The Thesis of
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On the Chemical and Physiological Balance of the Food

In treating of this subject we are naturally led, first of all, to offer a Synopsis of the functions of Digestion. On this head we shall endeavour to curtail our remarks as much as possible, and to accommodate them to the general subject of the Thesis.

As regards the title of the Thesis itself, it is not pretended that, within the limits to which we must necessarily confine our remarks, a subject so extensive can be discussed fully or satisfactorily. Indeed, one of the difficulties presents itself at the outset; either to confine the Essay to a special view, in which case it might be more complete, or to embrace a somewhat comprehensive enunciation of the subject, at the risk of meagreness in respect to detail.

In adopting the latter alternative, we aspire to little more than a sketch, the filling up of whose outlines we also venture.
The process of digestion, as it takes place within the living body, admits of considerable simplification if we regard it in a chemico-physical aspect. It is true that digestion may be termed a vital, rather than an organic process, so far as it depends upon the action of a fluid which is chemical in nature, out of the body, gives rise to, to wit, the gastric juice. But apart from the secretion of this fluid, many of the phenomena of digestion, which may occur under the action of the gastric juice out of the body as well as in it — one of a chemical, or chemico-physical nature, thus the process by which the food taken into the stomach is converted into chyme, and is reduced, by the gastric juice, &c, to a condition which admits of its being taken up by the lacteals and absorbents for the nourishment of the body, may be regarded as analogous in part to chemical solution; in part (taking into account the facts of artificial digestion) to fermentation.
fermentation; and in part, also, to catalysis, or chemical action by contact: chemical solution, as it affects the whole bulk of the food; fermentation, as it affects the amylaceous principles of the food; and catalysis, as it affects more particularly the albuminous principles of the food.

In digestion, then, we have first a chemical solution of the food. And here it is that we are led to view digestion as in one sense, a simple process of absorption. For, as to this chemical solution which takes place in the stomach, the soluble substances contained in the food at once pass into the blood, for the most part without alteration, whilst the insoluble substances make their way into the lyle, having first been rendered sufficiently attenuated to admit of their admission by the lacteal vessels.

Here we have a sufficiently simple view of digestion as a process. But it is important to notice at what particular parts
parts of the alimentary canal. The different principles of the food are absorbed, and how these principles themselves are acted on by the digestive fluids.

In regard to the first class of principles, the albuminious, it may be said that the digestion and absorption of albuminous substances are performed principally in the stomach. For the rest of the alimentary canal shows, when experimentally examined, almost no trace of albuminous solution in its contents; whereas this is found very abundantly in the stomach. We may therefore conclude, that the digestion of the albuminous elements of the food takes place principally in the stomach. As to the nature of this particular digestion, we have already spoken of it as taking place under the action of Catalysis, or a kind of chemical contact. The peristaltic action of the stomach no doubt promotes this action; but the change involved in it is generally referred to the influence of acids.
Acids, principally the hydrochloric—intained in the gastric juice, or at least in what we may regard as its solvent principle. However limited, such an explanation of what we term albuminous digestion may appear, there can be no doubt, on the evidence of experiment, that the hydrochloric acid of the gastric juice plays an important part in the process. Thus it has been found that the acid in question, when exceedingly diluted, accomplishes the solution of albuminous substances in glass vessels, as long as they are raw. Such substances, however, when boiled or exposed to a high temperature, are no longer thus acted on by the dilute acid, and, therefore it must be admitted that something more than a simple digestion in dilute hydrochloric acid takes place in the living stomach. But this albumin, while it furnishes perhaps a collateral illustration of the danger of pushing too far analogies observable between a dead and a living chemistry, does not render the presence of hydrochloric acid
acid the less indispensable, at all times, to the perfection of Alburnious digestion. Passing now to the Alburnious principles of the food, we are conducted from the stomach to the intestines, and arrive at what we may term a second digestion. For, on the simplest view of the physiological function, we recognise two distinct digestions: first, that of soluble substances, including in a general sense, the Alburnious principles of the food, (Albume, fibrine, casline, gluten,) which takes place in the stomach, secondly, that of the Fatty (and as we shall presently see, Glycaceous principles also,) or insoluble substances, which takes place further on in the intestinal canal.

The Alburnious principles pass nearly or entirely unchanged into the duodenum, where meeting with, and being acted on by the bile and pancreatic fluids, they are formed into an emulsion, in which condition, it would seem, they are alone fitted for absorption. This emulsion is found in abundance through nearly
the whole intestinal tract beyond the duodenum. And in proof of the fact that absorption of the deleterious principles of the food depends on a junction with the bile and pancreatic fluids, it has been shown (by the experiments of Schwann) in cases of artificial division of the bile duct, with subsequent discharge of its contents through a fistulous orifice in the walls of the abdomen, that the animals thus experimented on, although they often perfectly recover from the immediate effects of the operation, die from infection, as soon, nearly, as if they had been entirely deprived of food. This experiment further proves, so far as it goes, that the deleterious principles are absolutely essential to complete nutrition, and to a continuance of life. Moreover, it furnishes an illustration of the view here adopted, viz. that two distinct absorptions are necessary for the complete fulfillment of the physiological function of digestion in man—"the first digestive absorption, already spoken of as that of soluble matter, which
which takes place in the stomach, being alone inadequate to the physiological necessities of the economy.

In regard to the amylaceous or starchy principles of the food, we have already deferred their digestive absorption to fermentation. The steps— the intimate nature, of this fermentation, (if indeed we are justified in considering it as a true fermentation) are, doubtless, somewhat obscure. But it is chiefly to the change which starch undergoes into sugar, and probably into fat also, that a digestive fermentation may be held to apply.

The solution of fecula may be accomplished partly it would seem, in the stomach, without (in the ordinary state) being changed into sugar, or passing into the state of soluble starch or dextrine; the change which it undergoes being a conversion into lactic acid. And Bouchardat and Landres have endeavoured to show, that sugar is gradually converted, during its passage along the alimentary canal, into lactic acid, and that in general it is absorbed.
absorbed in this form, Starch, likewise, although its particles are very little acted upon unless ruptured previously by chemical agents (as may be the case in the processes of cooking), is converted, in the course of digestion, first into dextrine and grape sugar, and ultimately into lactic acid also, in which state it is absorbed.

The conversion of Amyloceous substances, (whatever the conversion may consist in) is very slowly effected in the course of the whole Alimentary Canal. It is supposed to commence in the mouth, under the action of an Alkaline fluid - the saliva, to intermit in the stomach, exposed to the action of an acid solvent - the gastric juice; and to go on again in the intestines, under the influence of the Alkaline bile and pancreatic fluids. The slowness incidental to this conversion of starchy matters into sugar, (and then into lactic acid), has been regarded as a provision of Nature to insure adequate conversion.

If sugar be too suddenly formed, it is introduced into the blood comparatively unchanged.
Uncalculated (i.e., without undergoing conversion into lactic acid, etc.) and, in such a case, it is drawn off by the urine without exerting its heat-sustaining agency on the system. In short, it becomes insensible, instead of being assimilated.

These remarks as to the slow conversion of starchy matters, serve to introduce us to Liebig's theory of the ultimate conversion of amylaceous substances into fat. On this point a considerable difference of opinion existed for some time. Dumas, and those of his school, at first refusing to recognize gum, starch, and sugar, as sources whence fat is supplied to the body, and viewing them simply as convertible into lactic acid, in which state they are absorbed, Liebig, and his followers, holding that the principles in question (gum, starch, sugar) may, by the elimination of a certain quantity of Oxygen, be converted into fat in the blood itself.

The theory adopted by M. Dumas, regarding animal fat, refers its derivation directly to vegetables—"Oils or fats," says he, "are

produced..."
produced by vegetables; they pass ready formed from them into the bodies of animals, and there they may be either burned immediately, in order to supply the heat which the animal requires, or they may be laid up in the tissues more or less modified, to serve as a reserve for inspiration. With a view to verify this idea we instituted many experiments, which all led us to recognise in the food of the herbivorous animals subjected to experiment, quantities of fatty matter superior to those found in the milk of the cow—for example, or stored up in the tissues of the ox put up to fatten.”

With these facts before us, it appeared natural to admit that animals assimilated directly the fatty substances of vegetables, without modifying them at all, or modifying them but little.*

In opposition to this, Liebig conceived that fatty matters are formed in the herbivora at the cost of their food, and, on subsequently repeating the experiments of Eckert, which proved that bees fed with sugar alone, have

* "Chemical and Physiological Balance of Organic Nature" P. 117
have still the power of producing fat, which must, of course, be derived from the transformation of the sugar, Dumas, Bousinault, and others, ceased to doubt that amorphous and saccharine substances may be converted, in the living body, into fatty or oleaginous matters.

Considerable obscurity however, it would seem, enfolds the situation, and Proclus Operandi of this kind of conversion within the body. It has, indeed, been shown, that the continued contact of bile with saccharine matter occasions the conversion of a portion of the sugar, into an adipose compound; whence we may presume, that beyond the duodenum—perhaps in the jejunum, the digestive absorption of that portion of the starchy and sugary principles of the food which is destined for conversion into fat, begins, although it may possibly go on in all the rest of the course of the small intestines.

In attempting to explain the Modes Operandi of this interesting conversion, we have recourse as already hinted, to a theory of Fermentation.
Into the general theory of fermentation it is not necessary to enter here; but we may just notice the production of the fucul oil, or folic oil of potato spirit, and its change into phlorizin acid — and the fermentation of sugar itself under the influence of cheese, resulting in the production of butyric acid — as examples of fermentation which probably bear a close analogy to that whence fat is produced from the saccharine principles of the food in the living body.

Keeping in mind the arbitrary division of the organic function, which we have suggested, into two distinct digestions, stomachal and intestinal — we have observed that, in the former, the azotised principles or the proteine compounds, as they are sometimes termed, are principally absorbed; whilst, in the latter, non-azotised articles of food are subjected to certain chemical changes, by whose operation they are assimilated and then absorbed. The azotised principles for the most part, require simple solution and subjection to the gastric fluid; but the
Non-oxised, have to travel further through the alimentary canal, and undergo more complicated chemical metamorphoses previous to absorption. The reason obviously is, that the former are already, in their essential nature, more nearly assimilated to the living organism which they are fitted to nourish; whereas, the latter require to be organised, as it were, by a vital chemistry, ere they are fitted to subsist in a different way, as we shall presently notice— a like purpose.

When we compare Animal Fibres, Albumen, and Lastic, on the one hand, with Glue, Starch, Sugar, and Oil, on the other, we perceive at once, without even having recourse to chemical analysis, but merely viewing them as articles of human aliment—how much more highly organised are the first group, than the second. Animal food, white of Egg, Cheese, as the representatives of the one; and the substances themselves standing for the other, offer a wide distinction, such as might lead us to suspect, in the absence of scientific information, the
former of easy and simple, the latter of more difficult and complicated digestion.

Trite as such an observation may seem, it nevertheless paves the way for a variety of considerations bearing upon diet, which serve to illustrate, not only the high practical utility of Animal Chemistry, but also the beautiful physiological consistency which attaches to some of its modern theories.

Into a general discussion of Dietetics it is not our object to enter, nor is it compatible with the limits to which this Thesis must necessarily be confined, to do full justice even to the Chemistry of the subject.

By way of practically applying, however, the imperfect Synopsis already advanced, we shall now enter upon some more particular observations.
When we consider the tortuous and tedious process by which the Ruminantia digest and assimilate their food, we are furnished with a forcible illustration of the chemical no less than the anatomical difficulties—so to speak—which have to be overcome before non-ozymotic and purely vegetable substances can be vitalised, converted into blood, or otherwise rendered available for the wear and tear of vital action, that is to say, of life. The three stomachs into which the food of the Ox successively passes, before it reaches the fourth, or that which bears a proper analogy to the human stomach, may be viewed as three chemically additional stages, at each of which it loses something of its purely vegetable character, and approaches, in certain particulars, to a more highly organised compound. We have only to contrast with this kind of digestive assimilation, that of a Carnivorous Animal, whose one small stomach, and short intestinal canal, fulfil the same requirements, in a much
shorter time, to be strikingly convinced of the superiority which animal food, and agotised substances in general, possess over vegetable food, and non-agotised substances in general, in point of assimilative convertibility.

Applying a criterion of this kind to Man, and taking into account at the same time the ominous indications of his anatomical structure, the first thing that strikes us is the untenableness of those extreme dietic doctrines, which have been advanced by the Vegetarians, in favour of an exclusive vegetable or farinaaceous diet as the proper food of Man.*

For it is purely a difficulty of some chemical importance to the theory of such a doctrine—so far as it hinges on a gummy and starchy farinaaceous diet—that whatever part of our food consists of non-agotised matters, must necessarily undergo, as it were,

were a second chemical digestion. And when we bear in mind, that even as regards a protein compound, the digestive and assimilative powers have to raise it to the higher standard of the material of the blood plasma, before adequate nutritive conversion is complete; and, further, that human food is intended, not only to supply the slower processes of nutrition and the ordinary separation of the body, but also to afford materials for the immediate protection of the blood against the chemical action of the Oxygen absorbed in respirations; we cannot fail to detect the chemical-physiological evils which must, in many instances, result from a too exclusive adoption of vegetable and fornicativeabettories, which essentially substitute for the speedy digestive assimilation of a carnivorous animal, the slower, and much more chemically complex one, of an herbivorous animal. On the well-grounded assumption, that many anatomically considered, is the omnivorous animal, a mixed diet constitutes his proper food, and
and, on such a diet, experience seems to join with chemical science in demonstrating he is constructed to subsist. *

Some of the opposite evils which may arise from a too highly nitrogenized diet — as a diet composed entirely of animal food — we shall presently have occasion to point out, in referring to the lactic acid diathesis, and the production of Gout and Rheumatism. In the first place, we must notice, shortly, the ultimate

* The strongest argument, as it appears to the writer, which has been advanced by the Medical Vegetarians in favour of man’s adaptability to a purely vegetable diet, is one derived from Comparative Anatomy. It is no doubt true that the Quadrumanæ, including the species which approach most nearly the human — the Orang-Outang, and the Chimpanzee (although it is doubtful whether, in a strictly anatomical classification, the latter animal ought to rank amongst the Quadrumanæ) present anatomical characters which approximate them in a greater degree than man to the Carnivora. Yet those animals appear naturally, to be purely vegetable feeders. The answer usually advanced to meet this argument, viz., that the Quadrumanæ are inhabitants of warm climates and that they do not undergo the labour and fatigue to which man is subjected, appears scarcely satisfactory. If we were better acquainted with the intimate natural history, and adult physiological anatomy, of the Chimpanzee, a better answer might probably be offered, on different, and more scientific grounds.
ultimate end, which the azotised and non-
-azotised principles of the food may be held
relatively to subsist in the Animal economy.
On a general view of the Animal Machine,
two actions are observed constantly to be
going on; the waste of its substance by
the attrition of the tissues, and the con-
sumption of its fuel by the action of
Respiration. Life, according to its definition
of "Vital Action," consists in, or rather depends
on the former; and the maintenance of
Animal heat, or the latter. In the first place,
much nitrogen, being thrown off from
the system—chiefly by means of the
Kidneys—is expelled; in the second, much
Carbon, being expelled from the lungs, is
consumed. The nitrogenous elements of the
food supply the nitrogen expelled in
the attrition of the tissues; the non-nitrogenous
elements supply the carbon burned in
the process of Respiration. But, in so
much as the nitrogenous elements of
the food contain more or less Carbon,
yet too may subsist the demands
of Respiration, and so far, take the
place, or assume the function, of the other great class of elementary substances.
whence, the non-nitrogenous elements can be of no service in repairing the
waste of the tissues, and therefore cannot, in any sensible degree, supply the place
of the protaeic compounds. This fact is one which it is interesting, in a
theoretical respect, to keep in view, since
it has an important bearing not
only on dietetic, but also on certain
physiological theories of disease.
We have already mentioned the Uric,
or lactic acid diathesis, as one of the
chief evils which sometimes result from
a too highly nitrogenized diet. The
injection of an unusually large quantity
of nitrogenous matter, does not, as might
a priori be supposed, give rise to an
increased development of the fibrous
and gelatinous tissues; whilst, at the
same time, the amount of nitrogen
thrown off with the Urine, varies
sensibly according to the nature of
the food, whether animal or forinaceus.

Where
Where we must infer, especially as superfluous Nitrogen cannot be stored up in the system like fat—that superfluous azotised matters are eliminated from the blood, and this, almost entirely, through the channel of the kidneys. Now as it is in the form of Urea that the elimination referred to takes place, this does not prove that a superfluity of azotised matters in the system must necessarily give rise to an increased production and excretion of Uric acid. It has indeed been shown by Dr. Lehmann, * that the effect of a purely animal diet is to increase the amount of the Urine acid, as well as that of the Urea in the Urine; but the difference in the quantity, from the usual standard, is too slight to warrant us to attach importance to the kind of diet, as the one direct cause of it. This * as regards the Urine itself.

*See the result of his experiments—made on himself—on the influence of various kinds of Animal upon the amount of the solid matters in the Urine; detailed by Dr. Carpenter, "Human Physiology".
He should bear in mind, however, that under a too highly nitrogenised diet, which may induce a superfluity of nitrogenised matters in the system, a uric acid tendency and condition may exist in the blood, although it be not apparent from the state of the urine.

Dr. Garrow has proved by analysis, that slight traces of lithic acid may be detected in the blood of persons who are comparatively healthy, or who are affected with other diseases than Gout; but in this malady the amount is much greater. Crystals of lithic acid have also been separated from the blood of patients suffering from derangement of the kidneys, with Aluminuria,†.

Such facts (and we may presume them to be substantiated) accord well with the theory which refers the proximate cause of Acute Gout and Rheumatism to a morbid matter—say lithic acid—in the blood.

†See appendix to the last edition of Dr. Williams' "Principles of Medicine."
††See article "Pathology of Gout" &c.
blood, and which causes the fibrile excitement, characteristic of the paroxysm of Gout and the onset of acute Rheumatism, as the result of a reaction which may succeed in eliminating the offending matter, and thus relieving the system. Exactly as it has been found by Dr. Garrod in several cases of Gout, that lithate of Soda could be detected in very appreciable quantity in the blood, though at the commencement of a fit of Gout there is a marked diminution of it in the urine. But as the abatement of the attack, the lithate acid or its compounds, appear in increased quantity in the urine, and that in the blood is hence diminished. On such a theoretical view, and on the evidence of the facts on which it assumes to found, we may conclude: - That a too highly nitrogenised diet - a diet pay exclusively composed of Animal Food - has the effect: First, of creating in the system a superfluity of azotised matter. Secondly, That this superfluity has a tendency to accumulate in the blood, where
where it may exist for a time in mobid quantity, without the operations, or the presence of actual disease, offering palpable evidence of the fact. Thirdly, that the ultimate effect of its so accumulating in the blood, is to occasion a feeble excitement or convulsion (say a fit of Goit or Rheumatism), which has for its object the expulsion of a circulating poison from the system.

The above general conclusions, however, must be viewed as subject to certain modifying considerations. The physiology of Man is a most complicated subject, involving not merely the separate elucidation of many different Functions, but also the balance of certain mutual Reactions which are known to subsist between these functions and their organs. We know, for instance, that a peculiar kind of sympathy subsists between the liver and the lungs, as it were on the one hand, and between the kidneys and the skin, as it were on the other, and this one fact even enables us clearly
to understand, how it is that many, if not most, perhaps all, Medical diseases are complicated in their intimate essence, and how it may be, that disease is often cumulative in the system. But more still occurs, often, in the course of disease. An organ not naturally connected, by what may be termed physiological sympathy, with another organ, sometimes takes on its function before the pressure of extraordinary conditions of the system or serious chronic disease. Thus it is well known that the kidneys may serve as a channel for the elimination of matters which are usually drawn off by another organ with whose normal function it is quite unalike. When the secreting action of the liver has been seriously impaired by organic disease, the kidneys appear to have performed its functions in separating at least some of the elements of the bile, and the elimination of Kesteine (which is nearly allied to Caffeine) by the kidney, in pregnancy, is another example...
somewhat in point.

These remarks, which apply to the function of secretion, may serve to illustrate a similar theory as applied to assimilative absorption and respiration. We have already said, that the nitrogenous elements of the food, in virtue of their containing carbon as a part of their chemical constitution, may assume, to some extent, the usual function, and take the place of the other great class of elementary principles, the non-nitrogenous. Now, if this be a fact, it must serve to modify very much the conclusion to which we are apt to jump, in reference to a highly or exclusively nitrogenised diet. In that such a diet has an invariable tendency to cause a dangerous accumulation of nitrogenised matter in the blood. In very many cases there can be no doubt that the cause in question produces such an effect; whence, as we have seen, the lithic acid diathesis and its consequences—Gout and Rheumatism.
But in many other cases, the cause may possibly exist without giving rise to the same effect. In a word, the carbon of the protein compounds may act as a safety valve to the system; a superabundance of nitrogenous matter may go to supply a temporary deficiency in the non-nitrogenous; combustion may do the work of eliminative secretion; the lungs may relieve the kidneys. In this way, many persons whose dietetic habits and indolent mode of life might otherwise give rise to rheumatic affections, be, are probably saved from their inflictions, and it is very possible that those cases of disease which arise from the above causes, are only the exceptional cases, in which combustion refusing any longer to do the work of eliminative secretion, the safety valve having got clogged—the system undergoes the inevitable convulsion attendant on the effort to throw off the morbid matter, now beginning to circulate in, and poison the body.
Blood.

Here let us, by way of contrast, take up the function of the other great class of the elementary principles of the food, and consider shortly, how it is that the non-nitrogenous elements act in giving rise to animical heat.

It is now well established, that the production of animical heat is due to the changes in chemical composition which are continually occurring within the system, of which changes respiration is the external manifestation.

Now, the saccharine and starchy principles, which, from the quantity of carbon and hydrogen they contain (in the absence of nitrogen) have sometimes been called the hydrates of carbon — pass into our bodies as food, and are there converted into blood. But this blood, in its venous state, is highly charged with carbon, and it is by a process quite analogous to combustion that the above non-nitrogenous elements of the food combine.
combine with oxygen where the blood undergoes oxidation, or conversion from venous to arterial blood in the lungs. As long as respiration goes on, carbon and hydrogen (the latter combining with the oxygen of the air to form water) are necessarily consumed; so that, at least the non-nitrogenous part of our food may be said literally to be burned in our bodies.

As to the seat of this chemical combination, it is important to remark, that while the air is a chief agent in the arterialization of the blood, and while it is by means of the capillaries spread out on the lining membrane of the air cells of the lungs, that water and carbonic acid—the products (the smoke we might almost say) of this combustion—are evolved, yet this water and carbonic acid are not formed in the lungs, but are previously contained in, and excreted from the venous blood itself. There can be no doubt that water and carbonic acid are
formed in the systemic circulation, and merely evolved from the venous blood when it arrives in the capillaries of the lungs, as oxygen is absorbed and carried with the arterial blood into the systemic circulation, both the absorbed oxygen and the evolved carbonic acid being not free, but in a state of combination in the blood. The chemical combustion, therefore, which attends the act of Respiration takes place, not in the lungs, but in the blood.

The above fact, taken in connection with that already stated in speaking of the nutritive elements of the food, viz., that a superfluity of nitrogen in the system sometimes accumulates in the blood, in the form of lithic acid, &c., seems to point exclusively to the blood, as the seat of the more important chemical transformations which occur within the body, and as the centre whence originate the more remarkable diseases to which it is subject.*

* We have endeavoured to prove this statement at
In this aspect, moreover, we view the blood as the grand medium by which the different and separate organs of the body communicate, as it were, with each other, and occasionally exchange, to some extent, particularly under the pressure of certain pathological conditions, their respective functions.

We have seen, in regard to the autogenous elements of the food, that though their chief and morical function in the actions of life evidently is to repair the waste of the tissues, yet, owing to the carbon they contain, they may, when in excess, also subserve the purposes of respirations; thus, in some cases, answering a double purpose. And just as we have found, that the other great class of principles, now under consideration, also answers, often, a double purpose in the animal economy.

As respects Stula and Rheumatism, of most forms of fever, and contagious and epidemic diseases, the same may substantially be shown, viz., that their proximate cause is a morbid matter or poison in the blood.
For although the carboehydrate and starchy principles of the food, owing to their excess of Carbon and Hydrogen, mainly go to feed the chemical combustion. Continually going on, yet they also, when in excess, go to the production of fat, which is stored up in the system. This is a most important fact, as bearing practically upon the mutual vital relations of the two opposite classes of principles. If, on the one hand, the carbon of the nitrogenous elements acts as a safety valve to an excess of these in the system; on the other hand, the conversion of starch into sugar, and of sugar again into fat, may likewise afford a safety-valve, not so much perhaps, to an excess of starch and sugar in the system, as to a want of normal proportion in the whole elements of the food, affecting the condition of the blood.* It is, for instance, matter

*"If more non-nitrogenised food be taken into the system, than can be got rid of by the respiratory
of popular observation, that the obesity of particular individuals is not to be satisfactorily accounted for by a reference to their dietetic habits—those who eat least and take an average share of exercise, being often more corpulent than

Respiratory process, and if there be not a sufficiently rapid production of adipose tissue to admit of its being deposited as fat, it will accumulate in the Blood, unless separated by the Liver. If too much work be thrown upon this organ, its function becomes disordered, from its inability to separate from the Blood all that it should draw off: the injurious substances accumulate in the Blood, therefore, producing various symptoms that are known under the general term bilious. This is particularly liable to happen in warm climates, in consequence of the diminished circulation through the lungs, occasioned by the warmth of the surrounding air, and the small quantity of exercise usually taken. To remove these symptoms, medicines are required which shall stimulate the Liver to increased action. The constant use of such, however, has a very pernicious effect upon the constitution; and careful attention to the regulation of the diet—especially the avoidance of a superfluity of oily or farinaceous matter—together with the employment of an increased amount of exercise, will probably answer the same end in a much better manner.

Carpenter's Physiology P. 647
than others who consume more food of the same kind, and lead less active lives. The enigma is readily solved on the theory of a chemical and physiological balance of the elements of the food.

In certain individuals, owing to peculiarities of anatomical or functional development, the healthy balance is not, in the first instance, struck, but it is digestive absorption, eliminative secretion, and respiration, that is, waste and repair. The one plus, in any one particular, which might go to degrade and arrest the entire machine, if the body were constituted on the imperative mechanical principles of a watch, for instance, to which it is often, most erroneously, compared, by superficial observers, is productive of no immediate injury: it is either burned off by an extra effort on the part of the systemic circulation, and the lungs, or it is thrown upon the liver or kidneys, or it is put past, as to speak, in the form of fat, to be afterwards got rid of as opportunity may serve. The partial conversion of the saccharine and
Starchy elements of the food into fat, and the storing up of that fat in the animal body, have their interesting analogue in the other great division of organic nature, the Vegetable Kingdom. We cannot doubt that there are some points of real resemblance between the fruit of plants and animal bodies, so that the fermentation heat of plants is somewhat analogous to animal heat. The fruit of many plants is the seat of certain succulences, in the course of which their sugar disappears, and becomes changed into fatty matter, or what vegetably corresponds to it. At certain periods also, those namely of germination and flowering, a very remarkable phenomenon occurs in the plant; it then evolves heat perceptibly. In accounting for this, we are forced to confess that, at such periods, the plant changes its character, and that instead of giving off Oxygen and storing up Carbon, it absorbs the former, and conserves the latter, as animals do.
At the periods of germination and flowering, therefore, the plant becomes an apparatus of combustion, and in some sense, for the time being, appropriates its chemical and physiological nature to that of an animal.

Now it has been shown that it is chiefly, if not entirely, the saccharine or starchy matters which it had previously stored up, as it were, against the time of need, that the plant consumes in this combustion. And from a consideration of the fact, that the higher animals and Man select as their food those parts of vegetables in which such sugary and starchy matters have been stored up for the purposes of vegetable calorie - we again return, by a process of analysis, to the conclusion already synthetically deduced, viz. That sugar and starch are the chief matters burned in Animal Respiration, and in the development of the heat which invariably
Accompanics that act.

Moreover, when plants become diseased, as well as at that period of their normal metamorphoses which immediately precedes the fall of their leaves, their tissues seem to undergo a kind of incipient decay, under the pressure of which they set free carbonic acid, at the expense of the sugary, starchy, or fatty matters stored up by them during the periods of their former vigour.

Something very analogous to this occurs in the animal body during the process of many wasting diseases—especially those in which little or no food is taken, as in the cancerous fleshes, etc. In such cases, the quantity of carbonic acid set free by Respiration is generally considerably increased, although no exercise is taken, and rapid evaporation supervenes, showing in the comparative absence of waste of the tissues by eliminative secretion, which is generally in accordance that...
all the fat in the system has been, or is being consumed in Respiration. From such considerations it is, that while we keep in view the primary importance of the part which the nitrogenous elements of the food play in supporting the wear and tear of normal vital action, we can, at the same time, fully estimate the importance which attaches to a corresponding ingestion of saccharine and starchy compounds, as habitual articles of diet; not in virtue of the part which the latter play as supporters of combustion and animal heat merely, but as innovators, often, to the fatal terminations of privation or disease.
The Chemical and Physiological Balance of the Food, which has now been imperfectly drawn, paves the way for a consideration of the importance which ought to attach to a due coöperation of the chief elementary principles - Albumen, Oil, Sugar, Starch - in systems of Diet. With a few general remarks on this branch of our subject we shall conclude the Thesis.

Apart from chemical theory, which, as we have attempted to indicate, points to the same conclusion, the direct experiments instituted by Jurgendie, Fedemann and Gimbel, seem clearly to have proved - that when separately used as an habitual diet, the simpler constituents of the food are insalubrious, and insufficient to support life for any great length of time. Fish, beard, which has been called the "Staff of Life," and which, it is generally supposed, is quite adequate,
with the addition of water, to maintain life, possess, perhaps, Achilles claims to such a reputation. Bread contains only two of the elementary principles—

- Vegetable albumen, in the form of gluten,
- Starch, which, being converted with sugar, may theoretically be held to serve for the production of fat, and the support of respiration in the animal economy. But there is good ground to doubt, whether the addition of oil, in some form or other, is not necessary to constitute bread that staff of life, which it is popularly held to be; and, indeed, the fact is significant, that commonly, and, as it were natural usage, leads the majority of civilized beings to regaining oil or fat, in the form of butter, with the use of bread.

* Even in countries where a primitive kind of civilization exists, bread, or that which chemically takes its place, is eaten with a fatty adjunct; proving that the addition of butter to bread is not so much an acquired taste as a suggestion of
At all events it is certain, that fine bread (manufactured from wheat, the external ligneous covering of whose seeds is entirely separated), whether or not it be capable of supporting life for any great length of time in the Russian subject - a question which appears not yet to have been fully tested - does not, by itself, constitute a salubrious diet. Supposing it to be the case - as it is held to be by many physiologists, possibly on insufficient grounds, that "Vegetable Alliments is the only simple principle which will alone maintain life"; this observation can apply to Man only as an Omnivorous animal. For Magendie has of nature.

In the more arid part of the Cape of Good Hope, where no butter is made from the beauty milk yielded by the half wild cows, the coarse kind of bread used by the Dutch Boers and the coloured population, is not eaten, unless from necessity, without the addition of sheep's tail fat - the favourite substitute for butter in that part of the world.
has demonstrated that Carnivorous animals soon die on such a diet: he fed a dog on white bread and water, but it lived only fifty days. As to the other principles of the food, the experiments alluded to have placed it beyond a doubt, that no one of them, singly, can support the higher orders of animal life. A variety of different animals—dogs, monkeys, geese, &c. were fed upon articles of diet relatively corresponding to simple elementary principles, as cheese, oil, gum and sugar, rice, white of egg, with the result that they all died, at various intervals, with the usual appearances of starvation.

In the latest and most elaborate work which has issued from the press in advocacy of the Vegetarian theories, a confused attempt has been made to impugn the conclusionness.

*"Fruits and Farinacea: The Proper Food of Man" by John Smith, 2nd Edition.
of the experiments instituted on this subject, by such authorities as Magendie, Burdach, Fiedemann, and Gmelin. The experiments in question are characterized as "anything but satisfactory." However, as the author, who thus calls in question the dictum of the latter, has not instituted any counter-experiments which might go to neutralize the same, or to establish his own exclusive doctrine, we are not bound to attack a great deal of importance to the unqualified assertions and vague speculations in which he frequently indulges. The work in question is an ingenious and even a talented performance, but it would be out of place, as less than quite beyond our limits, to attempt here an extended refutation of the objections raised. In dismissing the Vegetarian theories, which
which bear a good deal upon this part of our subject, with a curious notice, we cannot help remarking, that Milk, as an article of diet, seems to have been left comparatively unassailed, amidst the sweeping denunciations which have been levelled at all other forms of animal food. Perhaps there may be a sufficient reason for this. A milk diet, considered first, as the necessary, or at least the natural aliment of infancy; and, secondly, as the grand type of all the proper kinds of nourishment, obviates a serious difficulty in the path of those who would attempt to show, on scientific grounds, or to deduce from universal experience, that vegetable food is the proper food of man.

Milk, as Poet has chemically proved, contains all the necessary elementary principles of ordinary food: it contains animal albumen, oil and sugar, in combination with water.
This then, if there be any one exclusive food for man, constitutes, on chemical principles, and proper exclusive foods—and it were more scientific, and perhaps also more rational, to insist upon an exclusive milk diet, than to have recourse to far-fetched analogies and a forced citation of precedents, in a vain attempt to convert Man into an herbivorous or a granivorous animal.

But, in truth, Nature, in the matter of human aliment, seems to vindicate her own cause, and it is a remarkable fact that the resulting conclusions of legitimate chemical and physiological research coincide in a comprehensive manner with her (Nature's) usage and requirements. It may be interesting to notice this agreement shortly.

Nature provides milk as the food of infancy and early youth, and science proves the chemical perfection of the diet. Amongst agricultural and pastoral communities, in which,
from the cheapness and plenty of
the cereals, there is much temptation
to subsist too exclusively on an
amalagocous, or a mixed, vegetable,
glutinous diet - milk, butter, and
cheese, as articles of attendant and
consequent production, are in general
necessity, though perhaps unconsciously
ingested, and serve as corrective
adjuvants to what would otherwise
prove a too exclusively farinaceous,
and therefore an insalubrious diet. *

In cities, again, and amongst highly
civilized communities, where animal
food - containing animal albumen
and fat - is habitually consumed, a

* This fact exposes the fallacy of a common
vegetarian argument. The farinaceous and
vegetable diet of some savage nations, and
of many rural civilized communities - that
of the Scottish peasantry amongst others - is
often adduced as a proof of Man's natural
adaptability to such an exclusive diet. But it
is forgotten, that milk invariably accompanies
(in all cases it occasionally does so, at least),
such a system of diet, and it is extremely doubtful
whether one authentic general instance can be
advanced of a literally exclusive vegetable or farinaceous diet.
great variety of vegetables and fruits, as
beets, rice, potatoes, beans and peas,
parsnips, &c., is commonly used at
the same time, giving to each meal
a corrective proportion of diastaseous
principles, without which it would
not be sufficiently relished.
In many tropical countries, where inactive
habits prevail,—where comparatively
little oxygen is absorbed, and little
carbonic acid is given off by the lungs,
and the waste and repair of the
tissues go on more slowly, a concentrated
form of diet—such as animal food, &c.,
affords—is not so necessary as in colder
climates. Hence the variety, profusion, and
tempting richness of the fruits and
fruit—vegetables there forced, and here,
by the brilliance of their colours on the
light, by their exquisite perfume on
the smell, and by their sweetness on
the taste of Iran. The eagerness with which
Europeans, suffering from the inconveniences
of a sudden removal to a tropical climate,
apply to the indigenous fruits of the
country.
country— as insects to their accustomed, but inappropriate to nitrogenuous diet, is but too well attested by the statistics of (non-epidemic) Typhus and Cholera in the East and West Indies.

In cold, northern, and subarctic latitudes, where, from the scantiness of their vegetable productions, the inhabitants could not possibly continue to exist on the natural production of their native countries, as practical Vegetarians, - the imperious food offered by Nature, - animal blubber, the flesh of the seal, the Bear deer, the bear, and the wild duck, furnishes at once the means of a concentrated nutrition and a rapid reproduction of animal heat, as protection against the wearing effects of cold, and the active exertions of a hunter's life.

A diet of this kind, more or less imperative amongst the extreme northern races, is indeed not chemically perfect; it may be held to want—
saccharine and starchy principles. But science vindicates Nature even here. For the physical development of the hyperborean races is not, compared with that of some other races, a standard development—and this would seem to indicate, that while they are fitted for their climatic position, this position is in some respects inferior to that higher standard of civilization, and to those more scientifically perfect dietary habits which are naturally assumed by the leading nations of the world.

On the whole, the agreement which subsists, on this subject, between the revelations of modern chemistry and physiology on the one hand, and a rational view of man’s varied social and climatic position on the other, seems most important and interesting. It is not for us to pursue it further at present; but it suggests many considerations fitted to impress
upon the mind what in the ordinary course of a medical education is perhaps too much overlooked the beautiful relation in which science stands to other branches of more popular enquiry to the universal history of our species to the arts of life and even to some of the phenomena of mind.

For can we conclude this imperfect thesis without remarking how mutually explicative are the several branches of research which go to make up the compound science of medicine. Without the light which Physiology has borrowed from the modern advances of Organic chemistry how meagre were the actual knowledge of cause and effect derived from a Mechanical Anatomy joined to the crude theories of a merely speculative Pathology! True it is that much which is new in recent Physiology continues for the present to rest upon
Chemical theories. But such theories are not of a merely speculative character: they admit of ample investigation; and their rejection, modification, or demonstration by means of palpable experiment, and the verification of such experiment, involves obviously a simple question of time.

This is in most points a good, although brief summary. But there is one deficiency: no allusion is made to the mineral elements of food and of the body, a subject of at least equal importance to those of asphyxia and anaesthesia. A study of which would have cleared up several of the points mentioned as obscure by the author.

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