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

Solids.	Grains.
Iron perchloride	0.19
Magnesium chloride	1.84
Calcium chloride	2.98
Potassium chloride	.33
Sodium chloride	295.43
Strontium chloride	Trace.
Sodium bromide	.98
Total	312.55
Gases.	**Cu. in**
Free carbonic acid (in solution)	21.47
Carbonic acid in combination as carbonates	9.32
Total gases	30.79

This water possesses aperient, tonic, and diuretic properties. It is said, furthermore, to have a decided alterative influence on the economy. According to Dr. R. D. Webb, of Livingston, who has made a special study of the water for many years, it is highly beneficial in cases of chlorosis, malarial anæmia, affections involving the alimentary tract, the kidneys, and the bladder, and in nervous exhaustion. *James K. Crook.*

LOBELIA.—Indian Tobacco. "The leaves and tops of *Lobelia inflata* L. (fam. *Lobeliaceæ*) collected after a portion of the capsules have become inflated" (U. S. P.). This is an annual herb from 20 to 50 cm. (8 to 20 in.) high, with an upright, branching, leafy stem and thin ovate, nearly or quite sessile, slightly hairy leaves. Inflorescence composed of spike-like racemes, terminating the strongly excurrent stem and the branches, and making altogether a lax pyramidal, leafy panicle. Flowers small, consisting of a five-toothed calyx adherent to the ovary and becoming markedly inflated in fruit; a labiate corolla with a narrow tube open on the apparently upper side to its base, and a five-lobed border of which the two lobes next the fissure are erect, narrow, and pointed, the other three broader and spreading; stamens, five, syngenesious, ovary two-celled with innumerable microscopic ovules. Seeds very fine, light-brown, oblong, with a handsome reticulated testa. All parts of the plant contain, when fresh, an acrid, milky juice, and have an exceedingly sharp, peppery, tobacco-like taste. The seeds are rather more active than the rest of the plant and have been used separately. Lobelia is an abundant pasture weed, growing in most parts of the United States. The knowledge of its use was received from the aborigines, and is several centuries old.

Fig. 3227.—Lobelia inflata; Flowers and Fruit. (Baillon.)

Composition.—The most important ingredient of lobelia is the alkaloid *lobeline* ($C_{16}H_{24}NO$), "an oily yellowish fluid with a strong alkaline reaction, especially when in solution. In the pure state it smells slightly of the plant, but more strongly when mixed with ammonia. Its taste is pungent and tobacco-like, and when taken in minute doses it exercises in a potent manner the poisonous action of the drug. It dissolves in water, but more readily in alcohol or ether. It neutralizes acids and forms, with some, crystalline salts." Several of these salts are listed by manufacturers. Although volatile, it is decomposed by a high heat. Lobelia contains also *essential oil* and a doubtful substance, *lobelacrin*, probably a compound of lobeline and *lobelic acid*.

Action and Use.—This herb has had in times past an extensive employment in this country at the hands of irregular practitioners of the "Thompsonian" school, and the more modern "Eclectics." Despite its very active and dangerous qualities, it is still not infrequently called for as a family medicine. Regular physicians have never used it extensively, but neither has it been altogether neglected by them. It was in far more frequent demand fifty years ago than it is now. It is a nauseating expectorant, or a depressing emetic, much resembling tartar emetic. The nausea is primarily due to gastric irritation, and full doses are liable to be promptly vomited. Smaller doses produce burning and pain in the stomach, followed by nausea, lassitude, or depression, commonly cold perspiration and pallor, dizziness, rapid and weak respiration following temporary slowing. These systemic symptoms bear a general resemblance to those of tobacco sickness, whence the common name of the plant. The secondary nausea, often with painful and obstinate vomiting, is at least partly of central origin. There is no considerable increase of respiratory secretion, but spasmodic conditions, as of asthma, are relaxed. When the action is prolonged, as by repeated doses, the depression is profound, and there is paralysis of respiration, frequently with convulsions, dependent thereon. In children there are sometimes earlier convulsions, due to abdominal pain. Respiratory failure is the common cause of death. Gastric perforation has frequently occurred, with other indications of intense abdominal inflammation.

There have been two uses for lobelia, namely, as an emetic and as an antispasmodic of the depressing sort, applied chiefly to respiratory affections. As an emetic, it was formerly a common household remedy, used for the most trivial purposes, and fatal poisoning was common. This use is almost obsolete, being only occasionally resorted to in spasmodic croup. Its use in very small doses, combined with expectorant drugs, is still considerably resorted to, and is of advantage. If vomiting is desired, a full dose (gr. xx.–xxx.) should be given; otherwise the dose should be small (gr. i. to iij. or v.). Undesirable or dangerous results are most likely from doses just insufficient to cause vomiting, or from moderate doses repeated, so as to produce a cumulative effect. The official preparations are the fluid extract (doses as above, minims for grains), and the twenty-per-cent. tincture, used almost altogether as an expectorant in doses of ♏ v. to xxx. *Henry H. Rusby.*

LOCOMOTOR ATAXIA. See *Spinal Cord Diseases: Tabes Spinalis.*

LODI ARTESIAN WELL.—Fountain County, Indiana.

Post-Office.—Lodi. This is a station on the Indianapolis and St. Louis Railroad, 58 miles west of Indianapolis. The following analysis was made by Dr. J. C. Pohle:

One United States Gallon Contains:

Solids.	Grains.
Magnesium carbonate	0.66
Calcium carbonate	2.01
Sodium sulphate	2.13
Potassium sulphate	.80
Magnesium sulphate	3.26
Calcium sulphate	55.56
Calcium phosphate	1.20
Sodium chloride	502.46
Calcium chloride	47.93
Magnesium chloride	53.54
Magnesium bromide	.88
Silica	.52
Sulphur	.50
Nitrogenous organic matter	.80
Total	672.25

This is a strong saline sulphureted water and quite analogous to that of the Kentucky Blue Lick waters. *James K. Crook.*

LOGWOOD.—Hæmatoxylon. *Campechy Wood.* The heart wood of *Hæmatoxylon Campechianum* L. (fam. *Leguminosæ*). This is a small, spreading, irregularly branched tree, with a dark rough bark on the trunk and larger branches, and light-brown, white-spotted twigs. Wood hard and close, divided into a light-colored alburnum and a red heart wood, the whole of the former being

rejected. It is a native of Central America, especially of Honduras and Yucatan. It takes one of its names from Campeche. It is also naturalized and cultivated in the West Indies, where it grows freely.

It is supposed that logwood was used by the aborigines for dyeing before the arrival of Europeans, but this is not known with certainty. It was, however, imported into England in the latter part of the sixteenth century, and shortly after interdicted for a time as yielding poor and fading colors. It was introduced into the London Pharmacopœia about a hundred and fifty years ago.

The collection is simple enough. The trees are felled when the trunks are as large as, or larger than, a man's thigh, the yellowish sap wood is chopped away, and the heart wood cut in billets three or four feet long and dried. In this shape it is imported and sent to the dye mills. When first cut, these logs are of a light-red color, but by exposure to the light and air they become dark-brown, and finally almost black upon the surface, sometimes dark-bronze and iridescent. The inside becomes, in time, a rich reddish-brown. In the course of manufacture it is cut, by heavy machines with rapidly revolving knives, into fine chips, in which condition, or in powder, it is purchased for pharmaceutical purposes. For dyeing purposes, these chips are cured by soaking them in water and then frequently turning them over to expose them to the atmosphere. The chemical changes which ensue largely unfit them for medicinal use. Such chips are distinguished by their dark or blackish metallic green or blue surface. Logwood has a sweetish astringent taste and colors the saliva pink.

Logwood contains about ten per cent. of a sweet-tasting, crystalline coloring substance, *hæmatoxylin*, readily soluble in hot water or alcohol, but nearly insoluble in cold water. It turns red upon exposure to sunlight, and gives violet solutions in the presence of alkalies and air, due to the formation of *hæmatein*. Melted with potash, it yields pyrogallic acid.

Action and Use.—This substance is infinitely more used in the arts than in medicine, being an important dye and foundation for inks. In microscopical work, the purple solution of extract of logwood, or hæmatoxylin, is a favorite stain, acting with great rapidity and bringing into prominence the nuclei of cells. As a medicine, it is a mild and rather agreeable astringent, useful in subacute diarrhœa of children and in phthisis, but no better than a dozen other astringents, except that its taste commends it to children. The linen is very liable to be stained red when it is used. The extract is official (*Extractum Hæmatoxyli*, U. S. P.), made by exhausting with boiling water and evaporating to solidity. *W. P. Bolles.*

LOJA OR LOXA BARK. See *Cinchona.*

LONDONDERRY LITHIA SPRINGS.—Rockingham County, New Hampshire.

Location.—Londonderry.

This spring is evidently not used as a resort, but its waters have become widely celebrated and are extensively sold. The following analysis was made by Prof. H. Halvorson:

One United States Gallon* Contains:

Solids.	Grains.
Calcium sulphate	25.13
Potassium carbonate	18.33
Calcium bicarbonate	7.29
Magnesium carbonate	7.53
Aluminum sulphate	5.05
Lithium bicarbonate	7.29
Iron carbonate	1.85
Potassium sulphate	.30
Sodium chloride	.83
Silica	1.25
Organic matter	None.
Total	74.85

Carbonic acid gas, 62.84 cubic inches.

* The original analysis was estimated in grains per imperial gallon.

The analysis shows a very potent and valuable mineral water, possessing the virtues of an antacid, diuretic, and ferruginous tonic. It has been found beneficial in a wide range of diseases, but notably those due to the uric-acid diathesis. The best effects of the water have been observed in gout and rheumatism, in neuralgic pains, in gravel, and in giddiness, headache, insomnia, and other manifestations denoting the lithæmic state. Being entirely free from organic matter, the water is well adapted for domestic use. Although not used as a resort, the proprietors of the spring extend a welcome to visitors and are pleased to show them through their extensive bottling plant. *James K. Crook.*

LONGEVITY.—(L. *Longævus*, of great age, aged, from *longus*, long, and *ævum*, an age, the life of a man.) The word longevity has two meanings. It is sometimes used to designate the natural duration of life,—the length of life that an organism might attain if not destroyed by accident nor attacked by disease. The usual meaning of the term, however, is the duration of adult life beyond the ordinary limit, or the attainment of extreme old age.

The idea of a natural duration of life involves the question of natural death. This question is discussed fully elsewhere (see *Death, Physiological Theories of*); but it may be noted here that, while most physiologists are of the opinion that each organism begins its existence endowed with a capacity for living only to the end of a definitely limited period, this limit has never been determined and its existence is purely hypothetical. The evidence for such a limit is obtained, first, from the well-known facts that organisms on the average do not persist as individuals beyond a certain period, the average duration of life being characteristic for each species, and that likewise for each species there is a certain extreme duration of life beyond which no individual has been known to exist.

Secondly, there are observations like Minot's on the growth of guinea-pigs (see *Growth*) which show that at the beginning of individual existence an organism possesses certain functions at a maximum of efficiency, and that this efficiency begins to decline at once, rapidly at first, and then more and more gradually, until death ends all functions.

Thirdly, we have the line of evidence that has produced probably the most impression. This is furnished by the experiments of Maupas on Infusoria. Maupas found that if Infusoria were fed, but prevented from conjugating, they would continue to multiply by fission for a large number of generations. But at length this power of growth and multiplication would become impaired, and finally the organisms would become so weakened as to lose all power of multiplication and death would follow. But this catastrophe could be averted by allowing the Infusoria to conjugate with others of a different stock (see *Impregnation*). Then there was a rejuvenescence and the organisms would begin life anew with fresh vigor. These experiments of Maupas, then, seem to furnish at the same time a demonstration of natural death and an explanation of the importance of sexual reproduction. According to this view, by the union of two gametes, or of an egg and spermatozoon, the protoplasm acquires a supply of "vitality" that is gradually dissipated by the activities of the organism. The somatic cells of the higher forms must finally use up their vitality and die, but the species is prevented from becoming extinct by the sexual cells, which are set apart in order that they may undergo rejuvenescence by conjugation with similar cells from another individual, and thus begin a new cycle of life. But Maupas' results have not passed without adverse criticism. Besides Weismann's criticisms (see this Handbook, vol. iii., p. 381), we have the experiments of Joukowsky, who reared several species of Infusoria for many generations without conjugation. He observed a culture of *Pleurotrichia lanceolata* for eight months and during that time four hundred and fifty-eight generations were produced entirely by fission. And we have the very recent experi-