J. Rusche
On fatty Degeneration
Definition. By the term fatty degeneration is commonly understood either an abnormal deposition of fatty matter between the normal elements of an organ; or the natural conversion of these into fat. It may then be said to consist of a primary or secondary affection.

In what follows it is proposed to consider this subject under the following heads:

I. Conditions leading to fatty deposits in organs.
   a. General Obesity.
   b. Diminution or absence of function.
   c. Disease causing disintegration.
   d. Inflammation.
   e. Diminished vitality.

II. Is the fatty matter a deposit from the blood occupying the place of the other tissues which have been absorbed; or are the chemical compounds existing in the tissues converted into fat?

III. What are the changes in form which a tissue undergoes during the
the deposition of fatty matter, and what form does the fat assume?

IV. Nature of the fat deposited.

V. Ultimate destination of the fatty matters.

I. Conditions leading to fatty deposits in organs.

a. General Obesity — consists of an increased bulk of the body beyond what is considered the normal or healthy standard from an accumulation of fat in the adipose tissues. The seats of such superabundance are usually in the subcutaneous cellular tissue, the omentum, and filamentous structure around the kidney, mesentery and the interstices of the muscles; the pericardium and appendices epiploica may also be included. When the obesity is partial, the omentum, beneath the chin, or the mamma in some women, and sometimes the nates in the latter situation it has been said that some of the nations of Africa, as Baggumba, Hotentots afford an excellent example.
In some cases of obesity the bulk of the body is enormous. It is said that a breed of sheep exists in the Cape of Good Hope, in which partial obesity is so considerably developed in the hind quarters as to quite destroy the symmetry of their form.

The conditions which may give rise to this obesity may proceed from a variety of causes—depending partly on the habits of the body, food and mode of life, as the want of exercise.

Dr. L. J. B. Williams speaks of obesity occurring under two forms: sphenic & asthenic. The latter form says that writer is commonly allied with a leuco-phlegmatic temperament, having a soft languid pulse, defective perspiration, and a low irritability of body.

There is in such individuals a sufficient activity in the first part of the digestive process; but somnolent disposition is often present for some hours after meals which indicates the admixture of chyle in the circulation and a tardiness in the assimilation.

The chyle thus supplied probably abounds
more in fatty particles than in albuminous globules; until therefore the former are deposited from the circulating mass in the adipose membrane, the blood does not recover its natural and healthy condition. The cases in which I have had occasion to observe similar phenomena go to corroborate the remarks made by Dr. Williams.

Excess of food & want of exercise seem to be the principal causes in the fattening of animals, as we find it to take place in stall fed animals. The well known instance of partial obesity in the geese at Trastburgh, where they are confined in close cages, in heated atmospheres, are largely supplied with food, & deprived of exercise, by which means the respiratory functions are diminished, leading to a diseased state of the liver, and the consequence is an enormous enlargement of that organ, from an accumulation of fat, which should have been oxidized for the support of the animal temperature.

The abundant use of certain kinds of
Food have also a great tendency to produce fat; as those articles which contain much saccharine matter and farinaceous substances.

Experiments made in the feeding of the lower animals have proved how the addition of sugar to their food favours the feeding process. For cane sugar the following is the formula $C_{12}H_{22}O_{11}$, Starch $C_{12}H_{22}O_{7}$.

Here then are those indispensable elements in the formation of fat. Starch and sugar are the great sources from which fat is produced; now if we extract from starch 9 atoms of Oxygen, fat would be produced.

From this and other facts of a like nature it is incontrovertible that fat is produced by a deoxidizing process on non-acidified materials. Although as we will have occasion to show it is not the only source of fat which may exist in the body. The proximate condition of the formation of fat, or the deposition of the combustible respiratory materials in the cellular tissue of the body is a deficiency of oxygen. Were the supply of oxygen sufficient to convert the
carbon and hydrogen of these substances into carbonic acid and water these elements would be expelled and no part of them would be left in the form of fat.

A knowledge of the phenomena of fermentation allows us to penetrate into the processes by which, in the animal body, the highly oxidized sugar is converted into fat, a body containing so little oxygen.

The origin of fat in the animal organism presupposes precisely similar conditions; we regard the formation of fat as the result of two processes, which occur simultaneously: one is an imperfect process of oxidation (of decay or fermentation) by which a certain amount of hydrogen is separated from the elements of sugar; the other a process of splitting up a complex atom (of fermentation) by which a certain amount of oxygen is separated from the elements of sugar in the form of carbonic acid.

All substances which serve as food to men of animals always found under all circumstances contain a certain amount of fatty matter or
Bodies analogous to fat in their characters. (The flesh of wild animals are usually devoid of fat.)

In all those cases in which the weight of the body and the quantity of fat remain unaltered, we may therefore conclude that fat, sugar, and starch are exclusively employed in supporting respiration and that the latter are not employed to produce fat. The formation of fat, beyond the limit of the quantity required by the body for the promotion of the organizing processes or the deposition of fat in the fattening of animals, is always a misproportion between the respiratory and nutritive processes and rather a sign of morbid than of a normal healthy state. Nature has destined the non-nitrogenous bodies for the support of the animal heat, and we find all food most wisely compounded for this object. Nature has given to the organism the power to reduce every disturbance of the vital functions to a minimum of hurtful effects by storing up the excess of combustible
elements. These elements in the form of fat, being separated from the blood and deposited externally to the circulating system in a form well adapted to future use, the blood maintains its normal composition.

By a separation of the combustible elements from the blood, a deficiency in that fluid of oxygen indispensably necessary for other purposes is prevented and the equilibrium preserved.

As regards the different conditions which tend to the deposition of fat in against it seems that whatever tends to the increase of fatty matter in those situations in the body will also tend to its being deposited in situations where it is not usually found. Hence it may be presumed that one of the conditions of fatty degeneration will be found in general obesity. We find that the negro of the West Indies acquires an enormous size during the sugar season by drinking the cane juice.

It is said that the Ladies of Tunis and Tripoli are fattened, to please their lords with farinaceous food and a seed called
b. Diminution of absence of function. Fatty deposits take place in connection with atrophy in an organ. According to Walsh the production of fat in an organ is commonly the cause of atrophy acting by pressure, in other cases it is the result of atrophy. It may occurs as a primary or secondary affection in a part which is not much used as in the muscles of the extremities of the aged or the crippled limbs of persons, and in the structure of crippled organs; such a change we see best in the bodies of old persons. The parts which are no longer wanted are not simply atrophied, but are converted gradually into fat, and the blood is so overloaded with this ingredient, that it fails to remove the fat from these parts which are in earlier life naturally padded & distended with this substance; so that the body retains, in many respects, the form & plumpness of youth: but the texture is flabby and the colour pale, for the want of muscle and blood to give it the firmness.
and late of youthful life.

Advanced age appears to exert a material influence over this affection, arising probably from diminished activity of the cutaneous surface of the body combined with senile atrophy of the lungs. Hesse mentions that in 13 cases only two instances occurred under 40, and in 63 beyond 70 years of age. He goes on to remark that the influence of sex is still more remarkable. Amongst 38 males Kizot found but 4 amongst 172 females; no fewer than 23 cases affected accumulation of the heart's surface; nor did this appear to be connected with the greater tenacity of the female sex generally to obesity; for those of the 172 individuals 29 were quite emaciated; and of the latter 14 exhibited the disease; whilst among 80 emaciated men this was only the case with three.

From these remarks we may conclude that fatty degeneration may also result from diminished function.
The other condition frequently connected with this peculiar form of atrophy, which may then be called secondary, is the previous occurrence of chronic inflammation in the part. As in the former case we must look to the general habits of the individual for some share of the explanation; but the fact of the one being occasionally superimposed on the effects, or accompanying the progress of the other rests on the best evidence. This is most commonly seen as might be expected in internal organs. Probably, the same cause which has induced inflammation has, itself, in a great majority of cases, given the tendency to fatty degeneration of the particular organs.

Of the nature of this fatty degeneration, under whatever circumstances it may be produced, there can be no doubt it is essentially an atrophy whereby the most highly organized elements of the body are replaced by one of the most simple. It is not that the substances are changed into fat, that is plainly impossible, but that the
nutritive processes of muscle or gland or bone no longer restore particle for particle whatever is lost by the daily use of the part, but replace it by oil. Nutrition goes on, but the additions are of matters wholly unsuited to the office of those that they have replaced; they can neither move nor secrete nor even mechanically support the weight of the body.

Hence then we may regard diminution or loss of function in an organ as a second condition which leads to fatty degeneration.

c. Pressure causing disintegration.

A third cause of fatty degeneration of a part seems to be unusual pressure; thus in cases where tumours exist in the substance of organs, the tissue immediately surrounding it is found to be soft and infiltrated with fatty particles. In a case of tumour of the tongue (case of kotek in the clinical wards under Dr.}
Christison) the muscular substance around it for a considerable extent was found to be disintegrated and extensively infiltrated with fatty matter. A similar case is described and figured by Dr. Bennett in his work on Cancer & Cerebriform Growths.

In the cirrhosis of the liver also we generally find that the hepatic cells contain an abnormal amount of fatty matter. This is most abundant towards the circumference of the tubules.

In cirrhosis the fibrous structure composing the capsule of Glisson is, as is well known, very much hypertrophied. It must in order to increase in volume exert a greater or less degree of pressure on the cells of the tubules which it surrounds.

In the case of cirrhosis it is possible to explain the appearance of the fatty matter in the liver otherwise: that through the agency of pressure, that this however does give rise to disintegration and fatty degeneration of a part there can be no doubt.

As regards the manner in which it may
be supposed to do so: it may act by interfering with the proper nutrition of the part either directly or indirectly by preventing the due discharge of its function.

2. Inflammation

In inflammation of a part, one of the changes which takes place is the deposition of a quantity of fatty matter. Thus in inflammatory softening of the brain there is always present a number of bodies to which the name exudation or compound granular corpuscles has been given; these consist of a number of particles aggregated together, either surrounded by a cell wall or not.

The appearance, as well as the manner in which these particles are affected by ether and other reagents, indicates that they are of a fatty nature.

In inflammation of the parenchyma of the lungs, as in red hepatization these bodies are found to be present in large number.
A ten deny is generally manifested in the products of inflammation and other deposits towards fatty degeneration.

Thus the opaque exudation corpuscles found by Mr. Gulliver in great abundance in the lungs affected with low inflammation, especially chronic, and in gangrene were ascertained by Dr. Dany to consist chiefly of olein and margarine. The pus of old abscesses, mature and softened tubercle fibrous vegetations on the valves of the heart, and the softened fibrous found in blood vessels, or on serous surfaces long inflammation, also contain a very large portion of fatty matter in a solid crystalline granular form or in a liquid form.

According to Prof. Katz, fibrine is subject to a degeneration which we may compare to fatty degeneration. In coagula or solid parts of effusions that are found in the lower forms of inflammation or in very unhealthy persons, the fibrine is usually not uniform and filamentous, but rather opaque and turbid, nebulous or dotted.
just such an appearance as marks the earliest stages of fatty degeneration in muscular fibres. In such a coagula as these one sees not infrequently minute shining black edged particles which we may know to be drops of oil, while some general alteration in the composition of the fibrin is shown by its not being made transparent by acetic acid. In all such cases as these the fibrin is also very soft and easily broken; it is devoid of all that toughness and elasticity which is the peculiar characteristic of well-formed fibrin; and by breaking it up one may see the meaning of what one so often finds in the lowest forms of inflammatory exudation, such as occurs in erysipelas and typhus, namely, films and fragments of molecular and dotted substance floating in the fluid that is made turbid by them, and by abundant minute molecules and granules and particles of oily matter. These represent the disintegration of fibrine that has degenerated after clotting or has thus solidified in an imperfect
coagulation. Of such changes an excellent example is presented in the softening and disintegration of the clots within the heart, which Dr. Gulliver has described.

We have examples of numerous varieties of this degeneration and disintegration of fibrin found in inflammation. It is a principal constituent of what has been called "fibrinous synkize" in inflammation of serous membranes. And to the same source we may trace most of that molecular and granular matter, which is usually mingled with pus formed by the suppuration of inflammatory indurations, with the variously changed corpuscles of serous matter or with the granule cells and other corpuscles of pneumonia and the like inflammations. At least this disintegration of fibrin is probably a frequent origin of such molecular matter, while the quantity of fathy matter present in pus and the products of pneumonia, and its gradual increase while pus is retained in the abscess confirm the view that the changes here described are of the nature of fatty degeneration.
Now these are some facts which indicate the probability that the fatty degeneration is that which commonly precedes the natural normal absorption of many parts or rather that in the change which they undergo before absorption, fatty matter is one of the products; and that the principal evident difference between atrophy of a part which is manifested by its wasting, and the atrophy which is manifested by fatty degeneration, is that the fatty matter which is absorbed in the former case is retained in the latter. However this may be it is certain that the disintegration and fatty degeneration of the fibrous products of inflammation bring them into a state favourable for absorption.

The fatty degeneration of lymph cells is shown in their transition into granule cells (D. Bennett.) We owe the first demonstration of this to Reinhart.

The changes of transition are briefly these; the lymph cells which may have at first quite a normal character present a gradual
increase of shining black particles, like minute oil-drops, which accumulate in the cell cavity and increase in number and sometimes also in size till they nearly fill it. The fatty nature of these products is proved by their solubility in ether, and their accumulation is attended with gradual enlargement of the cell, which also at times assumes a more oval form.

Hence then we may regard inflammation in an organ as a fourth cause which gives rise to fatty degeneration.

e. Diminished Vitality

An impaired condition of the nutritive functions generally, also appears to be intimately connected with fatty degeneration. This is in patients who have been long ill, such as those who are affected with Rheumatisms it is rare to find some one or other of the organs of the body not infiltrated with fatty matter. The liver seems to be the organ most affected in cases of this kind, but it is also by no means uncommon for
the kidneys, the heart and great vessels to be the seats of fatty deposit.
Again, what it termed the natural decay of old age appears in many parts to be nothing other than fatty degeneration.
In almost all old people the great blood vessels are affected, and often to a very great extent, with atheroma or fatty degeneration of their coats; so also the bones contain an unusual amount of this material. In cases where fatty degeneration takes place in connection with impairment of the nutritive junction it is not a little remarkable, that the fat which occurs in the normal localities should at the same time disappear.
It seems indeed that just as the fat in the situations, in which it occurs normally, diminishes in quantity, so also it increases in quantity in parts where in the healthy condition of the body it either does not occur at all or only in very small quantity.
II. Is the fatty matter a deposit from the blood occupying the place of the tissues which have been absorbed or are the chemical compounds existing in the tissues converted into these?

In organs or structures which are undergoing decay we find more or less fatty matter deposited. The cells of cancer when undergoing decay, or when they have become effete, are infiltrated with fatty granules. Tubercle during the process of softening also becomes converted into fatty granules constituting an atheromatous mass.

So in old abscesses, especially those connective with disease of the vertebral column, we find the pus corpuscles gradually becoming more and more indistinct, and finally the whole mass is converted into a fuscaceous curdy substance which consists merely of fatty particles.

The deposits which take place in superficial subjects into the lymphatic glands are also converted gradually into fatty matter.
Whenever they lose their vitality or become effete so as to be unable longer to maintain longer their function they undergo the fatty transformation. It would seem as if it were necessary that they should be converted into fatty matter before they can again be absorbed into the system. This seems to be supported by the fact that they present after they have undergone the fatty degeneration, the same appearance and properties as the matters in the chyle consisting in short of fatty particles in a state of emulsion.

It might, and it has been said by some, that the fatty matter found in the above cases is deposited from the blood vessels into the decaying tissue - a portion of it may be derived from this source, but it seems also highly probable that the greater portion of it is derived from the tissue itself, that is to say that the protein compounds composing it are altered in
such a way as to give rise to fatty matter and soluble albumen. That the albuminous and protein compounds do undergo such a change is rendered probable from the following facts.

1. That during the artificial decomposition of the protein compounds, fatty compounds are formed.

We find from the experiments of Dr. Gregory in regard to the oxidation of albumen:

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\begin{align*}
4 \text{ egs Albumen} & \Rightarrow \{4 \text{ egs phosho acid} \}, \\
+ 40 \text{ egs Water} & \Rightarrow \{+ 8 \text{ egs phosho} \}, \\
+ 224 \text{ egs Oxygen from the air} & \Rightarrow \{12 \text{ Urea} \}, \\
& \{3 \text{ le carbonic acid} \}, \\
& \{+ 192 \text{ Oxygen} \}, \\
& \{6 \text{ manganese} \}, \\
& \{20 \text{ per cent. Sugar} \}. 
\end{align*}
\]

Here we see that on the left-hand the albumen is oxidised by the air alone, but on the right-hand is represented as unable to obtain more than 32 egs of oxygen, out of 224 that it requires from the air, and as procuring the remainder
from 20 cgs of sugar, which, yielding 192 cgs of oxygen, form at the same time 6 cgs of muriatre or fat, and 12 cgs of water. This proves that the formation of fat from sugar in the animal body, which certainly takes place, is a source where the blood may obtain oxygen when respiration is impeded. Were it not for this, an animal kept from free motion would soon die from the accumulation of muriatre matter in the blood.

Instead of dying, the animal lives; but, if supplied with starch in its food, obtains the oxygen necessary for the change of matter in the vital processes from the starch or sugar, and in doing so secretly becomes fat.

There is another process by which fat may be formed in the body, and which does not, like this one, depend on a want of oxygen. It is, probably, in this way that the normal fat, with a full supply of oxygen, is formed, and it appears to be a species of fermentation.
in which the liver seems to be in some
how concerned, and hydrogen gas is given
off, which of course is immediately oxidized
into water in the body.

Calf's liver, when placed in water, gives
off hydrogen by a species of fermentation,
and fat, the same as occurs in the
blood, is found at all times in the
bile. The supposed fatty fermentation
of sugar actually occurs out of the body,
and in the butyric fermentation, butyric
acid being a true fatty acid, and being found
in butter and fat, and in the fermentation
of starch, sugar, when capric and margaric
acids of the same series are produced, and
are found, along with hydrated oxide of amyl
in the grain or potato spirit.

2. In the case of fibrous tholiphe of
the heart we can trace the gradual breaking
up of the fibrin into an atheromatous
mater. Externally, the fibrin is unaltered
while in the centre we have it broken up
into a mass of atheromatous granules.
3. When animals have been buried for a length of time, or when they have been placed in a stream of running water, they are gradually converted into the fatty substance called adipocere. This holds true of all the tissues in the animal: muscles, skin, tendon &c. all undergo this change.

In Dr. Babington's observations the specific gravity of the milk like serum of the blood appeared to be so regularly reduced as to lead him to believe that the oil exists at the expense of the albumen. There are some facts in favour of the idea that albumen may be converted into oil. The rapid disappearance of the curd of perfectly fresh salmon, with the subsequent more oily state of the fish may be owing to a conversion of this kind, according to the conjecture of Sir Humphry Davy, as I have heard from Dr. Davy. I have observed that the oil in the livers of several fishes increases after death, probably in connection...
with incipient putrefaction, and Dr. Davy informs me that the liver of the cod after it had been kept in a damp place for twenty-five days, he found a small increase of oil, with the formation of carbonic acid and ammonia at the same time.” (Gulliver’s Notes to Newson’s Works)

III. What are the changes in form which a body tissue undergos during the deposition of fatty matter, and what form does the fat assume?

Fatty degeneration, affecting particular organs, as the kidneys, liver, heart, muscles and other structures, has of late years received the attention of many writers. This, however, is to be distinguished from the ordinary accumulation of fatty matter causing hypertrophy, of which we had occasion to mention under the head of obesity in the natural adipose texture of females.
True fatty degeneration consists in the formation of fat in the substance of the part.

It will be necessary for us to consider these changes of form in the different organs separately.

**Kidney**

The deposition of fatty matter in the kidney has received much attention of late years from the observations of Glage and Johnston, who have endeavoured to show that Bright's disease consists essentially in a fatty degeneration of the organ. Glage says there are three stages.

In the first stage the fatty matter is deposited in the cortical substance, unattended with obvious change in the tubuli or blood vessels.

In the second stage deposition of yellowish atretic fat globules takes place in the site of the cortical tubuli; these tubuli, themselves being destroyed in the same manner as the biliary ducts are in the most
advanced stage of cirrhosis of the liver.

Johnston seems to hold the doctrine that the disease of the kidney attended by albumenuria, and called Bright's disease, is always connected with deposition of fatty matter. He finds 1. That the epithelial cells of the healthy kidney contain oil to a variable amount 2. That an excessive increase of this fat constitutes primarily and essentially Bright's disease 3. That the presence of this fat causes, by a mechanical process, the presence of blood and albumen in the urine and atrophy of the kidney.

With respect to the first of these propositions Dr. Johnston's views are correct; that is always present in the kidney in a state of health a certain amount of fatty matter, and this fatty matter is deposited within the cells of the tubule. That Bright's disease发烧 consists, as he maintains, of a morbid accumulation of this matter we by no means think proved on the contrary the remarks which follow seem to show that the reverse is the case.

Dr. Johnston states that by keeping animals
confined in a damp locality he succeeded in producing in them Bright's disease of the kidney.

Now in the first place the kidney as has been above stated contains normally a certain amount of fat variable in different animals, and Dr. Johnston we fear, has not satisfactorily proved that this amount was increased in the animals on which he experimented. 2nd. But supposing it were increased in amount, as we have no doubt it is under certain circumstances as in fattened animals, Dr. Johnston does not inform us that the urine in his experiments was examined and found albuminous, so that as far as his observations go they prove nothing. Moreover we have found that the fatty matter in the kidney in many cases of Bright's disease is less than that in the organ in a state of health. 2nd. In animals which have been fattened although the fatty deposit in the kidney is often much increased in amount yet their urine is never found to be albuminous. Hence then we think that
we are justified in concluding that essentially there is no connection between Bright's disease of the kidney and fatty degeneration of the organ, and that fatty matter may exist in the organ to a large amount and yet the urine not be albuminous; and 3rd, that there may be decided albumenuria without the fatty matter being increased.

The fatty matter in the kidney may be increased under a variety of circumstances: 1st, it is increased as we have seen in animals which have been fattened. In these cases it is increased both beneath the peritoneal capsule and also in the secreting cells of the organ. In the latter situation it exists in the form of granules just as it does in the liver. 2nd, in cases of cystic disease causing atrophy from pressure it is also increased both within the cells and externally. 3rd, the same holds good of the deposits in the organ, which by their pressure interfere with the function of the organ. 4th, in acute inflammatory affections of the organ we often find it
infiltrated with numerous compound granular corpuscles, and free oil globules just as occurs in any other part.

There is however no true fatty kidney similar to fatty liver, which we have now to consider.

Liver

In fatty infiltration of the liver this organ is generally increased in size. It is however specifically lighter than the healthy organ, and is much paler, often presenting a pale fawn colour. On section it greases the knife and on being gently heated a large quantity of oily matter oozes out, which on cooling assumes a semisolid state.

The fat is generally deposited throughout the entire organ, but according to Weber it is sometimes limited to a portion of the organ.

The fatty liver yields on pressure an opaque emulsificant juice, and a thin section of it is also opaque.
With respect to the locality occupied by the fat in fatty liver, it is generally accumulated within the hepatic cells, sometimes to such an extent that they appear gorged with it.

Fatty matter exists in the liver to a certain extent in all cases, and it is only when accumulated in large quantity that it can be regarded as abnormal. Indeed that the mere deposition of fat in the organ does not interfere with its function of secreting bile is shown by the fact that in fish the liver always contains a large quantity of oil, sometimes amounting to 80 per cent, a quantity much larger than is found even in the most exaggerated conditions of the fatty liver in man.

The fatty matter in the liver exists in the shape of more or less minute granules. With respect to its nature it consists of oleum and stearin.

According to Aokitanski, this disease consists in the deposition of free adipon
tissue to such an extent as not only to replace the true granular structure, but to penetrate the entire parenchyma to the exclusion of the vascular tissue.

In a well marked case of fatty liver the organ is enlarged principally in a transverse direction; it is soft and fits on pressure, its edges flattened or swollen; its colour, both internally and externally, is uniformly yellowish red or light yellow, it is pale and exsanguine, and contains a large amount of fat, as is seen by the greasy deposit when cut with a dry warm knife.

There are two conditions which generally favour its production.

1st. It generally accompanies tubercular phthisis. Louis says that it is found in 2/3 of all the cases. Andral has supposed this to depend on impeded secretion of hydrogene by the lungs; but this is not the cause of it, but it seems to be an essential of the tubercular hypertrophy, in as much as it allies itself with tubercular
affections of every kind, with tubercle of
the intestinal mucous membrane, of the
bronchial glands, and of the serous mem-
branes.

2. Fatty liver may be developed in-
dependently of tubercle, in luxurious livers,
and persons addicted to the use of alcohol.
In this case there is generally found large
quantities of fat in the omentum, the
mesenteries, the heart, pericardium, and
subcutaneous, and frequently the muscular
tissue of the heart itself. The fat bears
a resemblance to tallow.

There is another variety of the fatty
liver called the waxy, known from the
former by its colour resembling beeswax;
by its greater consistence, dryness, and
brittleness.

"According to Dr. Bennett fatty
liver is well known to depend on the
secretion of a large quantity of oil which
is stored up in the hepatic cells. These
cells under these circumstances frequently
enlarged and contain oil, varying in amount
from a few granules, to a large mass which occupies the whole of their cavities. Not infrequently livers which to the naked eye appear healthy enough, may still be demonstrated with the microscope to contain an unusual number of fat granules, and there can be little doubt that considerable variation may exist in this respect, quite compatible with a state of health. Almost all stall-fed animals that do not labour profess a large amount of fat in their hepatic cells. It is only where the organ is much enlarged, altered in colour, and presses upon the neighbouring viscera, that its fatty degeneration can be said to interfere with the vital processes.

In man fatty degeneration of the liver has been observed to be very common in two kinds of cases. 1st in drunkards. 2nd in persons labouring under phthisis pulmonalis. Drunkards are continually taking alcoholic liquors, which abound in carbon, and which being too large in amount to be excreted from the lungs as carbolic.
acid, and from the liver as bile, is stored up in the latter organ in the form of fat. In pathoses pulmonalis the excreting power of the lungs is diminished and the excess of carbon in the tissues and food is thrown upon the liver to be excreted. Under these circumstances it is converted into fat, and stored up in that organ. This view has been objected to on the following grounds:

1st. That the connection between fatty liver and disease of the lungs is not general.

2nd. That there is no evidence that the fatty liver does not secrete bile as usual.

3rd. That a considerable portion of the bile is absorbed into the blood to be absorbed, excreted from the lungs, the liver must be considered as preparing a material for the organs. Hence it is argued that it would be a strange compensation if the functions of the liver were to be increased, while that of the lungs is diminished.
By disease (Budd). But if fatty liver be not always conjoined with distended liver, it will be found associated with some circumstances which diminishes the functions of that organ in relation to the work it is called upon to perform; for instance the separation of the carbon from the alcoholic fluid taken by the drunken again want of exercise from various diseases, and especially phthisis, whilst in order to support the strength, wine and nutritious diet are given liberally, may frequently seem to be the cause of fatty liver. Further, says Dr. Bennett, although it be granted that the liver may in health prepare carbonaceous matters for pulmonary excretion, it must be clear that if the lungs cannot accomplish this function such matters must be thrown back or retained in the liver and constitute a powerful cause of fatty degeneration of that organ.
There is another structural alteration of the liver, which from its colour and general appearance has been called "woody" liver.

This disease has been confounded, says Dr. Bennett, with fatty liver, although an examination of its minute character will show that the hepatic cells present a very different character. Instead of being enlarged and filled more or less with oil globules, they are colourless, shrunken, and for the most part destitute of contents, while the nucleus has disappeared.

The lesion seems to be a further stage of fatty degeneration, in which the oily matter is absorbed, and the cell-walls are left behind and aggregated together.

Dr. Bennett, Edinburgh Medical Journal of Jan 1852.

In the cirrhotic liver there is generally more or less fat contained within the hepatic cells.

The fact above mentioned was pointed
out by Gluge, Ballman, and Palentia, and Gluge believed that this deposition of fatty matter constituted the whole element of the disease cirrhosis, or at least that the fatty state of the liver was the first stage of the cirrhosis. Dr. Walse however does not agree with Gluge, and when we compare the amount of fat in the real fatty liver with that occurring in cirrhosis as well as the entirely different characters of the two conditions, we think that there can be no doubt that they are distinct.

The more probable explanation of the fatty deposit within the cells seems to be, that in cirrhosis the liver cells are prevented from discharging their function, and as a consequence of this they become infiltrated with fatty matter, just as the muscles become infiltrated when they cease to be exercised.
Atheroma. The conditions of the arterial coats which has been long known under the name of atheromatous degeneration is nothing more than a fatty degeneration.

The fatty matter when it affects the arteries generally exists in the first instance beneath the inner coat in the form of opaque irregular patches. Afterward it extends also to the middle coat.

In some instances it commences in the middle coat and gradually extends inwards and outwards. The inner coat of the artery is at first entire and smooth, but after a time it gives way and we have an irregular ulceration of the coats taking place, which seems to be the first stage in the formation of true aneurism of the artery.

When examined with the microscope the opacities above mentioned are found to consist entirely of fatty granules, with a few crystals of cholesterine scattered through them. The fibres of the arterial
coat immediately surrounding the atheromatous deposits are found to be broken down and softened. It appears that this change in the fibres is the first step towards the atheromatous deposits. According to Rohitansky the atheromatous process consists in disintegration of the deposit into a pulpy mass, consisting of a large number of crystals of cholesteryl fatty globules, and of molecules exhibiting various degrees of consistence, from coarseness to extreme fineness, and consisting of albumen and calcareous salts.

The metamorphosis begins with a finely punctated opaqueness and induration of the deposit, and is not limited to any definite duration, occurring sometimes at an early stage, and at other times at a more advanced period, although, as has already been observed, generally when the deposit has become opaque. It, moreover, commonly begins in the deeper strata of the deposit and advances from thence to the surface. It usually affects a space varying in
circumference from the size of a lentil to that of a shilling or crown piece. There is, at the same time, an increase of volume, and a swelling of the deposit; the uninjured lamella rising above the surface towards the interior, in proportion to the depth to which the process has affected the deposit, and then frequently exhibiting a perceptible fluctuation.

After this process has penetrated to the innermost layers, or when they have burst above the pulpy mass, and been torn asunder by the force of the blood pushing into the cavity, the mass itself appears uncovered on the inner surface of the artery, and in contact with the blood, in which case fibrous vegetations of different forms are deposited on the fringed margins, after the occurrence of the bursting or rent.

The pulpy mass, both immediately, it has been laid bare, and also subsequently is taken up in different quantities into the blood, although another and the more consistent part of it is infiltrated by the blood.
and permeated by its fibrillae, and thus rendered firmer, and at the same time coloured by the hematin, in various degrees of intensity, being first of a dark red, then a dirty brown, and lastly of a yeast-like colour. In addition to the decolorations, the mass acquires a very peculiar appearance, when it is covered with large crystals and accumulations of cholesterin, for it then looks as if it were interspersed with silver-like and shining scales.

These spots are even at the present day regarded as fungous ulcers of the artery. But the atheromatous process presents no essential analogy with an ulcersous process, nor is the deposit itself an inflammatory product. We discover no trace of an ulcersous product in the atheromatous mass, and its admixture with the blood is not characterized by any marked subsequent symptoms.

The atheromatous mass is very often gradually thickened, and converted into a moist, soft, and plastic looking substance, and finally appears in the form of a
coarsely granular calcareous concretion.

This loss of substance is occasionally replaced by a fresh deposit, when the atheromatous mass has either been wholly or for the most part, taken up into the blood, in which case these spots remain below the level of the inner surface of the vessel, and thus acquire a wrinkled appearance, in consequence of the amount of shrivelling of the collious cellular sheath. They also often acquire a slate gray or greenish-gray, or black colour from the hemosiderin by which the tissue is saturated, and which remains on the margin and on the base.

This change not only affects the larger arteries, but the smaller ones are often similarly affected.

In the least degree of the disease, according to Mr. Bayliss, the only apparent change of structure is that minute blackish-edged particles like molecules of oil, are thinly and irregularly scattered beneath the outer surface of the small blood-vessels of the brain. Such a change
may be seen in the vessels of portions of the brain that appear quite healthy as well as in the capillaries, as in branches of both arteries and veins of all sizes from 1/50th
of an inch in diameter to those of smallest
dimensions. As the disease makes progress
the oil particles may increase in number
till the whole extent of the affected ves-
sels is thickly set with them, and the
natural structures even if not quite waste
can hardly be discerned. While their
number thus increases, there is also usually
a considerable increase of the size of many
of the oil-particles, and they may be seen
of every size, from an immeasurable mi-
nuteness to the diameter of two or an inch.
In other places one sees instead of
this increase of scattered oil-particles or
together with it, groups or clusters of similar
minute particles, which are conglomerated
sometimes in regular oval or round masses
like large granule cells, but more often in
irregular masses or patches in the wall of a
great part of the circumference of a blood-vesSEL.
In a single fortunately selected instance one may see in different branches of a vessel all those degrees or states of the disease.

When fatty degeneration has made much progress changes in the structure and not rarely changes in the shape also of the affected blood vessels, may be observed. The chief change of structure appears to consist in a gradual wasting of the more developed proper structures of the vessel; growing faint in apparently the same proportion as the disease makes progress the various nuclei or fibres are at length altogether lost.

The granules according to D' Bennett vary in size from 650 to the 500 of a millimetre in diameter. They always contain among them round transparent globules varying in size from 500 to 150 of a millimetre in diameter. These are the nuclei of round or oval cells which may frequently be observed in various stages of development; when fully formed they vary greatly in size, for the most part measuring
from the 50 to 50 of a millimeter in diameter. They sometimes contain a few granules only, at other times they are completely filled with them, and assume a brownish black appearance.

Water and acetic acid cause no change in them, although the latter reagent on some occasions renders the cell-wall more transparent. They are immediately soluble in ether and break down into a molecular mass, on the addition of potash and ammonia; these are compound granular cells. Masses of these granules may be seen floating about of irregular shape without any cell-wall. They are produced either by the solution of the cell-wall in which they were contained, or from the separation of a vessel."
Heart. Fatty degeneration of this organ has, of late years, received much attention from pathologists, from the circumstance that some very eminent men have died from this affection. We propose to consider the different conditions that may lead to deposition of fat in this organ. We find that fat may be deposited on the external surface of the heart and often in large proportions, even when it is diminished in other parts of the body. It is found usually first between the serous covering and the muscular substance of the heart. 2ndly, In the fatty degeneration or infiltration of the muscular substance itself. It is sometimes deposited in so large a quantity between the muscular fibers as to appear as if the organ was converted into a mass of fat.

This abnormal deposition of fatty matter cannot be regarded altogether as constituting true fatty degeneration of the muscular tissue. In all cases of truly fatty degeneration, the deposit is not on the exp
terior, but in the interior of the sarcolemma of the elementary fibres. In all cases where the fatty matter is deposited on the exterior of the sarcolemma it will be found to consist of true adipose cells, similar to those found in other parts of the body. Whereas when fatty matter is deposited in the interior of the sarcolemma it is in the form of small granules. In the true fatty degeneration of muscular fibres the fatty matter gradually accumulates, while at the same time the true muscular substance disappears, until at length in extreme cases, the sarcolemma appears filled with minute granules, and as a consequence of this we find the transverse and longitudinal fibres becoming less and less distinct, and finally disappearing entirely.

There are three forms in which fatty disease may occur. In the first form the fat is accumulated in those parts where it is naturally deposited in greatest abundance, as at the base of the organ.
This is met with in those persons who have a general tendency to the accumulation of fat, and to this form most of what are called fat hearts belong. It is certainly a condition of disease, but probably not an important one. In the next form the fat collects chiefly about the apex of the heart; the deposit begins from without and is not attended with so great an enlargement of the heart, as in that form first described, for the fat is deposited at the expense of the muscular tissue. Moreover the degeneration is partial and in patches not general. This tendency to limit itself to particular spots is best seen in those cases where a single cardiac column is converted into adipose tissue, but still preserves the form of a muscular band whose place it now takes. In this second form belong all the cases described as examples of fatty disease of the heart. The third form is when it is found in the fibrils themselves replacing them altogether. To the unassisted eye
The muscular substance of a healthy heart presents characters distinguishing it from ordinary muscular tissue; for it is more compact and homogeneous and not loosely divided into bundles of fibres like an ordinary muscle. Under the microscope it also presents some striking differences; the transverse striae being less distinctly marked. It is very important to notice this normal difference at the outset, for the first step towards faulty degeneration consists in the loss of continuity of the transverse striae and in the increase of the granular marking of the fibres, which would seem to be in some degree their normal appearance.

This is the first step and it may often pass unnoticed, unless some change in the general condition of the heart call particular attention to that organ.

Such conditions, may be a small flabby heart, and we invariably find a change in the colour of the heart; it is generally of a yellowish brown or buff colour.
This appearance is not uniform. It is generally in spots or patches, and though the whole heart may be pale, these spots are still more so; these spots are usually best seen after opening the heart and examining the interior of the ventricles. The same appearance may sometimes be noticed beneath the pericardium; and in extreme cases is found on section to invade the whole thickness of the walls of the ventricles, and curve a columna. Of the latter the musculi papillae are most liable to be affected. All parts of the heart muscular fibres are liable to this change, but not equally so. It is most frequently found in the left ventricle; next in the right ventricle; least frequently in the auricles. It is generally most evident in the columnae cavae. The heart may be affected throughout, or the change may be limited to a portion of either side. Microscopic examination reveals the nature of these spots above mentioned; they are not deposits, but distinctly degenerated
muscular fibres, the outline not merely of the mass, but of each single fibre is accurately preserved. Instead, however, of transverse striæ and nuclei, the evidences of active vitality, there is little to be seen except congens of oil globules. The whole history of the degeneration may be traced in one of these little spots. First from the immediate neighbourhood of the spot we may obtain healthy muscular fibres; then the transverse striæ become less distinct; they are a series of dots rather than continuous lines; then the intervals between the dots become wider and the dots themselves run into longitudinal rather than transverse lines; and then all the regularity is lost, and the dots appear to stick the surface all over. Probably long before this the fibre has lost all its properties as a muscle; but there are further changes to be observed, for it is now intermixed with the minute dots are to be seen small oil globules, which increase and coalesce till the fibre presents little else but
congeners of oil drops contained within the sarcolemma.

From the foregoing observations, we may conclude that fatty degeneration of the heart is one of the most important pathological changes which can take place in the body; but we unfortunately do not possess any symptoms by which we might diagnose that disease.
Lungs. According to Waldeyer the fatty matter in the lungs is most abundant in connection with tubercle.

According to Guillot, who has examined the chemical composition of the lungs under various circumstances, especially of disease, he found among other points, that the pulmonary tissue of the fetus contains a much larger proportion of fatty matter before than after birth; the amount begins to diminish with the first commencement of respiration.

At the end of intra-uterine life and just before the respiratory function commences the quantity of fatty matter in the dried lung may amount to 10, 12, 15 or 18 per cent; but when respiration has commenced the proportionate quantity rapidly falls and seldom exceeds 6 per cent.

He found also that in all affections of the chest, the consequence of which is a temporary or permanent obstruction to the respiratory function over a greater or less extent of the pulmonary surface, the
proportion of fatty matter increases in these parts which have become impermeable to air. The quantity of fatty matter may in such cases amount to 15, 20, 30, 40, or 50 per cent, while the healthy portions of the same organs do not contain more than about 10 per cent. This is observed at all periods of life from the earliest infancy to extreme old age.
IV. Nature of the fat deposited.

In regard to the nature of the fat deposited in organs, it seems to be of the same principles as those occurring in ordinary fat. If an artery affected with fatty degeneration is exhausted with a mixture of warm alcohol and ether, the solution on cooling deposits a precipitate, which on examination with the microscope is found to consist of stellate crystals similar to margarine. If these be separated by filtration and the solution then evaporated, there is found remaining a fixed fluid oil, similar in its characters to oleine; occasionally there are found mingled with the crystals of margarine a few flat crystals of cholesterol.

The proportions in which these principles are present differs from that which may occur in the ordinary fat; the fluid fat or oleine being apparently in larger quantity when compared
with the solid fatty principles which are usually found in the ordinary fat.

V. Ultimate destination of the fatty matters.

It is difficult to ascertain in an accurate manner what the object of fatty degeneration of organs is.

The elementary principles which are taken into the body, the fatty and albuminous principles are united in such a manner as to form an emulsion previous to their being absorbed; this presents the same characters as that presented by structures which have undergone a complete fatty transformation.

It would seem probable then that before any morbid structure can be absorbed again, it must undergo a series of changes, the end of which is its conversion into an oleo-albuminous emulsion, which is absorbed into the blood. And on this account we may regard fatty degeneration
as a metamorphosis or conversion into fat of the expelanaut protein by a rearrangement of its elements. This conversion may be affected either before or after softening has taken place, and the fat thus formed may be subsequently absorbed. In fact, fatty degeneration is one mode in which solid-fibre-albuminous substances are brought into a suitable state for absorption.

Francis McM. Manus. Russell.