In addition to these important operations many other chemical changes doubtless go on in the liver cells which we have not yet been able to follow out experimentally because of the inherent difficulties of such investigations, and hence it must be admitted that the physiology of the liver forms one of the most fragmentary chapters in our knowledge of biological change. Even in those instances of hepatic activity which have just been enumerated, we know merely the end results because of the crudeness of our methods of study, and are ignorant in great measure of the links in the chemical chains of transformation which occur in the cell.

It may be pointed out that such important chemical changes, as occur in the liver, require a high state of activity on the part of the liver cells, and hence it becomes necessary that an extra stream of pure blood in abundant quantity shall be supplied to the organ in addition to that carried from the intestine, in which not merely has the oxygen been largely used up in the intestinal capillaries, but also further vitiation has resulted from the addition of foreign constituents arising from intestinal absorption.

Such a supply of pure blood is even more necessary in the case of the liver than in that of the lungs to which similarly in the body a large stream of venous blood is carried, for in the first place the hepatic cells are more physiologically active structures of a secretory type, while the endothelial cells of the pulmonary alveoli carry out a much more passive function, acting to a great extent as physical membranes; and, in the second place, the venous blood of the portal system is more heavily charged with substances foreign to the circulation and capable of acting as protoplasmic poisons.

The liver is hence supplied with arterial blood by the hepatic artery, and in addition the blood coming from the area of absorption is diluted, so to speak, as regards the products of absorption, by admixture with the *splenic* blood. This is a function of the spleen which has not hitherto been brought into prominence; but it furnishes an easy explanation of the peculiar position of the spleen with regard to the portal circulation, of the well-known anatomical fact that the blood supply of the spleen is much larger than the metabolic wants of that organ demand, and also of the increased size of the spleen and of the vigor of its rhythmic contractions during the period of digestion. By this anatomical arrangement of the spleen and its vessels as an adjunct to the portal circuit, a supply of blood which has not been materially vitiated by metabolic changes can be directly mixed with the portal blood coming from the intestinal area, before it is sent on to the hepatic cells, for the interposition of the resistance of the splenic capillaries and splenic spaces lowers the arterial pressure down to that of the portal vein. On operative removal of the spleen compensation probably takes place by means of an increased supply of blood through the hepatic artery.

The chief experimental methods by which the functions of the liver have been investigated are the following: 1. Investigations of the chemical composition of the organ and of its secretion, the bile, under varying conditions. 2. Histological and microchemical examination of the liver cells. 3. Comparative analyses of the blood in the portal vein and hepatic vein as indicating the changes which the blood has undergone in passing through the liver. 4. Studies of the effects of excision of the liver in certain animals, and also of short-circuiting it from the portal circulation by means of an artificial fistula established between the portal vein and inferior vena cava. 5. Observations on the changes in substances added to whipped blood as a result of perfusion through the excised liver.

1. Chemical Composition.—The liver tissue resembles other tissues in being alkaline during life and turning acid after death, the acidity being usually ascribed to the formation of sarcolactic acid. There is a certain amount of rigor or post-mortem hardening always developed accompanying the change in reaction, but this is not due to myosin formation since myosinogen is absent from the uncoagulated extracts of the fresh gland.

The proteids of liver have been investigated by Plõsz and by Halliburton who found the following coagulable proteids present: (1) A proteid coagulating at 45° to 50° C. which has all the usual properties of a globulin, and is not probably intrinsic to the liver, being indistinguishable from the cell globulin of Halliburton, which is found in most cellular tissues. (2) A nucleo-proteid which coagulates at 60° to 70° C. and possesses most of the common properties of the class excepting that it is not readily salted out of solution, and hence the sodium chloride precipitation method of Halliburton cannot be utilized for its preparation. (3) A globulin coagulating at 70° C. (4) Traces of albumin.

In addition, the liver contains traces of gluco-proteids which probably are derived from the connective-tissue elements, and also, like other tissues, traces of enzymes.

It has been claimed by some that a very appreciable amount of an amylolytic enzyme is present, which has been held responsible for the conversion of the liver glycogen into dextrose (*vide infra*), but other observers deny the existence of sufficient amounts of such an enzyme to accomplish this function and ascribe the conversion of glycogen to the activity of the cell protoplasm.

Undoubtedly the most interesting of the proteid bodies of the liver, are those which contain iron, since it is the presence of these in the liver substance, taken in conjunction with the chemistry of the bile pigments, which conclusively proves the important hæmatopoietic function exercised by the liver cell.

That practically all the iron contained in the liver cells is present in some organic form, is shown by the fact that the tissue reacts to the ordinary reagents for inorganic iron, such as potassium ferrocyanide or sulphocyanide, only after treatment by an inorganic acid, such as hydrochloric or sulphuric. The presence of iron may be demonstrated either microchemically or by making extracts of the tissue with dilute hydrochloric acid.

There are two distinct types of organic iron-containing compounds found in the liver. One of these is in the form of iron albuminates, which are characterized by the fact that the iron may be separated from the albumin by the action of inorganic acids. That these are simple salt-like compounds of albumin with iron is demonstrated by the fact that they are practically identical in their properties with salts artificially prepared by the action of oxide of iron on alkali albumin. Such artificial compounds of iron under the name of ferratins have been introduced into therapeutics, with the idea that from their resemblance to the naturally occurring iron albuminates of the liver they would be probably more readily absorbed. Such ready absorption from the intestine is claimed for such compounds, on, however, very dubious experimental grounds. There is a certain amount of evidence that if hæmoglobin is under any circumstances built up from such albuminates as are found in the liver, it is only intermediately through the second class of iron compounds found in the liver cells, which contain phosphorus in their composition and belong to the class of the nucleins. Such iron-containing nucleins were first demonstrated in the liver by Zaleski, who, under the view that only one such iron-containing nuclein was present, applied to it the name of "hepatin"; there is little doubt now, however, that several different iron-containing nucleins are present in the liver cells, and hence the name "hepatin," if preserved, would be better applied as a class name for these substances.

The iron-containing nucleins are distinguished from the iron albuminates by their behavior toward acid alcohol to which they yield up none of their iron; they also are stained black by alkaline sulphides only after long standing, and, in short, are not simple salts of iron like the albuminates, but *true* organic compounds of iron in which that element is directly united to carbon. It is for this reason that the reactions proper to iron salts are shown only when the nuclein molecule containing the iron is disintegrated.

It has been shown by Bunge, and workers in his laboratory, that it is these iron-containing nucleins which are

chiefly concerned in the manufacture of hæmoglobin in the body, and he accordingly terms them "hæmatogens." This has been demonstrated by the hatching of eggs in the yolk of which "hæmatogens" or iron-containing nucleins are the only form of iron present and from which alone the hæmoglobin present in the bird on hatching can arise. The same has been shown by feeding new-born mammals entirely upon egg yolk and iron-free food, and also by analyzing the total iron in ingesta and egesta, when the former contained iron only in the form of nucleins; it has thus been shown that the iron-containing nucleins or "*hæmatogens*" are directly absorbable from the intestine. It is hence supposed that the hæmatogens are absorbed, carried to the liver, and after undergoing certain obscure metabolic changes in that organ are carried to the red marrow where they form, in the erythrocytes, building material for hæmoglobin. (See article on *Blood, Formation of the*, vol. ii., p. 19.)

The total quantity of iron in the liver is very variable, averaging about 2 parts per 1,000. It is present in three to four times as great quantity in the liver of the newborn as in the full-grown animal, a reserve being so provided for the period during which milk is the only food, because this is very deficient in iron. The quantity stored in the liver is increased by any circumstance which leads to destruction of red blood corpuscles, and hence it is found to be very high in pernicious anæmia.

The bile pigments, from their close chemical relationship to hæmoglobin, furnish another proof of the important part taken by the liver in the metamorphoses of hæmoglobin in the body.

The liver is under normal conditions very rich in fats, and in bodies of a phosphorized character containing fats, such as *lecithin* and *jecorin*. Of these, the latter-named body was first isolated from the liver by Drechsel, who at that time thought it was exclusively found in that organ, but it has since been identified by Baldi as a constituent of spleen, muscle, and brain.

The total ether extract of liver is stated by Noel Paton as five per cent. of the undried gland, which is equivalent to twenty per cent. of the dried weight. This ether extract contains according to the same author an amount of fatty acid varying from forty to ninety per cent., and on an average the amount of fat unassociated with phosphorized bases may be placed at three per cent. of the fresh weight. The amount is increased by feeding richly on either fats or carbohydrates, and it is probable that on carbohydrate feeding a fairly large percentage of glycogen is slowly changed into fats by the action of the liver cells, and later carried to the connective tissues, instead of being converted into dextrose as is usually taught, and then discharged into the blood stream. The liver fats contain less olein and hence have a higher melting point than those found in other tissues. The percentage of ether extractives is reduced much less rapidly during inanition than is the percentage of glycogen.

The amount of lecithin is surprisingly high, reaching as much as 2.5 per cent. of the fresh organ, or over ten per cent. of the total solids; while cholesterin is very low, averaging only 0.03 to 0.04 per cent. of the gland (Noel Paton).

Jecorin is contained in the liver in considerable quantity. It is closely allied in character to the protagons found in the tissues of the central nervous system.

The carbohydrate contained in the liver when the organ is examined in the fresh condition is present almost exclusively in the form of glycogen or animal starch, a body belonging to the group of polysaccharides; but when the liver is allowed to remain for some time before examination, and especially if it be kept warm in the interval, the glycogen is found to have been, wholly or in part according to the percentage present, converted into glucose.

The amount of glycogen present in fresh liver varies within wide limits; by somewhat prolonged and excessive feeding upon carbohydrates it may be raised as high as seventeen per cent., and, as a result of prolonged inanition, it may be reduced to the merest traces. It is formed most readily from ingested carbohydrates, and under normal conditions it is probable that these are its chief if not its only source; but it has been shown that, in the absence of carbohydrates, a formation in the liver of glycogen from proteid may occur if this form of food-stuff be fed to the animal in excessive amount. There is, on the other hand, no clear experimental proof that it can be synthetized in the liver cells from fats.

Glycogenesis.—There have been many volumes written, and much discussion waged as to the sources, uses, and fate of the glycogen of the liver.

The simplest view is the one originally advanced by Claude Bernard which gives expression to what is usually termed the *glycogenic function* of the liver. This theory is still advocated in its entirety by many physiological chemists, but others nowadays are beginning to see reasons for modifying it to a certain extent.

According to this theory the glycogen of the liver solely carries out the function of acting as a temporary storage of excessive carbohydrate supplies. All the glycogen arises from dextrose and it all passes back again into dextrose; the effect of the backward and forward transpositions being to maintain as nearly as possible a constant percentage of dextrose in the circulating blood. When the percentage of dextrose in the blood rises above a certain normal level, amounting to about 0.15 per cent., the excess of sugar acts as a stimulus to the liver cells causing them to transform the circulating sugar into glycogen and so keep down the percentage in the blood to somewhere near the normal level. On the other hand, when no sugar is being absorbed, and that contained in the circulating blood is being gradually decreased by oxidation processes going on in the tissues, then a reverse stimulus is given to the liver cells, which causes them to change the stored-up insoluble glycogen into soluble dextrose which passes out into the blood stream and so tends to keep up the percentage, and send carbohydrate nutriment to the other tissues of the body.

There is sufficient experimental evidence to prove to a demonstration that this is the primary, and probably the most important, use of the glycogen storage in the liver; but at the same time there is also convincing evidence both that glycogen can be formed by the liver from other sources than dextrose, and also that by no means all the glycogen formed in the liver is reconverted into dextrose, for a certain amount is certainly converted into fats, and a further portion is in all probability united with nitrogenous organic substances, derived from partially disintegrated proteid, to regenerate proteid once more.

The chief experimental evidences in favor of the *glycogenic function* of the liver may be enumerated as follows:

1. The glycogen is most abundantly formed in the liver cells when carbohydrate food is given, it is formed in only small quantity on a liberal proteid diet, and is probably never produced from fat; also the amount of glycogen in the cells increases with the time which has elapsed after a meal rich in carbohydrates.

2. The glycogen contained in the liver cells is after death converted rapidly into dextrose, and such an action is probably due to the exaggerated activity of the asphyxiated and dying liver cells.

3. A similar disappearance of glycogen occurs during a period of inanition, the amount which has disappeared being proportional to the time which has elapsed, and during this period the amount of circulating dextrose is kept up close to the normal value. Hence the most probable explanation is that the blood is being continuously supplied with dextrose from the stored-up glycogen of the liver.

4. The kidneys tolerate only a certain percentage of dextrose in the circulating blood and commence to secrete urine containing dextrose when this low level of about two parts per thousand is exceeded. Hence, did the liver not store up the dextrose in some form, it would reach the systemic circulation, and so the kidneys, and be nearly all excreted in the urine and lost to the body. That this is the true explanation of the prevention of glycosuria after a carbohydrate meal is perhaps most

clearly demonstrated by slowly injecting a strong solution of glucose in whipped blood, under like conditions, in one case into the central end of a mesenteric vein and in the other into the central end of a systemic vein, such as the jugular. In the former case, no glycosuria occurs because the liver cells store up the sugar; but, in the latter case, glycosuria follows immediately, obviously because the sugar in excessive amount reaches the general circulation and so the kidneys, before it can be taken up by the liver cells.

5. Direct analyses of the blood of the portal and hepatic veins, (*a*) during carbohydrate absorption, and (*b*) during inanition, have demonstrated that in the former case the blood passing to the liver contains more carbohydrate than that leaving the organ, while in the latter case the reverse condition is observed. Here it must be remarked, however, that the blood supply to the liver is so copious as to render the difference in percentage small even when a large transference of material may be taking place. Further, the rate of removal of carbohydrate from the liver is never so great as the rate of its storage during the assimilation of a heavy carbohydrate meal, and hence, although the differences in percentages of portal and hepatic blood are sufficient to demonstrate storage in the liver, they are quite insufficient according to many observers to prove that this stored carbohydrate is again set free as dextrose.

There is then no room for doubt that the excess of dextrose carried to the liver by the portal vein is stored as glycogen for the time, and it appears clear that under usual conditions a great deal of this stored glycogen is again given back to the blood as dextrose, but it will be observed that there is absolutely no proof that *all* the glycogen is disbursed in this form.

The glycogen of the animal has been compared to the starch of the vegetable world, and this undoubtedly good comparison ought to help to make it clear that the glycogen may serve as a constructive raw material and not merely as a source of energy by combustion. It has been suggested by Pavy that a considerable conversion into fat may occur in the liver. Some hours after a meal rich in glycogen-forming elements, it is always found that the fat content of the liver cells has increased at the expense of the glycogen, and this is accomplished at a period when the plasma is perfectly clear from suspended fat, showing that the fat accumulation is probably not due to infiltration. Hence it is probable that, at any rate, when the glycogen storage is high, fat is formed in the liver from glycogen. Fat so formed may afterward be distributed to the connective tissues and stored therein.

It is impossible to give any such direct proof of the generation of proteid from glycogen in the liver, because an abundance of proteid is always naturally present in the protoplasm of the cells and in the bathing fluids, and accordingly even did granules of a protoplasmic nature appear in the cell after a heavy glycogen storage their source would not be clearly known. But it has been argued by Pavy from the great power as proteid sparers which the carbohydrates exercise, as shown by the enormously reduced amount of proteid upon which nitrogenous equlibrium can be maintained when carbohydrates are liberally supplied, as well as from the fact that carbohydrate can be isolated from practically any form of proteid by appropriate chemical treatment, that the glycogen of the liver is converted into proteid, and that the nitrogenous part of the proteid molecule can be used as a carrier for it. In fact Pavy regards this as the most important function of the glycogen storage, and it is, according to this observer, as a result of this office of the liver cells passing into abeyance that diabetes ensues.

Such a view furnishes an easy explanation of the persistence of dextrose in the urine, even after all carbohydrate has been cut off in the food. For if we regard the proteid molecule as a union of a carbohydrate with a nitrogenous rest, then it is easy to see how the vitiated metabolism of the liver cells may, by a simply reversed process, set free dextrose from the circulating proteid. In accord with this view is also to be easily placed the observed fact that in severe diabetes the output of nitrogenous material as urea is largely increased.

To sum up, then, the glycogen is placed at the command of the liver cells, which can probably use it for the manufacture of dextrose, fat, or proteid according to the wants of the organism as expressed by the condition of the circulation.

The liver contains more urea than any of the other organs and the quantity is increased during active proteid metabolism, as on a diet rich in proteid, or during proteid absorption; thus pointing toward that active formation of urea in the gland which has been proved by other methods (*vide infra*). Uric acid and the purin bases, such as xanthin, hypoxanthin, and guanin, have also been shown to be present.

The bile salts and bile pigments are formed in the liver cells, but it is certain that the former undergo a circulation in the intestine and tissues and are in great part carried each time to the liver cells in the circulating plasma. The lecithin and cholesterin of the bile are also probably excreted by the liver cells, although some hold, on rather insufficient evidence, that the latter substance is secreted by the gall bladder.

2. Histological Examination.—Microscopic examination of the liver cells under varying conditions with regard to the period of digestion demonstrates that glycogen first begins to accumulate in the form of minute granules at a period of three or four hours after a carbohydrate meal, and at a later stage as the amount of glycogen increases the granules fuse together to form amorphous masses, which when abundant give to the cell protoplasm the appearance of an open network. In the starving animal, the glycogen granules completely disappear in a period of about three days, the outer zones clearing first, and the area around the nucleus last.

The glycogen granules are best shown by staining microchemically with iodine which strikes a brown color with the glycogen.

In a normal liver, fat is always present in the form of minute granules, which may be demonstrated to be fatty in nature by staining black with osmic acid. The fat granules are most abundant in the outer or portal zone of the liver lobule, on which account when present in excessive amount they give rise to the well-known nutmeg appearance of the fatty liver. These granules are increased either immediately after a fatty meal, or some hours after a carbohydrate one, in which case they are formed at the expense of the glycogen which is first present.

The presence of the organically combined iron of the liver cells may be shown by different microchemical methods, such as treatment by the alkaline sulphides, by acids followed by either potassium ferrocyanide, or pure hæmatoxylin dissolved in distilled water.

That no inorganic iron, or iron simply combined as a salt with albuminate, is present in normal liver except in the fœtal condition, is shown by the negative results obtained by either the ferrocyanide method or the hæmatoxylin method, unless previous treatment by acid is employed which decomposes the organic compounds of iron. The treatment with acid is effected by placing the tissue in one part of hydrochloric or sulphuric acid to nine parts of alcohol, at a temperature of 35° C. for from one to twenty-four hours (Macallum). Then the acid may be removed by washing in alcohol, and the iron demonstrated by the ferrocyanide or hæmatoxylin method. The latter method is strongly recommended by its discoverer, Macallum, as giving perfectly permanent stains of a striking blue or blue-black color, which is only given by inorganic iron, and is apparent even when only traces are present such as cannot be demonstrated by the ferrocyanide or ammonium sulphide methods. This method may further be used for the demonstration of iron in extracts of the gland.

3. Comparative Analyses of the Blood in the Portal and Hepatic Veins.—The value of this method

is minimized by the rapid rate of the blood flow through the liver, as a result of which it is possible to show a reliable difference in composition only when the amount of substance being taken up from the blood or dissolved and added to it is large. It is in fact only in the case of the deposition of carbohydrate during active absorption that the method has given results which are trustworthy. Under proper conditions of experimentation the amount of dextrose in the portal and that in the hepatic blood are practically identical; so that Seegen's results (in which he found in this condition more dextrose in the hepatic than in the portal vein, thus apparently directly proving the re-solution of the glycogen) have not been substantiated by other observers. The method cannot be used in the case of either proteids or fats. Observations have been made by this method which appear to show an increase in the amount of urea in the hepatic blood above that in the portal during proteid absorption, when urea formation in the liver cells is probably proceeding at a maximum rate. A similar result, but in the reverse direction, is found in the case of ammonia which is said to be present in between three and four times as great quantity in the portal as in the hepatic blood.

4. Excision and Short-circuiting of the Liver.—By the application of these methods it has been shown that urea is formed in the liver, and considerable information has also been gleaned concerning the end products of nitrogenous metabolism from which it is here synthesized. The surgical difficulties standing in the way of the removal of the liver in mammals were for a long time regarded as insuperable, for if the organ be simply removed without making provision for the continuance of the portal circulation, the stasis of the blood in the whole intestinal area gives rise to such severe shock that the animal succumbs almost immediately as a result of the operation. In birds, however, the vein of Jacobson gives rise to an anastomosis between the portal vein and the *vena advehens* of the kidney, so that when the portal vein is tied between the liver and the junction of this vein, the blood coming from the intestinal area can be carried through the *vena advehens* and hence stagnation does not occur.

Minkowski took advantage of this anatomical relationship and tied the portal vein in this situation in geese. In some animals the portal vein only was tied, and in others the liver was subsequently excised. As a result of the operation, the uric acid in the urine, which in birds takes the place of the urea of the mammal, fell from representing sixty to seventy per cent. of the total nitrogen as in normal animals, until it represented only three to six per cent., while at the same time ammonium lactate, which is not present in normal bird's urine, appeared in sufficient amount to account for the deficit in urates. The lactic acid simultaneously produced is sarcolactic acid and is produced in somewhat greater quantity than is necessary to combine with the ammonia, so that the urine becomes acid. When the uric acid has reached the minimum given above, the ammonium lactate forms more than half the total solids. No change took place in the urea, showing that the small amount of this substance present in bird's urine is not formed in the liver, and the kreatinin also remained undisturbed. Lactic acid, leucin, and tyrosin were found in the blood. Injected urea was not changed in the blood but appeared in the urine as such, whereas in the normal goose it appears again as uric acid.

The ligature of the hepatic artery alone, in birds or mammals, leads to a temporary replacement of uric acid and urea respectively by ammonium lactate, this result being probably due to defective oxidation.

The total removal of the liver from the circulation or eventually from the animal was first rendered feasible by the operative procedure of Eck, a Russian surgeon, who found it possible to establish a fistula between the portal vein and inferior vena cava, whereby the portal blood system is drained directly into the vena cava without first passing through the liver. The liver could then either be left *in situ* or afterward removed. In those animals in which it was left *in situ* no great disturbance of nitrogenous metabolism occurred except immediately after the operation, or when the animals were given either excess of proteid food or ammonium salts in their food. Then it was found that convulsions ensued, and excess of ammonium salts and carbamate of ammonium appeared in the urine. In those animals in which the liver was also removed results similar to those given by Minkowski were obtained, viz., decrease in the urea and its replacement by ammonium compounds.

5. Perfusion through the Excised Liver.—These experiments are performed by placing cannulæ in portal vein and hepatic vein, and running whipped blood (which is arterialized each time after passing through) under a pressure somewhat greater than that of the portal vein during life through the blood-vessels of the excised liver. The effects of adding different chemical substances to the whipped blood can then be determined.

The percentage of urea in whipped blood taken from an animal recently fed upon proteid, is increased when it is led through an excised liver, and Schröder, who by applying this method first conclusively proved that urea is formed in the liver and not in the kidneys, found that when ammonium compounds were added to whipped blood which was afterward circulated round an excised liver, the ammonium compounds so added became decreased in amount and were replaced by urea. Similar results were not obtained by perfusion through the limbs or other organs, and hence it was proven that urea is formed in the liver, and further that it is formed from ammonium compounds, a result which corresponds with that obtained by studying the effects of excision of the gland. *Benjamin Moore.*

LIVINGSTON ARTESIAN WELL.—Sumter County, Alabama.

Post-Office.—Livingston. Hotels.

Livingston, the county seat of Sumter County, is located on the Alabama Great Southern Railroad, a part of the Queen and Crescent route operating, with numerous connections, between Cincinnati, Ohio, and New Orleans, La. The town is situated on a sandy plateau with perfect under-drainage. The climate at Livingston furnishes a fair type of the atmospheric conditions prevailing in central Alabama. The warmest weather recorded by standard signal service instruments for many summers has been 97° F., and this elevation has been very rare. The coldest weather noted in winter has been 20° above zero. The average temperature of the year is 63° F., and the average rainfall fifty-six inches. Geologically, the well is located at the extreme southern outcrop of the cretaceous limestone, which forms the basis of the rich belt of prairie land extending through middle Alabama. It pierces the entire thickness of the limestone stratum to reach the underlying sandstone formation in which the water is procured. The depth of the well is 1,087 feet and the flow of water one gallon per minute. It was bored with a view to obtaining a supply of good drinking-water, but it proved decidedly saline, and at first the venture was thought to have been a useless expenditure of time and money. By degrees, however, the citizens began to use it, and though at first disagreeable to the taste, it soon became a favorite beverage. Certain medicinal effects were observed, especially in dyspepsia and chronic bowel disorders, and little by little the well finally acquired considerable local celebrity. The water is beautifully clear and limpid and effervesces actively when drawn from the spout. The specific gravity of the water is 1.003, and its temperature, which does not vary at any season, is 68° F. From the circular issued by the town authorities we have obtained the following analysis by an unnamed chemist:

One United States Gallon Contains:

Solids.	Grains.
Silicic acid and silicates	1.14
Iron bicarbonate	.20
Magnesium bicarbonate	2.32
Calcium bicarbonate	7.14