ON FOOD.

FOUR CANTOR LECTURES,

DELIVERED BEFORE THE

Society for the Encouragement of Arts, Manufactures, and Commerce.

By H. LETHEBY, M.B., M.A., Ph.D., &c.,
PROFESSOR OF CHEMISTRY IN THE COLLEGE OF THE LONDON HOSPITAL, AND MEDICAL OFFICER OF HEALTH AND FOOD ANALYST FOR THE CITY OF LONDON.

Reprinted from the "Journal of the Society of Arts."

LONDON:
W. TROUNCE, PRINTER, 9, CURSITOR-STREET, CHANCERY-LANE.
1868.

LECTURES ON FOOD.

LECTURE I.—Delivered Monday, January 20, 1868.

VARIETIES OF FOOD—THEIR CHEMICAL COMPOSITION AND NUTRITIVE VALUE.

The economy of food, in its fullest signification, is a matter of national importance; for the political influence of a nation is as much dependent upon the muscular strength of the people as upon their intelligence and commercial industry; and this strength is wholly referable to a right use and proper distribution of food.

We perceive this not merely in the calamities of actual want, as in the fevers of famine, but also in the less prominent, but equally significant decline of health in times of partial distress, when the vigor and energy of the poorer part of the population are so reduced as to lay them open to disease. In fact, the exeprience of our public hospitals too often elicits the fact that the wasted power of the patient has been the advent of incurable disease. Nor is this all; for, as Mr. Simon observes—"Long before insufficiency of diet is a matter of hygienic concern; long before the physiologist would think of counting the grains of nitrogen and carbon which intervene between life and starvation, the household will have been utterly destitute of material comfort; clothing and fuel will have been scantier than food; against inclemencies of weather there will have been no adequate protection; dwelling-space will have been stinted to the degree in which over-crowding produces or increases disease; the home will be where shelter can be cheapest bought, where sanitary appliances are least considered, and where cleanliness is almost impossible." And all this distress falls heaviest upon those who are least able to bear it—the mother and her children; for the father, to be able to work, even lightly, must eat, and thus the others are the largest sufferers. Bad, however, as the immediate consequences are, they are nothing in comparison to the remote—the sickly race that comes of want.

In examining, therefore, this question of the economy of food, we must not only look at the nutritive value of different articles of diet, but we must also consider how food can be best distributed and utilized.

To-day we will investigate the principal varieties of food, and ascertain their peculiar qualities and dietetical values. For this purpose it will be necessary to have some standard for comparison, but this is avowedly a difficult matter; for if we compare foods according to the proportions of their principal constituents—viz., albuminous matters, starchy, saccharine, and saline—we shall find that the relative quantities vary to such a degree as to make the comparison almost useless; and if we fix our attention on one of these constituents—the nitrogenous, for example—and make it the exponent of nutritive value, we get into the difficulty of either overloading the equivalent with a large amount of carbonaceous material, or of having it deficient therein. If, for instance, we desire to know the quantities of different foods which would furnish the 1,200 grains of nitrogenous matter required by a man in his daily diet, we should find that the following are the proportions:—

Table I.

Proportions of Different Foods Required to Yield 1,200 Grains of Nitrogenous Matter.

	Grains.	Pounds.
Skim-cheese	2,681	0·4
Lean meat	6,217	0·9
White fish	6,630	1·0
Fat meat	9,231	1·3
Fat bacon	13,636	2·0
Bread	14,815	2·1
Rice	19,048	2·7
New-milk	29,268	4·2
Potatoes	57,143	8·2
Parsnips or turnips	100,000	14·3
Beer or porter	1,200,000	171·4

In this manner tables have been constructed of the nutritive values of food, and I show you one of them.

Table II.

Nutritive equivalents—calculated according to the amounts of Nitrogen in the Dry Substances; Human Milk being 100:—

VEGETABLE.

Rice	81	Oats	138
Potatoes	84	White bread	142
Maize	100	Black bread	166
Rye	106	Peas	239
Radish	106	Lentils	276
Wheat	119	Haricots	283
Barley	125	Beans	320

ANIMAL.

Human milk	100	Lamb	833
Cow's milk	237	White of egg	845
Yoke of egg	305	Lobster	859
Oysters	305	Skate	859
Cheese	331	Veal	873
Eel	434	Beef	880
Mussel	528	Pork	893
Ox-liver	570	Turbot	898
Pigeon	756	Ham	910
Mutton	773	Herring	914
Salmon	776		

I hardly need say that comparisons of this description are of little practical value, for they furnish no indication of the digestive labour required to utilize the products; besides which we are far from being assured, at the present time, that the nitrogenous elements of our foods are the most important.

In framing, therefore, a table of alimentary equivalents, regard must be paid to all the constituents. This I have endeavoured to express in Table No. 3, wherein I have shown the per cent. of nitrogenous and carbonaceous matter, and the proportions of the latter to one of the former; but here again the actual value of the several carbonaceous compounds is very different; for, although the fattening and respiratory powers of starch, gum, sugar, and pectin, may be nearly the same, yet the power of fat is about 2·5 times as great as that of sugar; and this must be considered, irrespective of other functions of fat, in estimating the value of carbonaceous food.

TABLE III.—NUTRITIVE VALUES OF FOOD.

	Water.	Albumen, &c.	Starch, &c.	Sugar.	Fat.	Salts.	Total Per Cent.		Carbonaceous to one Nitrogenous.
							Nitrogenous.	Carbonaceous.	
Bread	37	8·1	47·4	3·6	1·6	2·3	8·1	52·6	6·5
Wheat flour	15	10·8	66·3	4·2	2·0	1·7	10·8	72·5	6·7
Barley meal	15	6·3	69·4	4·9	2·4	2·0	6·3	76·7	12·2
Oatmeal	15	12·6	58·4	5·4	5·6	3·0	12·6	69·4	5·5
Rye meal	15	8·0	69·5	3·7	2·0	1·8	8·0	75·2	9·4
Indian meal	14	11·1	64·7	0·4	8·1	1·7	11·1	73·2	6·6
Rice	13	6·3	79·1	0·4	0·7	0·5	6·3	80·2	12·7
Peas	15	23·0	55·4	2·0	2·1	2·5	23·0	59·0	2·5
Arrowroot	18	..	82·0	..	..	..	..	82·0	..
Potatoes	75	2·1	18·8	3·2	0·2	0·7	2·1	22·2	10·6
Carrots	83	1·3	8·4	6·1	0·2	1·0	1·3	14·7	11·3
Parsnips	82	1·1	9·6	5·8	0·5	1·0	1·1	15·9	14·5
Turnips	91	1·2	5·1	2·1	..	0·6	1·2	7·2	6·0
Sugar	5	..	..	95·0	..	..	..	95·0	..
Treacle	23	..	..	77·0	..	..	..	77·0	..
New milk	86	4·1	..	5·2	3·9	0·8	4·1	9·1	2·2
Cream	66	2·7	..	2·8	26·7	1·8	2·7	29·5	10·9
Skim milk	88	4·0	..	5·4	1·8	0·8	4·0	7·2	1·8
Buttermilk	88	4·1	..	6·4	0·7	0·8	4·1	7·1	1·7
Chedder cheese	36	28·4	..	..	31·1	4·5	28·4	31·1	1·1
Skim do.	44	44·8	..	..	6·3	4·9	44·8	6·3	0·1
Lean beef	72	19·3	..	..	3·6	5·1	19·3	3·6	0·2
Fat do.	51	14·8	..	..	29·8	4·4	14·8	29·8	2·0
Lean mutton	72	18·3	..	..	4·9	4·8	18·3	4·9	0·3
Fat do.	53	12·4	..	..	31·1	3·5	12·4	31·1	2·5
Veal	63	16·5	..	..	15·8	4·7	16·5	15·8	1·0
Fat Pork	39	9·8	..	..	48·9	2·3	9·8	48·9	5·0
Green bacon	24	7·1	..	..	66·8	2·2	7·1	66·8	9·4
Dried do.	15	8·8	..	..	73·3	2·9	8·8	73·3	8·3
Ox liver	74	18·9	..	..	4·1	3·0	18·9	4·1	0·2
Tripe	68	13·2	..	..	16·4	2·4	13·2	16·4	1·3
Poultry	74	21·0	..	..	3·8	1·2	21·0	3·8	0·2
White fish	78	18·1	..	..	2·9	1·0	18·1	2·9	0·2
Eels	75	9·9	..	..	13·8	1·3	9·9	13·8	1·4
Salmon	77	16·1	..	..	5·5	1·4	16·1	5·5	0·3
Entire egg	74	14·0	..	..	10·5	1·5	14·0	10·5	0·7
White of do.	78	20·4	..	..	..	1·6	20·4	..	..
Yolk of ditto.	52	16·0	..	..	30·7	1·3	16·0	30·7	1·9
Butter and fats	15	..	..	..	83·0	2·0	..	83·0	..
Beer and porter	91	0·1	..	8·7	..	0·2	0·1	8·7	87·0

Another method of determining the values of food, is by estimating the proportions of nitrogen and carbon in them, and comparing them with the proportions required in a standard diet.

Judging from the minimum quantities of food which an ordinary individual is capable of existing on, without suffering in health, it would seem that about 4,100 grains of carbon, and 190 grains of nitrogen are required in his daily diet. These proportions have been determined from a large number of observations, as by those of Dr. Lyon Playfair, in his inquiries into the dietaries of hospitals, prisons, and workhouses, and by those of Dr. Edward Smith, in his examination of the amounts of food which the Lancashire operatives were capable of living on during the cotton famine, and also by his inquiries into the dietaries of in-door labourers. The proportions which Dr. Smith gives as a famine or barely sustaining diet, are the following:—

	Carbon (grains).	Nitrogen (grains).
Adult woman	3,900	180
Adult man	4,300	200
Average adult	4,100	190

These proportions are contained in 2lbs., and in 2lbs. 3oz. of bread; and they closely accord with another set of facts, derived from an examination of the amounts of carbon and nitrogen exhaled and secreted from the body during health and idleness.

Taking these numbers, therefore, as the exponents of the nutritive values of food, we are able to construct the following table:—

TABLE IV.—NUTRITIVE VALUES OF FOOD.

	Grains per Pound.		Value per Pound	Grains for One Penny.		Weekly Cost of Famine Diet for	
	Carbon.	Nitrogen.		Carbon.	Nitrogen.	Carbon.	Nitrogen.
			d.			d.	d.
Split peas	2730	255	1	2730	255	10·5	5·2
ndian meal	2800	123	1	2800	123	10·2	10·8
Barley meal	2730	70	1	2730	70	10·5	19·0
Rye meal	2660	88	1¼	2128	70	13·5	19·0
Seconds flour	2660	120	1½	1773	80	16·2	16·6
Oatmeal	2800	140	2	1400	70	20·4	19·0
Bakers' bread	1995	90	1½	1330	60	21·6	22·1
Pearl barley	2660	91	2	1330	45	21·6	29·5
Rice	2730	70	2	1365	35	20·5	38·0
Potatoes	770	24	0½	1540	48	18·6	27·7
Turnips	238	13	0½	476	26	60·3	51·1
Green vegetables	420	14	0½	840	24	34·1	55·4
Carrots	385	14	1	385	14	74·8	95·0
Parsnips	421	12	1	421	12	66·4	110·8
Sugar	2800	..	5	560	..	51·2	..
Treacle	2200	..	1	2200	..	13·0	..
Buttermilk	335	35	0½	670	70	42·8	19·0
Whey	154	13	0¼	626	52	45·8	25·6
Skimmed milk	350	34	1	350	34	82·2	39·1
New milk	378	35	2	189	18	154·0	73·9
Skim cheese	2348	364	3	783	121	36·6	11·0
Cheddar do.	2520	315	8	315	39	91·1	34·1
Bullocks' liver	1226	210	3	408	70	70·3	19·0
Mutton	2902	140	5	580	28	49·5	47·5
Beef	2301	175	8	288	22	99·6	60·5
Fresh pork	2950	108	7	421	15	68·1	88·7
Dry bacon	4270	98	9	474	11	60·5	120·9
Green do.	3990	79	8	492	10	58·3	133·0
White fish	900	130	2	450	65	63·8	20·4
Red herrings	1435	217	4	359	54	80·0	24·6
Dripping	5320	..	6	887	..	32·3	..
Suet	4710	..	7	673	..	42·6	..
Lard	4819	..	9	535	..	53·6	..
Salt butter	4585	..	12	382	..	75·1	..
Fresh do.	4712	..	16	294	..	97·6	..
Cocoa	3934	140	4	983	35	29·2	38·0
Beer and porter	315	1	1	315	1	91·1	1330·0

And now we may proceed to examine in detail the general properties, and the nutritive qualities of different foods.

Primarily all our foods are derived from the vegetable kingdom, for no animal has the physiological power of associating mineral elements, and forming them into food. What we may yet do by means of chemical agencies in the laboratory is another question; but within our own bodies there is no faculty for such conversion. As I shall hereafter explain to you, our functions are of an opposite kind. We are destructive creatures, not constructive. It is our province to pull down what the vegetable has built up; to let loose the affinities which the plant has brought into bondage, and to restore to inanimate nature the matter and cosmical force which the growing plant had taken from her.

Foremost, therefore, of our foods are those which come at once from the vegetable kingdom; and of these the *cereals* are the most important, as wheat, barley, oats, rye, maize, or Indian corn, rice, millet or durra, and Guinea corn.

Wheat.—Different species of this grain are cultivated, but the most common in this country is *Triticum vulgare*, of which there is a summer and winter variety.

The grain varies a good deal in composition according to season, climate, and soil; but, as a rule, the wheat of southern climates, and warm seasons, is richer in gluten, and of harder texture than that of colder times. They are then called stronger grains, although the latter, from their being softer and kinder, give a larger proportion of flour. Some of the hardest varieties of wheat, as *rivets*, are used to strengthen the flour of new grain, which is always unmanageable, and to improve that of bad seasons and of damaged quality.

The structure of the grain is like that of all the cereals; there is an outer siliceous and woody covering, which is altogether valueless as food; then there is a layer of rich nitrogenous matter, containing a digestive body called *cerealine*, and within that is the flour, which forms the great bulk of the seed.

When ground whole, it forms *brown meal*, which is rarely used in England at the present time, although it was the common food of our forefathers, and even now is much employed in Westphalia, to make the dark-coloured bread called *pumper-nickel*. It contains from 5 to 12 per cent. of indigestible matter, in the form of bran, the removal of which, according to Liebig, is only a refinement of luxury.

The practice at the present time is to bolt or sift the ground meal through sieves, or silks, of different degrees of fineness, and thus to remove the coarser bran. The products have different names in different places, and have also different values; but generally a hundred pounds of wheat will yield from 78 to 80 parts of good serviceable flour. The other products are about 2 parts of *specks*, or *tails*, or *tippings*; from 2 to 3 parts of *sharps*; about 3 of *fine pollard*; from 3·5 to 6 of *coarse pollard*; and from 4 to 10 of *bran*. The relative wholesale values of these are about as follows:—

Vegetable Foods.	lbs. per bushel.	Price per bushel.	Price per 20 lbs.
		s. d.	s. d.
Fine flour	56	10 0	3 7
Seconds ditto	56	7 9	2 9
Sharps	26	2 0	1 6
Fine pollards	18	1 0	1 1
Coarse ditto	14	0 10	1 2
Bran	12	0 9	1 3

Seconds flour is practically the best for domestic use; and of this there should be at least 80 per cent. obtained from the grain. Attempts have often been made to increase the produce; for as the bran contains a good deal of nitrogenous matter, and is, moreover, rich in fat and saline substances, it has been thought wasteful to remove it; but the experimental researches of Poggiale, the learned professor at Val-de-Grace, have shown that at least 50 per cent. of the bran is perfectly indigestible, and may be passed successively through the bodies of four or five animals without undergoing change. It, moreover, acts as an irritant; and, by hurrying the food through the alimentary canal, is very likely to cause waste. Those who labour hard, as railway navigators, invariably choose the whitest bread for food, believing that it is not only more digestible, but it is stronger, and will enable them to do more work. Without doubt, however, there is room for improvement in the treatment of flour, and in the complete utilization of its several constituents. M. Mège Mouries has invented a process whereby the outer skin only of the wheat may be removed, and from 86 to 88 per cent. of flour realised. The process was examined in 1857, and reported very favourably of by Dumas, Pelouze, Payen, Peligot, and Chevreul, but I am not aware that it has come into use.

M. Mège Mouries also directed attention to the fact that the bran contains a portion of very soluble nitrogenous matter, *cerealine*, which is of the nature of diastase, and has the property of dissolving starch. This, no doubt, might be utilized by treating bran with warm water, and then using the water in the manufacture of bread.

The nutritive value of wheat is shown in Tables No. 3 and No. 4; and although the average amount of gluten is there set down at about 11 per cent., it ranges from 8 to 15 per cent.—the largest quantity being found in the wheaten flour of India, Egypt, South America, and the South of Europe.

It appears, too, that the quantity of gluten, as represented by nitrogen, increases with the coarseness of the flour, and so, also, does the amount of mineral matter.

TABLE V.

Percentage amounts of Nitrogen and Mineral Matter in the different Products of the Mill:—

	Nitrogen.		Mineral matter.
Fine flour	1·70	..	0·71
Tails	1·86	..	0·99
Fine sharps	2·21	..	1·89
Coarse sharps	2·58	..	3·80
Fine pollard	2·44	..	5·50
Coarse pollard	2·42	..	6·50
Bran.....................	2·39	..	7·00
Average in whole grain	1·82	..	1·62

The starch and sugar amount to about 70·5 per cent. and the fat to 1·7; so that the carbonaceous is to the nitrogenous as 6·7 to 1, which is a good proportion. Other facts relating to its nutritive value are shown in Table No. 4.

The tests for a good flour are its sweetness and freedom from acidity or musty flavour; and its nutritive value, as far as gluten is concerned, is estimated by the process of Beccaria, who discovered gluten in wheat more than a century ago. A given weight of flour (say 500 grains) is made into a stiff dough, and is carefully washed by tender manipulation under a small stream of water. The gluten remains, and when baked it expands into a clean-looking ball, which should weigh, when thoroughly dried, about 54 grains.

Of all the preparations of flour, *bread* is the most important. I shall hereafter describe the process of making it, but I may here remark that it should not contain more than from 36 to 38 per cent. of water, and the other constituents, excepting salt, should be the same as of good flour.

In practice, 100 lbs. of flour will make from 133 to 137 lbs. of bread, a good average being 134; so that a sack of flour of 286 lbs. should yield 95 four-pound loaves. The art of the baker, however, is to increase this quantity, and he does it by hardening the gluten through the agency of a little alum, or by means of a gummy mess of boiled rice, three or four pounds of which will, when boiled for two or three hours in as many gallons of water, make a sack of flour yield 100 four-pound loaves. But the bread is dropsical, and gets soft and sodden at the base where it stands. A good loaf should have the following characters:—

Kindness of structure—that is, not chaffy, or flaky, or crummy, or sodden; and
Sweetness to the palate and to the smell.

Wheaten bread is best eaten on the day after it is baked, for new bread is difficult of mastication, and still more difficult of digestion, because of its gummy nature. When it becomes stale it does not really get much dryer, but it undergoes a molecular change, which may be restored by heating the bread in a closed vessel to a temperature of 212°.

Wheaten bread is preferred to all other varieties of bread, because of its sweetness, and because it may be eaten alone. The nutritive constituents of it are in the same proportion as in wheat—namely, as 1 to 6·5, and a little more than two pounds of bread will supply the requirements of the system; although, as I shall hereafter explain, it cannot be used alone without loss of health and strength.

Barley-meal is the chief food of a large number of people in the North of Europe and in the South of England, where the labourer is partly paid his wages in meal or grain. It is also used in Wales and Scotland, especially in winter time, when wheaten bread is dear; and to some extent in Ireland. It is employed by about ninety per cent. of the outdoor labouring population of England. At the time of Charles I. (in 1626), according to M'Culloch, it was the usual food of the ordinary sort of people; and as late as the middle of the last century hardly any wheat was used in the northern counties of England. In Cumberland the principal families used only a small quantity about Christmas-time; and the crust of the everlasting goose-pie, which adorned the table of every country family, was invariably made of barley-meal.

The grain is almost always ground whole, and the farina has much resemblance to wheaten flour; but the amount of gluten is very different, in fact, the nitrogenous matter, which amounts to about six per cent., is chiefly in the form of albumen, hence, the bread is heavy and compact, for albumen will not vesiculate or sponge like gluten. The common way of making it into bread, is by mixing it with an equal proportion of wheaten flour; and sometimes it is mixed with oatmeal and rye-meal, and baked into cakes. But the best way of using it is in the form of thick gruel or stirabout, which is made by stirring the meal into boiling water.

Pearl Barley and Scotch Barley are the grain deprived of its husk, and rounded by attrition. The former is more carefully prepared than the latter, but both are used to give consistence to broth.

The nutritive value of barley meal is somewhat inferior to that of wheaten flour, but as the meal is cheaper than flour, it is more economical to use it: in fact, it is almost

he cheapest article of diet, as may be seen by reference
› Table No. 4.

Oatmeal and rye-bread were once the chief diet of the
ervants of the wealthy, and even now the former is used
y 90 per cent. of the agricultural labourers of England,
nd by a still larger proportion of the Scotch. The grain
very rich in gluten and fat, and it contains a good
uantity of sugar and starch, the microscopic form of
hich is remarkable. The Scotch meal is always pre-
rable to the English, on account of its higher nutritive
ower. It is prepared by grinding the kiln-dried grains,
reviously deprived of their skins. The Scotch grind it
ather coarsely as compared with the practice in England.

Oatmeal is not nearly so white as wheaten flour, and
s taste is peculiar, being at first sweet, then rough and
itter. Like barley-meal, it cannot be vesiculated into
read, but it makes good cakes, and these may be either
avened, as is the custom in Yorkshire, or unleavened,
s in Scotland.

The common method of cooking it, however, is by
irring it into boiling water until it has the consistence
f hasty pudding, and in this manner *porridge* is made;
ut if it be afterwards boiled for a short time it makes
cotch *brose*. In Ireland it is mixed with Indian meal,
nd then stirred into boiling water, thus making the
ixture called *stirabout*.

The decorticated grain constitutes *grits* or *groats*, and
hen these are crushed or bruised they go by the name
f *Emden groats*. The sole use of them is for making
ruel, a drink that seems to have been a favourite with
ur forefathers; for in the *London Gazette*, for Friday,
ugust 13, 1695, there is an advertisement to the effect
at water-gruel was always ready at the Marine
offee-house, in Birchin-lane, Cornhill, every morning
om six to eleven o'clock; and, it added, that as much
from four to five gallons of it were consumed there
ily.

The husks of the grains are sold in Scotland under
e name of *seeds*, and these, when steeped in water for
few days, until they become a little sour, like stale
rewers' grains, and then squeezed out, produce a liquid
hich, when boiled down to the consistence of gruel,
akes the food called *flummery* or *sowans* in Scotland, and
ican in South Wales. If it be boiled still more, until
becomes as thick as jelly, it forms *budrum*, or *brwchan*,
it is named in Wales. Oatmeal is, no doubt, rather
rd of digestion, and causes irritation of the bowels.
here is a notion also that it produces heat and irritation
the skin; and formerly, when sufficient care was not
ken to remove the husk from the grain before it was
ound, it was not an uncommon occurrence to find
lculi or concretions of phosphate of lime, mixed with
e silky bristles of the grain, in the alimentary canal.
mewhat similar concretions are found at the present
ne in the bowels of horses that feed too freely on bran
grains. The nutritive value of oatmeal is shown in
bles No. 3 and No. 4, and it will be noticed that
hough it is, weight for weight, more nutritive than
heaten flour, yet, considering its price, it is not so
onomical.

Rye meal is the chief food of northern nations, and
s once a common article of diet with ourselves. It
ms the dark-coloured and sour-tasting bread of the
rth of Europe. In this country it is rarely eaten
ne, but is mixed with about twice its bulk of wheaten
ur, forming what in many places is called *maslin*, and
then made into bread. The nutritive power of rye-
al is a little less than that of flour, and the proportion
the nitrogenous to the carbonaceous constituents is
1 to 9·4.

Maize or *Indian Corn* is one of the most extensively
d grains in the world. It enters largely into the food
the inhabitants of America, Italy, Corsica, Spain, the
th of France, and the Danubian Principalities. Since
famine in Ireland, it has there also become a common
icle of diet, especially when potatoes are dear; but its
vour is harsh and peculiar, and nothing but a scarcity
of more agreeable food reconciles people to its use. The
young grain called *cob*, is, however, more palatable, and
forms, when boiled in milk, an American luxury, which
takes the place of green peas.

The farina is peculiar when examined under the
microscope, and will thus serve to recognise it.

Although the meal is rich in nitrogenous matter and
fat, it does not make good bread. It is, therefore, either
cooked by baking it into cakes, or by stirring it into
boiling water, or boiling milk, as in the case of oatmeal,
and thus making a sort of hasty-pudding, or thick
porridge. This is the method of using it in Ireland, and
it is flavoured with salt, or butter, or treacle. The
favourite mess called *corn-lob* by the creoles of British
Honduras, is prepared with milk in the same way.
Indian meal mixed with maple sugar, and baked into
cakes, formed, at one time, the chief article of diet of the
almost extinct Delaware Indians.

When deprived of its gluten, and harsh flavour, by
means of a weak solution of caustic soda, and then dried,
it forms the expensive food called *Oswego* or *corn flour*,
which is now largely used for puddings.

Lastly, it is often mixed with wheaten-flour and baked
into bread, but its harsh taste is never completely covered.

The grain is said to cause disease when eaten for a
long time, and without other meal—the symptoms being
a scaly eruption upon the hands, great prostration of the
vital powers, and death after a year or so, with extreme
emaciation. These effects have been frequently observed
among the peasants of Italy, who use the meal as their
chief food, but I am not aware of any such effects having
been seen in Ireland, where it is often the only article of
diet.

The nutritive power of Indian meal is very high, and,
considering its price, it is almost, if not altogether, the
cheapest food for the poor. Calculated according to the
physiological wants of the system, a week's diet for an
adult will only cost about 10½d., and excepting split-
peas, which are of doubtful digestibility, there is nothing
approaching it for economy.

Rice is the principal food of eastern and southern
nations. It is extensively cultivated in India, China,
South America, and the southern countries of Europe;
and it gives nourishment to not less than a hundred
millions of persons. In this country, however, it is
rarely employed, except as an adjunct to other foods.
Now and then, in times of scarcity, it is used in the
place of potatoes. Perhaps 50 per cent. of our labouring
classes use it in this manner. It is imported into this
country in a decorticated or cleaned condition, but when
it has the husk upon it, it is called *paddy*. The kinds
which are most esteemed in this country are Carolina
and Patna; but according to Dr. Watson, there are
many Indian varieties which are nearly equal to the
American. The proportion of gluten in it is only about
6·3 per cent., and it rarely exceeds 7. It is, in fact, one
of the least nitrogenous of all the cereals, and cannot be
made into bread, unless it is mixed with wheaten-flour,
as is the custom in Paris, in making the best white
bread. The proportion of nitrogenous to carbonaceous
matter is as 1 to 12·7, or nearly twice the amount in
wheat. It is, therefore, a good adjunct to highly plastic
foods, as ox-liver, poultry, veal, and fish; with all of
which it goes well, especially in the savoury form of
curry. Boiled with milk also, and dressed with egg, as
rice pudding, it forms a substantial meal; but in no
country is it eaten alone.

The *Millets*, called also *Dhurra* or *Dhoora*, are another
kind of grain, and are derived from many species of
plants, as *sorghum*, *penicellaria*, *panicum*, &c. Like rice,
they are extensively cultivated in India, Egypt, and the
interior of Africa, where they are important articles of
diet. They are a little more nutritious than rice: for
they contain, on an average, about 9 per cent. of nitro-
genous matter, with 74 of starch and sugar, 2·6 of fat,
and 2·3 of mineral matter. We have no experience of
their nutritive properties in this country, except in feed-

ing birds; but in India the grains are ground whole and made into bread.

The last of the grains of any importance is *Quinoa*, a species of *chenopodium*. It is hardly known in this country, although it is extensively cultivated and consumed on the high table-lands of Chili and Peru. Mr. Johnston has described it, and he says there are two varieties of it—the sweet and bitter—both of which grow at an elevation of 13,000 feet above the level of the sea, where barley and rye refuse to ripen. It is very nutritious, and approaches oatmeal in its chemical composition, the amount of gluten being about 19 per cent., the starch and sugar 60 per cent., and the fat 5.

Th next class of farinaceous foods are the *pulses*, as *peas*, *eans*, and *lentils* of this country, and the *dholls* and *grams* of India. They are grown and eaten in all parts of the world, and are everywhere regarded as very nutritious when they can be digested. Nothing, however, but the most prolonged cooking will serve to help in this particular. As will be seen by reference to the tables, where the composition of peas, the type of all of them, is given, they are rich in nitrogenous matter, for peas and beans contain about 23 per cent., and lentils about 25 ; but the carbonaceous constituents amount to only 59 per cent., or 1 to 2½. They are therefore, when eaten, invariably associated with fat. In India, the favourite pea (*cajanus Indicus*) is rubbed with oil before it is cooked. In Yucatan, and throughout the whole of Central America, where black beans, called *frijoles*, are extensively used as food, they are well boiled in water, and eaten with pepper, salt, and pork. In this country, butter with peas, and fat bacon with beans, are inseparable companions. Lastly, revalenta or ground lentils with cocoa, which contains over 50 per cent. of fat, are mixed in a well-known fancy preparation. The nitrogenous matter of the pulses is not of the nature of gluten, but is more like casein, or the cheesy matter of milk, and it was named by Braconnot, its discoverer, *Legumine*.

Other farinaceous foods, of little importance to us, are the meal of the *edible chesnut*, which is largely used by the peasants of Lombardy; the *Manioc* and *Lotsa meal*, which, Dr. Livingstone says, are the chief vegetable foods of the natives of some parts of South Africa; perhaps, also, the *horse-chesnut* and the *acorn* might be added to the list, for there is hope of their being easily freed from the bitter principle which now renders them useless.

And last of this class of foods are the *starches* and *arrow-roots*, which are largely imported or prepared in this country. They are *Bermuda*, *Jamaica*, or *West Indian arrow-roots*, from *maranta arundinacea ; East Indian arrowroot*, from various species of *curcuma ; Tous-les-mois*, from *canna ; Brazilian arrowroot*, from *jatropha manihot*, which, when dried and partially cooked on hot plates, makes *tapioca ;* and which, when baked in its whole condition, forms *cassava* bread ; *sago* and *sago-meal*, from the fruit of various species of *sagus ; Tahiti arrow-root*, from a *tacca ; Portland arrowroot*, from the tubers of an *arum ;* and *English arrowroot* from *potatoes*. All these are obtained in the same way—namely, by crushing, or bruising, or rasping the root or other substance containing them, and after diffusing through water, allowing the starch or fæculoid matter to deposit ; it is then collected on a cloth and dried. In this country, starches are obtained by soaking the grain in an alkaline liquor, which dissolves the gluten, and then crushing between mills, straining to keep back the husk and cellulose, and then washing with water, and allowing the starch to subside. By this method of manufacture a quantity of gluten is obtained, which can be set free from the alkali by an acid, and collected for food.

All the starches and arrowroots are known by their microscopic characters; and although they have the same chemical composition and nutritive value, yet they are very different in their digestibility, for the true arrow-roots of the West Indies, as Bermuda and Jamaica, will often remain on the stomach of an invalid when the others will be rejected.

They contain no nitrogen, or but a trace of it, and therefore have no nitrogenous value, but they are useful for their carbonaceous properties ; and they are best cooked by stirring them into boiling water or boiling milk, and then simmering for a minute or so.

The next class of vegetable foods are those which contain much water, and which may be called *succulent vegetable foods*, of which the *potato* is the most important.

Brought to us from America, in the seventeenth century, as a rarity, by Sir Walter Raleigh, it has gradually become an almost universal article of diet ; for its advantages are so numerous that it will ever be a favourite food. It is, for example, easily cultivated, easily kept, easily cooked, and easily digested ; besides which it requires but little flavouring matter, and never wearies the palate. It is therefore used in times of plenty by all classes of persons, and is often eaten in quantities that approach very nearly to the rice allowance of a hungry Hindoo. " In Ireland," says Dr. Edward Smith, " when the season arrives and potatoes are plentiful, as much as 3½lbs. are consumed three times in a day by an adult. This, indeed, is the regular allowance, and an Irishman finds no difficulty in consuming his rations of 10½lbs. of potatoes daily." In England, the farm labourer consumes, on an average, hardly as much in a week. In Anglesea, however, potatoes are eaten twice a day, and the consumption is about 16½lbs. per adult weekly ; and in Scotland the average allowance is 15lbs. per head weekly.

The nutritive value of the potato is not great, for, in the first place, it contains only about 25 per cent. of solid matter, and of this hardly 2·1 is nitrogenous. Potatoes are also deficient of fat, and therefore they require admixture with nourishing materials. They go well with meat and fish, and are considerably helped with a little dripping or butter ; but the great adjunct is milk. In Ireland, potatoes and buttermilk are the principal diet, even in times of plenty.

Considering the cheapness of potatoes, they are a most economical food. At the price of a halfpenny a pound, as set down in table No. 4, it costs but two shillings and threepence a week to provide the carbon and nitrogen required by an adult ; but when potatoes are cultivated upon cottage ground, by wife and children, as is the practice almost everywhere, as much as seven pounds can be easily obtained for a penny, and then the weekly diet would be rather less than eight-pence. At this price no vegetable food can compete with it.

Potatoes are best cooked in their skins, for the waste is then only about three per cent., or half an ounce in a pound ; whereas, if they are peeled first, it is not less than 14 per cent., or from two to three ounces in a pound. The mealy varieties are more digestible than the close and waxy ; in fact, when they are in this state, as is the case with new potatoes, and potatoes late in the season which have begun to grow, they are best cooked by stewing them.

All succulent vegetables are endowed with anti-scorbutic powers, but potatoes are especially renowned for this property. As far back as the year 1781, Sir Gilbert Blane, in his work on the "Diseases of the Fleet," alluded to the beneficial action of the potato in scurvy, and from that time to the present, its salutary powers have been repeatedly observed. The late Dr. Baly remarked, in his inquiries into the diseases of prisoners, that wherever potatoes were used scurvy was unknown ; and it is the almost universal practice now to carry potatoes, fresh or preserved, in all ocean-going vessels, with the view of preventing scurvy.

Other succulent vegetables in common use, as *turnips*, *parsnips*, *carrots*, *artichokes*, *onions*, *leeks*, *cauliflowers*, *cabbages*, and *greens*, have, among themselves, nearly the same nutritive value, but they are all much less nutritious than the potato, as will be seen by reference to the Table No. 3 ; in fact, they do not contain more than from 9 to 17 per cent. of solid matter, and of this only about 1·

is nitrogenous. They are chiefly valuable for their anti-scorbutic properties, and for their quality of flavouring insipid food, and diluting strong ones.

Banana and *bread-fruit* are also valuable esculent foods, and are largely used in the tropics. The former contains about 27 per cent. of solid matter, of nearly the same nutritive value as rice. About 6½ lbs. of the fresh fruit, or 2 lbs. of the dry meal, with a quarter of a pound of salt meat or fish, is a common allowance for a labourer. The *bread-fruit* is largely eaten by the natives of the Indian Archipelago, and of the Islands of the South Sea. There are several varieties of it which come into season at different times. It is very juicy, containing about 80 per cent. of water, and is generally gathered before it is ripe, when the starch is in a mealy condition, and has not undergone change into sugar. The fresh fruit is cooked, by peeling it, wrapping it in leaves, and baking it between hot stones. It then tastes like sweet bread; but much of the ripe fruit is preserved by peeling it, cutting it into slices, and packing it very closely in pits in the ground, made water-light, and lined with banana leaves. After a while it undergoes a sort of fermentation, or, as we should call it from the smell, putrefaction, and the fruit settles into a mass, of the consistence of soft cheese. When it is required for use, it is well kneaded, wrapped in leaves, and baked, like the fresh fruit, between hot stones.

Ripe fruits, as *apples, pears, peaches, pine-apples, oranges,* &c., are not of much nutritive value, for they rarely contain above 13 per cent. of solid matter, and this is of no more value than so much rice, but they have agreeable flavours, and serve the purpose of anti-scorbutic drinks.

Marine Algæ.—Everywhere along our coasts, there is abundance of comparatively nutritious food, which may, by a little management, be made palatable. I allude to our *sea-weeds;* and this Society has distinguished itself by its efforts to utilize this stock of now almost profitless food. Judging from the analysis of Dr. Davy and Dr. Apjohn, of Dublin, it would seem that when in a moderately dry condition sea-weeds contain from 18 to 26 per cent. of water; and that the nitrogenous constituents amount to from 9½ to 15 per cent., while the starchy matter and sugar average about 66 per cent. These results place sea-weeds among the most nutritrious of vegetable substances; in fact they are richer in nitrogenous matter than oatmeal or Indian corn.

The varieties of sea-weed at present used are the following:—

Porphyra laciniata and *vulgaris,* called *laver* in England, *sloke* in Ireland, and *slouk* in Scotland.

Chondrus crispus, called *carrageen* or *Irish moss,* and also *pearl-moss.*

Laminaria digitata, known as *sea girdle* in England, *tangle* in Scotland, and *red-ware* in the Orkneys; and *Laminaria saccharina alaria esculenta* or *bladder-lock,* called also *hen-ware* and *honey-ware* by the Scotch.

Ulva latissima or *green laver.*—*Rhodomenia palmata,* or *dulse* of Scotland.—These, with many others, are eaten by the coast inhabitants of this country and the Continent. In some parts of Scotland and Ireland they form a considerable portion of the diet of the poor.

To prepare them for food, they should first be steeped in water to remove saline matter; and in some cases a little carbonate of soda added to the water will remove the bitterness. They are then stewed in water or milk until they are tender and mucilaginous; and they are best flavoured with pepper and vinegar. Under the name of *marine sauce,* the lavers were once a luxury in London.

As to the last of the vegetable foods—namely, the *fungi* or *mushrooms*—I have but little to say; for although the edible varieties are highly nutritious, yet they can never become an important article of diet. Most of them are employed at the present time as flavouring agents; and among these are the *common mushroom* for ketchup, the *morel* for gravies, and the *truffle* for turkeys and the livers of geese *(Pâté de foie gras).*

Sugar and *Treacle.*—Both of these are very generally consumed on account of their flavouring and fattening qualities Dr. Edward Smith found that 98 per cent. of indoor operatives partook of sugar, to the extent of 7½ ozs. per adult, weekly. 96 per cent. of Scotch labourers use it, and 80 per cent. of Irish. In Wales, also, it is commonly used to an average extent of 6 ozs. per adult weekly; but there is a marked difference in the rate of consumption in the northern and southern portions of the country. In North Wales, for example, the average amount per head is 11¼ ozs.; whereas, in South Wales it is only 3 ozs. The principle use of it is to sweeten tea.

Treacle has more flavour than sugar, and it is also cheaper. It is, therefore, more largely employed; and that description of it properly called *mollasses,* which is the draining from the raw or unrefined sugar—treacle being the drainings from refined sugar,—is preferred on account of its stronger flavour, and is most usually sold for treacle. They go well with all descriptions of farinaceous food, as porridge, pudding, dumpling and bread.

Sugar contains from 4 to 10 per cent. of moisture, and treacle about 23. The rest is carbonaceous matter, without nitrogen. They are, therefore, heat-producing and fattening agents, and their power, in these respects, is about the same as with starch. Whether they can produce disease when used in excess is a matter of doubt; but Dr. Richardson declares that they cause blindness by creating opacity of the lens *(cataract).*

Animal Foods.—First on the list of these is *milk,* a liquid which contains all the elements of food required by the very young, and is therefore regarded as the type or standard of food.

In some countries, as Switzerland, it is the chief diet of the peasantry; and everywhere, if easily obtained, it is largely consumed. 76 per cent. of the labouring classes of England make use of it; 83 per cent. take it as butter-milk; and 53 per cent. as skimmed-milk. In Wales, the average consumption of it by farm labourers is 4½ pints per adult weekly—South Wales averaging only 3 pints, while in North Wales it is 7½. In Scotland the consumption among the labouring classes is still larger, for it amounts to 6½ pints per head weekly, and in Ireland it reaches 6¾ pints. Those who take least of it are the poor in-door operatives of London; the weavers of Spitalfields, for example, use only about 7·6 oz. per head weekly, and those of Bethnal-green only a fraction above 1½ ozs. per head. When examined under the microscope, milk is found to consist of myriads of little globules of butter floating in a clear liquid. On standing for a few hours the oily particles rise to the surface and form a cream, the proportion of which is the test of quality. Cows'-milk is heavier than water in the proportion of from 1,030 or 1,032 to 1,000. Asses' milk is the lightest, for its gravity is only about 1,019; then comes human milk, 1,020; and, lastly, goat and ewes' milk, which is the heaviest of all, from 1,035 to 1,042.

The quality of milk varies with the breed of the cow, the nature of its food, and the time of milking, for afternoon milk is always richer than morning, and the last drawn than the first. Taking, however, the average of a large number of samples, it may be said that cows' milk contains 14 per cent. of solid matter, 4·1 of which are casein, 5·2 sugar, 3·9 butter, and 0·8 saline matter. The relations of nitrogenous to the carbonaceous is 1 to 2·2; but as fat is 2½ times more powerful than starch, the relation may be said to be as 1 to 3·6.

When milk is heated to the boiling temperature, the casein is coagulated to some extent; and if the milk has stood before it is heated, so that the cream may rise, the coagulum includes the cream, and makes the so-called Devonshire or *clotted cream.*

Acids also coagulate the casein, and produce a curd, as in the making of cheese and curds and whey.

Cream is rich in butter, as will be seen by reference to Table No. 3. It contains 34 per cent. of solid matter, 26·7 of which are butter, and its gravity is about 1,013.

Skim-milk is the milk from which the cream has been

B

removed. It contains only about half as much butter as new milk, and its gravity is about 1,037. In all other respects it is similar to new milk.

Buttermilk is the residue of the milk or cream from which the butter has been removed by churning. It is still poorer in fat than skim-milk, containing, in fact, only about half as much. Unless it is very fresh, it is generally a little acid, and frequently the acidity has gone so far as to set the milk into a kind of jelly.

The *whey* of milk is the opalescent liquor from which the curd has been removed in making cheese. Although not highly nutritious, it still holds a little casein in solution, as well as the sugar and saline matter of the milk. It is rarely used as food by the poor, but is given to pigs. In Switzerland, however, it is considered to have medicinal virtues, especially for the cure of chronic disorders of the abdominal organs, and the treatment, which is somewhat fashionable, goes by the name of *cure de petit lait*. There is a popular notion, that the whey of milk is sudorific, and hence we have our *wine whey*, *cream of tartar whey*, *alum whey*, *tamarand whey*, &c., when the milk has been curdled by these several substances.

Cheese is the coagulated product of milk, obtained by the addition of rennet or a little vinegar. When cream is coagulated it makes *cream cheese*, which will hardly bear keeping, but must be eaten fresh. It contains about half its weight of butter, and a fifth of its weight only of curd.

When cream is added to new milk, and the mixture is curdled, it forms very rich cheese, as *double Gloucester* and *Stilton*.

When new milk alone is used the cheese is less rich, but still of high quality, as *Cheddar*.

When an eighth or a tenth of the cream has been taken off, it produces the quality of cheese which is most sought after, as single Gloucester, Chester, American, &c.

And when all the cream has been removed, and the skim-milk is curdled, it forms the poor cheese of Holland, Friesland, Suffolk, Somersetshire, and South Wales.

At first every variety of cheese is soft and comparatively tasteless, but by keeping they undergo change, and develop their flavours, when they are said to be ripe.

Analyses of two of the most important of them are shown on Table No. 3, and it will be noticed that they contain from 56 to 64 per cent. of solid matter, about half of which is curd. In skim-milk cheese the curd amounts to 44·8 per cent., and the fat to only 3·6; whereas, in Cheddar, the curd is only 28·4 per cent., and the fat 31·1. In nutritive power, therefore, especially in nitrogenous matter, cheese ranks high, and is a valuable article of diet; but there is a limit to its digestibility, and hence it cannot be taken in large quantity. Considering its price also, it is hardly so profitable as many other foods; although, where good skim-milk cheese can be purchased at from 2½d. to 3d. a pound it forms, in small quantities at a time, a good adjunct to bread.

Meat.—There is hardly a class of individuals, however poor, who do not make a strong effort to obtain meat. It would seem, therefore, to be a necessary article of diet. In this metropolis the indoor operatives eat it to the extent of 14·8 ozs. per adult weekly; 70 per cent. of English farm labourers consume it, and to the extent of 16 ozs. per man weekly; 60 per cent. of the Scotch; 30 of the Welsh; and 20 of the Irish. The Scotch, probably, have a larger allowance than the English, considering that braxy-mutton is the perquisite of the Scotch labourer; but the Welsh have only an average amount of 2½ ozs. per adult weekly; and the Irish allowance is still less.

It is difficult to obtain accurate returns of the quantity of meat consumed in London; but if the computation of Dr. Wynter be correct, it is not less than 30¾ ozs. per head weekly, or about 4½ ozs. per day for every man, woman, and child. In Paris, according to M. Armand Husson, who has carefully collected the *octroi* returns, it is rather more than 49 ozs. per head weekly, or just 7 ozs. a-day. We are not, therefore, such large meat-eaters as the French.

Butchers' meat differs very much in nutritive value according to the proportions of fat and lean; and there is a strong prejudice in favour of beef as the strongest kind of meat. In reality, however, the lean of all meat is of nearly the same nutritive power, provided it is digested; but in this respect there are large differences. The flavour also varies with the nature of the animal, and with its mode of feeding. Pampas-pig, and indeed most wild swine, are horribly rank, but by proper feeding they become delicious. In store animals, the proportion of lean is always greater than the fat, and the solid matter does not amount to more than 28 or 29 per cent.; not so, however, in fat animals, for then the fat is largely in excess of the lean, and the solid matters make up about half the total weight. The tendency, indeed, of the fattening process is to substitute fat for water in the carcass; and the quality of the meat depends on the intimate intermixture of fat with the muscular tissue. All animals are not alike in their method of depositing fat, for some put it upon the surface of the body, and others accumulate it among the viscera. The art of breeding and feeding stock is to overcome both of these tendencies, and, at the same time, to produce a fat which will not melt or boil away in cooking. Oily foods have always a tendency to make soft fat.

The average proportions of fat and lean in the offal and carcases of animals are shown in Table No. 6.

TABLE VI.—PERCENTAGE PROPORTIONS AND NUTRITIVE VALUE OF THE CARCASS AND OFFAL.

	In Animal.		Water.		Nitrogenous.		Fat.		Salts.	
	Carcass.	Offal.	Carcass.	Offal.	Carcass.	Offal.	Carcass.	Offal.	Carcass.	Offal.
Store Oxen	59·3	38·9	60·8	—	18·0	—	16·0	—	5·2	—
Half Fat do.	—	—	54·0	59·6	17·8	20·6	22·6	15·7	5·6	4·1
Fat do.	59·8	38·5	45·6	52·8	15·0	17·5	34·8	26·3	4·6	3·4
Fat Heifers	55·6	41·3	—	—	—	—	—	—	—	—
Fat Calves	63·1	33·5	62·3	64·9	16·6	17·1	16·6	14·6	4·5	3·4
Store Sheep	53·4	45·6	57·3	63·7	14·5	18·0	23·8	16·1	4·4	2·2
Half Fat do.	59·0	40·5	49·7	61·1	14·9	17·7	31·3	18·5	4·1	2·7
Fat do.	—	—	39·7	55·2	11·5	16·1	45·4	26·4	3·5	2·3
Very Fat do.	64·1	35·8	33·0	45·1	9·1	16·8	55·1	34·5	2·8	3·6
Fat Lambs	—	—	48·6	58·5	10·9	18·9	36·9	20·1	3·6	2·5
Store Pigs	79·3	18·8	55·3	67·9	14·0	14·0	28·1	15·0	2·6	3·1
Fat do.	83·4	16·1	38·6	59·4	10·5	14·8	49·5	22·8	1·4	3·0
Mean of all	64·1	34·3	48·4	53·8	13·5	17·2	34·4	21·0	3·7	3·0

and Table No. 3 (p. 616) exhibits the proportion of the principal nutritive constituents in ordinary joints of meat. Lean meat is evidently deficient of carbonaceous matter, and this is best supplied in bread or potato; but in fat meat, considering that the nutritive power of fat is twice and a half as great as that of starch or sugar, the carbonaceous matter is often in excess of the right proportion; it is remarkably so in pork, which will bear dilution with the flesh of rabit, poultry, and veal.

The amount of bone in meat varies: it is rarely less than 8 per cent. In the neck and brisket of beef it is about 10 per cent., and in shins and legs of beef it amounts to one-third, or even half the total weight. The most economical parts are the round and thick flank, then the brisket and sticking-piece, and lastly the leg. In the case of mutton and pork, the leg is most profitable, and then the shoulder.

Horse-flesh is hardly known in this country, except as canine food; but on the Continent, and especially in Germany, Belgium, and Swizterland, it is regularly sold in the public markets, and is considered by many persons superior to beef. Possibly we have often eaten it on the Continent without knowing it. A *Châteaubriand*, or double beef-steak of Paris, is said to be best of horse-flesh; and no doubt the frequenters of the *restaurants* of Paris have unwittingly acquired a fondness for it, and have relished it as good beef. A story is told by a writer in the *Saturday Review* of a Frenchman who blandly remonstrated with an Englishman for his scorn of French beef. "I have," he said, "been two times in England, but I navère find the bif supérieur to ours. I find it vary conveenient that they bring it you on little pieces of stick, for one penny, but I do not find the bif supérieur." "Good heavens!" cried the Englishman, red with astonishment, "you have been eating cat's-meat." To be serious, however, I do not see why the flesh of healthy horses should not be used as human food. It has indeed many powerful advocates, among whom is the great naturalist, Geoffroy St. Hilaire.

Venison and the dark flesh of other wild animals differs from butchers' meat in the circumstance that it is leaner, and that it contains more blood; but its nutritive power, when properly cooked, is not inferior to that of beef or mutton, and it is always more digestible.

The offal of meat constitutes about one-third of the entire weight of the slaughtered animal. It consists of the blood, the head and its contents, the tongue and brain, the heart and lungs, the abdominal viscera—as the diaphragm, the liver, spleen, pancreas, stomach, intestines, and reproductive organs, the feet, tail and skin. In the case of the pig, the skin and head are parts of the carcass.

Nearly all these, when properly treated, are good for food. The *blood* of the pig is mixed with groats and fat, and converted into *black-pudding*, which contains about 11 per cent. of nitrogenous matter. The *stomach* of the bullock is cleaned and boiled for *tripe*, which contains 13 per cent. of albumen and 16 of fat. The *heart*, *lungs*, and *pancreas*, which constitute about seven per cent. of the live weight of animals, are as nutritious as lean meat. The *head*, especially of the ox, makes good soup; but it requires long boiling to extract the nutriment. Boiled for eight or nine hours it will yield one-fourth of its weight of gelatine; besides which an ox-cheek will furnish about 4lbs. of good meat. Bones also contain much fat and nitrogenous matter, which they give up when broken small and boiled for many hours. Six pounds of bones are equal to one of meat for nitrogen, and to nearly two pounds of meat for carbon.

Bacon differs from fresh meat in the relatively large amount of fat and small proportion of water. It is an almost universal article of diet among the labouring classes. Seventy-four per cent. of farm-servants use it to the extent of from ¼lb. to 2lbs. per adult weekly. Sixty-nine per cent. of the Scotch use it, and 40 per cent. of the Irish. It is perferred to butchers' meat for many reasons—as that it goes further, especially with children, who don't generally like fat; it has more relish; it is easily cooked, and suffers less waste in cooking; besides which it is easily kept, and is always handy. Preference is nearly always given to the English bacon, notwithstanding that it is double the price of American, for the flavour is better, and it does not boil away in cooking. No doubt the inferiority of American bacon is due to the method of feeding the pigs, for they run wild and eat large quantities of acorns and oily nuts. Good bacon should not lose more than from 10 to 15 per cent. in cooking.

The nutritive value of both green and dried bacon are shown in Table III. and Table IV. Their peculiarity is the large amount of carbonaceous matter they contain as compared with nitrogenous. Calculated as starch, it is as 20 or 24 to 1. Hence it is that it will improve the value of substances rich in nitrogen, as eggs, veal, poultry, beans, and peas.

Poultry and the *white meat* of *rabbits* are not of themselves very nourishing. They contain too much nitrogenous matter and too little fat. In the case of aquatic birds, as the goose and duck, the fat is more abundant; but it contains certain flavouring matters which are not easy of digestion. The darker flesh of game is also somewhat indigestible, and requires management in its culinary treatment.

Fish is not a favourite article of diet with the labouring classes, unless it is salted or smoked, and then it is chiefly used for its flavouring qualities. There is a prejudice that it has no nutritive strength, and it arises, perhaps, from the circumstance that it does not easily satisfy hunger, and is quickly digested, but the inhabitants of our coasts use it largely as food.

The nutritive value of the white varieties of fish, as *whiting*, *cod*, *haddock*, *sole*, *plaice*, *flounder*, and *turbot*, are shown in the Tables No. 3 and No. 4, and it will be remarked that they contain only about 22 per cent. of solid matter—18 of which is nitrogenous. They want butter, therefore, to increase their nutritive value.

Mackerel, *eels*, and *salmon*, are, however, richer in fat, for the former contains about 7 per cent. and the latter 6, while the oily matter of eels amounts to nearly 14 per cent. The same is the case with the *sprat*, the *herring*, and the *pilchard*, and with most of our fresh-water fish.

All fish are in their best condition at the time of the ripening of the milt and roe, for not only are they fatter at that time, but when cooked they have a better flavour, and the flesh is solid and opaque. On the other hand, when they are out of condition the flesh is semi-gelatinous and watery.

Shell-fish of all descriptions have nearly the same nutritive values. They contain about 13 parts of solid matter in the hundred, and this has the composition of white fish. Their digestibility varies—*mussels*, *limpets*, and *whelks* being rather hard of digestion, while *scallops*, *cockles*, *periwinkles*, *lobsters*, and *crabs* are, perhaps, a little more easily digested, and *oysters* still more so. None of them are suited for delicate stomachs, although the poorer inhabitants on the coast eat them freely; and vinyard snail on the Continent, and even *slugs* in China, have a reputation for delicacy and nutritive power.

Eggs contain about 26 per cent. of solid matter, 14 of which is nitrogenous, and 10½ carbonaceous or fatty. The *yolk* is the part which contains the fat, for it there amounts to 31 per cent., while the *white* of the egg, which is entirely free from fat, is the richest in nitrogen—the albumen amounting to 20·4 per cent. Altogether, however, eggs are very deficient of carbonaceous matter, for, calculated as starch, it is only in the proportion of 1·75. to one of nitrogenous. Hence it is that eggs consort well with oil in salads, with fat bacon, and with all kinds of farinaceous matters in puddings.

Fat of some descriptions, as *butter*, *lard*, *suet*, or *dripping*, is universally consumed. In many cases it exists in sufficient quantity in the food, as in bacon and fat meat, but when this is not the case, it is invariably supplied from some other source. 99 per cent. of farm labourers use fat of some sort—butter or dripping, to the extent of 5½ ozs. weekly per adult. It is difficult to say how much is really required by the human system, but looking at the proportion in milk, it would seem to be not less than 28 per cent. of the dry solid food. The fats in common use contain about 80 per cent. of real fatty matter, the rest being water and salt, and although butter is the fat ordinarily purchased, yet dripping is equally valuable, and so also are the vegetable fats of the tropics. *Cocoa* and *chocolate* owe their chief value as foods to the fat they contain. Cocoa is composed of 50 per cent. of solid fat, called cocoa butter, and chocolate is a sweet preparation of it.

Of liquid articles of diet, *beer* and *porter* stand first in nutritive value. They contain about 9 per cent. of solid matter, 8¾ of which are sugar and gum. Their nutritive power is not, therefore, great; and yet, according to Liebig, whenever beer and porter are not used, there is always a larger consumption of bread.

The nutritive functions of *tea* and *coffee* are hardly understood; for although they are largely used, and as if by an instinctive craving, yet their actual nourishing power is insignificant. I shall deal further with this subject hereafter.

The last constituent of food that we have to consider is saline matter. Broadly, it may be stated that we require *phosphates* and *sulphates* of *potash*, *lime* and *magnesia*, and that we also want a still larger porportion of *common salt*. In most cases the phosphates and sulphates are in sufficient quantity in ordinary foods; in fact, Mr. Lawes found in his experiments on the fattening of animals that for every single part of saline matter retained in the system of the pig, there were from 14 to 15 parts in the food; not that the whole of this was lost, for probably it performed important functions in the processes of assimilation and secretion. Common salt, however, is not present in the food to any large extent, and therefore it must be added to it.

And now, before leaving this part of the subject, let us pause to consider the vast machinery which is in operation for the supply of food to this metropolis. At the present time over three millions of people have to be fed daily; and yet so regular is the supply, that no one considers even the possibility of its failing. On the other hand, there is no redundancy; and not only does this supply regularly reach the metropolis, but it is distributed to our very doors. About 4,200 tons of fish; over 4,000 sheep; nearly 700 oxen; about 90 calves; 4,000 pigs, including bacon and hams; not less than 5,000 fowls, and other kinds of poultry; besides a million or so of oysters; and eggs innumerable, with flour enough to make nearly a million quartern loaves; and vegetables, butter, and beer in proportion, are daily brought to this city. "Imagine," as Archbishop Whateley says, "a Head Commissioner entrusted with the office of furnishing all these things regularly to the people. How would he succeed?" And yet all this goes on with the regularity and precision of a machine—without Government or even municipal interference, but simply through the magical power and unfettered action of free-trade.

The lecture was profusely illustrated with specimens of foods from the collection in the Economic Museum of Mr. Twining, who kindly lent them for the occasion.

LECTURE II.—Delivered Monday January, 27, 1868.

COMPARATIVE DIGESTIBILITY OF FOODS—FUNCTIONS OF DIFFERENT FOODS.

The phenomena of digestion are altogether of a physical and chemical nature; there is nothing whatever of a vital quality about them; for the comminuted food is brought successively under the influence of special solvents furnished by the saliva, the gastric juice, the pancreatic fluid, the biliary secretion, and the intestinal mucus; all of which are associated with a large volume of water. Digestion, indeed, as Berzelius remarked, is a true process of rinsing—the amount of fluid secreted into the alimentary canal, and again absorbed from it, being, according to the researches of Bernard, Bidder, and Schmidt, not less than three gallons in the twenty-four hours. The following, in fact, are the daily proportions of the several secretions and their solid constituents:—

——	lbs.	Solid Matter.	Active Principles.
		grs.	grs.
Saliva	3·54	231	37 of ptyalin.
Gastric juice	14·11	2,960	316 of pepsin.
Pancreatic fluid ..	8·82	6,172	773 of pancreatin.
Bile	3·54	1,233	1,073 { of organic ferment.
Intestinal mucus ..	0·47	46	28 of ditto.
Total	30·48	10,642	2,227 { of special solvents.

All of which, by their special solutive actions on the several constituents of food, rob it of its nutritive quality, and carry it into the circulation.

Each of the fluids, so largely secreted into the alimentary canal, has its special functions.

The *saliva*, which is a secretion from many glands opening into the mouth, is a thin glairy liquid, of slight alkaline reaction, except while fasting; and containing about 1 per cent. of solid matter—half of which is a peculiar organic body, called *ptyalin*, and the rest is composed of chloride and phosphate of sodium, with a little carbonate and sulphocyanide. Ptyalin is a nitrogeneous substance, of the nature of diastase—the ferment, which in the vegetable converts starch into sugar, and hence it has been called *animal diastase* by Mialhe, who attaches great importance to it as the principal agent concerned in the digestion of starchy foods—one part of ptyalin, according to him, being capable of converting 8,000 parts of insoluble starch into soluble glucose. Saliva has no chemical action on fat, or fibrin, or albuminous bodies—its real functions being to lubricate the food for deglutition, to carry oxygen into the stomach, and to furnish a solvent for starch and tender cellulose. Those animals which feed chiefly on woody matters, as the beaver, have large salivary glands, and provision is made for a prolonged contact of the secretion with the vegetable tissue.

An artificial saliva may be obtained from seeds which have fermented, and in which the diastase is abundant.

iebig's *Extract of Malt* is an example of this; and Mr. lorson has taken advantage of the discovery of M. lège Mouries, that the inner layer of bran contains a itrogenous digestive principle called *cerealin*, of the ature of diastase, and has extracted it, and consolidated with sugar, in a preparation which he has named *accharated wheat phosphates*. Both of these are aids to le digestion of farinaceous matters.

Gastric juice is a secretion from the entire surface of le stomach. It is a transparent liquid, of a pale yellow olour, and of a saline and acid taste. It is much heavier han water (sp. gr. about 1,020), and it contains from 2 3 per cent. of solid matter—about 1·7 of which is a markable nitrogenous organic body, called by Schwann, s discoverer, *pepsin*. Its peculiarity is, that in the resence of an acid, it converts almost every description albuminous and fibrinous matter into a soluble form albumen, called by Lehmann, *peptone*, and by Mialhe *lbuminose*. It differs from common albumen in many articulars—it is, for example, more liquid; it is not agulated by heat, nor by weak spirit, nor by acids, nor most mineral salts; it is not very prone to decomposition; and it is capable of *dialysis*, that is, of transuation through animal membrane, and, therefore, of bsorption, which albumen is not. The digestive power it is very great, for Wasmann found that an acid quid containing only one part of it in 60,000 of the lution—that is, about one grain in a gallon, was capable dissolving meat; and Lehmann ascertained that 100 rts of the gastric juice of a dog would digest 5 parts coagulated albumen.

The nature of the free acid in gastric juice is somehat doubtful; Lehmann, who has frequently examined says it is lactic acid, but Schwann asserts that he has ten found free hydrochloric acid. It may be that the lorides contained in the stomach are partially decomosed by lactic acid, especially during the process of alysis, and thus the hydrochloric acid may be accounted r. When the acid is in too large excess, the digestive tion is abnormal, and so also when it is deficient; ehmann states that the best proportion is when 100 rts of the gastric juice is just neutralised with 1·27 of otash.

Considering the importance of pepsin as a digestive gent, the preparation of it has become a common affair trade. In France it is obtained from the stomach of e pig by carefully washing it, then scraping off the ft mucus membrane, rubbing it down with a little ater, filtering, precipitating the foreign matters with etate of lead, again filtering, and then precipitating e excess of lead with sulphuretted hydrogen, after hich it is allowed to stand, or it is warmed, to get rid excess of sulphuretted hydrogen; it is then filtered ce more, and after carefully evaporating to the consistce of syrup it is consolidated with dry starch. In this untry it is prepared from the stomach of the sheep as ll as of the pig, and we have our *pepsina ovis* and *pepsina rci*; besides which, the use of lead and sulphuretted drogen are avoided by precipitating the foreign atter with alcohol,—pepsin being soluble in weak spirit. the lecture-table are specimens of Boudault's pepsin, well as those of Mr. Morson, of London, Messrs. rner and Co., and Mr. Claridge, of Warwick, all of hich are also in operation, showing their relative digese powers on animal fibrin.

The pepsin preparations on the table contain varying oportions of starch, as from 20 to 50 per cent.; but digestive power of any specimen may be easily tested putting a dose of the preparation into a small bottle th half an ounce of water, acidulating with 20 drops hydrochloric acid, and then adding half a drachm of rd boiled egg chopped small, or the same weight of n meat, or 120 grains of the fibrin of blood. On nding in a warm place at a temperature of from 100 110°, the digestion should be complete in two hours. ted in this manner, Dr. Pavy found, some time ago, t nearly all the preparations in common use were inert; not so, however, at the present time, for, as you will notice, digestion is proceeding rapidly.

I am told that the strongest pepsin is obtained from young healthy pigs which are kept hungry, and are then excited by savoury food which they are not allowed to eat while the influence of it is strong upon them, and the secretions are pouring out in expectation of the meal, the animals are pithed.

Pepsin, like diastase, is rendered inert by a temperature of from 120 to 130° Fah.; and, therefore, very hot drinks after a meal are hurtful.

Pancreatic fluid is a secretion from the pancreas or sweet-bread. Until recently its true digestive functions were not well determined. It is a colourless fluid of a gravity of 1,008 or 1,009. Like the saliva, it is generally a little alkaline, and it contains about 1·3 per cent. of solid matter, one-eighth of which is a nitrogenous organic substance of the nature of ptyalin or diastase, and is called *pancreatin*.

More than twenty years ago, Bernard proved, what Valentin had long before suspected, that the pancreatic fluid was concerned in the digestion of fatty matters; but he fell into error in supposing that its action was to saponify the fat, and to set glycerin free. Here is a specimen of glycerin and of lead-soap obtained from fat upon which the pancreatic fluid had previously acted, showing that saponification had not been effected. The true action of the pancreatic secretion is evidently to break up the large granules, and crystals and globules of oil and fat, into myriads of minute particles of from 1-3,000th to 1-15,000th of an inch in diameter. In this way the fat is emulsified and converted into a milky liquid, which mixes freely with water, and passes through the tissues of the intestines into the lacteals. We are indebted for this knowledge to Dr. Dobell, who had long been of opinion that the functions of the pancreas were important in certain diseases, and required elucidation. With the assistance of Mr. Julius Schweitzer, of Brighton, the then manager of the laboratory of Messrs. Savory and Moore, he made a large series of investigations into the properties of the pancreatic secretion, and he found that when the fresh pancreas (and best of the pig) is rubbed down in a mortar with twice its weight of hog's lard, it rapidly emulsifies it; and on adding about four or five times the bulk of water, and straining through muslin, there is obtained a thick milky liquid, of the consistence of cream, which gradually consolidates. If this be treated with ether, the pancreatised fat dissolves; and when the ether is separated by distillation, there remains the purified pancreatised fat, which is still miscible with water; in fact, when mixed with four or five parts of water it forms the creamy emulsion which is used dietetically and medicinally in doses of a teaspoonful at a time.

The properties of the pancreatic fluid have been well described by Dr. Dobell, in a paper recently read before the Royal Society of London; and it would seem that the fluid has not only the remarkable property of emulsifying oil and fat, and so rendering them capable of absorption, but it has also the power of dissolving starch by converting it into glucose. In this respect its action is like that of saliva, but it is much more energetic; for in its fresh state, one part of the pancreas will dissolve eight parts of starch, and even after it has emulsified fat it will dissolve two parts of starch. It is, therefore, a powerful agent of digestion, in so far as fat, and starch, and young cellulose are concerned, but it has little or no action on albuminous substances.

I am indebted to Dr. Dobell and to Mr. Morson for the specimens of *pancreatin* and *pancreatized* fat upon the table. The first of these preparations is obtained by treating the fresh pancreas with water, and carefully evaporating the solution to the consistence of syrup, and then consolidating it with the flour of malt. Perhaps the dried pancreas, powdered and mixed with malt, would be a stronger preparation.

The *Bile* is a complex liquid, consisting of biliary acids (*taurocholic, glycocolic*, &c.) in combination with soda. Its reaction is slightly alkaline, and it contains about 14 per cent. of solid matter, not less than 12 of which are organic.

The true function of the bile is unknown; perhaps it aids in neutralizing the acid peptones from the stomach; perhaps, also, in emulsifying fat; and it may be that it helps the digestion of starchy foods. Lehmann thinks it is a rich residuum from the manufacture of blood globules in the liver, and that it is secreted into the alimentary canal, only to be reabsorbed into the blood. Mr. Lee, also, is of opinion, from his examination of the fœtal liver, that it separates a highly nutritious substance from the portal blood, which is elaborated in the intestines. Its functions, however, are manifestly obscure.

Lastly, the *intestinal secretion* which is thrown out along the whole course of the small intestines, is, according to the researches of Bidder and Schmidt, a powerful agent of digestion; for it combines the activity and digestive power of all the other secretions—starch, fat, and albuminous substances being all equally well digested by it.

The food, therefore, coming into contact with these special solvents, and being copiously drenched with fluid, gives up its nutritive constituents. Admirable, however, as this provision is for the digestion of food, a considerable portion of useful matter passes through the bowel unchanged; for cellulose, starch globules, and muscular fibre are common constituents of sewage. Dr. Lyon Playfair says that in the case of an adult man, with good digestion, 1-12th of the nitrogen of the food passes away with the excreta, and others have computed it at an 8th. In a dry state the fæces of man contain about 6·5 per cent. of nitrogen, and in the fresh state, 1·7. In Ranke's experiments, it was ascertained that the nitrogen in the fæces was to that in the urine as 1 to 12·5. Much of this is, doubtless, derived from the secretions which have done the work of digestion, and have thus become effete; indeed, Dr. Marcet is of opinion that the alvine discharges are chiefly composed of the residuum of albuminous substances which have been secreted into the bowel for the purposes of digestion. In ordinary individuals they amount to from 4 oz. to 5·5 oz. a-day—(Wehsurg says 4·6 oz.; Liebig, 5·5 oz.; Lawes, 4·2 for a middle-aged adult, and 6·2 for a person over 50—the mean amount for adult males being 4·2 oz., and for adult females 1·3 oz.); and when calculated in a dry state they amount to about 1·1 oz. daily. It would seem, however, that when indigestible and irritating food is used, the quantity of fæcal matter is increased, as if the food was hurried through the intestines without undergoing digestion. At the Wakefield Prison, for example, it was found that when brown bread, containing bran, was given to the prisoners, the weight of the fæces was 7 oz. per head daily; and the same fact has been observed at the Coldbath-fields Prison.

With this general account of the digestive function of the different secretions discharged into the alimentary canal, we are prepared to inquire into the digestibility of different alimentary substances.

Nitrogenous or *proteinaceous*, or *albuminous substances*, which constitute the leading articles of diet, are evidently digested by the gastric juice and the intestinal mucus. In the former case they are converted into acid peptones, of which, according to Lehmann, there are several varieties, as *albumino-peptones, fribrino-peptones, caseino-peptones, gelatino-peptones*, &c., according as they are derived from albumen, fibrin, casein, gelatin, &c., and of these substances the fluid form of albumen is most easily converted; then coagulated albumen; then fibrin; then casein; and, lastly, the derivatives of albumen, gelatin, chondrin and cartilage. The tegumentary forms of albumen, as hair, wool, feathers, &c., being entirely indigestible. Here is an example of the indigestibility of hair—it is a ball of it, obtained from the alimentary canal of a cow, and has come from the calf which the cow has a habit of licking. Serpents and other animals that swallow their prey entire, digest the soft tissues and bones, but they disgorge the hair and feathers untouched.

It is difficult to speak of the comparative digestibility of different nitrogenous foods; for the well-known experiments of Dr. Beaumont on the Canadian with a fistulous opening in the stomach, and even experiments made in bottles with pepsin, do not represent the full and natural conditions of the process: at the present time there are, no doubt, great differences in the digestibility of different animal substances. Dr. Beaumont found, in his inquiries, that soused pigs' feet and soused tripe were the most digestible of all foods, and that boiled tendon of meat was the least digestible. The following, in fact, are the times given by him for the chymification of different animal foods:—

Articles of diet.	How cooked.	Time of chymification. H.	M.
Pigs' feet (soused)	Boiled	1	0
Tripe (soused)	Do.	1	0
Eggs (whipped)	Raw	1	30
Salmon trout	Boiled	1	30
Venison steak	Broiled	1	30
Brains	Boiled	1	45
Ox liver	Broiled	2	0
Codfish (cured dry)	Boiled	2	0
Eggs	Roasted	2	15
Turkey	Boiled	2	25
Gelatine	Do.	2	30
Goose	Roasted	2	30
Pig (sucking)	Do.	2	30
Lamb	Broiled	2	30
Chicken	Fricasseed	2	45
Beef	Boiled	2	45
Do.	Roasted	3	0
Mutton	Boiled	3	0
Do.	Roasted	3	15
Oysters	Stewed	3	30
Cheese	Raw	3	30
Eggs	Hard boiled	3	30
Do.	Fried	3	30
Beef	Do.	4	0
Fowls	Boiled	4	0
Do.	Roasted	4	0
Ducks	Do.	4	0
Cartilage	Boiled	4	15
Pork	Roasted	5	15
Tendon	Boiled	5	30

It is doubtful, indeed, if cheese or tendons are ever digested except in small quantity; and it is evident, from these experiments, as I shall hereafter explain, that cooking has considerable influence on the digestibility of food.

It is a curious problem why the stomach does not digest itself, seeing that it belongs to the class of most easily digestible substances, as tripe. Hunter explained it by referring the protective power to the vital force, for when dead the stomach digests itself in common with the food contained in it; but Bernard's and Pavy's experiments have proved that this is not the right explanation, for if the legs of living frogs, or the ears of living rabbits, are introduced into the stomach of a dog through a fistulous opening in the side, they digest like other proteinaceous substances. Liebig supposed that the protective power was in the thick mucus which lined the stomach, but Pavy denuded a part of the inner walls of a dog's stomach, and found that the tissue did not digest, but, on the contrary, quickly healed, and he is of opinion that the protective power is in the alkaline condition of the blood, which circulates so freely through the capillaries vessels of the stomach during digestion.

Starchy substances and *cellulose* are digested by the yalin of the saliva, and the pancreatin of the pan-eatic fluid, as also by the animal diastase of intestinal ucus. The solution is effected by the conversion of e starch and cellulose into a low form of sugar, called *ucose*, which is freely absorbed into the circulation, becomes changed into lactic acid, that serves so im-rtant a function in the digestion of nitrogenous matter. he time necessary for the digestion of different vege-ble substances, as determined by Dr. Beaumont, is as llows:—

Articles of diet.	How prepared.	Time of chymification. H.	M.
ice	Boiled	1	0
pples (sweet and mellow)	Raw	1	30
go	Boiled	1	45
ipioca	Do.	2	0
arley	Do.	2	0
pples (sour and mellow)	Raw	2	0
bbage with vinegar	Do.	2	0
eans	Boiled	2	30
ponge cake	Baked	2	30
arsnips	Boiled	2	30
otatoes	Roasted	2	30
o.	Baked	2	33
pple dumpling	Boiled	3	0
dian corn cake	Baked	3	0
o. do. bread	Do.	3	15
arrot	Boiled	3	15
heaten bread	Baked	3	30
otatoes	Boiled	3	30
urnips	Do.	3	30
eets	Do.	3	45
bbage	Do.	4	0

It would be seen from this that the time of digestion is proportion to the amount of cellulose or woody tissue the food. No doubt there is a more complete solution these matters in the small intestines, where the pan-eatic fluid and intestinal mucus, aided by the alkaline ndition of the fluids, exert the greatest actions on them, t it is very doubtful whether hard cellulose and woody atter are at all digested by man. Even in the case of pig, whose digestive powers are singularly active, it thought by Messrs. Lawes and Gilbert, from their ex-riments on the fattening of animals, that there is little no digestion of these substances; and, under any cir-mstances, a very prolonged contact with the secretions necessary for their digestion. Raw starch will pass a nsiderable distance along the alimentary canal of man thout much change, and it is only towards the end of small intestines that the starch granules undergo rked disintegration. Those animals which feed entirely vegetables have always a contrivance for keeping the d for a long time in contact with the secretions. It curs as the paunch in ruminants, the crop in birds, the ge cœcum in rabbits and other rodentia, and as the g alimentary canal of all of them; but even then a ge portion of the vegetable tissue passes through the vels unchanged. Cooking, grinding, and otherwise dis-egrating the tissue helps considerably in the digestion t.

Gum and *pectin* are probably not digested at all, for as y are unchanged by contact with the secretions, and incapable of dialysis or absorption, they must pass ough the alimentary canal without serving any purpose nutrition.

Fatty matters are digested by the emulsifying action of pancreatic fluid; and by being thus broken up into remely minute globules they are freely admitted into lacteal vessels; in fact, the emulsified globules of fat seen covering the villi of the intestines, penetrating ir tissues, pervading the subjacent cellular bodies, and thus entering the lacteals; and, no doubt, the peristaltic action of the intestines contributes largely to this emul-sifying process.

Saline substances are generally soluble in water, and are therefore easily absorbed, but when this is not the case, as with the earthy phosphates, they are attacked by the acid constituents of the gastric juice.

And here I may remark that the great aids to digestion are:—

1st. Proper selection of food, according to the taste and digestive power of the individual.

2nd. Proper treatment of it as regards cooking, flavour-ing and serving it.

3rd. Proper variations of it, both to its nature and treatment, so that the appetite may not fail.

4th. Exercise, warmth, and a genial disposition.

Functions of food.—Although much attention has been directed to this important subject, viz., the immediate and remote functions of food, yet it must be admitted that the difficulties of the question have not been sur-mounted, and that we are hardly able to particularise the phenomena which are incidental to its transformations. We can see clearly enough that its ultimate destiny is the manifestation of force—the letting loose of the cosmical agencies which were bound up in it—when, by undergoing oxydation, it returns more or less completely to its original forms—carbonic acid, water, and ammonia; but how and where these changes occur, and what are the subsidiary phenomena, and concurrent functions, besides those of common motion and animal heat, are as yet almost unknown to us. Nor are we sufficiently acquainted with the special attributes of the principal constituents of food, as the albuminous, the fatty, the farinaceous, the saccharine, and the saline; for although the well-known opinions of Liebig, with regard to the dynamic or force-producing functions of the nitrogenous or plastic elements of food, and of the thermotic or respiratory powers of the carbonaceous have been generally received, yet there are abundant reasons for believing that both of these classes of food may perform exactly the same functions in respect of the development of force; and, again, it is more than probable that the nitrogenous, or plastic constituents of food may, like the carbonaceous, be oxydised and consumed in the living body without ever entering into the composition of tissue. In these respects, therefore, there are great points of divergence from the views of Liebig.

Looking, however, at the proximate elements of food, it may, perhaps, best serve our present purpose if we inquire generally into the several functions of water, albuminoid compounds, fatty substances, farinaceous and saccharine matters, and mineral salts.

1st. *Water* is, unquestionably, of great physiological value, for as much as 75 per cent. of the muscular tissue of the animal frame is composed of it; and of the 20 lbs. of blood which an average-sized adult contains in his body, about 15½ lbs. are water. It is computed, also, that not less than 30 lbs. of fluid ebb and flow daily from the blood and alimentary canal by secretion and absorp-tion. Bidder, indeed, estimates that about 28·6 lbs. of chyle and lymph are carried daily by the thoracic duct alone into the circulation—a quantity of fluid that amounts to about one-fifth of the entire weight of the adult human body; and, then, with regard to the excre-tions, we find that rather more than a pound of water is exhaled daily by the breath, about a pound and three-quarters by the skin, and not less than two pounds and three-quarters by the kidneys, making altogether about five pounds and a-half per adult daily.

These results indicate the importance of water in the functions of the animal body. It serves indeed to dis-solve the food and carry it into the circulation; to effect the distribution of it throughout the system; to dissolve effete matters, as the metamorphosed constituents of worn-out tissues, and so convey them out of the body; to establish the chemical activity which is necessary for nutrition and decay; to combine mechanically with the tissues and lubricate them, so that they may perform their functions; and lastly, to evaporate by the air-passages and skin, and thus maintain the proper temperature of the body.

2nd. The second constituents of our food—namely, *albuminous, nitrogenous*, or *plastic matters*, were once, and until very recently, thought to have the sole function of constructing and repairing the muscular parts of the body; and having so entered into the composition of tissues, their oxydation and decay were attended with manifestations of force which were the working powers of the animal machine. "We see," says Liebig, "as an immediate effect of the manifestation of mechanical force, that a part of the muscular substance loses its vital properties,—its character of life; that this portion separates from the living part, and loses its capacity for growth and its power of resistance. We find that this change of properties is accompanied by the entrance of a foreign body (oxygen) into the composition of the muscular fibre; and all experience proves, that this conversion of living muscular fibre into compounds destitute of vitality, is accelerated or retarded according to the amount of force employed to produce motion. Nay, it may safely be affirmed, that they are mutually proportional; that a rapid transformation of muscular fibre, or, as it may be called, a rapid change of matter, determines a greater amount of mechanical force; and conversely, that a greater amount of mechanical motion (of mechanical force expended in motion), determines a more rapid change of matter." He further remarks that "the amount of azotized food necessary to restore the equilibrium between waste and supply is directly proportional to the amount of tissue metamorphosed," that "the amount of living matter, which in the body loses the condition of life, is, in equal temperatures, directly proportional to the mechanical effects produced in a given time." That "the amount of tissue metamorphosed in a given time may be measured by the quantity of nitrogen in the urine;" and "that the sum of the mechanical effects produced in two individuals in the same temperature, is proportional to the amount of nitrogen in their urine; whether the mechanical force has been employed in voluntary or involuntary motions; whether it has been consumed by the limbs, or by the heart and other viscera."

These are the generalizations of Liebig, and they go to show, not only that the dynamical action of the animal body depends wholly on the transformation of muscular tissue, and may be measured by the quantity of nitrogen excreted as urea; but also that no oxydation of nitrogenous matter can take place until it has passed from the condition of food to tissue, and has thus become organized. According to this view, the mechanical force of the human machine is derived entirely from its own combustion, and not from the oxydation of matters contained in the food.

For some time past there have been suspicions that this view of the case is not correct; and the doubts of physiologists have been strengthened by the circumstance that great labour might be performed for a short period without the use of a nitrogenous diet; and that while there was always a relation between the quantity of nitrogen in the food and that excreted as urea, there was no such relation between the dynamical actions of the body and the proportions of urea. Moritz Troube, in fact, asserted in 1861, after a careful examination of the subject, that all muscular force was derived from the oxydation of fat and hydrocarbons, and none from the oxydations of tissue. Haidenham, in 1864, arrived at a similar conclusion; and Donders was likewise of opinion that tissue transformation would not account for all the force of the animal body.

The hypothesis of Liebig has been further shaken by the investigations of Dr. Edward Smith, who has shown that the proportions of nitrogen in the urine does not increase with exercise, although the amount of carbonic acid exhaled by the lungs does. But the most convincing proof of the fallacy of the hypothesis was furnished in 1866 by the experiments of Dr. A. Fick, the Professor of Physiology at Zurich, and Dr. J. Wislicenus, the professor of chemistry.

On the 29th of August of that year they prepared themselves for an ascent of the Faulhorn, one of the Bernese Alps, which rises 6,417 feet above the Lake of Brientz. For seventeen hours before the journey, they took nothing in the way of solid food but cakes composed of starch, fat, and sugar; and on the following morning, at half-past five o'clock, they began the ascent, choosing the steepest of the practical paths from the little village of Iseltwald on the Lake of Brientz. At twenty minutes past one in the afternoon their journey was accomplished without fatigue, and from that hour to seven in the evening they remained at rest in the hotel at the top of the mountain. During the whole of that time (a period of thirty-one hours) they took no other food but the non-nitrogenous biscuits; but at seven o'clock they had a plentiful meal of meat, &c.

The urine was collected at three intervals, namely:—

1st. From 6 o'clock, p.m. of the 29th to 5 a.m. of the 30th; and this they called the *night urine*.

2nd. From 5 a.m. of the 30th to 1.20 p.m.; and this they called the *work urine*.

3rd. From 1.20 p.m. to 7 p.m.; and this they called the *after-work urine*.

4th. From 7 p.m. on the 30th, to the morning of the 31st; and this they called the *night urine*.

All these were analysed for nitrogen, and the results were as follows:

	Grains of Nitrogen Secreted by			
	Fick.		Wislicenus.	
1st. Night urine	106·7		103·1	
2nd. Work urine	51·1	88·6	48·3	85·6
3rd. After work urine	37·5		37·3	
4th. Night urine	74·3		82·5	

So that not only were they able to perform the work without a nitrogenous diet, but the quantity of nitrogen excreted was less during the work than before or after. Even calculated at the hourly rate of excretion, it stands thus:—

	Grains of Nitrogen Hourly Excreted.	
	Fick.	Wislicenus.
During 1st night	9·72	9·41
During time of work	6·33	6·02
During rest after work....	6·17	6·17
During 2nd night after work	6·94	7·87

The work which they had performed was estimated thus:—Fick weighed 145·5 lbs. avoirdupois, and Wislicenus 167·5 lbs.; and as they had ascended 6,417·5 feet, it is clear that Fick had raised 933,746 lbs. one foot high (145·5 × 6417·5), and Wislicenus 1,074,931 lbs. (167·5 × 6417·5); so that for an expenditure of muscular tissue represented in the one case by 88·6 grains of nitrogen, and in the other by 85·6 grains, the foregoing amounts of work had been done. Now, as 1 of nitrogen represents 6·4 of dry muscular tissue, it is evident that Fick had consumed 567 grains of muscle, and Wislicenus 547·8 grains.

At the time of the experiment, the thermotic and mechanical powers of these proportions of flesh were not accurately known, but they have been since determined in a very careful manner by Dr. Frankland, who finds that when pure dry lean of beef, albumen, and ea are completely oxydised in a proper apparatus, they velope the following amounts of heat and mechanical ce:—

	Lbs. of water raised 1° Fahr.	Lbs. lifted one foot high.
grains of pure dry beef..	13·1	10,083
" " albumen..	12·8	9,878
" " urea	0·6	436

In considering the mechanical power of muscular tissue, must be remembered that it is never completely oxy- ed in the animal body, but it is changed into carbonic d, water, and about one-third of its weight of urea, so t the potential energy of muscle is not so great as in preceding results. Calculated, indeed, according to proportions of urea formed, the tissues of Fick and islicenus were capable of the following amounts of ysiological energy:—

	Fick.	Wislicenus.
antity of muscle onsumed	567·0 grs.	547·8 grs.
tual energy if ully burnt	571,706 ft.-lbs.	552,347 ft.-lbs.
ailable energy, leducting the irea	563,466 ft.-lbs.	544,386 ft.-lbs.
ork actually done	933,746 ft.-lbs.	1,074,931 ft.-lbs.

that, in the case of Fick, 370,280 foot-pounds of work, l, in the other, 530,545 foot-pounds are unaccounted . But this is not all, for, besides the mere labour of ending the mountain, there were the movements of piration, and the beating of the heart, and other tor actions, to be added to the work actually done. Now each beat of the heart is estimated as equal to a of 4·61lbs. one foot high; and it is considered from ndor's well-known investigations that the work of an piration is nearly the same—namely, 4·54lbs. a foot h. Fick says that during the ascent his pulse beat at average rate of 120 a minute, and his respirations were The beating of his heart, therefore, during the 5½ urs actually taken in the ascent was equal to 182,556 . lifted a foot high; and the respiration to 37,455 lbs. the internal labour, or, as it may be called, the *opus ale* of Wislicenus was in proportion to his bodily ight, as compared with Fick's—that is, as 7 to 6, then ascertainable work done, was to the power of the scle consumed, as follows:—

	Fick.	Wislicenus.
	Ft.-lbs.	Ft.-lbs.
ork of ascending the moun- ain	933,746	1,074,931
ork of circulation	182,556	212,982
ork of respiration	37,455	43,698
tal ascertainable work	1,153,757	1,331,611
ual energy of the consumed nuscle	563,466	544,386
ergy unaccounted for	590,291	787,225

om which it appears that taking only the three factors ascertainable work—namely, external labour, circula- n and respiration, and disregarding other unascertain- e motor actions of the body, which are estimated by ny as greater than all the rest, the work actually per- med exceeds the energy of the oxydised muscle by re than as much again.

It may be said, and truly, that these experiments of Fick and Wislicenus were of too short a duration to afford an opportunity of ascertaining whether the oxydised muscle was not afterwards excreted; but the recent re- searches of Dr. Parkes on the elimination of nitrogen by two healthy men (soldiers) in the prime of life, during a period of seventeen days, and under different conditions of diet and exercise, have shown that, although the results are not altogether accordant with those of Fick and Wis- licenus—yet the conclusions are certainly born out, that a non-nitrogenous diet will sustain the body during exercise for a short time, and that exercise produces no notable increase in the nitrogen of the urine. On the contrary, the amount of urea is actually less during work than at a period of rest; and he thinks that the muscle, instead of oxydising, and, therefore, losing its substance during labour, actually appropriates nitrogen and grows —its exhaustion being dependent, not so much on its decay, as on the accumulation of the oxydised products of hydro-carbon, as lactic acid, &c., in its tissue, which require rest and time for their removal. That some decay of the muscle takes place there can be no doubt; for, as Dr. Parkes observes, "although it is certain that very severe exercise can be performed on non-nitrogenous diet for a short time, yet it does not follow that nitrogen is unnecessary. The largest experience shows, not only that nitrogen must be supplied, if work is to be done, but that the amount must augment with the work. For a short period the well-fed body possesses sufficient nitrogen to permit muscular exertion to go on for some time without a fresh supply; but the destruction of nitrogenous tissues in these two men is shown by the way in which, when nitrogen was again supplied, a large amount was retained in the body to compensate for previous deprivation." It would seem, too, from the great exhaustion of the men on the second day of a non-nitrogenous diet, that their muscles and nerves were becoming structurally impaired, and that if the experiments had been continued for a third day there would have been a large diminution in the amount of work. The work which they actually performed on a non-nitrogenous diet of starch and butter, in the form of biscuits and arrowroot, was walking exercise of 23·76 miles the first day, and 32·78 the second. The first day's work occupied, with intervals of rest, about ten hours and three-quarters, and it was done without fatigue; but the second day's work took twelve hours, and the last thirteen miles were accomplished with great fatigue. Calculated according to Haughton's formula (that walking upon a level surface is equal to lifting 1-20th of the weight of the body through the distance walked), the labour in the two days was, for—

——	S. Weighing with clothes 162·4 lbs.	T. Weighing with clothes 124·2 lbs.
The first day........	1,018,676 ft.-lbs.	779,062 ft.-lbs.
The second day	1,405,397 "	1,074,817 "
Total work	2,424,073 "	1,853,879 "
Total nitrogen ex- creted	529·16 grains.	492·46 grains.
Equal to muscle oxy- dized	3,386·92 "	3,151·74 "
The energy of which (minus urea) is ..	3,267,361 ft.-lbs.	3,040,483 ft.-lbs.

The amount of nitrogen excreted during the time of actual exercise was only about half the above; and, cal- culated in this way, it would only account for about two-thirds of the labour-force. The results, therefore, prove that although the basis for the calculations of Fick and Wislicenus was too narrow for accurate deductions, yet the mechanical force of the oxydised muscle is not sufficient to account for external and internal work; and the conclusion is that, in the above experiments, the motive power of the muscles was not derived from their own oxydation of non-nitrogenous matters.

The researches of Dr. Edward Smith throw additional light on the subject, for he ascertained that the amount of carbonic acid exhaled by the lungs was in proportion to the actual work performed.

During sleep it was at the rate of ..	293 grs.	per hour.
When lying down and approaching sleep	355 ,,	,,
In a sitting posture	491 ,,	,,
When walking two miles an hour .	1,088 ,,	,,
When walking three miles an hour	1,552 ,,	,,
And when working at the treadmill	2,926 ,,	,,

It is highly probable, therefore, that the largest amount of muscular force is derived from the hydro-carbons of our food; not that the nitrogenous matters of it may not also be a source of power; but there is no necessity, as Liebig supposes, for their being previously constructed into tissue. The experiments of Mr. Savory, in fact, show that rats can live and be in health for weeks on a purely nitrogenous diet, and it is nearly certain that under these circumstances the nitrogenous matters are mostly oxydised without entering into the composition of tissue. This, as I have said, is the main point of divergence from the hypothesis of Liebig; and it is further indicated by the fact that the amount of nitrogen excreted is not in proportion to the work done, but to the quantity of it in the food, even when there is no muscular exertion.

That the chief functions of nitrogenous matters is to repair tissue, there can be no doubt, for animals kept on a purely carbonaceous diet quickly lose weight, and at last die from a disintegration of tissue; but it is equally certain that the nitrogenous constituents of food have other offices to perform. A daily diet of 2lbs. of bread contains enough nitrogen to supply the mechanical wants of the system, but it will not maintain life. There is required an addition of animal food to render it sufficient for this purpose; and indeed the instincts and habits of the human race show, beyond all question, that a comparatively rich nitrogenous diet is necessary for the proper sustenance of life; and it is very probable that it assists the assimilation of the hydrocarbons. In this way it may help in the development of force without itself contributing directly to it; and this may serve to explain the fact, that there is a relation between the amount of nitrogen contained in the food and the labour value of it. Carnivorous animals are not only stronger and more capablé of prolonged exertion than herbivororous, but they are also fiercer in their disposition, as if force were superabundant. The bears of India and America, says Playfair, which feed on acorns, are mild and tractable, while those of the polar regions, which consume flesh, are savage and untamable; and taking instances of people—the Peruvians whom Pizarro found in the country at its conquest, were mild and inoffensive in their habits, and they subsisted chiefly on vegetable food; whilst their brethren in Mexico, when found by Cortes, were a warlike and fierce race, and they fed for the most part on animal diet. The miners of Chili, who work like horses, also feed like them, for Darwin tells us that their common food consists of bread, beans, and roasted grain. The Hindoo navvies also who were employed in making the tunnel of the Bhore Ghat Railway, and who had very laborious work to perform, found it impossible to sustain their health on a vegetable diet, and being left at liberty by their caste to eat as they pleased, they took the common food of the English navigators, and were then able to work as vigorously. Abundant examples of this description—some of which will be further discussed as we proceed, may be cited in proof of the direct relation of plastic food to mechanical work; but there is no proof that this material must first form tissue before its dynamical power can be elicited.

It is, however, a remarkable fact that all forms of nitrogenous food have not the same nutritive value; the glutinous matters of barley and wheat, though almost identical in chemical composition, have very different sustaining powers. It is the same with muscular flesh and artificially prepared fibrin and gelatine. Magendie found that dogs fed solely, for 120 days, on raw meat from sheep's heads, preserved their health and vigour during the whole of the time; but more than three times the amount of isolated fibrin, with the addition of much gelatine and albumen, were insufficient to preserve life.

We may conclude, therefore, that although the main functions of nitrogenous matters are to construct and repair tissue, yet they have manifestly other duties to perform of an assimilative, a respiratory, and force-producing quality which are far from being understood. What do we know, indeed, of the actual *modus operandi* of the nitrogenous ferments—ptyalin, pepsin, pancreatin, &c., which are secreted so abundantly into the alimentary canal; or of the conjugate nitrogenous compounds which are present in the bile? and how far have we advanced in interpreting the functions of the nitrogenous constituents of tea, coffee, maté, guarana, cocoa, &c., which the instincts of mankind in every part of the globe have evidently chosen for some physiological purpose? The same may be said of the crystalline nitrogenous matters of soup—as creatin, creatinin, inosic acid, &c., which can hardly be regarded as foods, although they have powerful sustaining properties. But enough of this for the present; and before leaving this part of the subject, I would direct attention to the fact, that nitrogenous matters when oxydised in the animal body never yield up the whole of their potential energy, for, by being converted into urea, which is the chief product of their decay, there is at least a seventh part of their power lost in the secretion. It may be that this is a necessity arising out of the circumstance that if they were completely oxydised in the animal body and converted into carbonic acid, water, and nitrogen, the last-named gas would be unable to quit the system, because of its insolubility in the animal fluids.

Functions of Fat.—The hydrocarbons which go by the name of fat, differ from other hydrocarbons, as sugar and starch, in the circumstance that the oxygen is never in sufficient quantity to satisfy the affinity of the hydrogen; and, therefore, fat is more energetic as a respiratory or heat-producing agent. Its power, indeed, in this respect is just twice and a-half as great as that of starch or sugar; for 10 grains of it will, by combining with oxygen, develop sufficient heat to raise 23·2lbs. of water one degree of Fahrenheit; and according to the deductions of both Joule and Meyer, this is equivalent to the power of raising 17,923lbs. one foot high. In cold countries, where animal warmth is required, food rich in fat is always preferred; and the fat bacon of the English labourer contributes in no small degree to the production of mechanical force.

But besides this, fat serves important functions in the processes of digestion, assimilation, and nutrition. According to Lehmann, it is one of the most active agents in the metamorphosis of animal matter; and this is seen not merely in the solution of nitrogenous articles of food during digestion, but also in the conversion of nutrient plastic substances into cells and masses of fibre. Elsässer long since observed that during the process of artificial digestion, the solution of nitrogenous foods was considerably accelerated by means of fat; and Lehmann has since determined, by actual experiment on dogs, that albuminous substances deprived of fat remain longer in the stomach, and require more time for their metamorphosis than the same substances impregnated with fat. It is probable, indeed, that the digestive power of the pancreatic fluid is due in great measure to the presence of fat; and that the subsequent chymification of food and its absorption into the blood, is greatly assisted by it. There is also good reason for believing that it is largely concerned in the formation of bile, and that th liary acids are conjugated fatty compounds. This ıy account for the well-known action of fat bacon, d other such foods in promoting the secretion of bile. The digestive power of fat is certainly considerable; d it is no less active in the subsequent conversion of trogenous matters into cells and tissues, and perhaps so in effecting their retrograde decay. Colourless blood rpuscles receive perhaps the first impulse of their rmation from the metamorphosis of fat; and thus it ıy be an important aid in the genesis of blood. It ould appear, too, from the latest investigations of phy- ologists that it plays an equally important part in ery kind of cell development. Acherson showed, as r back as 1840, that albumen always coagulates from solution around a fat globule, and this is seen in the tle fatty particles of milk, which have a covering like a ll-wall of consolidated casein. Hunefield, Nasse, and hers, have further shown that the nucleoli of cells in- riably consist of fat, and that recently-formed plasma ways contains more fat than the mature cell. The nclusion, therefore, is that it takes an active part in l the processes by which the nutrient constituents of od are converted into the solid substrata of organs; ıd so energetic are its powers in this respect, that when e nitrogenous matters of the fluids are not in sufficient ıantity to form cells with the fat, it borrows the aterial from muscular or other tissues, and thus pro- ıces a fatty degeneration of the part. This is observed the muscular structures of over-fed animals, in the ssues of drunkards, who take a large amount of fat- rming food, and in the livers of geese that are crammed ith a farinaceous diet.

And not only is it concerned in the formation of new ssue, but it also pervades, and finally disintegrates, the der structures, especially when the vitality of them is w. In this manner it helps in the solution and subse- ıent removal from the animal body of decayed and orbid products of the protein type.

Again, its presence in large quantity in the tubules of erves, and in the ganglionic centres, would indicate ıat it performs some highly important functions in ervous action.

And lastly, the distribution of it in the tissues, and ıe accumulation of it around certain organs, serve to ll up the vacuities of the body, to give rotundity to the rm, to equalize external pressure, to diminish the iction of parts, to give suppleness to the tissues, and by s bad conducting property to retain the animal warmth. at, therefore, must always enter largely into the com- osition of our food, for other hydrocarbons, though ıpable of transformation into fat, cannot entirely take s place.

3rd. *Starches and saccharine substances.*—These are well illed hydrates of carbon, for the oxygen and hydrogen ontained in them are nearly always in the proportion to rm water. The carbon, therefore, is alone capable of xydation, and according to Liebig their functions are ıtirely calorific or respiratory; but, like other heat- roducing agents, they must also have mechanical ower, for everything that will raise the temperature of pound of water one degree of Fahrenheit will, by an- her modification of its action, raise 772lbs. a foot high. he energies, however, of this class of substances are not early so great as with fats, for in the last case, as I have id, there is much available hydrogen, as well as carbon, r oxydation. The diagram which is before you will ake this clear.

Calorific and Motive Powers of 10 Grains of the Substance in its Natural State.

	Lbs. of water raised 1° Fahr.	Lbs. lifted one foot high.
Grape sugar	8·4	6,477
Lump sugar	8·6	6,617
Arrowroot	10·0	7,731
Butter	18·6	14,358
Beef-fat	20·9	16,131

So that, in round numbers, the calorific power of fat is about twice as great as that of starch and sugar, and when dry it is twice and a-half as great.

But these substances have other duties to perform besides the development of animal heat, which is, in fact, the final product of their oxydation, for on becoming changed into glucose by digestion they take the form of various acid compounds, as lactic acid, which occurs in the stomach and in the juice of flesh; butyric, formic, and acetic acids, which are found in the perspiration. The exact functions of these acids are not known to us, although, as I have already explained, the presence of lactic acid in the stomach is essential to the digestion of nitrogenous matters; and perhaps also its occurrence in the juice of flesh is for a similar object—namely, the solution of effete tissues.

Starches and sugars are also concerned in the production of fat. This was once the subject of an animated discussion by Liebig and Dumas, whose views of it were in complete antagonism; but the experiments of Boussingault, Persoz, Lawes, and others, on the feeding of animals have proved beyond all question that fat may be derived from the hydrates of carbon, and that therefore the views of Liebig were correct. Common experience, indeed, has fully taught us that foods which are rich in farinaceous matters and sugar are very capable of producing fat.

4th. The *saline* or *mineral* constituents of food are largely concerned in the metamorphosis of matter; and, perhaps, this is their sole function. It is a specialty of these substances to give a soluble form to the plastic constituents of food, and of the animal tissues. They are, therefore, concerned in the phenomena of digestion, absorption, sanguification, assimilation, disintegration, and secretion. In truth they are the chief, if not the only, media for the transference of organic matter from place to place in the animal body—being on one hand the purveyors of nutrient materials into the system, and on the other the carriers of effete substances out of it; besides which, it is very probable that they are the agents whereby liquid colloidal forms of nutriment are changed into solid or pectous, as in the formation of solid tissues from the blood. In the case of digestion and absorption the plastic elements of our food, as albumen, fibrin, gelatin, &c., are not of themselves capable of dialysis, or of passing through the walls of the alimentary canal; and, therefore, absorption must be assisted by some physical agent. This agent is the highly diffusive acids and salts which are secreted so freely into the stomach during digestion; and it is very probable that they not only effect a solution of the proteinaceous matter of food, but, by converting it into peptones, as Lehmann expresses it, they also change the molecular form of the material, and make it pass from an unabsorbable colloid into a highly diffusive crystalloid. If, indeed, it be, as Mr. Graham supposes, that a colloid molecule is but a group of smaller crystalloids, the action of the saline and acid constituents of the gastric juice might be to break up the larger colloid molecule, and thus give it the property of diffusion and absorption. An opposite condition of things would occur in the alkaline blood, whereby the colloid molecule would regain its structure, and lose its diffusive tendency; but, coming to the tissues, where an acid condition of the fluids again exists, it once more changes its molecular structure, and quits the blood to serve the purposes of nutrition. The exact nature of the phenomena that occur when the liquid nutrient matter which thus escapes is changed into solid tissue is unknown to us; but there is good reason for believing that it is no more than a molecular movement effected by the agency of saline matter. In the case of certain structures which contain more than a common amount of mineral salts, this is unquestionably so, for it occurs in the consolidation of the spiculæ of sponges, the calcareous tissues of polypes, the hard dermal structures of the radiata, mollusca, crustacea, &c., and in the calcareous deposits of bone, teeth, tegumentary scales, egg-shells, &c., of the vertebrata. In all these instances the secreted matter must first have been crystalloidal, or it could not have been secreted; it then takes the form of a liquid colloid or jelly; and finally, by a further molecular movement, it passes into the condition of a pectous solid—the saline constituents, according to their nature and proportion, determining the degrees of hardness.

Again, the removal of effete matters and worn-out tissues is undoubtedly effected by the agency of saline substances; for, during the processes of oxydation, acid compounds are produced, which, by acting chemically on the saline constituents of the animal fluids, give them a solutive power on plastic matters, and thus enable them to remove the debris of worn-out tissue.

As to special functions of the several saline constituents of food, little can be said; but it is a remarkable fact that the *alkaline or basic phosphate of soda* is invariably found in the blood, while *acid phosphate of potash* is the chief constituent of the juice of flesh. Most likely the former is concerned in preserving the liquid colloidal condition of albumen and fibrin, and so keeping them from being lost by secretion, while the latter is engaged in an opposite duty. The alkalinity of the blood also helps in the oxydation of organic matters; and as the basic phosphate of soda is endowed, like an alkaline carbonate, with the power of absorbing carbonic acid, it is the chief agent whereby this compound is removed from the system. This is a remarkable property, and is one of the chief uses of basic phosphate of soda in the blood. In point of fact, when it is not there in sufficient quantity to perform this function, it is replaced by an alkaline carbonate. We find this to be so in the blood of herbivorous animals, where the proportions of the two salts are the reverse of what they are in man and carnivora. Some notion may be formed of the relative importance of the saline matters of the blood by reference to this diagram from Liebig.

Percentage Composition of the Mineral Matters of Blood.

	Man.	Pig.	Dog.	Fowl.	Sheep.	Ox.
Phosphoric Acid	31·79	36 50	36·82	47·26	14·80	14·04
Alkalies	65·66	49·80	55·24	48·41	55·79	60·00
Alkaline Earths	3·33	3·80	2·07	2·22	4·87	3·64
Mineral Acids and Oxide of Iron........................	9·22	9·90	5·87	2·11	24·54	22·32
Total	100·00	100·00	100·00	100·00	100·00	100·00

And in those cases where the phosphoric acid is deficient, it is replaced by carbonic acid. In man, for example, the quantity of combined carbonic acid in the ashes of the blood is only 3·78 per cent., whereas in the calf it is 9·85, and in the sheep 19·47 per cent., so that in all cases the alkalinity of the blood remains the same.

The *salts of potash* in the juice of flesh have, no doubt, an equally important duty to perform, although of an opposite character; for while the alkaline phosphate of soda in the blood prevents the transudation of nutrient matter, the acid phosphate of potash in the muscular fluid promotes it; and thus it is concerned in nutrition and in the solution of worn-out tissues.

Earthy phosphates, especially *phosphate of lime*, are, perhaps, the agents for the consolidation of tissue; for not only are they present in the hard structures of the body, as the bones and teeth, but they also enter into the composition of flesh.

And not less important in the morphological functions of the animal body is the presence of *common salt*. It is a large constituent of every one of the secretions, and forms about half the total weight of the saline matters of the blood. Unlike the phosphates, however, it does not enter into the composition of tissue, but seems to be only a medium of absorption and secretion; and so necessary is it for this purpose, that it is not possible to alter, to any large extent, its proportion in the blood. If we drink water containing but little common salt in solution, it does not permanently dilute the blood, but passes off immediately by the kidneys; and if we try to increase the amount in the blood by drinking solutions of salt, as sea water, it refuses to be absorbed. This normal proportion of it in the blood is evidently a physiological necessity, which the conditions for diffusion imperatively demand. It is a curious fact, also, that common salt has the faculty of forming crystallizable compounds with most of the unorganised and effete constituents of the body. May it not, therefore, be an important agent of diffusion, and be thus concerned in the phenomena of absorption and secretion; for as colloidal matters—albumen and fibrin—cannot pass through the walls of the intestines, or the blood-vessels, it may well be that through the agency of common salt and the free acid of the gastric and muscular juices, they temporarily assume a crystalloidal condition, and are thus absorbed or secreted.

The constant presence of common salt in the secretions and the necessity for it in due proportion in the blood indicate the importance of a proper supply of it with the food. We perceive this in the instinct of animals, and in our own craving for it when it does not exist in sufficient quantity in the food. Animals, in fact, will travel long distances, and brave the greatest dangers, to obtain it. Men will barter gold for it; indeed, among the Gallas, and on the coast of Sierra Leone, brothers will sell their sisters, husbands their wives, and parents their children, for salt. In the district of Accra, on the Gold Coast of Africa, a handful of salt is the most valuable thing upon earth after gold, and will purchase a slave or two. Mungo Park tells us that with the Mandingoes and Bambaras the use of salt is such a luxury, that to say of a man "he flavours his food with salt" is to imply that he is rich; and children will suck a piece of rock salt as if it were sugar.

The experiments of Boussingault have shown that although salt mixed with the fodder of animals does not much affect the quantity of flesh, fat, or milk obtained from them, yet it seriously affects their appearance and general condition; for animals deprived of salt, other than that contained naturally in the food, soon get heavy and dull in their temperament, and have a rough and staring coat. Reulin states that animals which do not find it in their food or drink, become less prolific, and th breed rapidly diminishes in number. This is confirmed by Dr. Le Saine, who says, in his prize-essay on salt, that it increases the fertility of the male and th fecundity of the female, and it doubles the power o nourishing the fœtus. During the period of suckling also, salt given to the mother renders the milk more abundant and more nutritious. It likewise accelerates growth, and gives a finer condition to the skin; and th flesh of animals fed with it is better flavoured, and more easily digested, than that of animals which do not partake of it. In barbarous times, the most horrible of punishments, entailing certain death, was the feeding of culprit on food without salt; and in the experiments of th French Academicians, flesh deprived of its saline con stituents by being washed with water, lost its nutritiv power, and animals fed on it soon died of starvation. Even after a few days, with such a diet, the instincts o the animals told them it was worthless as food; indeed for all purposes of nutrition, it was, as Liebig says, n better than the eating of stones, and the utmost torment of hunger were hardly sufficient to induce them to con tinue the diet. There was plenty of nitrogenous matte in the food, but there was no medium for its solutio and absorption, and hence it was useless.

The *oxides of iron*, and their homologues, the *oxides o manganese*, are largely concerned in the processes of san guification and oxydation. They enter into the compo sition of the globules of the blood—manganese being th chief mineral constituent of the corpuscles of whit blooded animals, and iron of red. In fact, the colouring matter of the blood discs (cruorin), as well as that of th muscles (myochrome), is a compound of iron and albu ıen (globulin), which has a remarkable property of ab- ›rbing oxygen when exposed to the air, and of giving out again in the presence of reducing agents. In the ıe case it acquires an arterial tint, and in the other a ›nous; and the spectrum informs us that these two ›nditions of it are easily assumed—one by the presence f atmospheric oxygen, and the other by decaying or- anic matter. It is hardly to be doubted that these re the conditions of it in blood—the bright red oxydized ruorin being the form of it in arterial blood, and the ark reduced variety of it in venous. The functions, ıerefore, of both cruorin and myochrome are entirely f a respiratory nature; for, in the former case it is the ıedium whereby oxygen is absorbed from the air in the ıngs, and is carried with the blood-discs throughout ıe body, and in the latter it may be the agent of inter- itial oxydation.

Lastly, there is a mineral constituent of our food, *silica*, hich enters into the composition of all the tegumentary ppendages. Its presence is not of so much importance › us as to the lower animals, whose warmth is retained y a natural covering of hair, or wool, or feathers. In ıe case of birds, indeed, the quantity of silica in the athers is very considerable, and Gorup-Besanez has de- cribed its physiological relations.

As to the proportions of mineral substances required ı the food, it is difficult to speak. Dr. Edward Smith ıys that an adult man requires daily from 32 to 79 rains of phosphoric acid; from 51 to 175 grains of hlorine (equal to from 85 to 291 grains of common ılt); from 27 to 107 grains of potash; from 80 to 171 f soda; from 2·3 to 6·3 of lime; and from 2·5 to 3 of ıagnesia. According to Mr. Lawes, a very small por- ion of these salts is retained in the system; for in ıttening pigs he found that of every 11 lbs. of mineral ıatter contained in the food only twelve ounces were tored up in the body, and this was chiefly the earthy hosphates, all the rest being either unabsorbed, or else sed in the work of absorption, assimilation, and secre- ion. In most cases, therefore, there is sufficient saline ıatter, excepting common salt, in all ordinary food; but ›r all this, the presence of it in the water we drink is ot an unimportant question. Four-fifths of the earth's urface are composed of calcareous strata, which yield vater that is more or less rich in carbonate and sul- hate of lime; and it may well be that this is a wise rovision for the supply of these salts to the animal ystem. As Mr. Johnston has truly observed in his Chemistry of Common Life," "The bright sparkling ard waters which gush out in frequent springs from ur chalk and other lime-stone rocks are relished to rink, not merely because they are grateful to the eye, ut because there is something exhilarating in the excess f carbonic acid they contain and give off as they pass hrough the warm mouth and throat; and because the me they hold in solution removes acid matters from ıe stomach, and thus acts as a grateful medicine to the ystem. To abandon the use of such a water, and to rink daily in its stead one entirely free from mineral ıatter, so far from improving the health, may injure it;" ı fact the water of a country may determine the diet of s inhabitants. The soft waters of the lakes of Scot- ınd, for example, may have had something to do with ıe choice of brown meal; and but for the calcareous aters of Ireland the potato could not have become a ational food.

And now, before I leave this part of the subject, it is ight that I should say a few words respecting the func- ons of certain beverages (as *tea*, *coffee*, and *fermented quors*), which have been more or less in use in all ages, s if from an untaught physiological instinct. Vegetable ıfusions, containing the same active principles—namely, stringent matter, volatile oil, and a crystallizable body ich in nitrogen, have been resorted to for some undefined urpose by the natives of every climate; indeed, to use the ords of Mr. Johnston, "the practice has prevailed equally ı tropical and in arctic regions. In Central America, the Indian of native blood, and the Creole of mixed European race, indulge alike in their ancient chocolate. In Southern America the tea of Paraguay is an al- most universal beverage. The native North American tribes have their Apallachian tea, their Oswega tea, their Labrador tea, and many others. From Florida to Georgia in the United States, and over all the West India Islands, the naturalised European races sip their favourite coffee; while over the Northern States of the Union, and in the British provinces, the tea of China is in daily and constant use.

"All Europe, too, has chosen its prevailing beverage; Spain and Italy delight in chocolate; France and Ger- many, and Sweden and Turkey, in coffee; Russia, Hol- land, and England, in tea—whilst poor Ireland makes its warm drink of the husks of the cocoa, the refuse of the chocolate-mills of Italy and Spain.

"All Asia feels the same want, and in different ways has long gratified it. Coffee, indigenous in Arabia or the adjoining countries, has followed the banner of the Prophet, wherever in Asia or Africa his false faith has triumphed. Tea, a native of China, has spread spontaneously over the hill country of the Himalayas, the table lands of Tartary and Thibet, and the plains of Siberia; has climbed the Altais, overspread all Russia, and is equally despotic in Moscow as in St. Petersburg. In Sumatra, the coffee-leaf yields the favourite tea of the dark-skinned population; while Central Africa boasts of the Abyssinian chaat as the indigenous warm drink of its Ethiopian people. Everywhere, in fact, unintoxicating and non-narcotic beverages are in general use among tribes of every colour, beneath every sun, and in every condition of life. The custom, therefore, must meet some universal want of our nature, some physiological function which science has not yet explained; and, considering that these beverages contain essentially the same chemical compounds, it is remarkable that they should have been selected from the whole range of the vegetable kingdom." As Mr. John- ston truly observes, "What constitutional cravings common to us all have prompted to such singularly uni- form results! Through how vast an amount of unrecorded individual experiences must these results have been arrived at!"

The principal constituents of these vegetable substances are:—

1st. A *volatile oil*, on which their aroma depends, and which rarely amounts to one part in 150. 2nd. An *astringent acid*, of the nature of *tannic acid* in tea, and called *caffeic acid* in coffee, which give them their bitter styptic taste; it amounts to from 13 to 18 per cent. in tea, and to about 5 per cent. in coffee; and 3rd. A crystallised nitrogenous substance of an alkaline nature called *Theine* or *Caffeine*, and *Theobromine*. The average amounts of this alkaloid in different vegetable substances, according to Dr. Stenhouse, is here recorded:—

	Theine or Caffeine per cent.
Guarana or Brazilian cocoa, from *Guarana officinalis*	5·07
Good black tea	2·13
Black tea from Kemaon, E. I.	1·97
Dried coffee leaves	1·26
Maté or Paraguay tea from *Ilex Paraguayensis*	1·20
Various samples of coffee-beans from 0·8 to	1·00

The physiological properties of this substance, and of its homologue, theobromine, are not clearly discoverable. Mulder states that they are not the agents concerned in the peculiar action of tea and coffee. Liebig, however, points to the fact that with the addition of oxygen and the elements of water, they can yield taurine, which is the nitrogenised constituent of bile; and he asks whether they may not be concerned in the production of bile. Theine, he also states, is related to kreatinine—that re- markable compound, produced in the vital process, and occurring in the muscular system of animals; and to glycocol, which we may suppose to exist in gelatine coupled with another compound. In fact, according to him, there are no drinks which in their complexity and in the nature of certain constituents, have more resemblance to soup than tea or coffee; and it is very probable, he says, that the use of them as a part of food depends on the exciting and vivifying action which they have in common with soup. Reasoning in this way it may be said that theine or caffeine, and theobromine are closely related in their composition to nervous tissue, and that therefore they are suited for the repair and renovation of the exhausted brain. Experiments made by Lehmann, in 1854, with infusion of roasted coffee, and with caffeine, went to show that their chief influence on the human body was to retard the waste of tissues; that when, for example, an infusion of three-quarters of an ounce of roasted coffee was taken daily for a fortnight, the amount of urea and phosphoric acid excreted by the kidneys was less by one-third than when the same food was taken without the coffee. The empyreumatic oil was found to exert a stimulating action on the nervous system, and when taken in excess caused excitement and wakefulness. It also operated on the skin by producing a gentle perspiration, and it removed the sensation of hunger. The conclusion from these experiments was, that both tea and coffee exhilarate the nervous system, and, by lessening waste, enable the food to go further in its nutritive action; that with a given quantity of food, more work could be performed when these beverages were taken than otherwise; and that in old, infirm persons, where the desire for tea is so strong, the waste and decay of the system was lessened. It operates, in fact, as a sort of lubricant of the animal system, and by oiling the machinery, enables it to work easier and longer.

The more recent experiments of Dr. Edward Smith are not exactly to the same purpose; for, in his opinion, tea promotes rather than checks the chemico-vital functions of the body, for directly after it is taken, the quantity of carbonic acid emitted from the lungs, and the quantity of air inspired are increased; and there is greater depth and freedom of respiration. In this way, he thinks it promotes the transformation of starchy and fatty food; besides which, it increases the action of the skin, and by inducing perspiration lessens the heat of the body. Coffee, he says, has an opposite effect, for it lessens the action of the skin, and promotes that of the bowels; and its influence on the respiratory processes is somewhat less than that of tea.

It is manifest from all this, that we have yet to learn what are the special actions of these beverages; and why it is that they have been used in all times, and in all countries, as a means of supplying some natural want which science is unable to discover—that everywhere, the poor and the needy, the aged and the infirm, will make a sacrifice of even nutritious food for some such beverage as tea and coffee—that not less than 500 millions of the human race should make use of an infusion of tea; that more than 100 millions should drink coffee; about 50 millions cocoa; and not less than 10 millions of the inhabitants of Peru, Paraguay, and the Brazils, should use an infusion of maté or guarana. In this country alone there is over 100 millions of pounds of tea consumed annually, and perhaps, about half as much of coffee. All this looks like the influence of some deep-seated necessity, which our philosophy is unable to fathom.

And with regard to the use of *fermented liquors*, there is the same universal indication of their serving a profound physiological purpose, and supplying a common want. It is no argument that, because these things have been abused they serve no purpose in man's economy. On the contrary, the fact of their use in all time, and that no saccharine liquid, or juice of ripe fruit, can be exposed to the air without spontaneous and almost immediate fermentation, are striking evidences of a useful purpose. They may not enter into the composition of tissues, but they may stimulate the energies of the living frame, and rouse them into increased activity. It is not merely the brick-work and marble, so to speak, of the human body, nor yet the concrete movements of the machine, that have to be sustained, for there are rarer forms of matter, and higher manifestations of force, concerned in man's existence; and his resort to such beverages as these may be for something more than the nourishment of the system, or even the mere raising of his spirit above the common concerns of this work-o-day world.

That *alcohol* stimulates the action of the nervous system there is no doubt, and it is equally certain that it increases the respiratory changes. Dr. Edward Smith is of opinion that it also lessens the action of the muscles which are subject to volition, and increases, in a certain degree, the action of those which are independent of it, as the heart and respiratory muscles. He finds, too, that it diminishes the functions of the skin, and by thus lessening the waste of animal heat, it has a conservative tendency. The effects of alcohol are, however, much modified by the substances with which it is associated in different alcoholic liquids—*beers* and *ale*, for example, act on the respiratory functions by reason of the saccharine and nitrogenous matters they contain; *wine* also, as well as *cider* and *perry*, have a similar action, and in proportion to their saccharine and acid constituents; *brandy* and *gin* lessen the respiratory changes, and the latter acts on the kidneys by reason of the volatile oil it contains; *whiskey* is uncertain in its effect on the lungs; while *rum*, like *beer* and *ale*, is a true restorative, as it sustains and increases the vital powers; and he says that the old fashioned combination of *rum* and *milk* is the most powerful restorative with which he is acquainted.

Leibig is of opinion that alcohol is burnt or oxydised in the system, and is therefore a calorific agent; but the researches of Lallemand, Perrin, and Duray, as well as those of Dr. Edward Smith, have demonstrated that a large portion of it passes through the system unchanged, and appears in the breath and perspiration, as well as in the urine. They, therefore, conclude that alcohol is not a food, but is a mere excitor of the nervous centres. On the other hand, Dr. Thudicum, in a rather large experiment on the students of his class (33 in number), found that of the 4,000 grammes of alcohol in the 44 bottles of wine which they drank at one sitting, only 10 grammes appeared in the urine; and assuming that about 10 grammes more were exhaled by the breath and skin, he concluded that only 0·5 per cent. of the alcohol escaped unchanged. He therefore believes that alcohol is oxydised in the body, and is a true food.

But besides this, the inquiries of Poiseuille have shown that it is a physical as well as a chemical and physiological agent, for it hinders the flow of liquids in narrow tubes, and may act in the same way on the movements of the blood in the capillary vessels. He found, for example, that when the flow of a certain quantity of water through a small tube occupied 575·8 minutes, and of the serum of blood 1048·5 minutes, the flow of the same quantity of Madeira wine under the same circumstances was 1138 minutes, of sparkling Sillery 1463, and of Jamaica rum 1832. Its functions, therefore, are manifestly of a complicated nature; in fact the whole subject is remarkably obscure, and requires the light of science to illuminate it. As in the case of tea and its allies, ages of empiricism are waiting for a philosophical interpretation.

Lastly, as to the functions of *condiments*, as *pepper*, *mustard*, *spices*, &c. They are merely stimulants of the digestive organs, promoting the flow of the saliva, the gastric juice, and other intestinal secretions; and increasing the peristaltic movements of the viscera. They thus aid in the processes of digestion; and by giving flavour to the food, they whet the appetite, and so increase the relish for it—indifferent food is thus made palatable and its digestion accelerated.

And now, in conclusion, we may safely inquire, as a supplementary question to the functions of food, what are the mechanical and thermotic powers, as well as the fattening capabilities of various articles of diet?

)r. Frankland has made some very careful determina-ns of the calorific values of different substances used food; and remembering that every pound of water sed one degree of Fahrenheit represents a mechanical ce of 772 lbs. lifted a foot high, it is easy to calculate working energy of any substance from its thermotic wer when burnt in oxygen, or when less perfectly nsumed in the animal body. Arranging the results der these two heads, we shall find that the energies of ferent articles of diet may be expressed as follows:—

TUAL ENERGY OF TEN GRAINS OF THE MATERIAL, IN ITS NATURAL CONDITION, WHEN COMPLETELY BURNT IN OXYGEN, AND WHEN OXYDISED INTO CARBONIC ACID, WATER, AND UREA, IN THE ANIMAL BODY.

	Per cent. of water in Material.	Lbs. lifted one foot high.	
		When burnt in Oxygen.	When Oxydised in the body.
utter	15	14357	14357
heshire cheese	24	9187	8613
atmeal	15	7913	7769
heat flour	15	7788	7591
a-meal	15	7778	7456
rowroot	18	7731	7731
round rice	13	7535	7424
olk of egg	47	6761	6532
ump sugar	19	6616	6616
rape sugar	20	6476	6476
ntire egg	62	4708	4507
read crumb	44	4409	4246
am	54	3915	3317
ackerel	71	3537	3187
ean beef	71	3098	2818
ean veal	71	2594	2314
uiness's stout	88	2123	2123
otatoes	73	2002	1969
'hiting	80	1787	1563
ass's ale	88	1530	1530
'hite of egg	86	1325	1138
ilk	87	1306	1241
arrots	86	1040	1026
abbage	89	858	830

It will be understood, of course, that to obtain these re-lts in the animal body the materials must be completely sorbed, and fully oxydised into carbonic acid, urea, c.

Estimated in this manner it may be said that a daily bsistence diet of two ounces of dry nitrogenous food, nd 13·2 ounces of dry carbonaceous, calculated as starch; nd a daily working diet of six ounces of dry nitrogenous atter, and twenty-six ounces of dry carbonaceous, have e following mechanical energies:—

	Lbs. lifted one foot high.	
	When burnt in oxygen.	When oxydised in the body.
ubsistence diet	6,319,783	6,307,078
'orking diet	13,349,405	13,311,290

But the actual working power of the human body does t approach this. In fact, although a man's daily bour has a very large range, as from 300,000 foot-unds when lifting dung into a cart to 1,500,000 foot-unds when pushing or pulling horizontally; yet, the erage is not above one million foot-pounds, as will be en from this diagram:—

Kind of labour.	Amount of work in foot-pounds.	Authority.
Bricklayer's labourer carrying bricks	1,627,200	Mayhew.
Coal whipping	1,293,600	"
Ascending Faulhorn	1,074,931	Wislicenus.
Do. do.	933,746	Fick.
Treadmill	1,008,000	Mayhew.
Do.	861,156	Ed. Smith.
Turning a winch	837,760	Coulomb.
Pedestrians (20 miles a day)	792,000	Haughton.
Paving and pile-driving	788,480	Coulomb.
Porters carrying loads	732,480	"
Shot-drill punishment	694,400	Haughton.
Average	967,614	

And even when we add the calculated internal work of a man's body, as the beating of the heart and the movements of respiration, the total of it does not much exceed a million and a-half foot-pounds a-day.

	Foot-pounds.
External work or actual labour	967,614
Work of circulation (75 beats a minute)	497,880
Work of respiration (15 a minute)	98,064
Total ascertainable work per day	1,563,558

It is evident, therefore, that a large portion of our food must escape digestion and absorption; indeed, the thermotic power of the food actually consumed daily, as estimated by the carbonic acid exhaled and the urea secreted, is not more than sufficient to raise the temperature of 10,000 lbs. of water one degree of Fahrenheit. This is equal to a force of 7,720,000 lbs. lifted a foot high; so that the ascertainable work of the food is about one-fifth of its actual energy, the rest of the power being consumed in molecular movements within the animal body. Helmholtz asserts that the external work should be a fifth part of the mechanical force of the digested food; but labour must be well applied to develop this proportion of its energy.

In the steam-engine, according to Sir William Armstrong, only a tenth part of the actual power of the fuel is realised as work. The human machine is therefore more economical of its force than a steam-engine; in fact it is assumed by Heidenham and others that not less than half of the force applied to the living muscles, as it is developed in their tissue, is ultilized. But although the animal machine is so much more economical of force than the steam-engine, yet on account of the costliness of its fuel, &c., it is far more expensive. Taking, for example, a steam-engine of one-horse power (that is, a power of raising 33,000 lbs. a foot high per minute), it will require two horses in reality to do the same work for ten hours a day, or twenty-four men; and the cost would be 10d. for the steam-engine, 8s. 4d. for the two horses, and just £2 sterling for the twenty-four men.

Dr. Frankland has estimated the weight and cost of various articles of food required to be oxydised in the animal body in order to raise 140 lbs. (a rather small man) to the height of 10,000 feet, supposing that only one-fifth of the actual energy of the food is manifested as external work. A part of his table is printed on the top of the succeeding column.

The motive power of fatty foods is thus shown to be far higher than that of lean meat or farinaceous substances, and this accords with experience, for the labouring classes have long since discovered that fat bacon is a good material for heavy work. Its efficacy may, in great part, depend on the ease and certainty with which it is digested and utilised in the body.

The *fattening functions* of food are liable to great varia-

	Ounces required.	Cost.
		s. d.
Oatmeal	20·5	0 3¼
Flour	21·0	0 3¾
Pea-meal	21·4	0 4¼
Bread	37·5	0 4¾
Potatoes	81·1	0 5¼
Rice	21·5	0 5¾
Beef-fat or dripping	8·9	0 6¼
Cheshire cheese	18·5	0 11¼
Cabbage	192·3	1 0¼
Butter	11·1	1 0½
Hard-boiled eggs	35·3	1 2½
Lump sugar	24·1	1 3
Milk	128·3	1 3½
Lean beef	56·5	3 6½
Guiness's stout	6¾ bottles.	5 7½
Bass's pale ale	9 do.	7 6

tion, not merely from the quality of the food itself, but from the peculiarity of the individual consuming it. This is a matter of common observation, and is well known to the breeders of stock. Messrs. Lawes and Gilbert found in their experiments on the feeding of bullocks, sheep, and pigs, that very different quantities of food were required to produce the same increase of weight. Oxen and sheep, for example, feeding on the same diet, namely, oil-cake, hay, and turnips, consume, in one case (that of oxen), 1,109 lbs. of dry substance for every 100 lbs. of increase in the live weight, while in the other, the sheep consume only 912 lbs.; and pigs fed on barley-meal will fatten to the same extent on 420 lbs. of the dry material. Pigs, therefore, store up about one-fourth of their food, reckoned in this way; sheep about one-ninth, and oxen only one-eleventh.

The proportions of the several constituents of the food are also very differently used by these animals; for in every 100 parts of the dry food eaten, the several amounts of nitrogenous, carbonaceous, and mineral matters are thus disposed of:—

CONSTITUENTS OF THE DRY FOOD.		Proportions in dry food.	Proportions stored in animal.	Proportions in manure.	Proportions lost in respiration.
Oxen	Nitrogenous	19·66	0·8	29·1	57·3
	Carbonaceous	72·86	5·2		
	Mineral	7·48	0·2	7·4	—
		100·00	6·2	36·5	57·3
Sheep	Nitrogenous	19·41	0·8	25·1	60·1
	Carbonaceous	73·57	7·0		
	Mineral	7·02	0·2	6·8	—
		100·00	8·0	31·9	60·1
Pigs	Nitrogenous	12·38	1·7	14·3	65·7
	Carbonaceous	85·00	15·7		
	Mineral	2·62	0·2	2·4	—
		100·00	17·6	16·7	65·7

So that the power of appropriation is greatest with pigs and least with oxen; in fact, of every 100 lbs. of the several constituents of the food, the following are the proportions stored up in the three classes of animals:—

	Pigs.	Sheep.	Oxen.
Of 100 Nitrogenous	13·5	4·2	4·1
Of 100 Carbonaceous	18·5	9·4	7·2
Of 100 Mineral	7·3	3·1	1·9

It will be noticed, too, that the proportions lost in respiration are very different in the three cases; for it is greatest in the pig—amounting to nearly 66 per cent. of all the food eaten, and least in the ox, 57·3 per cent. These proportions represent the vital work of the body during the processes of growth and repair.

The time also that is occupied in producing fat and muscular tissue is different with these animals, for the pig increases from 6 to 6·5 per cent. of its weight per week; the sheep not more than 1·75 per cent.; and the ox only 1 per cent. Some of this difference is, doubtless, due to the quality of the food made use of, for the pigs were fed on a nutritious and easily digestible diet—oat-meat; while the sheep and oxen made use of food with a large quantity of cellular tissue and woody fibre; and here, I may remark, that the power of utilising the inferior varieties of food is very different with different classes of animals. Man, as I have already explained, is unable to digest woody fibre, or even the harder kinds of cellulose; it is doubtful indeed whether he can digest cellulose at all. The pig also has but a limited capacity for this kind of work; whereas oxen and sheep, and the herbivora generally, can eat woody tissues with advantage, and convert them into flesh and fat. In eating meat, therefore, we are utilising the digestive powers of other animals; and are, in fact, employing their stomachs to do for us that which we could not do for ourselves. This, as Mr. Lawes says, is proved, not merely by the testimony of common experience, but also by certain anatomical facts relating to the structure and comparative size of the stomach in different animals. In oxen, for example, the stomach weighs 51 ounces for every 100 lbs. of live weight; in sheep it weighs 39 ounces; in pigs 14 ounces; and in man only 6 ounces. It is manifest, therefore, that the food of man should be more concentrated than that of the lower animal; and that he acts wisely in eating flesh and fat, which are the very essence of food, for he thereby economises labour, and employs the assimilative powers of other creatures to bring the crudest materials into a nutritious and highly digestible form. It is true that man, in common with other animals, is able to convert starch and sugar into fat, and the lower qualities of albumen into flesh, but by so doing he expends force, for in the case of fat he locks up in it twice and a-half the potential energy of sugar and starch.

Looking broadly, therefore, at the functions of food, and regarding the animal body as a machine, in which potential energy is rendered active, it would appear that its main duty is to develop force by the oxydation of carbo-hydrogens contained in the blood, and not by the oxydation of tissue. A portion of tissue no doubt decays in the transference of its energies to other forms of action, and requires repair; but the decay is scarcely more rapid at one time than another, and is in no case, when sufficient food is supplied, the cause of mechanical labour. "In man," say Dr. Frankland, "the chief materials for muscular power are non-nitrogenous; but nitrogenous matter can also be employed for the same purpose, and hence the greatly increased evolution of nitrogen under the influence of a flesh diet, even with no increase of muscular exertion. The non-nitrogenous matters, also, which find their way into the blood, yield up all their *potential* energy as *actual* energy; whereas the nitrogenous in leaving the body as urea carry with them a portion (at least one-seventh) of their potential energy unexpended. The transference of potential energy into muscular power is necessarily accompanied by the production of heat within the body, even when the muscular power is exerted externally. This is, doubtless, the chief, and probably the only source of animal heat."

LECTURE III.—Delivered Monday, February, 3, 1868.

ONSTRUCTION OF DIETARIES—PREPARATION AND CULINARY TREATMENT OF FOODS.

ıe construction of dietaries involves a variety of con- erations, as—1st. The determination of the real wants the body under different circumstances of age, sex, ıstitution, labour and climate; 2nd. A proper selection food, as regards quality, nutritive power, appetizing operty, digestibility, and price; 3rd. The association foods in such wise as not to offend the appetite or rden the digestive powers; 4th. A right treatment of ım by cooking, &c., so as to render them most useful the system; and 5th. A just distribution of the daily t in appropriate meals.

As regards the first question—namely, *the determination the actual dietetical wants of the body*—it may be ıwered from two sets of facts, as those which pertain the minimum quantities of food capable of being used thout loss of health or bodily vigour, and those which ate to the amounts of carbon and nitrogen exhaled m the body during different conditions of life.

In a general way it may be said that a healthy vigorous .n consumes from 700 to 800 lbs. of solid food (dry) in year. This amounts to about 2 lbs. of dry, solid ıtter daily; and the quantity of water (free and com- ıed) is about 5½ lbs. daily.

Pursuing the inquiry a little farther, we find that a n cannot live on a punishment prison diet of 1 lb. of ad a-day with water, for in three days he will lose out 3 lbs. in weight, and will show signs of commenc- starvation. This diet contains 1·3 oz. of nitrogenous tter and 8·42 of carbonaceous (=1,995 grains of car- n and 90 of nitrogen). Even the poor needle-women London can only just exist, in a state of feeble vitality, th an average diet of 1¼ lbs. of bread a-day, with out 1 oz. of dripping. This contains nearly 2 oz. of rogenous matter, and 14·65 of carbonaceous, calculated starch (=3,271 grains of carbon and 135 of nitrogen). d in military prisons, where as much as 3·8 oz. of rogenous food, and 22·2 oz. of carbonaceous (=6,925 ins of carbon and 256 of nitrogen), are supplied daily prisoners for short terms of confinement, they fre- ntly lose weight and give evidence of decay; so that longer periods of imprisonment it is found necessary increase the diet to 4·7 oz. of plastic matter, and 27·8 respiratory (=8,647 grains of carbon, and 317 of rogen); in fact, according to Dr. Christison, the men ıfined in the prison at Perth cannot even do the work pumping the water for the prison on a daily diet of 6 of plastic matter, and 25 of respiratory (=7,239 grains carbon and 405 of nitrogen).

Again, Dr. Edward Smith found in his inquiries into dietaries of adult male operatives of Lancashire and eshire, during the cotton famine, and also into those the low-fed operatives of England, that the daily ount of food, only barely sufficient for existence, must contain 2·84 oz. of nitrogenous matter, and 19·25 of car- bonaceous (=4,300 grains of carbon and 200 of nitrogen). These are contained in 2 lbs. 3 oz. of bread, which is regarded as a famine diet. The farm labourers of Eng- land consume daily an average of 3·18 oz. of plastic matter and 26·01 of respiratory. In Scotland, Wales, and Ireland, the amounts are somewhat larger, as will be apparent from this diagram:—

Average Daily Diet of Farm-Labourers in the United Kingdom.

	Dry nitrogenous matter.	Dry carbonaceous matter.		Carbon.	Nitrogen.
	oz.	oz.		grs.	grs.
In England..	3·18	26·01	=	5810	228
In Wales....	4·12	31·22	=	6901	290
In Scotland..	4·76	31·34	=	6297	335
In Ireland ..	4·94	28·73	=	6195	348
Average of all	4·25	29·07	=	6477	300

These are the results of inquiries into the dietaries of many hundreds of families, the results being computed as for adults; but it is very probable, as Dr. Smith remarks, that the nourishment obtained by the labourer himself is somewhat above the average. This, in fact, is confirmed by the more extensive investigations of Dr. Lyon Playfair, who concludes, from a large series of observations, that the following may be regarded as the average proportions of the several constituents of food in the daily dietary of an adult man under different cir- cumstances of existence:—

Daily Diets for	Flesh-former.	Fat.	Starch and Sugar.		Nitrogenous.		Carbonaceous calculated as starch.
	oz.	oz.	oz.		oz.		oz.
Subsistence only	2·0	0·5	12·0	=	2·0	+	13·2
Quietude	2·5	1·0	42·0	=	2·5	+	14·4
Moderate exercise	4·2	1·8	18·7	=	4·2	+	22·0
Active labour ..	5·5	2·5	20·0	=	5·5	+	26·0
Hard work	6·5	2·5	20·0	=	6·5	+	26·0

These conclusions accord pretty well with the deter- minations of Pettenkofer and Voit, who say that an adult requires daily, when at work, 5·22oz. of nitrogenous matter and 22·38 of carbonaceous (calculated as starch). Taking, therefore, the mean of all these researches, it may be said that a man requires daily the following amounts of carbonaceous and nitrogenous matter for idleness, for ordinary labour, and for active labour:—

Daily Diets for	Nitrogenous.	Carbonaceous.		Carbon.	Nitrogen.
	oz.	oz.		grs.	grs.
Idleness	2·67	16·83	=	3,856	187
Ordinary labour	4·56	24·48	=	5,757	319
Active labour ..	5·81	24·31	=	5,837	400

By pursuing the second method of inquiry, and estimating the wants of the body from the amounts of carbon and nitrogen exhaled and secreted, it is found that the proportion of carbon evolved as carbonic acid from the lungs of a man in health varies from 6oz. to 13½oz. daily, the difference being dependent on temperature, exercise, &c. Dr. Edward Smith says that it amounts to—

7·85oz. daily while the body is quiet;
9·11oz. do. with moderate exercise;
12·9oz. do. with considerable labour.

And he considers that a healthy man of average weight (150lbs.) emits 8·57 ounces of carbon from his lungs daily. This, added to the quantity discharged from the skin and bowels, is not less than 9·6oz. daily (= 4,200 grains) or just 28 grains per lb. of the man's weight. During light labour, he says it ranges from 9·6oz. to 10·5, and during hard work from 12·5 to 14oz.

The amount of nitrogen excreted as urea, &c., in the urine is also subject to great variation, according to the diet and exercise. Dr. Parkes found in his experiments on two soldiers, that with an ordinary diet and no exercise, it amounted to 2·03 grains per lb. weight of the body (= 304 grains per 150lbs.); and that with a non-nitrogenous diet, and no exercise, it was 0·95 grains per lb. weight (= 142 grains per 150lbs.); and with the same diet and active exercise it was 2·42 grains per lb. weight (= 364 grains per 150 lbs.).

Professors Fick and Wislicenus observed that the nitrogen secreted during an ordinary diet and no exercise, was at the rate of 1·53 grains per lb. weight (=203 grains per 150lbs.); and that it fell to a little less than one grain per lb. weight with a non-nitrogenous diet during the labour of ascending the Faulhorn.

The researches of the Rev. Dr. Haughton, of Dublin, have led him to conclude that an average-size man, performing routine work, secretes 187 grains of nitrogen as urea daily (= 1·25 grains per lb. weight); and Dr. Edward Smith has estimated it at from 0·93 to 1·4 grains per lb. weight—a fair average being 1·15 (= 173 grains per 150lbs.).

The more extensive inquiries of Playfair, Ranke, Beigel, Moos, Vogel, and others, give a daily average of 171 grains of nitrogen as urea for a healthy man at rest, and 252 grains for ordinary labour.

It may therefore be safely concluded that with an ordinary diet, an average-size man excretes daily as urea 175 grains of nitrogen; and during labour of a moderate description it amounts to about 250 grains. Adding to these the proportions of nitrogen excreted in other forms in the urine, and the quantities passed from the bowels, the total amounts are probably about 190 grains while at rest, and 300 grains when at routine work; the difference, perhaps, being more dependent on the food than on the metamorphosed tissues of the body.

It thus appears that the proportions of carbon and nitrogen excreted correspond very closely with those contained in the diets which experience has proved to be necessary for man's sustenance; for when the results are put into a tabular form they stand thus:—

Daily Requirements of the Body.

		Nitrogenous Food.	Carbonaceous Food.		Carbon.	Nitrogen.
		oz.	oz.		grs.	grs.
During idleness as determined	By dietaries	2·67	16·83	=	3,856	187
	By excretions	2·78	18·47	=	4,200	190
	Average....	2·72	17·65	=	4,028	188
Routine work as determined	By dietaries	4·56	24·48	=	5,757	319
	By excretions	4·39	19·80	=	4,813	300
	Average....	4·48	22·14	=	5,285	310

The first of these averages is represented by 2lbs. 2ozs of bread, and the second by about 3½lbs.

It appears also that the relation of the nitrogenous to the carbonaceous constituents of food should be about as 1 to 5½ or 6. These, in fact, are the proportions which Messrs. Lawes and Gilbert found to be best suited for fattening pigs. In milk, the proportions are as 1 to 3·((the butter being calculated as starch); and no doub these are the right proportions for the dietaries of children. Again, it will be observed, that the relation o nitrogen to carbon is nearly as 1 to 19; whereas in mill it is about as 1 to 11. Referring to table No. 4 (p. 617 it will be noticed that the proportions in bread are as 1 to 22, and in meat as one to 13, showing that the forme requires the addition of plastic matter, and the latter o respiratory.

In preparing dietaries, however, it will be best to take a rather liberal view of the question, and, therefore, I shall adopt the conclusions of Dr. Edward Smith—tha even in periods of idleness a man's daily food shoul contain not less than 4,300 grains of carbon, with 200 o nitrogen; and a woman's at least 3,900 grains of carbon with 180 of nitrogen—these being the proportions which in his opinion, are necessary to avert starvation diseases and they are represented in the case of a man's diet by 19·25 oz. of carbonaceous food, with 2·84 of nitrogenous The diagram before you exhibits the amounts of differen articles of diet capable of furnishing this quantity o nitrogenous matter, and it also shows the proportions o carbonaceous matter (calculated as starch) associate with it:—

Amounts of Food Yielding 200 Grains of Nitrogen or 2·84 oz. of Plastic Matter Necessary for Man's Daily Diet.

Description of Food.		Carbonaceous matter in it.	Carbon in it.
	oz.	oz.	grs.
Skim-cheese	8·8	5·57	1,290
White fish	24·6	5·99	1,384
Skim-milk	94·1	8·96	2,059
Peas	12·6	9·33	2,141
New milk	91·4	9·40	2,160
Lean meat	18·3	11·36	2,629
Oatmeal	22·9	17·54	4,000
Wheat-flour	26·7	19·28	4,433
Baker's bread..........	35·6	19·28	4,433
Indian meal	26·0	19·83	4,554
Rye-meal	36·4	26·40	6,046
Barley-meal	45·7	34·02	7,800
Rice	45·7	34·02	7,800
Bacon	32·6	38·04	8,714

So that, whilst the first seven of these substances a deficient of carbonaceous matter (19·25 oz. being r quired), the last seven contain it in excess. It is, ther re, not difficult to construct a dietary from the several bles which I have placed before you; but perhaps it ould interest you to know exactly what are the actual etaries in use among different classes of persons; and first I will direct your attention to what Dr. Edward Smith found to be the average weekly dietaries of the low-fed operatives of England, Wales, Scotland, and Ireland.

Weekly Dietaries of Low-fed Operatives, calculated as Adults (Dr. E. Smith).

Class of Labourer.	Bread stuffs.	Potatoes.	Sugars.	Fats.	Meat.	Milk.	Cheese.	Tea.	Containing		Cost.
									Carbon.	Nitrogen.	
	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Grs.	Grs.	s. d.
‑eedle-women (London)	124·0	40·0	7·3	4·5	16·3	7·0	0·5	1·3	22,900	950	2 7
ilk-weavers (Coventry)	166·5	33·7	8·5	3·6	5·3	11·6	1·0	0·3	27,028	1,104	1 11¾
)o. do. (London)......	158·4	43·8	8·8	5·5	11·9	4·3	0·3	0·6	48,288	1,165	2 8¾
)o. do. (Macclesfield) ..	138·8	26·6	6·3	3·4	3·2	41·9	0·9	0·3	27,346	1,177	1 8¼
‑id glovers (Yeovil)........	140·0	84·0	4·3	7·1	18·3	18·3	10·0	0·9	28,623	1,213	2 9½
‑otton-spinners (Lancashire)	161·8	22·6	14·0	3·1	5·0	11·8	0·7	0·7	29,214	1,295	2 3
‑ose weavers (Derbyshire)..	190·4	64·0	11·0	3·9	11·9	25·0	2·2	0·4	33,537	1,316	2 6¼
‑hoemakers (Coventry)	179·8	56·0	10·0	5·8	15·8	18·0	3·3	0·8	31,700	1,332	2 7¾
‑arm labourer (England) ..	196·0	96·0	7·4	5·5	16·0	32·0	5·5	0·5	40,673	1,594	3 0
)o. do. (Wales)	224·0	138·7	7·5	5·9	10·0	85·0	9·8	0·5	48,354	2,031	3 5½
)o. do. (Scotland) ..	204·0	204·0	5·8	4·0	10·3	124·8	2·5	0·7	48,980	2,348	3 3¾
)o. do. (Ireland)	326·4	92·0	4·8	1·3	4·5	135·0	..	0·3	43,366	2,434	1 9¾
‑ean of all................	184·2	78·1	8·0	4·5	10·7	42·9	3·1	0·6	34,167	1,500	2 7¾
‑verage per day	26·3	11·1	1·4	0·6	1·5	6·1	0·4	0·1	4,881	214	0 4½

You will see from this table that the poor needlewomen London are the worst fed of all the operatives in the ree kingdoms, for they subsist on a weekly allowance 102·52 oz. of carbonaceous food, with 13·49 oz. of trogenous (= 14·65 oz. carbonaceous, with 1·93 oz. trogenous daily), while the farm labourers of Ireland e, as regards the real nutritive value of their food, the st-fed of the lower operative classes. But it will also noticed that the cost of the weekly dietary of the Irish bourer is only 1s. 9¾d. per week, while that of the edlewoman is 2s. 7d.—the latter feeding chiefly on ead, bacon, and tea, which are expensive foods, while e former consumes potatoes, milk, and Indian meal—ods which yield more nutriment for their money value an the more expensive foods of the English, Welsh, d Scotch labourers. And now we will contrast the etaries of the poorer classes of operatives with those of tter-fed persons, as soldiers, sailors, navigators, &c.; and r this purpose I shall avail myself of the accurate returns tained and published by Dr. Lyon Playfair :—

ily Dietaries of Well-fed Operatives (Playfair).

Class of Labourer.	Flesh-former.	Fats.	Starch and Sugar.	Containing		Containing	
				Carbonaceous.	Nitrogenous.	Carbon.	Nitrogen.
	Oz.	Oz.	Oz.	Oz.	Oz.	Grs.	Grs.
lly-fed tailors....	4·61	1·37	18·47	21·64	4·61	5,136	325
ldiers in peace ...	4·22	1·85	18·69	22·06	4·22	5,246	297
yal Engineers (work)	5·08	2·91	22·22	29·38	5·08	6,494	358
ldiers in war......	5·41	2·41	17·92	23·48	5·41	5,561	381
glish sailor	5·00	2·57	14·39	20·40	5·00	4,834	252
ench do.	5·74	1·32	23·60	26·70	5·74	6,379	405
rd-worked weavers	5·33	1·53	21·89	25·42	5·33	6,020	375
glish navvy (Crimea)	5·73	3·27	13·21	21·06	5·73	5,014	404
glish navvy (Railway)......	6·8	3·82	27·81	37·08	6·84	8,295	482
acksmiths	6·20	2·50	23·50	29·50	6·20	6,864	437
ize-fighters (training)......	9·80	3·10	3·27	10·70	9·80	4,366	690
an of all	5·81	2·42	18·63	24·31	5·81	5,837	400
. of low-fed operatives......	3·04	0·64	21·18	22·78	3·04	4,881	214

In all these cases the carbonaceous matters of the food are estimated as starch; and I may state that the soldiers' dietary, when at peace, is calculated from the rations of the English, French, Prussian, and Austrian service; and when at war, it is derived from the actual dietaries of European and American soldiers during recent wars.

It would be interesting, if time permitted, to compare these dietaries with the dietaries of hospitals, prisons, workhouses, and lunatic asylums; for we should then perceive not merely how greatly they vary in their nutritive value, but also how little attention is paid to the principles which ought to guide our public authorities in the construction of public dietaries. In the prisons of England, Scotland, and Ireland, the several dietaries for short terms of imprisonment, as well as for longer periods, and for hard labour, vary respectively to so great an extent as to furnish an inducement for the commission of crime in certain districts rather than in others, because of the richness of the prison rations; and in all cases the dietaries of prisons are so greatly in excess of those of the union, that in times of distress they offer encouragement for misdemeanour, in order that the prison may be reached in preference to the workhouse; in short, while the day's rations of an unfortunate inmate of a union contains only about 17 oz. of dry nutritious matter, that of a destitute debtor contains 19·4 oz., and that of a convict 22 oz.; moreover, a prisoner confined for more than a month, without hard labour, in the jails of England, Scotland, and Ireland, would have 18·8 oz., 22·4, and 23·9 of dry nutriment respectively; the average rations for hard work containing about 21·7 oz., 31·5, and 25·6 in the prisons of the three countries.

Dr. Edward Smith has drawn attention to the serious want of uniformity in the dietaries of the unions of his district, and has urged the workhouse authorities to improve them. He also submitted to the Privy Council tables of dietaries, which are well suited to meet the requirements of the system at the lowest money cost. Here are a few of them, which may, perhaps, prove useful to those who are engaged in the benevolent work of supplying food to the poor in times of distress; and you will perceive that at various sums, from about 2s. to 3s. a-week per adult, very substantial rations may be provided. (See table, top of next page.)

The dietaries of women should be about 1-10th less than those of men in the case of indoor operatives, but

Dietaries to Furnish as nearly as possible 30,100 Grains of Carbon and 1,400 Grains of Nitrogen per Man Weekly—Women take One-tenth Less.

Cost.	1s. 11¾d.	2s. 0½d.	2s. 3½d.	2s. 4½d.	2s. 6d.	2s. 7½d.	2s. 8¼d.	2s. 10½d.	3s. 1½d.	3s. 3½d.
	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.
Bread	144	128	160	160	128	160	160	160	192	160
Flour for dumplings	..	..	..	..	..	..	..	16	16	8
Oatmeal	16	32	16	32	32	16	16	16	..	8
Peas	..	..	..	..	12	6	..	..	..	..
Rice	..	..	16	..	..	..	16	..	8	8
Sugar	..	4	4	..	4	4	4	4	8	8
Treacle	..	16	8	8	8	..	8	12	8	8
Butter	..	..	..	..	2	..	..	2	..	12
Dripping	..	..	4	..	..	4	4	..	4	..
Suet	..	..	..	..	..	..	..	4	4	2
Meat without bone	8	8	..	8	8	8	16	12	8	24
Herrings	..	..	..	..	4	..	..	..	..	..
Bacon	..	..	..	8	4	8	..	..	8	..
Skimmed milk	70	140	60	70	120	120	70	120	70	100
Buttermilk	60	..	80	..	..	..	60	..	60	..
Tea	..	..	..	..	..	0·5	..	..	0·5	0·5
Coffee and chicory	..	2	2	..	1	1	2	2	1	1
	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.
Nutritive values. Carbon	28,031	29,748	33,552	34,935	32,998	33,248	36,499	36,402	41,519	36,39[illegible]
Nutritive values. Nitrogen	1,409	1,291	1,511	1,548	1,859	1,609	1,674	1,638	1,768	1,62[illegible]

they ought to be from 1-3rd to 1-4th less than the larger dietaries of men engaged in out-door labour.

As regards the dietaries of children, it may be stated generally that the chief part of their food should be milk. Up to the age of nine or ten months it should, if possible, be the milk of woman, which is richer in sugar than cow's milk, and much less rich in caseine; failing this, however, asses' milk is a good substitute, as it contains nearly the same amount of sugar and caseine as human milk. MM. O. Henri and Chevalier have given these as the proportions of the several constituents in 100 parts of the milk of different animals:—

	Asses' milk.	Woman's milk.	Cow's milk.	Goat's milk.	Ewe's milk.
Caseine	1·81	1·52	4·48	4·02	4·50
Butter	0·11	3·55	3·13	3·32	4·20
Sugar of milk	6·08	6·50	4·77	5·28	5·00
Various salts	0·34	0·45	0·60	0·58	0·68
Total solids	8·34	12·02	12·98	13·20	14·38
Water	91·66	87·98	87·02	86·80	85·62
Total	100·00	100·00	100·00	100·00	100·00

Cow's milk, therefore, diluted with about one-third its bulk of water, and sweetened with sugar, may be given to children; and up to nine or ten months no other food should be administered, for infants have not the power of digesting farinaceous or fibrinous substances. A child may take from two to three pints of milk thus diluted daily. After ten months, and to about twenty months, farinaceous matters may be mixed in gradually increasing quantities with the milk; and they should be well cooked by first baking them, and then thoroughly dissolving them by boiling. After this age, and up to the third year, the quantity of well-cooked farinaceous matters may be still further increased, and given as puddings with a little egg. Bread and butter may also be eaten, and towards the end of the time the child will digest well-boiled potato, with a little gravy of meat. From the third to the fifth year a little meat may also be given, and at the end of the ninth year it may partake of the usual food of the family; but all along it should make use of a large proportion of milk, in the various forms of bread and milk, or milk puddings, with eggs. About the tenth year a child will require about half as much food as a woman; and at the fourteenth year it will eat quite as much as a woman; in fact, the proportion of food required by the child is much greater per pound weight of the body than that of adults, because it has to form its tissues and build up its several structures. Dr. Edward Smith calculates that the proportions of carbon and nitrogen in the daily food at different ages should be about as follows:—

Daily Proportions of Carbon and Nitrogen in the Food at Different Ages, per Pound Weight of the Body.

	Carbon.	Nitrogen.
	grs.	grs.
In infancy	69	6·78
At ten years of age	48	2·81
At sixteen do. do.	30	2·16
At adult life	23	1·04
In middle age	25	1·13

So that for its weight the infant requires three times as much carbonaceous food and six times as much nitrogenous as an adult.

The construction of dietaries for particular purposes, as for training, for developing muscular tissue, for producing fat, or for reducing it, is beyond the scope of these lectures; but it may generally be said that, as in training the object is to form muscular tissue, to give it great endurance of action, and, at the same time, to reduce the weight of the body, it is accomplished by the use of nitrogenous food, with but little fat or farinaceous matter, and as little fluid as possible—so that muscular tissue may take the place of fat and water; and by constant exercise, the endurance and strength of the muscular tissue is increased, and the proportion of water in the tissues is reduced. King, in training, is said to have taken for his breakfast two lean mutton-chops, somewhat under-done, with dry toast or stale bread, and a single cup of tea without sugar; for dinner, 1 lb. or 1¼ lb. of beef or mutton, with toast or stale bread, and very little potato or other vegetable, and half-a-pint of old ale, or a glass or two of sherry; for tea a single cup of unsweetened tea with an egg and some dry toast; and or supper half-a-pint of oatmeal-porridge or half-a-pint f old ale. The effect of this is to produce only a short-ived state of effectiveness, for, carried a little beyond the ppointed time, it leads to disease; and even after the rial, there is often, as in the case of Heenan, terrible rostration of the system, and a necessity for returning mmediately to an ordinary diet.

Foremost among the foods for developing fatty tissue re fats, as fat of meat, butter, cream, &c.; next to these re farinaceous matters, as arrowroot, starches, and the arious meals; and after these are sugar, alcohol, &c.; o that in an attempt to reduce the bulk of the body, all f them, but especially the first, should be but sparingly sed. Conversely, however, the use of fatty and fari-naceous foods has a tendency to produce fat, and so also vith fermented liquids, as beer and porter—the last aving a high character for its capabilities of forming nilk when drunk by nursing-women.

In associating different articles of diet, so as to secure he right proportions of the several constituents of food—at, sugar, or starch, and nitrogenous matter, we find hat we may not only rely on the sound indications of cience, but may also trust, and trust safely, to the unerr-ng guidance of our instincts—provided they have not een vitiated by fashion or perverted by evil habits. Science teaches us that the best proportions for the com-non wants of the animal system are about 9 of fat, 22 of lesh-forming substances, and 69 of starch and sugar; nd experience also shows that these are the very pro-ortions which we are constantly striving to maintain in ur daily dietaries. Borrowing largely from the graphic llustrations of Liebig and Johnston, I may state that, whenever one kind of food is wanting in any particular constituent we invariably associate it with another that ontains an excess of it. Certain meats, for example, which are deficient of fat are always eaten with sub-stances that are rich in it—bacon is associated with veal, with liver, and with fowl, or we capon the latter, and hus increase its natural fat. We use melted butter with nost kinds of fish, or we fry them in oil; while the her-ring, the salmon, and the eel, are usually fat enough in hemselves, and are dressed and eaten alone. It is with a view to similar adjustment that we mix eggs and butter with sago, tapioca, and rice; that we add oil and the yoke of an egg to salad; that we boil rice with milk, and eat cheese with maccaroni. The same instinct has deter-mined the use of vegetables with meat, and butter with bread. Bacon and greens, or beans and bacon, like pork nd peas-pudding, is a conjunction of viands which does not owe its popularity to old habit or the mere taste of he epicure; and so with a dish, common in Ireland, under the name of Kol-cannon—the potato, which is poor in gluten, and the cabbage, which is usually rich in this ingredient, are mixed together, and thus they pproach the composition of wheaten bread, but both of hese substances are deficient in fat; add, therefore, a ittle bacon or fat pork to the mixture, and you have a Kol-cannon which has all the good qualities of the best Scotch oatmeal, and to many it is more savory and alatable. Again, the mixture so usual in Ireland and Alsace, of butter-milk or curdled milk and potatoes, and he combinations of rice and fat which make the diet of astern nations; even the little dab of butter upon the oor man's potato, and the bit of cheese that he eats with his dinner, are matters not of luxury but of necessity, and they show how by long experience we ave at last learnt to adjust the proximate constituents f food, so as best to maintain the health and vigour of he body.

And then, again, *the times for taking food* and *the proper istribution of it in appropriate meals*, are questions of onsiderable importance, notwithstanding that they have ver been influenced by the caprices of fashion and the rtificial habits of society. How much they have had o do with the modification of the human species, and ven with the extinction of whole races of men, is an tiological problem of much interest.

Man in his savage condition feeds with great irregu-larity, for when he finds that food is plentiful he eats from morning to night, and knows no other pleasure than that of eating and drinking and sleeping; but when it is more scarce he is content with a single meal a day. In both cases, however, the quantity of food consumed is excessive. We are told by travellers that the Hottentots, the Bushmen, and the inhabitants of South Africa, who feed in this manner are enormous gluttons. "Ten of them," says Barrow, "ate, in his presence, an ox, all but the hind legs, in three days; and the three Bosjes-men that accompanied his waggon, devoured a sheep on one occasion in less than twenty-four hours." Parry, Ross, and others, have also given the most astonishing accounts of the dietetical capabilities of the Esquimaux. Captain Parry once tried the capacity of a young lad scarcely full grown, and in twenty-fours he had eaten 4 lbs. 4oz. of the raw hard-frozen flesh of a sea-horse, the same quantity of it boiled, 1 lb. 12 oz. of bread and bread-dust, besides a pint and a quarter of rich gravy-soup, a tumbler of strong grog, three wine-glasses of raw spirits, and nine pints of water. According to Sir John Ross, the daily rations of an Esquimaux are 20 lbs. of flesh and blubber. But the most marvellous example of gluttony is given by Captain Cochrane, on the authority of the Russian Admiral Saritcheff, who was told that one of the Yakuti had consumed the hind quarter of a large ox in 24 hours, together with 20 lb. of fat, and a proportionable quantity of melted butter. To test the truth of this, he gave him a thick porridge of rice boiled down with 3 lbs. of butter, weighing together 28 lbs.:—although the glutton had already breakfasted, yet he sat down to the meal with great eagerness, and consumed the whole without stirring from the spot; and, except that his stomach betrayed more than ordinary fulness, he showed no sign of inconvenience. Captain Cochrane further adds that a good calf, weighing 200 lbs., will just serve for a meal for four or five Yakuti; and that he has himself seen three of them consume a rein-deer at a meal. Liebig accounts for this by saying that a nation of hunters, especially when they go naked and are exposed to great losses of temperature, must consume large quantities of respiratory food; and if it so happens that the food is in its least effective form, as lean flesh, the quantity disposed of is enormous.

Among civilised nations, and until comparatively recent times, there were but two meals a-day—namely, dinner and supper. These were the meals of the Romans —the *prandium* or dinner being for the most part a light refreshment, eaten while standing, at about nine o'clock in the morning; and it generally consisted of the cold remains of yesterday's supper. It was commonly taken without wine, and, in fact, there was so little ceremony about it, that Plautus, in his comedies, has facetiously called it *caninum prandium*. The great meal of the day was the supper, or *cœna*, which was taken about three or four o'clock in the afternoon, and to which friends were invited. This was the ceremonious meal for which the wealthy and high families of Rome exhausted the resources of luxury and art. It always consisted of three parts—the *gustus* or antipast, which was intended as a mere smack or relish to whet the appetite. Then came the main part of the feast—consisting of many courses, with a chief dish or *caput cœnæ*, and when in thrifty families it was the only dish which went the round of the frugal board, it was aptly termed the *cœna ambulans*. After this there came the second course, or *mensa secunda*, composed of fruits and pastry, like a modern dessert.

The sums of money expended by the wealthy Romans on this meal were often ruinous. Vitellius is said to have spent as much as 400 *sestertia* (about £3,228 of our money) on his daily supper; and the celebrated feast to which he invited his brother Lucius cost no less than 5,000 *sestertia*, or £40,350 sterling. It consisted, according to Suetonius, of 2,000 different dishes of fish and 7,000 of fowls, with other equally numerous meats. His daily food, says our classical writers, was of the most rare and exquisite nature, the deserts of Libya, the shores of Spain, the waters of the Carpathian Sea, and even the coasts and forests of Britain were diligently searched for dainties to supply his table; and had he reigned long he would, says Josephus, have exhausted the great opulence of the Roman Empire. Ælius Verus, another of those worthies, was hardly less profuse in the extravagance of his suppers; for it is said that a single entertainment, to which only about a dozen guests were invited, cost above six million sesterces (6,000 *sestertia*, or nearly £48,500); and we are told by historians that his whole life was wasted in eating and drinking—being spent in the voluptuous retreats of Daphne, or else at the luxurious banquets of Antioch. So profuse, indeed, was the extravagance of those times, that to entertain an emperor at a feast was to encounter almost certain financial ruin—one dish alone at the table of Heliogabalus has been known to cost about £4,000 of our money; no wonder, therefore, that these imperial feasts were lengthened out for hours together, and that every artifice, often revolting in the extreme, was used to prolong the pleasure of eating, or that Philoxenus should have wished that he had the throat of a crane with a delicate palate all the way down.

Hardly less extravagant were the dining propensities of our own forefathers, who in every way copied too closely the luxurious habits of their Roman conquerors. In fact, no circumstance, as Mr. Wright observes, is more remarkable in ancient history than the readiness with which the people who came under the sway and influence of Rome, abandoned their nationality, and followed the luxurious habits of their rulers. Even so late as the time of Holinshed, the famous chronicler of the 16th century, the manners of the English were the subject of severe comment; for he tells us that "in number of dishes and changes of meat, the nobility of England (whose cooks are, for the most part, musical-headed Frenchmen and foreigners), do most exceed; sith there is no day in manner that passeth over their heads, wherein they have not only beef, mutton, veal, lamb, kid, pork, cony, capon, pig, or so many of them as the season yieldeth, but also some portion of the red and fallow deer, beside great variety of fish and wild fowl, and thereto sundry other delicates, wherein the sweet hand of the seafaring Portingale is not wanting; so that for a man to dine with one of them, and to taste of every dish that standeth before him, is rather to yield unto a conspiracy with a great deal of meat for the speedy suppression of natural health, than the use of a necessary meal to satisfy himself with a competent repast to sustain his body withal." He adds, too, "that gentlemen and merchants keep much about the same rate; and when they make their ordinary or voluntary feasts, it is a world to see what great provision is made of all manner of delicate meats from every quarter of the country, wherein, beside that, they are often comparable herein to the nobility of the land; so that they will seldom regard anything that the butcher usually killeth, but reject the same as not worthy to come in place. In such cases, also, *geliffes* of all colours, mixed with a variety in the representation of sundry flowers, herbs, trees, forms of beasts, fish, fowls, and fruits; and thereunto *marchpane*, wrought with no small curiosity, tarts of divers hues and sundry denominations; conserves of old fruits, foreign and home-bred; suckets, codiniacs, marmalades, sugarbread, gingerbread, florentines, wild-fowl, venison of all sorts, and sundry outlandish confections, altogether seasoned with sugar, besides infinite devices, not possible for me to remember."

The learned Caius, also, in his "Counseill against the Sweat" of the same century (1552) comments in severe terms on the gluttony of his time, saying that the reason why the disease attacks the English more than others is, that they have "so moche sweating stuffe, so many euille humoures laid up in store, fro this displeasante, feareful, and pestilent disease, cause of their euille diet, whiche destroy more meates and drynckes withoute al ordre, conveniet time, reason, or necessite, the either Scotlande, or al other countries under the sunne."

Gradually, too, as the dinner got to be later in the day, and reached noontime, there was necessity for a light early meal, or *breakfaste*, as it was called; and as the dinner became later and later still, a fourth meal was added—the *lunch* or *luncheon*, which literally meant a slice of bread. In process of time, also, with the introduction of tea and coffee into England, there came a fifth meal; but all along the dinner was the great feast of the day; and the rule in using it was pretty much as Dr. Kitchener, in his time, advised—namely, to eat until there was a sense of satiety, the stimulus of every fresh dish being but as a whip to the appetite, so that the sense of satiety might come and go a dozen times. "It is produced in us," says Christopher North, "by three platefuls of hotch-potch, and to the eyes of an ordinary observer our dinner would seem to be at an end; but no; strictly speaking, it is just going to begin. About an hour ago did we, standing on the very beautiful bridge of Perth, see that identical salmon, with his back-fin just visible above the translucent tide, arrowing up the Tay, bold as a bridegroom, and nothing doubting that he should spend his honeymoon among the gravel-beds of Kinnaird or Moulenearn, or the rocky sofas of the Tummel, or the green marble couches of the Tilt. What has now become of the sense of satiety? John—the castors!—mustard—vinegar—cayenne—catsup—peas and potatoes, with a very little butter—the biscuit called "rusk"—and the memory of the hotch-potch is as that of Babylon the Great." Sense of satiety, indeed! —"We have seen it for a moment existing on the disappearance of the hotch-potch—dying on the appearance of the Tay salmon—once more noticeable as the last plate of the noble fish melted away—extinguished suddenly by the vision of the venison—again felt for an instant, and but for an instant, for a brace and a-half of as fine grouse as ever expanded their voluptuous bosoms to be devoured by hungry love."

We smile at the accounts given of the gormandizing powers of the natives of Arctic regions and the savages of Southern Africa, but our own habits in eating and drinking are scarcely less preposterous. Look at a modern dinner; beginning with soup, and perhaps a glass of cold punch; to be followed by a piece of turbot or a slice of salmon with lobster-sauce; and while the *caput cœnæ*, the venison or South Down, is getting ready, we toy with an oyster paté or a bit of sweat-bread, and mellow it with a bumper of Madeira. No sooner is the venison or mutton disposed of, with its never-failing accompaniments of jelly and vegetables, than we set the whole of it in a ferment with champagne, and drown it with hock or sauterne. These are quickly followed by the wing and breast of a partridge, or a bit of pheasant or wild duck; and when the stomach is all on fire with excitement, we cool it for an instant with a piece of iced pudding, and then immediately lash it into a fever with undiluted alcohol, in the form of cognac or a strong liqueur; after which there comes a spoonful or so of jelly as an emollient, a morsel of ripe stilton or paté de foie-gras as a digestant, a piquante salad to whet the appetite for wine, and a glass of old port to persuade the stomach, if it can, into quietness. All these are more leisurely succeeded by the *mensa secunda*, or dessert, with its ices, its preserves, its bakemeats, its fruits, its geliffes, codiniacs, and suckets, as Holinshed would call them, and its strong drinks; to be afterwards muddled with coffee, and complicated into a rare mixture with tea, floating with the richest of cream.

As a modest example of this sort of thing, and an indication moreover of the kind of novelties yet in store for us, let me read to you the *menu* of a late dinner at the Langham, where horse-flesh was the principal *viande*. It is very appropriately prefaced with a little bit of French philosophy—"*Les préjugés sont des maladies de l'esprit humain.*"

"*Potages*—Consommé de cheval. A la purée de strier. *Amontillado.*
"*Poissons*—Saumon à la sauce Arabe. Filets de soles l'huile hippophagique. *Vin du Rhin.*
"*Hors-d'œuvres*—Terrines de foie maigre chevalines. ucissons de cheval aux pistaches syriaques. *Xérès.*
"*Relevés*—Filet de Pégase rôti aux pommes de terre la crême. Dinde aux châtaignes. Aloyau de cheval rci à la centaure aux choux de Bruxelles. Culotte cheval braisée aux chevaux-de-frise. *Champagne sec.*
"*Entrées*—Petits pâtés a la moëlle Bucéphale. Kromeys à la Gladiateur. Poulets garnis à l'hippogriffe. ngues de cheval à la Troyenne. *Chateau Perayne.*

"SECOND SERVICE.

"*Rots*—Canards sauvages. Pluviers. *Volney.* Maynaises de homard a l'huile Rosinante. Petits pois à Française. Choux-fleurs au parmesan.
"*Entrements*—Gelée de pieds de cheval au marasquin. ephirs sauté à l'huile chevaleresque. Gateau vetérinaire la Ducroix. Feuillantines aux pommes des Hesperides. *t. Peray.*
"*Glaces*—Crême aux truffes. Sorbets contre-préjugés. *iqueurs.*
"*Dessert*—Vins de fins Bordeaux. Madère. Café.
"*Buffet*—Collared horse-head. Baron of horse. Boiled ithers."

Even put into plain English all this would sound rearkable, and taken, as it is said to have been, without ying or gibbing, although, perhaps with a little boltg, it must have puzzled the stomach; and, like all r modern dinners, must also have severely taxed its owers, in selecting from the complicated mess, the ght proportions of fat and flesh, and farinaceous matter quired for the sustenance of the body.

Nor is it right to content ourselves, like savages, with single meal a day, as was the custom of Dr. Fordyce, e celebrated professor of chemistry of the last century. tudying the habits of carnivorous animals, and reflectg on the principles of chemistry and physiology, he me to the conclusion that man required but one meal day for all his physiological wants, and for more than venty years his daily dinner was as follows:—Regurly at four o'clock of an afternoon he would present imself at "Dolly's chop-house," and take his seat at e table reserved for him. Immediately on his arrival e cook would place a pound and a-half of rump-steak pon the gridiron, and while it was cooking the doctor ould amuse himself with some such trifle as half a roiled capon, or a plate of fish, and a glass or two of randy—his regular allowance being a quarter of a pint. hen came the steak with a full accompaniment of bread d potato, and it was always served with a quart nkard of strong ale. This was followed by a bottle of d port; and, when the dinner was finished, as it invarily was in an hour and a half, he walked leisurely to is rooms in Essex-street in the Strand, where he et his class and gave his lecture on chemistry.

But these are not habits of the great bulk of mankind, d although they may have been practised for a while ith impunity, yet they serve not as illustrations of what ight to be done in the way of eating, but rather as amples of the wonderfully accommodating power of the omach under the most disadvantageous circumstances; r experience teaches us that three meals a day, of the mplest quality, are best suited for our wants—breakst to supply the want of long fasting, and to restore e waste of secretion during the night; dinner in the iddle of the day, to support the system during the tigue of ordinary labour; and a light meal at night, the form of tea or an early supper, to carry on the nctions of repair and secretion during the night. ccording to Dr. Edward Smith, the daily distribution the food, supposing a physiological diet of 4,300 grains carbon, with 200 grains of nitrogen to be taken, should e somewhat in this manner:—

	Carbon.	Nitrogen.
	grs.	grs.
For breakfast	1,500	70
For dinner	1,800	90
For supper	1,000	40
Total in the day	4,310	200

So that about one part should be eaten for supper, one and a-half for breakfast, and about two parts for dinner.

It is hardly necessary to say, that in constructing dietaries, *the foods should be associated in such a way as not to offend the appetite or burden the digestive powers;* and that they should also be varied from time to time, not merely in their kind, but also in their treatment, as in the manner of cooking and flavouring them; for the best descriptions of food will, if eaten in the same fashion day after day, occasion disgust, and be wasted. This is often the case in the badly-arranged dietaries of workhouses, and on ship-board. It was once so with the dietaries of the English army, when the same daily rations of boiled meat were provokingly served out to the men, while they listened to the tune of "Oh the roast-beef of old England." All this is easily provided for, and it is true economy to do so, by varying the food, the mode of cooking it, the manner of flavouring it, and by serving it, in the case of dinner, with different kinds of vegetables. In constructing dietaries, therefore, the main considerations are the due supply of the right proportions of nitrogenous and carbonaceous matters; for when these are not adjusted in a proper manner, the health is endangered, and the constitution may be slowly undermined. To use the words of Liebig—"there is a law of nature which regulates these things, and it is the elevated mission of science to bring this law home to our minds; it is her duty to show why man and animals require such admixture in the constituents of their food for the support of the vital functions, and what the influences are which determine, in accordance with the natural law, changes in the admixture.

"The knowledge of the law elevates man in regard to an important function which he possesses in common with the lower animals, above the level of those beings which are destitute of reason, and supplies him, in the regulation of those bodily wants which are essential to his existence and prosperity, with a protection which the lower animals do not require, because in them the commands of the instinctive law are not opposed or overpowered by the allurements of sense, or by a perverted and resisting will."

The recognition of this law, and the practical application of it to the dietaries of a community, are obviously of great advantage, for not only would they tend to increase the health and strength of the population, but they would also effect a great economy in the general use of food. That there are difficulties in the way of such an application cannot be doubted; in fact, the natural peculiarities of individuals, to say nothing of the differences of occupation, and the ever-varying quality of the food itself, are enough to create a doubt as to the possibility of its general application until the progress of science has gone far beyond its present position. Nevertheless, there are certain well-acknowledged facts at our disposal which may safely serve as a guide to practice.

The diseases which are incidental to an abuse of the law can hardly be discussed in this place, but it may be said, in general terms, that too much or too little of either of the main constituents of food will soon be followed by marked derangements of the animal body. An excess of respiratory food not only promotes the growth of fat, but actually interferes with the nourishment of muscular tissue. Those who feed largely on rice, on potatoes, or other farinaceous foods, or who indulge too freely in malt liquors, have commonly a bloated appearance, and have no faculty for sustained exertion. The brewer's drayman, for example, is a bad subject for the ward of a hospital; and although he sometimes looks strong and muscular, yet in reality his vital power is feeble, and his tissues are fatty rather than muscular. The same is often the case with animals in the Zoological Gardens, when too large a quantity of respiratory food has been eaten, and their flesh has undergone a kind of fatty degeneration.

On the other hand, when the plastic elements of the food are in excess, the system becomes excited, too much blood is formed, and diseases of a plethoric character are induced. According to Liebig and his followers, an excess of force is developed, which manifests itself in irritability of temper, and in a savage disposition. How far this may be concerned in the frequently ungovernable conduct of our over-fed convicts may be deserving of consideration. A nation of animal *feeders*, says Liebig, is always a nation of hunters, for the use of a rich nitrogenous diet demands an expenditure of power, and a large amount of physical exertion, and this is seen in the restless disposition of all the carnivora of our menageries.

A deficiency of food, however, is quickly followed by a general breaking up of the animal frame. Plague, pestilence, and famine are always associated in the public mind; and the records of every country show how closely they are related. The medical history of Ireland is remarkable for illustrations of how much mischief may be occasioned by a general deficiency of food. Always the habitat of fever, it every now and then becomes the very hotbed of its development. Let there be but a small failure in the usual imperfect supply of food, and the lurking seeds of pestilence burst into frightful activity. The famine of the present century is but a too forcible illustration of this, for it produced epidemics which had not been witnessed in this generation, and it gave rise to scenes of devastation and misery which are not surpassed by the most appalling of the middle age. The principal form of the scourge was known as the contagious famine fever, and it spread, not merely from end to end of the country in which it had originated, but, breaking through all boundaries, it crossed the broad ocean, and made itself painfully manifest in localities where it was previously unknown. Thousands fell under the virulence of its action, for wheresoever it came it struck down a seventh of the people, and of those whom it attacked one out of nine perished. Even those who escaped the fatal influence of it were left the miserable victims of scurvy and low fever. Another example, not less striking, of the terrible consequences of what may be truly called famine, was the condition of our troops during the early part of their sojourn in the Crimea. With only just enough of food to maintain the integrity of the system at a time of repose, and at ordinary temperatures, they were called upon to make large muscular exertions, and to sustain the warmth of the system in the midst of severe cold. What could be expected but that the scourges which wait upon famine, as fever, diarrhœa, dysentery, and scurvy, should make their appearance in great force, and that the soldiers should perish by thousands. With an average strength of 24,000 men, the deaths from sickness alone, in the course of seven months, were at the rate of thirty-nine per cent., and in some cases it amounted to seventy-three. "Never before," says Colonel Tulloch, "is there record of a British army having sustained so frightful a loss in so short a time." During the Peninsula War, though the troops occasionally suffered much from sickness, the loss from that cause did not average above twelve per cent. for a whole year. Even in the ill-fated expedition to Walcheren, which threw the nation into mourning, the deaths amounted to only about 10¼ per cent. for the half-year; and here, in this great city, with all the aggravating circumstances of want, vice, infancy, old age, and disease, it did not reach two per cent. during the time that our strong men were dying by thousands. "Armies have perished by the sword, and have been overwhelmed by the elements, but never, perhaps," says Colonel Tulloch, "since the hand of the Lord smote the host of the Assyrians, and they perished in a night, has such a loss from disease been recorded as on this occasion." May the lesson of so great a calamity be wisely applied in the future.

The connection of scurvy with improper or insufficient food is a matter of medical history, and its prevention by the use of fresh vegetables, especially potatoes, is so well known that it has often been the subject of legislation. Rarely appearing in the cabin, where the dietary is good, it is a frequent visitor to the forecastle; so that half the men of our sea-going vessels are found to be suffering from the disease when they return to port. As many, indeed, as 70 per cent. of a ship's crew are not unfrequently disabled by it; and there is no saying how many of the disasters at sea are caused by the inability of the men to work the vessel in times of severe weather. The legal supplementary allowance in emigrant vessels of 8 oz. of preserved potato, 3 oz. of other preserved vegetables (carrots, turnips, onions, celery, and mint), besides pickles, and 3 oz. of lemon juice for each person weekly, is found to be a perfect prophylactic of the disease, so that the one essential cause of it is evidently a privation of vegetable food.

And not less important are the morbific results of too much or too little saline matter in the food. I have already spoken of the salutary effect of certain calcareous salts in the water we drink; but according to Dr. Grange the presence of magnesian salts in the water of a district may have something to do with the development of those remarkable forms of disease which are known as goitre and cretinism. In France, Germany, England, Sardinia, among all classes of people, of all habits, and in every variety of climate, those diseases are endemic where the soil is composed of magnesian rock, and the water charged with magnesian salts. How far the connexion extends is a chemico-physiological problem that has yet to be determined.

Treatment of Foods.—In the *treatment* of *vegetable food* it is important to remember, that all corky and woody tissues, as the skins of fruits, tubers, and cereals, are quite indigestible, and that in consequence of their irritating action they hurry food through the alimentary canal, and so occasion waste. It is necessary, therefore, that all such tissues should be removed as completely as possible.

When it is required to obtain the *starchy* or *farinaceous matters* of *vegetables*, one or other of the following processes is followed.

(*a*). The material is pulped or crushed, and diffused through a considerable volume of cold water. It is then strained and allowed to stand until the farina or starch subsides.

(*b*). Or it is allowed to pass into a state of putrefactive decomposition, whereby the albuminous matter, as the gluten, &c., decay and leave the starch untouched.

(*c*). Or it is subjected to the action of a weak alkaline solution, generally of caustic soda, which dissolves the gluten, and allows the starch to subside. The gluten thus dissolved may be again recovered by neutralizing the alkaline solution with acid, and collecting the precipitated gluten, as in the processes of Durand and others.

I have already explained that in the treatment of the ground meal of wheat and other grain, the bran and coarser kinds of flour are separated by sieves of different degrees of fineness, and that in this manner about eight or nine varieties of product are obtained, as *biscuit flour*, *best or fine households*, *seconds*, *tails*, *fine sharps or middlings*, *coarse sharps*, *fine pollard*, *coarse pollard*, and *long bran*, the proportions of these from ordinary brown meal will vary according to circumstances, but processes have been invented, as by M. Mège Mouriès, M. D'Arblay, and others, whereby the yield of fine flour is increased to 86 or even to 88 per cent. of the grain, and by which the quantity of gluten is also regulated.

When the flour is rich in gluten, as in the case of the ard wheats of Sicily, Russia, Sardinia, and Egypt, they re well suited for the manufacture of certain granular owders and dried pastes, which are known as *Semola*, *emolina*, *Soujee*, *Mannacroup*, *Maccaroni*, *Vermicelli*, and *agliari paste*. The last three are generally imported om Naples or Genoa, where they are made from a ighly-glutinous wheaten flour, by kneading it into a in dough or tenacious paste, and then forcing it through oles or slits in a metallic plate. In this way the several arieties of *pipe*, *celery*, and *ribbon maccaroni* are obtained; nd the fancy forms of it, called *Cagliari paste*, which are the shape of stars, rings, Maltese crosses, &c., are pro- uced by stamps. All these varieties of raw wheaten aste are cooked by boiling or baking, and are associated ith soup or beef-tea, or milk, or are mixed with eggs, heese, &c.

The best variety of flour for bread is that which con- ins less gluten than the preceding, as from 8 to 10 per nt. of it instead of from 12 to 14 or 15. Dantzic flour, nd soft Spanish, as well as the American called Genessee, e the best examples of it, and are highly esteemed by kers on account of the fine quality of bread which is rocurable from them; the richer varieties of hard glu- nous wheat being used only to impart strength to weak nd inferior descriptions of flour.

Bread, which is the most important preparation of our, owes its value as an article of diet to a good and uable vesiculation of the dough, the vesiculation being fected by the diffusion of small bubbles of carbonic id gas throughout its substance; and, as this vesicula- on can only take place in a proper manner when the uten of the flour is in sufficient quantity, and of good ality, it is, to some extent, a test of the goodness of e meal. Those flours which contain too little gluten, gluten which is deficient of strength, cannot be vesi- lated into bread. This is the case with almost every scription of flour, excepting that of wheat and rye.

The most common, and also the most ancient method vesiculating bread is by fermentation; and the process not very different from what it was in very early times, hen we were told that "a little leaven leaveneth the hole lump." Yeast of some sort—as brewers' yeast; patent yeast, prepared from infusion of malt and hops; German yeast, which is the solid residue of the yeast oduced by the fermentation of rye for making Hollands; bakers' yeast, which is made from potatoes and flour; leaven, which is old dough in a state of fermentation, mixed with the flour or dough, which soon begins to rment by the action of the yeast fungus (*micoderma revisiæ*) on the sugar of the flour. Carbonic acid is us produced; and by being diffused through the sub- ance of the dough it vesiculates it, and causes it to rise swell. The most usual practice with the baker is mewhat as follows:—A special ferment is prepared om mealy potatoes (technically called *fruit*) by boiling em in water, mashing them, and allowing them to cool a temperature of about 80° of Fahrenheit. Yeast is en added to them, together with a little flour to hasten e fermentation. In three or four hours, at a proper mperature (as from 80° to 90° Fah.), the whole mass generally in a state of active fermentation, with a sort cauliflower-head. It is then diluted with water and rained, and is mixed with sufficient flour to make a ther thin dough, which in about five hours rises to a fine *onge*. This is again diluted with water containing salt, d is worked with the necessary quantity of flour into ugh, and allowed to stand for two or three hours, when rises, and is in a fit condition to be baked into loaves.

It can hardly be said that the potatoes are an adultera- n in this case, for they do not ever amount to more an 6 lbs. to a sack of flour, which makes about 380 lbs. bread, or 95 4-lb. loaves. The salt is added to the tent of about 4 lbs. or more to a sack of flour, the pro- rtions being regulated according to circumstances, for e object of it is to improve the quality of the loaf as gards whiteness, firmness, and flavour.

There is, no doubt, a slight loss of nutritive matters by this mode of vesiculation, for a small portion of the sugar of the flour is converted into alcohol and carbonic acid, but the quantity is so inconsiderabe as to be undeserving of notice. The advantage of the process, however, is that it is an excellent test of the quality of the flour; for weak flour, or flour that has been injured by germina- tion, or by keeping, will not stand the action of yeast, but will be either ropy, or sticky, or heavy, when baked into bread.

Another method of vesiculation is to generate carbonic acid in the dough by the action of an acid on bicarbonate of soda. Dr. Whiting's process, which was patented in 1836, was to mix the carbonate of soda with the flour, and then to act on it with a proper proportion of mu- riatic acid added to the water. He used from 350 to 500 grains of carbonate of soda to 7 lbs. of flour, and to this he added 2¾ pints of water charged with from 420 to 560 grains of muriatic acid. Other proportions are used by bakers who make unfermented bread; but in all cases the proportions should be such as to form common salt (which is the product of the action of muriatic acid on carbonate of soda)—the carbonic acid being liberated in the substance of the dough. Care should be taken that the muriatic acid is pure, for that found in com- merce is generally highly charged with arsenic.

In 1845, another acid was patented instead of muriatic —namely, tartaric; and the various preparations called *baking-powders*, *custard-powders*, *egg-powders*, &c., are nothing but mixtures of tartaric acid and carbonate of soda, with a little farinaceous matter, the common pro- portions being 1 part of tartaric acid, 2 of carbonate of soda, and 4 of potato-flour or other dry starch, with a little turmeric powder to give it a rich yellow tint. When this is mixed with flour and wetted, it effervesces, as in the case of a common seidlitz powder, and so diffuses the carbonic acid through the dough.

Very lately, Mr. McDougall has proposed the use of phosphoric acid, as a more natural constituent of food than the preceding, and this, with an alkaline car- bonate, forms the preparation which is known as *phos- phatic yeast*.

A third process, which is now extensively used in the vesiculation of bread, is that of Dr. Dauglish, and by which the bread called *ærated* bread is obtained. It consists in the addition of a solution of carbonic acid in water to flour under pressure. The mixture is made in a closed air-tight vessel, in which the dough is well kneaded by machinery, and directly the outlet of the vessel is opened, and the pressure thus removed, the gas escapes from the water, as in the case of an uncorked bottle of soda-water, and expands into little bubbles within the substance of the dough. By its expansion, also, it forces itself out of the mixing-chamber, and rises into a spongy dough.

In all cases, however, where carbonic acid is generated within the dough by other processes than fermentaion, the dough must be baked immediately or it will fall, and the loaf be heavy. Various contrivances have been suggested for helping the process of kneading, which is laborious, and sometimes not altogether cleanly work. Mr. Stevens' hand-machine appears to accomplish this very well. It is in use in the Holborn Union, where about 5,633 lbs. of bread are made every week by one man and two boys; and they contrive to make ninety-six 4-lb. loaves out of every sack of flour (280 lbs.). The materials used on the average of a whole year being as follows:—

PROPORTIONS PER WEEK.

Flour	4,129 lbs.	Which produce 5,633 lbs. of bread, or 1,408 4-lb. quartern loaves.
Cones	140 „	
Potatoes	168 „	
Salt	68 „	
Malt	13 „	
Hops	1½ „	

The potatoes, the malt, and the hops, are for the pur- pose of making the yeast or ferment for the bread.

But, by whatever process bread is made, it is necessary to observe certain precautions to ensure the production of a good loaf.

1st. The flour should be from sound grain, sufficiently rich in good gluten.

2nd. The yeast should be sweet, and should show a lively action in the sponge.

3rd. The dough should be well kneaded to insure the thorough diffusion of the gas, and to give toughness to the gluten.

4th. The salt should be used in such proportion as to regulate the fermentation, and give firmness to the gluten, whiteness to the bread, and a good flavour.

5th. The baking should be so managed as to insure the thorough heating of the loaf to the temperature of at least 212° of Fahrenheit, in order that the insoluble starch may be changed by the heat into soluble dextrine; and the crust should be light-coloured and thin. This is best effected when loaves are baked singly, as on the Continent, and not in batches, as with us; for in the last case, the top and bottom crusts are thick and hard, and are frequently scorched, while the interior of the loaf is doughy and under-done.

Specimens of the different kinds of bread of England and the Continent are upon the table; and you will notice the dark colour of the *rye-bread* of Europe. I am indebted for these illustrations to the kindness of Mr. Twining, who has liberally placed the valuable collection of foods in his museum at our disposal. Here, also, is a sample of rye-bread supplied by Mr. William Ray Smee, who, in the interest of the poor, has had it made according to the formula of the Board of Agriculture of 1795. It consists of one part of rice and four parts of rye ground together, and sifted in the usual manner. The meal is then made into dough with yeast; and when fermented is baked in the form of long rolls. The bread is very dark, like all rye-bread, and has a close texture, but it is agreeable to the palate, and is very nutritious. The great recommendation of it is its cheapness, for it can be made at less than a penny a pound, and is therefore a very suitable bread for the poor.

Those flours which do not contain sufficient gluten of the proper quality for fermentation or vesiculation, as barley-meal, oat-meal, Indian-meal, and the flour of peas and lentils, are best cooked by baking them in the form of cakes or biscuits—a practice which is as ancient as the time of the Patriarchs, when, during the Passover, they were commanded to eat unleavened bread. The chief food of the common people of Rome was a heavy kind of unleavened bread, like the present *polenta* of the Italians, which is made of Indian meal and cheese. As in former time, biscuits and unfermented cakes are made from meal or flour mixed with water and baked; but the texture of the substance is close, and it is not easy of digestion unless it is thoroughly disintegrated. When biscuits are lightened by means of egg and sugar, with a little butter, they are much more digestible; and they are still more so when they are vesiculated and puffed up by means of a small quantity of carbonate of ammonia, as in the case of *cracknells* and *Victoria biscuits.*

The so-called *farinaceous foods* for infants are only baked flour, sometimes sweetened with sugar. The flour must be baked until it acquires a light-brown colour, the temperature being about 400° or 450° of Fahrenheit. The granules of starch are then disintegrated, and converted into a soluble substance, named *dextrin*—which, by a further process of cooking or boiling, as in making pap, forms, when properly sweetened, a very excellent food for children. *Tops* and *bottoms* owe their value to the same circumstance—namely, that the farinaceous matter, which is so indigestible with infants, is broken up by baking into soluble dextrin.

All varieties of meals and arrowroots are easily cooked by stirring them into boiling water, or boiling milk, until they have the consistence of gruel or hasty pudding, and then boiling for a few minutes. In the case of Indian-meal, rice, split-peas, lentils, and haricots, the boiling should be continued for a considerable time, and the whole grain should be previously steeped in water for many hours; for the starch and cellulose of these vegetables are not digestible unless they are thoroughly disintegrated by cooking. It may be said, indeed, that all vegetables with dense tissues require prolonged boiling to cook them, for cellulose is not capable of digestion by man unless it is broken up by the action of heat—even starch is likely to pass through the alimentary canal unchanged, if it be not rendered soluble by fermentation or cooking. It is an important question, whether in utilizing starchy foods, it may not be advantageous to help their transformation by allowing the grain to germinate to some extent, as in the process of malting, when the starch is changed into sugar. Mr. Lawes has examined this question, and has concluded, from his experiments on stock, that in the case of pigs and bullocks the fattening effect of the grain is not increased; but it may be different with the human stomach, where the transformation power is not nearly so active as with lower animals. Here, in fact, is an example of it:—The food which Liebig recommends for infants is a preparation of malt with wheaten-flour and milk, to which a little bicarbonate of potash has been added; and the reputation of it in Germany, as an article of diet for children, is considerable. The preparation is made by mixing one ounce of wheaten flour with ten ounces of milk, and boiling for three or four minutes; then removing it from the fire, and allowing it to cool to about 90°. One ounce of malt-powder previously mixed with 15 grains of bicarbonate of potash, and two ounces of water, are then stirred into it, and the vessel being covered, is allowed to stand for an hour and a-half, at a temperature of from 100° to 150° Fahrenheit. It is then put once more upon the fire, and gently boiled for a few minutes. Lastly it is carefully strained, to remove any particles of husk, and then it is fit for the child's food. The composition of the food, according to Dr. Liebig, is as follows:—

Foods.	Plastic matter.	Carbonaceous matter.
	oz.	oz.
10 oz. milk	0·40	1·00
1 oz. wheat-flour	0·14	0·74
1 oz. malt-flour	0·07	0·58
	0·61	2·32

The relation of the plastic to the carbonaceous being as 1 to 3·8, which is the right proportion for the food of children.

The effect of the malt-flour is to transform the starch into glucose, and thus the mixture gets thinner and sweeter as it stands; and the bicarbonate of potash is added to facilitate the change, and to neutralize the acid constituents of the flour and malt.

Liebig's extract of malt is another such preparation for a quick assimilation of starchy matters.

Vegetable substances are occasionally fermented, either for the purpose of increasing the relative amount of glutinous matter, or for the purpose of rendering them acid. Potatoes, for example, as well as barley, wheat, and rye, leave a residuum after fermentation, which contains more gluten than the original substance, in consequence of the transformation of sugar and starch into alcohol; and although the residuum is coarse, and is hardly suited for human consumption, yet it is an excellent food for cattle: in fact, in Germany it is often eaten by the poor.

When the process is carried still further, and the mass acquires an acid property in consequence of the formation of acetic, butyric, and lactic acids, various sour preparations are obtained, which are no doubt useful in assisting the digestion of other foods. The ancient Romans had many such fermented substances which were not unlik ie *sauer-kraut* of the Germans. This, as you know, is ade from the leaves of cabbages, gathered generally in itumn, and from which the stem and mid-rib are re- oved. They are cut up into thin slices, and are placed a tub or vat, alternately with layers of salt, until the ssel is full. It is then subjected to pressure, and allowed stand for five or six weeks (according to the tempera- ire); the lactic fermentation is thus set up, and the mass ecomes sour. It is cooked by stewing it in its own quor with bacon, pork, or other fat meat; and certain ondiments, as dill or carraway, are added to improve s flavour. In Prussia, and in many parts of Germany, iere is a similar preparation of fermented beans; and Holland and the South of Europe, cucumbers are rmented. We also have our pickled vegetables, in hich acetic acid takes the place of lactic acid. All these reparations are no doubt aids to digestion, especially hen the fibre of meat is tough, and contains tendon, or ardened cellular tissue. This is especially so with lted meat, and, therefore, a little pickle is always a good nd palatable addition to cold boiled beef.

Vegetable substances, as *tea, coffee, maté, cocoa, &c.*, the ifusions of which are used as beverages, are prepared or commerce in nearly the same manner. When taken om the tree, and while in a fresh condition, they are llowed to undergo a moderate kind of fermentation, nd they are then dried and roasted. In the case of tea, ie roasting operation is performed during the process f drying and curling, by heating the leaves upon wire- eves held over a charcoal fire, but cocoa and coffee are pasted in metallic cylinders, which are kept revolving ver a clear fire—coffee being roasted until it is partially iarred, and has lost from 14 to 20 per cent. in weight. y this means the aroma, or volatile oil, is, in each case, roduced; and there is also an empyreumatic change in ie astringent acids, the sugar, the gum, and the starch, hereby extractive matters, varying in amount and uality, according to the degree of heat, are formed. hrader has examined the subject in respect of coffee, nd has ascertained that the following are the propor- ons of the several constituents in raw and roasted offee:—

	Raw Coffee.	Roasted Coffee.
eculiar coffee principle	17·58	12·50
um and mucilage	3·64	10·42
atty matter and resin	0·93	2·08
xtractive	0·62	4·80
oody tissues and cellulose	66·66	68·75
lixture, &c.	10·57	1·45
	100·00	100·00

Infusions of tea and coffee should be made with oiling water, but they should never afterwards be oiled, for the aromatic principle is very volatile, and ould be thus lost; besides which a decoction of tea r coffee is disagreeably bitter on account of ie solution of the coarse forms of extractive atter. Soft water also extracts these matters, nd, therefore, appears to give a stronger infusion than oderately hard waters, but it is always at a sacrifice of elicate flavour. Excellent tea is made in London with ater of 14 or 15 degrees of original hardness, and of bout 5 degrees when boiled. This was a subject of in- estigation by the Government Chemical Commission Professors Graham, Miller, and Hofmann), who were ppointed in 1851 to inquire into the chemical quality of ie water supply of London; and they reported that in ieir experiments they found that tea made from the oiled London water of 5 degrees of hardness, could not enerally be distinguished from tea made with water of ½ degrees only, although a delicate palate would recog- ise a slightly increased bitterness without any enhance- ient of flavour in the latter. It would seem, indeed, that moderately hard water makes the best flavoured tea, provided it is allowed to stand upon the tea sufficiently long. In the case of the Greenwich pensioners the tea was made from water of 24 degrees of hardness before boiling, and 18·6 degrees after; but the infusion was maintained for half-an-hour, by surrounding the vessel with a steam case; and thus an excellently flavoured tea was obtained. The Commissioners indeed truly remark, that "where any great loss of strength of tea infusion has been observed in passing from a soft water to a harder, it may be probably referred to the circumstance that the mode of infusing it has not been properly adapted to the hard water; and then there is doubtless some waste of tea." Lake waters have been a good deal extolled on account of their softness and supposed fitness for making tea, solely because they happen to produce a deep-coloured solution, which conveys a false notion of strength; but, in reality, flavour is always sacrificed for the mere look of the thing, there being no increase of physiological or dietetical property. The Chinese, who are very good authorities on this subject, never use either very soft or very hard waters, for their rule is to take the water of a running stream—"best from the hill side, and next from a river." We may conclude, therefore, that water of from four to seven degrees of hardness after being boiled, is best suited for infusions of tea and coffee; for such water dissolves the aromatic and physiological constituents, without extracting the disagreeable bitter principles. In the case of coffee, in fact, a little acid, as a portion of lemon juice, improves the flavour, notwithstanding that it adds to the hardness of the infusion. Experimentally it is found that infusions of tea and coffee are strong enough when the former contains 0·6 per cent. of extracted matter, and the latter 3 per cent., so that a moderate sized cup (5 oz.) should contain about 13 grains of the extract of tea, or 66 grains of coffee. These proportions will be obtained when 263 grains of tea (about 2½ teaspoonfuls), or 2 oz. of freshly roasted coffee are infused in a pint of boiling water; and the amounts of the several constituents dissolved are about as follows:—

Constituents.	Tea.	Coffee.
	grs.	grs.
Nitrogenous matters	17·2	44·0
Fatty matter	.. ..	3·0
Gum, sugar, and extractive	31·7	103·2
Mineral matters	9·1	22·8
Total extracted	58·0	173·0

So that tea yields to a pint of fresh water about 22 per cent. of its weight, and coffee about 20 per cent. Lehmann found that only 15½ per cent. of tea was dissolved by water; whereas, Sir Humphrey Davy estimated it at 33⅓ per cent. No doubt the quality of the water as well as that of the tea affects the results, for distilled water will extract from 40 to 44 per cent. of black tea, and nearly 50 per cent. of green; but for all this, about 22 per cent. is a good average.

Tea is generally measured into the tea-pot by the spoonful, and Dr. Edward Smith has made a curious inquiry into the average weights of a spoonful of different kinds of tea. The results are here shown:—

Weight of a Spoonful of Tea.

Black Teas.	Grs.	*Green Teas.*	Grs.
Oolong	39	Hyson	66
Congou (inferior)	52	Twankay	70
Flowery Pekoe	62	Fine Imperial	90
Souchong	70	Scented Caper	103
Congou (fine)	87	Fine Gunpowder	123

From which it would seem that from three to seven tea-spoonfuls of black tea, or from two to four of green, are required for a pint of infusion of the strength already given.

Cocoa is best made by boiling the mixture for a little while, for it nearly always contains a large proportion of starchy matter, which has been added to dilute the rich fat of the cocoa. Indeed cocoa contains so much butter or solid fat (from 48 to 50 per cent.), that it is necessary to reduce it with some easily digestible substance, as starch, lentil powder, carageen moss, Iceland moss, sugar, &c.—hence the various preparations of it called *granulated cocoa*, *soluble cocoa*, *chocolate*, &c., the processes for making which I will briefly describe. When the berry is roasted and is cold, it is passed through a machine called a "kibbling-mill," which deprives it of its husk, and of the thin skin which surrounds the kernal or nib. If the nibs thus cleaned are ground in proper mills, they form the variety of cocoa called *flaked* cocoa, but if other preparations are to be made, the nibs are ground between heated rollers or otherwise, until they form a smooth paste, when the diluting substances are mixed with it and are thoroughly incorporated. If *soluble cocoa* is to be made, the diluting material is sugar with some kind of arrowroot, as tous-les-mois, maranta, curcuma, &c. If *chocolate* is required, the diluting material is sugar only, with some flavouring agent, as vanilla; and if fancy preparations, as *carageen moss cocoa*, *Iceland moss cocoa*, *lentil cocoa*, &c., are required, then these several substances are incorporated. *Granulated cocoa* is a preparation of cocoa, with sugar and starch, so ground as to form a coarse powder, in which the particles of broken cocoa are covered with a layer of sugar and starch. It is obvious that whenever the mixture consists of starch or other farinaceous substance, the solution of the cocoa preparation must be boiled; but when sugar has been used, as in chocolate, which is the most ancient preparation of it, the combination is such as to require no culinary treatment, or, at most, the action of boiling water or boiling milk.

It is remarkable that, although cocoa is much less used than either tea or coffee, yet it was known in Europe a century before either of the others. As early, indeed, as 1520 it was brought from Mexico by Columbus, who found it the common beverage of the people; and when Cortes was entertained at the court of the Aztec Emperor, Montezuma, he was treated to a sweet preparation of the cocoa, called *chocollatl*, flavoured with vanilla and other aromatic spices, and served to him in a golden vessel. The Spaniards thus acquired a knowledge of the berry and of its chief preparation, which they kept secret for many years, selling it very profitably as chocollat to the wealthy and luxurious classes of Europe. It was, however, an expensive preparation, and did not come into general use until long after the public coffee-houses of London were established. The earliest notice of it, according to Hewitt, is in Needham's *Mercurius Politicus*, for June, 1659, wherein it is stated that "chocolate, an excellent West India drink, is sold in Queen's Head-alley, in Bishopsgate-street, by a Frenchman, who did formerly sell it in Gracechurch-street and Clement's-Churchyard, being the first man who did sell it in England:" and its virtues are highly extolled. This was about five years after the London coffee-houses had been established, for the first of them is said to have been opened in 1650, by a Levantine named Pascal Rossee, in St. Michael's-alley, Cornhill; and a year after they were opened in Paris and in Holland. In 1660 they were so much frequented, and coffee was so largely drank, that they were made a source of revenue, a tax of 4d. a gallon being levied on all the coffee drank in them; and three years later they were regularly licensed at the Quarter Sessions, like common taverns. In 1668, when Ray, the distinguished naturalist, published his "History of Plants," he tells us they were as numerous in London as at Cairo; and at last they became so great a nuisance, on account of their political associations, that in 1675 Charles the Second endeavoured to suppress them by proclamation, calling them seminaries of sedition; but the keepers of them were sufficiently powerful to make him revoke the prohibition. The history of these houses would form a curious chapter in politics and literature, for they are associated with the earliest development of free political discussion, and with the greatest names in English literature. Among the oldest of them is the "Grecian," where Shakespeare and Rare Ben were frequent visitors; and hardly less ancient is "Wills," where Dryden held forth with pedantic vanity, and where the foundation was laid for that critical acumen which soon became a distinguishing feature in English literature. In the city, too, there was "Garraway's" where not only was tea first sold, but where, in Defoe's time, "foreign banguiers," and even ministers resorted to drink it. "Robins" and Jonathans," and the "Cocoa-nut Tree," in St. James-street, were also famous, and had their distinguished followers.

In the treatment of animal food there are several points for consideration. In the first place it is always best to prepare the animal for the shambles by fasting it for a few hours before it is slaughtered, as partially digested food, and the food recently absorbed into the system, quickly pass into a state of putrefactive decomposition and taint the whole carcase; besides which, a day's repose is often necessary to quell the excitement occasioned by the journey or voyage which the animal may have made on its way to the place of slaughter. In the second place, it is proper to remove as much blood from the body as possible at the time of killing, as this also is apt to pass into a state of decay. The regulations of the Jews in this particular are most effectual, and are derived from very ancient statutes in Leviticus, which ordain that no manner of blood, whether it be of fowl or of beast, shall be eaten by man; and with the view of letting as much of it flow away as possible, the practice is to slaughter every animal by cutting its throat with a sharp knife. There are, indeed, the most precise rules for this purpose. In some countries, however, the blood is regarded as a very nutritious part of the animal, and great pains are taken to prevent its escape. Dr. Livingstone says, that many of the South African tribes kill the beast by thrusting a javelin into the heart, so as to prevent the loss of blood. But in these cases the meat is never kept, but is eaten directly after the animal is slaughtered. A proposition has also been made in this country for killing animals by letting air into the pleural cavities, whereby the lungs collapse, and so cause almost instant death by asphyxia without loss of blood; but the practice is objectionable, not merely because of the liability of such meat to quick putrefaction, but also because of the difficulty of discovering disease in it.

In the third place it is proper that the carcass of the animal should be allowed to cool and set thoroughly, before it is packed for conveyance to the market. If this is not properly attended to it soon decays. It should also be packed loosely, or even freely exposed to the air, as the colouring matter of the blood and muscles continue to absorb oxygen, and to breathe, as it were, for some time after death, and while this goes on decay is arrested.

Lastly, all meat should be kept a little short of decomposition before it is cooked, or even until decomposition has just commenced, as the tissue then becomes loose and tender, and very digestible.

In the culinary treatment of animal food, the objects are fourfold:—

1st. To coagulate the albumen and blood of the tissues, so as to render the meat agreeable to the sight.

2nd. To develop flavours, and to make the tissue crisp, as well as tender, and therefore more easy of mastication and digestion.

3d. To secure a certain temperature, and thus to be a means of conveying warmth to the system.

4th. To kill parasites in the tissues of the meat.

Now, as the researches of Dr. Beaumont and others have demonstrated that meat is always rendered more and more indigestible in proportion to the prolonged action of heat, it is highly necessary that the temperature should not be continued beyond the point necessary to accomplish these objects. Liebig says, that a tempera-ture of 133° Fahr. will coagulate albumen, and that the red colouring matters of the blood and muscle are coagulated and destroyed at from 158° to 165° (say 170°). He therefore advises that all cooking operations, in respect of meat, should be limited to 170°. His direc-tions are that, in *boiling* meat it should be introduced nto the vessel when the water is in a state of brisk ebullition, and that the boiling should be kept up for a few minutes. The pot is then to be placed in a warm situa-ion, so that the water is maintained at from 158° to o 165°. The effect of this is, that the boiling water coagulates the albumen and tissue upon the surface of he meat, and to a certain depth inwards, and thus forms a crust which does not permit the juice of the meat to low out, nor the water to penetrate into the meat. The lesh, therefore, retains its savoury constituents, and is not too sodden; but if, on the other hand, the meat be set upon the fire with cold water, and then slowly heated o boiling, the flesh undergoes a loss of soluble and avoury matters, while the soup becomes richer in them. The albumen, in fact, is gradually dissolved from the urface to the centre; the fibre loses, more or less, its uality of shortness or tenderness, and becomes hard and ough. The thinner the piece of flesh is, the greater is ts loss of savoury constituents.

This explains the well-known observation, that that mode of boiling which yields the best soup, gives the riest, toughest, and most vapid meat; and that, in order o obtain well-flavoured and eatable meat, we must elinquish the idea of making good soup from it.

If finely chopped flesh be slowly heated to boiling with an equal weight of water, and be kept boiling for a ew minutes, then strained and pressed, we obtain the ery strongest and best flavoured soup which can be made from flesh. When the boiling is longer continued, some little additional organic matter is dissolved, but the avour and other properties of the soup are thereby in o degree increased or improved. By the action of the eat on the fibres of meat, a certain amount of water or uice is always expelled from them; whence it happens hat the flesh loses weight by boiling, even when mmersed in water (as much sometimes as 24 per cent. f the weight of the raw flesh). In larger masses this oss is not so great.

Even in *roasting* meat the heat must be strongest at rst, and it may then be much reduced. The juice hich, as in boiling, flows out, evaporates, in careful basting, from the surface of the meat, and gives to it the ark brown colour, the lustre, and the strong aromatic aste of roast meat. It is doubtful, however, whether he heat of 170° is sufficiently high to ensure the destruc-on of the parasites of meat, and therefore, I would lvise that the temperature should be as nearly as pos-ble to that of boiling water (212°).

Of the four methods of cooking which are commonly actised in this country—namely, *boiling*, *baking*, *roast-g*, and *frying*, the former is undoubtedly the most onomical, and produces the most digestible food, but e flavour of the meat is not well developed, and it is uite unsuited for many descriptions of meat; the flesh young animals, for example, consisting of an undue oportion of albumen and gelatine in the tissues, will oil away to a large extent, and so will lose fatty tissue, ke that of American bacon; and, indeed, unless the ocess is well managed, there will always be consider-ble loss, as I have just stated, from the escape of bumen, saline matter, and the alkaloids of the meat, to the water, amounting sometimes to from 16 to 24 r cent. of the weight of the joint; and that these are luable constituents of flesh, is proved by the experi-ents of the French Academicians, who found that when log was fed daily upon half a pound of boiled flesh, hich had been previously soaked in water and pressed, quickly lost weight, as much, indeed, as one-fourth of entire weight in 43 days; and in 55 days the emacia-tion was extreme. Of course, these observations do not apply when the liquor in which the meat is boiled is eaten with it, as in the case of hashes, stews, &c.

Dr. Pereira states that, at the Wapping Workhouse, where mutton (chiefly fore-quarters) and beef (consisting of the brisket, thick and thin flanks, leg of mutton pieces, and clods—all free from bone) were boiled, the average loss in weight was only about $17\frac{1}{2}$ per cent.; but this is under the common proportion, and shows that the meat was from old and lean animals. The ordinary loss of weight in cooking is about as follows in every 100 parts:—

	Boiling.	Baking.	Roasting.
Beef generally	20	29	31
Mutton generally	20	31	35
Legs of mutton	20	32	33
Shoulders of mutton	24	32	34
Loins of mutton..........	30	33	36
Necks of do.	25	32	34
Average of all........	23	31	34

But although the loss of weight in baking and roasting is greater than in boiling, yet it is chiefly from evapora-tion, and from the melting of the fat. Flavours also are developed which give a pleasant relish to the meat; but there are many disadvantages to these methods of cook-ing, as that the surface of the joint is often overdone, when the interior is almost raw; and that the action of the heat on the superficial fat frequently produces acrid compounds (consisting of *acrolein* and *fatty acids*) which are very distressing to a sensitive stomach. This is always the case when meat is fried or grilled, and is thus subjected to a temperature of 600° or more; in fact, all baked and roasted fatty foods are apt, on this account, to disagree with delicate stomachs; and it is often remarked that, although bread and butter, boiled pud-dings, boiled fish, or boiled poultry can be eaten freely without discomfort, yet toast and butter, or meat pies and pastry, or fried fish, or roasted fowl will disagree with the stomach. The practice of covering poultry and game with lard, or oiled paper, or thin dough, or even with clay (feathers and all, as is the Indian custom), and then roasting, is no doubt advantageous, as it modifies the temperature and prevents the formation of acrid fatty compounds. It was by some such device as this that Aristoxenes was able to serve up a pig apparently boiled on one side and roasted on the other—the savoury crackling being suited for stronger stomachs, while the more delicate side of it was best adapted for weaker digestions.

In deciding, however, on the proper method of cooking a joint, regard must always be had for the kind of flavour that is to be developed. Shoulders of mutton and fresh beef are rarely boiled, because of their insipidity. The same is the case with game and poultry, for the barn-door fowl and turkey are nearly the only examples of the latter which can be boiled, and there are no such examples among the former. What should we think of a boiled pheasant? A story is told by a writer in the Society's *Journal* of a poacher who wished to seduce a bumpkin new poacher by a practical illustration of the fine flavour of game, and calling at his cottage one day, he left for him a hare warm from the chase, telling him to cook it, and to try if it warn't a nice dinner for nothing. A week after he called again, and asked him how he liked his dinner. "Didn't loike it at all," exclaimed the recipient. "Well, man," says the poacher, "how did e cook en?" "Why, biled en in tarmuts, to be zure." I won't attempt to describe the disgust of the poacher. The same is the case with venison, although it may be boiled, especially when it is rather high, for about half the time necessary for cooking it, yet it must be roasted, in order to develop its flavour. Hunters in the wild prairies of America are accustomed to cook the flesh of the deer by *brittling* it in the following manner:—They strip off the long muscles from each side of the spine, both above and below, and tie them up in a roll, after well smearing them with oil or fat; they then roast them, and baste them perseveringly with oil. If opportunity permits they sprinkle them with lemon juice before they are oiled and made up into a roll. The flavour of roasted meat and its grateful effect on the sense of smell must have been recognised in very early times, for burnt-offerings are frequently spoken of by Moses as "a sweet savour unto the Lord," and particular accounts are given of the manner in which these offerings of the lamb and the kid, &c., were to be made acceptable, not merely to the Lord, but also to Aaron and his sons, who were to eat of them. How far back in history the flavour of roast-pig was eulogised I know not, but it is immortalised in the essay of Charles Lamb. As for the process of *baking* meat, it is not nearly so refined as that of roasting, although it has one advantage, in the circumstance that the temperature can be more easily regulated than with roasting.

In making *soup* the object is to extract, as completely as possible, all the soluble constituents of the meat or bone, and when the latter is used it should be chopped or broken into small pieces, and boiled for a considerable time—not less than nine or ten hours. Shin-bones will then yield about 19 per cent. of their weight of fat and gelatine—the soup being, according to Dr. E. Smith, very nutritious, so that 6 lbs. of bones will produce a soup that contains the nutritive power of 2 lbs. of meat, as far as carbon is concerned, and of 1 lb. of meat in respect of nitrogen; but although this may be so as regards the actual quantities of carbonaceous and nitrogenous matters present, yet it is very doubtful whether they are equally nutritious, for in the renowned experiments of the French gelatine commission it was found that the soup or jelly from boiled bones would not support the life of dogs, although raw bones, in like proportion, would.

Ox-tail soup is much richer than that from bones alone, as it contains the saline and other constituents of flesh. It is now a favourite and rather expensive soup, although at one time, it was the humble fare, and almost the only nitrogenous food of the poor Protestant French refugees of Clerkenwell. Prior to the year 1689, or thereabout, the butchers of London left the tails attached to the hides, which were sent to the tanners of Bermondsey, but the poor French refugees, in their extremity of want, bought the tails for a mere trifle, and converted them into soup, which was soon found to be of excellent quality.

Soup made from meat should be obtained in the way already described—that is, a given weight of meat, chopped fine, should be allowed to macerate in its own weight of cold water, and should then be gradually heated to the boiling-point, after which it should be strained and pressed. In this way about three per cent. of the nutritious matter of the meat is dissolved, besides the saline constituents. If the soup be simmered with the meat for some hours, a larger proportion of organic matter, chiefly gelatine, will be dissolved; and a good soup thus made from shin of beef will contain about 600 grains of solid matter in a pint, and of this about 39 grains are saline.

Lean meat contains about 25 per cent of solid matter, the rest being water, and of this from 7 to 10 parts are soluble in cold water; rather more than half of this is albumen and miochrome (colouring matter), which are coagulated by heat, and thus, if the cold solution of flesh be boiled, it contains only from 3 to 4 per cent. of the meat; and when evaporated to dryness it constitutes the *extractum carnis* of Liebig. It can hardly be said, however, that the nutritive power of this extract is very great, for its chief constituents are *certain acids, lactic* and *inosic*, with *enosite, creatine, creatinine*, and an indefinite colloidal organic substance of a brown colour and syrupy consistence; besides which it contains the soluble saline matters of the meat, as phosphate and chloride of potassium, with a little chloride of sodium. Analyses of this extract, as found in commerce, have furnished from 41 to 60 per cent. of water, from 22 to 41 per cent. of organic matter, and from 8 to 16 per cent. of saline matter. The extract is always acid; and it should be of a pale yellowish-brown colour, with an agreeable meat-like odour and taste. It should also be perfectly soluble in cold water, and should not contain albumen, fat, or gelatine.

False views have been entertained of the nutritive power of this extract, for, as one pound of it represents the soluble constituents of from 30 to 34 pounds of lean meat, or from 45 to 48 pounds of ordinary butchers' meat, it has been assumed that its nutritive power is in this proportion; but Liebig has taken care to correct this error, by showing that the extract, when properly prepared, merely represents the soup or beef-tea obtainable from that quantity of meat; and, as it is deficient of albumen, it must be conjoined to substances which are rich in this material, as beans and peas. No doubt the physiological action of the extract is due to the alkaloids which it contains; and as the former of these are of tea and coffee (theine or caffeine) in their effects on the body, it must be concluded that extract of meat is more of a vital restorative than a nutritious food. It is from this point of view that Parmentier, Proust, and even Liebig himself are disposed to regard the physiological effects of the preparations. "In the supplies of a body of troops," says Parmentier, "extract of meat would offer to the severely-wounded soldier a means of invigoration which, with a little wine, would instantly restore his powers, exhausted by great loss of blood, and enable him to bear being transported to the nearest field hospital;" and, in almost the same language, Proust remarks that "we cannot imagine a more fortunate preparation under these circumstances; for what more invigorating remedy, what more powerfully-acting panacea than a portion of genuine extract of meat dissolved in a glass of noble wine?

As in the case of soup and beef-tea, its nutritive power must be assisted by vegetables and other substances which are rich in nitrogenous matters. Conjoined, therefore, with wheaten flour, with peas or lentils, or even with the gluten obtained in the manufacture of starch by Durand's process, it may be made to have the nutritive power of meat. Already there is a preparation of it by Messrs. Peek, Frean, and Co., in which the extract is mixed with baked flour and pressed into small biscuits; indeed, as far back as the year 1851, Mr. Borden, jun., obtained a patent for combining extract of meat with flour, farina, or meal, and baking it in the form of biscuits. In this manner, by using the extract of 5 lbs. of meat with 1 lb. of flour, he produced biscuits which contained 32 per cent. of nitrogenous matter, and 1 oz. of the biscuit grated into a pint of water, then boiled and flavoured, made a good soup. In the case of Liebig's extract of meat, one pound of the preparation is sufficient with the usual rations of potatoes and other vegetables to make soup for 130 men; and a strong broth is made by dissolving a teaspoonful of it (about 150 grains) in half a pint of boiling water, and flavouring with salt and pepper.

A still more nutritious broth, containing the albumen of the meat, is obtained by infusing a third of a pound of minced meat in 14 ounces of cold soft water, to which a few drops (4 or 5) of muriatic acid, and a little salt (from 10 to 18 grains) have been added. After digesting for an hour or so, it should be strained through a sieve and the residue washed with 5 ounces of water and pressed.

The mixed liquids thus obtained will furnish about a pint of *cold extract of meat*, containing the whole of the soluble constituents of the meat (albumen, creatine, creatinine, &c.), and it may be drank cold, or slightly warmed—the temperature not being raised above 100° Fahr. for fear of coagulating the albumen.

There are many questions connected with the economy f cooking which I have not time to discuss, but I may ate that this Society has done good service for the ommunity in obtaining valuable information as to the mplest and cheapest apparatus for the purpose. Fore- ost among them is the cooking-pot of Captain Warren. ; is a sort of double sauce-pan, and is easily made by tting a small covered sauce-pan into a larger one. The ner vessel contains the joint or other thing to be cooked, ad the outer one has a little water in it, so that the mperature in cooking can never exceed 212°. By this eans the joint is cooked in its own vapour without oming into contact with water or steam, and thus it annot lose its soluble constituents; and if it be desired improve the flavour of the joint just cooked, it may afterwards roasted for a short time before the fire. he loss in weight under these circumstances is not early so great as in the common way of cooking, and e flavour and tenderness of the meat are considerably creased; besides which, there is the certainty of cook- g the joint equally throughout, without over-dressing Moreover, by the adaptation of a steamer to the ater vessel, vegetables may be also cooked at the same me. When the meat is boiled by this process, there is tle or no loss of weight, and even when it is after- ards roasted, for the purpose of improving its flavour, e loss is not nearly so great as when a joint is roasted the ordinary way. In one experiment it was found at 15 lbs. of meat roasted in the usual manner, in the tchen of the Cambridge Barracks, lost 4 lbs. 4 ozs. in eight, whereas the meat cooked in Captain Warren's t, and then roasted, lost only 2 lbs. 15 ozs., so that ere was a gain of 1 lb. 5 ozs.

Another apparatus of very great ingenuity is a cook- g-pot from Switzerland, where the saucepan containing e joint and a little water is, after boiling for a short ne, placed in a box lined with felt, and thus left for an ur or two to cook, the conducting power of the felt ing so bad that the heat is retained in the most perfect anner. The apparatus is not only economical, but it also excellently well suited for picnic parties, or for diers on the march, who may thus secure a hot dinner, oked while on the journey.

The cooking appliances of the poor are very imperfect, d hence they resort to the cook-shops of their neigh- urhood; but even then their meals are scanty and etchedly cooked. In the poor districts of London ree halfpence is the usual expenditure for a dinner by ildren—a penny going in pudding, and the halfpenny potatoes. If they pay twopence they are allowed to down, and have a little gravy with it. Everybody s heard how the poor of Paris dine *à la squirt*, where e tin soup basins are nailed to the table, and where the endant Leonoras draw up the seething soup from a lden cauldron by means of a huge syringe, from which s driven out into the customer's basin. The price of meal (4 sous) must be instantly paid down, or the lous handmaid sucks up the soup again into the nster squirt. Scenes like this, and even worse than this, in the abodes of the poor have urged philanthropists to seek a better means of supplying their wants, without trespassing upon the dangerous ground of charity. In Paris an enterprising widow (Madame Robert) conceived the idea of giving a poor man a good dinner for two- pence. Her daily bill of fare was cabbage-soup, a slice of bouilli (beef), a piece of bread, and a glass of wine; and thus, in the neighbourhood of the Marché des Innocents, did she daily provide for some six thousand workmen, who took their dinners in the open air, but sheltered from the weather; and she gained a farthing by each guest. In this country a like benevolence has set on foot, with more or less success, in different places, restaurants for the poor. In Glasgow, for example, the working-class dining-rooms, which are far above the rude accommodation of Madame Robert, are established to provide a substantial dinner for 4d. or 5d. Long ago the special correspondent of the *Daily Telegraph*, in writing about them, said that he obtained a capital dinner of good pea-soup, boiled beef, ten ounces of potatoes, and pudding—more than he could eat—for the sum of 5½d.; and a writer in the *Times* also stated that for 4½d. he had a pint basin of pea-soup, a plate of hot minced collops, a plate of potatoes, and eight ounces of bread; while his companion had, for the same sum, a pint basin of broth, a plate of cold beef, a plate of potatoes, and a slice of plum pudding, all excellent in their quality, and well cooked. The practice in these places is to pro- vide daily a variety of hot foods, as soup, broth, potatoes, rice, cabbage, pudding, tea and coffee, besides bread and butter, cold pressed beef and ham; and every ration, except meat, is so apportioned as to be sold at the uniform price of a penny. The meat costs three halfpence; and, with the view of clearing off the remainder of the soup after the proper dinner hour, so that a fresh quantity may be made every day, it is the practice to sell the soup and broth, at half-price, from six o'clock to eight o'clock in the evening, and then to give the remainder away. All the articles are of the best quality, and are well cooked. They are bought by contract at wholesale prices; and, although they are sold so cheaply, yet they yield a small profit, and so give the system the stability of a commercial enterprise.

Very recently, too, Mr. Riddle has proposed, in a paper which was read before this Society, that arrangements might be made for cooking dinners on a large scale, and sending them out to the houses of the poor. He proposes to prepare, daily, good rations of roasted, baked, and boiled meat, with vegetables, and to send them out in 2lb., 4lb., or 6lb. tin canisters, all ready for immediate use, and kept warm in little compartments of a properly- constructed cart. There would be no difficulty about this, and the meat might be delivered in excellent con- dition, and with great punctuality. None but those who are acquainted with the utter helplessness of the poor in the matter of cooking food, or who know the difficulties of even better classes of persons in this matter, can form any notion of the value of such a proposition; and I should be glad to see it realised.

LECTURE IV.—Delivered Monday, February, 10, 1868.

PRESERVATION OF FOOD—UNWHOLESOME AND ADULTERATED FOOD.

It requires no argument to show that the preservation of food is a matter of great public importance; for it not only enables us to provide against actual want in periods of unusual scarcity, but it also affords the means of equalising the distribution of food at all times, so that the excess of one country may be used in supplying the deficiency of another. In the pastoral districts, for example, of Canada, Australia, Tasmania, the Cape of Good Hope, Mexico, the Argentine Republic, and the Brazils, thousands of tons of meat are always available as food, and yet they are lost to us because of the difficulties of preserving it. In South America, at least two millions of beasts are annually slaughtered for the fat, skin, and bones, the flesh of which could be supplied here at less than 2½d. per pound. So also in Australia, the amount of meat available as food is practically inexhaustible. Last year Mr. Philpott stated to the Food Committee of the Society of Arts, that he himself was in the habit of melting down from 1,000 to 1,500 sheep daily for four months together; and that in the vast districts of rich pasture-land from Victoria to Brisbane, there was an unlimited supply of the very finest meat—all of which was at present entirely wasted, because of the difficulty of disposing of the flesh; and, therefore, the carcasses of the animals were melted down for fat. A bullock in Australia, he said, costs only from £3 to £4; and legs of mutton of the very best quality were, when salted, sold for three shillings a-dozen. If some simple and practicable means could be devised for preserving such meat, it might be supplied to our markets at less than 3d. a pound.

Until recently the only process employed for this purpose was the rude method of salting the meat, but the deterioration of it was so obvious, and the distaste for it so general, that it was only practised to a limited extent, and for occasions when fresh meat could not be obtained. The salt junk of the navy in olden time was a good example of the wretchedly unwholesome and indigestible meat prepared, for it could hardly be called preserved, by this process. Recognizing, therefore, the necessity for a bettter means of preserving food, the naval authorities of every country appealed to science, and gave the largest encouragement to inventors. A further stimulus to invention was created by the necessity for supplying our Arctic explorers with good and wholesome food during their long winter residence in the frozen seas of the north; and as that inquiry was set on foot, not merely for the purpose of discovering a north-west passage to our possessions in America, but also with the view of prosecuting scientific research in almost inaccessible regions, an unusual inducement was offered for the preparation of such food. The demand thus created was soon acknowledged by science, and was also met by the practical skill of the manufacturer, so that the Arctic voyager went confidently on his journey, knowing that he had other food than the unwholesome junk of the navy. The earliest preparations supplied to him were mixtures of dried meat with sugar and spice (*pemmican*), but after a time they were furnished with fresh meat, preserved in air-tight cases. At first the supply was chiefly for voyagers in cold countries, but when the value of this method of preservation became known, the European residents of hot climates, as India, eagerly sought for the fresh foods which they were accustomed to use in their own country, and thus an additional stimulus was given to this process of manufacture. At the present time it has acquired gigantic proportions.

I have before me a list of the specifications of patents relating to the preservation of food, from the year 1691 to the end of 1855, and I find that only one was described in the seventeenth century, and three in the eighteenth, while as many as 117 were specified in the first 55 years of the present century. Invention, however, has not been prolific of new processes, for it is mainly confined to an application of one or two simple elementary principles—26 of the patents, for example, are for the preservation of food by drying; 31 by excluding atmospheric air; 8 by covering the food with an impervious substance, as fat, extract of meat, gelatine, collodion, &c., and 7 by injecting meat with various salts.

But before we proceed with the examination of these processes, it will be advantageous to inquire a little into the circumstances which favour organic decomposition. It would seem, from experiment and observation, that three concurrent conditions are absolutely necessary for active putrefaction—namely, the presence of much moisture, the access of atmospheric air, and a certain temperature, as from about 40° to 200° of Fahrenheit; any of these being absent, the organic substance resists decay. All preservative processes must, therefore, depend on an application of one or other of these principles; and perhaps we may add a fourth—namely, the action of chemical agents. Let us review them in detail.

1st. *The preservation of substances by drying them* is of very ancient date. In our anatomical museums we have long known that specimens of the animal body may be preserved for an indefinite time by drying them, and then varnishing them so as to exclude moisture. Here is a dissection prepared in that manner, which has been used for lecture illustration at the London Hospital for more than half a century, and yet it is as sound as when it was made. In warm climates it has been a practice for ages to preserve fish, and even meat, by drying them—the meat being cut into strips and exposed to the action of warm dry air. Charqui or South American beef, which you see here, is an example of it. It is obtained from animals that are grass-fed, and they are killed by pithing and then bleeding them. Directly the hide is taken off, the flesh is stripped from the bones and allowed to cool. It is then placed on a table, and jerked, or cut up into thin slices, which are piled up in heaps with alternate layers of salt. After standing twelve hours the meat is turned, and fresh salt is added where necessary. The next day the salted strips are placed upon hurdles nd exposed to the sun to dry. It requires two or three ays to dry the meat thoroughly, and, for fear of damp, is always taken in-doors at night. There are several arieties of this meat, as *pato*, which is the best and ost free from sinew; *manta*, the second quality; nd *tasajo*, the third, which is very thin and full of news. All the varieties require to be well soaked in ater, and then to be cut small and cooked by pro- nged boiling. But animal foods are not well pre- rved in this manner, as they lose their flavour, and ecome tough and indigestible; the fat also gets rancid, nd in damp weather the meat absorbs moisture and be- omes mouldy and sour. Perhaps the lean parts of meat, the heart, tongue, and strips of muscle might be ad- antageously preserved in this way, especially in warm nd dry climates. The Food Committee of this Society ported favourably of a specimen of dry powdered beef om Queenstown, which they said was in excellent con- ition, and contained about four times as much nu- itious matter as ordinary meat. Generally, however, e fat is very rancid, even when pains are taken to revent the substance from getting mouldy. It is for e same reason that all attempts to preserve milk and e yoke of eggs by drying have failed, although the ried white of egg will keep well, as in the process of Ir. Charles Lamont, where the albumen is dried in thin ales—forty-four eggs making about one pound of the reparation. Absorbent substances mixed with the tty food will obviate the difficulty, to some extent, as in e preparation of *pemmican*, where sugar and spice are dded to the dry powdered meat; and in the several rocesses for preserving milk by evaporating it and ixing it with sugar, &c., as in the patents of Newton, 835), Grimwade (1847 and 1855), Louis (1848), &c.; well as the process of Davison and Symington (1847) r preserving eggs by mixing the yokes and whites ith flour, ground rice, or other farinaceous substance, nd drying. Extract of meat also may be preserved in e same manner, as in the patent of Donaldson (1793), Robertson (1851), and of Borden (1851), where the tract, after the separation of fat, is mixed with rinaceous matters; in the last case it is also baked in e form of biscuits. In the year 1854, MM. Blumen- al and Chollet obtained their patent for combining eat and vegetables in the form of tablets, by first dry- g the meat and vegetables and pressing into cakes, nd then submitting them to successive immersions in ch soup—allowing them to dry in warm air after each mersion. When the extract of meat is made without t or gelatine, as in the case of Liebig's extract, it may e kept for a long time in a pasty condition, without ixing it with farinaceous matters, although the pre- aration of it with baked flour, as already described, is a reat improvement.

The process of drying is, however, best adapted for e preservation of vegetable substances, and it has been used from time immemorial, as in the keeping of pot- erbs, in preparing the tea-leaf, in making hay, &c. In is country, the first recorded patent for preserving egetables by drying them, was granted in 1780, to John raefer, who sought to retain the flavours of vegetables y first dipping them in boiling salt and water, and then rying. Forty years later (1820) John Vallance ob- ined a patent for preserving hops by drying them, nd then compressing them into a small space. Then ame the patents of Edwards (August, 1840), for boiling, ranulating, and drying potatoes; and of Grillett (No- ember, 1840), for preserving both cooked and uncooked otatoes by drying. Ten years afterwards (in Novem- r, 1850) Masson obtained his patent for preserving egetables by drying them and forcibly compressing em, so that they were reduced to one-seventh their iginal bulk—a cubic yard containing rations for ,000 men. This process has been very successful, and is still practised by Devaux, Chollet, and others, r it serves for the preservation of all kinds of egetables, as potatoes, cabbages, carrots, cauliflowers, ans, apples, &c.; and when steeped in water they re- absorb their natural proportions of moisture and swell out to their original size. They are, however, some- what deficient of flavour, and they require prolonged boiling, as from one and a-half to one and three-quarter hours, to cook them.

By a more careful process of drying, Mr. Makepiece has managed to preserve both the colour and the flavour of vegetables, especially of pot-herbs, as you may see from these specimens.

Altogether there are, or have been, about thirty-one patents in this country for the preservation of various articles of food by drying them.

2nd. *The preservation of organic matter by excluding atmospheric air* is, like the last, a very ancient process. The old practice of burying the dead in leaden coffins, and the still more ancient custom of swathing them in resinous bandages or waxed cloths (called cerements, owe their preservative powers to the exclusion of at- mospheric air; and it is remarkable, seeing the efficacy of the process, that the scientific principle of it was not long ago recognised and applied to the preservation of food. The first patent of the kind that I am acquainted with in this country, was granted to Francis Plowden, in June, 1807; and he describes it as a process for "pre- serving butchers' meat, animal and other comestible sub- stances, by encrusting them with a substance, which must not only resist the effects of atmospheric air, but must not communicate any noxious quality to its con- tents," and for this purpose he employed essence or extract of meat—the substance being dressed, so that it may preserve the longer, is wiped dry, and put into a wooden vessel, and the hot extract is poured over it in a fusible state, so as to find its way into every vacuum. Three years later (in February, 1810), Augustus de Heine took out the first patent for preserving meat, by exhausting the air from the vessel containing the meat, and he contrived a machine for the purpose, as the action of the common air-pump was tedious. Six-and- thirty years after this (1846) the late Mr. Warington, of Apothecaries' Hall, obtained his patent for the pre- servation of animal substances, by coating them with common glue, gelatine, or concentrated meat gravies, or otherwise by dipping them in warm solutions of such substances; or by wrapping them in waterproof cloth, or covering them with caoutchouc, gutta-percha, or varnish. These mark the starting-points of the various processes now in use; for example:—

(*a*). Of those which owe their operation to the exclu- sion of air, *by filling up the vessel with something hot*, there are the patents of Plowden (1807), who used rich gravy or extract of meat; of Granholm (1817), who used hot fat, or hot animal jelly; and of Wothly (1855), who used oil, as in preserving anchovies. I am rather sur- prised, considering how easily the exclusion of air is effected by surrounding the substance with hot fat, that this method of preserving meat has not been adopted in Australia and South America; for as the fat which they prepare from their wild stock is sent to this country in casks, there would be no difficulty in sending with it the finer descriptions of joints, as legs of mutton and good pieces of beef. The process should be con- ducted as follows:—When the fat is melted, and is at a temperature of from 240° to 250° Fahr., the fresh joints should be plunged into it, and kept there for a few minutes, so that the superficial moisture might be thoroughly evaporated. They should then be imme- diately packed in sound dry casks, and filled up with hot fat, at a temperature of 212° or thereabout. In this manner the fat and the joints might be transmitted to this country, and on their arrival there would be no difficulty in melting the fat while in the casks, and then removing the preserved joints.

Vegetable substances are frequently preserved in bottles filled up with hot syrup, and the practice is a very old one. Hot water is also used for the same purpose, and this method dates from the year 1807, when this Society gave a premium to Mr. Saddington for his method of preserv- ing fruits without sugar. His process was to gather the fruit a little before ripening, and to put it immediately into clean bottles,—filling the bottles with the fruit to the neck. They were then placed in a vessel of cold water, and heat was applied until it rose to the temperature of 160° to 170° Fahr. After standing exposed to this temperature for half-an-hour, the bottles were filled up to within an inch of the top with boiling water, and were then immediately corked and covered at the top with cement. The action of the heat was not merely to expel atmospheric air from the bottles, but also to coagulate the vegetable albumen of the fruit. Fruits and green vegetables are still preserved in this manner, a little alum being generally added to the water in the bottle, for the purpose of hardening the tender skin of the fruit, and so preventing its disfigurement by bursting.

(*b*). A process not very unlike the preceding, is that which consists in *the destruction of the oxygen of the air in the vessel, by heating the substance in it.* This is the plan of M. Appert, who, in 1810 (three years after the publication of Mr. Saddington's method), obtained the reward of 12,000 francs, offered in the preceding year by the French Government, for the best method of preserving food. Here is the book which M. Appert wrote at the time, and he tells us to cook the food to some extent, and put it into strong glass bottles—filling them almost to the top. The bottles are then to be securely corked, and exposed for some time to the action of boiling water. To guard against accident from bursting, the corks are to be wired down, and the bottles wrapped up separately in cloths. After this the corks are to be well covered with pitch, to exclude atmospheric air. A like process was patented in the autumn of the same year (1810), by Mr. Peter Durand, who, no doubt, derived it from the published account of M. Appert, dated nine months before; and since then, many such patents have been obtained, which I need not describe. Attempts have frequently been made to preserve milk by this process. Appert recommended that the milk should be boiled down to about half its bulk before putting it into the bottles; and in 1847 Bekaert tried to improve the process by adding carbonate of soda to the milk. Later still, in the same year, Martin de Lignac obtained a patent for preserving milk, by evaporating it to one-sixth of its bulk before bottling it. Then there were the patents of Symington and of Moreau (1853), but all these methods have failed in practice, on account of the difficulty of preventing the separation of the butter.

(*c*). The preservation of food *by exhausting the air from the vessel containing it* dates, as I have said, from the year 1810, when Augustus de Heine proposed to use a vessel with a valve in the top of it, which allowed the air to be drawn out by means of a special apparatus, but not again to enter. The exhaustion, however, was so imperfect that the process did not answer. In 1828 Mr. Donald Currie improved it by admitting carbonic acid gas into the vessel after it was thoroughly exhausted; and later still, in 1836, M. Leignette still further improved it, by filling the vessels containing the food with salt and water, and then letting out the liquid through the aperture, which remained open for that purpose, while carbonic acid gas went in. Six years after this (in 1842), Mr. John Bevan patented a process for drawing out the air by an exhausting apparatus, and then admitting a warm solution of gelatine; and in 1846 Mr. Rettie employed, in the like manner, a solution of common salt. But none of these methods were successful; nor was the patent of Mr. Ryan, in 1846, for using gases, chiefly acetic acid vapour, and carbonic acid gas. The most perfect process of this kind was patented by Messrs. Jones and Trevethick. It consists of an apparatus whereby the exhaustion of the vessel containing the raw food is effected in an air-tight trough of water, and thus the entrance of air and the collapse of the sides of the vessel are completely prevented. After the exhaustion pure nitrogen is admitted into the vessel, for the purpose of diluting the residuum of air, and it is again exhausted. Lastly, a charge of nitrogen, containing a little sulphurous acid, is let into it, and thus the last trace of oxygen is chemically absorbed. The vessels are now in a proper condition for removal from the air-tight water trough, and for having the apertures sealed with solder. Meat, fish, and poultry preserved in this manner has been found good after seven or eight years; and specimens of them were exhibited in the London exhibition of 1862.

(*d*). The most common method of driving out the air *is by means of steam.* The food is put, with a charge of water, into a tin case with a hole in the top, and when the water is boiling actively, and steam has displaced the air, and is escaping freely, the hole is stopped with solder. This process dates as far back as 1820; but the first patent for it was granted to M. Pierre Antonie Angilbert, in 1823. He had, however, a very rude method of applying heat to the tin vessels, and this was improved by Wertheimer in 1840. In the month of January of the year following Mr. Gunter improved it still further; and later in the same year both Goldner and Wertheimer obtained patents for using a bath of muriate of lime for heating the vessels. This, in fact, is the practice at the present time by Goldner, McCall, Richie, Morton, and others, who are largely engaged in the preservation of food. The details of the process for effecting it are as follows:—The raw meat and vegetables are put into the canisters and soldered down—a pin-hole aperture being left in the lid. The canister is then subjected to the heat of the bath (a little above 212°) until the contents are about two-thirds cooked, and then, while the steam is blowing freely out, the aperture is dexterously sealed tight with solder. The canister is then painted over with a stiff oil paint, and is exposed for some time in the testing-room to a temperature sufficiently high to promote decomposition. If the canister shows no sign of bulging out from the generation of putrefactive gases, it is considered sound. Messrs. Hogarth and Co., of Aberdeen, use steam instead of the muriate of lime bath.

Meat preserved in this manner will keep for a considerable time. At the exhibition of 1851 vouchers were given for some of the samples that had been preserved for twenty-five years; and at the exhibition of 1862 I examined specimens of food that had been kept for more than thirty years. To-night, through the kindness of Messrs. Crosse and Blackwell, I am able to show you a specimen of preserved mutton, which has been in the case forty-four years, and you will perceive that it is in excellent condition. It formed part of the stores supplied by Messrs. Donkin and Gamble in 1824 to his Majesty's exploring ship *Fury*, which was wrecked in Prince Regent's Inlet in 1825, when the cases were landed with the other stores, and left upon the beach. Eight years afterwards (in August, 1833), they were found by Sir John Ross in the same condition as they were left; and he wrote to Mr. Gamble at the end of that year, saying, "That the provisions were still in a perfect state of preservation, although annually exposed to a temperature of 92° below and 80° above zero." Some of the cases were left untouched by Sir John Ross; and after a further interval of sixteen years, the place was visited by a party from H.M.S. *Investigator*, when, according to a letter from the captain, Sir James Ross, "the provisions were still in excellent condition after having lain upon the beach, exposed to the action of the sun and all kinds of weather, for a period of nearly a quarter of a century." Messrs. Crosse and Blackwell have placed the original letters in my hands for perusal, and they show, beyond all doubt, that meat preserved in this manner will keep good for nearly half a century —in fact, the case of boiled mutton now before you has been preserved for forty-four years. There can be no question, therefore, as to the success of the process; and hence it is largely practised, not only in this country, but also in our colonies, where food is abundant. In this way preserved salmon and lobsters are sent to us from Newfoundland, turtle from Jamaica, beef and mutton from Canada, and the dainty tail of the kangaroo from Australia. There are, however, two serious objections to the process—namely, that the meat is nearly always overcooked, and the cases are likely to buckle and crack from the constant pressure of the atmosphere—there being a vacuum within them. The over-cooking arises from a desire to ensure the complete exclusion of atmospheric air by the steam. Mr. Nasmyth has proposed, in his patent of 1855, that a little alcohol should be mixed with the water, so that the boiling-point may be reduced; while Mr. McCall, taking advantage of the absorbent action of sulphite of soda on oxygen, recommends a less prolonged boiling and the use of a little of that salt. The salt is contained in a small capsule, fixed by means of soft solder to the inner surface of the cover of the case. When the food is about two-thirds cooked, and steam is freely escaping, the hole in the lid is stopped with a very hot iron, which melts the soft solder of the capsule within, and so sets free the little pellet of sulphite of soda, which speedily absorbs the remnant of oxygen left in the case.

The other difficulty, namely, the cracking of the case from atmospheric pressure, is obviated, as I have already explained, by the introduction of inert gases, as carbonic acid, nitrogen, &c., and with a little sulphurous acid, and these have been the subject of many patents, as of Currie (1828), Leignette (1836), Ryan (1846), Nasmyth (1855), and others.

(*e*). The last method of any importance for excluding atmospheric air from food, is *by coating it with some impervious material*. This plan, as I have already stated, was first suggested by the late Mr. Robert Warington, who, in March, 1846, obtained a patent for the use of "common glue, gelatine, or concentrated meat-gravies; or thin cream of plaster-of-Paris, which, when set hard, was to be saturated with melted suet, wax, stearine, &c." "The things were then to be wrapped in water-proof cloth, or covered with caoutchouc, or gutta-percha; or coated with a varnish of these substances; or kept submerged in glycerine, treacle, elaines, oils, or other such matter not liable to oxydation." Nine years after this, in January, 1855, a patent was obtained by Messrs. Delabarre and Bonnet, for preserving meat, bread, eggs, vegetables or pastry, by coating them with a varnish, made from the flesh and bones of animals, by boiling them, and obtaining a rich syrup. This, when clarified, was used to cover the parboiled meat or vegetables. In the month of February in the same year, a like patent was granted to Mr. Hartnall, for a process of preserving animal and vegetable substances by immersing them in baths, consisting of gelatine and treacle dissolved together in certain proportions; then drying, redipping, and covering with charcoal powder. Later still, in the same year, Mr. Brooman patented the use of albumen and molasses, as a coating for meat, after the meat had been partially dried, and then suspended in an air-tight vessel, charged with sulphurous acid. Lastly, in the month of December of the same year, Messrs. Jouëtt and Douein obtained provisional protection for the use of collodion, either alone or mixed with other suitable substance.

But the best example of this method of preserving meat is the process of Dr. Redwood, whereby the meat is first covered with paraffin, and then with a flexible coating of gelatine, mixed with glycerin or treacle. The joints are dipped into a bath of paraffin, having a temperature of from 240° to 250° of Fahrenheit, and are kept therein until the surface moisture is evaporated. They are then transferred to a colder bath of paraffin, from which they receive two or three coatings, prior to their being covered with the last flexible covering of gelatine, &c. When the meat is required for use, the paraffin is easily removed from it, by plunging it into boiling water, which dissolves the flexible coating and melts the paraffin. The paraffin floats upon the water, and, when cold, may be collected for future use.

The common methods of preserving foods by forcing them into skins, as in the case of German sausages, lard, &c., is of very ancient date; although a patent was granted to Mr. Palmer, in 1846, for the preservation of the fat of beef, mutton, veal, or lamb, when fresh, by melting them, straining, and then packing in bladders.

3rd. *The preservation of food by cold* is a well-known process, for every one is acquainted with the fact that meat will keep for a long time in the winter-season without deterioration; but the extent to which this preservative power may be carried is not well known. Animals, we are told, have been found in a perfect state of preservation in the frozen earth of the arctic regions, where they must have been buried for centuries. Last year, indeed, a communication was made to the Royal Society, by Dr. Carl von Bear, of the fact that the entire body of a mammoth was found in the frozen soil of arctic Siberia. How long it had been so preserved it is hard to conjecture, but it must have been there for ages. Another good example of the preservative power of cold was observed in Switzerland in the autumn of 1861, when the mangled bodies of three Chamounix guides were found at the lower part of the Glacier de Boissons. The flesh of the bodies was perfectly preserved, notwithstanding that 41 years had elapsed since the unfortunate men lost their lives. They were carried away by an avalanche from the grand plateau of Mont Blanc, in the month of August, 1820, while attempting to ascend the mountain with Dr. Hamell; and no trace of them was discovered until the corresponding month of 1861, when, by the slow descent of the mountain ice, their remains were brought to the lower glacier. So well is this preservative power of cold known to the inhabitants of Russia, Canada, and other northern climates, that it is a common practice to slaughter fat animals on the approach of winter, when fodder is getting scarce, and to preserve their carcases by burying them in the ice or frozen earth; and they are thus preserved from the middle of November to the early part of May. We also have a practice of packing salmon in ice; and we receive game and poultry from America, and send the like to India in boxes surrounded with ice. The application of this method of preserving food is almost without limit, for not only can we obtain a stock of ice for such a purpose in the winter season, but it may be brought to us at any time from colder regions of northern Europe, or it may even be manufactured at a cost of less than half-a-guinea a ton. There is a machine of Mr. James Harrison, of Australia, made in this country, which is said to be capable of producing 8,000lbs. of ice a day, at a cost, including all expenses, and with a good margin for profit, of ten shillings a ton. Why, therefore may we not use ice in the summer months for the preservation of food? Dealers could easily provide themselves with close rooms containing ice, in which the food might be placed; and we ourselves might use ice-boxes more commonly in our households. It might interest you to know that the first patent for the preservation of food in this manner was granted to John Lings, in 1845.

Again, a temperature of from 200° to 212° will also arrest putrefaction; and joints of meat may be preserved for a time by dipping them every now and then in boiling water.

The 4th and last method of preserving food is *by the use of chemical agents, called antiseptics*, which act by destroying infusorial and fungoid life, and by forming compounds which are not prone to decay. Foremost of these is *common salt*, which has been used from the earliest time; but it is not a good agent for the preservation of meat, as it renders it tough, gives it a bad flavour, extracts the soluble constituents of it, and makes it hard and indigestible. The process, however, is much better managed at the present time than formerly, when the hard junk of the navy was the common diet of our sailors; and, considering how easily it is applied, it is not surprising that it is almost universally practised. In some parts of England and Wales it is the custom of the better classes of agricultural labourers to fatten a pig during the summer, and kill it and salt it for the winter. Hams and tongues are treated in like manner; and so are fish when they are plentiful among the inhabitants of our coasts. As far back as 1800 a patent was granted to Mr. Benjamin Batley for curing and preserving herrings and sprats by salting them; and it would seem that his process was very successful, for in the following year he obtained a patent for the like treatment of other fish. The dainty *caviare* of the Russian is nothing but the salted roe of the sturgeon. Even vegetables may be preserved in salt and water, as in the case of olives.

Other saline substances, saltpetre, acetate of ammonia, sulphite of potash, or soda, muriate of ammonia, &c., are also good preservative agents, and are the subjects of several patents. Here is a specimen of meat preserved by wetting it with the solution of one part of acetate of ammonia and nine of water; and here another, which has been similarly treated with a weak solution of sulphite of soda. It is only necessary to brush the solution over the surface of the fresh meat, and when dry it will leave the meat in such a state as to resist decay. Instead of covering the meat with the solution, it may be injected with it, as in the patents of Long (1834), Horsley (1847), Murdoch (1851), and others.

After meat or fish is salted, it is frequently dried and smoked by exposing it in close chambers to the vapours of smouldering peat, wood, straw, &c., and in this manner it becomes impregnated with the dark-brown empyreumatic oil of the burning wood. The chief agent concerned in the preservation of food thus treated is the creosote of the empyreumatic oil, and this it is which gives the food a smoky flavour. A like effect may be produced by dissolving the creosote of wood-tar in vinegar, and brushing it over the salted joint. The creosote of coal-tar (*carbolic acid*) is also a powerful antiseptic, but its flavour is not agreeable, and therefore it is not used in the preservation of food; although it is extensively employed, in the form of coal-tar, dead-oil, or creosote, in the preservation of wood, canvas, &c.; and the perfection of purity to which it is now brought by Dr. Crace Calvert and other manufacturers, encourage its use in medicine and surgery.

Spirit of wine and *vinegar* are other preservative agents which owe their antiseptic power to their destructive action on infusorial life, and to their combining with the albuminous constituents of food. Cherry brandy and pickles are good examples of this.

Lastly, I may state that the fumes of burning sulphur (*sulphurous acid*) are very powerfully antiseptic; and many patents have been taken out for their employment in the preservation of food. In the spring of 1854, Laury obtained a patent for it, the gas being introduced into the vessel containing the substance to be preserved. Later in the same year, Bellford received provisional protection for the use of sulphurous acid with about one-hundredth of its volume of hydrochloric acid—the object being to prevent the sulphurous acid combining with the alkaline salts of the meat, and so giving it an unpleasant taste. The acids were to be used in solution, and the meat immersed in it for twenty-four hours. In the following year (1855) there were three patents—those of Brooman, Demait, and Hands, for the use of the acid in a gaseous form; and in the specification of Demait it was directed that the substance should be preserved by hanging it up in a chamber, and exposing it for a time to the action of the gas. Professor Gamgee has revived this process in a recent patent, and with certain modifications. He recommends, for example, that the animal should be made to inhale carbonic oxide gas, and when it is nearly insensible, it should be bled in the usual way. After the carcase is dressed, it is to be suspended in an air-tight chamber, which is to be exhausted of air, and then filled with carbonic oxide gas, to which a little sulphurous acid has been added. It is to remain exposed to these gases for twenty-four or even forty-eight hours, and is then to be hung up in dry air; after which it is said that the carcass will keep for many months, without perceptible change in taste or appearance. The process has been tested by killing meat in London, and sending it to New York; and after the lapse of from four to five months, the meat has been pronounced good by a practical butcher. I am very much inclined to think that the real preservative agent is the sulphurous acid, and that the highly-poisonous carbonic oxide gas might be advantageously excluded from the chamber.

And now, in leaving this part of the subject, I cannot refrain from saying that the history of these patents for the preservation of food affords very striking instances of the necessity for an amendment of our patent laws; for not only is there a frequent disregard of all scientific principles in the construction of the patents, but in many cases there is also a total disregard, or else profound ignorance, of what has already been done in the matter. Repetitions, therefore, occur again and again of the same process, nearly always imperfectly specified; and, on the other hand, the most ridiculous propositions often assume an importance as if for no other object than that of obstructing invention. Out of the 121 patents for the preservation of food, which I have had an opportunity of examining, there are hardly a dozen that can be regarded as either useful to the community or profitable to the patentee.

I come now to the last division of our subject—namely, that which relates to the sale and use of *unsound* and *adulterated food;* and perhaps the most important of this kind of food is *bad meat*—that is, meat which is unwholesome on account of putridity or disease. Food of this description has always been a subject of legal prohibition. Among the Jews the prohibition dates from the time of Moses, who is supposed to have received from the Lord, during his sojourn upon Mount Sinai, certain oral commandments respecting the slaughtering of animals for food, and the examination of their bodies for disease. There is no account of these commandments in the written law, but they were evidently communicated to the people of Israel by Moses, for he says "thou shalt kill of thy herd, and of thy flock, which the Lord hath given thee, *as I have commanded thee*—(Deut. chap. xii., v. 21). It is presumed, therefore, that these instructions were very specific, and they have been practised by the Jews from that time until now. The Hebrew law is, that no flesh shall be eaten, except of animals that have been killed and searched, or examined by the officer (*bodek*) appointed for that purpose; and the most precise rules are laid down for his guidance in these matters. In fact, he is bound by very solemn obligations to declare of every animal that he kills whether the flesh is proper to be eaten (*caser*), or is unfit for food, by reason of its being diseased or torn (*trefa*). This expression appears to have been derived from an ordinance of Moses, that no flesh should be eaten that is torn in the field (Exodus, chap. xxii., v. 31); the word torn (*trefa* or *terefa*) being supposed, according to the traditions of Hebrew sages, to apply not only to animals torn in the chase, or by wild beasts, or by the bungling act of the butcher, but also to those affected with any disease that would shorten their lives; and as it is thought that such disease is always indicated by the condition of the lungs, the utmost care is taken by the searcher or *bodek* in the examination of these organs. His rules or instructions for this purpose are very strict; but generally it may be said that he condemns as unlawful, or unfit for food, the flesh of all animals in which the lungs present the following appearances:—Certain deficiencies, excess, or displacement of the lobes; adhesions, or false membranes; tubercles, or abcesses containing matter or opaque water; discolourations which do not disappear when the lungs are inflated; ulcers, holes, and abrasions letting air through them; consolidations that are impervious to air, and rottenness of tissue. Many of these are, no doubt, unimportant evidences of disease, and, therefore, although the flesh of such animals is rejected by the Jew, it is freely consumed by the Christian. The Jews, indeed, make a sort of bargain with the unorthodox butcher, to take only such animals, when slaughtered by their officer, the bodek, as he considers lawful, and the rest are sold to the public. I dare say this has been the practice at all times, for there are frequent references to it in our legal and domestic records. In *Liber albus*, for example, there is a memorandum to the effect that on the 24th of June, 1274, certain discreet men of the city were summoned before the king's council, to answer the question as to what was done with the unclean flesh of the Jews, and whether it was lawful for Christians to buy and eat the same. Their answer was, that if any citizen bought such flesh of a Jew, he would be expelled, and if convicted by the sheriff he would forfeit such flesh, which would be given to lepers or dogs, and he, in addition, would be heavily fined. To which the council replied that they commanded them in the king's name, to have the custom strictly observed. I fear, however, from the legal records of *Liber albus*, that less attention was paid in those days to the sale of diseased meat than to that of putrid meat; for, on examining the accounts of the citizens made and rendered in divers courts of the king, I find that while "judgment of pillory" is recorded in twenty-one cases for selling putrid meat, poultry, or fish, there is not a single instance of a like punishment for selling the unclean meat of the Jews.

In ancient Rome there were overseers appointed to examine the meat in the public markets before it was sold, and butchers were often fined for neglecting the law in this respect. Mr. Charles Reed has given us an example of this from the *Acta Diurna*, or Roman Gazette of 585 years after the building of Rome, which when translated, runs thus:—A. U. C. DLXXXV. Fourth of the kalends of April. The fasces, with Licinius, the consul, and Lerinus, ædile, fined the butchers for selling meat which had not been inspected by the overseers of the markets. The fine is to be employed towards building a chapel to the temple of the goddess Tellus.

In modern times, also, severe regulations have been made in all the States of Europe for the government of this matter, and in many cases particular instructions are given as to the kind of disease which renders meat unfit for human food—it being the practice to examine the animal while alive, and its carcass when dead. This examination is entrusted to properly-qualified officers, who are bound to condemn diseased and putrid meat, as well as the flesh of animals that have died otherwise than by the hand of the butcher; and no meat can be sold until it has undergone such an examination. In this country, however, although there are laws prohibiting the sale of unsound and unwholesome food, yet there is no provision for the systematic inspection of meat, even when it has reached the public shambles. All that the law declares is, that the local authority may, if it pleases, appoint an officer for that purpose; and as the appointment would cost money, and is not compulsory, it is rarely made. Practically, therefore, there is, except in a few places, an almost unchecked traffic in diseased and unwholesome meat; and the worst descriptions of it are generally sold to the poor at night.

Our forefathers made stringent rules to prevent this; for, among other things, they ordained "that butchers shall close their shops before candle-light, and shall not sell flesh meat by light of candle."—(*Liber albus.*)

Within the city of London the inspection is performed as carefully as it can be, but, nevertheless, amidst the confusion of business in the early hours of morning, a great deal of unsound meat escapes the notice of the inspectors. In fact, if it were not for the assistance afforded to them by the salesmen of the markets, it would be absolutely impossible to check, to any large extent, the sale of unwholesome meat; for, in the three markets of the city—Newgate, Aldgate, and Leadenhall, as much as 00 tons of meat are sold daily. It is brought from all parts of Great Britain and Ireland, as well as from Belgium, Holland, and France, and even from the ports of the Baltic. Of this, a large quantity is diseased, and it comes chiefly from our own country towns, where it is a common practice to forward to London everything that is unsaleable at home. I cannot tell what is the actual proportion of bad meat to good, but we seize and condemn about two tons a week, and this is in the proportion of one part to 750. Last year the amount of meat condemned as unfit for food was nearly 129 tons, and in the preceding year it was more than 152 tons. In fact, during the seven years which have expired since the inspectors were appointed under my recommendation, we have seized and destroyed 1,567,810 lbs., or just 700 tons of meat as unfit for human food. Of this quantity, 805,653 lbs. were diseased, 568,375 lbs. were putrid, and 193,782 lbs. were from animals that had not been slaughtered, but had died from accident or disease. It consisted of 6,640 sheep and lambs, 1,025 calves, 2,896 pigs, 9,104 quarters of beef, and 21,976 joints of meat; besides which, there were also seized and condemned in the city markets on account of putridity, 19,040 head of game and poultry, 207 quarters of venison, and above seven millions of fish, together with thousands of bushels of whelks, shrimps, periwinkles, &c.

It is to be regretted that in the various Acts of Parliament which relate to the condemnation of unsound meat, there are no special rules for the guidance of the officers appointed to investigate this matter—there being only a very loosely-worded general provision to the effect that the medical officer of health, or the inspector of slaughter-houses, or the inspector of nuisances, may, at all reasonable times, inspect and examine any animal, carcass, meat, poultry, game, flesh, fish, &c., exposed for sale, or deposited in any place for the purpose of sale, or in preparation for sale, or intended for the food of man; and in case it appears to the medical officer of health, or the inspector, to be diseased, or unsound, or unwholesome, or unfit for the food of man, it shall be lawful for him to seize the same, and for a justice to order it to be destroyed. In this regulation there is no particular reference to the kind of food which is unwholesome, or to the circumstances which render it so, and, therefore, much is left to the discretion of the officer who examines it. In the city of London the practice is to condemn the flesh of animals infected with certain parasites, as measles, flukes, &c.; and of animals suffering from fever or acute inflammatory affections, as rinderpest, pleuro-pneumonia, and the fever of parturition, and of animals emaciated by lingering disease, and those which have died from accident or from natural causes, as well as all meat tainted with physic, or in a high state of putrefaction. A little practice is required to distinguish meat of this description, but, generally, it may be said that good meat has the following characters:—

1st. It is neither of a pale pink colour nor of a deep purple tint, for the former is a sign of disease, and the latter indicates that the animal has not been slaughtered, but has died with the blood in it, or has suffered from acute fever.

2nd. It has a marbled appearance from the ramifications of little veins of fat among the muscles.

3rd. It should be firm and elastic to the touch, and should scarcely moisten the fingers—bad meat being wet, and sodden, and flabby, with the fat looking like jelly or wet parchment.

4th. It should have little or no odour, and the odour should not be disagreeable, for diseased meat has a sickly cadaverous smell, and sometimes a smell of physic. This is very discoverable when the meat is chopped up and drenched with warm water.

5th. It should not shrink or waste much in cooking.

6th. It should not run to water or became very wet on standing for a day or so, but should, on the contrary, dry upon the surface.

7th. When dried at a temperature of 212° or thereabout, it should not lose more than from 70 to 74 per cent. of its weight, whereas bad meat will often lose as much as 80 per cent.

Other properties of a more refined character will also serve for the recognition of bad meat, as that the juice of the flesh is alkaline or neutral to test-paper, instead of being distinctly acid; and the muscular fibre when examined under the microscope is found to be sodden, and ill-defined.

The signs of parasitic diseases are not always observable without careful examination. In the case of the fluke in the livers of sheep, and of measles in pork, and of hydatids in the brain or liver, the nature of the disease is at once discoverable, but it is not so with the smaller measles or cysticerci of beef and veal, and it is still less so with the trichina of pork—the microscope being required to reveal their presence.

And here, perhaps, we may ask, *what are the effects of diseased or putrid meat on the human system?* The question is undoubtedly very difficult to answer, for while, on the one hand, we have abundant evidence that such meat may frequently be eaten with impunity, so on the other we have many remarkable instances of injury occasioned by it. In Scotland there is a disease called *braxy*, which attacks the sheep and lambs in spring and early summer. It is the cause of at least half the deaths in the flock during the year. The disease kills the animals very quickly by causing stagnation of blood in the most important vital organs; and as the carcass is the perquisite of the herdsman, he most invariably eats it—taking the precaution to remove the offal, and to cut away the darker portions of the flesh where the blood has stagnated. He also salts it before he uses it; and if questioned on the subject he will tell you that the meat is not unwholesome. Every now and then, however, when perhaps the diseased parts have not been entirely removed, or when the salting has not been sufficiently prolonged, or the cooking has not been thoroughly effected, the most serious consequences result from it, insomuch that many medical practitioners who are acquainted with the habits of the Scotch shepherds in this respect, and have seen the mischief occasioned by the meat, declare that braxy mutton is a highly dangerous food for man. Again, it is a common practice with farm-labourers to eat the flesh of sheep affected with staggers, which is a parasitic disease of the brain; and even of animals dying from acute inflammatory diseases. There is a story told on the authority of Dr. Brücke, the professor of physiology in Vienna, that some years ago, when the *steppe-murrain* was prevalent in Bohemia, and the infected animals were killed and buried by order of the government, the poor people dug up the carcasses of the dead bullocks, and cooked them, and ate them, without injury. In this country also, during the prevalence of *rinderpest* in 1863, enormous quantities of meat from the diseased animals were sent to market, and sold and eaten. The same has been the case with the carcasses of animals suffering acute *pleuro-pneumonia;* and if, as Professor Gamgee says, the practice of making salvage out of diseased animals is so common, that at least one-fifth of the meat which is sold in the public markets is diseased, we may well ask, in the words of Mr. Simon, how it is that some sort of pestilence is not bearing witness to the fact? How it is that cattle having all the foulness of fever in their blood, or having local sores and infiltrations, that yield one of the deadliest of inoculable morbid poisons, or having their flesh thronged with larval parasites, do not when slaughtered and eaten produce a general poisoning? Parent Du Chatelet has commented in very forcible language on the apparent immunity from disease even when the most foul and loathsome of animal foods are eaten. But is it not possible that the danger is averted by the operation of cooking? Not that the human stomach has not also a wonderful protective power in its own natural functions; for the deadly poison of the cobra or the rattle-snake may be swallowed with impunity. It is possible, however, that these safeguards may fail us occasionally, and then it is perhaps that the most serious consequences arise. I have often had to investigate cases of mysterious disease which had undoubtedly been caused by unsound meat. One of these, of more than ordinary interest, occurred in the month of November, 1860. The history of it is this: a fore-quarter of cow-beef was purchased in Newgate Market by a sausage-maker who lived at Kingsland, and who immediately converted it into sausage meat. Sixty-six persons were known to have eaten of that meat, and sixty-four of them were attacked with sickness, diarrhœa, and great prostration of vital powers. One of them died; and at the request of the coroner, I made a searching inquiry into the matter, and I ascertained that the meat was diseased, and that it, and it alone, had been the cause of all the mischief. Dr. Livingstone tells us that when the flesh of animals affected with pleuro-pneumonia is eaten in South Africa, by either natives or Europeans, it invariably produces malignant carbuncle. He says, indeed, that the effects of the poison were often experienced by the missionaries who had eaten the meat, even when the presence of the disease was scarcely perceptible; and in many cases when the Backwains persisted in devouring the flesh of such diseased animals, death was the consequence. The virus, he says, is neither destroyed by boiling nor by roasting, and of this fact he had innumerable instances. Now, it is a remarkable circumstance that ever since the importation of this disease (pleuro-pneumonia) into England from Holland in 1842, the annual number of deaths from carbuncle, phlegmon, and boils, has been gradually increasing. In the five years preceding that time the mortality in England from carbuncle was scarcely 1 in 10,000 of the deaths; from 1842 to 1846 there is no record of the disease; but in the next five years, from 1846 to 1851, the mortality rose to 2·6 per 10,000 of the deaths; and in the next five years it amounted to 6·2 per 10,000; and in the succeeding five years to 5·4. In the case of phlegmons, the increase in the mortality is still more remarkable, for it rose from an average of 2·5 per 10,000 of the deaths in the five years preceding the importation of the disease, to 81 per 10,000 in the ten years from 1847 to 1856. The Registrar-General of Scotland has directed public attention to this fact, saying that deaths from carbuncle are on the increase, and that the mortality from it has been getting larger and larger ever since the lung disease of cattle was imported into Scotland. This accords with the experience of medical practice; but as it is very difficult to trace the immediate connection of bad food with subsequent disease, there being so many circumstances to weaken the connection, it is not surprising that differences of opinion should exist as to the morbific effects of unsound meat; nothing, in short, but an experimental inquiry into the subject, as has already been done in Germany in the case of parasitic diseases, will bring the question to rest; and I see no reason why such an investigation should not be made on the persons of those who send diseased meat to the public market for sale; for, as the common defence of their conduct is, that the meat is good for food, they cannot surely object to the penalty of being made to eat it. Here, for example, is a specimen of pork covered with pustules of small-pox; it was seized by one of the City officers on the road to a notorious sausage-maker, and it may, notwithstanding its disgusting appearance, be good and wholesome food; then why not put the question to the proof by making the vendor of it eat it? In the year 1862, when small-pox was prevalent among the sheep in several parts of England it was a common practice to send the carcasses of diseased animals to the London markets for sale as human food. Later still, in 1863, there was an epidemic of what seemed to be scarlet fever among the pigs of this metropolis, and their carcasses, with all the bright crimson look of the disease, were invariably sent to market for salt as food. Since then the London pigs have been the subject of a virulent spotted fever, of the nature of typhus, and these also have been killed in the last stage of the disease, and sold for food. Abundant illustrations of this kind are constantly coming under my notice; and I feel that the question of the fitness of such meat for food is in such an unsettled state that my action in the matter is often very uncertain, and I should like to have the question experimentally determined; for, as it now stands, we are either condemning large quantities of meat which may be eaten with safety, and are, therefore, confiscating property, and lessening the supply of food, or we are permitting unwholesome meat to pass almost unchallenged in the public markets.

As regards the injurious quality of meat infected with parasitic disease there can, however, be no question; and, perhaps, of all such infections, the most terrible is the *trichina* of pork. Fortunately, it is a rare affection in this country, although it is often common in Germany. The pork infected with the worm is generally darker than usual, on account of the irritating or inflammatory action of the creature lodged in the muscles; and when he parasite is encysted the meat presents a speckled appearance—the minute white cysts containing the worm being just visible to the naked eye. Here are specimens of it in both its encysted and non-encysted conditions; and this diagram represents the appearance of the worm when it is examined under the microscope. It is, as you see, a minute thread-like worm, about the thirtieth of an inch in length, coiled up in a spiral form; hence its name, *trichina spiralis*. It is generally found in the human subject in an encysted state, when it has passed beyond its dangerous condition, and has become harmless. In most cases, when thus discovered, there is no record of its action, and therefore it was once thought to be an innocent visitor; but we now know that while it was free—that is before nature had barricaded it up in the little cyst, its presence was the cause of frightful disorder—killing about 50 per cent. of its victims in terrible agony. In Germany, there have been frequent outbreaks of the disease, which, for a time, baffled the skill of the most experienced physicians; in fact, we hardly know how long or how often the disease has attacked the pork-feeding population of Europe, for its actual nature was unknown until the year 1860, when Dr. Zencker, of Dresden, discovered the pathology of the disease. Since then there have been several visitations of it, as at Plauen, in Saxony, in 1862; at Hettstadt, near Eisleben, in 1863; and at Hedersleben, near Magdeburg, in Prussian Saxony, in 1866. In all these cases the same symptoms, or nearly the same, were observed; there was sometimes immediate disturbance of the digestive functions, but more commonly a day or two elapsed before any particular symptom was noticed, and then there was a feeling of lassitude, with a loss of appetite, and pains in the head and back. Then followed a serious disturbance of the alimentary canal, with vomiting and diarrhœa. This lasted for a day or two; and by the end of a week after the worm had been eaten fever had set in, which became more and more severe, and by that time the young worms which had been hatched in the body had migrated to the distant muscles, causing the most excruciating pains, so that the patient, fearing to move his inflamed muscles, would lie motionless upon his back; and if he did not die in this state of the disorder nature came to the rescue, and imprisoned the creature by surrounding it with a fibrinous cyst, where it lives for years, being ready at any moment to acquire activity when it is swallowed and released from its cell. Indeed, the way in which it becomes dangerous is this—flesh infected with the parasite is eaten; and the cyst being quickly dissolved by the gastric juice, the creature is set free. Finding itself in the midst of nourishing food it rapidly grows, so that in two or three days it is three or four times its original size, and may be easily seen, like a bit of fine thread, with the naked eye. The worms are of different sexes, and they rapidly come to maturity—each female giving birth to from 300 to 500 minute thread-like worms, which immediately set out upon their travels, piercing the walls of the intestines and migrating to distant parts of the body, where they produce the terrible mischief I have described. Although the pig is the animal which is most commonly infested by it, yet it has been found in the muscles of dogs, foxes, badgers, sheep, moles, hedghogs, rats, mice, frogs, and most carnivorous birds, all of which must have been subjects of the disease, but none appear to suffer from it like man; even children are less affected by it, for they seem to sleep it away. Fortunately, there is an easy method of discovering its presence in animals, for the most certain seat of the creature is in the muscles of the eye; we have therefore only to examine these muscles with the microscope to declare whether the meat is infected or not; and, at the present time, the saussage-makers of Germany have the pork examined in this manner before it is used for food.

Other parasitic creatures, as *measles* in pork, and the smaller *cysticerci* of beef and veal, are found as little sacs or bladders diffused through the lean of the meat—the *cysticercus* or *measle* of pork being easily seen, for it is as large as a hemp-seed. Here are specimens of it in a fresh condition, which were seized in the City markets to-day; but the cysticercus of other animals is much smaller, and requires careful exploration to discover it. In both cases the sac contains a little creature with a sort of tuberculated head, crowned with a coronet of hooks, and having a bladder-like tail attached to it. Soon after it is swallowed, the enclosing sac is dissolved by the gastric juice, and the creature being liberated passes into the intestines, and there fixes itself by its little hooks, and quickly grows, joint after joint, into a tape-worm. In the case of the cysticercus of pork, it forms the variety of tape-worm called *tenia solium*, and in that of beef and veal it produces the *tenia mediocanellata*. The latter is the most common variety of it in the human intestines, and it is frequently seen where raw, or nearly raw, meat is made use of, as in Abyssinia and in Russia, where children are allowed to suck a piece of raw beef, on the supposition that it has a strengthening property. Each segment of the worm is an independent creature, containing myriads of ova, and when passed by the bowels, it gets with the manure upon the land and is eaten by pigs, oxen, and goats; the ova are then hatched in the stomach, and they pass, as in the case of the trichinia, through the walls of the intestine, and migrate to the muscular tissues of the body, where they become encysted, and form the little sacs or measles, which remain dormant for years, though they are ever ready to become tape-worms directly they are eaten. In this manner the creature is perpetuated, first as a tape-worm, with joints in the intestines of one animal, and then as a measle or larva in the muscle of another, and then again as a tape-worm. By a like process the *tenia chinococcus*, or little tape-worm of the dog, becomes the *hydatid* in man and other animals. In Iceland the dogs are very liable to this infection, and the cattle and sheep, as well as man, suffer from the hydatid of it. The subject has been well investigated by Dr. Leared, who has shown that the practice of giving the diseased offal of the slaughtered animals to dogs, causes tape-worm, and the dogs drop the segments of the worm, filled with ova, upon the pastures and into running water. By this means they enter the bodies of cattle and sheep, and even of man, and then, as in the last case, the ova quickly become developed, and the young hydatid or larva tape-worm, piercing the walls of the alimentary canal, migrates to distant parts, and finding a suitable nidus for its growth, it slowly becomes a large bladder-like *hydatid*. In the case of the sheep it often selects the brain for its habitat, and produces the disease called *staggers*; in the oxen it grows in the peritoneal cavity; and in man it haunts the liver, occasioning frightful disturbance of the system, and causing one-sixth of the total mortality of that country. Here are specimens of the disease from the human subject.

Again, there is another class of parasite called *trematoda*, or *flukes*, which infest the livers and intestines of men and herbivorous animals. The most common of them is the *distoma hepaticum* or *liver-fluke* of the sheep. In wet seasons the animal is so constantly infested with them, and suffers so much emaciation from them, that the disease is called the rot. You have before you infected livers which were seized in our public markets this very day, and there is no difficulty in obtaining specimens of them at almost any time. A few years ago (1863), when Professor Brown was lecturing on the liability of animals to disease from the present mode of feeding them, he said that once, when he wanted some animals for dissection, and applied for them to a large butcher, he received back five or six animals, which, though in a bad state of rot, were dressed for the market; and he was told by a certain individual not far from London, that within the space of six months he had killed no less than 750 of such animals, in a state of extreme disease, and he believed they were all sent to market and sold for food. What becomes, he says, of the hundreds and thousands of rotten sheep which we see in the fields? To bury them would require whole catacombs; the real catacombs are the intestinal canals of the human body. The way in which the disease is produced in sheep is curious. Ova are passed from the gall-bladder of infected animals into the intestines, and so upon the land; finding a moist situation they are soon hatched into ciliated embryos, which swim about and become developed into cylindrical sacs of minute hydatids; these attach themselves to some mollusc, as a small snail. In wet weather the infected snails crawl upon the grass, and are eaten by the sheep, and then the hydatid speedily changes his condition and becomes a fluke. When it is found in the body of man it has, perhaps, been drunk with water or eaten with some aquatic plant, as water-cress, &c.

Our safety against these intruders is to cook the meat thoroughly.

The flesh of animals that have been excited before death, as by over-driving, or by torture, has frequently proved unwholesome. A remarkable instance of this is quoted by Liebig, in his Letters on Chemistry, where a family of five persons were made seriously ill by the flesh of a roebuck which had been caught in a snare, and had struggled violently before death.

It is, moreover, a curious fact, that meat may be even poisonous from the nature of the food made use of by animals shortly before they are killed; and this, too, without any indication of disorder in the animals themselves. Hares which have fed upon the *Rhododendron chrysanthemum* are frequently poisonous; the same is the case with pheasants in Pennsylvania and Philadelphia, which feed during the winter and spring on the buds of the laurel (*Calmia latifolia*); and I have known many instances of serious mischief from prairie birds, which are now largely imported into this country from America, and I attribute it to the food made use of by the bird. In certain districts of North America, especially on the Alleghany mountains, the flesh of all the cattle is poisonous, and so also is the milk they yield, and the cheese which is made from it. Oysters, mussels, lobsters, and crabs have frequently caused disturbance of the human system; and the probability is that they were made unwholesome by the food which they had eaten. A singular case is recorded in the medical journals of France in 1842, where a whole family at Toulouse were poisoned by a dish of snails, the animals having been gathered from a poisonous shrub (*Coriaria myrtifolia*); and it is not at all uncommon for honey to be unwholesome, on account of its having been collected by bees from poisonous plants. The honey of Trebizond, for example, has long been notorious for its deleterious properties; it poisoned the soldiers of Xenophon during the famous retreat of the ten thousand. Pliny, too, speaks of it; and to this day its intoxicating effect is frequently witnessed. It arises, no doubt, from the plants, chiefly the *Azalea pontica*, from which the honey is gathered. Mr. Barton has given us a similar account of the poisonous quality of the honey gathered by bees from the savannahs of New Jersey, where the *calmia* and *azalea* are the principal flowering shrubs. As with the followers of Xenophon, all who eat of the honey become intoxicated to a high degree; and even when made into metheglin, it poisons all who partake of it, causing dimness of sight, giddiness and then delirium, with sometimes a fatal termination.

Occasionally we have examples of food which is in itself poisonous. This is so with many of the fish of tropical seas, and especially of the West Indies. Dr. Burrows has given us a long list of them; and it would seem that the yellow-billed sprat (the Sardine doré of the French, and *Clupea thryssa* of naturalists), the toad or bladder-fish (*Aplodactylus punctatus* or *Tetraodon* of Cuvier) and the grey-snapper (*Coracinus fuscus major*) are the most venomous; and that being eaten by larger fish, as the *Baracosta*, and various species of perch, as well as the conger-eel, the dolphin, the globe fish, &c., it causes these to be poisonous also. The yellow-billed sprat is so virulent in its action on the human body that both Europeans and negroes have been known to expire with the fish in their mouths unswallowed; and the toad or bladder-fish, is scarcely less dangerous. Sir John Richardson has described the defects of it on two sailors, the boatswain's mate and purser's steward, of the Dutch brig of war, *Postilion*, while lying at anchor in St. Simon's Bay, at the Cape of Good Hope, in September, 1845. The men were warned that the fish was poisonous, but believing that the liver was wholesome, and rather a delicacy, they cooked it, and ate it directly after their twelve o'clock dinner. In ten minutes the boatswain's mate was so ill that he could not stand; his face was flushed, his eyes glistened, his lips were swollen and rather blue, his forehead was covered with a cold perspiration, and his pulse was weak and fluttering. He was, however, quite conscious, and complained of pain and constriction of the throat, and he had a desire to vomit. In a few minutes more he became paralysed, his eyes were fixed, his breathing was laborious, his face was pale though his lips were livid, and in seventeen minutes he was dead. The other man exhibited the same symptoms, and died in twenty minutes. Sir John Richardson says, the fish was not more than six or eight inches in length, and the liver of it, which they had eaten between them, could not have weighed more than half an ounce.

The symptoms occasioned by the poisonous fish of the tropics are always of two kinds—there is either great irritation of the stomach and bowels, like cholera; or there is rapid prostration of the vital powers, and death by syncope or convulsions. These effects have been long known both to natives and Europeans, and were called by the Spanish colonists of tropical America, *Siguatera*. They are more frequently observed at certain seasons of the year than at others, and hence they are thought to be due to certain physiological changes in the body of the fish, or to the food which it has eaten. In some cases the roe, in others the liver, or the digestive organs, are the most poisonous parts of the fish; and in the case of the *Malette venenosa*, which inhabits the Caribbean Sea, it is only poisonous when the sea is covered with a green monad upon which the creature feeds. Happily for us, these dangers are confined to the tropics, although we sometimes suffer from a milder form of disturbance, as irritation of the skin and bowels, from eating unwholesome shell-fish.

Putrid meat is, perhaps, wasteful, rather than actually injurious; but there are plenty of cases in which it has caused disease. Foderé tells us that at the seige of Mantua, those who were shut up in the city, and were obliged to eat the half-putrid flesh of horses, suffered from gangrene and scurvy; and in Czant's history of Greenland there is an account of the death of thirty-two persons at a missionary station called Kangek, from a repast on the putrid brains of a walrus. Similar cases are recorded in all the books on legal medicine. Even game, when only sufficiently tainted to please the palate of the epicure, has caused severe cholera in persons unaccustomed to it; but, as Dr. Christison observes, "the power of habit in reconciling the stomach to the digestion of decayed meat is inconceivable. Some epicures in civilised countries prefer a slight taint even in their beef and mutton; and there are tribes of savages still further advanced in the cultivation of this department of game conomy, who eat with impunity rancid oil, putrid blubber, and stinking offal." The Zulus of Natal, according to Dr. Colenso, are so fond of putrid meat that they call it *ubomi*, which literally means to be superlatively happy. But, as a rule, there is a natural abhorrence of tainted food, insomuch, that with most persons, the mere commencement of decay is sufficient to excite disgust; and rarely do we find, except among savages, that an entire meal is made of putrid flesh. A little game or venison, or ripe cheese, at the end of a feast, with just a piquant touch of decay, is, perhaps, not objectionable; for it may, as Liebig supposes, promote digestion, by communicating its own quality of transformation to the rest of the food; but it is another thing to fill the stomach with putrid flesh, for if the corrective power of the gastric juice should fail, the effect of it might be serious. We have, indeed, abundant evidence of the terrible consequences of admitting putrid matter into the circulation, for they were once too common among those engaged in the dissection of the human body. In fact, the mere handling of decomposing animal matter for any time, will often produce disease of the hands or other parts of the body with which it comes into contact. Our safety, perhaps, in using such food, is in the antiseptic power of good cooking; but this is not always an easy affair; for the tissues are generally so soft from decay, that they will hardly bear the common action of heat; so that if they be boiled for any time they will fall to pieces; and if they be roasted, they will shrink without forming that delicious crust of osmazome which is characteristic of good meat. Let them, however, be cooked as they may, they always require a nice adjustment of rather strong flavours to make them palatable; and those who have dined in the cheap restaurants of Paris, or at the still worse table d'hôte of a German watering-place, will have experienced the art of the cook in this respect, in such dishes as *Turbot en vol-au-vent*, *Raie au beurre noir*, *sole en matelote normande*, and in the various forms of fish *au gratin*; or game *en salmis*.

But bad as this sort of tainted food is, it is nothing in comparison to the sausage poison, which is produced by a sort of modified putrefaction, to which the large sausages of Germany, and especially those of Würtemburg, are occasionally subject. According to an official return, there have been more than 400 cases of poisoning from these sausages in Würtemburg alone during the last fifty years, and of these about 150 were fatal. The effects are generally observed in spring, and mostly in April, when the sausages become musty, and acquire a soft consistence in the interior. They have also a peculiarly nauseous and rather putrid taste, and are very acid to test-paper. If eaten in this condition, they produce dangerous effects in from twelve to twenty-four hours—the first symptoms being pain in the stomach, with vomiting and diarrhœa, and dryness of the nose and mouth; then comes a feeling of profound depression, with coldness of the limbs, weakness and irregularity of the pulse, and frequent fainting. Fatal cases end with convulsions and oppressed breathing between the third and eighth day. The precise cause of these effects is still a mystery; some have thought that rancid fatty acids are produced during the decomposition of the meat; others that in the process of drying and smoking acrid pyrogenous acids have been developed; others, that during the decay of the sausages, a poisonous organic alkaloid is generated. Liebig is of opinion that the effects are due to an animal ferment, which produces in the blood, by catalysis, a state of putridity analogous to its own, and that the molecular movements of the putrefactive change in the decaying meat are thus communicated to the living organism. M. Vanden Corput, who is one of the most recent investigators of the subject, attributes the morbific action of such meat to the presence of a minute fungus, of the nature of a sarcina, which he calls *sarcina botulina*. This view is confirmed by the fact that there is always a peculiar mouldiness of the sausages; and the poisonous property is generally observed in April, when these cryptogamic organisms are most freely developed.

Similar effects have occasionally been produced by other kinds of animal food—as veal, bacon, ham, salt-beef, salt-fish, cheese, &c., and the food has usually been in a decayed and mouldy condition. It would be tedious if I were to detail, or even to enumerate the cases recorded by medico-legal writers; but I may, perhaps, refer to a few of them. In 1839, there was a popular fête at Zurich, and about 600 persons partook of a repast of cold roast veal and ham. In a few hours most of them were suffering from pain in the stomach, with vomiting and diarrhœa; and before a week had elapsed, nearly all of them were seriously ill in bed. They complained of shivering, giddiness, headache, and burning fever. In a few cases there was delirium; and when they terminated fatally, there was extreme prostration of the vital powers. Careful inquiry was instituted into the matter, and the only discoverable cause of the mischief was incipient putrefaction and slight mouldiness of the meat. Dr. Geiseler relates an instance where a family of eight persons were made ill by musty bacon; and M. Ollivier has given an account of six persons who were poisoned by mutton in a state of modified decay—four of whom died from it within eight days. In Russia, where it is the practice to eat largely of salt-fish, in a raw condition, it is not at all uncommon to witness the dangerous effects of it, when it has become mouldy or putrid; and, in fact, it is within the experience of every one who is concerned in medico-legal inquiries, that serious symptoms are frequently traced to the use of food in a modified condition of decay. This is especially so with bad cheese, the effects of which on the constitution have been so severe, that official investigations have been called for. These effects have been noticed at Schwerin (1823), at Minden (1825), at Hameln (1826), at Griefswald (1827), Frankfort (1828), and elsewhere; and they have been the subjects of interesting essays by Henneman, Hünefeld, Westrumb, and others. At first the effects were attributed to the copper vessels used in the dairies, and therefore the Austrian, Wirtemberg, and Ratesberg States prohibited the use of that metal for such purposes; but the subsequent inquiries of Hünefeld, Sertürner, and other chemists, established the fact that no metallic poison was discoverable in the cheese. In the police report, which was published in Frankfort, in January, 1828, informing the public of numerous cases of poisoning in that city from spoiled cheese, it was declared that no poisonous principle could be detected by chemical re-agents. Professor Hünefeld, and, subsequently, Sertürner, were of opinion that the effects were due to certain poisonous fatty acids, analogous to, if not identical with, caseic and sebacic acids; and they even describe the way in which they are produced in the cheese during the process of ripening—attributing them to the imperfect removal of the acid liquor from the curd when the cheese was made, or to the putrefaction of the curd before it was salted, or to the mixture of flour with the curd; but it is far more likely that the poisonous effects are due, as Vanden Corput supposes, to the presence of a peculiar mould or fungus. I have myself seen the most terrible consequences from the use of such cheese, and have failed to discover anything unusual in the acidity or other chemical reactions of the cheese. Hünefeld says, it is commonly of a yellowish-red colour, and is soft and tough, with harder and darker lumps interspersed throughout it, and it has a disagreeable taste, and an acid reaction. The symptoms which it produces are very much like those of sausage poisoning—namely, irritation of the stomach and bowels, with great prostration of the vital powers. These effects have been witnessed not only in Germany, where the cheese is generally rancid and bad, but also in this country, and particularly among the small hill-farms of Cheshire, where the limited extent of the dairies obliges the farmer to keep the curd for several days before a sufficient quantity of it is accumulated to make a large cheese.

I have said nothing of the improper practice of killing very young animals, especially calves, for food, before the tissues have had time to change from their uterine condition. On the Continent it is unlawful to kill or to sell calves for food, that are not more than fourteen days old, but in this country there is no such restriction, and it is a common practice to dispose of the carcasses of newly-born, or even fœtal calves to the sausage-maker; and as the flesh is sodden and insipid, he strengthens it with old, tough, and sinewy flesh. It has the advantage, moreover, of being miscible with any description of meat, and of taking any variety of flavour; in fact, it makes just that kind of sausage which is susceptible of any kind of flavour, and where, to use the expression of Dickens, "It's the seasonen as does it." I cannot say that such meat is positively unwholesome, but it is nasty, and excites the same sort of disgust as an egg with a chick in it.

As regards vegetable foods, they are not so liable to decay or even to parasitic infection, as animal foods; for the *acori* or *mites* of flour and sugar, or even the *weevels* of biscuit are harmless; indeed, the most important infection of grain is the fungoid disease of it, called *ergot*. This is the *muttercorn* or *roggenmutter* of the Germans, and as it chiefly infests the rye, it is named, from its appearance, *spurred rye;* but it also attacks barley, oats, wheat, maize, rice, and most of the grasses. It always appears as a black grain, of a larger size than usual, and it is mostly found in plants which grow upon moist clay soils, in damp situations, especially in the neighbourhood of forests. The district of Sologne, in France, between the rivers Loire and Cher, was once notoriously infested with the disease, and the Abbé Fessier, who was deputed in 1777 to investigate the causes of the extraordinary prevalence of ergot in that district, attributed it to the poorness and wetness of the land, and to the dampness of the air from the numerous forests. In bad seasons, as much as a third or a fourth of the crop was infected with ergot, and even in good seasons it constituted about two per cent of it. The disease in the grain is due to the growth of a peculiar fungus, which the late Mr. Queckett named *ergotetia abortifaciens;* and the effects of it on the human body are very serious. It acts chiefly on the nervous system, causing giddiness, dimness of sight, loss of feeling, and twitching of the limbs, and death by convulsions; or it produces a creeping sensation over the surface of the body, with coldness of the extremities, followed by insensibility and gangrene. These effects are no doubt referred to by Ligebert in his "History of Gaul and France," when he says that the year 1089 was a pestilent year, especially in the western parts of Lorraine, for many persons became putrid in consequence of their inward parts being consumed by St. Anthony's fire. Their limbs were rotten, and became black like coal, and they either perished miserably, or, being deprived of their putrid hands and feet, were reserved for a more miserable life. Bayle, too, in his account of this sickness, says that the bread was of a deep violet colour. The like effects have been observed in other parts of the Continent, as in Silesia, Prussia, Bohemia, Saxony, Holstein, Denmark, Switzerland, Lombardy, and Sweden, where the creeping sickness, as it is called, has attacked whole districts of the country, sparing neither old nor young, rich nor poor.

The remedy for the disease is in the hands of the miller, who should separate the ergotised from the healthy grains. Fortunately we have a ready test for its presence, not merely in the miscropic appearances of the flour, but in the circumstance that as it is the lightest of all the constituents of flour, it will float upon a mixture of one part of chloroform and six of alcohol, and will appear as a scum of dark-brown particles.

Another source of danger is the presence of poisonous grasses in the flour. The most important of these is darnel (*lolium temulentum*), which the careless or slovenly farmer will sometimes permit to overrun his fields, and the seeds becoming mixed with the corn, are ground into flour by the equally careless miller. The effect of the grains on man is to cause a species of intoxication, with headache, giddiness, somnolency, delirium, convulsions, paralysis, and even death. Occasionally it excites vomiting, with irritation of the alimentary canal, and then its effects are not so serious. Many instances are recorded of the poisonous action of the flour. Christison, for example, tells us, that a few years ago almost all the inmates of the poor-house at Sheffield, to the number of 80, were attacked with analogous symptoms, after breakfasting on oatmeal porridge, and it was supposed that the effects were caused by the presence of darnel in the oatmeal. A similar accident is mentioned by Perleb, as having occurred at the House of Correction at Freyburg, and still more recently the same effects were produced on 74 persons at the workhouse of Beninghausen. Dr. Taylor states, on the authority of Dr. Kingsley, of Roscrea, that in the month of January, 1854, several families, including about 30 persons, suffered severely from the effects of bread containing the flour of darnel seeds. Those who partook of the bread staggered about as if they were intoxicated, and although they all recovered, yet they experienced a good deal of distress from giddiness, coldness of the limbs, and great prostration of vital power.

Unripe grain, as well as grain affected with the *rust*, and *mouldy flour* and *mouldy bread*, have also produced disturbance of the human system. M. Bovier attributed the epidemic of dysentery, which occurred in the department of the Oise, in the autumn of 1793, to the use of *unripe grain;* and corn affected with *brown* or *black rust* is thought by many to be unwholesome. *Mouldy flour* or *mouldy bread* is certainly injurious, for several instances are on record where not only men, but horses, have been poisoned by mouldy bread; and M. Payen has given a graphic account of the distressing effects of the mouldy ammunition bread supplied to the troops who were encamped near Paris, in 1843; the mould on that occasion was a yellow fungus, the *oidium aurantiacum*, but at other times is has been of a green colour, from *pennicillum glaucum*.

Mouldy food of every description is dangerous to use, and considering to what an extent the *spores* or *sporidia* of poisonous fungi are floating in the atmosphere, it is surprising that they do not more frequently taint our food and cause disorder of the system, for air washed with distilled water will always yield abundance of these germs, which are ready at any moment to spring into activity when they come into contact with a proper nidus for their growth. A remedy for these hidden sources of danger is good and effective cooking.

And now, in conclusion, let me make a few remarks on the subject of the *fraudulent sophistications of food*—a subject which has been very popular for the last fifty years, or rather, I should say, since the year 1820, when Mr. Frederick Accum published his treatise on "Adulterations of Food, and Culinary Poisons," with the startling motto from the Book of Kings—"There is death in the pot." As you may easily imagine, such a terrible announcement by a well-known writer, could not fail to excite alarm in the public mind, and to provoke anxious curiosity. The book, therefore was eagerly sought for and a thousand copies of it were sold within a month of its publication; so that, to use the words of the author in his advertisement to the second edition—"there was sufficient inducement to reprint the work." The singular success of Accum's undertaking has been such a temptation to others, that the press has literally groaned with the efforts of sensational writers on this subject. And although I am ready to admit the importance of it, yet I am bound to state that it has often been grossly exaggerated, especially by those who have had but little practical knowledge to guide them.

The objects of fraudulent adulterations of food are three-fold:—

1. To increase the bulk or weight of the article.
2. To improve its appearance.
3. To give it a false strength.

Among the first of these adulterations are the follow-ng:—

(a) The addition of *inferior starches*, as potato-starch r English arrow-root, curcuma or East Indian arrow-oot, jatropha or Brazillian arrow-root, tacca or Tahiti rrow-root, canna or Tous-les-mois starch, sago-meal, c., *to true maranta, or West Indian arrow-root*—of which ermuda arrow-root is the most esteemed variety. A icroscopic examination of the starch or fæcula will ways discover the fraud.

(b) The mixture of *starch-sugar* or even *starch* itself *to mmon cane-sugar.* Starch-sugar, or as it is sometimes lled, grape-sugar, or glucose, is manufactured both in is country and on the Continent to a considerable tent. It is made fr[illegible] any description of starch, by oiling it for half-an-[illegible]r or so in water containing out one per cent. of s[illegible]huric acid. The acid is then utralised with chalk, [illegible] the liquor evaporated to a nsity of 1·28. While [illegible], it is run off clear from the soluble precipitate of su[illegible]hate of lime, and on standing a cool place for a few days it crystallizes or sets into solid mass. This description of sugar has a low veetening power—not half so great as that of cane-gar—in fact it is produced from the latter by the action vegetable acids and heat, when cane-sugar is added fruit in making a tart or fruit pie, and in making llies and jams. It is false economy, therefore, to veeten to any extent before the tart is baked. The gar is known by many characters, as a want of sparkle om the absence of well-formed crystals; its less solu-lity in water, and greater solubility in alcohol; and by giving a deep port-wine tint to a solution of potash, hen it is boiled with it.

(c) The dilution of *milk*, *vinegar*, &c., with *water.* his fraud is easily detected by the specific gravity of e liquid, and in the case of milk by the proportion of eam in the lactometer, and by the poor appearance of e milk when under the microscope.

(d) The mixture of *dripping* and *other fats* with *butter*, d *water* and *starchy* matter with *lard*. Butter and rd should always furnish, when melted, a clear-looking l, with but little deposit of water or other substance.

The addition of *gelatine* to *isinglass*, which is some-mes so well managed that it requires a skilful analysis detect it. Isinglass is an organised substance, and hen examined with the microscope, exhibits a peculiar ructure which is very characteristic of it; not so, how-er, with gelatine. A particle of isinglass put into ld water remains opaque, like a piece of white bread, d does not swell out; whereas gelatine becomes ansparent, and enlarges a good deal in bulk. Jelly ade from good isinglass has a slightly fishy smell, and neutral to test-paper, but that from gelatine has a stinct odour of glue, and an acid reaction. Lastly, if a w grains of isinglass be burnt in a metal spoon until e ash alone remains—the ash will be very small in antity, and of a reddish colour, while that of gelatine ill be much larger in amount, and of a white appear-ce. Gelatine never agrees with the delicate stomach an invalid like isinglass; and, therefore, it is often portant to discover the difference.

(f) *Coffee* adulterated with *chicory* is readily detected sprinkling the mixture upon water, when the coffee, hich is slightly greasy from volatile and fixed oil, floats hile the chicory sinks, and gives a brownish tint to the ater. The experiment is easily made, as you here see, a tumbler of water, and you may, with a little tact, termine the proportions of the mixture.

(g) *Wheaten flour* is frequently added to *flour of ustard*, and when the quantity passes beyond a certain nount, it is undoubtedly an adulteration, for the inten-on of it should be only to reduce to an agreeable extent e pungency of the mustard.

Of the second class of adulterations, where the object to *improve the appearance of the article*, there are many amples, as:—

(a) The addition of *alum* to *bread*, by which, as I have ready explained, inferior, and even damaged, flour may be made into a tolerable looking loaf. It is the property of alum to make the gluten tough, and to prevent its discolouration by heat, as well as to check the action of the yeast, or ferment upon it. When, therefore, it is added to good flour, it enables it to hold more water, and so to yield a larger number of loaves; while the addi-tion of it to bad flour prevents the softening and dis-integrating effect of the yeast on the poor and inferior gluten, and so enables it to bear the action of heat in the process of baking. According to the quality of the flour will be the proportion of alum, and hence the amount will range from 2 oz. to 8 oz. per sack of flour. These proportions will yield from 9 to 37 grains of alum in the quartern loaf, quantities which are easily detected by chemical means. Indeed, there is a simple test by which much smaller quantities of it may be readily dis-covered. Infusion of logwood, as you here perceive, acquires a rich purplish carmine, or claret tint, when it is brought into contact with alum; you have, therefore, only to dip a slice of the bread for an instant, as I am now doing, into a weak, watery solution of logwood, and if alum be present the bread will speedily acquire a purple, or reddish purple, tint. I have already described to you the other properties of good bread, as that it should not exhibit any black specks upon the upper crust; it should not become sodden and wet at the lower part by standing; it should not become mouldy by keeping in a moderately dry place; it should be sweet and agree-able to both taste and smell; it should not give, when steeped in water, a ropy acid liquor; and a slice of it taken from the centre of the loaf should not lose more than 45 per cent. by drying.

Sulphate of copper is found to act like alum in improv-ing the appearance of bread; and, according to Kuhl-mann, Chevallier, and others, it is commonly used by the bakers of the Continent, notwithstanding the severe penalties attached to it. In this country, however, it is but rarely employed.

(b) *The bloom, or glaze, or facing*, of green and black tea is generally artificial. In the case of green tea, it is ordinarily a mixture of Prussian blue, turmeric, and sul-phate of lime, or China clay; and in that of black tea it is not unfrequently a coating of black-lead. The tea prepared for the English market is notoriously subject to these adulterations; and it seems that it arises entirely from our own fancy, and not from any desire on the part of the Chinese to pursue such a practice. The adultera-tion is easily discovered by shaking the tea with cold water, and then straining through muslin, and allowing the fine powder to subside.

(c) *Pickles* and *preserved fruits* are often made green with a salt of copper, it being the peculiar property of that metal to mordant, or fix in an insoluble form, the green colouring matter or *chlorophyll* of vegetables. If, therefore, the pickling operation is conducted in copper vessels, or if a little verdigris or sulphate of copper is added to the vinegar in which the vegetables are boiled, the colour of them will be retained. In some cases the quantity added has been so large as to give a coppery look to a steel fork or knife plunged into the pickle. In such cases, as might be expected, severe symptoms of poisoning have been occasioned by it.

(d) *Ferruginous earths*, or *red oxide of iron*, is fre-quently added to sauces, to anchovies, to cocoa prepara-tions, and to preserved or potted meats, to improve their appearance.

(e) *Mineral pigments*, often of a poisonous nature, are used in colouring confectionary.

And lastly, with the view of giving a *false strength to the article*, we have instances of *sulphuric acid* added to *vinegar*, *black-jack* or burnt sugar to *coffee* and *chicory*, *catechu* or *terra japonica* to *tea*, *cocculus indicus* to *beer*, *cayenne* to *peppers*, &c.

That many of these sophistications are dangerous there can be no doubt, and all of them are frauds on the public. Parliament has therefore attempted to deal with the matter by legislation, as in the "Act for Preventing the Adulteration of Articles of Food or Drink" (23rd and

24th Vict., cap. 84) of 1860; but as the act is only permissive, little or no effect has been given to it. Even in those places, as in the City of London, where it has been put into operation, and public analysts have been appointed, no good has resulted from it; in fact, it stands upon the statute-book as a dead letter. Speaking for the City, I may say that every inducement has been offered for the effective working of the act, but nothing has come of it. In olden time the remedies for such misdemeanours were quick and effectual. In the *Assisa panis*, for example, as set forth in *Liber albus*, there are not only the strictest regulations concerning the manner in which the business of the baker is to be conducted, but there are also the penalties for failing in the same. "If any default," it says, "shall be found in the bread of a baker in the City, the first time let him be drawn upon a hurdle from the Guildhall to his own house through the great streets where there be most people assembled, and through the great streets which are most dirty, with the faulty loaf hanging from his neck; if a second time he shall be found committing the same offence, let him be drawn from the Guildhall through the great street of Cheepe, in manner aforesaid, to the pillory, and let him be put upon the pillory, and remain there at least one hour in the day; and the third time that such default shall be found, he shall be drawn, and the oven shall be pulled down, and the baker made to forswear the trade within the City for ever." It further tells us that William de Stratford suffered this punishment for selling bread of short weight, and John de Strode for making bread of filth and cobwebs. One hoary-headed offender was excused the hurdle on account of his age and the severity of the season; and it would seem that the last time the punishment was inflicted was in the sixteenth year of the reign of Henry VI., when Simon Frensshe was so drawn. A like punishment was awarded to butchers and vintners for fraudulent dealings; for we are told that a butcher was paraded through the streets with his face to the horse's tail, for selling measly bacon at market, and that the next day he was set in the pillory with two great pieces of his measly bacon over his head, and a writing which set forth his crimes. In the judgments recorded in *Liber albus* there are twenty-three cases in which the pillory or the thew were awarded for selling putrid meat, fish, or poultry; thirteen for unlawful dealings of bakers, and six for the misdemeanours of vintners and wine-drawers. Of a verity we have degenerated in these matters.

And now, in conclusion, having directed your attention to the nutritive values of different kinds of food; to their functional and dietetical powers; to the modes in which they are associated; to the quantities required for ordinary labour; to the manner in which they are digested; to the effects of culinary and other treatment; to the way in which they may be preserved; and to the causes of their unwholesomeness, we may finally ask if any great generalisations can be deduced from our inquiries?

In the first place, you will, I think, have observed that there are very striking evidences of design in the way in which organic matter is constantly kept in motion, for, whether living or dead, it is always in a state of molecular activity—either advancing towards the highest state of organisation, or retreating to the confines of the mineral kingdom. The result of this is that, with a comparatively small amount of material, and with but little expenditure of force, the work of the living world is fully and effectively performed. Starting from the mineral kingdom, as carbonic acid, water and ammonia, the elements of organic nature pass through a succession of changes, first in the vegetable and next in the animal, until they reach the summit of organization, when they again return to their primitive condition. In this manner a never-ending round of change is perpetuated, and the same material and the same force are kept moving in the same continuous circle. Through the efforts of the plant the crude materials are formed into vegetable acids, sugar, gum, starch, fat, albumen, and tissue; and then the animal converts them into higher forms of structure, as gelatine, muscle, and brain; the two extremes, therefore, of these changes are, to use the words of Gerhardt, carbonic acid, water, and ammonia at one end; albu[illegible]n, gelatine, fat, and cerebral matter at the other—[illegible] the transitions to these extremes are countless, and ar[illegible]s yet beyond the reach of science. Broadly, howe[illegible]we may say that the chemical functions of the p[illegible]e those of reduction or deoxydation, whereby ca[illegible] acid and water are deprived of their oxygen [illegible]oulded with nitrogen into food; while those o[illegible]ls are of an opposite nature, for they destroy t[illegible] by oxydation. The plant, therefore, is the m[illegible]e or medium whereby carbonic acid, water, and ammonia, are converted into new compounds, and light and heat are transformed into chemical affinity; and the animal is the medium or machine whereby these compounds are destroyed, and their affinities changed into other manifestations of force, and finally into heat. In this way, the circuit of change is completed; and it is not difficult to trace the phenomena of vitality to the cosmical forces which the plant had imprisoned. But shall we ever be able to follow, through all the intricacies of change, the countless transitions of both matter and force in their passage from the mineral kingdom to the animal, and then back to the mineral again? It is easy to connect, by a correlation of force, the muscular movements of the animal body, and even the highest efforts of the human mind, with the sunbeam which the plant had arrested; but shall we ever be permitted to unravel those mysterious functions, those intermediate changes which constitute the phenomena of life? Why is it, for example, and how comes it, that the living cell of the plant is able to aggregate mineral matter in opposition to the common laws of affinity, and can transform light and heat into cell-force? How is it, too, that the animal, in reversing the process, and so restoring the play of affinity, is able to transmute it into other manifestations of force? At present, the utmost we can say of it is, that organic matter is the appointed medium of all these changes, and is designed for the exhibition of vital phenomena, just as mineral matter is the appointed medium for the phenomena of electricity and magnetism; and yet to some extent, perhaps, we are able to penetrate the mystery; for by finding the clue to the peculiar action of the vegetable in reducing chemical compounds, we can, by operating on such substances as carbonic acid, water, and ammonia, produce a large number of organic principles; in fact, of the three great classes of alimentary substances, to which I have so frequently directed your attention—namely, the oleaginous, the saccharine, and the albuminous—it may be said that the first is already within the manufacturing power of the chemist, and the second is nearly within it; so that there is abundant proof that the agency of a vital force is not necessary to the formation of organic compounds; and there is even hope that the fabrication of food may not be altogether beyond the capabilities of man.

LONDON: W. TROUNCE, PRINTER, CURSITOR-STREET, CHANCERY-LANE.