With E. Lankester's Compliments

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REPORT OF LECTURES

ON THE

NATURAL HISTORY OF PLANTS YIELDING FOOD;

WITH INCIDENTAL

REMARKS ON THE FUNCTIONS AND DISORDERS

OF THE

DIGESTIVE ORGANS.

DELIVERED BY

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E. L.

19, Golden Square,
February, 1845.

LECTURES

ON THE

NATURAL HISTORY OF PLANTS YIELDING FOOD, &c. &c.

LECTURE I.

INTRODUCTION—MEDICINAL SECRETIONS—THEIN—TEA—CAFFEIN COFFEE—CHOCOLATE—PARAGUAY TEA.

Dr. Lankester commenced by some general observations on the three kingdoms of nature, the mineral, vegetable, and animal kingdoms; the first being also known as the inorganic, the two latter as the organic kingdoms. He illustrated the converging or diverging character of these kingdoms, by a diagram, representing three cones, the apex of each in contact with the others, and the base forming the circumference of a broken circle. Placing the higher parts of the scale of each kingdom in the base of the cone, he said that—supposing the types of the three highest to be a metal, an oak tree, and man—there would be no difficulty in distinguishing one kingdom from the other; but at the apex of each, where the lowest types of each were almost in contact with the others, it was exceedingly difficult to distinguish them. In a drop of water at any season of the year might be seen a number of little particles, which a botanist would declare were not vegetable, a zoologist would deny to be animal, and a chemist would say were not inorganic particles. Some of these might perhaps range amongst the lowest forms of cryptogamic plants; others amongst the small infusory animalcules; but at this point the three kingdoms seemed to meet. After adverting to the differences in the secretions of animals and plants, Dr. Lankester said his present object would be to point out the various secretions of plants which animals constantly consume, and which they elaborate in parts of their own system. There were only a few secretions, and these common to all plants, which were important to the animal kingdom. They might be divided into two great classes,—those possessing carbon as their basis, and those possessing nitrogen. To these were added hydrogen and oxygen; but these were common elements in all kinds of secretions of plants, and it was the carbon and the nitrogen which distinguished them. Belonging to the group called carbonaceous secretions are sugar, oil, starch, and alcohol, which last was a conversion of sugar by fermentation. These formed a large proportion of the food of man and other animals. The other group, called nitrogenous secretions, consisted only of one principle, named *protein*, though appearing in different forms, and then named *gluten*, *albumen*, *casein*, &c. It was, however, the same thing, in all its different forms, in the vegetable kingdom. There were some secretions, subsidiary to these; but they were not apparently essential to animal life. Men and animals could do without them for a long time; but still they constantly partook of them. Such were acids, and acid food seemed necessary under certain circumstances. The common form of taking it was that of acetic acid or vinegar; but various fruits were used, containing acids of different kinds, as citric, malic, and sometimes even oxalic acid, as in sorrel, rhubarb, &c.

There was another class of secretions not necessary to life, but which was largely consumed,—the alkaloids, which were characterised by possessing a small portion of nitrogen, and having the same general character as potash, soda, &c. He would first notice this class of vegetable secretions, which were generally taken in the form of infusions. Such were tea, coffee, cocoa, or chocolate, and other things used as substitutes. The most common of these, in consumption as an article of diet, in a state of infusion, is tea. The tea plant has been known in the East, apparently from time immemorial; at least it was known in China between the second and fifth centuries, though whether previously used we could not ascertain; but the Chinese books going back to that period contain frequent allusions to its cultivation there, and to its use, not however as an article of common diet, but as medicine. In the sixth or seventh century, an emperor of China, being dangerously ill, was cured by taking an infusion of tea; and this cure led at once to the extensive use of tea amongst his subjects; for the Chinese consider what is good for the sovereign to be good also for his subjects. Tea, therefore, became fashionable in China, and was cultivated at the expense of almost every thing else; and in the eighth century it began to be exported. Then its cultivation was commenced in Java, whence Europe obtained its first knowledge of tea. The Dutch, in 1610, brought the first tea ever seen in Europe from thence to Amsterdam; from that period tea was rapidly imported into Europe, and as extensively used as in China and the East.

But although tea seems to have been first consumed in China, it does not appear that it was indigenous only to China. It had long been supposed by botanists, from the character of the districts in which tea grew in China, that it might probably be found indigenous to our own East India possessions. Ten years since, the East India Company sent out an expedition to the northern parts of India, to ascertain if any part of those dominions contained the plant; and they found, on reaching Assam, a considerable quantity of tea growing there, which was supposed to have all the characteristics of the common tea plant of China. But since this tea has been imported into this country, and the plant has been sent over here, there has been considerable doubt in the minds of botanists as to whether the Assam is not a different species from the Chinese tea plant. This was a very important subject, and one which involved considerable commercial speculations at the present day.

Here the lecturer introduced the divisions of the whole vegetable world into the three great divisions of *Exogens* (of which the oak might be named as a type), *Endogens* (the cocoa), and *Acrogens* (the mushroom). Of exogenous plants the tissues were vascular, the veins of the leaf netted (as in that of rhubarb), and the flowers were quinary, or formed of five parts. Thus (as in a living plant on the table) there were five petals; the calyx had five parts, and the stamens, if under twenty, were either five, or a multiple of five. Endogenous plants had the veins of the leaves parallel (as in the onion, lily, tulip, spiderwort, cocoa-nut tree, sugar cane, &c.). Their flowers were all formed on the number three; three petals, three parts of the calyx, three stamens, &c. The acrogens, or lowest group of plants, were characterised by not possessing any flowers; and, indeed, were best distinguished by their negative characters of possessing no leaves or no flowers. He exhibited a drawing of the tree-fern, having its stem developed in the form of leaves, but having really no leaves. This group, however, afforded but a small quantity of matters for food to animals.

These three great classes were divided, especially the two first, into a great number of orders. The tea plant belonged to the natural order *Ternstromiaceæ*. The lecturer said he had no tea plant; but he showed some plants belonging to the same natural order, viz.: *Camellia sasangua*, &c., which had netted leaves, the exogenous form of wood, and the other characteristic, of that class. The genus of the tea plant was called *Thea*, the species *chinensis*; and by a magnified coloured drawing it was seen to possess five petals, five parts of the calyx, and the stamens numbering a multiple of five. The leaves (the part of the plant consumed in infusion) were slightly serrated and strongly veined, much more so than in the *Camellia*. There were two plants brought into Great Britain (and Europe) from China, having considerable difference; one, which was supposed to yield the black tea, was called *Thea Bohea*; and the other, the green tea, *T viridis*: but they were in fact only modifications of the same plant, just as ripston pippins and russets differed in apples. Assam tea had some characteristics entirely inconsistent with either the black or the green tea of China. If it were a differeut species, its secretions might be entirely different, and this might account for the want of that agreeable flavour or odour which was supposed to distinguish the Chinese tea. He had specimens on the table of black and green Assam tea; and he understood from some tea-drinkers that it was really much superior to the Chinese tea: but some tea-tasters objected to it; and, if such objection was confirmed, we should have to give up our cultivation of Assam tea. Another objection urged to its becoming an article of considerable consumption in this country was that the carriage throughout India is exceedingly expensive, and thus the price was considerably enhanced; so that the tea was not brought into the market for anything like the price of the same kind of tea from China. Within a recent period, however, large quantities of the Chinese tea plants had been carried to a district in the

Himalaya, and planted there, and it was found that that district was exceedingly favourable to their growth; and there were now in London considerable quantities of Himalayan tea, prepared from the Chinese species planted there, and having all the characteristics of the finest Chinese tea. In China the plant was cultivated to a very considerable extent. It was planted out from cuttings, or sown from seed; and at the end of three or four years from the growth of the plant, the preparation for exportation commences. The first process is picking off the leaves; in the course of the year there are four or five pickings; and upon the time at which the leaf is picked, depends the quality of the tea obtained from it. Of course the smaller kinds are prepared from the younger leaves; and, as the produce is much less at that time, those kinds of tea are much more expensive. There are two ways of preparing the tea after the leaves are picked, which constitute the real difference between black and green tea; for the same leaves would produce either black or green tea; but the black teas being prepared throughout the large district of Bohea, and no green teas prepared there—hence arose the opinion that the teas were of different species. For the purpose of making green tea, the leaves, immediately after picking, are exposed to a dry heat; they are cast into large pans, heated to a certain temperature; the pans are shaken well up; the tea is then thrown out of the pans warm, and persons are employed to roll it with their hands, and give it the peculiar curled form which distinguishes green tea. It is then thrown back again; and after having undergone that process several times, it then becomes green tea.

Many other processes in the preparation of tea he had not time to describe, but which were requisite before it was brought into the market; and these were conducted generally by women and children. The black tea is prepared in the wet way, being thrown into vessels which receive from beneath a considerable quantity of steam, which mixes with the sap of the plant, and, when it is supposed to be saturated with the moisture, it is taken out, rolled, and thrown into dry pans, and thus it becomes black tea. This was a mere outline of the process. Young Hyson was that form of green tea obtained at the first picking; Gunpowder was from the second picking; the third picking was called Hyson; and the fourth, Hyson-skin, of which very little was to be found in London. The fifth picking was called Twankay, the cheapest green tea; so that the price was just in accordance with the earliness or lateness of the picking; the younger leaves, when there is less produce, costing more. It was just the same with black tea: the first picking was called Pekoe; the second, Souchong; the third, Congou; and the fourth, Bohea. But these teas were seldom obtained pure; a system of mixing them was carried on in the London market, and every tradesman had his own peculiar teas; so that it was almost impossible to get pure specimens, unless by having recourse to persons coming from China, who can identify the product in this country. As to the chemical analysis of these leaves, now so extensively used in infusion, their great constituents, to which he would draw attention, as having anything to do with the effects of tea upon the system, were, 1st, volatile oil, which was a narcotic; 2d, a very common constituent of vegetable substances called *tannin*; and, 3d, an alkaloid called *thein*, a substance of a white crystalline texture, closely resembling quinine. *Thein* was the most remarkable secretion contained in these leaves; and the uses of tea depended upon these secretions. At first sight we might be led to suppose, that a little volatile oil, a little tannin, and so very small a proportion of alkaline matter as tea contains, could hardly have sufficient constituents to induce so large a proportion of the civilised world to drink it. But mankind was more led by instinct, in partaking of this beverage, than by habit or custom. Very few who taste it will give it up. The hard-working man, drinking large quantities of beer, will find a relief in tea which he did not find before; and, though he may still take his beer, he will not give up his tea. This is why, ever since this plant was introduced, it has been gradually gaining ground, and every year we saw an increase in the cultivation of the tea-plant, and in the use of tea. How, then, does this beverage act upon the stomach? Why should it be so extensively consumed? In the volatile oil we have something like a reason. It acts as a narcotic, and man requires narcotics under certain circumstances. We know that in China and Turkey they consume immense quantities of opium; in America and other parts of the world, they take *coca* (a species of Erythroxylon), and various other plants were consumed for the purpose of producing narcotism. Almost all medicines which act as narcotics, act first as stimulants; and thus, in an exhausted state of the nervous system, tea acts as a refreshing stimulant, and subsequently produces that kind of repose of the nervous system, which is so much needed, especially by the studious, in our artificial state of society. This volatile oil does not produce sleep, as other narcotics, as, for instance, opium, hemlock, henbane, &c. but produces rather a nervous rest or repose. The *tannin* is hardly worth being alluded to, as constituting a reason why the plant should be used; yet still it acts as a tonic on the stomach, and may thus combine with other beneficial effects. But we come to this alkaloid *thein*, which is a composition very similar to *quinine*; which last is the produce of a plant called *cinchona*, remarkable for its remedial effects in intermittent and remittent fevers. Might not *thein* have something like that action on the exhausted system, which *quinine* had in disease?

There were two theories advanced to explain the action of this principle. Liebig has found a principle in the bile called *taurin*, which is formed from the waste tissues of the body carried into the blood, and this *taurin* is necessary for the production of carbonic acid gas; or rather to get rid of the carbonaceous matter in the system, in the form of carbonic acid gas. This *taurin* must constantly be formed, otherwise the heat of the body could not be maintained, the carbonaceous matter was not got rid of, and disease was engendered. If persons had not food enough, or if the digestive organs did not enable them to carry a sufficient quantity of nutriment to the system, the tissues of the body were consumed to make this *taurin*. Liebig found that this *thein* had a composition identical with *taurin*, or so nearly so as to render it a sufficient substitute for *taurin*; and thus, by the use of *thein*, we are actually preventing the waste of the body, and so maintaining health at less expense than we could by taking more solid food. It was persons who could not consume large quantities of food to give in to the blood the quantity of carbon necessary for generating animal heat that have recourse to tea, and find that tea actually is a nutritious article of food; and it is only, says Liebig, by such means as this, that it can act as a nutritious agent. But another theory had lately been advanced by his ingenious friend, Dr. Playfair. He says *thein* is a composition very similar to the nervous matter. Now, seeing that every operation of mind must be attended with a loss of nervous matter, there is necessity for a supply of that nervous matter to enable the mind to carry on its operations. A considerable quantity of proteinaceous matter would be required to be taken in, to supply the nervous matter with proper constituents, if taken in by means of meat or bread. But, by taking in these alkaloids, an individual at once takes in a constituent of nervous matter; and this accounts for the agreeable stimulus and the permanent effect on the mind, from taking tea in considerable quantities, particularly by studious persons, as well as those whose nervous system is exhausted from other causes.

Coffee, which is also consumed in considerable quantities, is the produce of another plant, the *Coffea Arabica*. Recourse has been had to the use of coffee, much more recently than to that of tea. We have no earlier notice of it than 1554, when it was used at Constantinople as a common drink; but it was forbidden, in consequence of its supposed intoxicating properties, and it would seem as if there were no way more likely to make people fond of any thing than to interdict it. In 1580, Prosper Alpinus, a traveller, brought it to Venice, and described the means of raising it. In 1610, it was grown by the Dutch in the West Indies; and in 1652, coffee-houses were established in London. The people of England got passionately fond of this coffee; and in 1675 it was supposed to have an injurious effect on the constitution, and all coffee-houses were therefore suppressed in London. But another reason was probably this, that people assembled together for the purpose of drinking coffee, and there laid plots supposed to be dangerous to the state. The native countries of coffee at present are Ethiopia and Arabia Felix. It there attains to a much greater height than the plant on the table, as much as from 14 to 15 feet in height; and it is larger and more elegant. The flowers are white, and having all the characteristics of the class *exogens*. The fruit is a red berry, and in this red berry is contained a little seed, covered over with a covering sometimes called parchment. He had on the table some seeds taken from the red berry; but the parchment was removed in order to roast the coffee berries. These seeds vary in different districts and various parts of the world. He had on the table some from Jamaica, Demerara, and other countries. They all vary a little in quality and external character, but not much in their properties.

On a chemical analysis, coffee gives a large number of constituents. It gives two or three parts of caffeic and gallic acids, and a narcotic oil mentioned by several writers, but denied by others. However, there was no doubt that it did possess a narcotic oil, even in its raw state. It had also an alkaloid, named *caffein;* and it is very remarkable that its composition is identical with that of *thein,*—they were, in fact, one and the same thing, obtained from two different plants. This is very remarkable:— 500,000,000 lb of tea are consumed annually; next, 300,000,000 lb. of coffee are consumed annually in the world, the matter of both beverages containing the same salt. This does seem to point out that there must be something in this salt; that it was not mere accident that led mankind to use these two things, that undoubtedly act in the same way. Coffee acts in the same manner as tea upon the system, and we use it precisely under the same circumstances; one might be substituted for the other: the only difference is that of flavour; those who like coffee may take it, and those who like tea may take it, with the same effect on the system. However, the preparation of coffee, and the changes which take place in it, will produce some change in its constituents. The coffee is not eaten in the state of the raw berry, but is roasted, during which certain changes take place in it; and an empyreumatic oil is developed, in conjunction with the acids spoken of, and which renders coffee, in some points of view, a different thing to tea. This empyrumatic oil, like all other oils, has the power of arresting decay; and if, as Professor Liebig and Dr. Playfair maintain, the action of digestion is very similar to that of decay, and this resembles the process of fermentation; then, as the empyreumatic oil will stop this process out of the body, in all probability it will do the same in the body, and thus we can account for the injurious effects of taking coffee immediately after taking large quantities of food. We arrest the process of digestion; and, instead of assimilating the food, we stop its assimilation, and a large mass is thus kept in the stomach a longer period than usual; and the consequence is, that a feeling of heaviness and indigestion takes place. Thus we see there is a limit to the use of coffee, which we cannot put to the use of tea, which may be taken after meals, and used so far as the narcotic oil is concerned; but it is only right to observe, that large quantities of fluid after heavy meals are altogether incompatible with facilitating the process of digestion.

There has been lately some attention paid to an article which was formerly introduced into France as a substitute for coffee, namely, chicory. He exhibited a coloured drawing of this plant, which grows in the gretest abundance in the south of Europe, but is indigenous to Great Britain. It is found in abundance in the long magnesian lime-stone tracts of Nottingham, Yorkshire, and Durham. The root of this plant has been actually used as a substitute for coffee. He had on the table some dried roots of this plant, in the state in which it was obtained, for the purpose of obtaining this dark-coloured matter. It was coloured very much like coffee; but, when boiled alone with water, had a very much less agreeable flavour than coffee. Why had it not been used alone?—Because in chicory we have no alkaloid; we have no oil; we have a certain quantity of resinous matter; a certain quantity of a matter which strongly resembles the substance of a narcotic nature called *lactucarium*, which is the only constituent for which chicory can be used. All chicoraceous plants possess a milky juice, in which resides a narcotic element. Chicory, then, he believed, could not in any way be used as a substitute for coffee. It had not been examined carefully, and therefore he did not pledge himself to the examination of that particular; but it had been proposed as an addition to coffee, and used extensively as an adulteration to coffee. He wished to draw the distinction between the addition of chicory to coffee, and the adulteration of coffee with chicory. In France, where they use more coffee than we do, chicory is added in small quantities, and persons will not drink coffee without it. It has been used in this country, by the fraudulent seller, to adulterate coffee; but he had no hesitation in stating, that coffee, prepared with small quantities of chicory, was much more pleasant to the taste, and less liable to interfere with the process of digestion, than when taken without chicory. He was not prepared to explain how this was; but still we might find something in chicory which combines with the oil of coffee, so as to render it comparatively less injurious. Thus chicory was added throughout France, and the coffee-drinking part of Germany, to prevent these supposed ill effects of coffee. Persons in this country, when not aware that the coffee is adulterated with chicory, or that it has chicory in it, prefer it with this addition. He knew a respectable coffee dealer who conscientiously objected to put it in. He kept on selling his coffee, but lost gradually almost all his customers for that article. He was not able to account for it at all; but an old lady, who had long been his customer, at length said, "You don't sell such good coffee as your neighbour." He examined his neighbour's coffee, and found chicory in it, which might easily be detected by throwing some of it into water, when the chicory will float. The next coffee he sold to her he added some chicory; and she said, "Now your coffee is very good." He added some to his commonest coffee, for his own use; and his wife exclaimed, "My dear, you have been giving us some of your best coffee." Then he added a little to the coffee of his stock; and soon he did not send out a pound of coffee without chicory, and his coffee trade is now larger than ever. There was this to be said too,—at one time it was the law that a person adding chicory to coffee was liable to a penalty for adulteration; but government had now legalized the addition of chicory to coffee, and it might be legally added. He would say to those who were in the habit of grinding their own coffee, that they really would find it an agreeable addition to purchase chicory, and add a little to it. They would then be sure that the dealer did not add too much chicory, which was in fact the real danger; chicory being a much cheaper article than coffee. With respect to the substitutes for coffee and tea, several others had been proposed; roasted corn, amongst others, as a substitute for coffee; but here there was no alkaloid or narcotic oil. And what is the consequence? Very few people will drink it. But, with respect to the substitute for tea, there is at this moment a plant grown in the forests of Paraguay, called Paraguay tea, the produce of a beautiful plant, a species of *Ilex*, the *Ilex Paraguensis:* the common holly of this country being another ilex, the *Ilex aquifolium.* This tea is consumed in South America to the extent of from 30 to 40 million pounds.

On examining this plant chemically, we find a reason for the use of it; we find, that actually in the leaves of this *Ilex Paraguensis* there is an alkaloid which is not *thein* nor *caffein*, but intrinsically, in its qualities and effects, the same thing. We have still one more plant less extensively employed, the chocolate nut tree, or *Theobroma cacao*, a native of the forests of South America. It is cultivated extensively in the West Indies, and the best nuts of the plant which produce cocoa and chocolate are those brought from Trinidad. Two hundred million pounds of this nut are supposed to be consumed annually, by the inhabitants of various parts of the world. The plant attains a height of fifteen to twenty feet; it bears small red flowers, which develop themselves, and produce the large yellow capsules (as shown in the coloured drawing, and also in dried specimens on the table), each containing twenty-four seeds; each seed is enveloped in a little cover, which is taken off previously to preparing it. The albumen of the seed is the part used for making cocoa and chocolate. He had on the table some of these seeds not roasted, and also one of the capsules, which contained about twenty-four of the seeds. The capsules were not brought to this country, but were opened, and the seeds in this state were then brought here, forming, after being heated, "cocoa knibs." When put into a mill, and placed under the influence of heat, they were reduced to a pulpy state, and were then allowed to run into moulds, forming the large cakes, known as cocoa cakes. In France, and various parts of America, this paste was mixed with the fruit of a plant of the *Orchis* tribe, called Vanilla, and it was then known as chocolate. The mode of preparing it is to take the paste or cakes, and submit it to the heat of boiling water: we have then an agreeable fluid. The albumen of the seed contains a large quantity of oil; and, when we analyze the re-remaining part of the seed, we find it contains also another of the alkaloids, not identical with *thein* or *caffein*, but so nearly resembling these, that, by a slight chemical change, the one may be converted into the other. It is as nearly like *thein* as *quinine;* and thus we have made out a cause for the extensive use of all these plants, as having the same identical chemical constituent for their basis,—tending to confirm the theory of Liebig with respect to their action on the system.

Theobroma cacao is the name which was given to this plant by Linnæus;—*theos bromos* [Θεός βρομος] being Greek words, meaning "the food of the gods." However, on looking over an old Spanish traveller's book, he (the lecturer) found that he says of cocoa, "This is a food not fit for pigs;" so that there was considerable difference of taste between the botanist and the Spanish traveller.

With respect to the subject of *adulteration*, he had not time to enter upon it particularly. As to tea, there was an impression that considerable adulteration is carried forward, and that more especially the colour, or green character, was given to it by salts of the oxide of copper. But this appeared really to be a libel upon the Chinese, as very few specimens brought into this country had oxide of copper in their composition. However, lately, there had been a considerable adulteration of tea carried on in this country. Tea leaves had been collected and dried, and then prussiate of potash added to give to them the green tea colour; and thus considerable quantities of tea had been sold possessing no *thein*, but only prussiate of potash and some colouring matter, which, however, were not so injurious to the system as oxide of copper. Roasted corn was also added to coffee in considerable quantities; but it might be detected by a simple chemical test: the starch of the corn would form a purple colour with iodine, and therefore might easily be detected by the use of this test. The adulteration of cocoa was also easily detected. Persons were led away by appearances, and the object was to give to the paste a fine colour and appearance. For this purpose it was mixed with the red oxide of lead, and this was really a very improper ingredient, and consequently injurious results had arisen from partaking of such mixture. It was also mixed with hog's lard, sago, and other amylaceous articles of food, in order to make up the weight.

In his next lecture, he would consider those plants which contain carbon and nitrogen as their basis, and point out how much more extensive these things were diffused throughout the vegetable kingdom than those already noticed. The things now before his audience seemed to be merely supplied for the purpose of giving man, in his present artificial state of existence, those stimulants to the nervous system, which it needs to bear up against the otherwise deteriorating influence of external agents. But the other class, to which he would refer in his next lecture, consisted of the secretions in vegetable substances coming more strictly under the denomination of nutriment or food.

LECTURE II.

STARCH—POTATO—ARROW-ROOT—TAPIOCA—PROTEIN—WHEAT—MAIZE—RICE.

Dr. Lankester said, that, at the end of his former lecture, he had directed attention to the Paraguay tea-plant; and, since then, he had gained some further information respecting it. Mr. Markland, jun., a gentleman residing in Manchester, who had just returned from Paraguay, had given him some account of the places where the plant grows, of the mode of drying and preparing it,

&c.; and had also given him some of the prepared leaves. The leaves are collected in large quantities, and placed in the centre of a circle of dried wood, the latter was then kindled, and the fresh plant in the interior was dried by the heat around it. It was then chopped into fragments, placed in bullocks' hides for the market, and carried in immense quantities down the rivers Paraguay and Plate, for sale. Mr. Markland thought, that the consumption considerably exceeded 30,000,000 lb. annually—that it must be upwards of 50,000,000 lb. The natives of South America seem to have used this tea long before the Spanish settlers took possession of the country. The infusion was made by means of a small apparatus called the *maté*, consisting of a small cup, formed of a species of gourd, and a silver tube terminating in a bulb, perforated with small holes. A small quantity of leaves were put in the cup; then the tube was put in with the bulb downwards; and, hot water being added, the infusion was drawn into the mouth through the tube; and in this way, keeping it in frequent use, large quantities of this tea were taken during the day. It was not usual for the South Americans, generally, to take with it sugar or milk; but the ladies sometimes took sugar with it. There could be no question as to its being very similar to Chinese tea, as, like that, it possessed the *thein* or *caffein*. There might not be in the Paraguay tea the same agreeable narcotic oil as in the Chinese plant; but Mr. Markland said, that all European travellers in Paraguay liked it better than the tea from China. It might be introduced in this country; but if imported in considerable quantities would of course have to pay a high duty, as tea.

In his last lecture, he had spoken of various substitutes for tea; but had not then any specimen of the Piqua plant; but had since obtained some, which was on the table. It had been lately introduced, under the patronage of some considerable medical authorities, to the tea drinkers of London, as a substitute for tea. Since the last lecture, he had submitted some of this Piqua tea to a casual and very general analysis. It appeared to possess a very considerable quantity of *tannin*, with some indications of its also possessing an alkaloid, like *thein*; but the *tannin* abounds so much that it has an exceedingly disagreeable flavour, and he questioned if it would ever be used to the same extent as the Paraguay tea, on account of its bitter nauseous taste, which resembled cascarilla or cinchona bark more than any thing else. We knew nothing of the plant producing it; it was a secret preparation, and might, for what we knew at present, contain injurious matter; and therefore, until it was fully known, it ought not to be recommended.

At the time that tea was very extensively used, and very dear, there were many attempts to make substitutes from British plants, and considerable sale was obtained for an article called "British herb tea." It was no secret; but the government, understanding that it was used for the adulteration of Chinese tea, ordered it all to be seized, and, during the mayoralty of Sir Peter Laurie, about 20,000 tons of British herb tea was seized and destroyed. It was made from sloe leaves, lime leaves, and the leaves of other British plants. That tea had begun to be used, and, he doubted not, if its ingredients had been examined, they would be found to contain some constituents very similar to those which characterised tea, coffee, and the Paraguay tea. There could be little doubt that such plants might be made substitutes for tea, and, if we had growing wild in our own country plants that furnished those materials, he thought the sale ought not to have been suppressed in the summary and hasty way it had been, without proving any thing like an attempt to use it to deceive or impose on the public.

Passing to the subjects of his second lecture, he observed, that the secretions of plants yielding food might be divided into medicinal and alimentary secretions. The medicinal were alkaloids, such as *thein*, *caffein*, &c. which some used as medicine, to relieve the system. They were not essential; persons could live without them for a long time; but having once found benefit from them, they continued to have recourse to them. The alimentary secretions were what he had before described as carbonaceous, or combustible, and nitrogenised, or nutritive secretions. Of the carbonaceous, sugar, starch, and oil were the best examples; of the nitrogenous, that substance called *protein*, existing in different forms, as albumen, casein, and gluten, was an example. He would first notice plants containing one of the carbonaceous secretions, and, in a greater or less quantity, this nitrogenous principle,—the former commonly known as starch; which could be obtained from almost every plant extensively used as the food of man. It seldom occurred alone; but generally in conjunction with *protein*. However, some plants yielded starch alone, or their *protein* was so small in quantity as scarcely to be perceived. He had therefore grouped together some of these plants, as, for instance, arrowroot; the *Jatropha manihot*, which yielded tapioca; and various species of palm, yielding sago; and with this group he might also place the potato. He found from some results of Dr. Playfair's experiments, that the potato contained less of the nitrogenous principle than might have been supposed (only two per cent.), so that the principal constituent of the potato as an article of food was starch. Amongst the class of plants containing *protein* as well as starch, were wheat, barley, oats, maize, &c.

The first plant he would mention was the potato, known to botanists as the *Solanum tuberosum*, one of those valuable productions of food which the discovery of the new world had given to us. It was supposed to have been first found by Sir Walter Raleigh in his expedition to America, in 1584. He brought the first seeds of this plant to Ireland, and planted them in his garden at Youghal. When grown, he told his gardener to bring him some of the fruit; and the man, instead of taking him the tubers, took him the small fruit of the stem growing from the blossoms. Sir Walter said, that the plant was not that which he had seen in America, and told the man to pull it up and throw it away, as it was doubtless a weed. In endeavouring to eradicate the plant, the gardener found the tubers attached to the underground stems, and these were at once recognised by Sir Walter as the beautiful fruit he had seen. It seemed as if Ireland were destined to be the recipient of the potato; for a vessel load of potatoes coming to England, passing the coast of Ireland, were thrown ashore there; the people gathered and planted them, and from that spot proceeded the great cultivation of the plant, which was grown in Ireland, and even in Scotland, long before it was used in England. Gerarde says, in his Herbal, that the potato from America "is an excellent thing for making sweet sauces, and also to be eaten with sops and wine." So that at that time it could not have been extensively used. In 1732 the first field crop of potatoes was grown in Scotland, and the produce was very considerable; but it was for a long time denounced there by many persons, on religious grounds. It was urged that the potato was no where mentioned in the Bible, and that consequently we ought not to use it. This was one of the mistakes which mankind frequently made. We mistook the real value of the Bible, which was sent to reveal to us things of much higher importance than matters of domestic economy; and just the same mistake was committed with regard to questions in science,—men forgetting that the God of Nature and the God of Revelation must be one and the same God. The potato belongs to the natural order *Solanaceæ*, to which also belongs that poisonous plant the deadly nightshade, and some other exceedingly poisonous plants. The potato, when uncooked, contains in it a poisonous principle, like that in other plants of this order, called *solania*, which, being volatile, was dissipated in boiling, and thus the potato became an article of diet. Tapioca was obtained from a plant called the *Jatropha manihot*; the roots (from which the tapioca was obtained), were exceedingly poisonous; yet it might be eaten when the poison was driven from it by heat, or removed as in the mode of preparing tapioca. Although the potato presented so great a number of varieties, they all belonged to the *solanum tuberosum*; whether the red-nosed, the kidney, or whatever sort. The different varieties were obtained by placing the seeds in the ground under different circumstances to those in which they were grown, and then a new variety was obtained, which might be multiplied by planting the potato. The tuber was not the root but a portion of the stem; it belonged to the class called the subterraneous stems of plants. The potato, examined chemically, was found to consist of a large quantity of starch or *amylum*, a very small quantity of albumen or gluten, and an insignificant quantity of *solania*, or poisonous principle, which was got rid of absolutely in boiling. The starch in the potato preserved the same form as in almost every other plant in which it was found. It was imbedded in the cells of the cellular tissue of the potato; and if a potato were cut through and its structure examined under the microscope, it would be found to have a large number of little cells, in which the starch was contained (as shown in a magnified drawing or table, to scale, from the micrometer). Therefore the grains of starch consist of an external enveloping membrane, and internally of the chemical principle *amylum* or starch. The drawing or table was prepared for the purpose of distinguishing the adulteration of arrow-root with potato-starch, as was shown by the different size of the grains or particles. The great distinguishing character of carbonaceous from nitrogenous aliments was, that the former were used to keep up the heat of the body, and the latter to build up the fabric of the body. The potato containing a large quantity of starch, a carbonaceous aliment, could only be of use to keep up the heat of the body; just as carbonaceous matter (coal) in the grate kept up the heat of our rooms. The carbonaceous aliment was burned on coming into contact with the oxygen of the atmosphere, heat was given out; but the combination of the two was at too low a temperature to produce light and incandescence. Carbonaceous aliments, then, enter into the composition of the blood to raise and keep up the animal heat. This must be the principal use of the potato as an article of food, and, consequently, it could never become the basal food of any people ever remarkable for strength or power. From the very small quantity of proteinaceous matter in the potato, enormous quantities of it must be consumed, in order to build up the fabric of the body. This shows the injurious effects of keeping persons on a potato diet; and there could be no question that the inhabitants of the sister island were deteriorated both in strength and stature from their consumption of quantities of the potato, and their inability to obtain better kinds of food.

The plant which produced what was commonly known as arrow. root, belonged to the same natural order as the *Zingiber* or ginger plant. Ginger and arrowroot were obtained from the natural order *Cannæ*, and arrowroot was yielded by several plants of that order. The arrowroot of the West Indies was obtained from the *Maranta arundinacea*, and that of the East Indies from the *M. Indica*. The arrowroot plant belonged to the class of *Endogens*, and the substance was obtained from the root-stock or rhizoma, a kind of stem. When arrowroot was to be obtained, the root-stock was beaten and submitted to water: the fibrous or woody particles fell down, and the starchy matter was left suspended in the water. The water being poured off, the starch, being insoluble, was allowed to subside and the water was decanted, when it became quite clear, and the starch was collected from the bottom. Starch, though not considered of so pure or good a quality, was obtained from the potato in just the same way; and starch, from whatever plant obtained, had just the same character. It was always contained in the cellular tissue of the plant, covered by the delicate membrane of which that tissue is composed. Arrowroot was frequently adulterated in this country. The East India arrowroot was considered the best; and the French West India arrowroot not so good. The East India arrowroot had the finest grains; the second finest were those from the potato; and third the *tous les mois* or French West India arrowroot; so that, examining the size of these grains under the microscope would be a means of detecting adulteration which would escape chemical analysis. Arrowroot was often introduced as a very nutritious article of diet; and, indeed, till recently, it was supposed that all these carbonaceous aliments were nutritious; but we must distinguish between those which are really nutritious and those which go merely to raise the heat of the body. All nutritious articles contain nitrogenous matter. Arrowroot contains but little of it, and therefore it must be injurious to feed persons upon arrowroot entirely; yet little children were fed sometimes almost entirely on arrowroot. True they became fat, but never strong, and he believed that such practice frequently led to the destruction of their existence.

Another substance, containing chiefly starch, was sago, and the plant which produces it is the *Sagus Rumphii*. It was also yielded by the *Cycas revoluta*. These cycadaceous plants were very beautiful, from their stellate foliage branching from a point. Sago was yielded by the stem of the plant. The whole group of palms contained immense quantities of cellular tissue in their stems, considerably more than other plants, and the sago or starch matter collected in the cellular tissue of the palm, just as starch did in other plants. Some plants of the *Sagus Rumphii* yielded from 500lb. to 600lb. of sago. To collect it they fell the tree, and then, breaking it up into small portions, the tissue is submitted to nearly the same process for obtaining sago as the potato for starch, or the *maranta* for arrowroot. There were several kinds of sago, as sago meal, the common sago, pearl sago, &c., only differing in the mode in which they were prepared.

Tapioca was another form of starch, all these things containing very little proteinaceous or nitrogenous matter. The *Jatropha manihot*, which yielded tapioca, belonged to a poisonous tribe of plants, the *Euphorbiaceæ*. When fresh it was a very virulent poison; which quality, however, was removed from it merely by the process of washing, not even heat being necessary. One advantage possessed by tapioca over the other forms of starch, was, that it formed a thick jelly under the influence of heat, and was consequently more adapted for puddings and thick foods, than any other kind of starch, and, perhaps, of all those starches, was the best adapted for the food of children, as it contained a small quantity of proteinaceous matter, which would act as a real nutriment. Many other articles he might mention as containing starch. That obtained from a kind of orchis (the *O. mascula*) was used in London for making a common article of diet. So were several families of lichens, as the *L. Islandicus*, and some kinds of seaweeds, as the *Algæ*, to which the Carrageen moss belongs. Some who had analysed these matters had given the principle obtained the name of *lichenin*; and they had not, he believed, been able to find any nitrogenous matter in them; if so, it was difficult to account for the fact that the rein-deer, constantly living on Iceland moss, should support the wear and tear of great muscular motion; it must have nitrogenous matter supplied to the system from some source. It was therefore probable that the *L. Islandicus* did contain *protein*. He had on the table a very curious form of *Algæ*, used as an article of food in considerable quantities by the Chinese, forming the nest of the *Hirundo esculenta*. This swallow abounds in the islands of the Eastern Archipelago, from which islands these nests were collected in very considerable quantities, to enable the Chinese to indulge their taste for rare articles of diet. This could never have become a favourite food, but that the sea-weed contains a quantity of starchy matter, and probably of nitrogenous matter also, and it was eaten in great quantities by the more opulent

Chinese. He was not aware of these nests being brought to England, but swallow nest soup was sometimes seen as a curiosity.

He now came to the second group of plants,—those which contain starch in combination with considerable quantities of protein; and these plants must ever form a fundamental or basal portion of the food of mankind. They were distributed everywhere, and the great raw material out of which mankind was built up, was found in these plants, which included wheat, barley, rye, maize, and millet. Wheat so extensively used as an article of food, was the produce of a plant called the *Triticum hybernum*, belonging to the natural order *Graminaceæ*, or grain-bearing plants, which, although so apparently insignificant as to contain all the common weeds and grasses that proved such pests in our gardens, also included wheat, barley, oats, rye, millet, maize, and the sugar-cane. We were lost in attempting to trace the origin of the use of wheat amogst mankind. It seems to have heen used from time immemorial, and there is no question that the earliest records in the Bible refer to this form of wheat. He showed stalks in ear, of wheat, barley, and oats, and observed that the grain was merely the fruit of the plant. In preparing the grain for food, the pericarp or covering of the seed was separated in the form of bran, and all that was used was the interior, which was really the seed. Wheat was cultivated extensively throughout Europe and several other parts of the world, and formed the great basis of European food; and the importance of attention to its cultivation had become much more apparent from the investigations of modern chemists. Wheat contained certain principles which we could supply from without. Previously to our knowledge of this fact, we were in some difficulty as to the proper way to supply food to this plant, so as to obtain from it the greatest quantity of nutritious matter; but the investigations of chemists had led us to see what were really the elements of which wheat consists. The principal constituents of wheat are starch, gluten or fibrin (protein), and a certain number of inorganic constituents, and these were found not to be unimportant in wheat. Although we had starch maintaining the heat of the body, and protein building up its fabric, we had still these other ingredients hitherto regarded as unimportant; and one of these was phosphate of lime, of which the bones of animals were composed; so that these particles in the wheat were taken into the system to build up the bony fabric of the body: and had we not this small portion of phosphate of lime, our bones would grow soft, and would not be able to maintain the muscular fabric laid upon them. It had sometimes been supposed that we might introduce other salts of lime into the body, and thus furnish phosphate of lime to the bones, and a short time since there was a curious illustration of this. Dr. Clarke, of Aberdeen, went up to London, to state before the various bodies intesested in the health of the metropolis, his mode of cleansing the Thames water, so generally used in London for drinking. This mode consisted in separating the salts of lime and various organic constituents, which entered into the water; but he was met by the objection, "Why, if you take away the lime from the water of London, where will you find lime to build up the osseous system of the London people?" Dr. Clarke stated in reply, that he believed that, by his process of purifying the water, they could not obtain any water so pure as the Aberdeen water, and he believed that her majesty's Aberdeen subjects were the longest-boned and the strongest-boned people in the kingdom. One of the simplest modes of preparing flour was that of which he had specimens on the table, in the form of a vermicelli and maccaroni; which substances were prepared by moistening flour and passing it through moulds, so as to give the substance its form. This wheat contained a different kind of starch to that of ordinary European wheat, or it would not be able to assume that form. The subject had not been sufficiently investigated, how it was the Italian wheat assumed this form so much more readily than other European wheat. Maccaroni was used in puddings, pies, &c., and as well as vermicelli, was introduced into soups, and was an exceedingly agreeable article af diet. Another preparation of wheat flour was called "farinaceous food." It was a secret preparation, and was sold by persons to be used as food for children, being merely flour submitted to heat; and, so far as he was aware, he believed nothing of an injurious kind was added to it. The advantage of submitting flour to heat, previously to preparing it, was that the little cells of starch were thus burst, and the starch was then more readily acted upon by the stomach. This pointed out the necessity of cooking, so as to burst the cells; for, when used as food, without previous cooking, the starch was not so easily digestible. This would account for the fact, that many fruits eaten raw were not easily digestible. Many fruits contain considerable quantities of starchy matter, and subserve the purpose of respiration on that account; and these fruits, such as apples, pears, &c., would be much more easily digested in the stomach, if previously heated. Bread was the principal form in which flour was cooked; and there were two modes of making it,—fermented and unfermented. The advantage of fermenting the flour was, that thus prepared, it was lighter, and more easily digestible, than the unfermented bread, such as captains' and sea biscuits. In the process of cooking a fermentation went on very analogous to that in sugar for the purpose of forming alcohol, and it was well known that considerable quantities of alcohol were given off from bread, during the period of its being baked. This fermentation had been called the panary, in order to distinguish it from the vinous and the acetous fermentation; but it was questionable whether it was different from the vinous. At one time, in London, a company was established for the purpose of baking bread, and they had an apparatus for condensing the spirit from the bread, and thus carried on the two different trades of bakers and distillers. However, the poor people got to know that the spirit was abstracted from their loaves, and they were prejudiced against the company, —a prejudice of which the bakers availed themselves by putting bills in their windows, "Bread sold here with the gin in it."

Bread was exposed to considerable adulterations, the most common of which, in London, was the use of alum, which acts as an astringent upon the system, though not a poison. It might easily be detected by the application of the usual tests for alum, and it should be carefully avoided. Of all the forms in which bread could be used, that which was most wholesome and best adapted for the system was the form of brown bread, in which form the flour contained a small portion of the bran. Its advantages were, that the brown particles, or outside pericarp of the seed, contain a volatile oil, which acts as a stimulant, and assists digestion; there is also a mechanical action of the particles of bran; and many persons were much relieved from indigestion, and many of its symptoms and consequences, by eating brown, instead of white bread. There was a new mode of preparing bread without fermentation, and yet not unleavened like rusks or biscuits. This consists in preparing the flour with carbonate of soda, adding to it a small quantity of hydrochloric or muriatic acid, which sets free the carbonic acid, and during the process of baking the carbonic acid acts in the same manner as in fermentation, and throws up the bread into that vesicular form which makes it light and easy of digestion. It ought to be mentioned that starch had one peculiar property, that of entering readily into combination with oil, forming a peculiar chemical compound, exceedingly indigestible; but which was not formed at a low temperature, so that the starch in ordinary bread and butter would not combine with the butter, but it would so combine with oleaginous matter in baking or boiling; and this was why pie-crust and other matters were so exceedingly indigestible. Plum-cake, plum pudding, pancakes, &c. ought to be interdicted altogether as articles of diet, by those who wish to retain their digestive powers in all their original integrity.

Maize was the produce of the *Zea mais*, a native of North and South America, and supposed to be also a native of the South of Europe, and now (whether native or not) cultivated there to a great extent. It had an external resemblance to wheat, and in the fruiting season poduces a large head of fruit. The colours of the seeds were various,—passing from a light yellow to a deep red; which did not at all depend on the variety of the plant, but the same individual produced the yellow and the red seeds. This plant was not used merely to grind down for bread; but in all stages of its growth it was taken as food. The pods or heads of the fruit, directly they appear, may be gathered and used green in making soups and other dishes, as we use asparagus, cauliflower, &c. When perfectly ripe it was used as bread, and also in making the substance called furmety. It was also used for making sugar, and this manufacture of sugar was likely to come into general use in America, as there was every reason to believe that it would prove a greater source of profit than the manufacture from the sugar cane.

Another substance was rice, known to botanists as *Oryza sativa*, It was cultivated in the East Indies, China, the West Indies. central America, and in some parts of the south of Europe. It was supposed to be the food of 150 millions of people. One remarkable fact was, that it contained so small a quantity of nitrogenous matter; but we must remember that it was the food of persons living in hot climates: they did not make those exertions that the inhabitants of temperate climates do, for the purpose of obtaining their food, and consequently there was less nitrogenous matter required for building up the fabric of their bodies than our own. Dr. Playfair stated, that rice contained only two per cent. of protein; and therefore it was only equivalent to potatoes as an article of diet. He (Dr. Lankester) had also on the table some millet, which was the food of a large number of the inhabitants of the world, and which was used in just the same way as wheat, rice, or maize. It might be ground up, and flour obtained from it, and cooked in the same way as we cooked our common wheat flour. The other plants belonging to this gramineous group, which were used as articles of food, were oats and barley, and others of less consequence. Oats were used in considerable quantities as an article of diet. Oatmeal contained a large proportion of proteinaceous matter, and was therefore well adapted for the diet of human beings. Barley contained fourteen per cent. of protein, and consequently was also adapted for the diet of the human family. It was not many centuries since that oats and barley constituted the principle articles of diet for the people of this country; and it was only recently that wheat was used so extensively as an article of diet. However, there could be no question that wheat was superior to oats and barley; and this was a matter of great importance in a national point of view, that the whole mass of the people should cultivate a taste for the better kinds of food, and then, in times of scarcity, they might easily fall back upon inferior kinds of food. But, in the sister island, when the potato failed, they had nothing to fall back upon but the Carrageen moss, and sometimes even it failed; and, therefore, that gentleman was a bad economist who chose to say that five millions of our people were rejoicing upon potatoes; for when they failed, it must cause a famine and great distress; whereas, if the wheat failed the people were still not starving, for they could fall back upon potatoes.

Proteinaceous matter assumed three forms. The first was called *fibrin*. It was *fibrin* that was contained in wheat, oats, barley, maize, and rice; and it was also contained in the plant known as buck wheat, which might be used as an article of diet. It was also this fibrine which was contained in carrots, to a small extent. It was also contained in turnips and beet-root; so that all these forms were substitutes for the higher sort of food, and persons might live upon them for a length of time. The second form in which it was found, was *albumen*, which is contained in such plants as the almond tree and the acorn, and also in cabbages, cauliflowers, and asparagus. There was a third form of this proteinaceous matter, which was called *casein*, and this was found in a tribe of plants which were of great importance to man, on account of their serving so extensively for the food of the lower animals on which he is dependent for food; and this was called the leguminous group of plants; the common peas and beans, and also the various forms of tares and vetches, all characterised by having for their fruit a *legume*, were used for feeding the lower animals, and sometimes as an article of diet for feeding human beings. It was a matter of great importance that these leguminous seeds contain so large a proportion of this nitrogenous matter, casein. Peas contained 29 per cent.; beans 31 per cent.; and lentils 33 per cent. of this porteinaceous matter, and, consequently, these articles of diet were the most nutritious that we could have, and there could be no question that they might be made substitutes for wheat when combined with some of the articles of food which yield a great quantity of starch. We must also recollect that those plants yield a greater quantity of produce on a given soil than wheat, barley, oats, or other plants of that kind ; so that we might make a diet composed of peas and potatoes, which would be a substitute for the more expensive diet of wheat, and barley, and oats. He had a statement drawn up by Mr. Ransome, of Manchester, from an analysis of Dr. Playfair, in which comparison was made between the quantity of nutritious matter contained in the price of so many different sorts of food. Thus, peas contained the same quantity of nitrogenous or nutritious matter in three pennyworth, as meat did in 1s. worth ; as flour in 7d. worth ; as bread in 7d. worth ; and as potatoes in 1s. 7d. worth ; so that beans and peas might be made a very cheap substitute for these various other forms of diet. The question of digestibility came in here, and there could be no question that persons in a good state of health were capable of digesting this heavy form of diet; at the same time it might be mixed with potatoes, or any of the forms of starch which he had mentioned, and thus become a very important article of diet. But we did not go to the vegetable kingdom for our nitrogenous food. We went to the animal kingdom. The animal fed upon these secretions ; it took up the casein and the nitrogenous matter of the peas and the beans, and then we ate the animal and it was deposited in our own flesh. We did not go to the vegetable for it, but to the animal that had taken the vegetable. This, probably, was more adapted to our healthy existence than if we had to go to the vegetable kingdom ; but should the animals fail us, the vegetable kingdom would still supply us with a sufficient quantity of nitrogenous diet. He had a table of chemical analyses, which showed that the nitrogenous secretions did not undergo any change in passing into the system. They are taken from the vegetable and adopted into the animal system, without undergoing any chemical change, which is not the case with the carbonaceous principles, these being all burned. The carbon went off in the shape of carbonic acid gas ; but these were deposited in the same form in the animal, as they were taken out of the vegetable. Thus, if we took milk, we might obtain from it a substance identical with the *casein* which was obtained from beans, peas, and lentils. He then exhibited a specimen of the *casein* obtained from peas, and stated that if he had taken milk and separated the *casein* he should have found its *casein*, a substance identically the same. The same might be said of albumen,—the albumen contained in cauliflowers, asparagus, and so on. If we took the albumen contained in the egg, its animal type, we should find it precisely the same as the albumen contained in the cauliflower, the cabbage, the asparagus, and some other plants. It was thus we found that there was a dependence of the animal entirely upon the vegetable world; and, although mankind, the highest form of animal, had recourse to animal food, yet still it would be seen that the animal had recourse to the vegetable world for the purpose of obtaining those secretions which were necessary for building up the fabric of the body. And thus we had the great fact placed before us, that the vegetable kingdom was the great cause of all the chemical changes going on on the surface of the earth; that the animal kingdom could not be composed of matter, but as the vegetable kingdom stood between it and inorganic particles, converting them into the food or materials necessary for supporting their frame.

LECTURE III.

OIL—COCOA-NUT TREE—BRAZIL NUTS—NUTS—VEGETABLE IVORY. ACIDS—ACID-FRUITS, ORANGE, LEMON, ETC.

Dr. Lankester commenced by observing, that in his last lecture he had forgotten to mention one plant, namely, the bread-fruit tree of the islands of the Pacific, which constituted the food of a great proportion of the inhabitants of those islands; and at one time excited great interest here, as it was thought it might be introduced here and in other European countries. Most of his audience would recollect the interesting history of the voyage of Captain Bligh to Tahiti, to bring away this bread-fruit tree. He succeeded in bringing away a great many in the vessel; but the vessel had remained there too long for its safety, for the sailors had formed acquaintances and friendships with the islanders,—they mutinied,—Captain Bligh was put into a boat and sent afloat, and it was some days before he regained the shore; while the sailors returned to the Friendly Isles. The tree produces a large fruit about the size of a child s nead, and on cutting into the inside, it has something of the character of a piece of bread, after being cooked, such as is eaten in this country. But of course the interior is not bread, but an aggregation of a considerable number of individual fruits that press upon each other; so that the distinction of the fruit and seeds in them is quite annihilated, and the whole forms one great mass of matter that may be eaten. The constituent of this bread-fruit or seed is principally starch, with, undoubtedly, a considerable quantity of nitrogenous secretion, or this plant could never have become food for any great proportion of mankind. But the islanders live upon this fruit for a great length of time, without anything else; and consequently it must have both carbonaceous and nitrogenous secretions, to keep up the heat and build up the fabric of the body.

He would now introduce to them a group of plants, which were characterised by possessing a large quantity of oil, as secretive matter. His audience would recollect, that in the two former lectures he had alluded to oil as one of the carbonaceous secretions, which, on entering into the system, was carried into the blood, and, meeting the oxygen, was taken into the body by means of the lungs, when it became converted into carbonic acid gas; and this was the gas we were constantly giving out in respiration. He also alluded to this fact, that the process of respiration, or combustion, in the lungs, was precisely similar to that which goes on in the fire-place, a common lamp, or a candle; and in oil they had the very same ingredients used as in an ordinary candle, producing heat and light, which, on being introduced into the system, actually produced heat there. Oil was characterised by possessing a larger quantity of carbonaceous matter than either sugar or starch, and was consequently more capable of supporting the heat of the body than any of the other secretions in that group. Now, the use of the heat generated by the carbonaceous matter, was to keep up the heat of the body; the more rapidly that heat was conducted away by cold, the more necessity there was for keeping it up; and consequently people in cold countries had recourse to all the oily food they could get. Greenlanders consume fish or train oil in considerable quantities; and there was an instance related as to the Russians, who are attached to train oil, that when a Russian troop landed at Portsmouth, they were found, both officers and men, climbing the lamp posts, and drinking the train oil used for lighting the lamps. Oils were of two kinds; chemists divided them into those which were fixed, and not easily volatilised, and those which were easily volatilised by heat. There were numerous examples of these different kinds of oil; olive, spermaceti, and almond oil were instances of the fixed oils. If a drop of almond oil fell on paper, and was held over a spirit lamp or the flame of a candle, it would still remain; but take oil of cinnamon, nutmegs, or cloves, and expose it to the same heat, it volatilised and dispersed. There was also a great difference in the effects of these oils on the human system. It was the fixed oils which were used as articles of diet for supplying the respiratory process with combustible matter. The volatile oils were frequently used as articles of diet, but as medicinal secretions, such as the oil of nutmegs, of cinnamon, of cloves, &c., as condiments in our food, and not at all as secretions for supporting combustion. Fixed oil possesses two ingredients—*stearine*, which is a thick and solid substance, and *elaine*, which is fluid. A familiar example would be seen in olive or almond oil during the winter; at the bottom of the vessel there would be a precipitation of white matter, like hardened snow; this is the *stearine*, the *elaine* remaining fluid. Many oils are obtained from plants which possess a great quantity of *stearine*, and then they constitute vegetable butter; and there are numbers of trees producing so much *stearine*, that it may be scraped off with a knife, and spread and eaten as ordinary butter. Of all the plants which produce oil as food for mankind, perhaps the most interesting was the cocoa-nut tree, or *Cocos nucifera*, one of the palms. The natural order of palms seemed to contain within itself the types and representatives of all the other kinds of plants, and to produce all the secretions of the other plants. We have hardly any secretion obtained from other vegetables, which is not produced by some plant of the *Palmaceæ*. The *Phœnix dactylifera*, or date palm, was an important plant; and he also showed a specimen of another palm, the *Caryota urens*, or jaggary palm, grown in Ceylon. But perhaps the most important of all this group was the cocoa-nut tree, grown in abundance in Ceylon, and which affords a great proportion of the diet of the inhabitants. The trunk generally attains a height of 60 to 90 feet, and the fruit is borne at the point or central part of the tree, from which the *fronds* proceed. The trunk affords large timber, which may be used for a variety of purposes, as making furniture, building houses, and other purposes; the leaves, or fronds, are used extensively for covering the roofs of houses, and are of an enormous size. The flowers proceed from the base of the leaves, and these flowers are no sooner expanded than the inhabitants of Ceylon begin to make use of the plant. In order to supply this large plant with nutritious matter, the sap ascends through the stem. This sap is exceedingly sweet, and sugar may be obtained from it, as from most plants which produce starch. Always previous to the deposition of starch in the fruit of a tree, we had a considerable quantity of sugar in the sap; thus sugar might be extracted from maize while the sap ascended; but when the starch is deposited, no more sap ascends. Thus with the cocoa-nut tree: just at the time of the year when the plant is blossoming, there was a great quantity of sap ascending; consequently, if the flower buds or flowers were broken off, there would be a considerable exudation of sap from the point of fracture, and this sap is full of sugar. The sap, when collected, forms a fluid known by the name of toddy. It is collected every morning, and persons drawing it constitute a caste, called "toddy-drawers," who get up early to collect it for the use of the inhabitants of the district. This toddy, drunk early in the morning, is a pleasant sweet fluid, containing a considerable quantity of sugar, and also of nitrogenized matter; for palms contain nitrogen. Dr. Playfair, several years ago, in Calcutta, ascertained that there was a considerable quantity of nitrogenous matter in toddy, so that it forms an article of diet well adapted for the purposes for which all diet is supplied to the system. If the toddy be allowed to stand a long time, fermentation begins; the sugar enters into a new combination, and forms another carbonaceous secretion, known as alcohol, which is of an intoxicating quality; so that toddy, in three or four hours, or in the afternoon, becomes a highly intoxicating beverage, called palm wine. From this, what is known as *arrack* is extracted by distillation; and all those ardent spirits known among the Indians and Ceylonese, which they are not allowed by their religion to drink, are obtained from fermented toddy by distillation. But this toddy is applied to other purposes: it contains a quantity of sugar, and if placed on the fire, the sugar being suspended in water, the water may be evaporated, and a fluid obtained which is very much like honey, and it is called in those districts by a name signifying honey. If the process of evaporation is carried on further, sugar is obtained; and this is the sugar, called *jaggary*; so that the cocoa-nut tree, as soon as it blossomed, became of vast importance to the inhabitants. In the course of a short time, those little flowers began to develop the internal fruit, called the ovary. In the young stage, and in almost all stages, this young fruit was cut for the purpose of being eaten; it had a different character from the full-grown fruit, and the albumen was not yet deposited, but was mixed up with the milk in the interior, and formed a substance which might be converted into something very like our common *blanc mange*, and it made an agreeable article of diet. As the nut began to ripen, it assumed the form of the nut as mostly seen in this country. We had in this fruit a husky covering over the seed of the plant; that which is called the nut is, in fact, the seed of the plant. On opening the seed, we found there a considerable quantity of what botanists call albumen; for it must not be confounded with what chemists call albumen. This white matter is always called by botanists albumen. In the interior the nut was hollow, and in the hollow we found a considerable quantity of fluid, called frequently the milk of the cocoa-nut. However, it is not the cocoa-nut milk, which is a different thing. This white albumen of the seed contained several vegetable secretions, and a considerable quantity of oil, and from it may be extracted the *stearine* of the oil, so that we may get cocoa-nut butter; and then, if we allow the *elaine* to mix with the *stearine*, we get cocoa-nut oil. There is a considerable quantity of starch in the albumen, and also undoubtedly what chemists call albumen, which is found in considerable quantities in all articles of diet much used in Europe. Thus, then, we had in the cocoa nut all the constituents necessary for the feeding of man; and consequently it was used as an article of diet, in the countries where it grew, to a very considerable extent. The albumen was taken out and cooked in various ways,—sometimes as we cook rice; sometimes reduced to a kind of powder, and then submitted to heavy pressure, and a substance flowed out which in those countries was called cocoa-nut milk; it is an oily matter, mixed with a quantity of water, which is also contained in the nut; and this milk is drunk, while the albumen, starch, &c. is made into powder, &c. The shells can be submitted to the turner, and converted into a number of household utensils, considerably used. The husk was used for many purposes; when divided it could be made into a brush, and for this purpose it was used, he believed, in our own country. But this husk consisted of what botanists called woody fibre, being the substance from which many articles of wearing apparel and the coarser kinds of cloth may be manufactured. Woody fibre was found in the trunk of all trees. It could be woven out, and thus be formed into cloth, of various kinds. He had on the table some specimens manufactured from the fibre of the husk of the cocoa nut, a piece of rope, drawn as strong as ordinary hempen rope; also some of the strands from which the rope was manufactured. He had also a piece of matting made from the cocoa-nut fibre, and stated that a considerable manufacture of these things was carried on in London; and there could be no doubt of the applicability of this substance to all the purposes for which woody fibre was used at all. It was perhaps somewhat singular that this plant, which is so valuable, was not more employed in this country; but there seemed to be a prejudice against using this kind of food, and the substance was not easy digestible; and unless prepared in the same manner as it was in the countries where it grew, the cocoa nut was not found a good food. However, it might be brought over here at so little expense, that if persons employed it more generally, we might get into a mode of cooking it, which might perhaps answer the purpose. Cocoa nuts were sold in Ceylon at 12s. a thousand, so that we might have an idea what a large quantity of food could be got for a very small expense. He might state that the young plants are sometimes eaten. When the nut was thrown into the earth, its little embryo began to burst out on the spots at which the peduncle was attached to the fruit, and at this period the nut was frequently taken up and eaten, in the same way as we would eat asparagus. It was not allowed to grow large for this use.

Several other nuts contained considerable quantities of oil, and were eaten on account of the oil they contain, in combination with nitrogenized constituents. He had on the table some nuts, well known in this country, and which, in the countries where they grow, are of considerable importance, on account of the albumen they contain,—the Brazil nut, or *juvias*, which were produced in considerable quantities in South America, where the natives consumed them as an article of food. They grow in immense bunches, and the weight of them was such, that it really was very dangerous for any one to pass underneath at the time they were getting ripe. *Bertholletia excelsa* (named from Berthollet, the celebrated French chemist) was the name of the tree which produced these nuts. The same materials, which are contained in the cocoa nut, were contained also in the common walnut, in the chestnut, and also in various forms of the nut, and even in acorns. Now, although all these things were considerably used as articles of diet, we did not depend on them entirely, and there was an objection to their use, on account of their indigestibility. It seems that the oily matter is in some such state of combination as in pie-crust; that it had undergone some process by which the starch and the oil combined together, and formed an indigestible compound. He was not able to say, whether the atomic compound could be expresed in chemical equivalents; but at any rate, there did seem ground to believe that the starch and oil did combine together, to form an indigestible chemical compound. Sometimes, the combination between oil and starch was of such a nature, as to produce a solid body, much more so than any of the nuts that were eaten. He had examples from Mexico and Peru, of the fruit of *Phytelephas macrocorpa*, or ivory nut. It also belongs to the tribe of palms; the oil was in combination with the starch in such a manner that it was almost as hard as ivory, and consequently the nuts were easily converted into all those things for which ivory was used. He exhibited also, specimens of boxes, wafer stamps, and a pen wiper, of this vegetable ivory, carved in the form of a monk's head; so that this nut was hard enough to be used for all the purposes of ivory. In the early stages of the growth of this nut it had not this hard character; but in the interior, there was a fluid very similar to that found in the earliest stages of the growth of the cocoa nut. This is well-known to travellers and the natives, and they open these nuts to drink the fluid. But in the course of a short time, the fluid became so hard as to be able, under the hands of the turner, to produce the elegant articles he exhibited. The fluid was also drank from the cocoa-nut tree. Previously to the deposition of albumen in seed, the cocoa-nut contained a fluid, of which this milk was the remainder, which is exceedingly cool, and consequently the natives of the climates where they grow ascend the trees for the purpose of drinking the fluid. Travellers mention this as one of the greatest luxuries. In the interesting missionary voyages of the Rev. Mr. Williams, he frequently alludes to the circumstance of this nut having been gathered by the natives, and with what appetite he drank the cooling fluid. The reason of its being cold was, that the roots of the trunks extended deep into the soil, and the soil at some depth did not come under the influence of the heat of the sun, and consequently, the moisture or water there was very considerably cooler than the external atmosphere; and in passing up through the tree, the sap or water of the plant was constantly being renewed, and there was no time to get heat, and therefore it retained the temperature of the moisture under the surface of the earth, even after being conveyed 200 or 300 feet through the tissues of the plant. He might refer to a great number of other palms used as articles of diet, or for the purpose of making furniture and other things. He should have to allude more particularly to the date palm (*Phœnix dactylifera*) in his next lecture. The leaves and fruit of this palm contained a considerable quantity of sugar. The talipot palm, was another Ceylonese palm, remarkable for the size of its leaves. The leaf was applied to a variety of purposes by the natives, sheltering them from the sun. There was a remarkable incident related in the history of Ceylon, of some British soldiers pursuing the natives, when the natives gained an advantage by being sheltered and protected by the broad-spreading leaves of the talipot palm, which kept their powder dry, while the British soldiers, from the heavy rain, were unable to use their guns. He would next notice the *Areca oleracea*, or cabbage palm, and the *A. Catechu*. The cabbage palm developed its leaves just in the same way as the cocoa-nut tree; but in the early stages of its growth the inhabitants cut off the central bud of the tree and eat it, just as we eat cabbage. The tree ascends to a height of 200 or 300 feet, and yet they make no scruple of levelling the tree for the sake of this bud, which is not larger than an ordinary cauliflower. The betel-nut tree, or *A. Catechu*, produces a small fruit which contains a large quantity of *tannin*. The betel-nut is used for mastication throughout all the countries where it grows as our sailors use tobacco, and it is without the disagreeable flavour and odour of tobacco. Among the palms might be also mentioned the plantain and banana trees. The fruit of the *Musa Cavendishii*, one of the plantains was contained in long spikes, or *racemes*. It was of the most delicious flavour, containing a considerable quantity of sugar and starchy matter, and it became a staple article of diet to the inhabitants where it grew. An attempt had lately been made to cultivate it elsewhere; and these plants had been carried out by the Rev. Mr. Williams, in order to introduce them into the islands of the Pacific Ocean. He had not heard how the experiment had succeeded; but they were carried out safely by means of cases of Mr. Ward's ingenious construction. It would be a singular thing if this *M. Cavendishii* grew to any extent in the islands of the South Sea, through the medium of British ingenuity and British missionary enterprise. There were other species of the *Musa* which also afforded fruit of the same kind.

He could only barely enumerate the plants producing volatile oils, as they were not of such great importance as the others. These volatile oils were remarkable for volatilizing at a temperature at which the other oils were fixed, and were exceedingly numerous; in fact, all the peculiar scents of plants depended upon the quantity, or rather the nature, of the volatile oil retained in them; so that we might gather it from every plant containing such oil, by distillation. Oil of lemons gave the scent to the lemon, and the same with many others. They were commonly used as articles of diet, as stimulants—one of their uses being to stimulate the nervous system, and to excite the action of the heart, and thus to produce increased action whenever they were taken into the system; this was undoubtedly the use they subserved in the animal economy. It was very singular we found hardly any food without some quantity of this volatile oil. He had before told them that the pericarp of wheat contained a volatile oil, which was supposed to render brown bread more nutritious than white bread, which is robbed of this external covering. However, we constantly added artificial volatile oil to our food, when it was not to be found naturally in the plant. The common condiments, pepper and mustard, were from plants containing a considerable quantity of volatile oil, and we add these substances to food which does not naturally contain any of these oils. The nutmeg was the seed of *Myristica moschata*, which was contained in a large fruit or fleshy mass, and the seed was lying in this fleshy mass, covered over with a red substance, which was also known as mace, containing another volatile oil. Cloves were the produce of a plant called *Eugenia Caryophyllata*, also belonging to the natural order *Myrtaceæ*. Mustard is known as a plant which grows in Great Britain, and is manufactured here. Pepper grows in the isles of the Eastern Archipelago. One curious fact as to volatile oil was, that the progress of organic chemistry had arrived at a point at which we were beginning to see the way to imitate them. Already several substances produced in the vegetable kingdom had been produced by the chemist in his laboratory; and at the present time in this country, there was a series of experiments going on, in which there was a probability of obtaining from naphtha, turpentine, and other substances, some of these vegetable volatile oils. Already Dr. Smith, of Manchester had been able to obtain substances very like the oil of bergamot, from the decomposition of naphtha, which was a common substance obtained from gas tar.

He would now proceed to another group of plants, those containing acids; he had before him a number of plants containing acids; and we used them more for the acids they contained than for anything else (such as the currant, the pear, and the apple), although many of them contained considerable quantities of sugar, starch, &c. There had been a question as to whether acids might be regarded at all as articles of nutrition, or whether they ought not rather to be regarded as articles consumed in the lungs for the purpose of keeping up the animal heat. Physiologists had not been able to decide that question,—at the same time there seemed to be good reason to suppose that acids were of importance to the system; not of that importance that the principles are, which were found under the form of *protein;* nor so important as those of the carbonaceous secretions, such as sugar, starch, and oil were; but at the same time there were certain states of the system in which the acids act so beneficially, that we could at once see they might have a constantly beneficial effect upon the system. His auditors were all aware of the nature of the disease called scurvy, occurring occasionally on board our ships, and not uncommonly in ill-ventilated houses on land, and this disease yielded generally to the action of acids. It had been found that the acid which was obtained from the orange, or rather the lemon, was almost a specific for this disease. So much was it considered a specific, that none of our ships belonging to government were allowed to go out without taking a considerable quantity of lemon juice with them, in order that it might be administered as a preventive of scurvy. This disease appeared to result from the operation of two causes;—first, a want of ventilation; for, although sailors were constantly exposed to the atmosphere, yet, during the time they were sleeping, they had very ill ventilated apartments. This seemed to act, in the next place, on the digestive powers, and thus to render the system incapable of digesting the hard unleavened bread, or sea-biscuits, these biscuits containing the starch, which is necessary in the system in order to prevent the oxydation of the tissues going on, seemed to be the cause of the disease we call scurvy. The absorbent vessels were constantly carrying away a large part of the fabric that was being built up; this was carried into the bile, and it wanted carbonaceous matter there in order to convert it into the substance called *taurin,* which, being formed, would prevent these decomposed tissues from passing round into the circulation, and thus communicating to the healthy tissues of the body, that state in which they readily unite with oxygen, and thus become decomposed. We found in scurvy that the whole system was in a state of decomposition; large blotches appeared, in which the tissues of the body united with oxygen; they broke out; the flesh of the part was gone; and in this state the administration of citric acid rapidly relieved the system, even in cases where other forms of starch or carbonaceous matter would not relieve it. There was a difficulty in ascertaining how citric acid could relieve it; but Dr. Playfair, recurring to the fact, that the digestive powers got into such a state that they could not digest the ordinary form of starch, supposed that in this acid, which was easily digested and decomposed, carbon was introduced. He had drawn up, from the results of calculations by Dr. Playfair, a diagram which explained this. Citric acid contains 12 atoms of carbon, 5 of hydrogen, and 11 of oxygen. This carbon was what was wanted in the system, in order to prevent the progress of scurvy; but that carbon must be combined with other substances, in order to form *taurin*, before it could act beneficially on the system. We had here a state of the system in which citric acid would meet with those elements. We had ammonia in the decomposed tissues, water was constantly in the system, and oxygen was freely introduced. One atom of citric acid, 3 of ammonia, 7 of water, and 12 of oxygen would actually constitute *taurin*. Another action, he thought, might be attributed to citric acid; it was that the system got into such a state that it could not separate muriatic acid from the soda, through the food; the citric acid also assisted in digesting the food, and this would explain how it was that it acted beneficially on the system. There were several acids, however, besides citric acid, which were consumed in articles of food. He would, however, allude first to those plants which contained citric acid, among which were oranges and lemons, belonging to the natural order *Aurantiaceæ*. They were all remarkable for possessing a peculiar form of leaf. It was what is called by botanists a compound leaf—one leaf was jointed on to another. It was a compound leaf of the simplest kind. Many other plants were compounded by having several leaflets jointed together; but here there was but one leaflet united to the petiole by a joint. Wherever a plant was found with this characteristic, it might be known that it would produce a fruit which contained citric acid, and that fruit might be safely eaten; as the lemon, shaddock, or lime, and various other fruits of that kind, all of which belonged to this group of plants, and all yielded citric acid. He had on the table some crystalline citric acid, and this was chemically separated from the juice of the fruit, and then it assumed a crystalline form, and in that form it had precisely the flavour of oranges or lemons. The orange had the property of producing a considerable quantity more of sugar than the lemon, and this was the cause we preferred eating oranges as an article of diet. If the citric acid acted as he had stated, oranges were really an important article of diet; and in that state of the system, when carbonaceous matter could not be formed into *taurin*, citric acid was important. Citric acid was also found in the whortleberry, and in considerable quantities in gooseberries and currants. But these contained also another acid, the malic acid. These fruits acted beneficially on the system, by the acids they contained, and they were eaten either raw or cooked. They had the additional recommendation, when cooked, over the green or raw fruit, that the cells containing the starch were burst by cooking, and thus were rendered more easily digestible. The other acid of the currant and gooseberry was *malic acid*, which was found in the greatest quantity in pears and apples, and was the acid which gave to those fruits, as well as to quinces, their peculiar flavour. The apple, when cut into, contained in its juices not only malic acid, but also a considerable quantity of starch, deposited in the cellular tissues of which the fruit was almost entirely composed. These little cells of the apple were burst by cooking, and consequently the apple and pear, when cooked, were more easily digestible; and, when eaten in considerable quantities, they ought always to be previously cooked on that account. There were several other plants belonging to that group or natural order to which the apple and pear belong, which contain malic acid; and this was a favourite group with botanists on account of its containing the common rose, which gave to it its name of *Rosaceæ*. The hedge rose produced hips; the common white thorn produced haws; and each of these small fruits contained malic acid, as did those borne by several other members of the group. The natural order *Rosaceæ* were distinguished by having their stamens attached to their petals or calyx; their stamens were perigynous (inserted round the pistil.) Wherever that character was combined with a fruit, like the apple, would be found a plant producing a fruit containing malic acid, and which might be eaten with impunity. This showed the importance of botany to persons travelling, who might be at a loss in the woods of New Holland or of America as to what it was safe to eat of the various fruits around them. Many sailors had perished from having, while on shore, eaten fruits of whose poisonous character they were ignorant, while the slightest botanical knowledge was sufficient to distinguish the fruit of the *Rosaceæ* which might be eaten with impunity. Apricots, peaches, and nectarines all belong to the same natural order; as did also the cherry. He had not time to go into particulars as to the different characters of these fruits; but the cherry differed considerably from the apple in having its calyx inferior to its fruit, while the calyx of the apple grows to its fruit. This arose from the fact, that the apple was composed almost entirely of its calyx, and what would therefore be a superior fruit was thus converted into an inferior one. Another group of plants, to which he should have to allude more particularly in the next lecture, was that containing tartaric acid, as the grape, vine, &c. This acid had the same properties as citric acid; forming crystals when submitted to a chemical process, and was easily obtained in the form of crystals.

Many other plants contain tartaric acid, but the grape was the great soure from which it was obtained, and it was the more easily obtained from the grape, because it was used in considerable quantities on account of the sugar it contains, for making wine; during which process there was a separation of the tartaric acid in the form of tartrate of potash, and it was from this source that the tartaric acid of commerce was obtained. Carbonic acid flies off, and gives to wine that liveliness and effervescence, to produce which tartaric acid and carbonate of soda were sometimes used. However, he would warn persons against taking quantities of these effervescing draughts; for the tartaric acid, when combined with carbonate of soda, was in a state in which it was likely to communicate its own peculiar chemical state to other things in the stomach; and Dr. Prout had stated that he believed more injury was done by taking effervescing powders than by any kind of diet we were in the habit of consuming. There was another kind of acid, commonly known only as a poison, but which was frequently taken safely as an article of diet,—oxalic acid, which could be obtained from certain plants, just like the other acids, and like them was also obtained in the form of crystals, which were much like those of Epsom salts, for which they were sometimes mistaken. Oxalic acid had long been employed for taking stains out of cloth, cleaning boot-tops, &c., and when taken in any considerable quantity was a poison, but in small quantities, especially when combined with an alkali, as potassa or soda, it became an agreeable acid, and acted like the other acids. However, neither tartaric, malic, or oxalic acid contained anything like the quantity of carbon that citric acid did, and this was why citric acid acted so beneficially when the other acids did not. The plants containing oxalic acid were numerous, especially amongst our British plants, as the common sorrel, *Rumex acetosa*, and another, *Rumex acetosella*, which was used in some countries in considerable quantities, in salad, and which contained in considerable quantities the super-oxalate of potassa. He showed some specimens of the *Oxalis* (from which the acid had its name, having been first obtained from this plant), *O. acetosella*, and *O. carnosa*, (so named from the fleshy character of the leaves), which was not a native of Great Britain, but a foreign plant. But the most extensive use of this acid as an article of diet was one of recent introduction, viz. in rhubarb, which plant, only a few years ago, was unknown, except in the apothecary's shop, where its root was used in considerable quantities. But it was not the root which was used as food, or which contained the oxalic acid, but the petioles of the leaves; and, by cultivation and attending to the development of this part of the plant, we had succeeded in producing leaves of immense size, so that it could be consumed in considerable quantities at small expense. One great advantage was, that the leaves were produced early in the spring, long before we could have recourse to apples, or gooseberries and currants, and formed an agreeable substitute for those fruits; so that we were able, by preserving last year's fruit, and growing rhubarb, to have acid food throughout the whole year. There was still another acid used in considerable quantities, but not produced naturally by any plant, but by a change taking place in the character of the plant. This was acetic acid, or vinegar, which was constantly used as an article of diet. This might be obtained direct from the distillation of wood, the starch and liguin of the wood entering into a certain decomposition, by which vinegar was engendered. He pointed out that sugar, starch, vinegar, orange juice, alcohol, morphia, and hydro-cyanic acid had all similar chemical constituents, differing only in their proportions The acetic acid was produced from the sugar and starch in the wood; it was also obtained from alcohol, by the oxydation of the alcohol, and consequently it was frequently found that alcoholic liquor became sour, from the formation of acetic acid. Before vinegar was obtained from the distillation of wood, the common mode of obtaining it was from wine being set out in the air, to undergo the necessary change from alcohol into vinegar. This article, like any other acid, might be used too extensively, and vinegar was introduced in a more concentrated form than any other acid, and must therefore act more injuriously. There could be no doubt that it entered into the system, and was digested in the same way as citric acid. But it might also act by constringing the coats of the stomach, and thus prevent the due secretion of those matters necessary for digesting the food; it would then act injuriously. It had gained an unenviable notoriety, by being used by persons who wished to produce indigestion for the purpose of keeping thin. But this was a dangerous experiment; and a case was related of a young lady who wished to be thin, and took so much vinegar that at last it produced such a state of the system that tubercles were developed, and she shortly afterwards died of consumption.

He had thus brought to a close his remarks upon these two classes of vegetable secretions. There were many practical points connected with this subject, to which he might have alluded, and more especially to the influence of diet in the production of the various forms of disease which now, as it were, characterise the civilised community. He had intended entering on the subject of the development of tubercular and scrofulous diseases in civilized communities, as depending greatly upon diet; but he thought this might be rather transgressing the bounds he had given himself in these lectures, and might be considered too medical. However, with respect to the production of these diseases, there was one great thing connected with the taking of diet, and the state of the body thus produced; and that was, unless a sufficient quantity of oxygen were introduced into the system, for the purpose of the oxydation of the various kinds of food introduced into the stomach, they must be deposited in the body in the form of inorganic matter, which thus produces a state of the system which will at last terminate in death. This state exposes the body to the action of the oxygen, so that the body goes on consuming, and consumption was thus produced. It was in vain to suppose that any system of dieting could be beneficial, unless there was this due supply of atmospheric air, which formed, as it were, one-half the essential conditions necessary to nourish the body. There were numerous instances of diseases being entirely engendered by the want of a due supply of atmospheric air; and this subject could not be too much or too carefully attended to. People were constantly introduced into close and heated rooms, and there shut up for hours, while carbonic acid gas and other matters floating in the atmosphere were constantly given off; and there could not be the slightest doubt that it must engender a vast mass of disease, and be the cause, more frequently than any thing else, of the great proportion of scrofulous diseases. Where persons had plenty of exercise in the open air, and consequently possessed access to oxygen in the air, there consumptive scrofulous diseases seldom occurred.

LECTURE IV.

SUGAR—SUGAR-CANE, LIQUORICE. FERMENTATION—ALCOHOL, WINES, SPIRITS, BEER.

Dr Lankester said he had in a former lecture mentioned the natural order *Myrtaceæ*, as including, amongst other plants that which yielded the pomegranate,—one of such singular structure that botanists were uncertain where to place it. There were several other plants equally interesting, which were included in this group. The pomegranate was a very beautiful plant, and especially its flowers. It had not much of the character of a myrtle; but, if carefully examined, the affinity between the pomegranate and many other plants of this order was very evident. The fruit is a beautiful structure. It consists of a remarkable pericarp, or covering, which is hard, and of which most persons who had seen it would at once know the character. Inside, it was filled with little red seeds, and these were placed in the midst of a quantity of loose cellular tissue which yielded a large quantity of acid, and that was why he had spoken of it amongst the acids; but it also yielded sugar, for the fruits of plants which were eaten generally contained both sugar and acid. The outside of the fruit was not eaten; and it had a peculiary bitter character, for which it was used in medicine. The seeds had also the same bitter character, dependent upon a secretion, and which also rendered them useful. But the cellular tissue was the part which was eaten and had this acid and saccharine flavour. The *Myrtaceæ* also yielded the plant *Caryophyllus aromaticus*, which he spoke of in his last lecture as yielding a stimulant oil agreeable in diet. The *Myrtaceæ* yielded also the various species of the gum tree of New Holland (*Eucalyptus*), which were great ornaments of our gardens in the present day. The *Leptospermum grandiflorum*, was remarkable for having been partaken of by the sailors in Captain Cook's first voyage round the world. The scurvy broke out, and they had recourse to this plant, which was used by the natives of New Zealand for making an infusion similar to Paraguay tea; and it was said that this plant cured the sailors of scurvy. It was known by the name of the New Zealand tea plant. This order, the *Myrtaceæ*, yielded oil of cajeput and pimento, and other important oils: the whole order was characterised by possessing plants yielding these oils; and if we examined every plant belonging to this natural order, we should find that its leaves were dotted over with little dots or glands, in which cells were contained small quantities of oil. The cellular tissue between the glands contained no oil, but merely cellular tissue, and the ligneous matter of the leaf. The guava plant of the West Indies, *Psidium Cattleyanum*, now introduced into our hot-houses, yielded an agreeable fruit. Some persons doubted whether it was as good as many of our native fruits; but it had the advantage of yielding its fruit, in this country, twice in the year, when grown in proper places, and was therefore a very desirable plant for a hot-house. Other plants of this kind, the *Psidium Guiniense*, and the white guava and black guava of the West India islands had the same characters. Botanists had proceeded too far when they asserted that the structure of a plant was always accompanied with peculiar properties. The order *Myrtaceæ*, contained plants of all kinds.

He would now proceed to the subject of the present lecture, namely, plants yielding sugar. All plants more or less yielded sugar as a secretion : it was a production of plants generally, not so much for the use of the animal creation, as a fundamental portion of the plant, formed for its own nutriment. It belonged to the carbonaceous group, containing carbon, hydrogen, and oxygen, but no nitrogen ; which sugar did not contain when pure. Its action on the system was the same as that of starch or oil ; but why was one better than another ? Sugar was more digestible than starch or oil : consequently, in most cases, we should prefer giving sugar to oil or starch. There was also something in flavour. We had the organ of taste given us to direct us to what was most agreeable ; and we found that sugar was most agreeable to young individuals of the higher group of animals, the *mammalia*. Sugar existed abundantly in the earliest food which the human being partook of. Human milk contained a certain proportion of water, sugar, albuminous matter, and an oleaginous matter ; but the sugar preponderated. It was on this analysis of the food of all the higher forms of animals, that Dr. Prout formed his celebrated divisions of foods. He found water, sugar, albumen, and oil, in milk, and consequently divided his table thus :—Food which contained water as a principal ingredient, he called aqueous ; that in which sugar was a principal ingredient, saccharine : those containing albumen (differing somewhat from other chemists in his use of this term), albuminous ; those which contained oil, or its elements, oleaginous. The saccharine elements were more easily digestible, and this was why sugar was so important an article of diet to mankind. Sugar might be taken in large quantities, as well as other carbonaceous materials, without being burnt in the system. It was not necessary they should burn ; but, if they remained in the system, a change took place in these principles, and they were converted into other principles very analogous. Thus, when sugar and starch were taken in considerable quantities, the individuals taking these got fat ; this arose from the fact, that sugar and starch are not burned, but converted into oil, which is then deposited in the cellular tissue. It thus becomes a provision against the want of these carbonaceous materials. At certain seasons of the year, certain animals have abundance of carbonaceous food. They eat large quantities of it, more than they want to keep up the heat of the system. But the superabundant matter is converted into oil, which is not burnt, but carefully deposited in the form of fat. The time came when the animal could get none of the carbonaceous articles of diet, and then it fell back upon the fat in its own system. It was a singular fact that those animals which had the smallest lungs, got fat most rapidly. Dr. Playfair had observed that small lunged animals got fat quickest. This arose from the fact that small lungs did not expose the blood so freely to the action of oxygen; and thus the carbonaceous food was only converted into fat. Dr. Playfair had also found that animals with the broadest chests had the smallest lungs. He (Dr. Lankester) had met with a curious confirmation of this fact, in examining the tables made by Mr. Hutchinson with his spirometer. He there found that the weight of the individual was always in relation to the breadth of the chest. Mr. Hutchinson had found a relation between the quantity of air expired and the height of the individual; and he (Dr. Lankester) had found an equally remarkable relation between the breadth of the chest (indicating small lungs) and the weight of the individual. He had before told them that the consequence of the want of carbonaceous secretions was the production of a state of the system we knew by the name of scurvy; and this would undoubtedly come on in animals which required these secretions, if they were unable to deposit this fatty matter, and use it as their system required. With respect to sugar, as it occurred in the vegetable kingdom, it was exceedingly interesting that sugar was really required in the system of plants; and, although we go to plants, and take it from them, as if it was laid up there for ourselves, it had a purpose in the vegetable kingdom; and all this sugar would be formed in plants for the purpose of its own existence, had there been no animal existence to partake of it. However, sugar was subservient to certain purposes in the animal economy. He told them that sugar was found in the sap of the cocoa-nut tree. The sugar ascended along the cocoa-nut tree, in the sap, for the purpose of being converted into another element, and being deposited in the nut or seed. What purpose did starch subserve? The young plant converted the starch again into sugar for its own nutriment and growth. Thus these elements were constantly undergoing these changes. We found this was generally the case: the first introduction of the matter into the system, was the formation of a saccharine secretion. Thus maize, when growing, before the seeds were developed, contained sugar in its stem, which might be extracted or taken out in the sap, and large quantities of sugar obtained from it for the use of man. This was the case with nearly every plant; while growing, they had sugar in the sap. What this was formed from, was another matter, known by the name of gum; a matter which did not seem capable of being digested in the human system, and consequently ought not to be taken as carbonaceous aliment; but it was universally found in young plants. The only condition which young plants required to begin to grow, was to be supplied with plenty of carbonic acid and water. It converted the carbonic acid and water into gum; and this gum had again to pass through the cellular tissues of the plant, to get converted into sugar. How this change was effected, he could not say; but the gum, or the starch, or the sugar (whether grape or cane sugar), all contained 12 atoms, or just the same proportion of carbon; and then hydrogen and oxygen existed in all these secretions in the form of water; and they differed only in the proprotions of water they contained. The starch contained a certain quantity of water, and the sugar contained a certain larger quantity of water; while the gum, on the contrary, contained a less quantity of water. Therefore, the change seemed to be effected by the gum gaining water, and becoming starch; and then gaining more water, and becoming sugar. Some intermediate formations of this process were exceedingly interesting. They were all aware that, in the proces of malting, we availed ourselves of this conversion of starch into sugar. The young grain of barley contained, when thrown into the ground, starch, as the principal constituent. It contained also a nitrogenous principle, which seemed to engender an action in the starch, which caused it to unite with water; and then the plant began to grow, and it was converted into sugar. In malting, the seeds of barley are allowed to begin to germinate, till the starch is all converted into sugar. The process of germination was stopped by exposing the barley to heat; when a considerable quantity of sugar was developed, which was the cause of the sweetness of malt. This sugar was afterwards employed for the purpose of fermentation, for the making of the liquid called beer. While the starch was passing into sugar, a compound was formed, called *dextrine*, which had a slight sugary flavour, and was like starch, evidently indicating its progress from the one state to the other. It was a carbonaceous secretion with another atom of water added to starch; but not enough to form sugar. Another compound was an exceedingly interesting secretion in the carbonaceous group, a substance which chemists knew by the name of *lignin*, which formed the great bulk of the woody fibre of plants. A great part of the tissue of plants was made of *lignin;* and this, which was something like gum, we could not digest; but an elephant could. He pulled down the trunks of trees and large branches, and devoured them; and many *ruminantia* would take the young shoots of plants and devour them. *Lignin* contained a definite proportion of carbon, and a certain number of atoms of water, hydrogen and oxygen. These were arranged in such a way as not to be digestible; but, so as by the slightest change, easily to become so. If we took a large quantity of sawdust, and added sulphuric acid to it, it would convert the *lignin* into sugar; first, perhaps, into starch; so that we could get starch or sugar according to the quantity of acid we added. This process carried on by sulphuric acid would act by abstracting the water, for which it had a powerful affinity. When too much sulphuric acid was added to the sawdust, it developed the carbon, and took away all the water. Oil of vitriol, dropped upon a table, took away all the water from the wood of the table, and left nothing but the charcoal. He believed no manufacture had ever been attempted of sugar from sawdust; but it might be done. Starch might also be obtained in the same way; and thus, in extreme cases, where food from the fruits and stems of plants could not be obtained, we might convert this lignin into starch, and in saw-pits we might obtain food fit for the purposes of the human economy. The lecturer here exhibited a specimen of lignin, developed by a solution of nitric acid, being the ligneous portion of a stalk of henbane Although we never thought of eating wood, yet we were constantly eating starch, so nearly allied to wood that the slightest change would convert it into wood. But to speak more particularly of plants containing sugar; the principal supply was from the plant called the sugar cane, or *Saccharum officinarum*, which belonged to the natural order *Gramineæ*, to which belong wheat, maize, rice, &c. The sugar cane had not been known to Europeans for any great length of time, as a means of supplying an article of diet; and, till within a recent period, sugar was used only as medicine,—till the time of the crusades, when it appears that the numbers of persons who went from the northern parts of the world to the East, at that time, found this sugar cane was used; and it was first distinctly described by some writers who gave an account of those remarkable expeditions. There was reason to suppose, that not till after this period was sugar used as an article of diet in Europe. Sugar was formerly obtained from the grape and from the fig; and that from the sugar cane was only used as a medicine. The native countries of the sugar cane seemed to be China and the East Indies; but there the sugar cane was not now principally cultivated. Where it was now most extensively cultivated, in the European colonies, was not the native place of the sugar cane. It did not grow originally in the West India islands and various districts from which it was brought to this country. This proved, that, although the plant was not indigenous, we might expect constantly to introduce from countries having a climate like our own, the fruits and plants native there, and thus to constitute that diet which, after all, was essential to the welfare and health of man. The sugar now brought into this market was obtained principally from the West and East Indies. In the West India Islands it was grown in considerable quantities, and it was also obtained in considerable quantities in the East Indies; but a great portion of sugar, till recently, had not been so carefully cultivated in the East as in the West Indies; and consequently, till lately, we had been almost entirely dependant for supply on the West Indies. In all parts of the world, the principles on which sugar was obtained from the cane were the same. The sugar was rising in the sap to supply its flowers, leaves, and seed, with the necessary nutriment,—just as in the cocoa-nut tree and maize,—and it was just previous to the time that the plant was preparing for the development of the seed or fruit, that the sugar abounded in the cane in the largest quantity. The cane was then cut down, and cut into small pieces, and bruised in a machine; and after it was fully bruised, it was pressed very hardly, and the fluid was allowed to pass into large vessels. This was submitted to the process of boiling, the object of which was to get rid of a certain quantity of water and impurities contained in the sap with the sugar. It was then allowed to cool, and we found at the bottom of the vessel a substance, which was sugar. It was mixed with a quantity of treacle, which was nothing more than sugar in an imperfect state of solution, with some nitrogenous or albuminous matter, which was obtained from the pressure of the stem. The treacle was afterwards allowed to drain off; and according to the quantity of treacle taken away from the sugar, was its excellence for the European market, and it was then sent to the market. Our coarse brown and fine crystallised sugar only differed in the quantity of treacle they contained. The sugar, when allowed to crystallise slowly, assumed a larger form than when it was crystallised rapidly. And thus, if common brown sugar were boiled, and allowed to crystallise, it would form sugarcandy; and these crystals had just the same shape and form as, but were of larger size than, those of brown sugar. But the sugar cane was not the only plant which produced sugar. We had grown in this country, for the diet of animals, beet-root, or mangel wurzel, which had a very sweet flavour; and as soon as this became known, and chemistry had commenced to be applied to vegetable productions, it was attempted to obtain sugar from the beet-root; and during the time Napoleon Bonaparte pursued his continental system, the Germans had recourse to the manufacture of beet-root sugar, and it was found to succeed during that period. They obtained a considerable quantity of sugar from this beet-root. It then became an object of speculation among the French themselves; and although the Germans had given it up to a very considerable extent, still in France, it gained ground rapidly; and at last, when a better system of legislation was adopted by the French generally than that of Napoleon, with respect to commerce with other nations, it was found that the beet-root cultivators were a powerful body, with sufficient influence over the government to induce them to yield; and it was a remarkable thing, that France protected the beet-root sugar cultivation, though as stated by a writer in the *Quarterly Review*, it could not have lost by it, of dead loss, in not procuring cane sugar, less than £150,000,000 of money. We might as well try to cultivate cotton in this country, as the French to cultivate the beet-root for sugar, as a profitable article. There were other plants, as the turnip, the carrot, &c., and indeed all the roots eaten, which contain a considerable quantity of sugar, which might be obtained from them. Sugar might be obtained from the grain of corn, and the fruits of the grape, the currant, and raisin; and were it not a more profitable thing to consume them immediately as articles of diet, it would probably be done. Some of our forest trees which did not possess sweet fruits contained also sugar in their sap. The maple was a remarkable instance. It grew in considerable abundance in the forests of America; and there the first settlers soon found the sap was sweet, and obtained their sugar from it. The tree was tapped, the sap exuded from the tree, and the sugar was formed by boiling it down. He had some maple sugar, which any one might taste after the lecture; it had a sweet flavour, and was the same thing as grew in the sugar cane. The *Caryota urens* (or jaggary palm), which grew in Ceylon, was so called from the fact that its sap was collected, as the cocoa-nut sap, and, being boiled down, it yielded jaggary. He had said that the maize had considerable quantities of sugar, and it had also been used in America for the purpose of obtaining sugar; and he understood the plan was now carried on to a very great extent there, of cultivating maize; and then, during the early stages of its growth, taking off the flower-buds, and extracting from it the sap. He did not know why they should not do it, as with the sugar cane. Our own wheat, barley, and oats, might be made to yield quantities of sugar in the same way. This preparation of maize in America was likely there to supersede the sugar cane. However, at present it must be considered but as an experiment. There were many plants containing a much larger quantity of sugar than others, and they might be made substitutes for the use of sugar as an article of consumption. He had specimens of the fig, which contained remarkable quantities of sugar. On the outside of the fig accumulated large quantities of fig sugar, arising from the evaporation of the water, leaving the juice in the shape of sugar. The fig, in some parts of the world, supplied large quantities of food; and it was interesting to botanists on account of the peculiarity of the part eaten, which was not botanically the fruit, but the receptacle of the fruit. If we cut into one of the fruits, when it was beginning to change from green to brown, before it was mellow, we found it to possess a number of little bodies inside, which looked like grains, and were called seeds; but which, in the earlier stages of growth, were found to consist of little flowers, with and without stamens. Those little things inside the fig, were the real fruits, and inside them was the seed. The part on which a flower rests in a plant was always called the receptacle; so that the fig was the fruit-receptacle. Sometimes the receptacle was extended, as in strawberries; of which the part eaten was the receptacle, and the seeds were the real fruit.

There was another plant which produced a substance similar to sugar, the *Glycyrrhiza glabra* of botanists, belonging to the *Leguminosæ*. This plant was not a native of Great Britain, but had been introduced. It was grown in one district alone, in any considerable abundance, at Pontefract, in Yorkshire. The reason was that the liquorice, in order to produce fruit, and the sap in which the sweet juice was contained, required a very considerable depth of soil; and in the valley of Pontefract there was a large tract of deep soil, in which the liquorice grew well. However, the liquorice consumed in this country was not obtained from British growth, but from various parts of the continent,—the Italian juice being considered the best. The sweet secretion was called *glycerine* by chemists, to distinguish it from sugar. This substance children knew very well, from its use during colds and hoarseness, for the purpose of lubricating the throat and fauces. The root contained the glycerine or liquorice, and the mode of preparing it was very simple. The root was boiled with water, and then the glycerine, being exceedingly soluble, the water took it up ; and the water being evaporated, we got a mass very like the preparation which occurred in making Pontefract cakes. This substance was not obtained, as sugar was, directly from the sap, but was really an extract; the water having dissolved it, and left it in the vessel. Glycerine or liquorice sugar, there was every reason to believe, had the same dietetical properties or qualities as the ordinary grape or cane sugar, and consequently might be used for the same purposes. It was, however, seldom applied to those purposes, but used rather as a medicament; and he did not know any objection to it at all. It had the property of lubricating the fauces, which were generally dry under an attack of slight inflammation; and thus persons felt relieved by sucking it.

The consumption of sugar in this country was very great ; but it was remarkable that it had not increased within the last thirty years. In 1815 we consumed two million cwts.; and in 1841 the figures were the same—two million cwts. This was very extraordinary, when we considered that the population had nearly doubled in that period. Whether it had been from there being any more difficulty in obtaining this article, a necessary of life, and so essential to the comfort of life among the lower classes, he did not know. But at any rate it seemed a subject worthy of attention why an article so generally used, and so greatly conducive to health on account of its easy digestibility, should not have increased in consumption during that period.

Sugar, in the system, underwent a considerable change before it was burned ; and no doubt, under the influence of some peculiar secretions of the stomach, changes were required to prepare it for that process. There was a form of fermentation which differed from that of wine, or alcohol, called viscous fermentation, which seemed to take place in sugar when introduced into the system. Thus mannite and lactic acid were produced. Lactic acid had the property of easily dissolving phosphate of lime, which was introduced in considerable quantities into the system, and must be dissolved before it was taken into the bones. He had told them why brown bread was beneficial, because of the pericarp of the wheat eontaining phosphate of lime. Our bones contained phosphate of lime; now the substance which dissolved that would undoubtedly hasten the process by which phosphate of lime was deposited in the bones. Lactic acid dissolved phosphate of lime, and thus, probably, performed an important part in the economy of the human frame. It, however, might be taken in too large quantities, and lactic acid generated in too great supply for the health of the system; and, when deposited in the tissues, it induced other acid secretions ; and there were diseases which were attributed to too great acidification of the system, likely to result from a sugar diet, taken when the system was disposed to form acid. If persons were healthy, there did not appear to be any objection to sugar. The negroes, during the preparation of it, eat very considerable quantities, as while they are cutting down the sugar-canes they are then very seldom seen without a piece of cane to suck. During that time, the people were observed to grow fat and this would go some way to prove the previous point mentioned, that these things were capable of conversion into oil; the fact of the negroes growing fat when they took a large quantity of sugar was something like a proof that sugar was capable of being converted into the oily substance called fat. However, it was said that the negroes would live entirely on it, and that children were frequently fed for months altogether on nothing but the cane. The moment a child got up in the morning, it got a piece of cane, which it sat eating and sucking all day long; and when that was done, it got another piece. If there was nothing else but sugar in the cane, the children could not live upon it. It would act as all carbonaceous ingredients must do, but would not strengthen. Now, it required that there must be added to this some nitrogenous principle; and in the sap of the sugar-cane there was contained a quantity of albumen, which was a nitrogenous principle. Hence it was that persons who lived on sugar-cane might be very healthy, while they who lived on fine sugar would soon become diseased. The forms in which sugar was used in this country for consumption were various. The refined or white loaf, was prepared in this country from the common brown soft sugar, brought from the West Indies. The sugar candy was not much used, being merely a crystalline form of sugar, not so pure as the white sugar, as the colour indicated, which arose from the slight mixture of treacle, or impure solution of sugar. There might be prepared, with care, a quite white sugar candy. There were also other preparations of sugar. Sometimes fine sugar was boiled down, and a solution was made of it, called syrup. This was again exposed to evaporation; and, when in that state, it would admit of being moulded; and we found the varieties known as barley sugar, taffy, and various forms of acidulated drops; and other instances of the syrup boiled down, and the acid of lemons, or other acids, added to them. Sometimes cayenne or other volatile oils were added; giving a character and flavour to the sugar thus prepared. The molasses, or treacle, was brought in large quantities to this country, and was also obtained in the preparation of the refined sugar. It was also used as a food, and there was no objection to it. It contained a nitrogenous matter, and was undoubtedly more nutritious than sugar: therefore, in spreading treacle on bread for children, we were giving them nitrogenous matter, or protein. There was a substance called burnt sugar, used for colouring various fluids; and brandy, when distilled, was quite clear, till this was added to it. All the forms of hard confectionary, such as comfits, and other little things given to children, were preparations of sugar; and various fruits were boiled down with sugar, forming preserves. What he had said would be sufficient to point out why we used sugar, to enable persons to see in what forms we were using this article of diet.

When sugar was exposed to the action of a nitrogenous substance, in a putrefactive state, that state was communicated to the sugar; and the sugar, when in conjunction with water, combined with the water, gave out carbonic acid, and was converted into another thing, into a substance we call *alcohol*. It was a composition not virtually differing from cane sugar; by the addition of an atom of water, and the escape of carbonic acid, the one was converted into the other. This continued when we threw putrefactive matter into a sugary solution. This was the way in which the various forms of alcoholic liquors were obtained. We take the juice of the grape, the hot solution of malt, or any other form of sugared solution, and throw in some fermenting putrefied matter; and the process was immediately communicated to the sugar, and in a short time alcohol was developed from the elements of the sugar. This process had been known apparently from time immemorial, and must constantly occur where sugar was kept at all, and especially if a fluid were added; for if sugar came in contact with water, and putrefactive matter were added, the change described must take place. Mankind must, from an early period, as we find from history, have discovered this property of sugar, and so learned the properties of alcohol, which were exceedingly different from those possessed by sugar. Alcohol possessed an intoxicating power, combining in some manner with the nervous matter of the system,—that system by which we were placed in relation with external creation; and the consequence was, that it altered the ordinary sensations, and the ordinary process of reasoning and reflection on them, and constituted the state we knew as intoxication. However, although this state was produced, alcohol had been used as a beverage in conjunction with water (never by itself), by a considerable portion of mankind. One of its first effects was that of excitement, and a considerable degree of pleasurable sensation; and for that purpose alone it was sometimes taken. In that point of view it was like various other narcotics, to which men had recourse in various parts of the world. The coca of South America, the opium of China, and tobacco, were instances of the same kind of excitants of the nervous systems, but in a much lower degree. Now, the question must occur to every one as to whether this excitement could be good under any circumstances; he spoke now of the action of alcohol on the nervous system. It did appear that the nervous system was capable of being exhausted; and although men or animals in their natural state would not exhaust the nervous system; yet, directly we removed man into the artificial state of civilised life, disease of the nervous system takes place, and there was such a thing as being exhausted, or the exhaustion of the nervous system. Could it be remedied? and how? It might be remedied by various stimulants, and these narcotics seemed to have the power of refreshing the exhausted nervous system; and on this ground alcohol had been had recourse to, as an article of diet, and generally as a medicine. This was a state which seemed very generally to occur in civilised communities. The nervous system was taxed to the utmost, and consequently the necessity of having recourse to slight stimulants to supply that exhaustion was generally felt, and the consequence had been a very general use of alcoholic beverages. There was, however, another point of view in which we must look at alcohol. If we examined its constitution, we found it had a similar composition to sugar, starch, and oil; and the question was, as to whether it could ever act upon the system by keeping up the animal heat of the body. There could be but little doubt on the mind of any physiologist or chemist, that alcohol in the system was easily burned, and most easily burnable; consequently, for the purpose of keeping up the animal heat, it was the best element we had. And a confirmation of this fact of the burning of alcohol in the system, in the union of oxygen, was that persons in cold climates could drink a very much larger qwantity of alcoholic liquors than those in warm climates; which arose from this, that the system being exposed to cold air, the heat of the body was rapidly carried off, and alcohol supplied the material for making more heat, and keeping up the functions of the system. It might, consequently, be taken in larger quantities by people in cold than warm climates, especially if the cold be combined with moisture in the atmosphere. In Holland, and places lying low, people could consume considerably more alcohol in spirits than in countries more elevated. The farther we went north in our own country, the stronger we found this love of ardent spirits; and our Scotch brethren were remarkable for the quantity of alcohol they consumed in the form of whiskey. There were considerable dangers attending the taking of ardent spirits as stimulants; seeing their power was so great over the sensationary and the reasoning faculties. Persons might use them; and after having brought the nervous system up to a healthy point, from its previous exhaustion, they might carry it a little beyond that, and produce a state of excitement, which would be again followed by exhaustion; and then, if again they had recourse to the liquid, and caried it beyond the right point, it would produce at last a permanent state of exhaustion of the system. Persons habitually taking any large quantities of wine or beer would get into a state in which the nervous system was completely exhausted. With respect to the consumption of alcohol as a diet, and to keep up the animal heat, he might say, than when digestion was good, and man was placed in circumstances not to require a large quantity of heat to resist cold, he had no occasion to have recourse to it: in cold climates, considerable quantities of it might be consumed. There was another question which he did not wish to interfere with; but he would just allude to it. Persons had thought that, on moral grounds, it was not their duty to take these liquors at all. He most ardently admired those who underwent this self-denial, if they knew they might be doing themselves harm. He thought they had a perfect right to do that as an act of self-denial, in order that their example might not be injurious. At the same time, he thought that the whole question of abstaining from alcoholic liquids should be placed on moral grounds, and not on those of a physical kind. He did not believe it could be maintained, with respect to the whole mass of mankind, that they would be better without ardent spirits at all. This was a point which had never been demonstrated. He did not think, from the abundance of alcohol supplied to us, that that question could be entertained; and, therefore, he thought those who abstained on moral grounds should not come forward and make the general broad statement that these things were all injurious; declaring that every one who took alcohol was doing great physical injury to himself, and inflicting a moral injury on his fellow-creatures. He had intended going briefly into the composition of some of the liquids, the products of fermentation; but he should do that much more briefly than he had intended, on account of the consumption of time. The plant, the sugar of which was mostly used for the purpose of producing fermentation, was that of the grape. We had the earliest record of its juice being used for producing fermentation, and afterwards for consumption as a fluid we knew by the name of wine. It had been so extensively cultivated throughout the world for this purpose, that, although now occupying districts both in the old and new worlds, we could not assign to it any given point, where it was indigenous. There was a district in Persia where it was said that the vine climbed over the forest trees, and the natives were never able to gather the whole crop: there, then, it might be indigenous. At any rate, in that part of the world was the first historical record of the use or abuse of wine. The grape vine was cultivated throughout Europe, and in considerable districts of Africa and America, not only for the purpose of procuring its fruit, but also its juice for fermentation. The juice was extracted by pressure,—the ordinary mode of obtaining the juice of plants,—and then exposed to the action of putrefactive matter. A fermentation was thus produced, which after a time subsided; and when the fluid was poured off from the grapes, we had remaining at the bottom of the vessel a substance called tartar, or the tartrate of potassa, producing tartaric acid, and the fluid above was the wine. These wines were various in their composition, not according to the character of the fruit, but to the district in which the grape vine was planted. The grape vine was known to botanists as the *Vitis vinifera*, and there was no other species of *Vitis* which yielded wines of any value at all. Wines, after being bottled, contained several ingredients. That which gave to them their distinguishing character was called the *bouquet*, or the odour of the wine, which had lately been the subject of investigation by Professor Liebig, of Giessen, who found that it depended on œnanthic acid, united with alcohol, and forming an ether. Alcohol uniting with acid—formed ethers: thus we had nitrous ether, &c. The standard article in the composition of wines was alcohol, which varied in quantity very considerably in different wines. The light French and German wines contained a considerably less quantity than those drunk in this country, as sherry and port; and he would just point out this fact, that as a means of keeping up the heat and stimulating the nervous system, we did not require so much alcohol in warm or hot weather, as we did in cold; the latter wines ought therefore to be taken during hot weather somewhat sparingly, while they might be taken with advantage in wet and cold weather. Wines also varied in quality according to the quantity of sugar they contained. Grapes produced varying quantities of sugar; and thus we had sweet wines and dry wines. There was more than one acid contained in the grape, and these varied in quantity; but tartaric acid was the principal. In that state of the system, when it had a tendency to form acid, persons should avoid taking the wines with large quantities of these acids. There were wines with little or no acid; but the light wines of Germany, which were called Hock, Moselle, &c., generally contained considerable quantities of acid, and should not be drunk by persons who had a tendency to form acid. Then they varied in the colouring matter they contained; the dark-coloured grape producing the red, and the light grape the light colour; this caused the difference between the colour of port and sherry. These were the principal constituents of wine, and we knew them sufficiently definitively to recommend particular wines in particular states of the system. The ardent spirits consumed in this and other countries were merely the alcohol distilled in particular forms, from particular substances. Thus, wheat and barley might be fermented; and, instead of getting beer, we need not add hops, or so much fluid, but at once distil alcohol. Whiskey was obtained from wheat and barley: and gin from various species of corn. It differed from whiskey in possessing a small quantity of oil of juniper in it, from the addition of juniper berries. Whiskey contained a considerable quantity of empyreumatic oil, arising from the mode in which it was distilled both in Scotland and Ireland. Rum was obtained from molasses and treacle; and a flavour was given to it by the addition of pine apples. Brandy was obtained from various forms of wine, with the addition of peach kernels, which added hydrocyanic acid. Beer had just this advantage over the ardent spirits and wines; he had mentioned that it was generally drunk in combination with a bitter principle, which was procured by the addition of hops, a vegetable secretion called *lupuline*, which modified the taste and flavour of the beer, so that it acted both as a stimulant and a tonic. It had become a favourite drink, and in consumption almost rivalled tea and coffee.

He had now brought these somewhat desultory remarks to a close. He trusted, however, that he had not failed in conveying an impression of the great provision constantly made in the vegetable kingdom for the support of the animal kingdom; and that a wise, good, and beneficent Creator had abundantly provided more than sufficient for the support of the whole animal kingdom; and whenever the cry of distress was heard, and want of food was its cause, we should remember that some great law of Providence had been broken somewhere. The bountiful Creator had provided an ample store of provision, which he had spread everywhere around us, and there was no assignable cause in his Providence why one single man should want. That was a subject to which, he hoped, these lectures would draw attention, because he felt that no one ought to want amidst such natural abundance. He trusted, also, that an impression had been produced of a beauty in the laws of the two kingdoms of nature, quite independent of the wants of man, or the *cui bono* of the question. He felt a loftier consideration always involved in these wondrous laws of the universe, by which all were maintained. We all felt that we, in common with inanimate nature, formed part of the one great whole, the produce of one great Mind. This was an elevating thought, and one which ought to lead us to study those things which might not immediately render us mere pecuniary advantage for the time spent.

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