a portion of acid is developed in it, and it is then denominated *hard.* Formerly, when hard porter was in request, publicans were in the habit of rendering new beer hard, or, as it was called, of bringing it forward, by the addition of sulphuric acid. To render old beer mild, carbonate of lime, or of soda, or of potash, is used to neutralise the acid.

Beer, especially Porter, is very extensively adulterated.† *Cocculus indicus* is used to augment its intoxicating quality; and some of the popular treatises on brewing give directions for employing it. Thus Morrice directs three lbs. of Cocculus to be used for every ten quarters of malt. "It gives," says he, "an inebriating quality which passes for strength of liquor;" and he adds, that "it prevents second fermentation in bottled beer, and consequently the burst-

* The high temperature employed in preparing the brown or black malts greatly alters or actually decomposes the saccharine matter, the diastase and other constituents of the grain, and gives rise to the formation of a colouring matter analogous to caramel.

† In the *Sunday Times* of March 13, 1842, is the report of the conviction of a druggist for selling, and of a brewer for buying, various drugs to adulterate beer. Each was fined £200. The drugs were *Cocculus Indicus, Grains of Paradise, Liquorice, Linseed, Caraway,* and *Cayenne Pepper.*

ing of the bottles in warm climates." This sophistication is a highly dangerous one, cocculus indicus being a very poisonous fruit, as well for man as for the inferior animals; and the legislature has, therefore, very properly imposed a penalty of £200 upon the brewer, and £500 upon the seller of the drug. In order to avoid detection, brewers' druggists are in the habit of preparing a watery extract of the fruit, which is sold as *black extract* or *hard multum. Quassia* is used as a substitute for hops, to communicate a bitter taste. *Grains of Paradise* and *Cayenne* give pungency; though it is a common, but erroneous opinion, that grains of paradise have an intoxicating or narcotic property. *Coriander, Caraway,* &c. are used to communicate flavour; *Liquorice, Treacle,* and *Honey,* give colour and consistence. A mixture called *Beer-heading,* composed of green vitriol (sulphate of iron), alum, and common salt, is used to give *a fine frothy* or *cauliflower head* to beer.

2. WINE. By the term wine is usually meant a drink or liquid prepared by the vinous fermentation of *must* (*i. e.* the juice of the grape); but sometimes it is made to include the fermented juices of fruits generally, as of elderberries, currants, gooseberries, &c.; and, in a more general sense, it comprehends all saccharine liquids which have been subjected to the vinous fermentation. The liquid called ginger wine is an instance of this more extended use of the word wine.

In a dietetical point of view it will be necessary to notice those wines only which are obtained from the grape; and to these, therefore, the following remarks are intended to apply.

Must—the expressed juice of the grape,—whose composition I have already noticed (see p. 353), readily undergoes fermentation when subjected to a temperature of between 60° F. and 80° F.; while in the grape itself the juice does not ferment, owing, as Gay-Lussac has shown, to the exclusion of atmospheric air, the presence of which, therefore, is in some way necessary to set up the process of fermentation.

The peculiar qualities of the different kinds of wine depend on several circumstances; such as the variety and place of growth of the vine from which the wine is prepared,—the time of year when the vintage is collected,—the preparation of the grapes previously to their being trodden and pressed,—and the various manipulations and processes adopted in their fermentation.

The wines of different countries are distinguished in commerce by various names. The following is a list of the wines most commonly met with, arranged according to the countries producing them:—

1. French Wines.—*Champagne* (of which we have the *still, creaming,* or *slightly sparkling,*—the *full frothing,*—the *white*—and the *pink*); *Burgundy* (*red* and *white*); *Hermitage; Côtie Rôtie; Rousillon; Frontignac; Claret* (the most esteemed being the produce of *Lafitte, Latour, Château Margaux,* and *Haut-Brion*); *Vin de Grave; Sauterne;* and *Barsac.*

2. Spanish Wines.—*Sherry* (Xeres); *Tent* (Rota); *Mountain* (Malaga); *Benicarlo* (Alicant).

3. Portugal Wines.—*Port, red* and *white* (Oporto); *Bucellas, Lisbon, Calcavalla,* and *Colares* (Lisbon). An inferior description of Red Port Wine is shipped at Figuera and Aveiro.

4. German Wines.—*Rhine* and *Moselle Wines.* The term *Hock* (a corruption of *Hochheimer*) is usually applied to the first growths of the Rhine. The term *Rhenish* commonly indicates an inferior Rhine wine.

5. Hungarian Wines.—*Tokay.*

6. Italian and Sicilian Wines.—*Lachryma Christi; Marsala; Syracuse; Lissa.*

7. Grecian and Ionian Wines.—*Candian* and *Cyprus* wines.

8. Wines of Madeira and the Canary Islands.—*Madeira* and *Canary* (Teneriffe).

9. Wines of the Cape of Good Hope.—*Cape Madeira, Pontac, Constantia red* and *white* (a sweet, luscious wine, much esteemed).

10. Persian Wines.—*Shiraz.*

11. English or Home-made Wines.—*Grape, Raisin, Currant, Gooseberry,* &c.

The composition of wine is subject to considerable variation; but, in a general way, the following may be said to be its constituents:—

CONSTITUENTS OF WINE.

Water.
Alcohol.
Bouquet (*volatile oil? an ether?*).
Sugar.
Gum.
Extractive matter.
Gluten (*except when tannin is present*).
Acetic acid.
Bitartrate of potash.
Tartrate of potash and alumina (*in German wines*).
Sulphate of potash.
Chlorides of potassium and sodium.
Tannin } (*in red wines*).
Colouring matter of the husk } (*in red wines*).
Carbonic acid (*in Champagne and other effervescing wines*).

1. *Bouquet of Wine.*—Every wine has a peculiar odour, called its perfume or bouquet, and which must depend on the presence of some volatile principle generated during the process of vinous fermentation. In some cases, if not in all, it appears to be an ether formed by the action of an organic (fatty?) acid on the alcohol. Thus by submitting wine lees to distillation, Liebig and Pelouze procured an oily liquor,

having a vinous odour, consisting of *œnanthic ether* ($C^{18}H^{18}O^{3}$) mixed with *œnanthic acid* ($C^{14}H^{13}O^{2}$).

"The wines of warm climates," says Liebig, "possess no smell; wines grown in France have it in a marked degree; but in the wines from the Rhine the perfume is most intense. The kinds of grapes grown on the Rhine, which ripen very late, and scarcely ever completely, such as the *Riessling* and *Orleans*, have the strongest perfume or *bouquet*, and contain, proportionally, a larger quantity of tartaric acid. The earlier grapes, such as the *Rulander* and others, contain a large proportion of alcohol, and are similar to Spanish wines in their flavour, but they possess no *bouquet*. The grapes grown at the Cape, from Riesslings transplanted from the Rhine, produce an excellent wine, which does not, however, possess the aroma which distinguishes Rhenish wine. It is evident from these facts, that the acid of wines, and their characteristic perfumes, have some connexion, for they are always found together; and it can scarcely be doubted that the presence of the former exercises a certain influence on the formation of the latter."

2. *Alcohol.*—The quantity of alcohol in different wines has been already stated (see pp. 157-9). Wines which contain a comparatively small quantity of it are denominated *light wines;* as Claret, Sauterne, Hock, and Moselle; while those which are rich in it are termed *strong* or *generous wines;* as Lissa, Port, Marsala, Madeira, and Sherry. By keeping them in casks or bottles the quantity of alcohol in them is modified. Madeira and Sherry kept for a moderate term of years become somewhat stronger; the sugar

which they contained becoming slowly converted into alcohol, while tartar is deposited. After a time, that is, when all the sugar has disappeared, the formation of alcohol ceases, and from this period the strength of the wine diminishes, partly by the evaporation of the spirit through the sides of the cask, and partly by its conversion into other substances, as acetic acid.

3. *Sugar.*—This is a constituent of many wines. Those in which it is very abundant are called *sweet* or *luscious wines.* Tokay, Tent, Frontignac, Lunel, Rivesalte, Constantia, and Malmsey, are examples. In these the process of fermentation has been arrested before all the sugar was decomposed. Those wines, on the other hand, in which all the saccharine matter has disappeared, are called *dry*. Examples of this are frequently found in Sherry.

4. *Acids.*—All wines are more or less acidulous, as determined by litmus. This has been in general attributed to *malic acid;* but Dumas thinks that the presence of this acid in wine is very doubtful. In old and spoiled wines, as well as in the wines of the more northern countries, *acetic acid* is often found. The brisk, frothing, *sparkling* or *effervescent* wines,—as Champagne, which have been bottled before fermentation is complete, though without its being arrested, owe their peculiar properties to *carbonic acid* retained in solution under pressure. Some wines, as Port, contain *tannic acid,* to which they owe their *roughness* and astringency. They derive this from the husk, and perhaps in part from the seeds, of the grape. The acidity of some wines depends on *bitartrate of potash.*

5. *Colouring matter.*—All wines contain more or less colouring matter; but those which are prepared without the husk of the grape are pale, and are denominated *white wines,*—as Sherry, Madeira, and Bucellas. But if the husk of the dark-coloured grapes be present during fermentation, the wine acquires a deep colour, and is called *red wine.* By exposure to the sun, as well as by age, the colour diminishes.

6. *Tartrates.*—The most important saline constituent of wine is *Tartar* (Bitartrate of Potash), which deposits, along with colouring and extractive matters, both in the cork and bottle, constituting *argol,* the *crust,* the *bees' wing,* &c. The deposition augments with the formation of alcohol. *Tartrate of Lime* is usually found along with tartar in wine; and in the German wines, Berzelius mentions that there exists the *Tartrate of Alumina and Potash.*

Wine, when used in moderate quantities, as to the extent of two or three glasses daily, proves a very grateful, and to those who have been accustomed to it, an almost indispensable stimulant. It quickens the action of the heart and blood-vessels, diffuses an agreeable warmth through the system, promotes the different secretions, augments the muscular force and activity, excites the mental powers, and banishes unpleasant ideas and reflections.

Many persons, who have during a considerable period of their lives accustomed themselves to the daily but moderate use of wine, have attained a good old age; and it cannot, therefore, be denied, that the most perfect health is quite compatible with the moderate enjoyment of wine.

It must be admitted, I think, that wine proves a most valuable restorative when the powers of the body and mind have been enfeebled by fatigue. Its daily use, therefore, is more adapted for those who lead a life of great activity, or whose occupations are laborious, than for the indolent and sedentary. To the former it proves a very agreeable stimulus. Taken after the fatigues of the day are over, it assists in recruiting the exhausted energies.

But, on the other hand, it cannot be denied that the most perfect health is compatible with total abstinence from wine; and that the habitual employment of it, especially by the indolent and sedentary, is calculated, in many instances, to prove injurious. To a person in perfect health, and who has been unaccustomed to it, no possible benefit can accrue from commencing its use. The preternatural excitement which, in these cases, it would occasion, must be followed by a corresponding degree of depression. Even though no sensible injury may result therefrom, no benefit can be expected to result. The habit of using this stimulus creates a want for it; and thus it often happens, that those who have accustomed themselves to the temperate use of wine, suffer when they are deprived of it. The "artificial states of the constitution," says Dr. Christison, "produced by the habits of civilized life, are supposed to render it, for some people, a necessary stimulant, especially during exposure to unusual fatigue. So far do some carry this notion in the upper ranks of society, as to follow the strange practice of allowing wine daily, and in considerable quantity, even to young healthy children.

Very few constitutions of this kind really exist among those who are willing to think they themselves possess it."

Dr. Paris asserts that "there exists no evidence to prove that a temperate use of good wine, when taken at seasonable hours, has ever proved injurious to healthy adults." I am by no means disposed to question the accuracy of this statement, since he has so qualified it, that, in almost any case where ill effects resulted from the use of wine, they may be ascribed to the nonfulfilment of some of the conditions here mentioned: viz. the *temperate* use of the wine,—the *goodness* of the liquor,—the *seasonable* time of taking it,—or the *health* of the individual. All I would assert is, that, for healthy individuals, wine is an unnecessary article of diet.

The actual amount of injury which may be inflicted on the system by the use of wine depends on the quality and quantity of the liquid used, and on the greater or less predisposition to disease which may exist in the system. Disorders of the digestive organs and of the brain, gout, gravel, and dropsy, are the maladies most likely to be induced or aggravated by the use of wine. Intoxication, in its varied forms, is the effect of the excessive use of it.

Though the effects of wines depend, in the main, on the alcohol which these liquids contain, yet they differ from those of ardent spirit in several respects. In the first place, wine possesses a tonic influence not observed after the use of spirit. Common experience proves to every one that the stimulant influence of wine is slower in its production and subsidence than that of

spirit. On this account wine is employed as a tonic or corroborant in the convalescence after lingering diseases. Secondly, the diseases induced by the excessive indulgence in wine are somewhat different from those caused by alcohol. Delirium tremens, and diseased liver, are the common maladies of spirit-drinkers; whereas these affections rarely, if indeed they ever, follow the use of wine merely. But, on the other hand, gravel and gout are frequent consequences of habitual over-indulgence in wine, while they much less frequently result from the use of spirit. Thirdly, while wine-drinkers are frequently fat, lusty, and plethoric,—spirit-drinkers are generally thin and emaciated (see p. 54). Lastly, the intoxicating influence of wine is not equal to that of mixtures of ardent spirit and water of corresponding strengths, nor proportionate, in different wines, to the relative quantities of alcohol which they contain. This will be obvious from the following table, drawn up from Mr. Brande's results, before quoted (see p. 157, et seq.):—

AVERAGE QUANTITIES OF ARDENT SPIRIT AND OF WINE, CONTAINING FOUR FLUIDOUNCES OF ALCOHOL (sp. gr. 0·825 at 60° F.)

Brandy, about . .	8 fluidounces.
Port Wine . . .	18½ ditto.
Claret	26¼ ditto.
Champagne . . .	32 ditto.

Now it appears from this table, that if the intoxicating power of vinous liquids were in proportion to the spirit contained in them, that a pint of Port wine would be almost equal to half a pint of brandy, and that Claret would exceed Champagne in its influence over the nervous system; all of which we know not to be the case. It is, therefore, obvious, that the action of the alcohol on the animal economy is modified in the wine by the water and vegetable matters with which it is either combined or mixed.

Some doubt on this point has been recently expressed by Dr. Christison, who observes, that "wine is generally considered less inebriating than its equivalent alcohol, in any other shape. And this fact has been vaguely referred to its alcohol being in a peculiar state of combination, so as to be more easily digestible. Notwithstanding," he adds, "the general admission of this peculiarity in the effects of wine, doubts may be entertained of the doctrine being so unequivocal, or so generally applicable, as late authors on wine have maintained; and I suspect it is founded, in part, on the mistaken notions that have prevailed as to the alcoholic strength of wines, which has been overrated by analysts,—and partly on a disregard of the influence of habit, which seems to render one species of alcoholic fluid more digestible, or in some other way less stimulating, than another."

I am inclined to agree with Dr. Christison in the belief that the alcoholic strength of wines has been overrated by analysts. But I believe that the same has been done with regard to the strength of ardent spirits, as ordinarily found in the shops; both brandy and gin, but especially the latter, being usually sold considerably below the strength stated by Mr. Brande. So that though the actual quantity of alcohol in both wines and spirits may be overrated, yet the relative proportions are probably correct, or nearly so; and the

inferences which have been drawn as to the comparative effects of the alcohol contained in these liquids, are, perhaps, not far from the truth. It appears to me, therefore, that the evidence of the modifying influence exercised by the other ingredients of wine on the alcohol contained therein, is greater than Dr. Christison is disposed to admit.

Old wines, it is well known, are less intoxicating than new ones. This is usually ascribed to the chemical union which is ultimately effected between the alcohol and the water, by which the inebriating power of the spirit is lessened. But it is probably due, for the most part, to the diminished alcoholic strength of the old wine; for Dr. Christison's experiments have shown that the alcoholic strength of wines does not increase with age, as many persons have supposed.

The precise changes which the alcohol undergoes in wine are at present but imperfectly known. Dumas says that it doubtless passes gradually into the state of ether by combining with the different acids contained or produced in wine, and by which its inebriating power must be diminished, or perhaps otherwise modified. He also suggests that there may be different kinds of alcohol, having a similar relation to each other that phosphoric acid bears to pyrophosphoric acid; and that thus the alcohol of old wines may be possessed of somewhat different properties to that of new wines.

It is obvious, therefore, that there is not *à priori* anything improbable in the opinion commonly entertained by connoisseurs in wine, that a brandied wine (*i. e.* wine to which brandy has been added) is more intoxicating than a non-brandied wine of equal strength. The wine-growers of Bourgogne have long acted on this principle. In cold or rainy seasons, when the grape is deficient in sugar, and, in consequence, yields a poor wine, they prefer adding sugar to the must, instead of adding alcohol to the wine. "Formerly," says Dumas, "it was supposed that when wine was deficient in alcohol, this ingredient, in proper quantity, might be added to it to give the proper quality. Now, however, whoever considers the phenomena of fermentation, will not hesitate to admit that the addition of sugar to the must is a very different thing to the addition of spirit to the wine: for sugar, in fermenting, produces a chemical movement in which all the different materials of the must concur."

In forming an opinion as to the kind of wine best fitted for dietetical use, we must consider the colour, the alcoholic strength and intoxicating property, the sweetness, the nature and quantity of acid which it contains, and the age of the wine. *Red* wines contain more extractive and colouring matters (derived from the husk of the grape), which are apt to disagree with some dyspeptics. *Strong* wines are more likely to prove injurious than weak ones. But the inebriating quality of wine is not proportional to the quantity of contained alcohol. *Sweet* wines are objectionable in dyspeptic and some urinary diseases; as diabetes. *Acid* wines are improper for rheumatic and gouty subjects. *Old* wines are, in general, to be preferred to new ones; for, in the first place, their alcoholic strength is somewhat less; and, secondly, by keeping, wines deposit bitartrate of potash, and colouring and

extractive matters, which are apt to disagree with some constitutions. Liebig says, that minute crystals of uric acid are deposited from the urine after the use of those wines in which the alkali necessary to retain the uric acid in solution is wanting; but that this is never observed from the use of Rhenish wines, which contain so much tartar.

On the whole, I am inclined to think, that, of the stronger wines employed in this country, good dry Sherry is best fitted for dietetical use. It is devoid of the extractive and colouring matters found in red wine, and is free both from acid and sugar. In general, however, I think the lighter or weaker wines preferable; and of those commonly used in this country Claret appears to me the best.

1. *Sherry.*—This is made in Spain, near Xeres, and is exported from Cadiz. "From the gradual mixture of wines of various ages," says Mr. Busby,* "no wine can be further from what may be called a *natural wine* than sherry." Boiled must (of the consistence of treacle, and having a similar flavour, but with a strong empyreumatic taste) is employed to deepen its colour. Amontillado, or Montillado, (a very dry kind of sherry) is added to sherries which are deficient in the nutty flavour. Being very light in colour, it is also used to reduce the colour of sherries which are too high. Brandy is added to sherry before it is shipped, but never in greater quantities than four or five per cent.

Sherry varies considerably in the depth of its co-

* *Visit to the Vineyards of Spain and France.* Lond. 1834.

lour; and London wholesale dealers distinguish five kinds, called respectively *very pale*, *pale*, *golden*, *brown*, and *very brown;* and occasionally an *extra very pale*, and an *extra very brown*, are met with. Some years since fashion ran on pale sherries, and to meet the demand the wine-growers made their wines from the grapes before they were quite ripe, and the consequence was, an inferior class of wines was exported; and had the fashion continued, the characters of sherries would have been greatly altered. But the inferior quality of the pale sherries, thus produced, led to a change in the fashion, and now dark or brown sherries (coloured as before stated) are run after. It should, however, be remembered, that colour is no criterion of the goodness of sherry.

I have already stated that of the stronger wines sherry is preferable for ordinary use, on account of its great freedom from acid, sugar, colouring, and extractive matters. It is, therefore, the least injurious of the strong wines for gouty persons, as well as for those troubled with acidity of stomach, and for the lithic acid diathesis.

2. *Port-Wine.*—This is manufactured on the banks of the Douro, and is exported from Oporto. It is made from round black grapes (see pp. 351-352); and owes its colour and astringency to the husks and stalks of the grapes which are contained in the fermenting juice.

To augment the strength of this wine brandy is added to it. In Portugal the juice of the elderberry has been employed to augment the colour. To such an extent was this at one time practised, that the wine

company of Portugal rooted out the elder trees, and prohibited their growth in the wine district. Kino, it is said, is used to give roughness or astringency to Port-wine.

Old Port-wine has a duller, browner, and paler tint than new wine, which has a more purplish, red or ruby tint, and a brighter though deeper colour. To detect the shades of colour, dealers use small silver dishes, called *tasters*, having raised bottoms, by the reflected light from which, the colour of the wine is readily perceived. In order to imitate age, dealers sometimes add white Port-wine to the red kind; but I am informed that the crust which is deposited is never good and firm.

Port-wine belongs to the class of stronger wines. It more frequently disagrees with individuals than sherry; but to this statement many exceptions occur. It is more apt to disorder the head and the stomach, and to constipate the bowels, than sherry. It is popularly supposed to be more strengthening than the other kinds of wines; and, accordingly, is more frequently resorted to as a medicine. On account of its astringency it is particularly adapted for those cases which are attended with a relaxed condition of bowels.

3. *Madeira.*—This wine, the produce of the island whose name it bears, is in general somewhat stronger and more acid than sherry. Before it is shipped, brandy is usually added to it. In order to improve its quality it is frequently sent a voyage to the East Indies. Heat and agitation are probably the effective agents in this improvement. Madeira is well adapted for old persons and debilitated constitutions, where its

slight acidity is not objectionable. It is an excellent wine for invalids; but its acidity sometimes causes it to disagree.

4. *Champagne.*—This wine is called after the province of France of which it is the produce. It is usually procured from a black grape. The Champagne wines are generally divided into the *white*, and the *red* or *pink;* and each of these again into the *still* and the *sparkling*. Of the still Champagne that called *Sillery* is generally admitted to be the best. In this country, however, the sparkling Champagne is usually preferred; and of this the wine of *Ay* is considered the best; that which merely creams on the surface (*demi-mousseux*) being more esteemed than the full-frothing (*grand-mousseux*). The sparkling, creaming, or frothing of these wines depends on the evolution of carbonic acid gas.

If carbonic acid gas be condensed into ordinary white wine, it usually renders the latter turbid, owing to the precipitation of gliadine contained in the wine. But by the previous addition of tannin (which precipitates the gliadine) this may be prevented.

Champagne is an exhilarating wine, which speedily produces intoxication; it also acts as a diuretic. It excites lively and agreeable feelings, and is, in consequence, adapted for hypochondriacal cases; it is very apt, however, to occasion headache. On account of its effervescing property it is occasionally useful in allaying sickness and vomiting. It is objectionable in gouty subjects.

5. *German Wines.*—These are produced principally on the banks of the Rhine and the Moselle. They

are light wines, and remarkable, as I have already stated, for their very powerful bouquet (see p. 422), as well as for containing tartrate of alumina and potash (see p. 424). "A notion prevails that they are naturally acid; and the inferior kinds, no doubt, are so: but this is not the constant character of the Rhine wines, which in good years have no perceptible acidity to the taste, at least not more than is common to them with the growths of warmer regions. Their chief distinction is their extreme durability."

The *Johannisberger* stands at the head of the Rhine wines. It has a very choice flavour and perfume, and is characterized by an almost total want of acidity. *Steinberger* ranks next; and after this follow *Rudesheimer, Hochheimer*, &c. In this country the term *Hock* (a corruption of Hochheimer) is usually applied to the first growths of the Rhine; while the inferior Rhine wines are simply called *Rhenish wines*.

Of the *Moselle* wines the *Schartzberger* is deservedly esteemed.

The German wines of good quality, are, in general, light and wholesome; though they are occasionally objectionable on account of their acidulous character. They prove diuretic and slightly aperient. Liebig asserts that crystals of uric acid are never deposited from the urine under their use, on account of the tartar which they hold in solution.

6. *Claret Wines.*—Under this name are generally included the red wines of France, which are produced in the districts adjoining Bourdeaux. The most esteemed are, *Lafitte, Latour, Château-Margaux*, and

Haut-Brion. They are light and wholesome wines, and well adapted for the table; though in gouty and rheumatic subjects, and in some cases of dyspepsia, they prove injurious by their acidity.

7. *Burgundy.*—This wine enjoys the highest reputation on the continent. It is stimulant and somewhat astringent. It is apt to occasion headache or indigestion.

Other intoxicating drinks.—Among European nations alcohol is the basis of the inebriating drinks in ordinary use. But by the Mahometan, and other oriental nations, Opium and Hemp are employed for producing intoxication. The consideration of these, however, scarcely falls within the scope of the present work; and I must, therefore, refer the reader to my *Elements of Materia Medica* for full details respecting the effects and uses of these and other narcotic substances (Tobacco for example), which are used as inebriants.

3. CONDIMENTS OR SEASONING AGENTS.

The name of Condiment is usually given to those substances which are taken with foods for the immediate purpose of improving their flavour. But most of them serve other, and much more important, purposes in the animal economy, than that of merely gratifying the palate. Most of them are, in fact, alimentary substances—as Sugar, Oil or Fat, and Vegetable Acids. Common Salt, which by most dietetical

writers is spoken of as if it were a mere luxury,—as if its use were to gratify the palate merely,—is essential to health and life, and is as much an aliment or food as either bread or flesh. "Without salt, or some other mineral substance which can be substituted for it, as chloride of potassium, no solid substance could be taken into the system; nor, if it could be taken into the blood, could the albumen there be retained in solution; nor could the changes which are requisite for life take place in the tissues; nor could any bile be formed. As hydrochloric acid is found in the stomach, and soda in the bile and blood, it must be supposed that there exists some power in the body by which the chloride of sodium is decomposed *."

But all the substances employed as condiments are not necessary to our existence; and accordingly they are not assimilated. This is the case with the aromatic and pungent condiments, the volatile oil of which is, in many cases, thrown out of the system unchanged; as in the case of Onions. The purposes which these substances serve in the animal economy is not very obvious; but it is probable that they promote the activity of the assimilating organs, by acting as stimuli; and in some cases, perhaps, they may serve to correct the injurious qualities of the foods with which they are taken.

The following are the orders of condiments usually admitted. It will be seen that they have been already noticed in other parts of this work:—

---

* *On Gravel, Calculus, and Gout,* by H. Bence Jones, M.A. p. 46. Lond. 1842.

1. Saline Condiments (see *Common Salt*, p. 223).
2. Acidulous Condiments (see *Acetic Acid*, p. 148; *Citric Acid*, p. 151; and *Lemon Juice*, p. 356).
3. Oily Condiments (see the *Fixed Oils*, p. 166).
4. Saccharine Condiments (see *The Saccharine Alimentary Principle*, p. 112).
5. Aromatic and Pungent Condiments (see *The Volatile* or *Essential Oils*, p. 184).

Under the name of *Sauces* are used, at the table, mixtures of various condimentary and alimentary substances. Salt and spices are essential ingredients of them, and vinegar enters into the composition of several. *Ketchup* (made either from Mushrooms or Walnuts), *Soy*, and *Essence of Anchovies*, are the sauces in most frequent use. These substances are seldom employed in sufficient quantity to prove injurious by themselves; though by provoking the appetite, and thereby promoting the use of indigestible substances, they frequently prove indirectly injurious. By invalids and convalescents they should, therefore, be carefully avoided.

" Condiments," says Dr. Beaumont*, " particularly those of the spicy kind, are non-essential to the process of digestion, in a healthy state of the system. They afford no nutrition. Though they may assist the action of a debilitated stomach for a time, their continual use never fails to produce an indirect debility of that organ. They affect it as alcohol or other stimulants do—the *present* relief afforded is at the expense of *future* suffering. Salt and vinegar are

* *Experiments and Observations on the Gastric Juice and the Physiology of Digestion*, p. 40. Edinb. 1838.

exceptions, and are not noxious to this charge, when used in moderation. They both assist in digestion,—vinegar, by rendering muscular fibre more tender—and both together by producing a fluid having some analogy to the gastric juice."