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December 1891.

THE OTTAWA NATURALIST

VOLUME V. NO. 8.

The

TRANSACTIONS

Of the

Ottawa Field-Naturalists' Club

(Organized March, 1879. Incorporated March, 1884.)

CONTENTS.

OTTAWA, CANADA:
THE TAYLOR PRINTING HOUSE, 48 RIDEAU STREET.

Issued Dec. 5th, 1891.

Published Monthly at $1.00 per annum.

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MONDAY AFTERNOON LECTURES. Nos. 7 & 8.

The Chemistry of Food.

By Frank T. Shutt, M.A., F.C.S., F.I.C.

(Two Lectures delivered Feb. 23rd, and March 2nd, 1891.)

He, indeed, would be an unreflecting and unthankful individual who would not be willing to admit that the higher civilization of later times has given us great and innumerable blessings. We might, perchance, find such an one among those who have grown up amid the comforts and luxuries of wealthy modern life, an unconscious recipient of good things and ignorant of the life of our forefathers; or among those who, from long-continued poverty or degradation, can hardly be said to enjoy those blessings. To recount the triumphs of science and enterprise—not to speak of other and not less important factors of our civilization—during the last fifty years would be a more than Herculean task. Triumphs of the Natural and Applied Sciences—great triumphs in the art of healing and no less great in electricity, and mechanics, and agriculture, and a host of sister sciences—triumphs that have added to our comforts and have alleviated our sufferings, attend and surround us on every side.

But yet, while confessing all this with ready lips, a moment's serious reflection tells us that there is scarcely a blessing without its concomitant evil—an evil too often the result of the abuse of the blessing. Evils whose origins may easily be traced to the wrong or excessive use of things in themselves good and wholesome, pervade all ranks of society. It is only when we view exclusively this side of the picture—as too many of us occasionally do—that we are apt to conclude that our boasting of the achievements of the nineteenth century and the so-called betterment of the race, is worse than vain.

But what has all this to do with the subject under discussion—the chemistry of food? A little careful thought may show us the applicability of these remarks as an introduction to a lecture on such an important matter as food; for although my title might be considered, strictly speaking, to confine me to the composition of foods, I propose to incorporate with the chemistry somewhat of the physiology of food.

In this way I hope to make these lectures not only more interesting but more instructive than they otheswise might be to a general audience. By learning the functions of the constituents of foods in the system we may—as we shall see more clearly later on—be the better able to practise economy and preserve health.

To many of us civilized life has brought with it the accumulation of wealth, and wealth grants us comparative leisure and the means of obtaining not only necessities but luxuries in abundance. It gives us plenty of good, nutritious and palatable food, but it also gives us the opportunity of indulging in those luxuries of the table, the excessive use of which is so disastrous to our health. Leisure takes from us the *necessity* of that wholesome amount of exercise, which promotes a normal and healthful condition of the system.

On the other hand the conditions of society make us ambitious and encourage us to strain every muscle and nerve towards the attainment of more money and power, and thus it is that often we overwork ourselves, body and mind—become physical wrecks, not from the want of an ample supply of food, but because from the mode of our living we have not allowed it to nourish us properly.

I, therefore, wish to emphasize the great and, I may say, vital importance that a knowledge of the requirements of the human body and of the composition and character of our daily foods is to everyone nowadays. In the first place we are confronted with the statement on good authority that more suffer from over eating than from over-drinking, though the number of victims of the latter vice, we must all admit, is not small. Over-eating is a term used not only to designate the more than sufficient use of simple, wholesome food but also to include the taking in excessive quantities of rich and concentrated foods, most of which may be called luxuries, and lastly, one-sided diets adopted either from necessity or from mere fancy. Such diets are sooner or later inevitably followed by disease or a disordered system. That dyspepsia and allied ailments, especially on this side of the Atlantic, are very prevalent, and that the same are due to an abnormal or excessive diet, is well known, but that probably over fifty per cent. of the common disorders now afflicting mankind are from the same causes, and which are preventable by a proper care of the body and a judicious diet, is certainly not widely recognized by the laity, though the medical profession have repeatedly attested the truthfulness of the statement.

From a hygienic standpoint, therefore, we must admit the usefulness of that knowledge which tells of the true nutritive value of the different foods and the amounts of them required to sustain health and vigour—a knowledge that will enable us to use with discretion those foods best suited to our wants and as a result experience *mens sana in corpore sano.*

But the importance of the subject may be urged from another aspect—the economic one. "Half the struggle of life is a struggle for food," says Edward Atkinson, and though this may appear an extreme statement, reflection assures us of its truth. Evidence in its support is supplied in abundance by our large cities where competition is rife and the inhabitants are massed together. When the scourge of famine overtakes a country, the misery and horrors which attend such a catastrophe emphatically attest its accuracy. Surely, then, food-economy is a subject well worthy of study, for from it governments and individuals may learn how to obtain the most nutritious food for the least outlay, and thus in times of distress be enabled to alleviate much suffering. But nearer home there seems to be ample room for improving our own condition in this matter of food-economy. I do not here refer to that wilful waste of food in our homes, which I must designate a sin against mankind, nor to that excessive use of food that engenders disease. I wish, rather, to direct your attention to the study of contrasting the money value of foods with their nutritive value. For by such we shall be enabled to make choice of the most nutritious and palatable viands at the least cost. Then, perhaps, while spending a little less on our stomachs, we should have somewhat more to expend on other and no less noble objects in life—the improvement of our faculties and mental enjoyments—to say nothing of the noblest of all, the benefitting of our fellow man in one or other of the many ways now open to us.

And there is yet a third side to the question—that of pleasure. This is, undoubtedly, a legitimate one for our consideration. The pleasure of eating and drinking of the good things provided for us is assuredly a right one, and one that has been so recognized from all times. But my subject is rather with foods themselves, and I must hasten on, having briefly outlined the reason why I deem a knowledge of what we eat so important, so necessary as to warrant my impressing upon you so urgently the value of its study.

It is the food we eat that forms the tissues and developes the heat and energy of our bodies. The body creates nothing, neither matter or force. The physical life is dependent directly upon the digested food, water, and the oxygen we breathe. The changes the food undergoes in the life functions are simply and truly transformations. We shall therefore do well at the outset to consider briefly those elements and compounds that compose the body structure.

THE CHEMICAL BASIS OF THE HUMAN BODY.

Chemical analysis has proven that only fifteen, or at most seventeen, of the elements enter into the composition of the tissues of the body. In the following table, from Brubaker's Physiology, they are enumerated together with the relative quantities in which they exist and the tissues in which they are found.

CHEMICAL COMPOSITION OF THE HUMAN BODY.

Oxygen,	72.00	O. H. C. are found in all the tissues and
Hydrogen,	9.10	fluids of the body, without exception.
Nitrogen,	2.50	O. H C. and N found in most of the fluids
Carbon,	13 50	and all the tissues, except fat.
Sulphur,	.147	In fibrin, casein, albumen, gelatine of the tissues, in sweat and urine.
Phosphorus,	1.15	In brain, saliva, blood and bones.
Calcium,	1.30	In bones and teeth, in blood, saliva and chyle.
Sodium,	·10	In all the fluids of the body.
Potassium,	.026	In muscles.
Magnesium,	.001	In bones, associated with calcium.
Chlorine,	.085	In the fluids and solid tissues.
Fluorine,	.080	With calcium in bones and teeth.
Iron,	.01	In blood corpuscles and in muscles.
Silicon	traces,	In blood, bones and hair.
Manganese	traces,	Probably in hair, bones and nails.

These elements do not exist in the body in the free state, if we except traces of uncombined Oxygen, Nitrogen and Hydrogen, but in various combinations with one another forming exceedingly complex compounds. These, for the sake of convenience, fail into two great classes :—ORGANIC and INORGANIC, though the distinction is no longer a strictly accurate one. The organic compounds may be considered under the divisions, (*a*) NITROGENOUS, (*b*) NON-NITROGENOUS, according as to whether Nitrogen enters into their composition or not. Many of the elements above cited are common to both the Organic and Inorganic compounds.

The NITROGENOUS COMPOUNDS are the most numerous as to their number as well as most complex as to their quantitative composition, though they are made up of but four elements, Carbon, Hydrogen, Nitrogen and Carbon, with occasionally small amounts of Phosphorus and Sulphur. We can here only mention certain large groups ot these compounds.

Albuminoids or *Proteids*, a generic term including a number of substances having the same percentage composition but different physical properties. Sub-divisions comprise, (1) *Native Albumens*, of which the white of egg is an example; (2) *Globulins*, chief among which is Myosin, the organic basis of muscle; (3) *Derived Albumens*, the casein or curd of milk and certain substances formed in the stomach during digestion; and (4) Peptones or Soluble Albuminoids, formed by the action of the digestive fluids on food, and which pass into the blood to nourish the body. Besides these there are the Gelatins found in bones, etc., and certain other waste products formed by the life functions ot the various organs of the body.

The NON-NITROGENOUS ORGANIC COMPOUNDS are made up entirely of Carbon, Hydrogen and Oxygen. They consist of (*a*) Carbo-hydrates, in which the Oxygen and Hydrogen are in proportion to form water; (*b*) Fats, richer in Carbon and Hydrogen than the Carbo-hydrates, (*c*) Fatty acids and (*d*) Alcohols.

Carbo-hydrates, Sugar, Starch, are represented in comparatively small quantities in the body, though found in many of the fluids and tissues. The forms of sugar are G ycogen of the liver, Lactose or sugar of milk, Glucose (grape sugar) and Inosite or sugar of muscle.

Fats and Oils—Palmitin, Olein and Stearin. These are really salts of the alcohol Glycerins with the fatty acids Palmitic, Oleic and Stearic. The fat of the body is made up chiefly of Palmitin and Stearin (solids) with small quantities of Olein (liquid).

The *fatty acids* require no special discussion here. Mention of the three principal ones has already been made. These with Butyric acid in milk and Propionic acid in sweat, exist in combination with certain bases, e.g., Potassium, Calcium and Sodium in various parts of the body.

Alcohols:—Glycerine, a true alcohol has already been spoken of under "fats;" it is also produced during digestion; Cholesterine, a crystallized uncombined alcohol, is present chiefly in bile. Ordinary alcohol has been detected in the body—probably the result of a fermentation in the digestive tract. Under normal conditions, however, it is doubtful if it is produced.

INORGANIC OR MINERAL COMPOUNDS.—The chief of these is WATER (Oxygen and Hydrogen), present to a very large extent in every fluid and tissue. Its great importance and function will be spoken of later on. Calcium phosphate (phosphate of lime), another essential compound, is the basis of bones and teeth, but also found in other parts. Chloride of Sodium (common salt) is to be met with in all tissues and fluids. Iron in minute quantities enters into the composition of hæmoglobin, the colouring matter of the blood. It is also to be detected in many of the body tissues.

The foregoing outline may serve as an enumeration of the more important body substances. Their origin and physiological function will be discussed when speaking of the nutritive ingredients of foods and the processes of digestion and assimilation. A knowledge of the relative amounts of the chemical elements and of the compounds already alluded to, as they exist in the body, will be found to be of interest and value. I, therefore, subjoin the following admirable tables compiled for the United States National Museum, Washington, by Messrs. Welch and Pomeroy.

WEIGHTS OF CHEMICAL ELEMENTS IN THE BODY OF A MAN WEIGHING 148 LBS.

Oxygen	92.4	pounds
Carbon	31.3	"
Hydrogen	14.6	"
Nitrogen	4.6	"
Calcium	2.8	"
Phosphorus	1.4	"
Potassium	.34	"
Sulphur	.24	"
Chlorine	.12	"
Sodium	.12	"
Magnesium	.04	"
Iron	.02	
Fluorine	.02	"
Total	148.00	"

COMPOUNDS IN THE BODY OF A MAN WEIGHING 148 POUNDS.

Water	90.0	pounds
Protein (Albuminoids)	26.6	"
Fats	23.0	"
Carbo-hydrates (starch, sugar)	.1	"
Mineral matters (inorganic)	8.3	"
Total	148.0	"

THE NUTRIENTS OF FOOD.

Having learnt somewhat of the compounds of the body and that the latter is built up by the functions of the organs of the body from the digested food, we may go on to consider the composition of foods, vegetable and animal. In view of what has already been said we shall not be surprised to hear that the edible and nutritive portions consist, in varying proportions, of those ingredients or compounds already considered, viz: Albuminoids, Carbo-hydrates, Fats and Mineral matters (including water). These are termed Nutrients, and the composition of the three classes of organic compounds is roughly as follows:

	Albuminoids. Per cent.	Fats. Per cent.	Carbo-hydrates. Per cent.
Carbon.....................	53.0	76.5	44.0
Hydrogen..................	7.0	12.0	6.0
Oxygen....................	24.0	11.5	50 0
Nitrogen..................	16.0	None	None
	100.0	100.0	100.0

These Nutrients are by no means equally distributed throughout the food materials. The animal foods—meats and fish—while very rich in albuminoids and fats, possess but traces of the carbo-hydrates. They may be considered, therefore, essentially nitrogenous. Vegetable foods as a rule contain a large percentage of Carbo-hydrates, starch and sugar, and small quantities of albuminoids and fats, and consequently may be considered as essentially non-nitrogenous. An exception to the latter is to be found in peas and beans, which contain a notable amount of albuminoids. Very fat meats on the other hand, by reason of the large amount of fat they possess, cannot be considered as highly nitrogenous.

This great distinction between these classes of foods is one worth remembering as helping us to arrive at their true nutritive value. To enable us to do this the better, however, we may now proceed to state the physiological functions of these nutrients, whether they be derived from animal or vegetable foods. For this purpose I shall take the liberty of placing before you another chart from the National Museum.

USES OF FOOD IN THE BODY.

Food supplies the wants of the body in several ways. Food furnishes:

1. The materials of which the body is made.
2. The materials to repair the wastes of the body and to protect its tissues from being unduly consumed.

Food is consumed in the body as fuel to

3. Provide heat to keep it warm;
4. Produce muscular and intellectual energy for the work it has to do

The body is built up and its wastes repaired by the nutrients. The nutrients also serve as fuel to warm the body and supply it with strength.

Ways in which the nutrients are used in the body:

The albuminoid of food	Form the nitrogenous basis of blood, muscle, sinew, bone, skin, &c. Are changed into fats and carbo-hydrates. Are consumed for fuel.
The fats of food	Are stored in the body as fats. Are consumed for fuel.
The carbo-hydrates of food	Are changed into fats. Are consumed for fuel.
The mineral matters of food	Are transformed into the mineral matters of bone and other tissues. Are used in various other ways.

This is a very instructive table, and it will be well before passing on to consider in more detail what it means. It emphatically tells us in the first place that we cannot exist for any length of time on any one class of nutrients—a fact amply proved by actual experiment No one nutrient is a complete diet. A diet consisting entirely of albuminoids, or of carbo-hydrates, or of fats, is an impossible one, though a glance at the table shows that the albuminoids are more universal in their functions that the other two nutrients. We shall learn later on somewhat of the proper ratio in which they should be used in order to preserve health. The tissues of the body are continually undergoing disintegration, heat is being dissipated and muscular and intellectual energy constantly expended. Let us examine for a moment the different classes of food as to their power to supply these wants.

We have already said that animal foods—meats of all kinds and fish—are principally nitrogenous. The albuminoids they contain are often called flesh formers, because such go to form in the body the muscle and the blood. They also possess more or less fat, which may be laid up or converted into adipose tissue or used up in the production of heat.

The vegetable foods consist largely of the carbo-hydrates, and cannot be said to assist in the formation of new tissue—muscle, blood, &c., but are of service as fuel in developing the necessary heat and energy. Of course, the fats they contain may be so used, or deposited as such in the adipose tissues.

Water and mineral matters are common to both classes of foods. While both are absolutely necessary, they can scarcely be called nutrients. Water is the universal solvent. Dependent upon its presence are the processes of digestion and assimilation. The blood and lymph are largely water, and by them the nutritive matter is conveyed to every part of the body. It also takes part in the elimination of waste products. Mineral matters, especially common salt and phosphate of lime are required for tissues and bones. "The salt in the blood holds the albuminoids in solution, and by regulating the amount of water in the blood corpuscles and the cellular elements of the tissues, preserves their form and consistence." Phosphate of lime gives solidity to the bones and teeth, and is also present in muscle, milk, &c.

Composition and Digestibility of the More Common Foods

We may now consider the composition and digestibility of some of the more common foods. In the subjoined table, obtained from the same source as the preceding, the percentage indigestible, as well as the total amount of each nutrient is given. It is a very instructive chart and one that well deserves a careful study. It shows most clearly the large amount of albuminoids, entirely digestible, in the animal foods (meats and fish), and that in such, increased fat generally means decreased water. This is exemplified in the case of fat pork. The carbohydrates (starch and sugar) are practically absent in these foods. Eggs we see to be a highly concentrated food, being rich in albuminoids and fat, but containing no starch or sugar. Fish, generally speaking, is a very nutritious food, being easy of digestion. Its value as a brain food will be spoken of later on. Cod may be considered albuminoids and water. Milk is shown to be a well balanced food—*i.e.* it contains all the materials in good proportions and approaches most nearly the composition of a 'perfect food.' Its almost total digestibility makes it a most important factor in the diet of the young and aged. It has been found that boiling milk somewhat impairs its digestibility. Butter may

TABLE showing composition and proportion of indigestible materials of the more ordinary foods.

—	Albuminoids.		Fats.		Carbo-hydrates.		Mineral Matters	Water.
	Total.	Indi-gestible.	Total.	Indi-gestible.	Total.	Indi-gestible.		
Beef, rather lean....	23.0	0.0	9.0	0.9	0.0	0.0	1.3	66.7
" rather fat.	20.0	0.0	19.0	1.9	0.0	0.0	1.0	60.0
Mutton, fat	15.0	0.0	40.0	. ..	0.0	0.9	1.0	44.0
Pork, very fat.......	3.0	0.0	80.5	6.0	0.0	0.0	6.5	10.0
Cod	15.0	....	1.0	....	0.0	0.0	1.5	82.5
Salmon	22.0	....	14.3	....	0.0	0.0	1.7	62.0
Mackerel	18.8	0.0	8.2	0.8	0.0	0.0	1.4	71.6
Eggs	13.4	0.0	11.8	2.4	0.7	0.0	1.0	73.1
Milk	3.4	0.0	3.7	0.1	4.8	0.0	0.7	87.4
Butter	1.0	....	87.5	1.7	0.5	....	2.0	9.0
Cheese, whole milk .	27.1	0.0	35.5	0.9	2.3	0.0	3.9	31.2
Wheat, flour.........	11.6	2.1	0.8	....	72.2	1.8	0.4	15.0
" bread......	8.9	1.2	1.9	....	55.5	0.6	1.0	32.7
Oatmeal	15.0	....	5.0	....	69.0	....	1.0	10.0
Pease...............	22.9	3.2	1.8	....	57.8	2.1	2.5	15.0
Cornmeal	9.1	1.2	3.8	....	71.0	2.3	1.6	14.5
Sugar..............	0.3	....	0.0	0.0	96.7	0.0	0.8	2.2
Potatoes	2.0	0.5	0.2	....	21.3	1.6	1.0	75.5
Turnips............	1.0	0.3	0.2	....	6.9	1.3	0.7	91.2

be considered pure fat, which is easy of digestion and assimilation if the condition of the stomach be normal and too much be not taken. Cheese is a highly nitrogenous and exceedingly valuable food. It not only is easily digested but also assists in the digestion of other foods. Its price, when we consider these important desiderata, recommends it for more extensive use than it at present enjoys.

The vegetable foods are characterized by low albuminoids and high carbo-hydrates. The amount of fat in most of them is small, and need hardly be taken into account as a nutrient. Peas and beans (fruit of the Leguminosæ) stand out as exceptions in containing large percentages of albuminoids. Oatmeal also more closely approximates animal foods than any of the other cereals. The starch and sugar of vegetable foods is as a rule very digestible. The vegetables proper consist largely of starch, or allied substances, and water. Potatoes, cabbage and many other vegetables are also valuable for the mineral salts they contain. Asparagus, lettuce, celery and some others contain but little nutritive matter, but play a very important hygienic rôle, aiding the digestion of other viands, diluting the more concentrated foods, and thus rendering them more easily assimilable; the salts and active principles many of them contain have a beneficial and medicinal effect on the system. Vegetables must form a large part of every wholesome diet. Fruits are largely water, and are divided into (*a*) Sweet, in which sugar predominates when ripe; (*b*) Acid, containing tartaric and citric acid, generally refreshing and giving a healthy tone to the organs; (*c*) Starchy; and (*d*) Oily, the essential oils in which give the peculiar flavour Fruits, though having a low nutritive value, are, when ripe, easy of digestion. The pectose of green fruit is indigestible. This as the fruit ripens turns to pectin, akin to sugar, which, as before stated, is easily digested. The odour and flavour of fruits, due as before mentioned to oils and volatile ethers, chiefly abundant in the pericarp, seem to enhance their palatability.

Here a word may be said of a large class of substances which act rather as stimulants than nutrients. Tea, coffee, spices and alcohol come under this category. They act as appetisers, and in moderation as useful and proper excitants of the digestive organs, especially in cases of enfeebled digestion.

Amounts of the Nutrients Required.

The quantity and kind of food eaten must depend largely on the age, the weight, and the kind and amount of work of the individual, taking into consideration the climate and the peculiar characteristics of the person's digestion—a most important factor. The amount of food required per diem by the body is measured by the amount of carbon and nitrogen eliminated daily from the system. These represent the final and waste products of the food compounds. The weight of carbon excreted by a healthy person in one form or another doing a fair amount of work is about fifteen times heavier than that of the nitrogen. The carbon daily eliminated is about 4,600 grains, the nitrogen about 300 grains. These numbers are the results of many experiments, but for many reasons are only approximate. In order to retain health it is necessary to preserve as closely as possible this ratio in our diet, for not only do we wish to avoid an excess or lack of food, but also the excess or lack of any one ingredient. If we supply the nitrogen (Albuminoids) altogether from vegetable foods, such a large quantity has to be consumed that there would be a large excess of carbon—a state of affairs seriously affecting the health. On the other hand, if the required amount of carbon is to be obtained from an exclusive meat diet, about four times as much nitrogen as needed would be furnished. This would seriously impair the digestion and be apt to induce disease.

As I have before emphasized, no one class of nutrients is in itself a complete food, and it is only when they are in proper proportions that a healthy and vigorous system can be maintained. Though there is strong tendency in the system to eliminate any excess of food, yet, as I have pointed out before, too much food acts deleteriously. The habitual use of large quantities of meat and albuminous foods induces a diseased condition of the liver, gout, &c., while excessive amounts of the fats, starch and sugar cause obesity and dyspepsia.

Professor Ranke found that when doing no muscular work, his weight was maintained with the following per day.

Albuminoids, 3.5 ozs.; Fats, 3.5 ozs.; Carbo-hydrates, 8.5 ozs.

Professor Voit, an eminent German scientist, gives the following amour is per day for an adult doing an ordinary day's (muscular) work, supposing neither to gain nor loose weight.

Albuminoids, 4.2 ozs.; Fats, 2 ozs.; Carbo-hydrates, 17.6 ozs. Professor W. O. Atwater, of Washington, U.S.A., who has written a splendid series of articles in the "Century" for 1887, on the subject of foods, to which I am largely indebted for material in these lectures, estimates that an average man doing muscular work requires—

For moderate work, Albuminoids, 4.4 ozs.; Fats, 4.4 ozs.; Carbo-hydrates, 14.4 ozs.

For hard work, Albuminoids, 5.2 ozs.; Fats, 4.4 ozs.; Carbo-hydrates, 14.4 ozs.

Professor Parkes says that the food required for a healthy adult is: For laborious occupation, Albuminoids, 6 to 7 oz; Fats, 3.5 to 4.5 oz; Carbo-hydrates, 16 to 18 oz; Salts, 1.2 to 1.5 oz.

At rest, Albuminoids, 2.5 oz; Fat, 1 oz; Carbo-hydrates, 12 oz; Salts, .5 oz.

The harder the work the more nitrogenous (albuminoids) should the diet be.

The heat of the body in order to be maintained necessitates the combustion of a large proportion of the food, probably about $\frac{9}{10}$ of it. This heat, together with the work expended internally in the functions of the heart, respiration, &c., and the external muscular action in locomotion and other voluntary work, represent an amount of energy calculated at about 3,400 foot-tons, *i.e.*, the force required to raise 3,400 tons 1 foot high. The heat of the body represents in amount that required to raise 48.4 lbs. from the freezing to the boiling point, or in mechanical power would be sufficient to raise 150 lbs. through a vertical height of 8½ miles. All this must be provided for by food and oxygen before making any demands on the system for muscular or brain labour.

Fish as a Brain Food.

I may here allude very briefly to the common, but erroneous, opinion that brain work requires or is benefitted by a liberal fish diet. This has arisen from statements made to the effect that thought and brain work in general used up a large quantity of phosphorus, and secondly, that fish supplied in abundance this element. Neither of these assertions appears on investigation to be true. The brain tissue consumed by mental activity contains no more phosphorus than that of other parts of the body—not so much as the bones and teeth. Fish does not furnish this element more abundantly than other animal foods. Good head work like good hand work requires a good digestion, and as fish is easily assimilated it may, for this very reason, be found of great value to brain workers, especially if such do not take sufficient muscular exercise to induce a vigorous digestion.

Before bringing these lectures to a close I wish to give you an outline of the process of digestion, the changes that take place in cooking food, and a few practical remarks drawn from a consideration of the whole subject.

Digestion.

Mastication or trituration of the food in the mouth serves by a thorough division of the material to present a greater surface to the solvent action of the digestive fluids. An increased digestion is the result. Saliva, secreted by certain glands of the mouth, softens and moistens the food and converts the insoluble starch into soluble sugar. In this reaction the active principle is Ptyaline.

The gastric juice, the secretion of the true peptic glands of the stomach, has a physical and chemical action. It dissolves and disintegrates the food, reducing it to a liquid condition, and converts the albuminoids into peptones, which are assimilated by the blood. Its composition is:—

Water	97·5
Pepsin	1·5
Hydrochloric acid	·5
Salts	·5
	100.0

It has an acid reaction.

The intestinal digestion is promoted by the pancreatic juice, which has an alkaline reaction. It has a fourfold function:—

(1) Converting starch into sugar.

(2) Converting albuminoids into peptones.

(3) The emulsification of fats.

(4) Conversion of cane sugar into grape sugar.

Bile, formed in the hepatic cells, assists in the emulsification of fats and promotes their absorption and stimulates the secretions ef the intestinal glands. It also serves to prevent putrefactive changes in the food. The digested food or chyme is absorbed by the blood as the food passes through the intestines, the undigested portion entering the large intestines.

THE CHEMISTRY OF COOKING.

The changes induced by cooking are manifold, some increasing, others decreasing the digestibility of the food, while others only serve to render the same more tasteful by the production of certain substances which pleasantly excite the palate.

Meats are more readily digested when "underdone" than well cooked, though undoubtedly very tough meat by its disintegration is rendered more tender and easy of mastication by the process. Certain empyreumatic substances are developed by roasting and boiling meats which give agreeable taste and savoury odours. These act rather as stimulants than nutrients, and render the food more palatable than in the uncooked condition. Roast beef, beef tea and soups owe their piquancy to these compounds. Eggs and milk are rendered less digestible by cooking, for the reason that coagulated albumen is not readily acted upon by the digestive fluids.

On the other hand, most vegetable foods require cooking to increase their digestibility. The cells containing the starch in the raw material have walls of cellulose, difficult of digestion. By cooking, this cellulose is softened and the starch grains are burst. The contents then are more completely exposed to the digestive fluids.

In summing up I would offer the following remarks and deductions. Their importance, I think, merits your consideration.

1. That in the choice of viands care should be taken that the diet consists of both vegetable and animal foods. The proportion of nutrients may roughly be stated at three times the weight of carbohydrates to equal weights of fats and albuminoids. Excess of any one nutrient is likely to be injurious to health.

It would seem that nature teaches what science confirms—a proper combination of materials. The Irishman with his potatoes (carbo-hydrates) and buttermilk (albuminoids), the Englishman with his bread and cheese (carbo hydrates, fat and albuminoids), and many others, exemplify this inference.

2. Starch, sugar and fats are essentially heat and energy producers. As heat producers fats are about 2½ times more valuable than carbohydrates. In cold climates we find the inhabitants existing largely on fatty foods. Esquimaux and lumbermen are notable examples.

The albuminoids are the most costly of all the nutrients. While performing to some extent the functions just mentioned, they have for their chief office that of building up the tissues of the body and repairing the waste continually going on. The albuminoids cannot be replaced in the diet by any other material.

3. Fruits and many vegetables while not rich in nutritive material should form a large part of the diet, as they assist in digestion and, acting medicinally, give a healthy tone to the system. Salads of lettuce, celery and beets, if not too rich, have a cooling and refreshing effect.

4. Condiments and stimulants are often desirable as appetisers and in moderate amounts excite the flow of the digestive fluids, and thus aid digestion. Excess of alcohol, tea and certain other articles of this class is well known to have injurious physiological action.

5. Cooking, while, as a rule, rendering the animal foods rather less digestible, makes vegetable foods more fit for consumption.

6. Mastication should be thorough in order that the food may be well mixed with saliva, and for this purpose slow eating is to be recommended.

7. The process of digestion is a continuous one. Active work retards somewhat the digestion of a heavy meal, and such should, therefore, be taken rather after the work of the day than during it. The times of meals must largely be regulated by the amount and kind of work. It is better to eat a little and often than to overload the digestive apparatus at any one meal. Though the digestive process is not so vigorous during sleep as in the day time, light refreshment is to be recommended before retiring—the stomach thereby is kept from being totally void of food in the morning. To those who are not robust eaters this advice is more particularly given.

8. The blood which conveys the digested food to every part of the body is largely water. On this account and because all the tissues contain

a large amount of this compound, and the waste of the body is partially eliminated in a fluid form, it is necessary that as such, or under the guise of some drink, a considerable quantity of water be daily taken. Very cold water lowers the temperature of the stomach, retarding digestion. In excess, water dilutes detrimentally the gastric juice. The aged, therefore, and those whose digestion is not vigorous should avoid too much water, especially of a low temperature. For such, a light wine or other stimulant in moderation is undoubtedly beneficial. In drinking as in eating the appetite is a safe guide. As a rule it is wise not to satiate the appetite for solids or fluids. The old adage " Rise with an appetite and you will always sit down with one," is a wise one.

9. Pastry and sweetmeats. Hot rich pastry and cake are excessively indigestible, and in no sense can be considered as complete foods. They should be sparingly eaten, if at all. Excess of sugar, as in sweetmeats, deranges digestion.

10. Many "made dishes" are very rich and concentrated, and can scarcely be considered as having a place in a wholesome diet.

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PROGRAMME.

1891.

Dec. 17—President's Inaugural Address, (The work of the Geological Survey) . . . . Dr. Ells

1892.

Jan'y 14—Notes of a trip in Japan, ... Mr. Harrington
Report of Ornithological Branch.

Jan'y 28—The Educational value of Natural Science, ... Mr. Cowley

Feb'y 11—Microscopical Soiree. (Normal School Students particularly invited).
Four short papers of not more than ten minutes each, by Messrs. Ferrier, Harrington, Shutt and Fletcher, to be illustrated by microscopes.

Feb'y 25—On some New Chazy Fossils, ... Mr. J. W. E. Sowter
The Spring Flowers of Ottawa and Vicinity, . Mr. James Macoun
Report of the Entomological Branch.

March 10—Water: its properties and functions, ... Mr. Lehmann
Report of Zoological Branch.
Report of the Geological Branch.

SUMMARY

—— OF ——

Canadian Mining Regulations.

NOTICE.

THE following is a summary of the Regulations with respect to the manner of recording claims for *Mineral Lands*, other than Coal Lands, and the conditions governing the purchase of the same.

Any person may explore vacant Dominion Lands not appropriated or reserved by Government for other purposes, and may search therein, either by surface or subterranean prospecting, for mineral deposits, with a view to obtaining a mining location for the same, but no mining location shall be granted until actual discovery has been made of the vein, lode or deposit of mineral or metal within the limits of the location of claim.

A location for mining, except for *Iron* or *Petroleum*, shall not be more than 1500 feet in length, nor more than 600 feet in breadth. A location for mining *Iron* or *Petroleum* shall not exceed 160 acres in area.

On discovering a mineral deposit any person may obtain a mining location, upon marking out his location on the ground, in accordance with the regulations in that behalf, and filing with the Agent of Dominion Lands for the district, within sixty days from discovery, an affidavit in form prescribed by Mining Regulations, and paying at the same time an office fee of five dollars, which will entitle the person so recording his claim to enter into possession of the location applied for.

At any time before the expiration of five years from the date of recording his claim, the claimant may, upon filing proof with the Local Agent that he has expended $500.00 in actual mining operations on the claim, by paying to the Local Agent therefor $5 per acre cash and a further sum of $50 to cover the cost of survey, obtain a patent for said claim as provided in the said Mining Regulations.

Copies of the Regulations may be obtained upon application to the Department of the Interior.

A. M. BURGESS,
Deputy of the Minister of the Interior.

DEPARTMENT OF THE INTERIOR,
Ottawa, Canada, December 19th, 1887.

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