THESIS

ON

The Digestion of a Meal

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PREFACE

Probably no other process of such importance is so little understood as that which takes place within our own bodies. We know that we drink water and are refreshed, eat a meal and are strengthened, that the food we consume is in some way converted into living tissue; but the changes involved, the process through which the food must go, and the organs and agencies which assist in digestion are not familiar to the average person. Such a knowledge of the course of the food through the body is especially essential to the teacher of cookery and to the one who prepares the food. Knight in his "Food and its Functions" remarks that of the majority of us it may still be said that we are concerned not so much with the history of the last meal as with the prospects of the next. This however cannot longer be said of the girls and women who study cookery. In the schools where this subject is taught much strees is laid upon the physiology and chemistry of foods, their function in the body, and the physiology of digestion.

This work is written from a knowledge of facts obtained from a course in Domestic Science at the Oregon Agricultural College, supplemented by references from the following physiological text books; Fischer's Test Book of Physiology, and Physiology of Alimentation, Knight's Food and Its Functions, Chittenden's Nutrition of Man.

THE DIGESTION OF A MEAL

Food The various functions of food are; to repair waste, furnish energy, and build new tissue during growth, The food, in order to accomplish these ends, must go through the process of digestion, whereby it is so changed that it is absorbed by the blood and utilized by the tissues of the body. Although quite varied in character, upon analysis we find that all food is composed of one or more of the food principles, the classification of which is usually given as follows:

Food Principles
- Water.
- Inorganic salts.
- Proteids.
- Carbohydrates.
- Fats.

Only a little concerning the nutrituve value of each of these principles will be given here.

Water and Salts Water and salts are not commonly considered as foods, but both are absolutely necessary to the body. Water acts as a solvent and cleanser in the body and many diseases might be prevented by drinking pure water. All the tissues of the body contain mineral substances of one kind or another. The most important of these being soda, potash, lime, and phosphoric acid.

Mineral salts give alkalinity to the blood, share in the forming of bone, assist in digestion, and are essential to cell growth.

Proteids. Proteids exist in the form of white of egg, curd of milk (casein), lean meat, gluten of wheat and other grains, and vegetable proteid.

The essential uses of proteids to the body are to build new and repair old tissue. They also are a source of energy. Proteids contain nitrogen and are sometimes called the nitrogenous foods. It follows from this that fats and carbo-hydrates could not of themselves form new protoplasm. Whatever, therefore, we may omit from our diet we must have proteid matter.

In some classifications of food principles, albuminoids are given. These resemble proteids but cannot be used in the place of proteids to build protoplasm. Their value is similar to the non-nitrogenous foods rather than the nitrogenous.

Carbo-Hydrates Carbohydrates constitute the bulk of our food. The physiological value of carbohydrates lies in the fact that when they are destroyed in the body energy is liberated. This energy we are constantly giving off in the form of muscular work and heat. We must of necessity then take a great deal of material for the production of energy in our foods. The cheapest and easiest source of energy is the carbohydrates, among which we include starches, sugars, and gums.

Fats Fats, as the fat of meat, butter, olive oil, and vegetable fats, contain no nitrogen, and their use in the body is quite the same as that of the carbohydrates. They are really able to furnish more energy, but carbohydrates are easier to obtain and are more easily destroyed in the body.

Fats are stored in the body in the form of fats and used as a reserve fund of food. This is probably their chief value.

Carbohydrate Foods The term as used by scientists means that division of food stuffs which contains carbon, hydrogen, and oxygen in the same proportion as in water but no nitrogen.

Foods The ordinary foods contain a mixture of the food principles, with various flavors. A few foods contain the nitrogenous and non-nitrogenous compounds in such proportion that they are perfect foods in themselves, but in the majority of cases it is necessary to combine different foods in order to secure the best result.

Digestion The physiology of digestion as used here consists principally of a consideration of the various chemical and physical changes through which food passes before it is excreted from the body as waste.

Enzymes Enzymes are unorganized ferments, produced in the cells of animals and plants, but are regarded as dead matter. They are given the name of unorganized ferments to distinguish them from the living ferments such as the yeast plant and bacteria. Enzymes contain nitrogen. Their exact chemical composition is unknown but they seem to somewhat resemble the proteids. A classification of the enzymes according to the reaction produced is as follows;

Proteolytic enzymes

Pepsin of the gastric juice

Trypsin of the pancreatic juice

Amylolytic enzymes

Ptyalin found in the saliva

Amylopsin of the pancreatic juice

Enzyme of the liver that converts glycogen to sugar

Diastase, found in germinating seeds of plants

Fat-splitting enzymes, change fats to glycerine and fatty acids.

Steapsin of pancreatic secretion

Sugar-splitting, changes double sugar to single.

Invertase acts on cane sugar, small intestine

Maltase acts on maltose, found in small intestine

Coagulating enzymes

Changes soluble proteids into soluble form

Rennin in the gastric juice, milk-curdling enzyme.

Thrombin, a fibrin ferment found in shed blood

Reaction of the Enzymes

In studying the general reactions of the enzymes we find that they are soluble in water and glycerine, the latter being most commonly used to obtain extracts of enzymes from the various organs. Each enzyme has a certain temperature at which the action is greatest. Very low temperature retards the action.

The action is incomplete, due to the products of the activity of the enzyme preventing further action. After the amount of enzyme has reached a certain percentage, to increase that amount has no effect. The action is peculiar, as they do not themselves enter into the reaction, but simply act as agents. The process is called hydrolysis; that is, the enzyme acting as the hydrating agent causes the molecules of the substance upon which it acts to take up molecules of water, then the resulting molecule may break up into simpler molecules. This is illustrated by the action of amylase upon starch.

$$C_{12} H_{20} O_{10} - H_2O = C_{12}H_{22}O_{11}$$

Starch Water Maltose

The breaking of the end molecule into simpler bodies is well illustrated by the action of invertin on cane sugar

$C_{12}H_{22}O_{11}$ H_2O $C_6H_{12}O_6$ $C_6H_{12}O_6$

Cane sugar water dextrose levulose

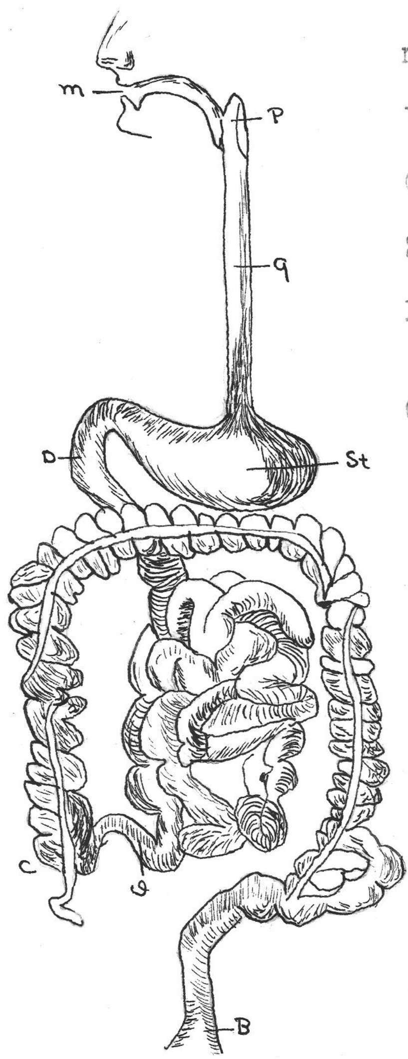
The Juices, their Constituents and Aid in Digestion

Saliva: This is the first secretion with which the food comes in contact.

It is the mixed solution from the parotid, submaxillary, and sublingual glands of the mouth. The gases of the saliva are oxygen, nitrogen, and carbon dioxide. About 99.4% of its constituents is water and .6% is solids. The latter consists of mucin, epithelial cells, from the epithelium of the mouth, ptyalin, albumin, and inorganic salts. Ptyalin is the ferment found in the saliva. We commonly say that ptyalin converts or changes starch into sugars; however, the change is not direct nor simple, but consists of a number of intermediate stages; the final product depends upon the stage at which the action is interrupted.

One interesting and important fact, according to Chittenden, is that a slight increase in acidity stops the action and kills the enzyme. This is important to know because it indicates that the action on starch is suspended after the food reaches the stomach and becomes mixed with the hydrochloric acid of the gastric juice.

Alimentary Canal



m - mouth

P - pharnyx

G - gullet

St - stomach

D C I - small intestine

C I B - large intestine

Starch is in the best condition for digestion after it has been boiled and cooked for a long time, three hours is considered a good length of time to cook starchy cereals. The reason for this is that raw starch grains are surrounded by a layer of cellulose that resists the action of the ptyalin. Also starch itself is changed during boiling, it takes water and hydrolysis is more rapid.

Although the ptyalin is very energetic in its action upon starch it is not probable that the food remains in the mouth long enough for much action to take place. If indeed the action of the ptyalin is stopped when it reaches the stomach we conclude that the chief value of saliva is to facilitate the swallowing of the food. This is done by the mucin, which supplies the food with a coating of ropy fluid thus allowing of a ready passage through the esophagus.

The Gastric Juice

The food passes from the mouth through the esophagus and into the stomach. Here is the gastric juice, which is a secretion of the gastric mucous membrane. It has a strong acid reaction, due to the hydrochloric acid, and is the only secretion which does contain free acid. It is composed of 97.3% water and 2.7% solids. The ferments of the gastric juice are pepsin and rennin.

Pepsin has the peculiarity of acting only in an acid solution. Solid proteids that are exposed to the action of the pepsin in the gastric juice soon pass into solution. These soluble proteids are then fitted for rapid absorption and called peptones. The protėids however before reaching the final product, peptones, pass through a number of intermediate stages. A general idea of the process may be gained from the following outline:

Proteid

Syntonin (acid - albumen)

Proteoses - primary

Proteoses - secondary

Peptones

The final products of peptic digestion are usually spoken of simply as peptones although it is probable that there are two distinct varieties.

Rennin: another important enzyme of the gastric juice is the one which coagulates milk. Dry mucous membrane of the calf's stomach when stirred with fresh milk will curdle it and is often utilized in preparing food and in the manufacture of cheese. When in commercial form we call it junket. The rennin acts on the casein of the milk and changes this soluble proteid into an insoluble modification and precipitates it into curd. The chemistry of the change will not be treated of here as it is not thoroughly understood. We have no knowledge of rennin acting on anything but milk, As to the value of the curdling of the casein it is presumed that it is more easily digested by the proteolytic enzyme after it is brought into an insoluable, form.

Human gastric juice contains no amylolytic enzyme, that is it has no direct action upon carbohydrates. Neither is there any action on fats. Recent investigation shows that there is the enzyme steapsin in the gastric juice but since it would not act in the presence of acid, the fat is not affected and we take no account of it. It is probable that the stomach brings about such a similar mixture of the fats with the other food of the chyme that digestion is more rapid in the intestines.

Intestinal Digestion

On leaving the stomach the food passes through the pyloric opening into the small intestine. It is here that the most important digestive change takes place, and that mainly while the food passes through the small intestine. The process is completed during the passage through the large intestine.

The pancreatic juice is the secretion of the pancreas which opens by means of a duct into the duodenum below the opening of the pylorus. The pancreatic juice is composed of 86.4% water, 13.2% organic substance and .34% salts. The ferments of the pancreatic juice are the trypsin, amylopsin, and the steapsin.

Trypsin: Trypsin digestion resembles peptic although it is more powerful and differs in that trypsin acts best in an alkaline media. The most characteristic difference however is that the pepsin cannot act further after the proteids reach the peptone stage and the trypsin can. Therefore it is common to say that pepsin converts proteids into peptones and trypsin carries the action further splitting the peptones into simple nitrogenous bodies, most of which are amido-acids.

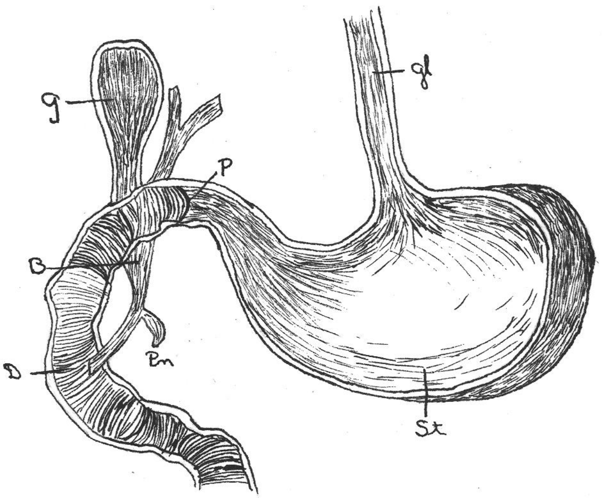
Amylopsin: The chief reaction of amylopsin is its effect upon starch. This is apparently the same as that produced by ptyalin, and as far as our knowledge goes the composition of amylopsin and ptyalin is the same. The end product of the action of anylopsin on starch is a sugar, maltose ($C_{12} H_{22} O_{11}$). The action of the amylopsin is important, for starches form a large part of our diet, and as has been seen the action of saliva is of subordinate importance.

Steapsin: Steapsin or lipase is a fat-splitting enzyme. Neutral fats when they come in contact with steapsin take up water and then break up into glycerin and fatty acids. This peculiar power of the pancreatic juice is of the greatest importance in the digestion and absorption of fats. It has been shown that the action on fats takes place much more rapidly in a mixture of pancreatic juice and bile. These two secretions are poured into the duodenum together and are mixed with the food. This effect of the bile is not due to any enzyme of its own but the mere presence of the bile seems to favor the action of steapsin.

Digestion in the large Intestine

The food passes from the small intestine through the ileo-cecal valve into the large intestine. As it is still incompletely digested and is mixed with the ezymes of the small intestine it is probable that some of the digestive processes described above are continued for some time here. The chief changes however are the absorption that takes place and bacterial decomposition. The bacteria, or organized ferments, cause some changes to the food before it is eliminated as feces. But just to what extent they are responsible is disputed. However it is now generally believed that animals will not thrive when the entire alimentary canal is free from bacteria. However there are troublesome bacteria, and when the digestive enzymes

The Stomach



gl - gullet

St - stomach

P - pyloric opening

D - duodenum

G - gall-bladder

B - bile duct

Pn - pancreatic duct

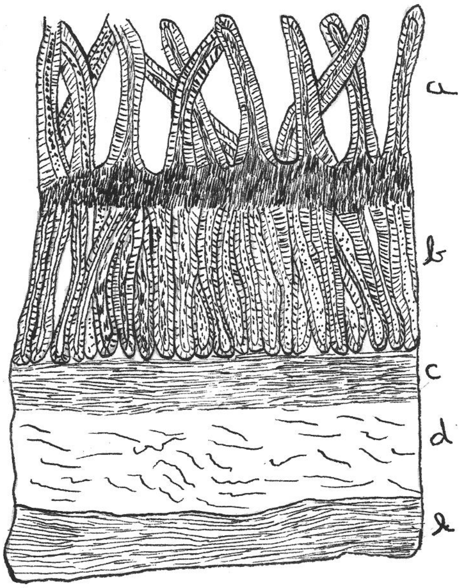
and secretion are hindered in any way the action of the bacteria is increased and the result may be intestinal trouble.

Absorption. In order to be of use to the body the foodmust be absorbed into the circulatory system and fed to the tissues. There are two ways by which absorption may take place. The soluable substances may pass into the blood directly and so on into the liver or they may enter the lymphatic system by way of the lacteals and hence into the blood. The thoracic duct, into which all the lymph glands empty, opens into the blood system at the junction of the jugular and subclavical veins.

Stomach Absorption does not take place readily in the stomach. But possibly the following substances are absorbed: water, salts, sugars, and dextrine, which were eaten as such or formed by salivary digestion, and the proteoses and peptones formed by peptic digestion; also besides these all liquid substances such as drugs and alcohol are readily absorbed.

Experiments by means of a fistula in the duodenum just beyond the pylorus have been made and show that very little actual absorption goes on in the stomach. Water taken along is scarcely absorbed at all. Exper-

Structure of Small Intestine



a - villi

b - intestinal glands

d-e - outer coat of muscles

iments being on record where 500 cubic centimeters were given a day and within twenty-five minutes 495 cubic centimeters passed through the stomach into the duodenal fistula. Alcohol by the same kind of experiment was found to be readily absorbed.

Salts have not been thoroughly experimented with but it is thought that very little absorption takes place as a concentrated solution of 3% is necessary. The same thing is true of sugars and dextrines. They may be absorbed but a concentrated solution of 5% is necessary.

Fats are not digested at all in the stomach, hence no absorption takes place until they reach the small intestine.

Absorption in the Small Intestine

Absorption takes place to the greatest extent in the small intestine. This is due to the vast number of villi and to the folds of the intestine, which increase the surface greatly. The three important food principles, proteids, carbohydrates and fats, are acted upon powerfully in the small intestine and are readily absorbed, as are also water and salts. The loss of water, however, is compensated for by the secretion along the intestine so that when the food reaches the ileo-caecal valve it is still of a fluid consistency.

Large Intestine Absorption The absorption inthe large intestine is not great, owing to the absence of villi and the fact that there are but a few folds. However the food passes through the large intestine slowly and some absorption does take place, and it is an important part of the function of the large intestine. This is strikingly illustrated by the fact that various food substances can be injected into the rectum and suffice to nourish the animal. This is taken advantage of in medical practice where enema are given with satisfactory results.

Proteids Absorption We will now take up the absorption of the various food principles more in detail. Proteids are absorbed in the stomach, the small intestine and the large intestine. In just what form they are absorbed is a question. Innumerable experiments have been preformed but have not in any case proven conclusively that proteids are always absorbed in any certain form. Facts seem to indicate and recent work shows that proteids are absorbed, at least for the most part, in the simplest digestive product. The most accepted theory is that the peculiar columnar cells of the muceus membrane have the power of rebuilding their own particular proteid from the molecules of the broken down proteid. This conclusion was reached partially because of the fact that after a meal of proteid matter an examination of the blood fails to find any proteoses, peptones, or amine acids.

Carbohydrate Absorption — The carbohydrates of chief importance are the polysaccharides, starch, glycogen and cellulose; the disaccharides, cane-sugar (sucrose), malt-sugar (maltose), and milk-sugar (lactose); and the monosaccharides, dextrese, levulose, and galactose.

Starch forms the bulk of all carbohydrate food and is formed in grains and vegetables, which comprises such a large part of our diet. Glycogen is one of the constituents of lean meat. Cellulose we usually consider as the weedy fibrous part of vegetables and fruits.

Sucrose (cane-sugar) is the ordinary commercial sugar. From the "breakfast foods" and beverages, which contain sprouted grains, is obtained maltose. Dextrose and levulose are found in the commercial "glucose" and in certain fresh and dried fruits; with these exceptions all that is found in the alimentary canal is the result of the decomposition of the polysaccharides and disaccharides. Galactose is produced through the action of lactose upon milk-sugar.

Dextrose is the ultimate product of all the polyaccharides and disaccharides. The monosaccharides are absorbed as they are. The disaccharides are absorbed without further breaking up if fed rapidly, and as they cannot be utilized in this state are eliminated through the kidneys. This shows one of the injuries of "belting" our food.

Starch may be absorbed when it reaches the stage maltose but usually breaks down into dextrose before absorption. The absorbed sugars pass directly into the blood and do not enter the lymph gland.

Fat Absorption

The fats undergo two changes previous to absorption. First the changes of emulsification and second the chemical change saponification. Authors disagree as to whether fats are absorbed in solid form or not. Although fats as fats are insoluble they may be emulsified into such minute globules that they easily circulate through the capillaries. Because of this it has been held that fats are absorbed as fats. But later works contend that fats are absorbed as fatty acids, glycerin or soaps but not as fats.

The minute fat globules penetrate to the central lacteal through the lymph stream. After a fatty meal the blood appears quite milky. Fats are eventually stored in the connective tissue cells of the adipose tissue.

Water and Salts Absorption

As has been stated there is very little absorption of water in the stomach. Whatever soluble substances are absorbed in this organ carry with them a certain amount of water. But most of the water passes through the pylorus into the small intestine. Here the absorption of water and salts directly into the blood takes place readily. Soluble salts are absorbed unchanged.

Feces The feces vary in amount and composition with the character of the food. If a diet of meats exclusively is taken the feces are small in amount and dark in color. A mixed died increases the amount and with a diet of vegetables exclusively it is the largest. The average of the feces on a mixed diet in 24 hours is 170 grams.

The composition we will consider only briefly. Although the composition varies with the diet, ordinarily we would find the following:

Indigestible material

Undigested material

Under normal conditions this is slight. Some form of fat however is nearly always present

Proteids of the intestinal secretion

Products of bacterial decomposition

Of these indel and skatol, from the putrefaction of proteid material, are the most characteristic. These occur together. They are crystalline bodies possesing a disagreeable odor, especially is this true of skatol. Only a part of these are eliminated from the body through the feces. A portion of each is eliminated in a modified form through the urine.

Cholesterin

This exists in small amounts and is probably derived from the bile

Excretin

A crystallizable, non-nitrogenous substance found only in minute quantities

Mucus and epithelial cells

Dislodged from the intestinal wall

Pigment

Hydrobilirubin which is derived from the pigments, bilirubin, of the bile

Inorganic salts

Soliem, potassium, calcium, magnesium and iron salts.

Micro-organisms

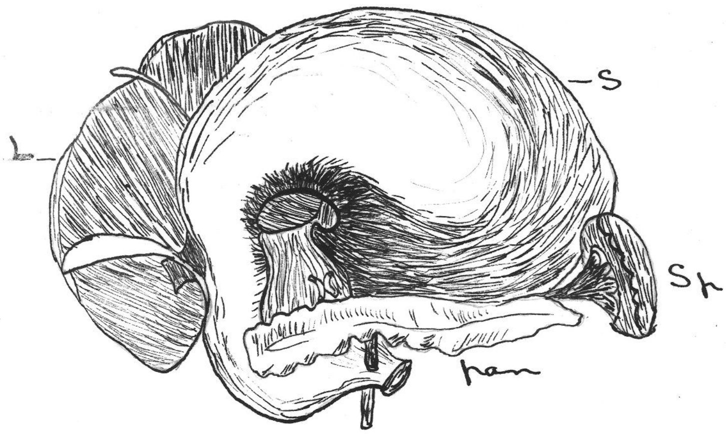
Many different kinds of these exist in great quantities. There is also present in the large intestine a quantity of gas that may be eliminated through the rectum. CH_4, CO_2, H, N, H_2S, are some of the gases. These arise from the bacterial fermentation of the proteids with the exception of CO_2 which is probably taken in the food with the air.

Relation of Stomach to

Liver

Pancreas

Spleen



S - stomach

L - liver

Sp - spleen

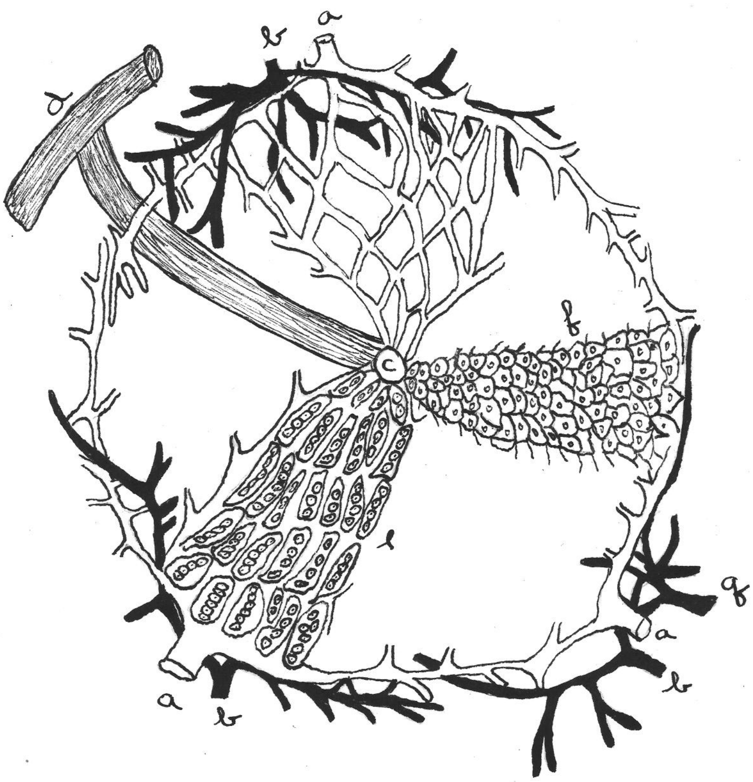
Pan - pancreas

Liver and Spleen — The liver is of great importance in the nutrition of the body. All the blood from the intestinal canal, containing soluble food material, passes through it. This blood drains into the portal vein and is again distributed to the liver. The liver itself receives its blood supply from the hepatic artery which comes from the heart. Out of the blood from the portal vein the liver cells manufacture glycogen or liver starch and out of all blood they form bile and urea which are excreted.

Each lobule gives rise to bile capillaries which carry off the bile. According to these facts the physiology of the liver cells may be treated in two parts, one treating of the bile and the other showing the metabolic changes produced in the mixed blood of the portal vein and hepatic artery as it flows through the lobules. In thelater the formation of urea and glycogen is of chief importance.

Bile — Bile is a transparent secretion of from a yellowish brown to a dark green color and extremely bitter. The color varies according to the proportions of the bile-pigments, bilirubin and biliverdin. In carnivorous animals in which the bilirubin is predominant the bile is a golden color, while in herbivora it is of a greenish

Structure of Liver Lobule



a - interlobular branches of portal vein

b - branches of hepatic artery

c - interlobular vein, draining into

d - subclobular vein

e - cells cut across, showing bile capillaries

f - bile duct

color due to the biliverdin. Human bile varies as to color. Unlike other digestive juices bile is being secreted all the time. When not required for digestion it passes into the gall-bladder.

Bile Pigments — The bile pigments, biliverdin and bilirubin, originate from the haemoglobin. The theory is that when the blood corpuscles go to pieces the haemoglobin is brought to the liver and converted into an iron-free compound, bilirubin or biliverdin.

These pigments are carried in the bile to the duodenum and are there mixed with the food in its passage through the intestine. However they are not found in the feces, but in their place is found hydrobilirubim which is formed in the large intestine. It is believed that some of the bile pigment is reabsorbed, is carried to the liver, and agains eliminated. As far as the bile is concerned the value of the circulation is not apparent.

Bile Acid — There are two bile acids, blycoholic, and taurocholic, both of which are secreted by the liver cells. The chief function of the acids is to facilitate the absorption of fats. They also serve to dissolve the cholestrin which is an excretion to be removed.

Cholesterine — This is an non-nitrogenous substance found in all animal and plant cells, especially in the white matter of nerve fibers. It is not formed in the liver but is eliminated by the liver cells from the blood which collects it from the various tissues of the body. It is regarded simply as a waste product, excreted chiefly through the liver but partly eliminated through the skin. Lecithin is another waste product that is eliminated through the liver.

Fats and nucleo-albumen are two constitutents of the liver, the physiological significance of which are unknown.

In general we find that bile is physiologically important as an excretion and as a digestive secretion. As the former it removes the waste products of metabolism, and as the latter aids in the digestion and absorption of fats, splitting the neutral and emulsifying the remainder.

Glycogen The formation of glycogen by the liver cells is one of their most important functions. As has been said before it is chiefly from carbohydrate food that glycogen is formed. However, that it may be produced from proteids is proven by the fact that in the case of a diabetes patient fed on proteid diet alone sugar is found in the urine. Also after a period of starvation, when an animal is living on the proteids and fats of its own body, the amount of sugar in the blood remains practically the same.

The function of glycogen is to form a reserve supply of carbohydrate material. This is stored in the liver and is converted into dextrose and enters the blood as needed, thus keeping the percentage of sugar in the blood system nearly constant, .1% to .2% Muscular exercise exhausts the supply of glycogen.

Urea Urea is the form in which the proteid material of our food is finally eliminated, after metabolism is completed. It has been definitely proven that urea is not formed in the kidneys, the organs that eliminate it. Experiments have shown that it is formed, at least in part, in the liver, and is then given to the blood.

Excreting Organs - Kidney and Skin

Kidney The secretion of the kidney is urine. It is a yellowish liquid, varying greatly in color. It has an acid reaction, not due to a free acid but to an acid salt. The composition is very complex, due to the nature of the excretion. It is through the kidneys that the end products of the metabolism of the tissues, organic substances, and the products of decomposition of the alimentary tract are eliminated.

Urea occurs in the urine in large quantities. As was mentioned it is the end product of the oxidation of proteid. In round numbers one gram of proteid will yeild one-third gram urea. An appreciable amount of urea, eight grams, may be eliminated in the sweat in twenty-four hours. It is found in small traces in the milk.

Skin The excretions of the skin are found in the sweat glands and sebaceous glands, both of which are found over nearly the entire surface of the body.

Sweat is the excretion of the sweat glands. The important constituents of the sweat are the water, the inorganic salts and the urea. It is one of these three main channels through which water is lost from the body. The skin and lungs removing 40% of the total to the kidneys 60%. This gives some idea of the value of keeping the sweat glands in good working order.

Sebaceous secretion is from the sebaceous or oil-glands which are associated with the hairs. The secretion is an oily, semi-fluid material, the value of which is to keep the hair oiled and pliant.

Metabolism Metabolism is defined by Knight as the name given to the physiological changes concerned in the transformation of energy. Considering the body as a machine we have found that it requires fuel and air. This fuel is not taken in its pure elements, as carbon, hydrogen, nitrogen, etc. But is found in the food-stuffs that have been described previously. Foods in order to be more appetizing and digestiblemay be cooked in various ways, but their history in the body remains the same. A consideration of the process which a particle of food must undergo between the time it enters the body, and that at which it is either absorbed or eliminated, necessitates a tracing of its passage through the alimentary tract; the changes it undergoes during digestion; its absorption into the blood; its history in the tissues, to some extent at least; and the final condition in which it is eliminated. The intermediate stages of metabolism are not all well understood. We know that the body transforms the stored energy into kinetic energy, which is used as work and heat. Of this total energy the body of a working man is capable of yeilding one-fifth in the shape of mechanical work daily. This means that the body has to liberate 1500 feet tons of internal energy and 300 foot tons, i.e. as much as would be required to lift a ton 300 feet vertically, or as much as is expended in sixteen mile.walk, is put out daily. A steam engine is capable of transforming only one-eighth of the energy of the coal into work.

Assimilation, as defined by Knight, is the process by which the living cells of the body take up the materials supplied by the blood. Just how the tissues exercise the power of selection in taking that which they need from the blood, and from these form living muscle and nerve, is understood to slight degree only. It is one of the mysteries of life concerning which we speculate and theorize but of which we know little.

Digestion may be good and absorption perfect but the body still fail to be properly nourished due to some disturbance to assimilation.

Therefore scientific research should be difinitely directed toward a final study of assimiliation, for there is nothing more important to the human race than proper nourishment of the body.