Fibrin : its origin and development in the animal organism, and its relation to life, health, longevity, and disease / by John Goodman.

FIBRIN

AND ITS RELATION TO LIFE, HEALTH LONGEVITY. & DISEASE.

BY J. GOODMAN M.D.

FIBRIN:

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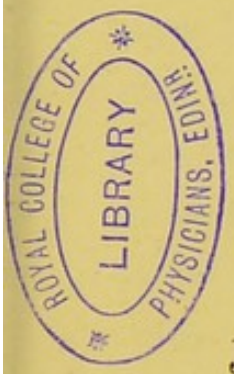
AND ITS RELATION TO

LIFE, HEALTH, LONGEVITY, AND DISEASE.



BY

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PREFACE.

In dedicating the present Essay to the Medical Profession at large, the Author has only the following excuses,—to plead for, may be, its many errors, deficiencies, and compilation in general—viz: advanced years, multitudinous employments, and much isolation in this locality from reference to Medical Literature, especially as regards the latest discoveries. Yet, at the same time, he would plead his profession-loving spirit, his urgent desire for the well-being of humanity in general, which has caused this Essay to emanate from the press, and also the long course of Medical experience which has dictated much of its contents. At the same time he would invoke the Divine blessing upon the introduction of the subject matter in hand, which appears to him to be of overwhelming value and importance to the entire human family, many suffering ones having already partaken of the benefits of the views and practice herein propounded.

Southport, *February, 1878.*

ERRATA.

P. 50, last 2 lines, for *ources* read *sources*, and for *hem* read *them*.

P. 82, line 23 from top, for *earth* read *air*.

P. 121, line 2 from top. for *emmunctories* read *emunctories*.

Readers desirous of avoiding technical terms and scientific details may omit Chap III. to page 58.

CHAPTER I.

FIBRIN: ITS ORIGIN AND SOURCES OF DEVELOPMENT IN THE ANIMAL ORGANISM.

ORIGIN OF FIBRIN.

LIFE consists of waste and supply, action and extinction; living substance assuming the state of death, and dead materials, by the laws of vitality, the condition of life.

In a galvanic battery, so long as the zinc water and acid continue to be supplied, the current is maintained; but when the elements of development are used up, all electrical action ceases. Now, animal life, according to Liebig, emanates from the union of oxygen with blood and nutritive substances, producing the elimination of carbonic acid. But when oxygen or nutritive matters cease to be supplied, of course life becomes extinct.

In addition to the above definition of life, we may further add that, in the higher animal and vegetable structures, its maintenance is specially dependent upon the encasement and protection of the living organism from the direct influence of those elements and forces which serve to excite and stimulate it to action. It is by this encasement that the interior substances and liquids of the body are preserved in their original integrity and power, probably as electro-chemical elements. In order to show the necessity for this encasement, we may remark that in living animals and vegetables, whilst it remains entire, vital action continues to be manifested; but when it is removed, death ensues. Even in fruits, peas, and other vegetables, when separated from the parent stem, a sort of waning vitality is still preserved for a time. But the moment the corticle—skin, peel, rind, or husk, &c.—is removed, then that chemical action sets in, which supersedes death, and effects decomposition and putrefaction. By the construction of the organism in this manner, the vital stimuli and sustenance are admitted only under given restrictions into the interior of the body. Here they produce such chemical changes as liberate the forces—caloric, or heat, and most probably electricity.

1. They thus maintain the body at that degree of temperature which is best adapted to the performance of its functions.

2. On the other hand, by the communication or contact of the terminals of nerve with these chemical actions and transformations, during the process of aeration of the blood, and other decompositions and combinations—(like the circuit connecting wires of a voltaic battery, attaching the negative and positive elements of the series)—the result is, the development of that subtile fluid which evidently traverses the nervous system, and is denominated the "Vis Nervosa, Nerve," or Vital Force. By this fluid all the functions and operations of the animal are performed.

In the primary construction of the animal organism, modern science discovers and displays three predominant rudimental and elementary forms of animal matter, viz., fibrous, corpuscular, and cell elements. These are shown by the histologist in all his descriptions, delineations, and drawings, as the principal constructive substances that are first visible in the earliest stages of embryonic life. We find always fibrous filaments, bands, network and membranes, corpuscular bodies and cells, depicted as the constructive materials by which the various organs, structures, and tissues of the animal frame are built up. Nevertheless, we do find albumen abounding in some organs, and in the muscles and structures especially, of young animals. Yet albumen is not commonly discovered unalloyed in the solid form. In order to effect its solidity, it would have to be deprived of the water, of its fluidity, or to be exposed to a temperature of 212° Fah., a temperature which is never witnessed in the living animal. Wherever present, therefore, albumen is found to be modelled, shaped, moulded, and maintained in form, simply by fibrous structure. The human eye, and the hen's egg, are composed of semi-fluid albumen. Yet physiology has to draw our attention to a network of membranes and fibrinous bands, which retain the albumen *in situ*, and are only discoverable by the microscope. *Albumen, therefore, in its ordinary form is incapable of construction, and cannot be reckoned as a plasm of the animal body.* Again, such is the mysterious nature and constitution of albumen and fibrin, that neither chemical analysis nor physiological discovery can afford us any definite data upon which we can rely, as regards the chemical or essential distinction of these two substances.

"Chemical analysis," remarks Liebig, "has led to the remarkable result, that *fibrin and albumen contain the same organic elements, united in the same proportion, so that two analyses—the one of fibrin, and the other of albumen—do not differ more than two analyses of fibrin, or two of albumen respectively do, in the composition of one hundred parts.*" ("Organic Chemistry," p. 41.) Moreover, it is a subject which has not escaped the attention of

physiologists, that coagulable fibrin does present itself in the lacteal vessels, but how or whence it receives its origin, none have been able to divine.

Müller supposed that the lacteals and their glands have the power of converting, by the *agency of their parietes*, a part of the albumen of the chyle into fibrin. On the other hand, Tiedemann and Gmelin held that the fibrin of the chyle is not derived immediately from the food, but is *formed in the blood*, and poured into the chyle and lymph *by the glands* of the absorbent system, and by the spleen. "However," says Müller, "the opinion that fibrin is thus added to the chyle is as difficult to prove as the opposite hypothesis, that the albumen of the chyle itself is converted into fibrin." (Müller's "Physiology," pp. 302, 612.) Other physiologists, up to the present hour, have also advanced equally perplexing and untenable hypotheses, as regards the mode of development of fibrin in the lacteals, which will be seen as we advance.

PAPER I.

In 1870, the author read a paper before the Physiological Section of the British Association for the Advancement of Science, in Liverpool, on the Origin of Fibrin in the Animal Organism, entitled, "*Albumen, and its Transformation into Fibrin by the Agency of Water.*" The substance of this paper was to the following effect:—

Albumen, he declared, is known as the *pabulum vitæ*, or raw material of the animal frame, and abounds in the fluids of the sanguineous and lymphatic systems. Yet is this substance evidently devoid of constructive qualities, and incapable of affording nutrition to the body, unless it be first more or less transformed into the coagulable, solid, and organisable material, called Fibrin. This transformation, the author showed by experiment, is effected by the metamorphosis of albumen into fibrin by the agency or influence of water. Now, although fibrin has been long held to afford supplies to wasted tissue, and that its chief design is the nutrition, growth, and reparation of the organism, yet has chemical research hitherto been unable to discover between it and albumen any satisfactory distinction as regards their elementary composition; nor has the physiologist done more than guess at the mode and means by which this transformation is effected. Under these circumstances, the

author instituted a series of experiments, in 1870, in order to elucidate this transformation which he had observed, as accomplished by the agency of water, years ago :—

Experiment 1. A portion of the white of an egg, or ov-albumen, was suspended in ropes in a glass vessel filled with pure water.

Experiment 2. A like portion was suspended in sea-water.

Experiment 3. The albumen was arranged in a similar manner in porter.

Experiment 4. The albumen was suspended in ropes in the atmosphere.

In each instance, the substance was left to stand for a period of from 12 to 24 hours or more.

In No. 4 (the atmosphere), the water of fluidity was evaporated, and the rope of albumen remained in the form of a brittle, yellow, and still transparent rod.

In No. 2 (sea-water), a very slight change only was perceptible, viz., the formation of a thin and flimsy veil seen to envelop the suspended albumen. Here we have an illustration of the influence of neutral salines in the prevention of the development of fibrin.

In No. 3 (porter), the development of fibrin was evidently arrested, and a dark coagulous substance was seen to surround the albuminous product, of which hereafter.

In No. 1 (pure water), *in a very short time a beautiful and opaque white veil began to appear upon the entire surface of the albumen. After a time, the albumen gradually exchanged its simple, granular, transparent, and homogeneous appearance for that of an opaque, white, fibrous, striated, and organised formation, as seen by the aid of a moderately powerful microscope. Beautiful fibrinous threads, of the most delicate construction, were seen shooting in various directions, and clinging to contiguous objects, until ultimately the entire substance under the microscope was found to consist of striated bundles of threads, or fibrillæ, resembling spun glass.**

* This experiment is now found to be effected with the greatest facility, by dropping a globule of ov-albumen, or blood-serum, into pure water, under the microscope, when fibrin is seen to be formed in a few minutes.

Any physiologist witnessing this product would be unable to denominate it by any other name than that of a beautiful specimen of genuine organised fibrinous material, when compared with genuine blood fibrin. The action of the water-dressing—now so extensively employed in hospitals—powerfully exemplifies the action of water upon albumen, as seen in *Exp.* No. 1. We have frequently seen ulcers and sores of long standing, and previously devoid of all tendency to cicatrization, when subjected to the action of water in wet lint covered by waterproof, in a short time, say from 12 to 24 hours, assume an opaque, white appearance upon a portion of their surface. Sometimes they are literally covered with a perfect bloom of coagulable lymph; whilst at other times the edges of the sore become white, and the sore itself is seen to be dotted over with small islands of the same material upon its surface, abundantly manifesting the rapid progress of cicatrisation. Water was thus seen to effect in the living tissues and fluids the very self-same process, and beautifully to repeat the experiment before us upon the living organism itself. These experiments, still continued, appear to be fraught with incalculable results as regards nutrition, growth, the reparation of tissue, and the treatment of disease, &c. They appear also to unfold a new view of the functions of the Lymphatic and Lacteal Systems, as well as of the absorbent veins. In these vessels not only are albuminous matters abundant, but also *water* itself. This fluid is absorbed by the skin from the atmosphere, the circulatory system, and various other parts of the body. Here, by its contact with the albuminous matters, the transformation of albumen into fibrin ensues. The contents of these vessels now begin to assume the power of coagulability, and corpuscles are seen to manifest themselves.

Finally, the product herein formed, which we have denominated "ARTIFICIAL FIBRIN," *cannot be coagulated albumen, which does not coagulate, or become solid, as albumen at a temperature below* 145° *Fah., whilst this formation was produced at a temperature of* 50° *to* 60°. *Moreover, the chief characteristic of fibrin is declared by the chemist to be "its spontaneous coagulability in water perfectly cold," which was the case in this experiment.* (See Dr. Miller's "Chemistry," Vol. III., p. 800.) *Either, therefore, the*

substance thus produced must be accepted as veritable fibrin, and not albumen, or the coagulation of the latter must henceforth be admitted (entirely contrary to all hitherto received statements of chemistry) to take place in perfectly cold water.

That the substance developed in this manner is true and genuine fibrin remained still to be proved. It had, therefore, now to be subjected to the most rigid investigation, and the following proof experiments were instituted for that purpose, and have been attended with the most perfect and unanticipated success. These experiments were, in each instance, performed *in conjunction with real blood fibrin,* with which the results of each test were constantly compared, and found as certainly to correspond.

The Proof Paper, No. II., annexed was read before the Chemical Section of the British Association for the Advancement of Science, held in Edinburgh in 1871, and printed in the Annual Report; was also printed, *in extenso,* in the *Chemical News* in January, 1872.

PAPER II.

The author having read a paper on the "Origin of Fibrin," at the Liverpool meeting last year, which is published in the Report, has been since that period engaged in attempting to prove, by a long and complete series of experiments, the truth then set forth. The following is an epitome of the results arrived at:—

1. *Albumen from the egg suspended in ropes in cold and pure water, and exposed for some little time to its influence, loses its character of Albumen, and assumes the nature, appearance, and constitution of Fibrin.*

Thus it coagulates independently of the application of heat, and becomes solid and insoluble—characteristics which distinguish fibrin from all other analogous substances. (See Dr. Miller's Organic Chemistry, Part III., p. 800.)

2. Under the microscope, which was used in all these experiments, when thus transformed by water, it *exactly resembles Blood Fibrin,* with the reactions, &c., of which it was constantly compared. So great was the resemblance, that a medical gentleman from Manchester selected this substance under the microscope for the real genuine blood fibrin, in preference to a specimen of the latter substance itself.

3. *Intense affinities and formative qualities.*

Blood fibrin, and especially this substance, differs from albumen in possessing intense attractive powers and affinities, which appear to be the secret cause of the formative qualities of fibrin, causing it to form, in definite lines, into rods and substances, &c., which evince the presence of a controlling constructive power, and enable it to assume forms and grotesque figures, of which it might be said, that nothing but vitality was wanting to endow them with the character of living beings. In several instances, the *fibrin ab albumen,* as we will now call it, manifested decided electric attraction, for it was drawn aside and out of its perpendicular, in several instances, some quarter-inch or, so, by attractive influence towards a copper wire when raised from the water. On the other hand, albumen presents itself as a homogeneous, motionless, and shapeless mass, and entirely destitute of these powers and characteristics.

4. Like blood fibrin, it was found to decompose *peroxide of hydrogen with effervescence,* whilst, as stated by Dr. Miller (p. 806), "albumen produces no such effect."

Again, Dr. Miller tells us, that *neutral salts,* mixed with blood, on abstraction, prevents its coagulation. This we found to be the case with regard to this substance—even sea-water prevented, in a great measure, the transformation.

Is oxygen capable of effecting this change?

Dr. Miller declares (p. 807) that there is a great difference between the action of oxygen on albumen and fibrin. That the former, when exposed to oxygen, enclosed in a glass tube, over mercury, indicates scarcely any absorption of the gas, and little or no carbonic anhydride is eliminated; but when coagulated fibrin is exposed, *in a moist state,* to the air, it gradually absorbs oxygen, emits carbonic anhydride, and in a few days becomes putrid. I found that *fibrin ab albumen* as well as *blood fibrin,* has a great affinity for oxygen, especially when moist and near decomposition; whilst *albumen,* in ropes hung up in the atmosphere, remained entirely unchanged in its nature, save that it became a brittle rod.

In order to show that oxygen of the air takes no part in this transformation (in *Exp.* 102, 103), I found that the transforma-

tion of albumen into fibrin proceeded exactly similarly in two bottles, the one closed by a stopper, the other open to the atmosphere—no perceptible difference occurring between them for days, and even weeks.

In all these experiments, I have not discovered one instance in which oxygen has shown itself capable of effecting any change in albumen without the previous intervention of water.

There is, however, an experiment on record, as given by Dr. Carpenter, in which Mr. Smee is said to have produced a substance presenting numerous points of similarity to fibrin, if not identical with it, by passing oxygen through defibrinated blood serum to which ordinary ov-albumen has been added, or through albumen slightly acidified with acetic acid. (See Dr. Carpenter's "Principles of Physiology," p. 56.)

In these experiments, *pure albumen*, or *albumen alone*, was not employed. In the one case, it was mixed with *blood serum*, and *perhaps with water*, of which we are not informed; and, in the other, with acetic acid.

In the first experiment by Mr. Smee, the serum employed had been, of course, exposed to the agency of water in several instances in the animal magnetism, and therefore, even when defibrinated, as shown by Müller, *and mixed with water*, coagulates after passing a filter. In the other, acetic acid was used, and the water which it contains was, we contend, sufficient to induce the change in question.

But there are no acetic or other strong acids, in the lymphatics and lacteals in which fibrin is at first seen to derive its origin, and therefore the latter experiment has nothing to do with the subject in hand.

I find, by experiment, that we have in blood serum always—

1. Already *formed fibrin in solution ready to coagulate.*
2. Do., do., which will manifest itself on *exposure to the air.*
3. The remaining albumen, which is all capable of transformation by being *diluted with water.*

Exp. 99.—In order to prove or disprove Mr. Smee's experiment as regards simple albumen itself, I exposed ov-albumen to a stream of oxygen in a glass tube for six hours, and afterwards for forty-eight hours, to bubbles of the same still remaining in

the albumen. At the end of this time its transparency remained unaltered,—slightly more yellow—and the bubbles were somewhat diminished in size. There was no appearance, under the microscope, of any fibrin having been formed. The albumen was unchanged.

Exp. 100.—In order to show the *effect of the addition of water to the above,* the tube and contents were merely washed out with the same, when it *at once assumed an opaque white appearance.* In five to ten minutes, under the microscope, fibrinous rods and other formations began to manifest themselves, and after two days' exposure to water, the whole had become changed completely into fibrinous material.

These experiments, therefore, declare that oxygen is not the producing cause of this transformation; but albumen requires—first, the agency of "moisture," "dilution," or water, to change it into fibrin before oxygen can exert any influence upon it of this kind. Afterwards, it seems to endow it with new qualities and a higher state of organisation, and gives, as it were, the finishing touch to this important product. Such also appears to be the case in the animal organism. Albumen is transformed into fibrin by water in the lymphatics, lacteals, and liver, &c.; and afterwards in the vena cava, by water absorbed by the gastric veins, &c.; and then its organisation is rendered perfect and complete by respiration. In the animal and vegetable kingdoms we observe that the most tiny animalcule, or vegetable substance, does not start into existence independently of the presence of water. It appears that fibrin has to be first formed by water before even the germ can exert its living influence upon it and develop a living being, and endow it with its own species and nature. We also notice that fermentation, decomposition, and scarcely any operation in living or dead organic substances can occur without the presence of water. It appears, moreover, that this substance, "fibrin ab albumen," exactly resembles fibrin when first formed in the lymphatics. Dr. Carpenter has shown that the latter differs from blood fibrin, in its inferior tendency to putrefaction (p. 180), whence, says he, "it may be inferred that it has not undergone its complete vitalisation." This substance also possesses a very low degree of putrefactive tendency, for it

remained in the water three whole weeks (see *Exp.* 5) perfectly white and beautiful, as on its first formation, and did not become decomposed for several days afterwards. Oxygen evidently confers upon fibrin increased attractive and formative qualities. Many more rods, &c., presented themselves generally after exposure to the air in most of these experiments.

Exp. 105, 107, 108, 109.—When the cold water was exchanged for that of blood-heat, *i.e.*, from 98° to 100° or more Fahrenheit, no difference was observable in the rapidity or intensity of the transformation.

Mr. Smee is said, moreover, to have produced a substance very similar to, if not identical with, fibrin, "*by feeble currents of electricity* passed through an albuminous *fluid*, where it accumulates round the positive pole." It appears pretty clear that water was here employed,—by the words "*fluid*" and "*accumulation*" round the pole being used. (See Dr. Carpenter's "Principles of Physiology," p. 56.)

Ov. Albumen with the Voltaic Current.

Exp. 116.—In order to test this experiment more particularly, I employed *ov. albumen alone* between two platina poles of a voltaic battery of six cells.

I found that there were only a very few small specimens of fibrin produced under the microscope, but that the albumen, by evaporation and effervescence, became less and less fluid, the fibrin apparently being transformed by the water of fluidity, —compelled, as it were, by the influences of the voltaic current, —and very shortly all transformation ceased. After a time, the albumen became a thickened, and ultimately a solid mass. On examination, it was found to consist almost entirely of unchanged albumen, as the specimen which we have here manifests.

Ov. Albumen with Water and the Voltaic Current.

Exp. 110.—I employed *water in this experiment*, and the following, *in conjunction with the voltaic current. In half a minute the albumen became covered with dense and opaque whiteness*, showing that, in contrast with the other experiments, in which water only was used, the rapidity of transformation was,

by electric agency, greatly increased. *Exp.* 112.—The change to dense and opaque white was again effected in about half a minute. With older ov. albumen there is usually an increase in the amount of gas eliminated. Here we had a globule of albumen immersed in water midway between the poles, which was found to be a great advantage. In this experiment I perceived a dense, dark brown ring of fibrin forming around each bubble of gas, which we have preserved, and which can now be seen in the specimen. In fifteen minutes fibrinous rods were seen shooting forth like the fingers of a human hand (one of the most beautiful exhibitions I ever witnessed), towards the neg. pole, or in the lines of current.

All these experiments, together with 113 and 115, in which, apparently, thousands of ovoid corpuscles made their appearance, many of which were attracted in beautiful lines, and formed rods—and many of them can still be seen in the specimen—resulted in the formation of perfectly formed fibrin, without scarcely a vestige of unchanged albumen being left.

Dr. Miller declares (p. 808) that, when fibrin is treated with acetic acid under the microscope, it is found to consist of two portions, one of which is granular and soluble in acetic acid, while the other is fibrinous and insoluble. This we found to be a graphic description of what took place with fibrin ab albumen.

EPITOME OF EXPERIMENTS.

I.—*Solution.*

Exp. 9 and 69.—*Fibrin ab albumen* dissolved in 3 *min.* in liq. potassæ.

Exp. 66.—*Blood fibrin* was completely dissolved *in twelve hours,* whilst ov. albumen required more than *twenty-four hours* to effect its solution without heat. *Here this substance was much more dissimilar to albumen than even blood fibrin itself.*

Exp. 52.—In strong hydro-chloric acid, *fibrin ab albumen and blood fibrin both dissolved in twenty-four hours,* whilst ov. albumen was not completely dissolved in sixteen days.

II.—*Precipitated Solutions.*

In solution in acids precipitated by alkalies—and in alkalies precipitated by acids—*this substance always manifested the same*

reactions as blood fibrin, and also equally differed from those of albumen. *Exp.* 57 to 63 and 68.

In the fibrinous solutions precipitated, *we had always fibrinous rods and formations of fibrin without the coagulum* peculiar to albumen. In the solutions of albumen precipitated, we had as *invariably a dense and dark or light coagulum, without fibrinous rods and formations.*

Moreover, in alkaline solutions of albumen with *acetic acid*, we had always *a dense white and flocculent coagulum;* and when precipitated by *nitric acid*, as stated by Dr. Miller,* *a lemon yellow precipitate*, whilst neither coagulum *nor colour* were present in the precipitates from solution of fibrin ab albumen, or blood fibrin.

The results of these experiments have been so marked, so harmonious and constant, under the microscope, as to give them a conclusiveness which demands our most serious consideration and attention.

OTHER MODES BY WHICH FIBRIN IS SAID TO HAVE BEEN PRODUCED.

I find that many physiologists who have been reputed to have produced fibrin, have done so out of dilute solutions, that is, under the influence and agency of water.

Thus Müller produced coagulated fibrin out of clear, filtered, and consequently defibrinated, blood serum. "But," says he, "the blood was diluted with water or with a very thin syrup, 1 part sugar in 200 water." In a few minutes a coagulum formed in the clear liquid after it had passed the filter. But (even then) "this coagulum could not be detected save by drawing it out of the fluid by a needle. This," says he, "gradually (after a few minutes) contracts, becomes *whitish and fibrous*, and then has exactly the aspect of human lymph." As regards the admixture of two (diseased) serous fluids, such as those of hydrocele and ascites, or ascites and pleurisy, as suggested by Dr. Buchanan,† these could take no part in the mode of transformation of albumen into fibrin, in the absorbments, &c., and are therefore foreign to our present subject.

Finally, as regards the renowned experiment of Professor

* "Organic Chemistry," Vol. III.

† Dr. Carpenter's "Physiology," p. 242.

Schmidt, who is declared by Dr. Carpenter to have attempted to explain the phenomena in question (p. 242) by attributing them to the combination of two substances, existing in the liquor sanguinis, which he has been pleased to denominate "*Globulin*" and "*Fibrinogen.*" But if albumen is capable, *per se*, of transformation by any agency, it certainly would be far more simple to discover, first, that direct agency as a solution of the question, rather than to develop two new compounds, and then, by the union of these, to pronounce the source of the phenomena in question. However, Dr. Carpenter goes on to say, "both Schmidt and Hoppe Seyler have been successful in producing a coagulum differing in no respect from ordinary fibrin, by the admixture of these two substances." One might have some difficulty and trepidation in assailing such an explanation of the origin of fibrin in the animal organism, as the above, were it not for the great uncertainty that attends all speculations upon matters formed out of the body by chemical decompositions. But when we read on a little further—that both these compounds were precipitated by carbonic acid from *dilute solutions*, all difficulty is at an end. A good deal of *water* must have been employed, and, according to the facts of this paper, the *rationalé* is obvious.

It is thus seen that many physiologists, in experimenting upon, and endeavouring to discover the origin and source of fibrin in the animal organism, whilst employing other measures which they have supposed capable of effecting this transformation, have been *unwittingly and unsuspectingly making use of the very agent* which alone is capable of developing this important product.

It is rather remarkable how much Liebig insists upon the necessity of the *presence of water, before oxygen can effect any change in organic substances.* ("Organic Chemistry," pp. 225 and 111.) Müller, in his work on Physiology (p. 294), declares that when frogs have been kept out of water for eight or more days, during the summer, their blood often loses the power of coagulation; and, under such circumstances, the lymph taken from the lymph cavities of the same animal affords no coagulum.

Fibrin is formed, therefore, as shown by Dr. Carpenter and

other physiologists, in the lymphatics, lacteals, absorbent, and mesenteric glands and vascular system;* *and we maintain, from the foregoing facts, that this transformation is effected by the agency of water.* That this water is drawn from the sanguineous circulation—the great cavities of the body, &c., &c., and from the skin—while at the same time albuminous substances are brought up from the blood vessels and other organs along with effete matter and used-up materials, which, as Dr. Carpenter says, are capable of being again assimilated. That these, on meeting with the aqueous fluids, begin at once to undergo a change, and that change is the transformation from albumen to fibrin, which he represents as the being subjected to an elaborating or preparatory agency previous to their introduction again into the circulation. This elaboration he speaks of again as being the formation of fibrin, the assumption of coagulation, and the appearance of a number of chyle or cytoid corpuscles.

We observe, likewise, that the aliment itself is exposed to the action of water, in the shape of all fluids that enter the alimentary canal by imbibition ; and afterwards the venous blood in the liver is also subject to an influx of water, which is drawn from the stomach by the gastric veins.

Here, then, is the admitted presence of the transforming agent at the very point or locality—*i.e.*, in the lymphatic vessels and glands—where the presence of fibrin is first detected; and the existing estimated amount of this fluid in the lacteals and lymphatics in comparison with the amount of existing albumen, and at the same time, in comparison with the relative quantities of water and albumen in the blood, becomes an important subject of inquiry in this place.

According to Gubler and Quevenne, quoted by Dr. Carpenter (p. 178), we have in 1000 parts :—

	Water.		Albumen.
Of Lymph,.....	939·87	...	42·75
Of Chyle,.....	904·08	...	70·80
Of Blood,.....	796·93	...	58·82

Thus presenting nearly twenty-two parts of water to one of albumen in lymph—to thirteen and a-half water to one of

* Carpenter's "Principles of Physiology," pp. 179, 180.

albumen in the blood. In the chyle we have a higher amount of albumen in man, though not in animals, so it is stated, to the existing amount of water. But it must be remembered that this fluid had not as yet joined the lymph, being drawn for examination before it reached the receptaculum chyli, in which the lymph unites with the chyle. Nor had it either been subjected to the action of the imbibed fluids from the gastric veins, to which it is at least for a short time exposed after its entrance into the sanguineous circulation.

If water, therefore, is capable of producing with such facility the change in question; if this change is, as we have seen, incapable of being effected without the presence of water; and if this fluid is also discovered to be present in the lymphatics and absorbent glands, where fibrin is first and chiefly discovered to receive its origin, and that in an amount ample and sufficient to meet every requirement of the organism; unless some more probable cause can be discovered, we shall, of course, be under the necessity of admitting water to be the producing cause of this phenomenon.

We have in possession several specimens of this product preserved in spirit, which could not be distinguished from blood fibrin—others, the result of exposure to oxygen—to the voltaic current—and also of precipitation, which present incontrovertible evidence of the facts herein adduced.

That water was employed in all the experiments of Professor Schmidt in the production of fibrin is evident, inasmuch as the "globulin"—which he declared to be the agent in its transformation—was stated by Kühne, "to have been precipitated by means of carbonic acid from blood corpuscles, modified to a certain degree by the action of water;" or, in the words of the experimenters themselves, that "both globulin and fibrinogen were precipitated by carbonic acid from *dilute solutions*." I have also had the pleasure of an interview with Mr. Smee, who honourably acknowledged that water was used in his experiments.

We see, then, that all the experimenters upon this subject—Müller, Schmidt, and Mr. Smee—did employ water in the production of fibrin; and if water was employed, a globule of ov. albumen dropped into it would develop fibrin in a very few minutes. Whatever other process was adopted, therefore, would be of no consequence, if it did not retard the formation of this

substance—providing that the fluid was present, which is herein proved to be the grand agent in its production.

The transforming agency by which these phenomena were produced is evidently not chemical; for although gas is invariably eliminated in large quantities when old albumen is subjected to the influence of water, yet in fresh albumen no such effect is produced; neither is there discovered to be any well-authenticated chemical difference between the original substance and the substance formed. Liebig declared, as we have already seen, and which has not as yet been successfully contradicted, that "chemical analysis has led to the remarkable result, that *fibrin and albumen contain the same organic elements, united in the same proportion.*" (Liebig's "Organic Chemistry," p. 41; see also "Organic Chemistry," by late Dr. Miller, Vol. III.)

But water is held by the electrician to be a great electrolyte, as it becomes the conductor of electric force, simply "by *assuming* a polar condition, and transmitting that force by its own decomposition, and the transmission of its particles in directions parallel to the current." (See Faraday's "Researches into Electricity," pp. 275, 276, &c.)

It appears therefore probable, that water acts upon albumen by electric agency; that the uniting together and forming in line of molecules or corpuscles of this substance, in order to the development of fibrinous threads and rods, &c., as well as of its "assuming various forms and grotesque figures" (2nd Paper, p. 7), is the result of electrolytic action, primarily, of the living molecular or corpuscular substances upon the water, which, in accordance with electric laws would take place. Thus the vital force present in the molecules or corpuscles appears to possess the power to electrolyse, or, in other words, produce a polar condition in the elements of the water. In its turn, the water thus electrolysed reacts upon those spherical bodies, and causes them to arrange themselves in polar lines. After this manner a magnet acts upon soft iron, and causes it to assume a given position; and, in return, the iron now magnetised reacts upon the magnet, and causes it to arrange itself in accordance with fixed laws. In the same way the voltaic current, present in a helix of copper wire, acts upon the magnetised needle, called a "galvanometer," and causes it to assume a given direction by the influence of the voltaic force.

When thus electrolysed, each elementary particle assumes itself a fibrinous nature, and by the law of aggregation, unites with its fellow on either side, or, in other words, the polarised molecules of each electrolytic line combine together and form fibrillæ, which, when thus united, develop beautifully striated and elaborated fibrin.

GREAT VALUE OF ELECTRICITY AND ATMOSPHERIC AIR IN THE ELABORATION OF FIBRIN.

It has long been held as a fact, that no coagulation of the blood of animals occurs when they have been hunted to death, killed by lightning, by electrical shocks, or by blows upon the the epigastrium, &c.; but this opinion has not been found altogether true. "Still," says Dr. Carpenter, "there seems to be no reasonable doubt that non-coagulation may occur, when the blood has been previously subjected to conditions which affect the vitality of its fibrin. Such appears," he says, "to be the case, for example, when death occurs from asphyxia—as by hanging, drowning, or breathing irrespirable gases, poisoning by hydrocyanic acid, &c." No doubt, also, death by lightning, if our hypothesis is correct, must be a fruitful source of non-coagulation.

Dr. Gairdner stated that a rabbit, having been kept for half-an-hour under the influence of an electro-magnetic current, between the chest and the spine, which produced a great acceleration in the respiratory movements, its blood was found to contain as much as 2·9 parts of fibrin in 1000; whilst the average amount in blood is only from 1·56 to 1·95. (See Paper II. pp. 9 and 10.)

ATMOSPHERIC AIR.

This same physiologist has also shown that blood drawn from individuals who had been made to respire oxygen, gave on the average 2·40 parts of fibrin to 1·65 in others who had not respired the gas.

We have in our own experiments frequently witnessed an increase in the development of fibrin, when vitality has begun to flag, by exposure of corpuscles and other fibrinous substances to the air. Lehman supposed oxygen to be so valuable in the production of fibrin, that he believed it to be the producing cause of its development. ("Physiological Chemistry," Vol. I. p. 360; see Paper II. pp. 7, 9, &c.) It does not appear, however, that any modern chemist or physiologist attempts to maintain that fibrin is at all changed in its chemical constitution by the action of oxygen, or that it possesses a greater amount of that element after exposure to its influence than previously. Neither does it appear by analysis that any addition of oxygen takes place by exposure of albumen to the action of water.

We have already shown that atmospheric air is incapable of itself of effecting any change in albumen save decomposition—that it is therefore incapable of developing fibrin from this substance. But that when albumen has been already exposed to the influ-

ence of water, and has produced fibrin or a coagulable form of fluid, that then oxygen, as in respiration, produces a still higher degree of elaboration of the product, and perfects its development—gives, as it were, the finishing touch to this all-important change. (See Paper II. pp. 7, 8, 9.)

This Proof Paper has been transmitted to every medical college of note in England, Ireland, and Scotland, to several colleges upon the Continent of Europe and America, and to almost every physiologist and chemist of eminence in the United Kingdom. It was translated into the French language, and forwarded to the Academie des Sciences du Paris, and to all physiologists whose names appeared in the list of visitors to the British Association at Edinburgh in 1871. Hitherto *nemo contradicente.* The following are some of the complimentary notes received:—

"Royal College of Surgeons, London,
"23rd day of Oct., 1871.

"Sir,—I am directed by the President to return you his best thanks for the desirable addition made to the Library of the College by your donation of a copy of your Essay on 'Fibrin: Its Origin and Sources of Development in the Animal Organism.' —I have the honour to be, your obedt. servant,

"Edward Sumner, *Secretary.*

"John Goodman, Esq., M.D."

From University College, London:—

"Nov. 2. 1871.

"Sir,—I am requested by the Council to request that you will accept their sincere thanks for your kind present of the undermentioned work to the College Library.—I am, sir, your obedient servant,

"John Robson,
"*Secretary to the Council.*

"'Fibrin: Its Origin and Source of Development in the Animal Organism.'"

Similar acknowledgments have also been received from King's College, London, and from the Literary and Philosophical Society of Manchester, &c.

From Dr. Carpenter, the eminent physiologist of London, I received the following note during the meeting of the British Association in Edinburgh, dated Aug. 3, 1871:—

"Dear Sir,—I am very sorry that, as I must leave Edinburgh to-morrow evening, and have my time fully occupied till then, I can take no personal concern in the interesting observations which you are prepared to bring forward. . . . I have placed

your letter in the hands of the Secretaries to the Anatomy Department of Section D, who I find have already received a Paper from you, and they assure me that they will endeavour to give you an opportunity of briefly describing your observations. —Yours truly, "WILLIAM B. CARPENTER.

"Dr. Goodman."

I have also been honoured by a note from the present editor of Dr. Carpenter's "Principles of Human Physiology"—Henry Power, Esq., M.B.—dated London, Oct. 23, 1871, in which he thanks me for my communication on "Fibrin," &c., which he has read with much interest.

This gentleman has since witnessed some specimens of artificial fibrin thus produced by the author, and kindly and voluntarily pronounced them "distinctly fibrinous."

Dr. Buchanan, of Glasgow, Professor of Physiology, has also written as follows:—

"Athole Place, Glasgow, 30th Sept., 1871.

"DEAR SIR,—I have read with much interest your Paper which you kindly sent me, &c., &c.—Yours very truly,

"A. BUCHANAN."

Similar notes have been received from the lecturers on anatomy and physiology of the Schools of Medicine in Manchester and Liverpool, &c., &c.

A copy of the Proof Paper (No. II.) was also translated into German and forwarded to the late Baron Von Liebig, from whom I received the following reply, edited by the Professor of Chemistry at Munich University, which, being translated, reads as follows:—

"University of Munich, Nov. 2, 1871.

"HIGHLY ESTEEMED SIR,—Sir Liebig wishes me to acknowledge the receipt of your Treatise on Fibrin, and to say that he has read the same with deep interest." &c.

The learned Professor, after further descanting upon the vast importance of the subject, had himself tried the experiment since the receipt of my letter, and gave me the following as the result of his experiment:—

"*If the white of a hen's egg is suspended in water by a wire net, there certainly is left, after some time, a white mass which cannot be distinguished from fibrin.*"—With the highest regards.

"T. VALHART,

"*Professor of Chemistry.*"

THE VOICE OF NATURE.

How strikingly expressive and highly corroborative of the facts herein adduced, is the existence of the fœtus of the mammalia during embryonic life! It is submerged in an almost purely aqueous fluid, which has free and constant access both to the alimentary canal and also to the absorbent system through the skin—a fluid whose composition is declared to be only 7 parts of albumen to 1000 of water. By such an arrangement, we have an entire guarantee for every facility and ample resources being afforded for the development of fibrin.

WATER, THEN, IS THE GRAND PROLIFIC AGENT OF ALL ANIMAL AND VEGETABLE LIFE.

There can be no such life independently of the presence of water. Dry air and heat may act upon animal matter for years without producing any product save the results of decomposition; but when moisture is introduced, even animal life is seen to spring forth as though by magic.

A corn of wheat has remained dry and entombed in one of the Pyramids of Egypt for thousands of years perfectly dormant, yet when afterwards it was placed in contact with water in moist earth, it began at once to vegetate, fructify, and grow.

Some seeds, indeed, such as those of mustard, are found to vegetate and grow, when simply scattered among lead shot, moistened by water. We do not, however, wonder at the value of water to animal and vegetable life, when we remember that it forms generally 75 per cent of the entire substance of living vegetable and animal bodies, and must be therefore, of course, a chief element in their growth, nutrition, and the development of their structures.

ABSORPTION OF WATER.

Water is absorbed by the skin from the tissues and blood-vessels of the body, and by the branches of the *vena porta* portal vein) from the digestive cavity (stomach) itself. This fluid coming into contact with the animal, or nitrogenous substances, travelling onwards in the absorbents towards their destination, effects the transformation of which we speak.

ABSORPTION OF WATER BY THE SKIN.

Dr. Carpenter has adduced several individual cases in which absorption occurred through contact of liquids with this organ. Shipwrecked sailors and others suffering from thirst, owing to

the want of fresh water, find it greatly alleviated, or altogether relieved, by *dipping their clothes into the sea, and putting them on whilst still wet,* or by *frequently immersing their own bodies.*" In a case related by Dr. Currie, of a patient labouring under an entire inability to take food, an attempt was made to prolong his existence by the exhibition of nutritive injections, and by immersing his body, night and morning, in a bath of milk and water. During the continuance of this plan, his weight, which had previously been rapidly diminishing, remained stationary, although the quantity of the excretions was increased. Dr. S. Smith mentions the case of a man who had lost nearly 3 lbs. by perspiration during an hour and three-quarters' labour, in a very hot atmosphere, but who regained 8 oz. by immersion in a warm bath at 95° for half-an-hour. Dr. Madden showed a positive increase in the weight of his own body during immersion in the warm bath, even though there was at the same time a continual loss by pulmonary exhalation, and the transudation through the skin. Dr. Carpenter also adduces other phenomena, which testify that a considerable amount of water may be absorbed under particular circumstances from the vapour of the atmosphere. Upon the importance of the absorption of water by the skin, this physiologist further remarks—" In the lowest tribes of animals, and in the earliest condition of the higher, it would seem as if absorption by the external surface is almost equally important to the maintenance of life, with that which takes place through the internal reflection of it forming the walls of the digestive cavity."

It is a remarkable fact connected with loss of blood, in relation to the absorption of water into the system, as the producing cause of the development of fibrin and corpuscles, that, as remarked by Dr. Carpenter, "almost as soon as the stream begins to flow from a wounded vessel, *there seems to be an increased transition of watery fluid from the tissues into the current of the blood.* For this latter becomes rapidly less dense, and the last drawn is of lower specific gravity, and contains a considerably smaller amount of solid matter. . . . . That the principal diminution occurs in the proportion of red corpuscles ; *and yet strange* to say *the amount of fibrin and albumen is only slightly affected.*" Hence, we may infer, that when the quantity of water is thus rapidly increased in the blood, so rapid is the introduction of albumen into the vessels, and so quickly is it transformed into coagulable lymph and fibrin, that the decrease of these substances is scarcely perceptible. (See " Principles of Human Physiology," by Dr. Carpenter, pp. 167, 168, and 220.)

It would appear, therefore, that the appropriation of food and water by the alimentary organs is not more important in the

animal economy than the reception of water by the absorbents from the atmosphere through the medium of the skin, from the circulatory system, or from the other tissues of the body. On the other hand, the respiratory apparatus is constantly inhaling a gas (oxygen), which may be termed the vivifier of all animal vitality, and which is discovered to produce the perfect elaboration of all constructive and nutritive substance.

PAPER III.*

The following paper was read before the Biological Section, at the meeting of the British Association for the Advancement of Science, at Bradford, in 1873 :—

FIBRIN AND WHITE CORPUSCLES: THEIR NATURE AND ORIGIN IN THE ANIMAL ORGANISM.

I.—*Fibrin produced from Blood Serum by the Agency of Water.*

Ov. albumen, immersed in cold and pure water, and exposed for some little time to its influence, loses its character of albumen, and assumes the nature, appearance, and constitution of fibrin. Contrary to the statements of chemical science, it coagulates independently of the application of heat, and becomes solid and insoluble—characteristics which distinguish fibrin from all other analogous substances. (See Dr. Miller's "Organic Chemistry," Part III. p. 800; also a Paper by the author, published in the Annual Report of the British Association for 1870.)

Under the microscope, which was used in all these experiments, when thus transformed by water, it *exactly resembles blood fibrin*, with the reactions, &c., of which it was constantly compared.†

A globule of human serum, submitted to the action of cold water in a watch-glass, under the microscope, gave similar results. It presented an opaque white aspect in a few seconds, and assumed a fibrinous character. (See Plate I.)

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* See Proof Paper, published in the Annual Report of the British Association for 1871 ; also, *in extenso*, in the *Chemical News*, January, 1872.

† Professors Müller and Schmidt, as well as Mr. Smee, have all admitted the employment of water in their various modes of production of fibrin.

II.—*Development of White or Colourless Corpuscles.*

Blood serum and ov. albumen, immersed in pure water, were sometimes found to develop only corpuscles. This result was ultimately discovered to arise from *the employment of old eggs, or blood serum long drawn.* It was found also that *a low temperature, just above the freezing point,* produced the same effect, and the substance developed under such circumstances was *of lighter specific gravity* than the water in which it floated; whilst that which produced fibrin was heavier, and always sank to the bottom of the vessel. The substance produced by an all but freezing temperature was *covered with a more or less dense coating of coagulum-like material,* which, by the reflected sunbeams, was discovered to be *constituted entirely of corpuscles,* and yet within its interior was sometimes found well elaborated fibrin. (See Figs. 2 and 3.)

Corpuscles thus produced have, ever and anon, *a tendency, when apart from each other, to arrange themselves in definite lines, to unite together, and to form rods and other fibrinous substances,* Thus, like fibrin, they exhibit a force of affinity or cohesive attraction one for another, which power was discovered in these experiments always to be increased by exposure to the atmosphere. (See Plates and Figures; Figs. 1, 4, and 5; and Plates I. II. and III.)

This attractive energy was also found to be *more or less intense in proportion to the freshness, or, in other words, the vital energy resident in the albumen employed: That from old eggs, or long-kept serum, or subjected to an all but freezing temperature, developed corpuscles; whilst that which was obtained from fresh albumen, whose vital powers had not been reduced by cold, produced well-formed fibrin.*

COMPRESSION.

It was, moreover, again and again proved that the *adhesive power* of fibrinous rods, when developed from corpuscles, old eggs or serum, or after being exposed to a very low temperature, *is so slight, that even compression between two glass plates, under the microscope, was sufficient to cause the same to break-up, and to resolve themselves into corpuscles.* In some instances, *when the*

compression was removed, the corpuscles again united in definite lines, and produced fibrinous rods.

Finally, when *fibrinous substance, during decomposition,* and by the action of the atmosphere, was *disintegrated and destroyed, it was found to be resolved into corpuscles, and corpuscles were seen to be the final and last witnessed products of decomposition,* previous to their ultimate disappearance and extinction. (See Fig. 7, which it much resembled.)

It was thus rendered evident *that the nature of corpuscles is identical with that of fibrinous material, corpuscles being convertible into fibrinous structures, and fibrin being again resolvable into corpuscles.*

These two great coagulable and structure-forming components of the blood and lymph are thus seen to possess a common nature, and to derive their origin from like substances, conditions, and agencies, viz.: the subjection of albuminous material to the action of pure water, under the influence of the vital force. They exhibit similar characteristics, and arise, as is well known, in the same anatomical localities in the animal organism—the lacteals, lymphatics, and vascular system.

They are found side by side in the inflammatory and reparative processes of the frame, &c., are inseparable in the coagulum of lymph and blood, and appear to fulfil like offices, and to have a like destination in the animal economy; whilst the excess of the one or the other afford, according to the views of some of our most eminent physiologists, indication of the healthy or morbid condition of the body—the predominance of fibrin being held by them as the symbol of the highest condition of health, and the predominance of corpuscles as the indication of a cachectic or otherwise unhealthy state of the body.

Thus, Sir James Paget, speaking of the action of a blister upon the skin, declares that the "highest health is marked by the exudation of the most perfect and unmixed fibrin—the lowest by the formation of the most abundant corpuscles," &c.; that "colourless corpuscles are especially abundant in the blood of frogs that are young, sickly, or ill-fed." (See also remarks by Mr. Wharton Jones and Professor J. H. Bennett, *Philosophical Magazine,* May, 1845.)

These conditions are also, by Sir James Paget, declared to extend to and influence the inflammatory affections, as well as the reparative processes of the animal economy. He divides the chief product of the inflammatory state, viz., coagulable lymph, into two typical forms, which he denominates the *Fibrinous* and the *Corpuscular*, and he declares that it is mainly upon the preponderance of fibrin that the plasticity of the fluid (or its capacity for organisation) depends; whilst according to the preponderance of corpuscles will be its tendency to degeneration. Thus, he remarks, the exudation of fibrinous lymph is the symbol of the adhesive inflammation, whilst that of the corpuscular is similarly characteristic of the suppurative inflammation. (See "Lectures on Surgical Pathology," by this author, Vol. I. pp. 313, 314, 332, &c.)

Dr. Carpenter has also shown "that, in what is called the scrofulous or strumous diathesis, we find an imperfectly organisable or cacoplastic deposit, or even aplastic product, known by the name of tubercular matter, frequently taking the place of the normal elements of tissue;" and he shows that the coagulum of the blood of such persons is not composed of well elaborated fibrin, but is "greater in bulk," yet "soft and loose in its texture, and contains an unusually large number of colourless corpuscles." "Such deficiency in plasticity, &c., and the deposit of cacoplastic products, appears to be," says he, "the history of the formation of tubercles." *

How remarkably do such statements entirely coincide with the experiments herein adduced, in which it is seen that white corpuscles have an affinity for each other, but in a minor degree, compared with fibrin; and that the fresh egg, recently drawn serum, or, in other words, albumen which possesses high vitality, develops fibrinous products; whilst old albumen, or that whose vital energy is considerably reduced by a low temperature, produces corpuscles!

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* "Principles of Physiology," pp. 417, 418.

DESCRIPTION OF PLATES AND FIGURES.

Fig. 1. Corpuscles in line, forming a fibrinous rod.

Figs. 2 and 3. The external coating (page 4, Nos. 3 and 23), seen by ordinary light, and by the solar ray.

Plate I. (May 31, 1872) was the result of a globule of blood serum immersed in pure water in a watch-glass. Shortly, corpuscles and grotesque figures of fibrin presented themselves. The corpuscles were witnessed adhering together and forming various structures; the long bead-like structure at *a a* stealing insensibly upon the vision, and forming in the very sight.

Plate II. (Oct. 23, 1872). A long fibrinous thread, produced in the same manner, was by compression compelled, as it were, to separate into corpuscles, its power of adhesion being slight and easily overcome. On removing the compression, the corpuscles again united together in line, and developed this fibrinous rod. The three small bodies at *a a* were seen speedily to unite and form a rod. There were also three small bodies at *b b* which had already formed themselves in line. I watched them all afternoon and evening at intervals, but the only change that took place was their nearer approach to each other. Next morning they had completed their union, and increased thus the length of the rod. Several other portions also joined elsewhere, and the appearance now (12 noon, Oct. 24) is seen in Plate III. There are also several portions forming rods in various parts of the field, but the substance is now evidently very deficient in formative energy.

Fig. 4. In some instances there appeared some three or four corpuscles interposed in the line of a fibrinous rod, in the act of transition, which were closely watched, and seen, after a time, to unite with one another, and with the ends of the rod, and thus to complete its formation.

Fig. 5. In one hour afterwards, there were presented thousands of corpuscles formed in parallel lines, in order to develop rods, whilst others were already formed into bundles of fibres, as seen in Fig. 5.

Fig. 6. Others presented a wavy appearance, as observed in Fig. 6.

Fig. 7 (Dec. 30). Submitted a globule of old ov. albumen to the operation of water in a watch-glass under the microscope. In five or ten minutes the entire globule had become of an opaque white, and shortly it was transformed into thousands of corpuscles, enclosed in meshes of fibrinous rods and formations. (See Fig. 7.)

FIG 1.

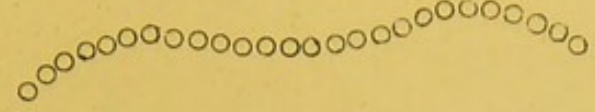
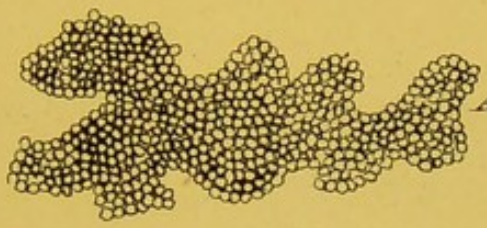


FIG 2.

As seen by Ordinary Light.

FIG 3.



As seen by the Solar Ray.

PLATE I.

PLATE II.

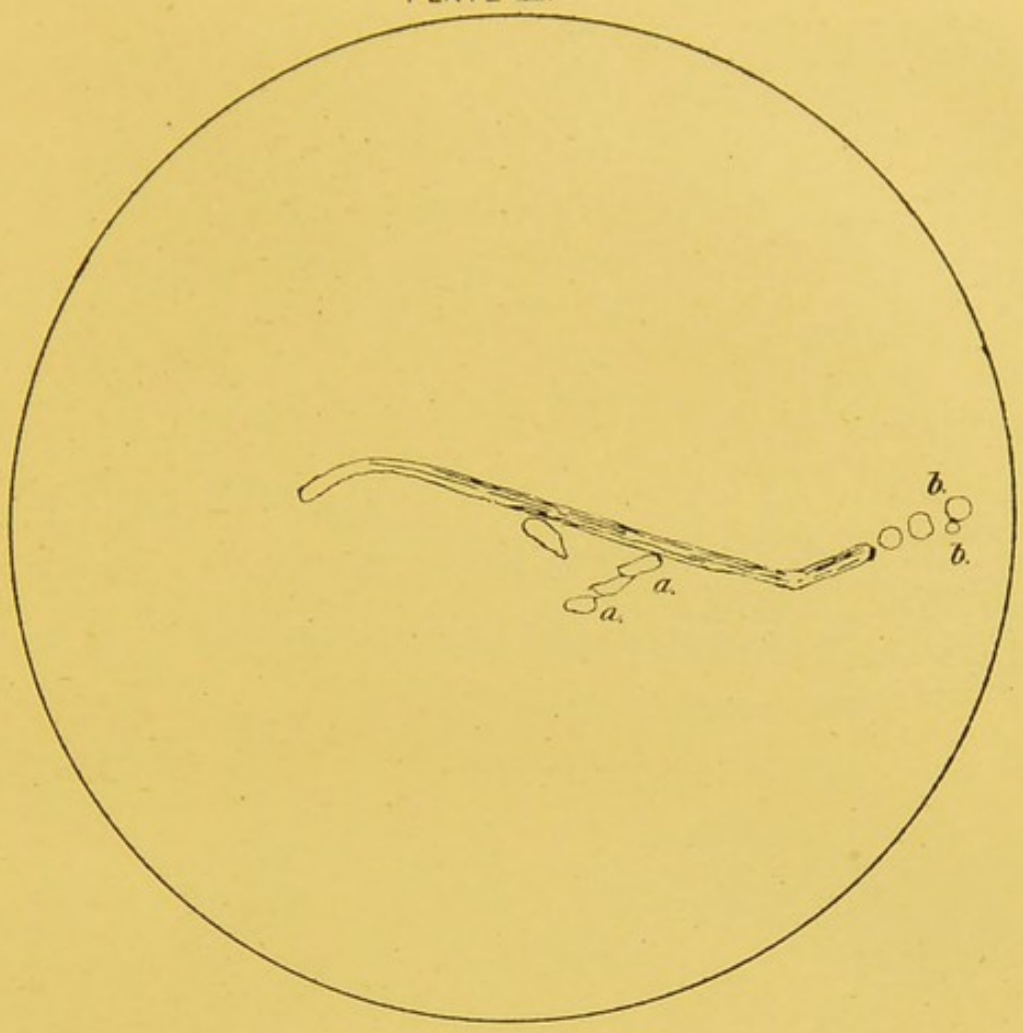


PLATE III.

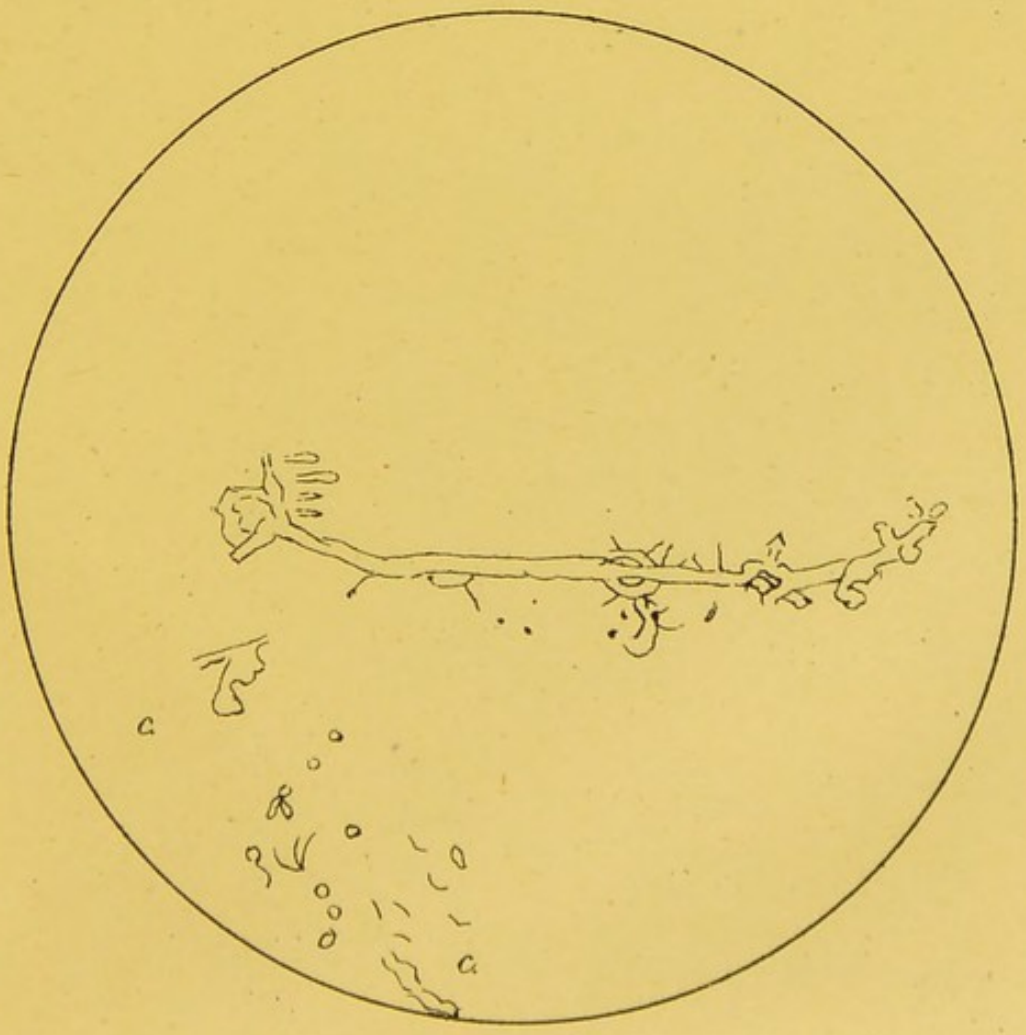


FIG 4.

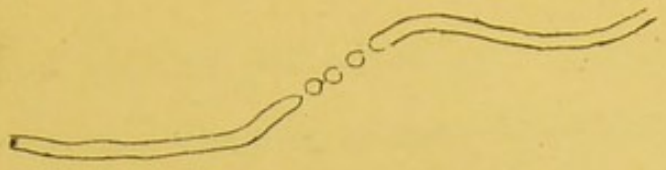


FIG 5.

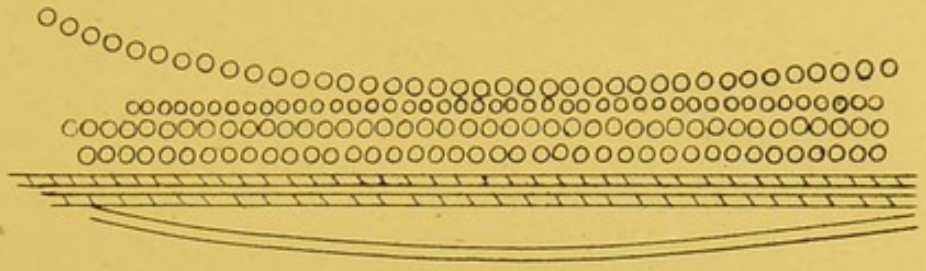


FIG 6.

FIG. 7.

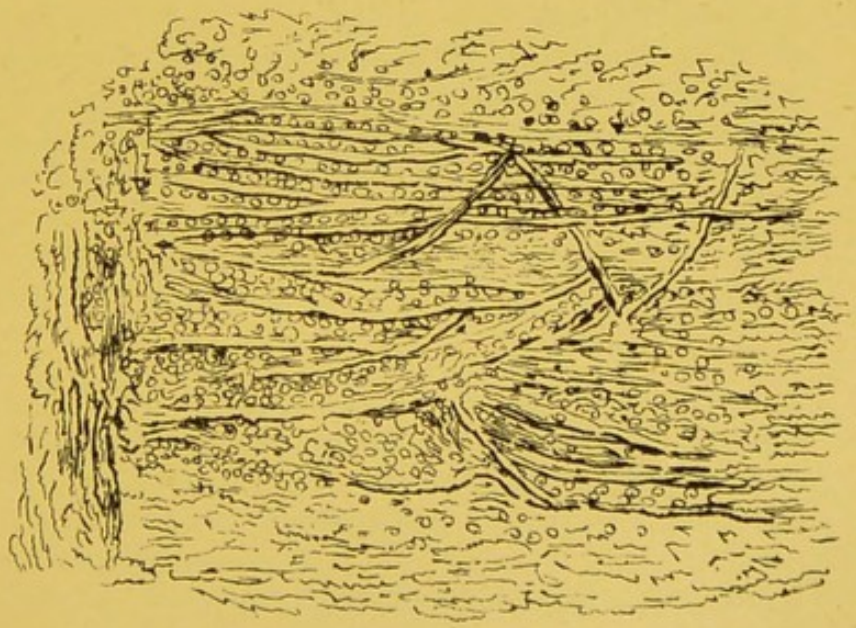


FIG. 8.

Specimen of Fibrin found during disintegration. Page 7.

It appears that the corpuscles witnessed in these experiments were of two kinds—

First, *Those which, possessing a very low vitality, if any, had been developed by water from the albumen of old eggs and long drawn blood-serum, or from that which had been submitted to a freezing temperature. These, which may be termed primary corpuscles, presented themselves invariably of a specific magnitude, and of an uniform size, corresponding with that of the white corpuscles of the blood,* as seen in Figs. 3 and 7.

Secondly, *Those which were the direct products of exposure to water, of fresh albumen or serum, which possessed a considerable amount of vitality, and may be denominated Vital Corpuscles, were discovered of various sizes, some large, and others of exceedingly minute dimensions, and appeared to be simply fragments of fibrin, and form not only corpuscles, variable in size, but also probably the nuclei of cells.*

Corpuscles, whose vitality is not too much reduced, or has been resuscitated by the refreshing influence of atmospheric air, arrange themselves in lines, and combine together to produce fibrinous filaments and rods, and other forms of this material. It is thus seen that, in proportion to the force of existing vitality, we have fibrinous or corpuscular development, or a preponderance of the one or the other, in proportion to the freshness or otherwise of the ov. albumen or serum employed—just as it is shown by physiologists that we have a preponderance of fibrin or corpuscles in the human organism corresponding with the force or energy of existing vital power. (See p. 23.)

THE FIBRINOUS STATE OF CONSTITUTION INDICATIVE OF THE HIGHEST, AND THE CORPUSCULAR OF THE LOWEST STATE OF HEALTH.

We have already shown (Paper III. pp. 24, 25) that some of our most eminent physiologists maintain *that the predominance of fibrin is the symbol of the highest condition of health,* and the *predominance of corpuscles an indication of a cachectic, or otherwise unhealthy state of body.*

Sir J. Paget has also observed, that the colourless corpuscles are especially abundant in the blood of frogs that are young, sickly, or ill-fed; and, in confirmation of the statement made by Mr. Wharton Jones and Professor J. H. Bennett, he declares that the increased proportion of these corpuscles in inflamed blood is most frequent, when the subjects of the disease are

persons in weak health, or of the Tuberculous Diathesis (constitution). We have also shown that the same author declares, "that it is mainly *upon the preponderance of fibrin that the plasticity of the lymph (or its capacity for organisation) depends;* whilst according to the *preponderance of corpuscles will be its tendency to degeneration and suppuration.*" In the light of the experiments already adduced, we are inclined now rather to suggest, that these statements need some degree of qualification. We regard the *highly vitalised corpuscles* just alluded to, as seen in Plates I. II. and III. and Figs. 4 and 5, as *evidently fragments of fibrin.* They are, *in consequence of their high aggregative power, almost equally valuable with the coagulable portion of the Liquor Sanginius* (fibrin) *itself, in the healing of wounds, or adhesive inflammation. Left alone, they will unite and form fibrin.* Whilst the corpuscles seen in Figs. 3 and 7 possess *a very low degree of vitality, and have apparently no aggregative tendency whatsoever,* the latter being simply the result of disintegration and decomposition, and the former of an all but freezing temperature (page 23).

Similar corpuscles I have since discovered in "*adipocere*" (Paper IV.), as the result of the action of water upon a dead organism. *No doubt these are in a measure the kind of corpuscles* described by Sir J. Paget and Dr. Carpenter as an *aplastic, or cacoplastic* (depraved) *nature, which go to form the tuberculous and scrofulous Diathesis* (constitution). By preponderance in the blood, they will, of course, lay the foundation for the lowest state of health possible. Dr. Carpenter, evidently speaking of corpuscles of this kind, says:—"From an examination of the blood of tuberculous subjects, it appears that although the bulk of the coagulum, obtained by stirring or beating it, is usually greater than that of healthy blood, yet this coagulum is not composed of well elaborated fibrin; for it is *soft and loose, and contains an unusually large number of corpuscles;* whilst the red corpuscles form an abnormally small portion of it. Such are evidently the unhealthy corpuscles which abound in what these authors denominate the Tuberculous Diathesis. They are discovered also in exudations such as those of diphtheria, &c., are devoid of any plastic force, and more or less destitute of any tendency to organisation. (See Diphtheria.) *It is quite clear, moreover, that the presence of corpuscles in the blood evinces somewhat of low vitality, and incapability of aggregation, or of uniting together to form fibrin in solution. Whilst the presence of corpuscles in abundance in the blood indicates its low vitality;* and of coagulable lymph in predominance, the high and healthy vitality of the organism. *It is, indeed, the low vitality of the corpuscles which prevents their assumption of a fibrinous condition,* and also

evinces why they do not take any active share in the process of coagulation of drawn blood, but are found clustering together in the interspaces of the network of fibrin, and not uniformly diffused through the whole mass—the process of coagulation being due alone to the fibrin." The clot thus formed, Dr. Carpenter has shown, gradually acquires a degree of firmness proportioned to the amount of fibrin which it contains, to the higher degree of its vitalisation, and to the degree of its consequent elaboration; that the clot which is more solid and firm, is much longer in being formed than that of cachectic subjects, which coagulates very rapidly, but is feeble and imperfect.

The plastic effusions poured out from the blood in these two opposite conditions, he declares, partake of the character of the blood itself. Those of the inflammatory blood of a previously healthy subject being converted into fibrous membranes of considerable firmness, which are subsequently penetrated by blood-vessels and become regularly organised tissues; whilst those proceeding from the blood of cachectic (unhealthy) constitutions frequently undergo a certain degree of organisation with great rapidity, but do not go on to the same perfection (that is, do not form perfect, healthy, and permanently organised tissue) and speedily degenerate. (See Dr. Carpenter's "Physiology," pp. 234, 235, 236.) Of such rapidly formed growths, we may remark, are what is denominated "proud flesh," and many varieties of ephemeral and hastily formed new structures which disappear as rapidly as they were originally developed.

Simultaneously with the presence of corpuscles, we observed that *fibrillæ, or minute threads* of structure, were visible, such as connected together the minute corpuscles at *a a*, Plate I., and which presented a diameter more minute than any substance in the microscopic area. Such may also be observed in Plate III.

These minute threads might, by their small dimensions, appear to contradict the idea of the development of fibrin by the aggregation of corpuscles. (Paper III.)

Miller declared that "the hypothesis that all tissues of the animal body are in their perfect state composed of globules aggregated together in different forms, is now known to be incorrect. The ultimate muscular fibre in the frog, he says, is from five to eight times more minute than the red particles of its blood, and more minute even than the nuclei of those red particles. The diameter of the ultimate nervous fibre in mammalia, he declares, "according to my observation is twice or three times less than that of their blood corpuscles, and is greater than that of the nuclei of those corpuscles." This theory, he further remarks, is rendered exceedingly improbable by the discovery of Erinburgh, that monads which themselves do not

measure more than $\frac{1}{10000}$ of a line, have compound organs. We do not, however, see any contradiction to the conclusions arrived at in this paper by such considerations as these. Were it true that fibrous filaments in the animal body are found more minute than even any corpuscular bodies rendered visible by the microscope, such a discovery would by no means overturn the fact, that the globule molecules, or atoms of fibrin in solution in the serum of the blood, must evidently be more minute than the fibrils themselves, since none of these molecules have ever become apparent under the microscope until aggregated together, and until they had assumed the solid form. To place this matter in a stronger light, we may remark that Dr. Quain, in the introduction to his Plates on the Nervous System (evincing the possession of nerves, or some equivalent arrangement, and even of various acts of volition by the most minute creatures, and thus declaring how infinitely minute must be the ultimate atoms of matter), adduces the fact of groups of living animalculæ in a drop of water, under the microscope, making determinate efforts in eluding one another, in seizing their prey, &c. "We cannot hesitate to admit," he says, "that they are susceptible of external impressions—*i.e.*, are the subjects of sensation, and that they are capable of originating distinct acts of volition."

Dr. Grant, in his Lectures, speaks of the "poriferous animals, which, by their ciliated gemmules, are endowed with remarkable living properties and powers of spontaneous motion. They have," he declares, "an obvious object in their motions: they can accelerate, retard, or cease at pleasure the vibrations of their cilia: can change the direction of their course in the water, perceive each other's vicinity, revolve round each other, &c., &c.; yet their gemmules contain no visible (nerve) fibre."

From such sketches as these of minute animal life, let the reader contemplate the exceeding delicacy of the nerve fibres which execute such movements; and next, the incalculable minuteness of the molecules which serve for their construction; and lastly, the inconceivably small diameter of the atoms of which such molecules must be constituted. It might be contended, we think, without fear of successful contradiction, that the minute threads of fibrin observed in Plate III. were developed directly by the action of water upon the molecules independently of corpuscular aggregation. Molecules of albumen transformed into fibrin under the influence of water, forming in line, uniting together by the power of aggregation, and producing threads and filaments the most minute and delicate witnessed in nature, just in the same manner that we see effected by corpuscles themselves under the microscope. By a combination of such threads or fibrils we should have the development of beautifully striated

fibrinous substance. On the other hand, these fibrinous molecules might aggregate together and develop corpuscles, and by continuous aggregation or otherwise, produce corpuscular bodies of all varieties of magnitude, as witnessed in Plates I. II. and III.

ASSUMPTION OF A WHITE ASPECT BY THE CHYME AND THE DEVELOPMENT OF CORPUSCLES DURING DIGESTION.

The water present in the secretions which accomplish digestion, appears to possess an influence in that process, which has not been hitherto observed. The assumption of a white aspect by the food under the influence of water contained in the saliva, gastric juice, and mucous secretions, during digestion, as witnessed in the formation of chyme, is not, as supposed by physiologists, dependent so much upon the presence of fat globules, as that it *indicates the change of nitrogenous substances into white corpuscles.* I found that mixed food which had remained in the digestive organs of a dog for two hours, and then vomited, had already assumed a *pearly white appearance*, and, under the microscope, was seen to be *almost entirely transformed into globular or corpuscular bodies*, equal in magnitude to the white corpuscles of the blood.

I find also that *food ejected from the human stomach*, after two hours' digestion, has in each instance *assumed a white appearance* (even in persons who never eat fat), and under the microscope presented, in some instances, nothing but corpuscular bodies. Even more solid portions, when examined very particularly by manipulation, *proved to be altogether composed of corpuscles*, which evidently *gave the opaque white appearance* to the entire mass. Moreover, the food which lodges upon the palate plate of false teeth, is after a time always more or less *milky white* and *corpuscular* under the microscope, although entirely independent of the digestive process.

Since writing the above, I find that Müller witnessed *these corpuscles in the chyme.* He says, speaking of the changes which take place in digestion—"The solids are, with the exception of the insoluble parts, reduced to a substance called 'chyme,' which is in part fluid, *in part consists of globules.*" (Müller's Physiology, p. 577.) *I find also that these white bodies were the chief source of the white appearance of the chyle.* "The chyle does not appear," says he, "to be a mere solution of animal matter, containing no other globules than those of fatty matter" (which Tiedman and Gmelin declared to be the source of its milkiness). "On treating," says he, "the milky serum of chyle of the cat with ether freed from alcohol, it gradually became more transparent; *but there still remained a turbid matter at the bottom of the watch-*

glass, in which I could, by the use of the microscope, distinguish globules." In the milky chyle of the thoracic duct of a dog, five hours after eating food, there were numerous globules of oil, very unequal in size, and *quite transparent,* but the *greater part of the globules were of quite another kind,* namely, *whitish, not transparent,* and very small. . . . . *These minute globules are excessively numerous, and are evidently the cause of the white colour of the chyle.*" (P. 609.) Of the globules of chyle, he says in another place (p. 606), " I found the smaller number of the chyle globules larger than the particles of the blood; and once also, namely, in the cat, I found some of them equal in size to the blood particles, but here also the greater number were smaller."

Speaking of the " white " or milky colour of the chyle in this place, he declares the colour is owing to the presence of globules, the size of which I have stated above. (Müller's Physiology, 2nd edition by Dr. Baly, Vol. I. pp. 606, 607.)

It would, therefore, appear that the formation of chyme can be produced independently of the gastric juice, or various other acid secretions, simply by the exposure of food to the action of a living membrane, and in the presence of as much water as can be procured from the saliva, or even from ordinary mucous secretion. Such a mode of production affords a practical explication of the mode by which life is sometimes maintained by nutritious enemata when digestion is no longer available.

In order to show the large amount of water in the principal fluids engaged in the digestive process, we may state that the relative quantity of water contained in the *saliva* is, according to the analysis of Berzelius and others 992·9 parts of water to 7·1 parts of solid matter.

The *gastric juice* is declared by C. Schmidt to contain 994·40 parts of water to 5·60 of solid residue; whilst the *pancreatic juice* of the dog is represented as containing 980·45 water to 19·55, and by another analysis, from the pancreatic duct itself, 900·76 water to 99·24 solid residue. Bile is represented by Gorup-Besanez and Frerichs as containing from 828 to 908 parts of water in 1000; by Berzelius, 90·34 in 1000 parts. The secretion, denominated the " intestinal juice," elaborated by the glands of Brunner and the follicles of Lieber Kühn, &c., contain, according to the analyses of Bidder and Schmidt, only 3 to 3½ per cent. of solid matter.

Even opaque white fibrin itself must be sometimes produced in the stomach during digestion. As a proof of this, we may revert to the fact (Paper III. p. 22), that raw ov. albumen—entirely apart from any presence of oil or fat—cannot remain in contact with water many minutes without its surface assuming a milky

white appearance, indicating the development of that substance. Besides, it appears to have escaped the notice of physiologists, who declare that the white and milky appearance of the chyme and chyle is due to oil corpuscles; that the chief digestive secretion—the pancreatic juice, which changes fat and oil into a white emulsion, to which they must of course owe much of their opaque whiteness—does not mingle with the food until it has escaped from the main digestive organ, the stomach, and therefore cannot affect the first products of digestion.

Under the light of the experiments herein contained, may we not attribute much of the preparatory action of the saliva, the gastric, and pancreatic fluids, and the secretion of the glands of Brunner and Peyer, &c., especially upon albuminous substances and muscle, to the action of the water in them contained? (See Paper IV.) At all events, there is an action excited by this simple fluid upon nitrogenous, and other substances in general, which has not hitherto been recognised or taken into account.

CHAPTER II.

NUTRITION; OR, FIBRIN, THE FUNDAMENTAL AND BASIC STRUCTURE OF ALL ANIMAL BODIES.

NUTRITION.

THE constant necessity for nutrition by every organ and tissue of the body is evident in that they are continuously producing waste, and therefore need a constant supply in order to the maintenance of their existence. It is generally believed by physiologists that not a movement or action ensues in the animal economy which does not cause the death of substance and waste of tissue. The twinkling of an eyelid, the smile upon the lip, the enunciation of a syllable by the vocal organs, or, according to some, the mere flash of thought which occurs in the mind, produce death of substance; and new matter, identical in its nature with the substance of the organ employed, has to be afforded in order to supply the place of the waste or effete matter thus produced. When not called into action, moreover, organs still undergo a gradual disintegration and waste, whose demands require also to be met by the nutritive process. This doctrine, however, like many which have cost years of labour, thought, and investigation, is at the present time, without due and sufficient ground, being attempted to be set aside. But whether the contractile material of muscle be speedily or otherwise removed, and replaced, is foreign to our subject; the question in hand having only reference to the source of supply. (See Bioplasm, by Dr. Beale, p. 222.)

That the general nutrition of the body is dependent to a very great extent upon the presence of fibrin in the blood is evident from the fact that *the repairs of the frame, or renewal of tissue* of the entire organism, is effected, not by albuminous matter, which possesses no formative capability, but *by good, healthy plastic, coagulable lymph.*

Wounds, lesions, ulcers, and loss of substance are all filled up, repaired, and cicatrized; divided tendons and fractured bones are all glued together, and even the development of new bone, tendon, ligament, etc., is all accomplished by the effusion

of plastic lymph, or fibrinous substance. It is, moreover, most highly probable, if not absolutely certain, from microscopic discovery, *that the original basic structure and foundation of the frame, with all its component parts, was originally developed and laid down by the deposition of material of this kind.* If the production of all new portions of the body and the repairs of the frame are accomplished by the deposition of plastic, coagulable lymph, is it not quite natural and logical to infer that all its supplies, for nutrition and growth, are derived from the same elements? (See Paper III., read at Bristol, 1873.)

The share which fibrin and corpuscles, or coagulable material, take in the nutrition of the animal organism was aptly expressed by the late John Hunter, who declared (and it does not as yet appear to have met with any successful opposition)--"*That fluidity is only necessary for the motion of the blood to convey life; and the continuance of life is probably owing to its being coagulated, and becoming solid, or, at least, the support of the body is owing to this cause.*" (See Treatise on the Blood, p. 86.)

Although we would by no means infer that albumen is not extensively discovered as a component part of the animal frame, yet we believe that under such circumstances it is always in conjunction with fibrin. True it is that in the muscles of young animals albumen abounds, and that it enters almost unchanged into the constitution of the organs of vision, the eggs of birds, and the construction of nerve, and is found predominant in the various glands of the body. Yet albumen possesses of itself no formative character, but requires to be shaped and fashioned and held together by a network of fibrous bands, minute membranes, and threads of fibrous structure, now denominated "*connective tissue.*" In the eye and fowl's egg, for example, this arrangement is beautifully seen. Professor Valhart (chemistry), Munich, speaking of the bands which maintain the albumen of the egg in situ, denominates them as "a network of fine skins in which the egg is enclosed." (See remarks on Paper II.) A. Rollett has also shown that the epithelial structures, blood and lymph vessels, muscles and nerves, are all held together by a basement membrane, and a supporting layer of investment, denominated connective tissue.

We may further remark that albumen does not ever become solid, save by the removal of the water of its fluidity, or by the exaltation of its temperature to that of 146° Fah., whereas the animal body rarely rises in temperature more than from 98 to 105 degrees. A much higher temperature would of course parboil the tissues and produce destruction of vitality, and the organs and tissues naturally contain some 75 parts of water in 100 of their structures.

Another reason why albumen cannot be held to be an extensive source of nutrition is the fact that *it is unchanged by respiration*, the albumen of the serum in the veins being similar in its chemical constitution and character to that in the arteries. Neither is it found to be in any higher state of elaboration after being subjected to this process.

Now there is no doubt that the fibrils, bands, and membranes, just mentioned, were originally laid down by fibrin itself under the influence of the vital force. For although much of the fibrous tissue of the organism is no longer fibrinous, but has assumed a gelatinous nature, yet such was not originally the case. Protoplasm is not gelatine. No chemist or physiologist has ever witnessed gelatinous material in embryonic development. The source of this substance will be commented upon shortly.

Fibrin then, in the form of membranes and network of fibrillæ and general organic structure, we maintain, forms the original basis of all animal organs and tissues. It may with propriety be denominated the normal timbers laid down in the construction of the ship; corpuscles, cells, fibrin, albumen, etc., filling in the interior or forming as it were the boards and planks, etc., by which the vessel is completed. For the production of nutrition, it does not appear either absurd or strange therefore that albumen should become endowed with the capability of assuming the solid form, in order to the sustenance of the solid tissues, organs, and various structures of the body. That a considerable quantity of coagulable and corpuscular material is necessary and required by the organism for this purpose is evident from the fact that a very large amount of coagulable fluid is being continually manipulated and poured from the lacteals into the sanguineous system, in order to maintain the same at a standard condition, in which, according to Scherer, 117·5 parts of coagulable fluid, containing 1·95 fibrin, and 115·16 corpuscles, are constantly present in the blood. Bidder the physiologist estimated the amount of lymph and chyle daily passing into the circulation as two-thirds the weight, and others as about equal to the entire quantity, of the blood in the body. Bidder and Schmidt also declared that in man nearly 30 pounds of mingled lymph and chyle were daily poured into the subclavian vein. To this statement physiologists in general appear pretty well agreed. It manifests how vast is the importance of these fluids, not only as elements of the blood, but also as regards the positive nutrition of the tissues and organs of the body. The above may, however, be considered as a low estimate of the amount of coagulable fibrin in solution, which is being continually and daily developed in the sanguineous system. For we have already seen that the serum of the blood, pellucid as it is, pos-

sesses in solution elements which are incessantly at work, elaborating coagulable material. The continuous flow of lymph and chyle, rich in albumen, into the circulatory system is charged and constantly co-mingles with water, imbibed by the absorbents, and from the digestive organs, when this liquid is duly employed. Thus this fluid is being continuously poured into the lymphatics and lacteals, and into the sanguineous circulation, and forms a fruitful source for the constant elaboration of coagulable material, even in the arterial blood vessels, probably from their commencement to their termination. (See Paper II., p. 5.) This unceasing elaboration will give us therefore a far higher quantity of coagulable element for the nutrition of the body than can be estimated in the amount discovered in any selected portion, taken at any one period, from either the chyliferous or sanguineous fluids. We may also further remark that although this vast quantity of lymph and chyle is daily poured into the blood, it is as certainly employed in the necessities of the frame, as that it disappears from the vascular system. Such, indeed, is the evident importance of coagulable fibrin and corpuscles in the supply of a nutritive pabulum to the system, that a physiologist, whose name I forget at the present moment, asks the appropriate question, "If such an amount of fibrin as is constantly being poured into the circulation were not employed, would not the consideration of its presence in the blood be overwhelming?" The reason therefore of the small amount generally of fibrin detectable in the blood is, as we have seen, due, on the one hand, to the rapidity with which it is continuously being absorbed and employed in nutrition by the tissues; and, on the other hand, by its not being, as it were, manipulated and developed in the lacteals only, and previously to its entrance into the blood, but continuously produced and elaborated as the liquor sanguinis proceeds in its course along the arterial circulation. Yet, in order to show that, even under these circumstances, these solid substances are developed simply for the nutritious supply of the organs and tissues of the body, we observe that it is on all hands admitted that fibrin, small as is the estimate accorded to it, and its continuous exhaustion for the purposes of nutrition, is more abundant in arterial than in venous blood, its coagulum firmer, and its quality superior, as regards its tenacity and compact nature: in other words, that its abundance is greatest and its elaboration most perfect while in the arterial vessels and subject to drainage by every organ and tissue, in supplying the entire waste of the body, than when the demands of the latter are met, and the contents of the vessels consist only of overplus and effete matters, which the veins are carrying forward to their destination.

COMBINED FIBRIN AND ALBUMEN.

We believe it is rare that albumen is discovered in a pure, simple, and unalloyed condition in the construction of animals. But we are free to admit that, in addition to the filaments, bands, membranes, and network, etc., already alluded to, that form the basement and supporting structures of the tissues and organs, etc., there may be frequently present in so-called albuminous organs, or those which partake of an albuminous character, *a combined form of free albumen with fibrin*, which we have often witnessed in the experiments adduced in these papers. These combinations present many shades or varieties, which exhibit a preponderance of fibrin or albumen, one or the other, as the case may be. Such is the case with the fibrinized egg which has not remained sufficiently long in water. Such is the case also with the flesh of young animals, whose muscles are declared to be more albuminous than those of a more advanced age.

It is not our intention, in this place, to enter into a discussion upon the character and constitution of the many varieties of substance as well as of their nomenclature, to which the results of combination and re-combination, or chemical analysis, have given origin in the animal organism, and which would only lead us astray. They are the mere products of chemical art, and not elements of supply. The substances which have been denominated myosin, syntonin, chondrin, gelatine, keratin, leucin, tyrosin, kreatine, sarkosine, etc., etc., were not originally discovered in the protoplasm of embryonic life. It fully suffices to know that these thousand and one various products derived from the substance or blood of the animal and found in various parts of the system are generally admitted to be, as we have seen, the production of cell elaboration, or the products of foreign intervention, such as that of oxygen or other elements introdueed into the system.

Such is the common identity and nature of the substances, albumen, fibrin, etc., that chemical agents are found readily to cause any one of them to assume the nature and characteristics of another, or to produce new compounds entirely dissimilar from all. There can be, therefore, no certain, true, and correct analysis of existing substances by mere chemical tests and agency, but only by the ultimate reduction of their elements. The muscles of the animal body, when subjected to ultimate analysis, always give, as shown by Playfair and Boeckmann, not myosin or syntonin, but a formula which, in its ultimate elements, resembles in its chemical composition, blood, albumen, fibrin, casein, gluten, and the coagulable portion of

the liquor sanguinis: a fact which has never as yet been overturned.

We prefer, therefore, the rather to revert to the one simple and original fact herein adduced, that the nutrition of the body in general is confined to the three great sources of supply, viz., fibrin, corpuscles, and albumen, out of which all organs were originally constructed, and upon which they are dependent for supplies during life. In our paper, No. IV., it will be rendered evident that the entire organism, with all its apparently dissimilar structures and organs, etc., with the exception of fat, does, when life becomes extinct, resolve itself under the influence of water to the one entire corpuscular condition—proving that the entire constitution of all the parts, organs, and tissues of the body were originally of a fibrinous or corpuscular nature, and were simply modified during life by the agents, elements, and influences to which they were exposed.

We have already shown that fibrin and corpuscles are identical in their nature, albumen, being capable of transformation into either in proportion to the degree of vitality which it possesses. All true animal pabulum or nutritive material is, therefore, thus seen to be developed primarily and originally in the form of one or other of these substances. Professor Stricker remarks "that it is even conceivable that the colourless blood corpuscles are destined for the regeneration of all the tissues of the animal body." (Vol. I. p. 38.) In every step of histological development, as already adduced, we find that constructive fibrin (in the form of fibrous bands) forms the grand basis of the organism,—the wondrous network, interlacing texture, or organic framework, which, in the shape of "*connective tissue,*" binds together the structures of the body, preserves their form, and maintains the integrity of all parts of the organism,—whilst corpuscles, whether as globules or nuclei, or having assumed the condition of cells, form the chief building materials which, with other elements, complete the erection of this marvellous and wonderful fabric. In inflammatory diseases the amount of fibrin undergoes an extraordinary increase, which is not checked in the slightest appreciable degree by the most copious venesection. It is very remarkable and noteworthy that, after very considerable losses of blood, as shown by Dr. Carpenter, *a decided increase shows itself in the proportion of colourless corpuscles,* not only relatively as to the red, but absolutely.

PLASM, PROTOPLASM, ETC.

The word *Plasm* is derived from the Greek verb Πλασσω, to form. It is applied by most physiologists and modern lexico-

graphers *to the coagulating, plastic, formative portion of the blood, in which the corpuscles float, or the liquor sanguinis.* But, as we have already observed, albumen is not formative, and therefore is not entitled to this appellation.

To speak of albumen as *per se* effecting the construction of any organ is absurd: as readily might we erect a pyramid out of the sand. It is quite true that it does enter into the construction of the eye, brain, nerves, liver, kidneys, and other glandular organs; but there must be in each instance an accompanying network of fibrous structure interwoven with it, in order to retain it in situ in these organs, as already remarked, or its apparent solidity would be destroyed.

THE LIQUOR SANGUINIS—THE PLASM OF AUTHORS.

Professor Stricker *denominates the liquor sanguinis, or coagulable portion of the blood, as the "blood plasma, in which abundant corpuscles are distributed."* He speaks of *animal sarcode* also *as protoplasm,* and of the colourless or white corpuscles of the blood as true protoplasmic masses. The meaning of the word Protoplasm is restricted by the author to the substance which is present in the living fluid, the liquor sanguinis, which, in the words of John Hunter, is capable of becoming solid for the continuance of life, or, at least, for the support of the body. This is the material which has evidently received from physiologists the various appellations of animal sarcode, blastema, plasm, the matrix, or general element of tissues, pabulum, primary animal substance (Stricker), protoplasm, etc. (See Stricker's Histology, Vol. I., p. 574, and 414, 415.)

BIOPLASM.

Perhaps the most important definition of protoplasm given by physiologists is that it is a living substance. Dr. Beale, who has denominated it "Bioplasm," entirely confines the name Bioplasm to germ life. But the life of animal substances may be regarded as embracing four degrees or varieties of vitality.

1. *Germ life,* or the vital force, which appertains to the germ, or as found in the ovum, seeds, etc. This is denominated by Dr. Beale also as "forming matter." It possesses an independent power of vitality, denominated vital force. According to Liebig, it is a cause of resistance to external agencies which tend to destroy the substance in which it resides. It is also a force of growth in the mass, which appropriates to its own use and increase, etc., surrounding elements of food, and renders them identical with its own structure, nature, and composition. He represents it likewise as a force which is superior to the physical and chemical forces by which it is surrounded, and causes

them to succumb to its controlling power, and become willing servants in the accomplishment of its functions.

2. The vital condition which is usually denominated "*vegetative life.*" This is common to cells, nuclei, and living corpuscles, by which they are able to effect certain functions, spontaneous movement, nutrition, growth, and possess the capability of reproducing like substances; but independently of a living germ are unable to produce a living being.

3. That lower form of communicated vitality which appears to appertain to all the various organs, tissues, and substances whilst embraced within the sphere and under the influence of the vital force, and which dead matter in the shape of food also receives from the vitality of the body. In this classification we should embrace fibrin, white corpuscles, the serum of the blood when fresh drawn, flesh or albumen, etc. (Plates I. II. III., and Figs. 4 and 5.)

4. To this category may be added also a fourth, or that lowest form of life witnessed in Figs. 2 and 3, and in disintegration, Fig. 7, and, as also particularly commented upon, in Paper IV.

FIBRIN AND CORPUSCLES.

Dr. Carpenter, speaking of fibrin and corpuscles, declares them to be "*the two constituents of the blood that are most highly endowed with vital properties.*" (See "Principles of Human Physiology," p. 234.)

The observations of Mr. Newport seem to indicate *that the corpuscles of the blood of insects play an important part in the elaboration of nutrient material.* He discovered that the corpuscles which are denominated granule cells by Mr. Wharton Jones, in the larva, are most numerous at the period immediately preceding each change of the skin, at which time the blood is exceedingly coagulable, and evidently possesses the greatest formative power. On the other hand, the smallest number are met with soon after the change of skin, when the nutrient matter of the blood has been exhausted in the production of new epidermic (or skin) tissue. (See *Philosophical Magazine,* May, 1845.)

The vitality of fibrin and corpuscles is evident in their power of aggregation, and in the required presence of vitality in the albumen from which they are developed. Moreover, we have shown that such is the high state of communicated vitality resident in fibrin, that it possesses vast powers of construction, which enable it to assume great varieties of form, and grotesque figures, and even the appearance, in some instances, of strange insects. (See Paper II. p. 7.) In fact, it is impossible to

conceive that Nature would have taken such pains with these substances, as to develop them in so highly elaborate a condition, unless designed to be directly laid down under the control of the vital force in the construction or growth of the organism, independently of cell interference. Especially may we thus speak, when it is remembered that these two substances are employed and effused upon the surface of wounds, and intermediately between fractured bones, divided tendons, etc., in order to glue, as it were, these divided parts together; and that their substance does afterwards, probably in many instances, independently of any cell agency, assume the condition of living structure. With the statements of Dr. Beale, that *albumen* and *fibrin* are "lifeless substances, and are only the products of the death of a mass of bioplasm," I entirely disagree. (See Bioplasm, Dr. Beale, pp. 10 and 11.) Existing in the blood, they form a part of that fluid, of which it is said by the Great Constructor of all things, "*The blood is the life*" (Gen. ix. 4; Deut. xii. 23); and, again, "*For the life of the flesh is in the blood*" (Lev. xvii. 11, 14); and when drawn, we have shown that it is in proportion to the degree of vitality which remains, and which they possess, that we have when in contact with water the development of corpuscles, or well elaborated fibrin. (See Paper III. p. 4.) Nor, in the light of the facts adduced in these papers, can we accord our assent to the remarks of this author that "a dead thing cannot be revitalised," or, "that matter from which life has once departed cannot be made to live again." (Bioplasm, by Dr. Beale, p. 12.) The fact of dead aliment being revitalised by the processes of digestion, chylification, elaboration, and æration, we think entirely negatives such a proposition. But when we witness the development of living corpuscles by the immersion in water of dead animal substances, as will shortly be seen in Paper IV., it is quite evident that there is an economy exercised in nature in the revivification of dead animal matters of which we were not previously aware.

It is imperative, also, that we withhold assent to the statements of this author, that leaves, flowers, trees—every tissue, *skin, bone, nerve, muscle,* etc., are but the (lifeless) results of the death of bioplasm, or, in his own words, "*non-living matter.*" (Bioplasm, Dr. Beale, p. 10.) That every tissue, skin, bone, nerve, muscle is only dead substance, would give untruth and *unreality to the consciousness of our own existence.* Feeling, sensation, and motion are commonly received as the chief evidences of animal vitality; and there is no part of the healthy human body that can be penetrated by the point of the finest needle without conscious pain. Parts of the body which

are evidently carrying on what are admitted to be vital functions, such as inhalation, natural excretion, the throwing out of plasm for the healing of lesions, arresting the progress of sphacelus (mortification), or, resisting decomposition, cannot rationally be held to be in a state of death; else would sense be no longer available as a diagnostic; gangrene would be quite as much alive as living flesh, and the greater-part of the so-called living body only another word for a decomposing corpse—conclusions which, we think, few persons would be prepared to receive.

LIVING CORPUSCLES AND LIVING FIBRIN THE TRUE PROTOPLASM.

We have seen, then, that there is no living plasm in nature, but corpuscles and the coagulable material of the chyle, lymph, and blood. *The very nature and character of fibrin and living corpuscles is plasticity.* In order thereunto, it is discovered by the microscope to be always more or less organised or organisable. Cells are not plasm. No one hitherto has contended that they are such, or that they are even thrown out upon the surface of a wound in order to produce "adhesion by the first intention." They are, however, *plasm-elaborating*, and they have the power to transform ordinary plasm into the nature and character of the tissue to be renewed or nourished.

Moreover, in addition to what we have already advanced, there is an entire absence of any other substance than fibrin capable of affording plasm, or constructive nutrition to the body. *Had albumen been of itself adequate to supply the wants of the organism, it is quite clear that we should not have had the fact to record of the extraordinary machinery which is so elaborately constructed in connection with the alimentary system and development of chyle and lymph.* Neither should we have witnessed *the origin and presence of fibrin and corpuscles in the lymphatic and sanguineous systems.* But physiologists are agreed that even the chyle itself is not eligible for nutrition until it has undergone a *still further process of elaboration*, which Dr. Prout declared to be "a sort of second digestion all over the body," in order to prepare and perfect it for nutrition. This process Dr. Carpenter designates as "*a higher state of elaboration*," in which it undergoes "its *complete vitalisation*," by being "*submitted to the action of oxygen in the respiratory organs.*" (See Paper II. p. 6.)

NUTRITION OF THE MUSCULAR SYSTEM.

This system, as we have already seen, constitutes more than one-half the substance of the organism, and comprises all the voluntary and involuntary muscles of the animal species. Upon

the former depend all the principal physical operations of life, such as the appropriation of food, mechanical toil and labour, locomotion, etc. The involuntary muscular system performs all those vital functions and actions which are independent of the will and caprice of man, the action of the heart and great vessels, the mechanical movements of the pharynx (gullet), digestive, and intestinal organs, and the important functions of respiration, etc. Formerly, muscle was held to be entirely constituted of fibrinous material; but it is in modern times the rule to deny facts and doctrines which have been uttered by such men as Hunter, Liebig, Bichat, Müller, and the physiologists of the past. The view, however, that muscle is formed of fibrin and nutrified by the coagulable elements of the blood was maintained by one of our most eminent modern chemists, the late Dr. Miller. He declared that "fibrin in the form of muscular tissue constitutes a large portion of the soft parts of animals. *It occurs* (he remarked) *in muscle arranged in bundles of fibres, and from this circumstance the name fibrin derived its origin.*" (See Dr. Miller's Organic Chemistry, Vol. III. p. 806.)

THE CHEMICAL COMPOSITION OF FLESH AND BLOOD IDENTICAL IN ANALYSIS.

The analyses of our modern chemists, Playfair and Boeckman, give for flesh and for blood, as the most exact expression of their numerical results, one and the same formula, namely, C 48, N 6, H 39, O 15. Mulder also discovered that *animal albumen, fibrin,* and *caseine,* or the chief constituents of the blood, when separated from the organic substances which they contain, by an exact and careful analysis, yield, when incinerated, a product the relative proportion of whose elements of *carbon, nitrogen,* and *oxygen* is invariably identical. This product he denominated protein. The renowned chemist Liebig declared that "the fibrin of the blood is identical in all its properties with muscular fibre, when the latter is purified from all foreign matters." (Liebig's Organic Chemistry, p. 40.) "*Both albumen and fibrin in the process of nutrition* (he declared) *are capable of being converted into muscular fibre, and muscular fibre is capable of being reconverted into blood, without the aid of a third substance, and without the addition of any foreign element, or the separation of any element previously present in these substances.*" (Liebig's Organic Chemistry, p. 42.) Against such statements as these in modern times we have no well authenticated or well proven counter analysis. Bowman declared muscle to be composed of *sarcous* elements. At a meeting of the Royal Society, held April, 1875, Mr. Schäfer, the Sharpey physiological scholar in University College, in describing living

muscle under very high powers, declared that each fibre was seen to have the following structure, viz., to consist of a homogeneous nongranular basic substance of *protoplasm*, etc., etc. "If we assume," remarks Lehman, "the formation of tissue to be the highest stage of animal metamorphoses, *fibrin* pertains to the ascending or progressive series, inasmuch as it *yields* the *proximate stratum* for the *development of cells* and the *formation of tissues.*" "The fibrin in the muscles," he declares, "is by no means perfectly identical with spontaneously coagulated fibrin: it is one of the many species embraced under the genuine name of fibrin." (Vol. I. p. 359.)

We have also shown *that fibrin when first formed in the lymphatics greatly resembles fibrin when formed artificially by water, and that both differ from blood fibrin in their inferior tendency to putrefaction.* We may not wonder then that fibrin in muscle should differ even from that which is discovered in the blood of animals as well as in the lacteals. (See Paper II. p. 6.)

Dobie maintained that the fibrils themselves consisted of two different substances, of bright and dark bodies, which he denominated "the chief substance" and the "intermediate substance." "Looking at the fibrils alone," he says, "the chief substance corresponded to a *sarcous* element or a *sarcous* particle." "Sometimes the whole intermediate substance," observes Professor Stricker, "*appears in the form of a finely granular zone of protoplasm.*"

GENETIC DEVELOPMENT OF MUSCLE.

"It is on all hands admitted that the entire structure of the cell and its nucleus, from which muscle is developed (Stricker declares), are derived from protoplasm" (coagulable fibrin). Now this renowned physiologist says that "muscular fibre proceeds from a *cell*, which elongates and becomes fusiform (spindle shaped), and at the same time increases in thickness. The nucleus then increases, and on its surface appears a mantle of *longitudinal striæ*, etc. As soon as this mantle is formed fibres may also be met with in which the transverse striæ are apparent." "It is important to notice that the first traces of muscular substance in the fibre cells constantly appear to be *fibrillar.*" "*The muscular and connective tissues,*" *he says,* "*are to be referred genetically (in their development) to one and the same origin.*" (Stricker's Histology, Vol. III. p. 545, 549, 552, 553.)

Dr. Beale similarly describes the origin of muscle. "Many muscular fibres," he says, "exist at an early period as spindle-shaped bodies, which taper at either extremity into the tendon. *The large mass of bioplasm* (protoplasm of other authors) *is in the centre*, and is surrounded by formed material, which gradually

accumulates upon its surface and at its two extremities. Thus the fibre increases in thickness and in length. The position of the *masses of bioplasm* varies very much in different kinds of striped muscle." As regards the pabulum or protoplasm that feeds the germ or ovum, and the nucleus of cells, he admits that in the higher animals and man the nutritious fluid is conveyed through tubes or vessels, through which solutions pass very quickly. A solution of substances adapted for the nutrition of the tissues is continually flowing, he declares, through the wall of the vessels towards the bioplasm of the several tissues. (See Bioplasm, p. 30.)

Dr. Beale says that muscle is formed from bioplasm or protein, and elsewhere (p. 212) he speaks of fibrin as identical with protein matter—" fibrin or protein." He says (p. 212) that a little fluid is expressed from the substance of muscle during contraction, and taken up again during rest. This contractile fibre, perhaps, consists of a passive basic substance of a fibrous character, through which is diffused a soft material, prone to move in directions at right angles to one another. This substance can be expressed from the muscular tissue, and coagulates spontaneously like the fibrin of the blood. Young muscles yield a larger proportion of this material than old ones. As regards vitality, the signs by which it is known are not discovered in the points of living matter spoken of by Dr. Beale, but always in what he denominates dead matter. It is in the skin, the muscular system, the flashing eye, the moving limb, the sensitiveness of some one or other of these so-called "*dead organs*," in which we first perceive, say in a supposed drowned person, indications of the return of life.

Whatever route physiologists may pursue, we always discover them, as regards the subject before us, ultimately arriving at the same common termination. Dr. Beale denominates the muscle corpuscle-bioplasm, or living matter. Each living particle, he declares, was derived from pre-existent living matter. In the very substance of the living matter itself, he says, one or more spots make their appearance as new centres of living matter. *Absorbing nutrient material* they grow. New points of forming material may arise within these last. By these, he declares, apparently similar masses of bioplasm, different tissues, organs, and membranes are formed. (See Bioplasm, by Dr. Beale, pages 8, 7, 21, 13, 22, 23.) Now, bioplasm, like all other constructive material, receives its nutritive pabulum from the digestive canal. The food is formed into chyle, and ultimately into blood, in which is contained red and white corpuscles, albumen, and coagulable chyle, and lymph in solution, the latter being, as we have elsewhere shown, the only

true protoplasm discovered in the circulatory fluid. "All organs," this author declares, "whether skin, bones, or muscles, as well as all other organs, come from bioplasm." (See p. 15.) Dr. Beale, however, contends that all *forming matter* is also *living matter*, but that all *formed material*, such as albumen, fibrin, bone, muscle, etc., is *all dead matter*. We do not see how he can reconcile this statement with one which is commonly and universally acknowledged, that "the blood (which is constituted chiefly of albumen and fibrin, etc.) *is the life* thereof, if the substances which it forms and nutrifies are only *dead* substances, or why the formed and, as he says, dead tissues do not enter into decomposition.

ORIGIN OF THE HEART AND BLOOD-VESSELS FROM PROTOPLASM.

"Originally all vessels, whether they subsequently form the heart, arteries, or veins, are," observes Professor Stricker, "constructed similarly to the capillaries. They have only a single nucleated wall, and this wall in the embryonic condition is composed of embryonic cell-substance or protoplasm." The first traces of muscular substance in the fibre cells appear to be fibrillar."

DEVELOPMENT OF BLOOD-VESSELS.

"The development of the blood-vessels in the embryo is produced," he observes, "by nervous cells, or vesicles, placed in juxtaposition, and in continuous line. Remak says," he declares, "that cells coalesce to form cords and plexuses in such manner that the peripheral elements of each cord coalesce to form a vascular wall, while the central ones (or nuclei) become blood corpuscles." According to Klein, blood corpuscles are developed endogenously in the cells, owing to buds protruding from the internal wall of the vesicle, and the central part of a large cell sometimes undergoes conversion into blood corpuscles. "The walls of such vessels," according to Klein, "give off projections, at first solid, but subsequently become hollow." The free extremity of a bud of this kind may again grow out to form a vesicle of one form or the other, so that two cysts communicate with one another, or the buds of different vesicles may inter-communicate, or a bud may open into a vesicle, or the vesicles may open directly into each other, and thus a communicating vascular system originates. No other mode of the new formation of vessels has been observed. (See Stricker's Histology, Vol. III. p. 540, 541, 542.)

The muscular system forms, as proved by the author of this essay, more than one half by weight of the entire substance of the human body, and therefore naturally requires its full share of

nutritious supply. We have also seen that the lymphatic and chyliferous vessels, according to the statements of Bidder and Schmidt, pour into the blood-vessels through the subclavian vein of man daily nearly 36 pounds of mingled lymph and chyle (fibrin in solution), or an amount equal to the entire quantity of the blood in the body. Now, this fluid embraces the almost entire products of digestion as regards its nutritive elements, and of it may be averred, that no other aliment in the body has undergone any process so perfect and extensive, or in any degree to be compared with the elaboration of the chyle. Moreover, the muscles are largely supplied with blood, and the flow of blood into their structures increases in proportion to their powerful or continuous employment. Indeed, it is not too much to say that the muscular system requires a larger amount of blood or nutrient supply for the performance of its functions than do any other organs in the animal body. *It would be, therefore, surpassing strange if the muscular system (which is in substance more than half the weight of the organism, is extremely vascular, and has, in consequence of its unceasing and laborious action, more need generally of nutrition than any other organ or part of the animal system) should not require its share of the most elaborate and nutritious portion of the blood.* It is clear, therefore, that, in its due order of sustentation, the muscular system must partake of not less than one half the amount of lymph and chyle which is daily poured into the subclavian vein. Further, as muscle is the most active, and, when slaughtered for the sustenance of other animals, intrinsically the most nutritious portion of the animal, and since it possesses a chemical constitution exactly identical with the blood from which it receives its supplies, whatever may be the modifications it may undergo, *it cannot essentially differ from the nature of the source whence it is derived and sustained.* The words of holy writ are exceedingly strong as regards the supply of muscle by the elements of blood:—"The life of the flesh is in the blood" (Leviticus xvii. 11).

As regards Dr. Beale's statement that muscle is not a rapidly changing tissue, or that muscular tissue is not formed very quickly, or its elements removed and replaced within a short period of time, if it were true, it is of no essential importance to the matter in hand. Such a statement is, however, we think, met with the old established anatomical fact which cannot be refuted, viz., that all organs which manifest great, constant, or laborious action, and would seem, on this account, to require a large amount of nutrition, are always discovered to be supplied with numerous and capacious blood-vessels: in other words, that the extent of the vascularity of an organ may generally be

received as an evidence or indication of its amount of labour or activity; that when in active operation, such organs receive always a profuse determination of blood. *Now, muscle is abundantly supplied with blood-vessels.* When it ceases to be active, the current greatly diminishes, and the vessels decrease in calibre. But during severe, constant, or laborious activity, its blood-vessels considerably increase in diameter, and the flow of blood in them is also greatly augmented. These facts reasonably manifest that the functions of muscle produce a large amount of waste, and, therefore, require an abundant nutritive supply for their performance. But if muscle, which constitutes the greater part of the human organism, needs little nutritive supply, the consideration of 30 pounds of coagulable lymph and chyle daily poured into the blood, is a consideration at once crushing and overwhelming. It would be, indeed, marvellous that the organism should present such wonderful machinery, and put forth such efforts, for the purpose of elaborating and perfecting this coagulable fluid, if, as some physiologists of our day, by denying the muscular system its due and proportionate quantity, would teach us, that this fluid is only designed for the sustenance and nutrition of bones, tendons, skin, and general connective tissue, etc., which are of a *gelatinous* character and composition,—or for that of the brain, nerves, and glandular organs, such as the liver, kidneys, etc., whose essential nature is *albuminous.* Be it also ever remembered that none of these *classes of organs can receive their supplies direct and without modification from the coagulable elements of the blood.* It must also be borne in mind that the above organs are all comparatively *stationary and at rest,* and, therefore, as indicated in the size and numbers of their arterial vessels, with the exception of the skin, brain, and some other viscera, do not in consequence require much nutritive supply.

On the other hand, how absurd and unreasonable is the teaching that would inculcate that the greater half of the body —the active and highly vascular-muscular system, which performs all the laborious functions of locomotion, circulation, manual labour, and indeed all the mechanical movements of the body—has neither part, lot, nor share in the supplies which emanate from the grand emporium and fountain of coagulable supply.

As regards the rapidity of formation of muscle, it is pretty certain that the connective tissue, which forms the sarcolemma, binds together the fibrils, and gives form, etc., to the organ, is not subject to any rapid change. But the fact of the contractile tissue being developed by muscle corpuscles or cells does not at all militate against rapidity of removal or replacement, if we

may expect equal celerity in this process, which is so abundantly manifest in the production of excretion by similar agents in such organs as the kidneys, skin, etc. If the statements of the chemist are to be received as truths, the rapidity of change in the muscular system is manifested, according to Liebig, in the amount of urea secreted in the urine, the latter being the representation of the amount of metamorphosis undergone by exercise of these organs. (See Liebig's Organic Chemistry, pp. 59-61, etc.)

In the fowl's egg we have all the elements of vitality and nutrition. The germ, with its germinal vesicle separating into its three layers, called the blastoderm; the upper layer is known to form the organs of locomotion (muscle) and sensation (nerve); the middle layer is destined to form the blood-vessels and connective tissues; and the third layer, the organs of respiration and digestion. Yet all these are found to be genetically produced by what are called *embryonal cells*—those in the upper lamina being of smaller dimensions, and the lower of somewhat larger and more coarsely granular cells. We have also the yelk or vitellus, which is destined for the food of the germ during its earliest period of development; and the white yelk, both of which are composed chiefly of *albumen.* Thus out of albumen by the process of genesis is produced muscle, nerve, blood-vessel, and connective tissue, etc., as well as the organs of respiration, digestion, secretion, etc. After the same manner casseine in milk is known to supply the growing frame of young animals with bone, muscle, nerve, blood-vessel, skin, glandular substance, and indeed every component of the living organism.

But finally we would enquire, What other acknowledged source of nutrition and supply to the muscular system is there than that which is afforded by the chyliferous and lymphatic system? There is no other plastic substance than that which is poured out by these vessels into the blood, no other real proteineous product as the result of digestion, and no other material so entirely resembling muscle in its chemical nature and constitution as the corpuscular and coagulable portion of the lymph, chyle, and blood. These are as it were the very essence, the very intrinsic ingredients, of the food, rich in nitrogen, upon which, as regards the chyle, the whole powers of the digestive process have been expended, and for the reception and transmission of which the entire system of absorbents has been so specially and wonderfully provided. Objectors to the nutrition of muscle by these elements are bound to find a substitute and to set forth other ources of supply for these organs, which we hereby challenge hem to produce.

It is quite clear, therefore, from the evidence of all physiologists, that the coagulable fluids of the blood are the Protoplasm of authors. That it is from this protoplasm that every organ, whether it be muscle, tendon, connective tissue, cartilage, or bone, etc., drinks in its nutritious supply. Only let this fact be admitted, and then it matters not what may be the modified nature of the organ thus nutrified, it cannot differ essentially from the source whence its nourishment is derived.

CHAPTER III.

PHYSIOLOGICAL DISQUISITION.

FIBRIN, THE COAGULABLE MATERIAL FROM WHICH EVERY STRUCTURE OF THE ANIMAL ORGANISM IS DERIVED AND MAINTAINED.

Origin of Cells, Nuclei, etc.

It is commonly held by physiologists that all the active functions of the animal body are performed by the agency of cells. The cell consists usually of a definite cell wall enclosing a nucleus. The cell presents many of the phenomena of life. These phenomena are active or spontaneous movement, nutrition and growth, development of tissue, and the capability of reproduction. It is the cell nucleus which effects these vital actions. The cell is dependent for its existence upon a nutritive fluid, *or protoplasm,* to which we have just adverted, for the materials of its development, by which this little organism nourishes itself, increases in size, and begets its like. The nucleus attracts to itself, assimilates, and organises the particles of nutrient fluid in its vicinity, converts some of them into a cell wall, whilst it draws others into the cavity of the cell, and transforms them into material identical with its own nature. Schwann declared that animal cells are completely analogous to vegetable cells (1839), and are quite as independent in their mode of growth. Dujardin discovered in the year 1835 a contractile substance, capable of movement in the lower animals, to which he applied the name of "sarcode," which is identical with the *cell nucleus.* It is in the substance now generally called protoplasm, from which cells receive their origin. It serves as the pabulum for their nutrition and growth. *It does not appear that germinal matter differs at all in chemical composition from the pabulum or protoplasm upon which it subsists,* or, in other words, bioplasm from protoplasm. Therefore our position with regard to these questions remains unaltered. The several functions of selection, absorption, assimilation, respiration, secretion, etc., are performed by the agency of cells. In the multiplication of nucleated cells by division the nucleus as a rule divides, and the division of the nucleus is usually followed by the division of the cell;

otherwise the nuclei may increase in number, and the cells become considerably enlarged. (For a further account of these interesting and independently living structures see Professor Stricker's Human and Comparative Histology, Vol. I. p. 1.)

Having already adverted to the nature of plasm (fibrin and corpuscle), from which all structures are derived, we now proceed to consider the origin of the cell membrane or walls. Leydig maintained that the cell membrane is in his view only the hardened external layer of the cell substance. Max Schultze defined the cell to be a little clump of matter (protoplasm) with a nucleus evincing that the cell membrane is of the same nature and identical with the protoplasm out of which it is developed. Further on in this essay we shall show from experiment the origin of cells, the cell wall, and the mode in which it appears to be developed.

THE CELL NUCLEUS FORMED OF PROTOPLASM AND LYMPH CORPUSCLES.

Max Schultze was the first to show that sarcode (protoplasm) is analogous to the body (nucleus) or contents of animal cells (Müller's Archives, 1861, p. 17, and Stricker, Vol. I. p. 3). That *the nucleus is the most important portion of the cell* is shown by Prof. Stricker inasmuch as he declares that when a nucleated cell divides, the division first proceeds from the nucleus, which elongates, becomes hourglass shaped, and ultimately constricted into two segments. And although he cites instances of non-nucleated cells undergoing division (p. 31), and other cases cited as objections, yet these are evidently rare instances, and may be set down as the exceptions and not the rule. He admits that when the nucleus is present, it fulfils some important end in the act of propagation; *that it presents almost all the known characters of protoplasm*; for he declares that many nuclei appear to be homogeneous, *and are distinguishable from the surrounding protoplasm only by a single well-defined contour;* that in many instances the presence of an investing membrane is doubtful, etc. He speaks also of the entire mass of protoplasm contained within a membrane dividing into two or more segments, which he regards as cell genesis by fission (development by division). Schwann declared that the *extra cellular formation of cells,* or as developed in free blastema (protoplasm), was the most frequent mode of their production in animals. Stricker *gives several instances in which cells were at first destitute of a cell wall, but afterwards were invested by one at a subsequent period* (Vol. I. p. 34). Lastly, observes Professor Stricker, since the migratory power of the white corpuscles has been ascertained, some doubts

may arise whether any other cells besides these are capable of undergoing multiplication.

LYMPH AND BLOOD CORPUSCLES.

The lymph corpuscles, this physiologist declares, are now universally admitted to be *identical* in all their characters *with the colourless corpuscles of the blood.* He declares further (p. 421), "We know as a fact that they migrate from the interior of the vessels into the tissues, and that they participate in effecting certain *plastic* changes in these tissues." "It is even conceivable," he declares, "that *the colourless blood corpuscles are destined for the regeneration of all the tissues of the animal body*" (Stricker's Comparative Histology, Vol. I. pp. 37, 38, 341).

NUCLEI—FRAGMENTS OF FIBRIN.

In corroboration of the experiments herein contained, and the existence of uncellular living fragments of fibrin (seen in Plates I. II. III.), we may adduce the statements of Max Schultze and Prof. Stricker. The former speaks of the embryonal cells as *little masses of protoplasm* and a nucleus, which are products of the division of similar constituents of another cell. The protoplasm, he says, is no farther isolated from external objects (evidently by a membrane) than by the circumstance that it will not combine with the surrounding medium, and that *it constitutes with the nucleus a single whole* (Loc. cit. p. 8). Professor Stricker speaks of morphological elements of the higher animals in whose structure we are unable to discover anything more than that they are *little masses of animal sarcode or protoplasm.* "I have shown," he says, "*that little masses of protoplasm destitute of nuclei,* and which might be presumed to be the remains of cells, may still present some of the phenomena of life. I also now know that in other places where many young cells are collected together, *fragments* or *minute separated particles* occur about the size of a nucleolus, which (showing their vitality), if they become attached to the slide, sometimes exhibit very lively movements, etc."

Professor Stricker goes on to say, "May we not consider these little masses as cells? In the present state of our knowledge, we shall certainly reply in the negative. We shall continue to regard such minute masses as living or organised matter without reference to their size, so long as the optical means of research at our disposal do not permit us to make the observations necessary for a different statement" (Stricker's Histology, Vol. I. p. 9). Max Schultze declared that the fibrillar substance of connective tissue originates from embryonal cells composed of *protoplasm*

and destitute of any investing membrane, and that they amalgamate with one another; that a thin layer only of *protoplasm* remains lying around the nucleus of the primary cell, representing with this nucleus a connective tissue cell destitute of cell wall (connective tissue corpuscles). (Loc. cit. p. 13.) He also admits as constant constituents of human blood irregularly formed masses of colourless globules, which he regards as *fragments* of cell substance. (See Plates I. II. III., and Fig. 4.)

DEVELOPMENT OF CARTILAGE, BONE, TENDON, LIGAMENT, MUSCLE, AND SKIN, ETC., FROM PROTOPLASM, LIQUOR SANGUINIS, OR COAGULABLE FIBRIN.

Modern science classifies all these substances under the general term of "connective tissue." Connective tissue in modern histology includes, according to one of our best authorities, A. Rollet (Professor of Physiology in Graz), cartilage, fibro, cellular, and hyaline, bone, the tissue of the cornea, dentine, fibrillar connective tissue, ligaments, tendons, and elastic fibre. Hence all gelatine containing substances, such as skin and serous membrane and nerve tissue, etc., etc., are embraced in this category. Thus, in consequence of their functional agreement and continuity of substance, a series of microscopically different structures are combined under one common term. All these tissues are remarkable for their fibrous character, and are usually striated with parallel lines which may be broken up into fibrils of the most extreme delicacy: even primitive fibrils of nerve are enveloped in a sheath or two of this material. Connective tissue is now believed to be developed, like most other tissues of the animal organism, by the elaboration of cells from one common matrix, viz., protoplasm. A. Rollet has shown that the epithelial structures, blood and lymph vessels, muscles and nerves, are all held together by a basement membrane, and a supporting layer of investment, which includes in the vertabrata the connecting tissue of cartilage, bone, the tissue of the cornea, dentine, and the general connective tissue.

ORIGIN AND DEVELOPMENT OF CONNECTIVE TISSUE, FIBRILLÆ, ETC.

These connective tissues are developed in the embryo by the agency of cells from the middle germinal layer, in which blood and muscle also originate, and form a beautiful example of the fibrous bands, membranes, threads, and fibrous structures, which maintain the form, size, etc., and general construction of the various organs and tissues of the body. According to Stricker,

the cells contained in the embryonic mass destined to form connective tissue, increase to fusiform cells of considerable length, separate from one another; and at first a small, but subsequently gradually increasing, number of fibrils *appear between them.* (See Stricker's Histology, Vol. I. p. 91.) Max Schultze stated his opinion that the fibrillar substance of connective tissue originates from embryonal cells, composed of *protoplasm,* and destitute of any investing membrane, which have amalgamated with one another; a thin layer only of protoplasm remains lying around the nucleus of the primary cell, representing with this nucleus a connective tissue cell, destitute of cell wall (connective tissue corpuscles). (Loc. cit. p. 13).

ORIGIN OF THE FIBRILLÆ.

Stricker speaks of a blastema containing nuclei or coalesced masses of protoplasm, from the cleavage of which the fibrils originate. "It can only be said with certainty," he remarks, "that the *fibrils originate at the expense of a large continuous mass,* by a kind of transmutation." This mass he describes as a transparent *interruptedly striated substance,* in which the fibrils become apparent at a later period. (Stricker's Histology, Vol. I. pp. 50, 54, 91.) These characteristics of the mass whence the fibrillæ are developed familiarly evince its analogy with striated fibrin. This physiologist appears, however, entirely to agree with the original development of the fibrillæ of the connective tissue, the peritoneum, tendons, ligaments, etc., from the *deposition of striated fibrin.* "For," he says, "in regard to the genesis of the elastic fibres, very various views have been at different times expressed. Their origin from nuclei which Henle long ago believed he had perceived, has been by Henle himself reckoned doubtful. It has also been proved that they do not develop from cells in the mode described by Donders. The opinion is now generally held *that there is an actual deposit in the form of fibres*" (Stricker's Comparative Histology, Vol. I. pp. 86, 92). The facts adduced in these papers would lead us also to a similar conclusion: well elaborated and beautifully striated fibrils being *produced by the agency of water upon living albuminous matter in the course of a few minutes.* It may be objected to the above, that much of the structure of the animal organism is *gelatinous,* and differs considerably in its chemical constitution from protein or plasm, being neither of an albuminous nor fibrinous character. To such an objection we reply, *that gelatin is not discovered as gelatin in any of the primary forms of matter from which the embryo is developed previously to the intervention of cells.*

DEVELOPMENT OF GELATIN, CHONDRIN, ETC.

As regards the transformation of protoplasm—that is to say, coagulable lymph or liquor sanguinis—into gelatinous matter and chondrin, etc.; the development of all such tissue is pretty well admitted to be elaborated by the agency of cells from one common matrix or plasma. When we bear in mind the mode by which tendon is renewed after its division, as in the case of a divided tendo-Achilles, or the usual operations for club foot (which the author has frequently performed), we receive a complete and satisfactory solution of the source of renewal, as well as of the repair of tendon. The experiments of Von Ammon Günther and Bonvier have demonstrated, we are told, on horses and dogs, that reunion of tendons takes place in whatever manner the division be effected, and whether the ends be maintained in apposition or at a distance, or even when portions are removed. (Treatise on Club Foot, by W. J. Little, M.D.) That is, if the divided ends remain in apposition, they are glued together by an effusion of coagulable lymph; or whether they be drawn asunder and separated from each other in the sheath, or a portion be absolutely removed altogether, yet the same liquor sanguinis, or *coagulable lymph*, which glues the former together, fills the space between the two ends of the divided tendon; gelatin-producing cells are formed, this protoplasmic mass rapidly assumes an organised condition, and becomes transformed into new and living tendon, and thus elongation of a shortened tendon, by newly elaborated structure, is beautifully and wonderfully accomplished.

DEVELOPMENT AND NUTRITION OF BONE.

Embryological investigation, says Professor Stricker, shows that almost the entire skeleton of vertebrate animals is developed from a *cartilaginous* skeleton which is laid down at an early period. Sharpey and Kölliker demonstrated that several of the cranial bones originated directly from the *connective tissue*, and Virchow pointed out osseous tissue as developed from the periosteal connective tissue in all bones when once formed. Bone, like all other animal tissue, is therefore generally developed, as admitted on all hands, from connective tissue. It is originally deposited, in the language of Professor Stricker, by cartilage cells as cartilaginous structures, and afterwards gradually undergoes ossification by a deposition of salts of lime from the blood-vessels. We may therefore conclude, that the *same protoplasm* which serves for the development of connective tissue, serves also for the development of bone.

Several instances of necrosis have occurred in our hospital here for the relief or cure of disease by external appliances, in which new bone has been developed shortly after the dead portion has been ejected by exfoliation. In one instance, the entire clavicle was removed, and a completely new bone was developed from the effused coagulable lymph, or liquor sanguinis, which filled up the cavity on the exfoliation of the necrosed bone. The lymph, by the agency of cells migrating into, or developed in, its structure in conjunction with deposited salts of lime, etc., developed the new bone, and these, of course, would be equally available for its nutrition and sustentation during the continuance of life.

In order to show that the muscular system is fibrinous and, together with other parts of the animal body, dependent upon fibrin and corpuscles (which have been already shown to be identical in their nature) *for its nutritious supplies,* the following experiments were instituted, and the paper read before the physiological section of the British Association at Bristol in September, 1875.

PAPER IV.

PROTOPLASM AND ADIPOCERE; OR THE ORIGIN AND ULTIMATE TERMINATION OF ALL ANIMAL STRUCTURE.

(Read before the Anatomical and Physiological Section of the British Association, held at Bristol in 1875.)

During a long series of experiments the author has invariably found that semi-fluid and other amorphous animal matters, simply by contact with water, cease to be any longer albuminous, but spontaneously coagulate, or are transformed into corpuscular bodies, and thus assume the condition of solid and constructive substances.*

Originating in this manner, and at the same time being endowed with a kind of low or vegetative life, they become the basis, as it were, of all living animal structures, and can alone be rightly denominated "*Protoplasm.*" Even cells and other formations, which are only secondary products, have no claim to this title, much less more perfectly elaborated substances, tissues, and organs.

* That Fibrin and Corpuscles possess the same nature, and are convertible the one into the other, was shown by the Author in a paper read at the British Association, held at Bradford in 1873.

DEVELOPMENT OF FIBRIN FROM DEAD ANIMAL SUBSTANCE.

We have seen in our former papers that living albumen is speedily changed by the action of water into living fibrin. But a question seemed to arise in this stage of the enquiry—whether living fibrin or corpuscles could be produced by the same agency from dead animal substance? In order, therefore, to institute an enquiry into this subject the following experiments were devised, and resulted in more than anticipated success.

In instituting this enquiry, *dead animal matters*, such as portions of cooked and uncooked flesh (beef or mutton), were divested of fat, carefully weighed, and suspended in pure water. In a short time they were found to have assumed upon their surface a white and milky appearance. This being removed, was again and again replaced by successive layers of a similar kind, *until the entire substance was, in some four weeks, found to be transformed into a white and apparently fatty or waxy material.* The above, it will be observed, is *a graphic description of the changes that ensue during digestion*, independently of the supposed indispensable accessories of that process. (See pp. 32, 33.)

The substance formed is, the author avers, *a true specimen of adipocere*, a substance which he has frequently witnessed, and which is found in our wet and swampy graveyards, as well as after the protracted immersion of a drowned body. "The human body," remarks an author, "which has been for weeks in water, assumes the appearance of fat or wax." The suspended flesh had also eliminated a large quantity of an oily looking fluid, which floated upon the surface of the water, almost equal to its own bulk, and yet it had not lost, but actually gained, some grains in weight.

When these two only remaining products of the experiment were placed nnder the microscope, *they were discovered to consist entirely of corpuscular bodies*, perfectly uniform in size, and resembling the white corpuscles of the lacteals, thoracic duct, blood, etc.

These oft-repeated experiments, as well as the production of Adipocere naturally as adduced, the author maintains, clearly manifest that the animal body, with all its complex organs,

and seemingly dissimilar structures, was originally constructed, and is sustained almost entirely by corpuscles and fibrinous material, which are discovered in the first streams of nutrition, and in large quantities in the serum of the blood. That its ultimate transformation, after being exposed to the action of water, is into one simple and homogeneous mass, which in these experiments is shown to consist entirely of corpuscles, and plainly indicates its original basis to be of a corpuscular or fibrinous nature.

Assumption of Vitality.—Dead animal matters are thus seen to be *capable of resuscitation by contact with water, and to become endowed with a sort of low vegetative life,* common to plants, corpuscles, etc.

This low vitality is found to be revivified *by exposure to the air,* for after exposure they evince an accession of aggregative power, indicated by the development of fibrinous material. (See page 9 and 17, and Paper read at Bradford, page 23.)

Animal matters, in which life is not extinct, such as the white of hen's egg, and serum of the blood, *form beautifully striated fibrin, speedily, by contact with water,* which needs no teazing out or other interference to produce this effect as suggested by Dr. Beale, as may be seen by dropping a globule of fresh ovalbumen or serum into that fluid, under the microscope.

On the other hand, *exposure to the air, independently of the influence of water, does not resuscitate dead animal matters,* but only hastens their decomposition.

Water, then, is the *great resuscitating agent for dead animal matters;* and *Air* the great vitalizing medium for already living animal substances.

Living constructive molecules, or cells, etc., can never of themselves develop a living organism : it requires a living germ for its production, and to impart unto it its own specific character and species.

Now, every living object in nature is clothed with a protective covering or skin, which is vital to its existence, and which preserves it, especially from the direct action of the imponderable forces, water and atmospheric air. Thus protected, it is enabled to maintain its *identity,* and to avail itself of the use

of all external forces and elements, to subserve them to its own existence, and to perform undisturbedly its own specific and peculiar functions. When this defensive wall is removed to any considerable extent, by exposure to the influence of surrounding elements and forces, etc., great changes ensue, and either transformation, or extinction of vitality, followed by decomposition and disintegration.

In illustration of the mode of development of this protective covering, we may observe that after a time the oily looking material floating upon the surface; by exposure to the air, was seen to be covered over with a network of fibrinous threads and filaments, which formed a sort of membranous covering, and presented a beautiful arborescent appearance. This production of a membrane upon the surface of living animal material has been frequently witnessed by the author, both naturally and artificially produced. He suggests that it beautifully illustrates the *modus operandi* employed in nature, during the formation of the protective external sheath or covering just alluded to, which is developed by nature upon all living structures. Thus we find in the animal kingdom that the lymph and serum of the blood, by contact with the atmosphere, and in some instances by the agency of cells, produce skin, scab, cicatrization, nails, and diseased cutis, etc., in animals; whilst the sap and other juices of vegetables, rich in fibrin, develop bark, skin, peel, husk, rind, etc., so called in the vegetable kingdom. Probably the animal cell wall is also produced in like manner.

We see, then, that even dead animal substance in the shape of muscle, by exposure to the action of water, becomes converted into corpuscular bodies, or plasm, in the form of "adipocere," This, by floating upon the surface, and exposed to the *air*, is soon covered over with a network of fibrinous threads and filaments, which form a beautiful membranous covering. (See p. 17.) Such, indeed, is the vivifying influence of the air or oxygen upon even these spherical bodies, which are possessed of the very lowest degree of vitality, that by it their power of aggregation is increased to a degree equal to the power of living albumen (see Paper I. p. 17).

ORIGIN OF THE CELL NUCLEUS AND WALL.

From these experiments, therefore, it may easily be conceived

how a single molecule of living albumen, by exposure to the action of water in the chyliferous vessels, becomes transformed into a cell nucleus of fibrin or protoplasm ; whilst, at the same time (as we have seen), water, by acting more powerfully upon the *surface* of the molecule with which it is in contact, would of course increase the density of its exterior. On entering the sanguineous circulation, and passing through the respiratory organs, the more dense exterior of the molecule would assume a perfected fibrinous condition, and become clothed, as it were, by an external membrane, denominated "a cell wall;" whilst the nucleus or nuclei within would assume a perfectly elaborated condition. (See Paper I. p. 4, and Paper IV. p. 4.)

These experiments appear to unfold unto us some of the phenomena of elementary animal life, and the mode by which its molecules and cells originally derive their existence. As we have already seen (Paper III. p. 5) that all fibrinous material ultimately resolves itself into corpuscular bodies, previously to disintegration ; so we now see (Paper IV.) that all dead animal substance becomes converted by the action of water also into corpuscular bodies. Further, we gather that the animal organism is developed and sustained from the products of the death of other animal structures, and by a plasma derived from the lowest forms of corpuscular life, such as are found in "adipocere." That, as truly as the vegetable world is incessantly at work in the manipulation of food for man and beast, so truly is all dead organic matter constantly at work, in unison with water and electricity, in elaborating corpuscular plasma for the development and growth of living substances. Thus the *lower forms of life* appear to be ever and anon spontaneously evolved, in order to minister to the sustentation of the higher or germ life. At length when animal life becomes itself extinct, all its tissues, membranes, structures, and organs, in the presence of water, return again to their pristine elements, and become themselves a plasma for the sustentation of other germ life, just as the germ itself (the seed) becomes, in the presence of water, mere pabulum for the nascent germ which itself has put forth.

Finally, we conclude that the intrinsic nature of the entire animal body, including bone, tendon, muscle, skin, nerve, etc., with the exception of their inorganic and foreign elements and fat, is identical with fibrin and corpuscles ; for all animal bodies when exposed to the resolving power of water after death return again to adipocere, which is found to be simply corpuscular or plasmic substance.

It is thus rendered clearly evident by these considerations and the revelations herein contained, that all animal substance and organs, whatever may be the modification in their character,

form, peculiarity of construction or functions, were originally constructed of this one nutritive pabulum, denominated by physiologists by the various names of protein, blastema, sarcode, protoplasm, coagulable fibrin, etc., and pass through various chemical and other forms and modifications during the life of the body, and whilst exposed to the elements which enter into its construction. But that ultimately when life is extinct, if exposed to the influence of water, they, as well as fibrin itself during decomposition, are again resolved into the same homogeneous substance, and found in the shape of the original corpuscular bodies from which they originated. The only conclusion, therefore, that can be drawn from the foregoing facts and data is, that at least the entire muscular system, including the voluntary and involuntary muscles—the heart and respiratory muscular apparatus, the muscular coat of arteries and of the digestive organs and intestinal canal, bladder, uterus, etc., is dependent upon the coagulable material of the blood, or fibrin and corpuscles, for its sustentation and nutrition.

CHAPTER IV.

FIBRIN, AND ITS RELATION TO LIFE, HEALTH, AND LONGEVITY.

SHOWING the value of the white corpuscles in the elaboration of nutrient material, Mr. Newport found that the oat-shaped corpuscles (the granular cells of Mr. Wharton Jones) in the larva are most numerous at the period immediately preceding each change of skin; at which time the blood is exceedingly coagulable, and evidently possesses the greatest formative power; whilst the smallest number are met with soon after that change, when the nutrient matter of the blood has been exhausted in the production of new epidemic tissue. (Dr. Carpenter's Physiology, p. 244.)

DEVELOPMENT OF FIBRIN.

Speaking of the development of fibrin, Dr. Carpenter declares that "the characters of the chyle drawn from the larger absorbent trunks near their entrance into the receptacle of the chyle are very different from those of the fluid first absorbed into the lacteals. For, during its passage through these vessels and the mesenteric glands it undergoes important alterations, which gradually assimilate it to the blood." The chyle drawn from the lacteals that traverse the intestinal walls he says "contains albumen in complete solution, but is generally destitute of the power of coagulation, no fibrin being present in it." But, during the passage of the chyle through the absorbents on the intestinal edge of the mesentery towards the mesenteric glands the presence of fibrin begins to manifest itself by the slight coagulability of the fluid when withdrawn from the vessels. This undergoes a regular coagulation, separating into clot and serum, and a few chyle or cytoid corpuscles begin to make their appearance. The smaller chyle corpuscles appear, like the lymph corpuscles, to be in the condition of nuclei; in those a little larger the *cell wall* is beginning to be visible from the nucleus; whilst in those of greatest diameter the *cellular* character is very distinct, and the nucleus may be plainly seen in the interior, especially after the addition of a little water or acetic acid. The chyle from the receptaculum (chyle receptacle) and thoracic duct coagulates

quickly, often almost instantaneously. "Bidder and Schmidt," he says, as we have before stated, "estimated that in man nearly thirty pounds of mingled lymph and chyle were daily poured into the *subclavian* vein." The analysis of the blood in regard to the relative proportion of albumen and corpuscles is given by Scherer:—

	In a Vigorous Man Fifty Years Old.	In a Robust Man Twenty Years Old.
Water - - - -	796·93,	783·63
Sold matters - - -	203·07,	216·37
Fibrin - - - -	1·95,	1·56
Corpuscles - - -	115·16,	113·54
Albumen - - -	58·82,	64·32
Extractive matters and salts,	27·14,	36·95

THE IMPORTANCE OF FIBRIN AND WHITE CORPUSCLES AS INFLUENCING LIFE, HEALTH, DISEASE, AND LONGEVITY.

That the due development of fibrin is absolutely essential to health is held as an axiom by many physiologists. Sir J. Paget, speaking of the exudation produced by a blister, declared "that the highest health is marked by an exudation containing the most perfect and unmixed fibrin;" Dr. Carpenter, "that the increase of fibrin may be considered as the alternative most characteristic of a previously healthy state of the system." On the other hand, Sir J. Paget declared that "the lowest state of health is marked by the formation of the most abundant corpuscles." "The excess of corpuscles in the vertebrated animal seems always to be associated," remarks Dr. Carpenter, "save in the early part of life, with an imperfect performance of their nutritive operations." Thus, according to the observations of Sir James Paget, they are especially abundant in the blood of frogs that are young, sickly, or ill fed; and as regards the human subject, he confirms the statement of Mr. Wharton Jones and Professor J. H. Bennett that the increased proportion of colourless corpuscles in inflamed blood is most frequent when the subjects of the disease are persons in weak health, or of the tuberculous diathesis (constitution). (Dr. Carpenter's Physiology, page 244-45.)

THE FIBRINOUS VERSUS THE CORPUSCULAR DIATHESIS.

The distinguished author just mentioned has further shown that "the *predominance of fibrin*, or the development of the white corpuscles of the lymph and blood has much to do with the future well-being of the patient as regards either the formations of matter or the healing of wounds. It is mainly," says he, "upon the *preponderance of fibrin that the plasticity of the fluid, or its capacity for organisation depends; whilst according*

to the preponderance of corpuscles will be the tendency to degeneration." *Thus the exudation of fibrinous lymph is the symbol of the adhesive inflammation; whilst that of corpuscles is similarly characteristic of the suppurative inflammation,* or the formation of purulent matter which it is in general so desirable to avoid. (Lectures; Surgical Pathology, vol. 1, page 332.)

DEPRAVED OR DEGENERATED FIBRIN.

It is declared by Dr. Carpenter, as we have already noticed (Paper III., page 25) that "in that unhealthy state of the organism which is called the scrofulous or strumous diathesis (constitution) we find an imperfectly organisable or cacoplastic product, known by the name of tubercular matter, taking the place of the normal elements of tissue;" and he further shows that the coagulum of the blood of such persons is not composed of well-elaborated fibrin, but is greater in bulk, yet soft and loose in its texture, and contains an unusually large number of colourless corpuscles. "Such deficiency in plasticity, etc., and the deposit of such cacoplastic products, appears to be," he remarks, "the history of the formation of tubercules." (See Paper III., pp. 25 and 27.)

EFFECTS OF A DEFICIENCY OF FIBRIN IN THE BLOOD UPON THE MUSCULAR SYSTEM.

As the strength of muscle is, as we have seen, greatly dependent upon the due and liberal supply of coagulable material to the muscular organs, deficient nutrition will of course engender enfeeblement and deficient strength of body. No organ can work efficiently and with continuance independently of nutritive supplies. The voluntary muscular organs being, as it were, the machinery by which the entire movements of the body are effected, and by which the power and energy of the frame is manifested; and fibrin, as we have seen, being the substance whence muscle derives its nutrition, the amount of fibrin present in the blood-vessels must, to a very great extent, represent the power of the muscular or mechanical force of an individual; hence a badly nutrified muscular system must at all times present deficiency in the power of manual labour. A man possessed of Herculean strength must become weak as a little child when muscular nutrition is cut off. Ordinary toil itself, with deficiency of nutritive supply, is well known to be the harbinger of premature old age, and occasionally of death itself.

DEFICIENT NUTRITION OF THE HEART.

Too much stress and importance cannot be laid upon the well-being and efficiency of this organ. The labour to which it is

moment by moment subjected in the onerous duty of supplying every other part of the body as well as itself with nutrition is enormous; and when we remember that a few moments' discontinuance of supply must produce the end and termination of life, the action of the heart becomes prominent in the extreme. The mechanical force of the entire muscular system depends for supplies upon this great and central organ. The heart itself is, moreover, a muscular organ, and requires coagulable or fibrinous material for its own nutrition and incessant toil and action. When deficiency of fibrin prevails in the nutrient fluids, the heart will be of course affected thereby, and will become weak and feeble from deficient nutrition; the general circulation of the blood will flag, and every organ and tissue thereby reduced in strength. Moreover, a heart inefficiently nourished is very liable to take on disease; even contraction of the coronary arteries of the heart, when the supply is abundant, by limiting nutrition, will cause atrophy, or wasting of this organ. Rupture of the heart may occur from enfeeblement of its walls; and other diseases of a highly formidable nature, such as dilatation, aneurism, etc., from the impairment of their resisting power. Fatty degeneration of this organ is always held to be the result of impaired vital power, accompanied by imperfect assimilation of food—*i.e.*, diminished nutritive qualities in the blood.

Speaking of this disease, Dr. Lionel Beale declares the contractile material of muscle in great part disappears, and in its place oil granules and globules are found. "The deposition of fat in the tissues (says Dr. Carpenter) is not due to the removal of the normal components of tissue and the substitution of newly deposited fatty matter in their place, but is (in most cases at least) the result of real conversion of the one class of substances into the other—the albuminous or gelatinous materials being changed into fat," the generation of fat taking the place of the coagulable or fibrinous material. Albuminous substances are now admitted, he declares, to be capable of this transformation. (See Dr. Carpenter's Physiology, pp. 385, 394.)

THE ENTIRE INVOLUNTARY MUSCULAR SYSTEM.

As a further result of deficiency of fibrin in the blood, there will be a general enfeebled action in all the involuntary muscles of the *vocal organs*, the *pharynx*, the *œsophagus*, the *larynx*, the *bronchial* and *respiratory* muscles. The *muscular coat of the stomach* and *whole intestinal canal*, etc., will also more or less participate in deficiency of power and action. The share which the *muscular action of the stomach takes in the digestive process*, and in removing the food onwards into the intestinal canal, the *peristaltic or vermicular motion* of the intestines, and the action of all organs

whose province it is to produce the *expulsion of matters* from the body will be equally impaired. The uterus also, and the involuntary muscles appertaining to the functions of the generative organs will, of course, correspondingly suffer.

RESPIRATION.

The function of respiration is also effected by muscles of this class. Let muscular nutritive supply become deficient, and at the same time the heart's action enfeebled, and we have herein a twofold cause for decreased power in the *respiratory organs;* and *when the power of respiration is diminished, less oxygen will be respired and conveyed to the blood, and the vastly-important function of aeration in the lungs will be proportionally reduced.*

CHANGE OF MATTER.

The temperature of the blood of man is the same all over the globe. Wherever situated, at the poles or at the equator, there is little or no deviation in his temperature. Moreover, under ordinary circumstances a man consumes say about 2 lbs. of solid food daily, as well as about 2 lbs. of oxygen by respiration, yet at the end of the year he is little or no heavier than at the beginning. Again there is given off from the body every day in the shape of breath, perspiration, urine, and fœces, a very considerable amount of matter—but he is still found slightly altered, if at all, in weight at the close of 12 months.

These facts clearly declare that there are going on in the body two antagonistic processes—a process of waste exactly counterbalanced by a process of reproduction or supply.

The 2 lbs. of oxygen enter the body daily by respiration, unite with 2 lbs., or thereabouts, of the materials of the body, and with these the oxygen quits the system in the shape of breath, perspiration, urine, and fœces. Now we have already shown what are generally held to be the producing causes of the chief waste of tissue and substance in the animal body, viz., organic function, motion, or physical action. These when they take place use up a certain amount of the tissues of the organ employed, and cast them off as effete, waste, or dead materials, and with these it is supposed the respired oxygen unites, and ultimately escapes from the body. (See page 35.) Besides these there is also the ordinary waste of matter which ensues from the combination of oxygen with effete matters cast off from the substance of the living parts.

Now this combination of oxygen with the various parts of the body producing waste is called "*change of matter,*" which is so highly connected with the continuance of life, that it becomes to our senses a chief evidence of the presence of vitality, as

witnessed, for instance, in the returning respiration of persons supposed to be drowned, or in that state of suspended animation called asphyxia. It appears to be held by many as the main manifestation of animal life—if not actually its producing cause. Oxygen enters the body during inspiration, and is given off again during expiration in the form of carbonic acid. Further, as oxygen is, as we have noticed, the admitted source of chemical change, decomposition and recombination in the organism, as well as the great agent in the removal of effete material; by the diminished respiration of oxygen there will be also *an equal reduction in the amount of chemical change* ensuing in the body. This chemical change or transformation of matter is generally held to be the producing cause of the vital force.

THE VITAL FORCE.

No one, we think, will contend that the albuminous material, or serum of the blood, has any share in aeration, or is in any measure modified or changed by transmission through the respiratory organs, nor can it be said in any way to perform the office of carrier of oxygen in the sanguineous system. This office is held to be performed by the corpuscles of the blood. We have also shown that the albumen of the serum does not to any extent supply the waste of tissue. Hence, as in a voltaic battery, the electric current developed is at all times proportionate in amount to the quantity of zinc, or other element, and acid consumed; so in like manner it is to the amount of fibrin and corpuscular material exposed to the action of oxygen in the lungs, that we must look for the amount of vital force developed in these organs. Probably, the combustion of heat-giving foods, as alcohol, fat, oils, etc., do not to any great extent engender vital power; inasmuch as electricity given off in the form of caloric or heat is no longer force—but only heat-producing.

Whatever amount of this force may originate in the combinations and recombinations which are the result of the nutrifying process; the demands of the tissues, wasted by the performance of their several functions, are, as we have seen, met and supplied almost entirely by the coagulable portion of the blood. Under all circumstances, therefore, the amount of coagulable material in the blood undergoing change by oxygen in the respiratory organs, or utilised in effecting the nutrition of the organism, will, of course, determine the amount of vital force developed, if that force is really the result, like that of a voltaic battery, of chemical action. Hence the preponderance of fibrin in the blood will at all times, when uninfluenced by disease, and all other things being equal, give the highest degree of vital force; whilst a

deficiency in fibrin would, on the same ground, evince the lowest degree of vitality.

Moreover, as we have just seen that deficiency in fibrin in the blood, by not affording a sufficiency of nutritive supply to the heart, will cause this organ to become enfeebled, and will render it unable to transmit a due supply of blood to the respiratory organs. Owing to the same cause, as we have already seen, the respiratory muscles, or those engaged in the function of respiration, will be inadequately sustained, the amount of oxygen inhaled by the respiratory organs will be diminished, and the vastly-important function of aeration in the lungs reduced. Hence a very important reason, on these grounds, for the diminished amount of the vital force itself.

CONGESTION, HEMORRHAGE, ETC.

The *larger arteries*, whose action altogether depends upon their muscular parietes, or walls, are not unfrequently the subjects of disease. All congestions may be defined as over-distended vessels, and it is not to be wondered at that vessels should become over-distended as the result of innutrition and consequent weakness of their walls.

"It appears," says Dr. Carpenter, "from the experiments of Majendie that one of the effects of a diminution in the proportion of fibrin is a tendency to congestion, or hemorrhage" *(bleeding)*. Thus over-distention, or congestion of the blood-vessels, may occur in the brain, constituting congestive apoplexy; in the spinal marrow, forming congestive paralysis, as well as in the chest and respiratory organs, the nasal organs, or throat, stomach, and various other parts of the body.

HEMORRHAGE, AND THE HEMORRHAGIC DIATHESIS (CONSTITUTION).

"We find," says Dr. Carpenter, "that it is entirely on the coagulating powers of the blood that the cessation of hœmorrhage from even the most trifling injuries is dependent." (Dr. Carpenter's Physiology, p. 248.) "Where there is great deficiency of fibrin in the system, we may have incontrollable bleeding ensuing even from the mere extraction of a tooth."

How many are the thousands of cases which fall annually under the care of medical men, which may all be attributed to what is often termed "thinness of blood." Thin blood, devoid of fibrin, affords little or no nutrition to the walls of the vessels, leaves them in a low and impoverished condition, and exceedingly liable to rupture. When ruptured, there is no element in the blood in sufficient quantity to arrest the overflow, that is to say, to form "a clot"—to stem the torrent, to plug the leak,

and stop the hemorrhage. Whereas *the blood is the life*, blood is, in reality, the pabulum that maintains the structures, replenishes function, and affords supplies for all physical and chemical action, etc., and by union with the oxygen of the atmosphere, imparts the vigour, energy, and power or force of animal life itself. Well, then, may the organism be enfeebled by loss of blood; and how many are the vital organs that are liable to this loss, and to which the loss is, in many instances, equivalent to the loss of life! The brain, the heart, the lungs, the stomach, the intestinal canal, the uterus, the kidneys, etc., are each one of them not the unfrequent subjects of hemorrhage. How all important is it then that hemorrhage should be under the control of the medical adviser. If we want to arrest bleeding in a hemorrhagic (thin blood) constitution, we may give acids and astringents, employ styptics, and all the newly discovered remedies of the age, without benefit. For unless there be fibrin developed in the blood, these remedial agents will be often found to be of little value. There is no secure plan that can be adopted save by the increase of coagulable material in the blood. At the annual meeting of the British Medical Association, held at Cambridge, in 1871, J. B. Bradbury, Esq., M.D., Physician to Alderbrook's Hospital, Cambridge, speaking of the hemorrhagic diathesis, made the following remarks—"Closely allied to these cases of hæmoptysis (or expectoration of blood) are those occurring in habitual drunkards, and in scurvy, purpura, hemorrhagic exanthemata, typhus, small-pox, etc. In all these instances (he declared) we probably have *a morbid tenderness of the walls of the blood-vessels*, occurring without any assignable cause in the *hemorrhagic diathesis*. But in chronic alcoholism, purpura, etc., it is probably owing to a *deterioration of the blood*, and, in the words of Niemeyer, '*so modifying the nutritive state of the walls of the blood-vessels as to impair their resisting power.*'"

Herein is seen then the danger, by the use of alcohol, of producing that state of constitution (termed the *hemorrhagic diathesis*). Medical men of eminence usually forbid the employment of spirituous potations during hemorrhage (or bleeding), simply because of the vascular excitation which it produces, which endangers vascular distention and rupture, or a recurrence of the bleeding. Moreover, the production of fibrin by water opens out an exposition of the grand underlying reason for the employment of water in all diseases of this kind, viz., that water produces the fibrin which metamorphoses this state of the constitution, and thus prevents a tendency to a recurrence of the disease; water itself being in various modes of application, by its refrigerating effects, the most generally useful, if not the most effectual, styptic known.

APOPLEXY.

One of the most important diseases resulting from deficiency of fibrin in the blood is apoplexy—in which Dr. Carpenter declares there is a marked deficiency of fibrin. (Page 222.) It depends for its occurrence, according to the statements of Niemeyer, upon the morbid fragility of the blood-vessels and the increased pressure of blood within them. (Vol. II. p. 191.) In this statement we see as much danger from absence of nutrition as in congestive fulness of the vessels. But vessels filled to repletion by fluids which are entirely innutritive and at the same time stimulate to excessive action, such as alcoholic potations, present, of course, the greatest sources of danger.

How frequent are the cases of *apoplexy, paralysis, hæmoptysis* (spitting of blood), etc., which occur as a consequence of *inebriation,* and even by the *moderate use of alcoholic beverages!* In these cases the very *self-same cause which prevents the due or healthy formation of fibrin in the blood,* and consequently the nutrition and healthy resistance of the vascular walls, and renders them weak and liable to distention, rupture, and hemorrhage, *at the same time whips and spurs to vehemently excited action the heart and arterial system, and produces that forcible distention which ultimately effects the rupture of these vessels.* On the other hand it may cause such *obstruction* and arrest to the venous current in the head, chest, liver, etc., and in the circulation generally, as may impede the return of blood through the veins and tend also to develop congestion or repletion therein.

As regards the *hemorrhagic diathesis* (constitution) I have made enquiry from numerous dentists as to what parties in their practice are most liable to hemorrhage, or bleeding, and in whose cases they have the greatest amount of trouble in arresting it. In all the replies that I have received one common answer has been returned, viz., "that the 'inebriates' are the parties most subject to hemorrhage after tooth extraction." Some have described fearful and long protracted loss of blood before it could be arrested, and in which alarm was most seriously excited of nothing less than the occurrence of a fatal result. One case related, "bled for more than 24 hours, being alone in his house, and had a very narrow escape from death."

ANEURISM

Consists in the dilatation or rupture of a large blood-vessel, which is the result of innutrition or the depraved condition of its walls. This disease when spontaneous, and not the result of mechanical injury, evidently, in the words of Niemeyer, depends upon the degeneration of its walls, as the result of inflammation,

fatty degeneration, innutrition, or mal-assimilation—all which latter words merely express a want of good, coagulable, and well elaborated fibrin in the blood. (See Niemeyer, Vol. I. p. 400.)

VALUE OF FIBRIN IN REPARATION, HEALTHY INFLAMMATION, RECOVERY FROM ACCIDENTS, ETC.

We have already seen that good and healthy fibrin is the essential ingredient in the repairs, renovation, and healing of all breaches of continuity, lesions, and accidental injuries of the human frame. That it is alone *by good, healthy, plastic, coagulable lymph that wounds, fractured bones, divided tendons, and other lesions of the several organs and tissues of the body can be, as it were, glued together by the adhesive process. Even new bone, tendon, cartilage, etc., are developed only in strata of this kind.* In order to the production of many of these results, it is a well known fact that a sort of inflammatory action, called the adhesive inflammation, takes place; and Nature herself has abundantly displayed how necessary is the presence of coagulable fibrin, or corpuscles, in increased quantity, for healing purposes in all inflammatory affections.

HEALTHY INFLAMMATION, PLASTIC EXUDATION.

Healthy inflammation occurs in a plethoric frame, and may be regarded as an irritation in the organic nerves of the part attended with an exaltation of the *vis vitæ*, affording manifestation of increased rapidity of the nerve current and of the sanguineous circulation in proportion to its extent. The capillaries become congested, the affected part becomes hot, red, and swollen. The swelling is to be ascribed partly to the over-distention of the vessels and partly to the escape of various constituents of the blood into the tissues. This is what is called the inflammatory exudation, and claims our attention owing to its important connection with the development of plastic exudation. This exudation consists, apart from its fluid portion, of embryonic cells which have migrated from the vessels, the fluid itself being coagulable lymph. These living corpuscles, or nuclei, which we have elsewhere shown to possess the nature of fibrin, by uniting together, form the protoplasm which is so valuable in glueing together dissevered parts of the frame. They are found considerably to increase during inflammatory action; and their multiplication has been the source of much discussion. (See Rindfleische's Pathological Histology, Vol. I. p. 112.) It does not seem improbable as one great cause of their increase that, during inflammatory excitement, a great thirst for water may be set up inwardly in the system, just as we experience it outwardly in the demand for drinks. With this thirst an increased supply of water may rush from the tissues

and organs, etc., to the absorbents and lymphatics, as is shown by Dr. Carpenter to take place during excessive loss of blood; whilst a large supply of albuminous substance may be transmitted by the increased action of the vessels, and thus create a much greater amount of coagulable fluid than is present in the natural condition of the body. When arrived at the point of injury, the blood, being in a highly coagulable state (witness the blood drawn from the veins during inflammation), will present, of course, a greatly increased amount of coagulable lymph and plastic corpuscles. In such case, how valuable must be the application of water dressings of all kinds to the skin whence these thirsty absorbents quench their thirst. The local determination of the blood current will, at the same time, determine an increased supply of these materials to the seat of injury. These corpuscles, it has been found by Professor Stricker, are increased by fission (or division into two halves), which being repeated, produces multiplication in their numbers. Their protoplasm increases in bulk. In a given time they assume, he declares, "the appearance of multi-nuclear masses of imposing size." The same author has also directly observed the fissiparous multiplication of the emigrant cells at the seat of inflammation.

THE FIBRINOUS CONSTITUTION ASSOCIATED WITH THE HIGHEST DEGREE OF HEALTH.

If we observe society we find that the laws and habits which regulate the development of fibrin in the blood, regulate also individual health, energy, and robustness of constitution. Persons who are the subjects of out-door exercise *in a pure atmosphere,* of early hours and repose, of active lives and regular habits; who are *abstainers* from strong drinks, highly seasoned foods, luxuries, and medicine; who partake of *food rich in nitrogenous substances,* and quench their thirst with *pure and sparkling water*; who are not afraid of, and do not suffer from exposure to, a passing shower, so highly calculated to furnish a large supply of water to the absorbents—are all, as a rule, more or less, proverbial for strength, robust nature, and the highest possible state of health. Such are the sportsman, the agriculturist, the British sailor, and the out-door operative.

ABUNDANCE OF CORPUSCLES ASSOCIATED WITH THE LOWEST HEALTH, STRUMA, TUBERCLE, ETC.

Mr. Wharton Jones and Professor T. H. Bennett declare that "the increased proportion of colourless corpuscles in inflamed blood is most frequent when the subjects of the disease are persons in weak health or of the tuberculous diathesis." These gentlemen and others all attribute the occurrence of the tuber-

cular diathesis to the decrease of fibrin, and the increased amount of corpuscles, in the blood. In persons of that peculiar constitution which is termed scrofulous, or strumous, Dr. Carpenter remarks, "We find *an imperfectly organisable* or cacoplastic (depraved) deposit, or even an altogether aplastic (unorganisable) product, known by the designation of tubercular matter, frequently taking the place of the normal elements of tissue. We can understand, therefore," he says, "that such a constant *deficiency in plasticity* (fibrin) must affect the ordinary nutritive process, and that there will be a liability to the deposit of cacoplastic products instead of the normal elements of tissue, even without inflammation. Such appears to be the history," he declares, "of the formation of tubercles in the lungs and other organs." (See Dr. Carpenter's Physiology, pp. 417, 418.) Speaking of inflammation generally, this author declares that, "as the ultimate tendency of inflammation is to produce the disintegration of the part, the ultimate *tendency of the fibrinous material developed* is to keep its elements together, and *to repair the losses* which may take place." We do not quite agree with the idea that inflammation generally tends to disintegration, but that the rather all healthy inflammation is the kind hand of Nature put forth to bind up that which was broken, to unite that which was dissevered, to heal that which was bruised, and to restore that to its normal condition, animation, and health which has been subjected to the common accidents of our nature.

THE HEALTHIEST KIND OF INFLAMMATION MAY BE ASSOCIATED WITH EXCESS OF CORPUSCLES.

The statements just adduced appear, however, in accordance with the experiments already brought forward, the facts of modern science, and the statements of physiologists, to require modification.

According to the discoveries of science, it is found that, although coagulable lymph itself may be thrown out upon the surface of a wound or ulcer in adhesive inflammation, and in many other instances for healing purposes, yet the exudations described by physiologists which are found in ordinary inflammation itself are produced, *not by fibrin or coagulable lymph only, but by the exudation of white corpuscles* which escape through the walls of the vessels, unite together, and form the plastic material which, when *full of vitality and duly elaborated*, is so valuable in the healing of wounds and lesions of all kinds.

We may, therefore, have the most healthy inflammation associated in such instances with an excess of vital corpuscles. (See pages 23, 27, 28, 29, 41-3-4, 54.)

On the other hand, the vitality of the constitution and, conse-

quently, of the corpuscles may be so low that they are unable to unite together, and form a good, healthy, and compact exudation, not being composed of "well elaborated fibrin," but of that which is "soft and loose," and exhibiting a deficiency in plasticity, and also the presence of "cacoplastic products," "completely unable to undergo any degree of organisation." "There is no doubt," remarks Sir James Paget, "that a very large proportion of what are called unhealthy inflammations, especially those of the erysipelatous type, are to be regarded as *owing their peculiarity to a deficiency in the due elaboration of fibrin.*" This author has also shown that the formations of matter, the unhealthy healing of wounds, and general recovery from accidents, etc., are greatly dependent upon the predominance of fibrin or the development of white corpuscles in the system. (See Lectures on Surgical Pathology, by Mr. Paget, Vol. I. p. 332; and on Unhealthy Inflammation in the *Lancet*, 1849-50, and *Medical Gazette*, 1850-51.) It is mainly, as pointed out by Sir J. Paget, that upon the preponderance of fibrin the plasticity of the lymph, or its capacity for organisation, depends; whilst according to the preponderance of corpuscles will be its tendency to degeneration. Thus, says he, the exudation of fibrinous lymph is the symbol of the *adhesive* inflammation, whilst that of the corpuscles is similarly characteristic of the *suppurative* inflammation. On this subject, this author declares that "it has been too much the habit of pathologists to speak of coagulable or plastic lymph as if it was always one and the same thing; yet it really presents various gradations of character, which are manifested in its different degrees of organisibility and in the *diverse* nature of the tissues developed from it." He pointed out that there are two typical forms of this exudation, viz., the fibrinous and the corpuscular, between which the others are intermediate. The former, he says, coagulates into a fibrous clot, resembling that of healthy blood, but usually showing a more distinct fibrillation; the latter (the croupous exudation of Rokitansky) is characterised by the want of any proper coagulation, the fibrous clot being replaced by an aggregation of cells, which in their first appearance resemble very nearly the primordial condition of the corpuscles of the fluids of the absorbent vessels and the colourless corpuscles of the blood. These two states, he declares, are, moreover, often blended in various proportions.

The difference, however, between the corpuscular and the fibrinous diathesis of Sir James Paget, and which explains the entire phenomena, appears to consist *in the degree of vitality of the organism in which they exist.* Thus when corpuscles are endued with high vitality, such is their power of aggregation together and development of large quantities of

fibrin (Paper III. p. 23), that a predominance of this substance is discovered in the system; whilst, on the contrary, when vitality is low, and the aggregative power of the corpuscles feeble, a small amount of fibrinous material will be manipulated, and the corpuscles will remain in abundance and present what is termed the corpuscular diathesis, or constitution. *Thus a high degree of vital power gives the predominance of fibrin; and vice versa, the predominance of corpuscles.* As an illustration of our position, we may adduce the two opposite cases of genuine inflammatory croup and diphtheria; the former occurring in a plethoric temperament, the other in a strumous depraved, or cachectic, or otherwise unhealthy, constitution. (See also pp. 27, 41.)

CROUP AND DIPHTHERIA.

There is a wide constitutional distinction between acute laryngitis, or croup, and the disease denominated diphtheria, which distinction to some extent illustrates the phenomena just alluded to. Croup begins with a true inflammatory state and vascular action in the larynx and upper part of the trachea, attended by high inflammatory fever. After a short period of redness and inflammation of the membrane of the larynx, fauces, etc., a whitish exudation of coagulable lymph, or a firm and continuous coating of that substance, presents itself on the inflamed surface, which gradually, by its steady and unflinching action, may fill up the narrow opening of the glottis, and sometimes in a few hours induce death by suffocation. On the other hand, in diphtheria we have low fever, the inflamed parts presenting a dark red, approaching to a brown or livid hue, and the exudations, instead of being pellicular, firm, tenacious, and whitish or yellowish white, as in the case of croup, and adhering firmly to the surface, are soft, broken, and easily detached. In the one case we have the presence of active healthy inflammation, attended with high inflammatory fever, and the exudation of true and well elaborated plasm, or healthy corpuscular exudation; in the other we have unhealthy inflammation, bordering on gangrene, and death of tissue, with the low fever of extreme prostration and of a typhoid character. The exudation is described by authors as a greyish, utterly unorganisable or cacoplastic product, consisting of aplastic or unorganisable corpuscles, evidently emanating from a most unhealthy or cachectic state of constitution.

In the one we have generally the occurrence of disease in each instance in a healthy, if not plethoric constitution, more or less abounding with fibrin; in the other, in a constitution of a very low state of vitality and health, and in which a predominance of aplastic corpuscles in the blood is usually present.

ESCAPE OF PURULENT MATTER ARRESTED.

One of the frequent results of inflammation is the formation of purulent matter. If there is a great deficiency of fibrin in the organism, this fluid, as long since shown by the late Benjamin Travers, will issue forth among the tissues, and, by infiltration, produce effects upon the entire organism of the most formidable, disastrous, and fatal kind. But by the due presence of coagulable material in the blood a protective wall is set up, which surrounds and hems in the matter on every side, and prevents its escape. Such a process may be observed even in an ordinary abscess, the hardness and swelling produced by this protective wall remaining for a considerable time after the abscess is healed.

ARREST OF GANGRENE.

Gangrene is the incipient privation of life, or death, of an organ. It is frequently employed synonymously with the second stage of this disorder, viz., mortification, or sphacelus. It frequently proceeds as a result from inflammation.

"When gangrene is spreading by continuity," says Dr. Carpenter, "it is only when an inflammatory reaction occurs, or in other words, *when the development of (a wall of) fibrinous lymph* takes place in the substance of the tissues bordering on those which have lost their vitality, that a line of demarcation between the dead and living parts is formed," and the life of the individual preserved.

CHOLERA.

We have been frequently struck with the number of inebriates who have fallen victims to this disease. In fact, it has been a fact patent to the medical profession that the majority of seizures has occurred in this class of persons. "*In cholera,*" Dr. Carpenter declares, "a *reduction in the coagulable element of the blood* seems to be an almost constant occurrence; and in some instances this fluid, although loaded with solid matters, *has scarcely coagulated at all.*" The absence of water, removed by previous diarrhœa or other cause, accounts in some measure for the deficiency in coagulable material.

TYPHUS AND TYPHOID FEVERS.

"In continued and typhoid fevers," remarks Dr. Carpenter, "*whilst the proportion of corpuscles is commonly increased, there is a decrease in the proportion of fibrin,* especially in the early stage; though the usual augmentation will take place if any local inflammation occurs." (Page 229.)

The entire exhaustion and loss of strength in prolonged fever is well known. This state of things is usually met by the

medical practitioner by large quantities of alcohol and quinine, by which, no doubt, when administered at the right and opportune period, exhaustion is in some cases relieved. The nervous current is lashed into quickened action, the digestive organs are stimulated to renovated function; food is taken; febrile disturbance is abated; the tongue loses its febrile character, and the case becomes convalescent. But, on the other hand, how many untoward instances are met with, where supposed critical days are observed! Times and seasons pass away, and yet there is no remission of symptoms, and no tendency or ability to partake of aliment. When the administration of alcohol and quinine do not alleviate, but aggravate existing fever, only produce continuance of the malady, and thus add to the already severe emaciation and loss of substance; in such cases, perhaps the most important subject next to the bringing to a termination of existing febrile action, is the power which physiology presents to us in the

RE-ELABORATION OF EFFETE MATERIAL.

Dr. Carpenter has shown that the *death of tissue* by no means involves its immediate and complete destruction. That whilst the matter which has undergone too complete a disintegration to be again employed as nutrient material is carried off by the excreting processes, *the portion which is capable of being again assimilated may be taken up by the lymphatic system and conveyed back into the circulatory apparatus in a state of higher elaboration;* thus showing that the most highly elaborated material can be developed in the animal organism, and made available for nutrition, independently of food, digestion, or any other mode of alimentation whatsoever. This re-elaboration, we now know, is effected by the agency of water. This phenomenon has been beautifully illustrated by cases of

STARVATION, AND PROLONGATION OF LIFE BY RE-ELABORATION.

It has been shown by physiologists that the period in which life may be prolonged during starvation can be greatly increased by the occasional use of water. In these cases, effete matters are being continually removed, and, in the light of this essay, they can be re-elaborated and converted into nutritive material by the presence of water.

During a visit to North Wales I had pointed out to me at a coal mine a Welsh collier, some years after the occurrence, who had been actually twenty-seven days imprisoned without food in the bowels of the earth by overflow of water. He mainly attributed the prolongation of his life to the fact of having frequently had recourse to the water by which the pit was overflowed, dipping his fingers into it, and imbibing the water as it

dropped. The usual duration of life under such circumstances, independently of water, is said to be about eight days, so that in this instance there would be a clear gain of nineteen days' prolongation of life. Dr. Sloane relates a case in which the individual was confined in a similar manner for twenty-three days, during the first ten of which he was able to procure a small quantity of foul water. He was, however, in a state of extreme exhaustion when rescued, and died three days afterwards. The occurrence of such cases, whilst they highly corroborate the truth of this discovery, at the same time, by the light of the facts before us, may now receive their full and complete explanation. How valuable, then, must be this knowledge in the treatment of long protracted febrile diseases, when the effete and wasting matters of the body are constantly being disintegrated, and passing away, as each succeeding hour destroys all hope for the final recovery of the patient. All power of assimilation gone, all capability of appropriating nutritive substance vanished; under such circumstances the administration of water, externally to the body and internally to the digestive organs, can, we have proved in scores of instances, not only diminish febrile action, but gather up, as it were, the passing away fragments of effete material, and, without the aid of digestion, reconvert them into highly elaborated nutrition. Thus we may be able to maintain the already flickering flame of life until febrile action is put to flight, and the assimilative powers of convalescence have in some measure returned.

THE VITAL FORCE VIEWED AS THE VIS MEDICATRIX NATURÆ (THE HEALING POWER OF NATURE).

It is quite evident from the phenomena that attend the manifestation of the vital force, as superior to all surrounding elements and forces (p. 40), that the epithet *vis medicatrix naturæ* is an appropriate name for the power which it exerts in the healing or removal of disease. As the alone healing power of nature, no disease can be arrested, overcome, put to flight, or ejected from the organism but by this force. It is this force which presides over, controls, regulates, and performs all the actions and functions of the living organism, and lays down and nutrifies the substance of all its tissues and organs; and no function, action, or change in the system can take place independently of the agency or concurrence of this vital and organic force. Moreover, this force is ever and anon actively engaged and occupied in protecting the frame from injury, in preventing morbid changes in the organism, and, when morbid alterations do ensue, in continuously instituting salutary actions for their arrest, suppression, and removal.

Associated with the vital force is the substance which composes the entire organism, which may be rightly denominated, as it is, the germ substance, and which, so long as its connection with the vital force continues, receives from it life and the supreme powers of which it stands possessed.

Now, as disease is derangement or morbid alteration in this germ substance, and inasmuch as it stands, as we have just noticed, possessed of the supreme powers of the germ itself, so no remedial agent which is simply drawn from the ranks of subordinate forces and elements can ever alter, rectify, or overcome of themselves derangements of the organism independently of the concurrence of the vital force.

Hence, as the healing of disease and the restoration of the organism can only be accomplished by organic or vital energy, how absurd is the practice of reducing and enfeebling the powers of the organism in order to the removal of disease. In extreme cases, the contest is waged between these two great forces, and either the organic power or diseased action must prevail in the last and final death struggle which ultimately sets in. How often has the physician to lament the reduction and loss of strength produced on the onset of fevers and other serious maladies, when afterwards and towards the close of the disease the few elements of strength lost cause the balance to turn in favour of diseased action, and the patient is lost. By opposing or enfeebling this healing power, it is quite true that remedial agents may greatly hinder its operations and the prospect of recovery; or by placing a dead lock upon its efforts, may altogether suppress the vitality of a part of the body, or produce extinction of life itself; but it is also evident that they can never of themselves, as we have shown, effect the arrest or removal of the simplest form of disease.

The only purposes for which remedial agents can be employed, be they external appliances or internal remedies, is, in the first instance, and all the way through the treatment of disease, to endeavour to exalt and maintain at its highest degree of energy this healing power of Nature; and, secondly, by pursuing the track which Nature herself indicates, to work in conjunction with her. Of course at all times placing an arrest upon her injuriously tending efforts. This is accomplished by aiding and assisting her in restoring function, and effecting those healthy actions which tend to produce removal of the disease and restoration of the health of the frame. Finally, be it ever and anon remembered that the exaltation of the vital force is as we have already shown, at all times dependent, to a very great extent, upon the development of fibrin and its predominance in the sanguineous system. Take, for instance,

CARBUNCLE,

Which proceeds from the death of cellular tissue, and evinces a considerably depraved state of constitution, in which are plainly indicated—1st, considerable local reduction at least of vital power, and 2ndly, innutrition, or the want of good, healthy plastic lymph or fibrin in the blood. The proof of the above statement is found in the measures required for the exaltation of the vital force, and the amount of good nutritious and nitrogenous food necessary for recovery in these cases.

CACHEXIA.

Cachexia, or bad habit, is held to be the result of diminished vital energy, produced by various mental or physical causes. In consequence of this, the food is not sufficiently elaborated and assimilated, the circulating fluid does not undergo its requisite degree of change, and the functions of the viscera are imperfectly performed. Thus the whole mass of blood is impoverished or depraved, and ultimately the structures more or less vitiated.

VALUE OF NUTRITIVE ALIMENT, WATER, AND PURE AIR IN HEALTH AND DISEASE.

Nutritive aliment is the basis, and "*Air* and *Water* are the great agents of germination. Seeds may rise by the agency of water alone, even without the intervention of earth; but water without earth is insufficient. Mr. Homberg placed several seeds in moisture under the exhausted receiver of an air-pump, *i.e.*, without the presence of air. Some did not rise at all, and the greatest part of those which did made very weak and feeble productions." ("Cyc. Britannica Germination.") Air, as we have seen, is required for the elaboration and perfection of Fibrin.

As a resumè, then, of what we have adduced in regard to life, health, and longevity, we may say with Liebig that (1) the "first condition of animal life is the assimilation of what is commonly called nourishment" (nutritive food); (2) "the second is a continual absorption of oxygen from the atmosphere," or the breathing of a pure air; (3) the use of pure water which is also strongly insisted upon by him, inasmuch as its presence he declares to be necessary for the due performance of the vital functions (Organic Chemistry, p. 43), and as being required for all the transformations of the body (p. 111), to which we may also subjoin the elaboration of fibrin in the blood.

If we would possess, therefore, that state of constitution which betokens the highest degree of life and health; which is held to be the result of a preponderance of healthy fibrin in the blood; ensures to us the greatest freedom from disease, by the exalta-

tion of the vis medicatrix naturæ; and consequently in all probability the greatest prolongation of human life; *these are the three* main elements that can effect our object, and for which nothing else can be substituted.

ALCOHOL—ITS INJURIOUS INFLUENCE.

Now alcohol is well known to be entirely antagonistic to change in animal matter. No fact is more patent than that all kinds of dead animals, from the human being down to the lowest form of reptile, can be preserved unchanged, almost for any length of time, in dilute alcoholic liquid. Admitted into the system, it is found also greatly to diminish the amount of chemical transformation therein (page 68), and to manifest itself as a narcotico-irritant poison, from the presence of which the system has no rest until it is expelled from the organism.

Sir B. Brodie and others have shown, by experiment, that alcohol *robs arterial blood of its oxygen* during respiration. That it converts this fluid—that is, duly oxydised blood of a bright vermillion colour, and fitted for nutrition, into blood dark or black in its colour, innutritious in its nature, and literally poisonous in its properties. The most positive experiments have proved that the presence of black blood in the arterial vessels is directly hostile to human life. That it cannot be circulated through the head for more than a few seconds, without inevitably producing death. The effects of alcohol on the body in degree, therefore, are precisely those produced by drowning, strangulation, etc. Thus alcohol seizes upon and appropriates to itself the oxygen of the arterial blood, upon which the latter is dependent for its renewal and vitalising qualities, as well as for the perfect elaboration of its fibrin. And as oxygen is the great agent in the chemical transformations of the body, hence *the arrest of change of matter.* Thus the action of alcohol upon the bright scarlet arterial blood, is to change it to a dark or purple colour, and more or less resembling venous blood, and at the same time, as we shall presently see, to deprive it of good, healthy, and well elaborated fibrin.

The dark colour of arterial blood, by the use of alcohol, is plainly and unmistakeably manifested in the livid or purple countenance of the confirmed inebriate.

ALCOHOL VERSUS WATER.

It is in accordance with the facts and evidence adduced in this essay, that we may account for the contrast there is in the stamina, enduring energy, and augmented strength, witnessed in the water drinker in all heavy and laborious exertions and enterprises, in comparison with those who indulge in the supposed

nutriment (!) of intoxicating liquors. Water, and good nitrogenous food, being the producing elements of all true and healthy nutritious supply to the muscular organs, and alcohol being not only a non-producer, but a direct antagonist to the production of good healthy and well-elaborated plasm, calculated for the renewal of muscular tissue, of course, in the latter instance, when the elements of healthy supply are deficient, the power of muscular action must be decreased and enfeebled, and the power of endurance of toil correspondingly reduced.

It is on these accounts that, in all competitions and trials of strength between these two classes of men, victory, as a natural consequence, with fair play, must be on the side of the former.

The due development of animal heat for the continued sustentation of the temperature of the exposed, is also always adjudged by those who have made trial of these elements, to be in favour of the sons of temperance.

In the lower animals, which are naturally exposed to all the vicissitudes of atmospheric variation, we notice that none of them by Nature ever partake of alcoholic potations, but quench their thirst with water only. Yet great numbers of them surpass mankind immensely in muscular power, and all of them in endurance of cold, and, except by egregious wrong doing, during the period of life probably seldom know pain.

Perhaps no better illustration of the advancing opinion of society in general about water drinking can be adduced here than the fact, that men employed in the manufacture of armour plates for her Majesty's navy, and who have in bands to carry almost white hot and immense pieces of metal, some 14 inches thick, from the furnace to the forge, are not, it is said, permitted to taste alcohol while engaged in this laborious work. In order to protect them from the intense body of fire thus conveyed, it appears that around each waist is secured a sackcloth belt saturated with water. Moreover, such is the danger in the conveyance of the heated metal, that the occurrence of mistake in its transit might be fatal to many, and therefore to ensure perfect clearness of intellect during an operation so dangerous to human life, water, as a beverage, is imperatively enjoined by their employers.

It is also clearly evident, that in order to the development of the greatest amount of muscular power and endurance in so arduous an employment, alcohol is condemned, and water alone allowed.

More fully to evince the action of alcohol in the production of fibrin by water, I instituted a series of experiments, and the following were the chief results at that time arrived at.

INJURIOUS EFFECTS OF ALCOHOL IN THE DEVELOPMENT OF FIBRIN.

By the results of these, I found the original experiment (No. 3, page 4), in which albumen was suspended in porter, fully borne out as regards its resistance to the development of good, well formed, and healthy fibrin.

1.—PRODUCED ELIMINATION OF GAS BY ALCOHOL.

Exp. Oct. 18, 1872. A rope of albumen was suspended in dilute alcohol (1 part in 10 of water). It speedily commenced eliminating gas, and continued so to do for a considerable period. This was the case in all instances in which alcohol was employed. The same occurred by water alone, when old eggs were used, or where the albumen had been subject to a freezing temperature, evincing that alcohol produces a lowered condition of the vitality of the albumen operated upon. (See page 23.)

2.—REDUCTION OF SPECIFIC GRAVITY BY ALCOHOL.

Exp. S. In this experiment, as in all others in which dilute alcohol was employed, a great change was seen to occur in the specific gravity of the rope of albumen suspended in the liquid. It very shortly became so buoyant, as to rise up and float upon the surface of the liquid, and upon eversion of the bottle, rose up perpendicularly, and in that condition remained three months, or until Jan. 13, 1873.

3.—RESISTANCE TO DEVELOPMENT OF HEALTHY FIBRIN.

Exp. In Bass's beer, after remaining for three whole weeks, the interior of the suspended albumen continued still translucent, and apparently unchanged.

Exp. Nov. 18. The specimen which was immersed in dilute alcohol ($\frac{1}{10}$, Oct. 18), still remained more or less clear and transparent, during which period I frequently examined it under the microscope, but could in no instance observe any change indicative of the development of fibrin. Compare this Exp. with those in which water was employed. (Exp. 1, pp. 4 and 22.) On the 23rd November, however, it had assumed *a somewhat opaque white* appearance throughout. I removed a portion, and although remarkably soft and gelatinous in its appearance, I found, after exposure to the air, that by teasing it out fibrinous threads and minute fibrilla were produced. These were subjected to the nitric acid test, and it was evident that it had become more or less fibrinous, as no lemon yellow colour was produced. It remained undecomposed for the space of three months, when

for the first time (Jan. 13, 1873), it began to assume the specific gravity of fibrin, and to hang downwards in the liquid.

Oct. 10, 1877. This specimen still remains suspended in the liquid now for a period of five years. Its specific gravity, which in January, 1873, became greater than that of the liquid in which it was immersed, in October 1877 still remains the same. There is now some degree of departure from the original clearness and transparency of the liquid, which has at length become muddy, and the specimen flocculent, indicating that it is undergoing decomposition. Such is the resistance which $\frac{1}{10}$ alcohol presents to all change of animal matter. On the contrary, all specimens developed in pure water hang downwards from the very onset, and thus evince a specific gravity superior to the liquid in which they are immersed, and *enter into decomposition always in three or four weeks.*

4.—PORTER AND BEER—PRODUCTION OF A DARK COATING EXTERNALLY.

Exp. In all cases in which ov-albumen was suspended in beer or porter, the substance exhibited, after twelve hours or so, a coating externally of a dark colour, which, on submission to intense light under the microscope, was found to be composed entirely of corpuscles. In the interior, when this coating was opened, was generally found a small specimen of apparently genuine fibrin. These circumstances led me to conclude that the action of the alcohol was expended upon the external of the albumen in producing the dark corpuscular coating, and that the specimen within was the result of the action of the water, filtered as it were through this exterior coating.

5.—DEPRAVED FIBRIN PRODUCED BY ALCOHOL.

Exp. In pure water, in all these experiments, the fibrin produced always exhibited upon its surface well marked and acute fine lines or striæ, and intermediate fibrillæ of very minute character and diameter. On the other hand, in dilute alcohol or beer, etc., the fibrin itself produced was always found more or less bulky and bloated (if we may so speak), and often without striated lines, or if any, more distant and exposing intermediate fibrillæ of a broader, less acute, and more ribbon like structure.

6.—DECREASE OF TENSION AND FRACTION RESISTING POWER BY ALCOHOL.

Exp. Feb. 3, 1872. Fibrin (No. 1) formed in pure water, will bear being drawn out with needles into long threads, and

when let go its elasticity causes it to draw back again; whilst that formed in dilute alcohol ($\frac{1}{10}$, No. 2), cannot usually be drawn out more than half the distance, without snapping and breaking in two.

7.—DECREASE OF AGGREGATIVE POWER BY ALCOHOL.

When thus divided, the pieces of No. 1 attract each other, cling together, and unite into one compact mass, whilst those which had been produced by dilute alcohol (No. 2) appear to have little or no affinity for each other.

For instance, on two needle points being introduced into the liquid (No. 1), the pieces all cling to one another, and to the needle points, and the whole mass, thus adherent, is with facility drawn out of the water by the needles. This was repeated several times, without the aid of any magnifying instrument. But in No. 2, by the same measures being employed, not any one portion was seen to combine with another, although it did with difficulty come out of the water by the attractive influence of the needles.

Exp. In strong alcohol, albumen is at once destroyed, and assumes the appearance of a dense, insoluble, and brittle mass, the result of coagulation.

It is thus evident, as the result of all these experiments, that although the amount of fibrin developed by the use of alcohol may not in all cases be reduced in quantity, yet its substance is depraved. It becomes of considerably decreased specific gravity and lowered vitality, bloated in character, devoid of natural striæ, its tension or power of resisting fraction reduced, and its aggregative energy almost annihilated. Thus, by the use of alcohol in any form or quantity, fibrin as good sound healthy nutritive substance, is most seriously damaged or destroyed. Thus this substance, which we have seen to be the grand basic tissue and foundation material of the frame, becomes by this means evidently depraved and degenerated, and rendered unfit for the healthy nutrition of the organism. The consequences must of course be (in accordance with the specimens which we every day meet with), an unsound structure, builded up of unsound materials, bloated in its dimensions, and bulky in diameter; whilst its density, power of resistance, and solidity, are greatly decreased, and effectually prepared for the contraction of any manner or form of disease to which the body may be exposed.

ENFEEBLED CONSTITUTIONAL POWER OF HABITUAL DRINKERS.

The late Sir Astley Cooper, in his lectures on Surgery, used to remark that the draymen of the metropolis, who indulged so ex-

tensively in alcoholic beverages; notwithstanding their apparent robust appearance, burly dimensions, and seeming muscular strength, are men the least able to bear the effects of bodily injury and accident. He found that when any of these men as a class became the subjects of accident, which in those days appeared to require the removal of blood by venisection, the mere loss of one pint of that fluid was almost invariably followed by fatal consequences.

CHAPTER V.

ENTIRE CHANGE OF THE STRUMOUS AND TUBERCULAR CONSTITUTION INTO THE FIBRINOUS BY THE DEVELOPMENT OF FIBRIN IN THE LACTEALS AND SANGUINEOUS SYSTEM.

(Illustrated by several cases of successful treatment of Phthisis Pulmonalis, or Tubercular Consumption, Diseased Joints, Bones, &c.)

FROM the observations already adduced, it has been shown that the predominance of corpuscles of low vitality in the blood forms the true hindrance to the healthy healing of the lesions of the body, and especially to that rapid process of agglutination which is denominated the "adhesive inflammation, or healing by the first intention." That it presents the predisposing cause of the suppurative inflammation which so eminently retards the healthy healing of wounds, etc., and constitutes the basis of that unhealthy character of the entire system which is denominated the strumous-scrofulous, or tubercular diathesis (constitution). In this latter state of the body are discovered diseased bones, unsightly and long discharging abscesses, diseases of the joints and spinal vertebræ, etc., and above all that vast scourge of humanity termed phthisis, or pulmonary consumption.

To be able to *remove this state of constitution, and to substitute for it what is called the fibrinous diathesis,* is a proposition well worthy the consideration of every true lover of the healing art: since this state of constitution has been shown to be the basis of all speedy, sound, and healthy processes of healing, the promoter of all healthy function, the mainspring of strength and of the vital force, and the indicator of the most sound health of which the frame is capable. But this transformation appears to be more or less perfectly fulfilled by the use of the measures which form the chief subject of the chapter before us.

I.—FOOD, ADMINISTRATION OF.

As food is the raw material from which all the nutrient substances of the frame have to be elaborated, the selection of aliment becomes a most important feature in the maintenance of health, the prolongation of life, and the treatment of dis-

ease. Food designed to exalt the power of the vital force in diseased bodies, and to afford an abundant supply to the tissues and laborious organs, must of course be easy of digestion, highly assimilable, and pre-eminently nutritious. Just as no image is ever witnessed upon the reflecting surface of a ruffled lake, and inasmuch as nature seems to teach us that even wasted organs receive their supplies during the peaceful hours of slumber and repose, so all food designed for the nutrition of the body whose nerves are already ruffled by the disturbing influences of disease must be bland, mild, and free from irritative or provocative qualities. The very presence of an acid or acrid principle in food may, in the case of a susceptible person, prevent the nutrition of the tissues, even with the most powerfully nutritive aliments. Thus pork, in every form, ham, bacon, tongue smoked, pickled, salted, or potted, fish, and salted and rancid meats, sauces, pickles, marmalades, preserves, vinegar, and dried and, in many instances, even ripe fruits, etc., may prevent the salubrious assimilation and anticipated nutrition of food of the most nutritious kind. Even hare, duck, geese, and salmon, shrimps, shellfish, sardines, etc., possess within them an acrid and irritative principle which produces considerable suffering in highly susceptible and nerve-shattered subjects. The most bland and unirritating of ordinary nutritious foods is tender beef and mutton, lamb, venison, roebuck, pheasant, partridge, grouse, woodcock, fowl, turkey, etc., and of fish—trout, sole, pike, perch, turbot, whiting, etc., etc. The fowl's egg and cow's milk, fresh butter, bread, and oatmeal, together with ordinary and unirritating vegetables, and milk, bread and farinaceous puddings, form stable additions to the more substantial meals of ordinary life.

THE FIBRINISED EGG, OR ARTIFICIAL FIBRIN, AS A DIETETIC.

In the transformation of the corpuscular into the fibrinous constitution, as well as in the strength-giving treatment of multitudinous diseases, we find no food so directly applicable as that of the fibrinised egg for the production of this important change. By the immersion of an egg divested of its shell, in cold water for twelve hours, it is found that its *Albumen* ("*white of egg*") has, in accordance with the principles herein enunciated, assumed more or less the character of Fibrin. A portion of the same placed under the microscope exhibits an entire fibrinous appearance, either in the shape of striated fibrinous material or corpuscles. Already transformed by the action of cold water, it presents us with the very substance we require for our present purpose. By this means we are enabled to give to our patient fresh and, as it were, solid fibrin to eat, the material itself that is so pre-eminently needed in the system and in the blood. The extreme *lightness* of this sub-

stance in the alimentary organs would almost lead one to draw the very extraordinary conclusion, that, as it highly resembles the coagulable material first formed in the lacteals, it appears to pass the digestive organs without undergoing change, or requiring the digestive process to be exerted upon it, no change being necessary, inasmuch as it has already passed into that condition to which digestion would reduce it.

Such, indeed, is its extreme lightness in the digestive organs that it literally dissolves in the mouth, even without mastication. There are numerous cases to which the author is able now to refer, in which the digestive power was reduced to a minimum, who have found this most nutritious substance to be exactly adapted to their condition.

Many have adopted its use, who had been quite unable to eat a single boiled egg for a long time without considerable pain or uneasiness of some kind, and find that they can partake of one or two of these fibrinised eggs with perfect impunity, ease, and comfort. There have been also several other cases in which this artificial fibrin has been retained when almost all other food has been rejected by vomiting. The fibrin supplied by these eggs is useful in preventing loss of blood by bleeding; in the protection of the system during formations of matter; in the healing of ulcers, wounds, and other lesions.

It is found to be admirably adapted to cases of long standing dyspepsia. Its presence in the stomach being attended with perfect ease, and freedom from pain, flatulence, and eructations; whilst from the ordinary boiled egg these symptoms had in many instances been very distressing and almost unendurable.

But the grand use of this substance is found to be in conjunction with other measures in cases of recent tubercular, or pulmonary, consumption; and, no doubt, equally so in all strumous cases, or when there is a predominance of corpuscles of low vital power, or of tubercles in the system. It appears to supply such an amount of fibrin to the vomicœ, or ulcers of the pulmonary organs, that, as we have found, the very character of the sputa itself is changed. Indeed, whilst other medical men have been despairing, and giving their verdict that the patient was actually expectorating the substance of the lung itself, we have been able hopefnlly to point out that such was not the case, but that so great was the profuse supply of fibrin to the diseased organ that the patient was actually expectorating plasm or artificial fibrin from the surface of the ulcers, and that this was to us a criterion that the ulcer would soon be healed. So far as we have witnessed in recent cases the tendency to heal under the use of stimulating inhalation has been constant, four fresh vomicœ having healed in succession in one individual case, and they have

at all times shown, under fair circumstances, a constant disposition and tendency to certain and progressive restoration.

PREPARATION OF THE FIBRINISED EGG.

The "fibrinised" egg is prepared in the following simple manner:—Divest an egg of its shell, as done for "poaching," and plunge it into, say a pint, not less, of cold water. When it has remained immersed from twelve to twenty-four hours, it will be found to have assumed a perfectly opaque white aspect and solid condition. The water, with the egg still immersed, must now be raised to the boiling point, and it will be ready for use, and may be eaten as an ordinary "poached egg." It is found, however, in the preparation of these eggs that the use of a piece of galvanized iron wire gauze some three and a-quarter inches square, with its edges turned up for about three-eighths to a-half inch on every side, will, when placed at the bottom of a basin of water and the egg upon it, allow the under surface to be likewise exposed to the action of the water, and by this means a greater amount of transformation effected. When the egg is not very fresh, the albumen is apt to rush to the surface or to be dissolved in the water, especially in winter, and in such case a lid or cover of the same material as above-named will be found useful. For the wire gauze, an ordinary gauze wire strainer is found to be an admirable substitute when galvanised.

In summer, in which the egg is very fresh and highly vitalised, the transformation is almost entirely fibrinous and not corpuscular, and the operation requires to be carried on in a cool place, or it would become rather too firm and solid, and not as easy of digestion. Developed "vital" corpuscles are always the most tender and delicate, more readily dissolve in the mouth, and, being of the same nature as the products of digestion, appear to need less digestive energy exerted upon them. (See pp. 41, 43, 31, 27.)

II.—WATER, ITS EMPLOYMENT.

It is quite true that individuals who enjoy a high degree of health are frequently found to be the subjects of the administration of water. It is now a well known fact that water drinkers far surpass the imbibers of alcoholic drinks in their capacity and appetite for nutritive aliments, the clearness of their intellectual powers, strength of muscle, and endurance of fatigue. This sparkling liquid is by them frequently partaken of in the form of beverage; and, providing they do not see the necessity of resorting to the cold sponge or ablution on rising, they may be during the day frequently bedewed by the passing shower, which refreshes the absorbents of the skin, and their thirst as it were quenched by the wetted garments, as well as by perspiration itself.

Hence in them there is a continuous supply of the elements which, with the abundance of food taken, develop fibrin in the blood.

But since the invalid usually is unable to endure the falling shower, or to resist the, to them, evil influence of wet clothes, artificial measures of this kind have to take the place of the provisions of out-door life which nature supplies. In addition, then, to the imbibition of water as a beverage, the intention of providing a continuous supply of water to the skin, and by it to the absorbents of the body, is fulfilled by the use of various baths and ablutions, of a temperature exactly adapted to the capabilities and powers of the sufferer. In addition to these, a very valuable mode of producing absorption of water by the lymphatics is found in the constant application next to the skin, of what are called wet compresses and bandages, wet lint, etc., covered by dry materials or waterproof, and what are denominated wet packings and hot fomentations to the same. Besides the valuable aid they themselves provide in alleviating the diseases of the body, they form a very efficient and useful mode of supplying the absorbents with abundance of this salubrious liquid. In this manner the passing aliment taken up by the absorbents from the digestive organs is at once met and acted upon by the water thus imbibed by the absorbent system, and gradually and systematically transformed into coagulable lymph and corpuscles, which passing through the thoracic duct, etc., enter the circulation of the blood, and daily, all other accompanying adjuncts being present, tend to increase the amount of coagulable and fibrinous material, and to transform, as we have declared, a redundance of corpuscles into a predominance of fibrin in the blood. (See pp. 9, 13, 14, 15, 16, 20.)

The rapidity and certainty of this process is also, as we have, shown, considerably increased by the employment of the fibrinized egg already described.

ABSOLUTE NECESSITY FOR A DUE SUPPLY OF WATER TO THE BLOOD.

We have frequently known individuals shudder at the thought of water being taken into the system, pure and simple, and without addition. Such parties entirely forget, if ever they were aware, that water forms three-quarters, or about 75 parts per cent. of the blood and substances of the animal body.

That water is absolutely necessary to the system is seen in that in various diseases, such as typhoid fever, cholera, erysipelas of a typhoid type, etc. (as shown in a paper read by the author at a meeting of the British Association in Oxford, 1847), deficiency of water in the blood is found to be the chief source of disease by producing a great preponderance of the solid

over the liquid components of this fluid. But when water was duly supplied, the preponderance gradually ceased, the typhoid and other symptoms passed away, and inflammation when present disappeared The same remedy was also employed during the cholera of 1832 with extraordinarily beneficial results. In these latter cases the watery part of the blood had been removed by the diarrhœa incident to such cases, whilst they were deficient also as regards its quantity by inattention to the wants of nature, or otherwise by the attempt to quench thirst by alcoholic instead of aqueous drink.

III.—AIR, OR THE BREATHING A PURE ATMOSPHERE.

We have already shown that although atmospheric air of itself is quite unable to transform one molecule of animal material into fibrin, yet, when already transformed by the action of water, air is equally essential for the perfection of its constructive properties, or, in the words of Dr. Carpenter, its complete elaboration. Indeed, the estimation of the value of pure air to the animal organism cannot be placed too high. The human body can live without food, as we have already observed, many days; but deprived of air, although for a very few minutes, the powers of life become at once extinct. Neither is it possible to overestimate the value of pure air for the healthy performance of the functions of the organism. Health, strength, freedom from disease, endurance of toil and fatigue, and prolongation of human life, are usually found among the ranks of those who reside in a pure, fresh, and untainted atmosphere. From these facts the importance and value of the sanitary arrangements, which in our day are held in such high estimation, are evident. Although all men cannot live in a pure and salubrious atmosphere, yet all men can endeavour to secure as much pure air as lies within their reach. In such cases, in order to the promotion of even comparative purity of atmosphere, the suburbs of a smoky manufacturing town will always be found preferable to the town itself. (See pp. 7, 9, 10, 17, 60, 61, 82, etc.)

Then all foul odours must be abolished, good drainage effected, and good and free ventilation adopted. There must be, as far as possible, lofty rooms, open fireplaces and windows, and the free admission of light and air into the dwellings. The water for drinking must be pure, and the food untainted and undecayed. No overcrowding of apartments, no centres of decay and decomposition, no contiguous green or stagnant pools, open sewers, or decomposing sewage, cesspools, or other sources of obnoxious effluvia. All filth, dirt, and bad habits, filthy apparel, etc., must be removed, and every possible salubrious measure adopted which will tend to increase the purity of the person, clothing,

dwelling, and atmosphere in the locality. It is this pure atmosphere which, as we have already noticed, *causes the more or less perfect elaboration of the coagulable material which is transmitted through the pulmonary organs for this purpose.*

Again, as far as possible, the pure, nutritious, and unadulterated food which Nature furnishes must be partaken of. All thanks to the efforts that are at present in these days put forth by the strong arm of the law in order to expose and destroy the adulteration of Nature's own precious gifts and supplies.

The sweet sleep which is only realized and enjoyed after laborious toil and exercise is well known to be one of the highest promotives of health. Moreover, the mountain rides and drives, the ascent of the steep and romantic cliffs, the observance of beautiful, ever changing, grand and picturesque scenery, the cheering and exhilarating influence of charming society, are all well known to be provocative of the highest and most desirable state of health, and all these may be set down as measures by which fibrin is developed in the blood. To these may be added, as already seen, the endurance of the passing shower without damage, whose salubrious drops the skin so eagerly imbibes and employs for this invaluable purpose.

SPECIMEN CASES OF PULMONARY CONSUMPTION RESTORED BY WATER, INTERNALLY AND EXTERNALLY APPLIED, PREVIOUS TO THE DISCOVERY OF THE FIBRINISED EGG.

In 1845, Mrs. T———, of Manchester, greatly reduced in health and strength, attended with much emaciation, had taken to her bed. Expectorated large quantities of purulent matter, about one quart daily; night perspirations, streaks of blood in the sputa; pulse rapid, breathing much affected on going up stairs, respiration twenty-nine to thirty per minute, appetite none, taking little food, digestion morbid; her medical attendants holding out no hope for even amelioration of symptoms.

This case was treated simply with tepid sponging, and wet friction to the chest once or twice daily, together with the wearing of wet linen, covered by waterproof, next the skin (called a compress), the linen being wet only after each bath. Took cod-liver oil and good nourishing foods. Under this treatment, the digestive organs rapidly rallied, the respiratory organs gained strength, and dyspepsia gradually lessened.

The cough was met on the onset by a simple linctus, and speedily gave way, and the patient became very fleshy and robust. Her weight was not, however, taken. Although the cough and chest affection never entirely left her, yet they became matters of secondary import, and the lady lived seven years, gained a very

fair share of health and strength, and died ultimately, not of the disease, but fell a victim to domestic grief and sorrow.

Robert Norris—a hospital case, from near Shevington, Wigan, much emaciated, severe cough, expectoration of purulent matter for years, occasionally streaked with blood, severe difficulty of breathing on ascending rising ground or going up stairs, pulse 123 per minute, night sweats, respiration twenty-eight to twenty-nine per minute, left lung hepatized in its upper part, and little or no respiratory murmur. Declared to be consumptive and incurable by his medical attendant he came to the hospital about May, 1859. The treatment consisted of a tepid sponge over in bed, one part at once, every morning, and wet friction to the chest, noon and afternoon, the wearing of a wet linen compress, covered by waterproof material, both to the chest and abdomen. This patient had also what is called the wet pack of hydropathists, only the wet piece round the body was only about nine to eighteen inches wide: well covered with several blankets till warm, and followed by a tepid wash down. Under this treatment, with good nutritive food, this patient entirely recovered, so as to live and follow his employment for many years.

Some scores of incipient cases of pulmonary phthisis (consumption) similarly and successfully treated at this *hospital for the relief or cure of diseases by external applications* could be here adduced, but space does not permit.

Mrs., the wife of the Rev. W. Kitson, of Lymn.—Her sister, two cousins, one uncle, and an aunt, had all died of pulmonary consumption. She had been suffering six years from hoarseness more or less, pulmonary cough, and shortness of breath on ascending an eminence or employing any extra exertion; expectoration of purulent matter, often streaked with blood, considerable emaciation, and night perspirations, hepatization of the left side of the chest, with pain in shoulder-blades and left arm, hectic flush and fever in an evening for years. This case has been under the use of a morning ablution and wet compress on the chest and abdomen now for about four years, commencing first at Southport in 1873. She has lost her cough, night perspirations, hoarseness, difficulty of breathing, and gained weight, flesh, and strength. Is now nearly well, and is expecting, by the use of water alone, entirely to recover from her long indisposition.

We think the above cases are sufficient to show that the development of fibrin in the lacteals, by the internal and external use of water, and nutritive animal substances, does transform the tubercular into the fibrinous diathesis (constitution), and proves itself thus to be the great want where the tubercular condition obtains.

TREATMENT OF CASES SUBSEQUENTLY TO THE DISCOVERY AND EMPLOYMENT OF THE FIBRINISED EGG IN CONJUNCTION WITH EXTERNAL APPLIANCES.

The Rev. J. R. B., of Sheffield, had suffered from chest affection about a year and a half, and from indigestion for years. Found his strength failing very much about April, 1876, when the cough was particularly noticed. Had symptoms of great weakness, considerable lassitude after slight physical or mental efforts, accompanied by cough, loss of appetite, constipation, night sweats, hectic fever, and shortness of breath, especially on going up stairs or ascending rising ground, expectoration of purulent matter, which at times was streaked with blood.

Came under treatment here in June, 1876, after being for some time under medical treatment at home, and recommended to Southport by his medical adviser, who had no hope of his recovery. The stethoscope evinced almost complete hepatisation of the right lung, with the entire loss of respiratory murmur for the upper two-thirds of the same. This gentleman took two fibrinised eggs every morning to breakfast; had a tepid ablution of the most mild form one hour before rising, and wet friction to the chest noon and afternoon, with a suitable wet pack about once per week. He employed, when out of doors, both nasal and oral respirator all winter; wore wet linen, in the form of compress, covered by water-proof, next to the skin of the chest and abdomen. The former speedily brought out a *critical eruption*, attended with a discharge of *dark green matter* for several months. These and other appliances were also accompanied by the administration of cod-liver oil, inhalations, and as much nutritious food as possible. In about nine or ten weeks, his cough was greatly diminished, chest much improved, and the patient had gained twenty pounds in weight. Fibrinous threads and fibrillæ were observable in the sputa, under the microscope, along with the pus corpuscles, indeed, he *actually expectorated plasm*, which enabled me to state my belief in, and anticipation of, the healing up of the chest ulcerations.

In February, 1877, he had a very severe attack, which came on with inflammation of the bursa in front of the knee, with intense pain, and which greatly aggravated all his symptoms. There was hectic fever, pulse from 120 to 130 per minute, great increase of cough, and expectoration of purulent matter streaked with blood, etc., etc., and the patient had to take to bed for some ten days or so, in which time he lost about nine or ten pounds, and became exceedingly prostrate. On recovering from this serious attack, and returning to his former treatment, he regained, however, some four or five pounds in about three months.

Since his return home, he has continued the treatment as far as practicable, and the fibrinised eggs, etc.; and in his report of himself he says, "I am feeling stronger, and better able to walk and work than for many months past. My appetite is good, and I sleep well. I am taking regular work. I preach twice on the Sunday and three or four times during the week with ease. I feel that changes of temperature, etc., do not affect me as they used to do. I am careful to avoid too frequent alternations as far as possible; but the changes I have been exposed to have not materially affected me, only so as to produce tickling of the throat two months ago. This, however, I soon got right again by the use of linseed poultices and throat compress. *I do think that, were the measures adopted in my case generally applied in similar instances, many lives might be saved that are otherwise lost.*"

The second case was Miss M———, of S. Several of her relatives, as well as two brothers, had, it appears, died of pulmonary consumption. She had suffered as a child from severe winter cough, and, having no advice to the contrary, did many things which tended to exasperate and prolong the pulmonary irritation. About four years ago, the affection began to be attended by "hœmoptysis," or expectoration of blood. A second attack of this nature occurred about two years afterwards from a little extra exertion. After this attack, she spent the winter in Torquay. In March, 1876, she experienced severe stitches in the chest, which "caught" the breath, and suffered from hectic flush in the evening during the whole winter. The journey home and some over exertion afterwards brought on a third attack of hemorrhage (bleeding) from the lungs, of a more severe character, when she expectorated from a half to a pint of blood. After this period, the cough commenced in earnest, and expectoration of purulent matter attended with the ordinary signs of tubercular phthisis, physical and stethoscopic, which continued until her removal to this place, August 26, 1876. Previously, she had been given up by the two principal physicians of her native town. On examination, the left side of the chest was found to be tolerably good, and has been all through the treatment; but the upper half of the right lung was discovered to be completely hepatised, and no respiratory murmur heard on any part of the surface. Little or no resonance on percussion; the only sound of importance being that from a small cavity situate in the upper part of the right lung, from which the purulent expectoration emanated, occasionally streaked with blood. There was, however, the absence of night perspirations, and, with few exceptions, a slow and very weak pulse. External appliances were instituted along with the fibrinised egg, with the intention of entirely

changing the tubercular into the fibrinous diathesis (constitution). Frequent wet frictions, at seventy degrees, to the chest were employed, to fortify the skin against changes of temperature, cold, damp, etc. An occasional wet and hot pad was applied to the suffering organ, and the chest kept constantly in a state of *crisis*, from which issued for months, as in the former instance, *a green fluid*, as green as grass, and the exact colour of the sputa expectorated at that time. Cod-liver oil was persevered with, and everything which could possibly conduce to the support of strength. A mild wet pack occasionally was found invaluable all through the treatment: inhalations, enemata, when required, and measures adopted to lessen chest congestion. Unfailing out-door exercise was adopted in fair weather, always in localities sheltered from strong winds, and indoors when wet. The interior of the chest was at all times, except in the very mildest weather, protected when out of doors by a *naso oral* respirator, south or south-west aspect of bedroom and sittingroom selected, and every care taken that could possibly avert exasperation of the complaint. In February, by a little mistake made, a fresh vomica formed, and rendered the case very unpromising for some weeks. These vomicæ (abscesses) continued to form also afterwards at different periods, and rendered the case for a long time very doubtful of recovery. Yet, strange to say, by constant perseverance in the remedies, there was ever and anon *a manifest* progress and *disposition in the organism to heal these newly-formed abscesses*, during which, with fair play, the cough and sputa decreased; and we have just now, October, 1877, had the high satisfaction to witness the last vomica, formed at the termination of spring, producing scarcely any expectoration, the cough all but gone, and what small quantity of phlegm there is, thick, tenacious, and actually *plasmatic from the large amount of fibrin* contained in it, as seen under the microscope; it is also less purulent, exceedingly loose, and expectorated without much effort.

On January 29th, 1877, we had the great satisfaction to notice the first sound of respiratory murmur in the upper part of the right lung, which has continued to spread with more or less change, and now a good respiratory murmur is heard over every part of the suffering organ, and the patient that at first ascended the stairs with the greatest difficulty can now mount them with a quick step. The appetite, which was reduced to zero, is in full exercise, general health and strength improving, and the weight of body increasing. High winds, formerly so prejudicial, and atmospheric change are now borne with considerably increased impunity; and, I may say, progress in every department gives hope for an entire and perfect recovery.

In this case, which was very minutely watched, I found that particularly in the *treatment of pulmonary consumption* (and often in bronchitis and other diseases of the respiratory organs in this variable climate) the following essential rules require more or less the most sedulous fulfilment and the most urgent solicitude in all parties intimately concerned. In fact, if success must be secured, they are so imperatively necessary in highly susceptible persons generally, that without these the most promising case may be entirely lost.

1. Sandy, rock, or other dry substratum, and not clay.
2. Pure and dry, and not foggy or steamy, atmosphere.
3. Well sheltered residence, without excess of foliage.
4. As far as possible, capacious and lofty rooms.
5. South and sunny aspect of all rooms occupied by the patient.
6. Judicious and excellent ventilation.
7. Hot rooms and highly artificially-heated atmosphere, together with hot food and drinks, to be especially avoided.* Room temperature to be maintained at about 62° when possible.
8. Clothing of all parts of the body to be always in proportion to the atmospheric temperature and in accordance with the voice of instinct, but never, either in or out doors, so great, as to produce uncomfortable heat, or more than to preserve an equable, moderate, and comfortable temperature.
9. Out-door exercise, as far as the strength will permit, in the open air twice daily, but not to fatigue, or to waste the vital energy. The walks must always be sheltered from strong prevailing winds, especially from the north, east, and north-east, by rows of houses, walls, or plantations, etc. In a town like Southport, which is highly adapted to chest cases, this can generally be accomplished. When rain, heavy fog, or much moisture is present, in-door exercise, and, if possible without fatigue, half an hour twice daily.
10. The pulmonary organs and air passages must always be protected in winter, rough or cold weather, and in summer when necessary, in severe cases, by both a nasal and oral respirator, which must be clothed in proportion to the velocity of the wind and lowness of temperature.
11. Early morning and night air must be entirely avoided—say from the extremes of after three p.m. in winter and five p.m. in summer; and before eleven, or so, a.m. in winter and ten a.m. in summer.
12. Must avoid chill, wet (and even a few drops of rain), and draughts of air, and keep comfortably warm at all times—not so

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* See further remarks on the treatment of Struma, at page 103.

much by increasing the heat of fire, but by extra clothing or by wrapping up to the arm-pits in a good rug.

13. Be most careful about all these latter rules, especially when suffering already from cold taken; and keep the surface comfortable by extra clothing until the latter is removed.

14. In cases of hæmoptysis (chest bleeding), be very careful to prevent, if possible, all paroxysms of severe racking cough, or, indeed, excitement or exertion of any kind, which may cause the rupture of another blood-vessel.

15. In all cases of emaciation, the full, free, and frequent administration of the most nutritious foods. Three general meals per day, at which fibrinised eggs, good animal food, fowl, sole, etc., are taken, and beef tea, beaten-up egg, milk and bread, or other nutritious liquid, introduced once or so between each meal hour.

N.B.—It must ever be borne in mind that *the use of judicious fibrin-producing measures almost invariably improve the appetite and digestion, and every function of the body.* (See page 92—II., etc.)

STIMULANTS AND MEDICAMENTS.

16. In accordance with the principles herein manifested, alcohol, as a rule, is antagonistic to this natural plan of cure; yet sometimes, when the constitution is very weak, faint, or feeble, one wine-glass of good claret, with as much water, daily or so, will be found useful. A nervine mixture made up at the chemist's, and containing some chief stimulating medicaments, may be administered in small quantities instead. But all these matters will of course be left to the wise discretion of the duly authorized medical attendant.

17. Whatever causes or course of life *known* to bring on the disease must be most sedulously avoided; seeing that, so long as the cause is persevered in, the effects will assuredly follow.

INJURIOUS EFFECT OF HEAT, HOT ROOMS, OVERCLOTHING, ETC.

The general effect of heat applied to the animal body is the diminishing of warmth and power. By breathing hot air, the lung becomes more or less *congested,* and the *determination* of the circulation of the blood is increased in the direction of these organs, which is often a chief exciting cause in chest cases of *cough, dyspnœa,* or *difficult breathing;* the tendency to *spasmodic* action is engendered, susceptibility to cold is augmented, and cough exasperated; the use of the respirator is more and more necessitated, and the pulmonary organs increasingly debilitated and enfeebled. If previously there were power to endure a cooler atmosphere, that will become gradually lost, and the strength of the respirator will have to be proportionately increased.

Similar effects are at the same time accomplished outwardly in the skin by living in hot rooms. The heat of the room enfeebles the skin and perspiratory organs, increases susceptibility to cold, and especially to draughts of air. Even a moderately mild atmosphere now tends to produce chill. All heated parts of the body are colder when the heat is removed, and a medium temperature is afterwards hardly endurable. By this means, the tone and fortifying influence of all baths and ablutions is destroyed, the general tone of the body is dissipated, and the strength of frame reduced. Emaciation and loss of flesh are the sure concomitants, and the general energy of the organism is reduced, at the same time that the power of the disease may be thus rendered victorious. Inasmuch as, according to Liebig, exposure to cold increases, so warm air diminishes, appetite and digestive power. Buoyancy of spirits will be reduced, and the vital force itself, which, as the *vis medicatrix naturæ*, or healing power of nature, may be so greatly lowered, and hereby diminished, as to render it unable to heal the lung and effect the cure.

THE SOUTHPORT HOSPITAL FOR THE RELIEF OR CURE OF DISEASES BY EXTERNAL APPLICATIONS, &c.

SUCCESSFUL TREATMENT OF SCROFULOUS AND OTHER DISEASES OF THE JOINTS, NECROSIS AND DISEASED BONE, ETC., BY A NEW AND SIMPLE PROCESS OF EXTERNAL AND FIBRIN PRODUCING APPLIANCES IN CONJUNCTION WITH HYGIENE.

In the treatment of cases of this nature, I had for a long time employed wet compresses, hot fomentations, and poultices, without any beneficial result or amelioration of symptoms. The parts to which the latter were applied became evidently worse, and, by frequently repeated hot and relaxing appliances, only more and more tumefied and disorganized. We had also used steam, hot air, and the wet pack, tonic wet frictions, washings, and local spoutings, and frequently the douche, in many instances without any certain salutary effect. At length a new mode of procedure was tried by the *author*, and has been found almost uniformly successful. *The diseased part was subjected to hot fomentation for ten minutes, followed by immersion in tepid water (seventy degrees Fahr.) for three minutes, three times a day.* This was effected by a sixfold pad, or compress, of flannel wrung out of hot water, from 102° to 110° Fahr., well and warmly covered with similar dry material, and generally under the bedclothes. When immersion was not practicable, *sousing* with tepid water was substituted for the same length of time. In the meantime, the

suffering part was covered with wet lint, linen, or calico, in the form of wet bandage, or compress, generally six or eightfold in thickness, wrung out of cold water, and enveloped in waterproof material, etc.

CONSTITUTIONAL AND GENERAL TREATMENT.

The indications for general treatment were chiefly as follow:—

1. To dilute and then eliminate morbific matters from the blood.
2. To produce a healthy state of the functions of the digestive and other vital organs, and thus to impart the highest possible degree of tone and energy to the constitution; or, in other words, to *exalt the vis medicatrix naturæ.*
3. To change the character of existing plasm circulating in the lymphatics, lacteals, and sanguiferous system from a morbid corpuscular into a healthy fibrinous character by the development of good and well elaborated fibrin in the blood.

1. For the first intention, the hot air and steam bath, the wet pack and wet compresses were employed, in conjunction with water diluents, such as tea, cocoa, milk, etc., and water, in any other form.

2. The second indication was met by general tonic baths of a temperature adapted to the vital powers and reactive energy of the sufferer, such as the bed ablution, the wash down or general ablution, the so called dripping sheet, the rain bath, the douche, etc., and cold water as a beverage. Moreover, the pack, hot air and steam baths were, of course, always instantly supplemented by a tonic bath of the latter kind.

In addition to the above, all manner of hygienic measures were adopted. The chief of these were pure air, out-door life and exercise under proper limitations, good and nutritious food and uninjurious beverages, regular hours, due repose, rest, and sleep, and suitable arrangements for maintaining due exhilaration and tranquillity of mind and body.

3. In order to fulfil the third indication, all such measures as are calculated to *supply the absorbents and chyliferous vessels with nutritious animal substance and pure water, and the chest with pure air at the seaside (as preferred) for respiration.*

By these measures the "tubercular" state of constitution was exchanged for the "fibrinous," and "suppurative" for "adhesive" inflammation.

Of course, all injurious and not easily assimilable foods were prohibited, as well as alcohol in every form. The latter we have elsewhere shown to deprave and destroy the healthy characters of fibrin, and to have a tendency to produce a sub-vital corpuscular instead of a fibrinous diathesis.

The cases subjected to this treatment were the following,

which have been almost the entire number of such cases admitted into this hospital since this new plan of treatment was adopted:

1. Mrs. Whittle, of Preston, admitted January 18th, 1869. Chronic inflammation and general swelling of the knee joint, but brought on by injury, and not apparently scrofulous. Treatment: hot fomentation to the knee ten minutes, three times a day, followed by immersion of the joint in tepid water for three minutes. Some sixfold wet bandage round the knee, with waterproof, constantly applied. She wore an abdominal compress, which was also re-wetted three times a day, and was placed under constitutional treatment, such as already described and indicated by the nature of the case, under which she remained about six weeks. She had scarcely been able to move about for two whole years previously to her coming, and came with crutches to the hospital. February 3rd, began to walk, without help of any kind. Left the hospital, February 27th, comparatively well, and has been little troubled with the affection since that period.

2. Jones, of Wrexham. Necrosis (death) of tarsal bone, and scrofulous disease of the ankle, which was much tumefied. The above method of treatment, viz., hot fomentation to the foot and ankle, with subsequent immersion, and a sixfold wet compress, with waterproof, upon the parts affected, were employed for some three months, in conjunction with a wet compress in front of the abdomen, with a general course of constitutional treatment, when he went away. He afterwards returned, and remained under treatment some six weeks more, during which period the necrosed bone was removed by exfoliation; the sore healed and became quite well, and he has not suffered from the affection since.

3. The following may be viewed as a model case:—Mary Tute. Admitted into the hospital, January 30th, 1869. Scrofulous disease of the elbow-joint, hand, and wrist, but chiefly of the elbow. The elbow was much swollen, and covered with discharging sinuses, its flexion, extension, and rotation all but annihilated. The treatment was at once commenced as follows:—A sixfold wet compress, or bandage, to the elbow was employed, covered by waterproof. The wash down two or three times a day, and the mild wet pack two or three times a week. Feb. 12th, the cold douche was ordered down the spine and legs daily at noon. The elbow *gradually decreased in size, and the discharging orifices dried up.* By the sedulous employment of the *foment* and *immersion* and renewed abdominal compress three times a day, in conjunction with the constitutional measures, she became gradually more and more healthy in constitution;

and as the joint assumed its natural size, its use was gradually restored, and *flexion, extension and rotation* more and more easily accomplished. March 5th, the waterproof covering of the compress was left off, and the elbow was douched for a short time daily. April 15th, the douche, which had been discontinued for a few days on account of slight irritative fever, for which one or two fever packs were employed, was now resumed, when after a few weeks more treatment, this girl went away restored to a very healthy condition both of life and limb.

4. Greenwood Lindon, admitted October, 1869. Scrofulous disease of the ankle-joint for eight months, with several discharging sinuses. He was subjected to hot fomentation and immersion, as above described, and also to sixfold wet linen round the joint, with waterproof, and a wet covered compress to the abdomen. Also suitable, general, or constitutional treatment, such as already described. November 9th, the ankle was subjected to cold spouting from a tube for that purpose. December 22nd, an eruption came out spontaneously upon the ankle when the spouting was omitted. December 30th, cod-liver oil was ordered to be taken. February 2nd, some degree of fever occurring, fever pack was ordered daily or every second day, followed by tepid drip sheet. This was omitted February 4th. March 7th, can now move the joint much better; swelling and discharge less. In this case, the ankle was ultimately completely restored.

5. R. L., Bolton, Lancashire, admitted March 24th, 1869. Scrofulous "white swelling" of the knee-joint. Anchylosis (a stiff joint) had taken place previously to his applying for medical aid. The ordinary measures already described were instituted. This man was for a considerable period quite an inebriate, and a very unmanageable patient. But as time advanced, and he found the new mode of treatment producing a marked salutary influence upon the limb, he began to conduct himself better and to treat others with more respect. There was nothing peculiar in this case, save that he had crisis solution applied to the knee, which brought out an eruption. The knee became perfectly restored to its normal size, soundness, and usefulness, with the exception of its immobility. Since that time, he has gone through a variety of hardships, such as night watchman, attendant upon maniacs, and has frequently had to struggle with them, etc., etc., under which severe employment the knee has not given way, and he is to this hour a useful member of society, earning his own livelihood and burthensome to none.

6. M. Povey, Birkenhead. Scrofulous swelling of the foot five years, with necrosis of the tarsal arch. Came under treatment Jan. 18th, 1870. *The foot was fomented at* 102° *to* 110° *Fah. three times a day for ten minutes, followed by immersion in water at*

70° *three minutes*, and all indicated constitutional measures, such as above named, were employed, together with a wet, covered compress on the abdomen. The foot, at first much swollen, became gradually reduced in size. Sometimes inflammation would set in, and tumefaction again ensue. But the occurrence of these indications was found always simply to precede and to be the harbinger of exfoliation of bone, which occurred in two or three instances during her stay here. This case remained some months under treatment, and afterwards, the sores all being healed, she went home, there to pursue the same process of cure. During the latter period, I often met her driven out by her father, in obedience to prescribed orders, when, on being interrogated as to improvement, the answer was always in the affirmative. After a few months' home treatment, a complete cure was effected, which has remained undisturbed up to the present hour.

7. Joseph Ogden—August 7th, 1872, No. 8, Hibbert Street, Bolton. White swelling of knee-joint five years, two years off work. Joint nearly anchylosed, very slight motion remaining. *Knee foment and immersion three times daily.* In the interim, as usual, wet bandage, covered by waterproof material, was employed. Hot air, steam, ten minutes each, and wet pack, were, one or the other, alternately and daily administered, followed by wet rubbing of the entire body with a sheet dripping, as taken out of tepid water. The abdominal wet compress was also employed. About September 12th, a very strong solution of common salt in water (full strength), called crisis solution, was employed to wet the knee bandage. This speedily brought out an eruption (as usual) with much relief to the knee. Some degree of febrile irritation being present, walking exercise (usually permitted within limits) was prohibited in any amount which would produce pain. The ablutions and baths were generally reduced to cold as soon as the patient was able comfortably to bear that temperature. This case continued some time longer, or until December 12th, when he went away quite well.

8. Jas. Eastwood, of Blackburn, admitted February 1st, 1867. Scrofulous inflammation of the elbow-joint, with several discharging orifices. Necrosis (death) of the sternum (breast bone) and one rib. The ordinary measures were employed, with sixfold wet linen upon the joint and sternum, covered by waterproof. Sousing of the sternum and rib for three minutes, after fomentation ten minutes, was adopted, and extra washings to each diseased part after every bath. Feb. 8th, the immersion of the elbow after fomentation was reduced to sixty-five degrees, the elbow being much improved, one discharging sinus almost dried up. March 8th, elbow much reduced. March 22nd, it is now decreased quite to

one-half its original dimensions. Fever occurring, a wet fever pack was administered simply under the bedclothes three times a week, and subsequent tepid dripping sheet; the latter also, as in many other cases where it is used, employed two or three times daily. April 8th, fever gone; fever pack was omitted. All ablutions were now administered cold. May 24th, treatment for febrile symptoms had again to be resorted to, but was discontinued May 27th. Baths, when fever was gone, again cold. June 8th, last time prescribed for, "quite well." The fever pack is effected by means of a wrung wet piece of calico, yard wide, and about one and a half yards long, placed horizontally, up to the armpits, round the digestive organs, abdomen, hips, thighs, etc.; the whole body being covered by a blanket up to the neck, and well tucked in on each side down to the feet, which are also very closely and carefully tucked in. Over this the bedclothes are spread, until thirty minutes or so has elapsed, when the patient is taken out, and stripped quickly, and at once covered over with a sheet dipped in tepid water and rubbed with the same a short time, then rubbed dry, and put again to bed.

9. Jno. Greenwood. Heywood. July 30th, 1870, admitted for treatment. Scrofulous disease of knee joint, perforated with several sinuses discharging cheesy, curdy, and sanious matter. Knee, fifteen inches in circumference. Joint was fomented as above for ten minutes and immersed afterwards for three minutes in tepid water, three times a day, and suitable constitutional measures adopted. The abdominal compress was as usual employed. August 4th, diarrhœa came on, which was treated simply by *hot fomentation* to the bowels, at 100° to 110° Fah., under the bedclothes, and renewed every ten minutes, or kept warm by a tin filled with hot water for some twenty to thirty minutes three or four times a day. The compress was removed before, and re-applied after each fomentation. This, with simple *boiled rice* at each meal, our usual treatment for this complaint at this hospital, soon arrested the diarrhœa. Sept. 1st, baths ordered, to be gradually lowered in temperature as able to bear the reduction. Sept. 25th, much improved in general health; knee now only thirteen and three-quarter inches, instead of fifteen inches. October 26th, all the sinuses are now healed save one, which discharges a very trifling quantity and is rapidly healing. This case was ultimately perfectly restored.

10. Miss B———, of Liverpool, presented herself on crutches, the foot and ankle joint bound up with stiff starch splints. The case was found to be scrofulous disease of the foot and ankle. This case had been protracted for over twelve months. The ordinary treatment of fomentation and immersion was adopted; the wet compress, with waterproof, and a wet, covered abdominal

compress were worn as usual continually night and day. November 17th, the single-fold wet bandage was now exchanged for a fourfold ditto, and covered with waterproof. Had much trouble with this patient, who would have beer, and was otherwise very refractory. November 30th, the saline solution was employed in order to produce an eruption of the skin. The patient could scarcely be induced to go out or to sit in the open air, both which are so valuable to improvement in these cases. This stubborn case, although much improved, and walking sometimes without crutches, prematurely went away.

11. John Noble—Necrosis of sternum and ribs, right side. Much physical debility. No fomentation was employed in this case for fear of further increasing local debility, but only tonic measures. The morning drip sheet, at first tepid, and gradually colder, to cold; the sixfold compress with waterproof; wet friction to chest and ribs at every bath. Was packed in a wet piece under a feather bed twice a week till warm, followed by a drip sheet, etc. March 11th, the douche, cold, was ordered, down the spine and back of each leg. April 1st, was last prescribed for, much improved; and, if the remedies were sedulously continued as ordered, he would, no doubt, like others, obtain final restoration from the disease.

12. Herbert Bell, Heywood Street, Moss Side, Manchester, aged seven years, came under treatment A.D. 1872. White swelling of knee joint four years, knee quite deformed, and attended with several discharging sinuses. Visited me at Southport only once in three or six months. The usual treatment was ordered, but could only be carried out at home. The fomentation was applied all right, but the temperature of the immersion was raised to eighty or ninety degrees Fahr., without orders. The case was not doing well, and was in consequence for years under treatment. As, however, the proper measures ordered began to be employed, the size of the knee became greatly diminished. About Sept., 1875, appetite improved as the joint becomes less and less irritable. He now sleeps well, which he had not done before, and grows fast, as the grasp of this formidable disease upon the constitution is lessened: maintains his flesh well, and increases in health and strength, although he was formerly a very weak, puny, and emaciated child. The discharge from the sinuses is now entirely arrested, and the joint restored, save that the knee was permanently flexed by anchylosis before I saw him, and he now runs about, in so far as disease is concerned, perfectly well.

April 1st, 1876. I have this day seen this case, and he is quite well, with the exception of incurred irremediable deformity previously to the treatment.

13. Robert Pindar, aged eighteen years; scrofulous necrosis

of the entire clavicle on the right side; came under treatment in 1869. This case was treated in accordance with existing symptoms and general constitutional treatment of course; a body compress, and a four or sixfold wet compress on the part, covered by waterproof. Sometimes *local vitality was increased by hot fomentation to the part, followed by good tepid sousing for some three minutes;* at other times, *wet frictions* were employed to induce a flow of nerve force and blood to the diseased bone: sometimes *spouting* and the douche were resorted to for a similar purpose, when the constitution assumed a condition capable of this high stimulation. At other times, the ordinary wet pack was employed (including, of course, the part affected) in order to increase general function, and to stimulate and exalt the vitality of the living parts, so as to enable them to separate from and exfoliate the necrosed portion of bone. When fever occurred—a condition not unfrequent in the simple treatment of these diseases—what is termed the fever compress for the night, or the fever pack for some thirty minutes or so was resorted to in the day time, followed by tepid wash down or the drip sheet at seventy degrees, with, at all times, a very speedy and salutary result. It was found on the long run, although this case was protracted and tedious, that the health of the patient was being gradually established. The greater part of the clavicular bone was exfoliated; the space occupied by and around it was filled as it was removed by good plastic lymph, which soon, as far as the original seat of bone was concerned, assumed an osseous condition. Thus, *the old clavicle being removed, an entirely new bone was formed,* and nature was entirely restored to her normal and natural condition. The parts became entirely healed; and this once diseased and scrofulous subject has from that period been known as a sound, healthy, industrious, and hard working man.

KNEE JOINT, NOT STRUMOUS.

In addition to the above and that of Mrs. Whittle, already adduced, several cases of knee disease, not strumous, have been submitted to this mode of treatment, which has been attended with marked success.

14. Mr. M———, of Manchester. Synovitis; the synovial capsule of the knee distended, with much fluid, and increased in dimensions to a very considerable size. The ordinary hot foment was adopted, and tepid sousing afterwards for the usual period. A fourfold wet compress, or bandage, was applied to the swelling, covered with waterproof, and the usual abdominal compress employed. The effused fluid was rapidly taken up by the absorbents, the inflammation of the synovial membrane was speedily removed, and the knee quite restored to its natural size and

shape in about three weeks. In this case, little else than the local treatment was adopted, as the patient carried out all the measures with his own hands.

Several cases of inflamed bursæ, especially of the front of the knee, and under the tendon of Achilles, treated simply and successfully by a sixfold wet compress, and some in addition with the hot foment, might be here cited did space permit.

15. Mrs. C——— fell down and seriously injured the knee joint with some degree of violence. The entire joint evinced signs of considerable inflammation, and became exceedingly painful. Next day, hot fomentation and immersion, as usual, were instituted, and the pain and swelling were in three or four weeks reduced. Little else was used in this case, except the local remedial measures, the drip sheet, and abdominal compress; and by continuance the inflammation of the joint was entirely overcome, and has been now for some years or so quite well. The value of the treatment in this case was fully put to the test. In order to please a medical friend, she discontinued the external appliances for a time after the pain and swelling were entirely gone. But during the absence of remedial measures the knee began again to swell, and became so painful, that in twenty-four hours she was absolutely compelled and glad to resort to the use of the fomentation and immersion, which she took care afterwards not to relinquish until the cure was complete.

16. Mrs. Salvidge, Birkenhead. An acute case of arthritic inflammation of the knee joint during utero gestation. This case was also treated by hot fomentation ten minutes twice daily, succeeded by immersion of the joint in tepid water three minutes, which speedily removed all inflammatory action, and reduced the knee to its normal dimensions and previously healthy condition.

Miss S., of Ulverstone, left this place and treatment only a few weeks ago, December, 1877. Considerable chronic and puffy thickening of the tissues surrounding the knee joint, with a great degree of tenderness and pain on pressure in one spot near to the patella. This tumefaction commenced two years ago. The general health of the patient is not much affected. The knee was submitted to hot fomentation ten minutes, followed by tepid immersion for three minutes, three or four times a day. The wet bandage covered with waterproof was applied to the knee, and the abdominal compress adopted, together with a course of constitutional treatment. Daily improvement presented itself so long as the young lady could be induced to limit her locomotive exercise. But frequently the knee was made worse, and backened in its progress of restoration, by overdoing. Hence advancement

was to some extent hindered; but after eight or ten weeks she went home nearly well.

Numerous cases of acute iritis and ophthalmia (inflammation of the eye) have been treated in a similar manner and with complete success by the above simple mode of treatment, the only change made being the addition of a few drops of tinct. belladonnæ to each hot pad.

HIP DISEASE.

Several private cases of *hip disease* may in this place be adduced, which were treated by these fibrin producing external appliances, etc., previously to the discovery of the value of hot fomentation followed by immersion, and that with perfect success. We have not as yet, indeed, employed the foment and immersion in any cases of hip disease. Specimen cases:—

Miss B., of Uttoxeter, daughter of a Wesleyan missionary in Canada--1849. Hip disease: pronounced incurable by medical attendant. Fever high, pulse over 120; much restlessness; motion of limb excruciating and unbearable. As she could only remain under treatment ten days, her father having to return to his missionary station, the appliances were pushed forward very sedulously. Fever pack daily, followed by tepid ablution. Drip sheet twice a day. Hip and abdominal or fever compress constantly worn. At the end of this short treatment she returned home, and bore the journey much better than was expected. Continued the treatment at Uttoxeter. Purulent matter formed, and issued, some ten to fourteen days after she left, at an opening previously made in the part. Joint saved. Case perfectly restored. Lived in Southport for several years afterwards; quite well.

Peter Kilgore—July 28, 1851. Hip disease for two years. Considerable swelling and chronic thickening of the joint. Pain great on rotation, or on attempting to bear the weight of the body on that side, etc., etc. In the treatment of this case the abdominal compress, and one also upon the joint, were employed. The wet pack and drip sheet two or three times a week, wet frictions, etc. The disease was removed by the discharge of about a pint of purulent matter from the joint. The discharge commenced again two or three times when residing in a smoky atmosphere, but always ceased, and the hip to all appearance perfectly recovered, when in pure air. This case was ultimately lost by a final and resolute residence in the city of Manchester.

Miss M. Bowdon. Hip disease, right side. Pain, as frequently the case, referred to the knee, which deceived the medical attendants, and caused them to treat it as rheumatism of that joint. Came here afterwards. High fever, restless, tumefaction of hip joint, with severe pain on pressure or on attempting to stand on

right leg, or on rotation of joint. Used measures as above. In a few days an immense abscess formed, extending from the groin to the nates. On being punctured, purulent matter ascended to a considerable height, like a fountain playing, and discharged a large quantity. This orifice had now to be stopped until a fresh formation enabled to open the abscess also posteriorly, without which it probably would not have healed. The entire cavity now ceased to discharge, and was perfectly healed in a few days. Case quite restored. Years afterwards learned that "she is now the finest and healthiest of a large family of young ladies."

Miss E. P. Disease of the hip joint, in which disease had done its worst, and produced its most extensive ravages. Ligament destroyed, and head of bone dislocated to an extent of about three inches. Limb consequently shortened; power of locomotion gone; joint and thigh the seat of some twelve or fourteen sinuses discharging sanious and purulent matter, etc. Constitutional treatment, chiefly wet pack, hot air, etc., and drip sheet; wet covered compress to hip and abdomen; douche and spoutings. Abscesses gradually dried up and healed. Constitution evidently entirely changed. Perfect recovery of health, and use of limbs, save with an irremediably shortened leg. For years bath attendant here, and rarely knows now what suffering is. Numerous other cases of this kind might here be adduced.

DISEASED BONE.

The following, with many others, may be further cited also as illustrative of the use of these external fibrin-producing and simple hydro-hygienic measures in the restoration of cases of diseased bone:—

Mr. W., of Southport. Chronic inflammation and tumefaction of the left ankle, with general thickening of the tissues in a strumous constitution. In this case the foregoing treatment of fomentation, subsequented by tepid immersion, was employed, together with wet lint, covered with waterproof material, to the ankle, and abdominal compress. A suitable constitutional course of external appliances, in the shape of the wet pack and hot air, general ablutions, cold douche, sitz bath, etc., etc., were employed. Towards the close of the treatment *exfoliation* or ejection of a small portion of *necrosed* (*dead*) *bone* occurred, the sinuses healed, and perfect soundness and restoration of health and limb was effected. This gentleman still resides in Southport.

Miss B———, in 1871 to 1872. A very similar case. Disease of the lower end of the fibula (or outer bone) of the left leg, just above the ankle. Similar appliances were adopted, with suitable constitutional measures. In this case *exfoliation* or removal of a small portion of necrosed or dead *bone* ensued, and the discharg-

ing sinus healed. This case was under treatment about six months, and has been well repaid for the pains taken by having had no recurrence of the disease up to the present moment.

17. *Enoch Wilkinson*, an operative machine-maker, had been the subject of spinal bone disease with angular curvature for seven years, three years and a-half of which had been spent in bed. He came into the hospital *May 29th*, 1871—at that time crawling along with two sticks. There were *several* sinuses, or discharging openings, from the locality of the disease. He was treated by a long spinal compress with single wet material, save at the diseased portion of the spine, where the wet material was increased to sixfold, and covered by waterproof. The remedial measures used in this case in addition to the spinal compress were, morning and afternoon, drip sheet; at noon, the wet pack was administered two or three times a week; spinal extra washing at every bath. After a time, spouting and ultimately cold douching of the spine were prescribed. Exercise was ordered in the open air after each appliance, as usual, to the extent of his constitutional powers—*i.e.* as far as possible without inducing pain or fatigue. This case occupied some twelve months or so in the repair, healing, and restoration of perfect soundness to the spinal bones. He has since that period undergone much active and laborious toil, but the spine still remains intact, the body corporate healthy, and he follows his employment in this town up to the present moment.

18. *George Evans, Castle Street, Southport.* Necrosis of part of the left femor (thigh bone), just above the knee joint. This case, who is still a well known *gardener* in Southport, had been the subject of strumous abscess attended with discharge for twenty years. He had employed much medical assistance, but altogether without avail, and had had the advantage of the salubrious air of this coast for several years. He entered the hospital on *April 3rd*, 1868. This case was treated with hot fomentations and sousing and with the stimuli of the ordinarily prescribed hygienic and fibrin producing measures, wet frictions, spoutings, and the douche, etc. The drip sheet was at first administered tepid, but was gradually reduced in temperature as he gained reactive energy, in order to impart more and yet more tonic influence. The wet pack was employed every alternate day as an alterative, stimulus, and function-inducing appliance. In two month's time (July), a large piece of necrosed (dead) bone, four-and-a-quarter inches long by measure, presented itself through the ulcerous opening. This came away in the latter end of the month; the parts healed up entirely, and the case has been for years quite well, and continued his avocation in this place.

The rationale of this new mode of treatment appears to be as

follows: the tendency of the frequently repeated hot fomentation is to soothe the irritation of the local nerves, and through them the nerves of the entire organic system, and, at the same time, to increase their vitality. Moreover, by a heat of from 100° to 110° Fahr. these nerves are stimulated to increased energy, and a greater and more powerful current of nerve force appears thereby to be impinged upon the suffering organ.

As a result of this increased nerve current, according to the ancient axiom, "*Ubi stimulus ibi fluxus*," the supply of blood to the part is sensibly augmented, the blood-vessels are distended and congested, the suffering part more or less swollen, and the tumefaction is found to continue, and to increase so long as the hot appliances *alone* are used. In following up the fomenting process however, by a given immersion or sousing with tepid water, the tumefaction produced is found salutarily to subside, the blood-vessels are more and more constringed, and reduced to their natural and healthy dimensions. This tonic and healthy constriction of the blood-vessels does not retard or prevent, but rather augments, the constantly increased determination of blood to the part. This determination is daily more and more augmented in proportion to the amount of suitably stimulant and tonic measures employed, such as wet friction, sousing, packing (with the suffering organ included in it), spouting, and douching, etc., etc. By the constitutional measures adopted, the general vitality and healthy susceptibility of the system is exalted, *the "corpuscular," or "strumous," is exchanged by the agency of water, good nutritious food, and pure air, for the "fibrinous" diathesis*, and with this change the general health is more or less restored, and the suppurative tendency arrested; abnormal tissues, thickened by disease, are, by thus removing the corpuscular state of constitution and stimulating the absorbent system, gradually reduced; effused fluids are absorbed, curdy and sanious discharges are seen one by one to be arrested and dried up, and their sinuses perfectly healed. Further, by the greater part of the appliances being made to the suffering joint or part affected, as before observed, we have reason to believe that a continuously increased current of nerve force and of well elaborated fibrinous blood is in consequence being constantly transmitted to this organ. This increases its vitality and power of renovation; enables it to separate from necrosed bone, when present, and cause the exfoliation of the latter. The exalted vitality and healthy blood supply, of course, facilitate in every instance repair, growth, and healing, and rapidly tend to fill up all cavities and excavations produced by ulceration or exfoliation, and to communicate to each recently formed substance by the agency of cells and under the influence of the vital force its own peculiar

and specific form, constitution, and structure, whether it be osseous, tendinous, muscular, or cuticular, etc., etc. Thus are all the conjoined conditions and influences necessary for the healthy restoration of the suffering organ met and secured. The natural action and movements of the limb are instituted and maintained by gentle and limited exercise, the employment of suitable friction, etc., etc., and the results entirely surpass our most sanguine expectations.

THE APPARENT TRANSFORMATION OF THE CARCINOMATOUS DIATHESIS AND THE REMOVAL OF SCIRRHUS AND CANCER BY THESE SIMPLE MEASURES.

Perhaps the most astounding revelation which has presented itself in the treatment of disease by these simple measures has been the removal of scirrhus, and even cancer which was fully and completely formed. In several instances, a scirrhus state of the os uteri has been observed strangely to disappear during the use of the wet pack, followed by an ablution, as usual in the treatment of other diseases for which this measure was adopted. The most extraordinary instance, however, of the value of external application in these cases was that of Mrs. R———, of Rochdale, who came here suffering from true scirrhus tumour of the right breast. The extreme dense and lobulated hardness, the turgid ramuscular veins, the lancinating pain, etc., etc., and the presence of symptoms manifesting the near approach of ulceration of the tumour or the breaking out into open cancer —all declared that, in a surgical point of view, the use of the knife could not long be delayed.

The patient entirely objected to the operation, and we therefore resorted to the simple measures about to be described. The breast was ordered to be fomented with hot water three times a day for ten to fifteen minutes, and then soused or sponged over with tepid: a compress of wet lint fourfold was applied all over the breast, covered by waterproof material: a morning tepid ablution was adopted, and the use of an abdominal compress employed, together with which was the prescription of an occasional wetpack. I saw no more of the case until about twelve months afterwards, when, to my astonishment, without any other treatment, the tumour of the breast was softened and had almost disappeared, and the health of the patient was considerably improved. A perseverance in the above simple mode of treatment for two years or so had, when I last saw her, removed all hardness, and there did not appear to be a vestige of induration remaining calculated to awaken any alarm. The patient was still ordered to persevere; and as she has not visited me since that time, no doubt, all unpleasant appearances have altogether vanished.

Another instance has occurred which is worthy of note. The lady of J. W———, M.D., was suffering from cancerous tumour of the breast, and had taken quantities of morphia, opium, etc., to remove pain and to procure sleep. To a great extent these narcotics had been used without effecting this desirable object. Staying in Southport only one night, on her way to the Metropolis, where it was intended that the sub-cuticular injection of bromide in some form should be employed, we induced her to try the hot fomentation at bed-time for this one night only. She had the best night of sleep and freedom from pain experienced for many months. Yet, after all, this lady could not be induced to stay longer, so intent was she upon the application of the new remedy. We received information afterwards that the only effect of the bromide was great exasperation of the symptoms, and that its employment required the administration of largely increased quantities of opium to still the pain. This was the result of a two months' trial, when death put an end to her sufferings.

A very remarkable result of these simple appliances is also discovered in the fact, that, after the removal of cancer of the breast by operation, the use of a course of wet packings, tepid morning ablutions, and sitz baths, so far as we have witnessed, actually prevents a return of this formidable disease. Miss ———, of R., had one breast removed which was just on the point of breaking out into open cancer. The case had been seen and examined also by my friend the late T. Turner, Esq., of Manchester, and the same conclusion for an immediate operation arrived at. Three weeks after our first interview, the operation was successfully performed, and the wound nicely and kindly healed. Another case, Miss B———, of Ireland, had a cancerous breast excised, and some six knotty indurations also removed from the axilla. This case did well, perfect adhesion having taken place in every part. These have been the only two cases which, in cancer removed by myself, a course of treatment by these external and simple appliances and measures have been adopted for two months after the operation. Five or six years have now elapsed since the former case, and three or four years since the latter was under treatment, yet the disease has not again in either instance returned. On the other hand, whilst in medical practice in the city of Manchester, several similar cases were operated upon, but in each instance the patient succumbed to a recurrence of the disease.

One extraordinary fact which transpired in this latter case was, that, Miss B. having required a very large amount of chloroform to produce the requisite degree of insensibility to pain during the operation, and not being willing to administer any

more, one small cancerous tubercle was permitted to remain in the axilla. This evident nucleus of the disease was watched with anxiety during her residence, but gradually gave less and less indications for uneasiness. On her return here in twelve months or so, this tubercle was not to be found, nor had it given any evidence of existence from the period of her first residence here up to the time she last visited Southport—about two years ago. It would therefore appear that in what is denominated by Rindfleisch (vol. 1, p. 180) as the alveolar type of structure in which is found carcinoma, or the cancer cell, the latter is, by the measures thus employed, exchanged for the normal and healthy vital corpuscle, or in other words, the "*cancerous*" is transformed into a "*fibrinous*" or healthy constitution.

On medical evidence, we have it from the elder Munro, that of sixty persons operated on for cancer, four only remained free from relapse at the end of two years. Scarpa observed only three cases of extirpation of true scirrhus permanently successful. Boyer maintained that of 100 patients operated on, ninety-five or ninety-six succumbed under a return of the disease; whilst others maintain that successful extirpation has seldom or never been effected.

PURIFICATION OR REMOVAL OF MORBIFIC MATTERS FROM THE BLOOD.

Many are the nostrums and specifics vaunted by the charlatan and others, in the market and elsewhere, as purifiers of this all important fountain of life. In order, however, to test the subject, let the blood and tissues of a healthy individual be examined by a competent person side by side with those of a constitution rendered morbid by tuberculosis, scrofula, or syphilitic virus, etc. Then let the boasted specifics, in the shape of iodine, bromide or iodide of potassium, antimony, mercury, or arsenic, etc., be administered, and a further and second histological and chemical analysis be instituted. Previously to this second analysis, let it be perfectly understood *that none of these medical substances do expel, or radically remove any of these diseases from the constitution.* That, unfortunately for these remedial agents, there is a known and positive *affinity* of many if not all of them *for the substance of the animal organism,* in which they take up their residence and lodge, and to which they cling with a tenacity that, when once partaken of, they never again quit the system, but are discovered in the bones and tissues long as vitality remains. Under such circumstances, we would ask what would be the verdict of the analyst after the second examination? Of course it could not be anything else than histologically and chemically morbid and impure. But although, for the sake

of argument, it might be admitted that some of these remedies do assist nature in some measure in an attempt at purification, by the partial expulsion of the morbid elements or virus by the various emunctaries of the body; yet there would still present itself a grand deficiency in what we may call the substitutionary process, they being of themselves perfectly incapable of adding one element to the animal structure. To illustrate our meaning: A steam-engine might continue its action for a time, so long as a supply of steam could be obtained, but when the water in the boiler becomes deficient, or the fire in the furnace is not kept up, and the supply of steam becomes thus reduced, the action of the engine will speedily cease. So likewise the emunctaries of the frame may be stimulated to perform increased action so long as the vitality of the system is maintained, and diseased elements might thus be expelled; but the moment deficiency in the nutrient materials of the blood and lowered vitality ensue, all depurifying processes must necessarily and at once terminate. It is impossible to nutrify the system independently of this universal pabulum—*coagulable fibrin.* (See Chapter II. on nutrition.)

In the ordinary method of treating diseases of this nature, therefore, we contend that there is no substitute provided. Wine, brandy, and other ardent spirits, as well as all simply carbonaceous foods, are unable to supply one molecule of constructive material to the frame, except fat, which is of no earthly use in building up the true organic structures of the body. On the contrary, as we have already shown (pages 85, 86), that dilute alcohol in every form positively hinders the formation of healthy constructive substance, and at the same time renders positively morbid and depraved the coagulable material which is being developed by such agencies (page 87), and actually tends to the production of the low vital "*corpuscular*" instead of the "*fibrinous*" constitution.

Jellies, so prized as strengthening food, isinglas, "sweetbread," kidneys, &c., of animals, have to be considerably changed and modified in their chemical nature to enable them to present an aptitude to meet the general wants of a constructive organism.

Inasmuch as shown by Lehman (quoted page 45), Dr. Miller, and others, that the fibrin in muscle is by no means perfectly identical with, but differs considerably, and in many particulars, from spontaneously coagulated fibrin; so even beef, mutton, and the flesh of other animals, although shown by analysis to possess the exact chemical constitution of the blood itself, yet have to be entirely remodified and reduced by digestion and assimilation into corpuscular bodies (pages 31, 32, 33), and subsequently into fibrino-plastic coagulable material, ere they can be employed in ministering to the supply, healthy nutrition, and construction of the organism.

If, therefore, diseased materials must be removed, healthy elements must be as surely substituted, and such as are perfectly adapted to the specific wants of the affected and wasting tissues, as well as those of the general organism, and which Nature herself employs. Now fibrin, in the shape of vital corpuscles, or coagulable fluid, can alone form a healthy substitute for corpuscles of a tubercular character, whilst normal and healthy cells can substitute those of a carcinomatous kind. But fibrin, we contend, is developed by the agency of water; and water was employed as the remedial agent in all these cases, and that with the most successful results. Inasmuch, also, as these diseases more or less implicate universally the organism, so we have shown by the cases adduced that this coagulable material of the blood is the universal pabulum of the body, and forms a healthy substitute for diseased osseous as well as tubercular and all other morbid tissue. The specimen cases adduced in these last pages, which illustrate so pointedly and universally the removal of the tubercular, unhealthy, and malignant states of constitution, and the substitution of a normal and healthy state of body, rendered evident by the perfect healing of all the results of the morbid diathesis, evince, we maintain, that the mode of treatment thus pursued is the only true and genuine method by which purification of the blood can be effected.

As a general result of the facts and inferences arrived at in this essay, we would add, in conclusion, that we are not to be led away with the idea that if an individual eats freely of artificial fibrin, or of the fibrinized egg, that therefore health, strength, longevity, and immunity from disease will be his lot. No such thing.

No organism can enjoy health which is already in a diseased condition, independently of the due and healthy fulfilment of its multifarious functions, of the elements of life, or of the measures by which health is produced and maintained. We have already shown that it is high vitality which, with its required elements, develops fibrin in the blood; whilst the predominance of fibrin in the blood tends to, and usually is accompanied by, the highest state of vitality. Yet is it also evident that the means which develop fibrin in the blood do not consist in the mere partaking of food, however nutritious and highly adapted to the system it may be, but also by the employment of those measures and elements which tend to the due and healthy exercise of all the functions of the body. *The very preponderance of fibrin in the blood, being an evidence of the highest degree of health, is also an evidence that such measures are adopted in its development as are most conducive to the health of the system.*

We think that the cases adduced in this Essay plainly manifest that, inasmuch as there can be no successful removal of *materies morbi* (morbid matters) from the blood independently of substitution of the same by the healthy material manipulated for this purpose, so not even the most nutritious, salubrious, and judiciously adapted substance imparted to the body can be of any avail in the radical removal of congenital, or blood disease, unless the emunctaries be acted upon, and the *materies morbi* simultaneously removed and ejected by appropriate measures from the constitution.

In other words, we cannot expect the low vital tubercular, the syphilitic, the carcinomatous, or any other malignant or virulently morbid condition of the blood, to be transformed into the fibrinous or healthy diathesis (constitution), or even the "suppurative" to be exchanged for a healthy healing process, unless the whole of these conditions in their entirety be fulfilled.

Be it possible then, we would add, that these two dire and dreadful states of constitution, the tubercular and the carcinomatous, are capable of transformation by the displacement of morbid matters and the substitution of good and healthy material in the blood: be it possible, that by the removal of diseased substance and the development of fibrin, or coagulable material, in the system, aided by the appropriation of solid, living fibrin as an aliment, that these two fearful states of constitution can be entirely transformed into those that are natural and healthy: be all this possible (and almost unanswerable is the evidence of its truthfulness), who can tell the amount of unparalleled suffering, excruciating agony, and death that will be thus spared and averted from that portion of the human family who refuse to allow their prejudices or ignorance to prevent their participation in the use of measures so intensely valuable to the afflicted sons of mortality?

If we are, however, justified and warranted in the conclusions we have drawn, do not the facts before us plainly declare that hope may be entertained that all morbid states of the blood, such as the strumous or scrofulous and tubercular, the syphilitic, the carcinomatous, the scorbutic, the melanotic, etc., can be more or less changed into that of a normal and healthy character by the employment of these fibrin producing remedial measures?

This system of external remedial agency herein adduced we have found to be adapted in its multitudinous forms to almost every variety of disease admitted into the hospital for more than twenty years. By these means we can soothe and tranquillise, stimulate or give organic tone to the entire system of nerves, as well as to the great nerve centres, and can produce sleep often when unprocurable by other means. We can powerfully affect

the performance of function, and generally with facility and ease unlock and set open the closed secreting organs and emmuctories (excreting organs) of the frame. We can reduce morbid action by the influence of moist heat, etc., etc.; soothe pain and irritation of almost every kind. By high external stimulation we can radically exhaust eruptions of the skin, and by other measures derive the flow and determination of blood from a congested organ to any other part, and with the soothing and refrigerant effects of water, the notorious febrifuge, speedily reduce fever and inflammation, and generally arrest hemorrhage. By measures of this kind we can exalt the *vis medicatrix Naturæ*, and thus, in a state of body fitted for such a result, develop the highest possible condition of health of which the constitution is capable, etc., etc. During a course of judicious constitutional treatment, cold and wet friction to the hair, with excellent brushing, will cause it to grow profusely, and lose many of its primary grey hairs; to the countenance, will cause it to assume the ruddiness of health. Cold and cool immersion of the eye will increase the tone and power of that organ. Cold and wet appliances to the spine will daily increase the strength of this main pillar of the organism. Wherever, indeed, the greatest amount of this tone-producing fluid is projected upon any part, or brought to bear upon any limb, locality, or organ of the body capable of such a result, it will daily augment its strength, increase its heat, develop its structures, and cause its evident and palpable growth and power of action.

"*Ubi stimulus, ibi fluxus.*"

If all these things be true—and we refer in proof of their veracity to the facts and deductions adduced in this entire volume—then does this system of external remedial agency, in the treatment of disease, assume an importance and claim for itself a value in the vast portion of the chronic as well as acute sufferings of humanity, with which no other agency can compare—no other elements supply—and no other remedial measures substitute.

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