

as to materially affect the temperature of the planets. "This seemed a very reasonable view, and, indeed, it cannot well be questioned that if one-half of the heat that reaches the earth's surface comes from the stars, it is likely to be warmer near an aggregation of three suns than it is where we are now" (p. 70); but astronomical considerations show that the hypothesis as a whole is untenable. Next is the view of Lyell, who attributed climatal oscillations to changes to the relative position of sea and land; but the view is open to the sweeping objection that the formulated cause would produce opposite effects from those which the hypothesis attempts to explain. The effect of minor geographical alterations on climate cannot, however be denied. Tyndall and others have shown that slight variations in the quantity of aqueous vapor, carbonic acid, or some other substances contained in the atmosphere must materially effect terrestrial temperature; but any such variations which we are justified in assuming would probably be inadequate to alone explain the phenomena of the glacial period. The next hypothesis is that of Croll, who, recognizing the fact that the "orbit of the earth around the sun is not circular, as it might be if the earth were the only companion of the sun in the solar system" (p. 73), points out (1) that during periods of high eccentricity in the terrestrial orbit the precession of the equinoxes may lead to a considerable variation in the length of the seasons, and hence to an accumulation of snow and ice in the hemisphere having the long winter and the short summer; and (2) that when such accumulation was in the northern hemisphere the effect upon the trade winds would be such as to deflect the Gulf Stream feeders to the south of Cape St. Roque and thence into the Antarctic regions, and thus further refrigerate the northern hemisphere. The hypothesis is the most important yet enunciated, though it presents certain difficulties. Other views are that changes in the earth's axis of rotation, or in the obliquity of the ecliptic may materially affect the temperature of the globe; but these views can be mathematically proven to be inadequate. Yet another hypothesis is that which attributes the phenomenon to variations in solar emission, and which "seems a most likely cause of glacial conditions" (p. 90). Less important hypothetical causes are minor geographical changes affecting aerial or marine currents—for instance, the comparatively recent elevation of Sahara, and the probable late Quaternary depression and subsequent re-elevation of Alaska and Kamchatka; but it is clear that no conceivable array of geographical changes can explain the origin of the last glacial epoch.

(To be continued.)

THE HIPPOPOTAMUS.—Dr. Henry C. Chapman, of Philadelphia, has recently devoted much attention to the anatomy of the Hippopotamus, and has read an elaborate paper before the Academy of Natural Sciences, of Philadelphia. We notice that he draws the following conclusions: "beginning with the pig, we pass by an easy transition to the Piccary, which leads to the Hippopotamus, and thence in diversing lines to the Ruminantia on the one hand and the Manatee on the other. Paleontologists have not discovered a form which bridges over the gap between the Hippopotamus and the Manatee, but it will be remembered that certain fossil bones, considered by Cuvier to have belonged to an extinct species of Hippopotamus, *H. Medius*, are regarded by Gervais as the remains of the *Halitherium fossile*, an extinct Sirenean of which order the Manatee is a living representative." Dr. Chapman adds further on, "I do not mean to imply that the Manatee has necessarily descended from the Hippopotamus," but he considers that "there is some generic connection between them."

PROF. C. V. RILEY believes that the diminished virulency of Phylloxera in sandy soils is due to its mechanical action on the insect, his own experiments showing the difficulty such insects meet with in soils of a sandy nature.

NEW YORK ACADEMY OF SCIENCES.

November 21, 1881.

SECTION OF BIOLOGY.

The President, DR. J. S. NEWBERRY, in the Chair.

Thirty one persons present.

The following paper was read by Prof. LOUIS ELSEBERG, M. D.

ON THE CELL-DOCTRINE AND THE BIOPLASSON-DOCTRINE.

Mr. President and Fellows of the Academy, Ladies and Gentlemen.—Last May, at the meeting of the American Laryngological Association, I rendered account of some histological investigations of the cartilages of the larynx, a report of which is published in the October Number of the *Archives of Laryngology*. As the structure of hyaline cartilage has an important bearing on my subject of this evening, I crave your attention for a few minutes for a brief review of those investigations.

You know the larynx or voice-box consists of a framework of cartilage or gristle. This cartilage is called hyaline or glasslike, because it is opalescent and looks like milk-glass. Having frequently been examined under the microscope, it has always been looked upon as one of the simplest tissues, namely, as being composed of a hard matrix or basis-substance, in which are imbedded a number of small softer bodies. These softer bodies, the cartilage corpuscles, have since the establishment of the cell-doctrine been called cartilage cells. As these cells were known to be alive, the question which scientific men have had to try to answer was: how can they obtain nutrition, being isolated and enclosed in the firm, unyielding cartilage basis-substance?

Without going too much into details, I may say that it was assumed that nourishing liquid reaches the corpuscle either by imbibition and diffusion or else through canals or fissures in the homogeneous basis-substance. The idea of the existence of "juice-channels" originates with VON RECKLINGHAUSEN, although others before him had spoken of "pores" through which nutritive juices might pass. BUDGE and others believe in the presence of regular canals for this purpose, while TILLMANN and many with him believe that hyaline basis-substance consists of fine fibrils so closely held together by a cement-substance that the mass appears to be homogeneous; it is supposed by some that this inter-fibrillar cement-substance is a viscous, soft material which permits the imbibition of nutritive liquid; by some that there are clefts or fissures, and by others that there are regular channels tunnelled in this cement-substance. On the other hand, HEITZMANN, SPINA, FLESCH and others have found that there are cilialike offshoots or prolongations of the substance of the corpuscle penetrating into the basis-substance. Such prolongations might carry on nutrition. I have had the opportunity 6 or 7 years ago to repeat Heitzmann's observations under his own eyes and with his assistance; but the results as to their correctness at which I arrived, were to the best of my belief uninfluenced by him.

My own recent investigations have not only confirmed the existence of such offshoots and shown that they form an inter-connected reticulum or network throughout the basis-substance, but I have discovered in several specimens, small lumps in this network which, by all the tests applied to them, were proved to be lumps of living matter in various stages of existence! These investigations are illustrated by the accompanying drawings viz.

Fig. 1. exhibits the appearance of a longitudinal section of the plate of the thyroid cartilage with an amplification of 100 diam.

Fig. 2. shows offshoots from the cartilage corpuscles and the network in the basis-substance with more or less large granules interwoven, as it were, in the network.

Fig. 3. shows granules of various sizes in the basis-substance with lower power of the microscope, which granules are seen with higher powers to be connected with the network of living matter, as shown by fig. 4.

Doubt as to the interpretation is impossible: instead of being a mass of basis-substance in which a number of cartilage corpuscles are imbedded, hyaline cartilage is a filigree of living matter, in the meshes of which a number of blocks of basis-substance are imbedded.

the study of cartilages has led to the cell-doctrine, which at the time of its establishment was a great advance in biological science, so the further study of cartilage has supplied the basis for a generalization which is a further development, and must take the place of the cell-doctrine. This is Heitzmann's doctrine of living matter, or, as I have named it, the *bioplaxson-doctrine*.

When the term "cell" was introduced in 1838 and 1839, by Schleiden and Schwann, it was believed that

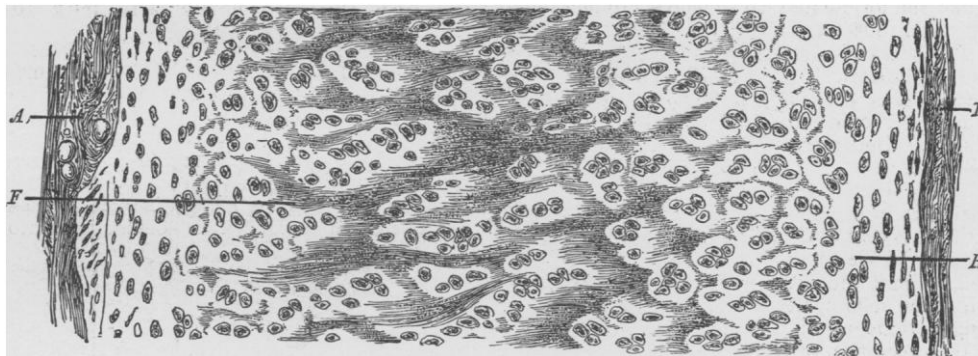


FIGURE 1.—Plate of the Thyroid Cartilage of Adult. Longitudinal Section x 100.

A. Perichondrium towards the mucus membrane.
B. Perichondrium toward the skin.

F. Fibrous portion of cartilage in the centre.
H. Hyaline portion, on either side, near the perichondrium.

Now, for our subject proper.

The founder of the Cell-Doctrine, Schwann, has recorded in the Introduction to his great work published in 1839 that the doctrine was based to a large extent upon investigation of the constitution of cartilage. After Johannes Müller had described cartilage-corpuscles that were hollow, and Gurlt had spoken of some as vesicles,—when Schwann had succeeded, as he thought, "in actually

on ultimate morphological analysis every plant and every animal would be found to consist of a number of minute vesicles or sacs, enclosing liquid contents in which is suspended a more solid body, the nucleus. For fully twenty years this idea has been known to be erroneous. In fact, *Goodsir*, nearly *forty* years ago—only a few years that is, after Schwann had established the cell-doctrine and attributed the vital power to the cell-membrane, I say,

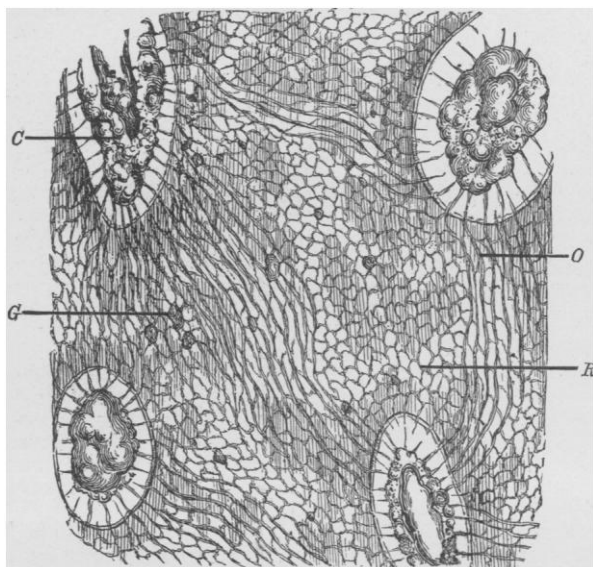


FIGURE 2.—Thyroid Cartilage of Adult, kept in strong Alcohol. Horizontal Section x 1200.

C. Shrivelled cartilage corpuscle.
O. Longitudinal off-shoots.
R. Reticulum in basis-substance.
G. Granules of living matter.

observing the proper wall of the cartilage corpuscles, first in the branchial cartilages of the frog's larvæ and subsequently also in the fish," he was led by these and other researches to conjecture "that the cellular formation might be a widely extended, perhaps a universal, principle for the formation of organic substances." And just as

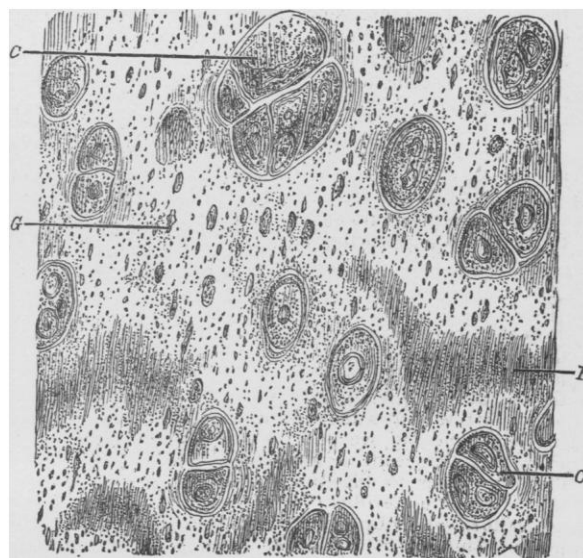


FIGURE 3.—Thyroid Cartilage of Adult. Horizontal Section x 600.

C. Cartilage corpuscle.
F. Fibrous portion of cartilage.
G. Granules of living matter.

nearly forty years ago Goodsir had experimentally determined that the seat of the vital process of secretion is *not* in the vesicle as such, but in the so-called cell contents; Naegeli, in 1845, and Alexander Braun, in 1851, had also shown the cell-wall to be comparatively unimportant; and in 1857 Leydig had declared the "cell" to consist only of a soft substance enclosing a nucleus. Certainly, twenty years ago it was proved beyond dispute by Max

Schultze, Beale, Hæckel, and others, that what was called a "cell" was not a vesicle, but essentially a jelly-like lump of living matter characterized by the presence of a nucleus; soon after, Robin, Brücke, Kühne, Stricker, and others, conclusively showed that not even a nucleus is an essential constituent of an elementary organism; and, biologists were compelled to transfer the power of manifesting vital properties to "living matter" instead of restricting this power to any definite form-element. As long ago as in 1861, Brücke proposed to discontinue the use of the word "cell" as being a misnomer and misleading, and offered as a substitute the expression "elementary organism." Beale proposed, instead, the term "bioplast" to designate any definite mass of living matter, and Hæckel the term "plastid." From the latter I devised the word "plastidule" as synonymous with ultimate molecule of the substance of living matter. Elementary living matter is called with Dujardin "sarcodé," or with Von Mohl "protoplasm," or with Beale "bioplasm," or, still better (because it is a designation etymologically more nearly meaning living, forming matter), "bioplasson." Of these four synonymous terms "protoplasm" is the one best known; but has been used in other senses, as well as to designate, merely, elementary living matter. I therefore think that "bioplasson" is to be preferred. Of course, *dead* bioplasson is a contradiction in terms: bioplasson deprived of vitality is no longer bioplasson at all, but merely the chemical remains of what *once was* bioplasson. If this be remembered, there will be no confusion, even if the word be used in describing tissues, etc., after death. According to Drysdale, Dr. John Fletcher of Edinburgh was the first, who clearly arrived at the conclusion that "it is only in virtue of a specially living matter, universally diffused and intimately interwoven with its texture, that any tissue or part possesses vitality."

As Fletcher's work was published in 1835, several years before even the establishment of the cell-doctrine, we cannot but agree so far with Drysdale as to say that Fletcher has framed a "hypothesis of the anatomical nature of the living matter which anticipates in a remarkable manner" its discovery! In 1850, Cohn¹ recognized the protoplasm "as the contractile element, and as what gives to the zoöspore the faculty of altering its figure, without any corresponding change in volume." He concludes that protoplasm "must be regarded as the prime seat of almost all vital activity, but especially of all the motile phenomena in the interior of the cell." In 1853 Huxley² said "vitality, (the faculty, that is, of exhibiting definite cycles of change in form and composition), is a property inherent in certain kinds of matter." In 1856 Lord Osborne discovered carmine staining, and distinguished by means of coloring it the living formative matter from the formed material, a means which has borne important fruits in the discovery of Cohnheim's staining of living matter by gold chloride, and in that of Recklinghausen's staining all except living matter by silver nitrate.

In 1858, and in a number of later articles,³ Max Schultze, by showing that, as had been hypothetically supposed by Unger, the movements of the pseudopodia and the granules are really produced by active contractile movements of the protoplasm, as well as by other observations, contributed much to the establishment of the theory of living matter. Hæckel has also for many years, and in various publications,⁴ labored to maintain and extend the same theory, of which he thus expresses himself.⁵ "The protoplasm or sarcodé theory, that is the theory

that this albuminous material is the original active substratum of all vital phenomena may, perhaps, be considered one of the greatest achievements of modern biology, and one of the richest in results." And says Drysdale⁶: "if the grand theory of the one true living matter was, as we have seen, hypothetically advanced by Fletcher, yet the merit of the discovery of the actual anatomical representation of it belongs to *Beale*, in accordance with the usual and right award of the title of discoverer to him alone who demonstrates truths by proof and fact. * * * The cardinal point in the theory of Dr. Beale is not the destruction of the completeness of the cell of Schwann as the elementary unit, for that was already accomplished by others. * * * But that, from the earliest visible speck of germ, up to the last moment of life, in every living thing, plant, animal, and protist, the attribute of life is restricted to one anatomical element alone, and this homogeneous and structureless; while all the rest of the infinite variety of structure and composition, solid and fluid, which make up living beings, is merely passive and lifeless formed material. This distinction into only two

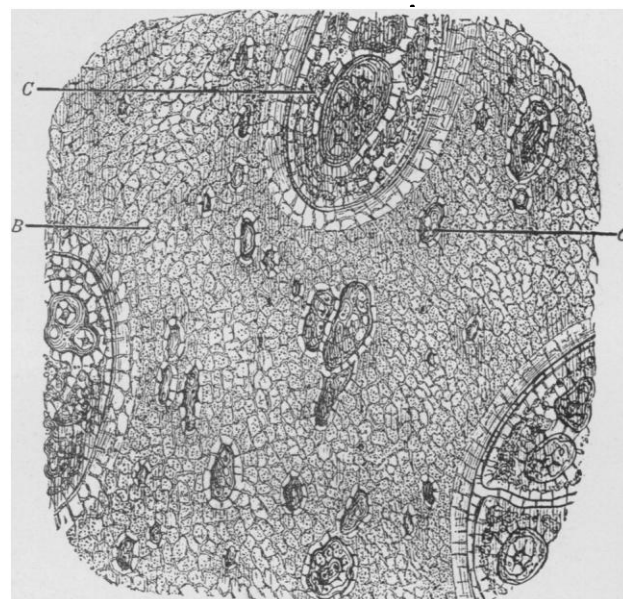


FIGURE 4.—Thyroid Cartilage of Adult. Horizontal Section $\times 1200$.

C. Cartilage corpuscle.
B. Hyaline basis-substance.
G. Granules of living matter.

radically different kinds of matter, viz., the living or germinal matter and the formed or lifeless material, gives the *clue* whereby he clears up the confusion into which the cell-doctrine had fallen, and gives the point of departure for the theory of innate independent life of each part, which the cell-theory had aimed at, but failed to make good. The one true and only living matter—called by Beale germinal matter, or bioplasm—is described as 'always transparent and colorless, and as far as can be ascertained by examination with the highest powers, perfectly structureless; and it exhibits those same characters at every period of its existence.' * * *

The name of bioplasm, continues Drysdale, given by Beale, or protoplasm, as indicating the ideal living matter, cannot be given to any substance displaying rigidity in any degree, nor to anything exhibiting a trace of structure to the finest microscope: nor to any liquid; nor to

¹ "Nachträge zur Naturgeschichte des Protococcus pluvialis." *Nova acta Acad. Leop.-Carol.*, vol. xxii., part i., p. 605.

² "Review of the Cell-theory." *British and Foreign Medico-chirurg. Review*, Oct., 1853.

³ "Ueber innere Bewegungs-Erscheinungen bei Diatomeen," *Müller's Archiv*, 1858, p. 330; "Ueber Cornuspira," *Archiv f. Naturgesch.*, 1860, p. 287; "Ueber Muskelkörperchen und das was man eine Zelle zu nennen habe," *Reichert und Du Bois-Reymond's Archiv*, 1861, p. 1; "Das Protoplasma der Rhizopoden und der Pflanzenzellen," Leipzig, 1863,

⁴ *Monographie der Radiolarien*, 1862, pp. 89, 116; "Ueber den Sarcodécörper der Rhizopoden," *Zeitsch. f. Wissensch. Zoologie*, 1865, p. 342; *Generelle Morphologie*, vol. i., pp. 259, 289.

⁵ *Monographie der Moneren*, "Jenaische Zeitschrift f. Medizin und Naturwissenschaft", 1868, iv, 1; translation in *Quarterly Journal of Microscopical Science*, London, 1869, vol. ix, p. 223.

⁶ *Loc. cit.*, 42, et seq.

any substance capable of true solution. Thus, 'nothing that lives is alive in every part,' but as long as any individual part or tissue is properly called living it is only so in virtue of particles of the above-described protoplasm freely distributed among, or interwoven with the textures so closely that there is scarcely any part—of an inch in size but contains its portion of protoplasm. Thus we see realized the hypothesis of Fletcher, that all *living action* is performed *solely* by virtue of portions of irritable or living matter *interwoven* with the *otherwise dead textures*." The objection, however, urged by *Bastian* to Beale is so very pertinent, that it must also find a place here, but I shall not dwell upon other points on which Beale differs from the bioplasm doctrine; such as, that living matter exhibits the same characters at every period of its existence; and that it is always perfectly structureless. "It has always appeared to me," says Bastian,¹ "to be a very fundamental objection to Beale's theory, that so many of the most characteristically vital phenomena of the higher animals should take place through the agency of tissues—muscle and nerve, for instance—by far the greater part of the bulk of which would, in accordance with Dr. Beale's view, have to be considered as *dead* and inert."

In 1873, the morphological knowledge of living matter became exact. In that year, Heitzmann discovered the manner in which bioplasm is arranged throughout the body, and announced the fact that what had until then been regarded as *separate form-elements* in a tissue are really *interconnected portions* of living matter; that not only are there contained *no* isolated unit-masses in any *one* tissue, but *no tissue* in the *whole body* is isolated from the *other* tissues; and that the only unconnected particles of living matter are the corpuscular elements of liquids, such as blood, sperm, saliva, pus, etc., and so-called wandering corpuscles; so that, to use his own words: "the animal body as a whole is a connected mass of protoplasma in which, in some part, are imbedded isolated protoplasma-corpuscles and various not-living substances (glue-giving and mucin-containing substances in the widest sense, also fat, pigment-granules, etc.)." This announcement marked the commencement of a new era in biology.

Heitzmann discovered that the living matter as seen in an amoeba is *not without structure*, as had, before his accurate investigations, been supposed; and that its structure, in all cases when developed, is that of a network, in the meshes of which the bioplasm fluid, or the not-contractile, not-living portion of the organism, exists. When there is a nucleus, it is connected by delicate threads with the extranuclear network; nucleoli and nucleolini inside of the nucleus, as well as granules outside, are portions of living matter: sometimes in lump, sometimes mere points of intersection of the threads constituting the intranuclear and extranuclear living networks, sometimes terminals of section of such threads, as first explained by Eimer,¹ and after him by Klein.²

Heitzmann discovered that what is true of the structure of bioplasm in the amoeba, where a single small unit-mass of living matter constitutes the entire individual, is true also of the structure of bioplasm of all, even the highest, living organisms.

To be sure much had been previously known regarding protoplasm or living matter, but the knowledge was

fragmentary, until Heitzmann demonstrated *not only*, that membrane, nucleus, nucleolus, granules, and threads *are really* the living contractile matter, but also, 1st, that this matter is arranged in a network, containing in its meshes the non-contractile matter, which is transformed into the various kinds of basis-substance, characterizing the different tissues of the body; and 2d, that the tissue-masses of bioplasm throughout the whole body are *interconnected* by means of fine threads of the *same* living matter.

Unless these two facts of Heitzmann's discovery are accepted, there cannot be urged much against the continued use of the word "cell," misnomer though it be. Ranke,¹ after speaking of the "cell-wall," "cell-nucleus," etc., says: "of these component parts of the cell, one or other may be wanting without the totality ceasing to be a cell. The nucleoli, the cell-wall, or the nucleus may be wanting, and yet we must designate the microscopic form a cell, or elementary organism." Drysdale thus comments upon this quotation, viz.: "if any one choose to describe a gun-barrel as a stockless gun without a lock, he is free to do so; but what good purpose can it serve? Or is there even any fun in it? The truth is, this clinging to the mere name of the cell-theory by the Germans seems to arise from a kind of perverted idea of patriotism and of *pietas* toward Schwann and Schleiden." But, I think Tyson² has the better of the argument, in saying: "the word 'cell' has become so intimately associated with histology, that it is doubtful whether it will ever fall into disuse, nor does it much matter, so long as correct notions of the elementary part are obtained." Now, if *there were any* separate and distinct "elementary part," it certainly would matter little or nothing whether it were called "cell" or by any other name, provided the name be properly defined and agreed upon. It is not against the name but against the idea of any *isolated individualized form-element* that the objection lies. Virchow maintains¹ "that the cell is really the ultimate morphological unit in which there is any manifestation of life, and that we must not transfer the seat of real action to any point beyond the cell." Against this statement nearly every author nowadays protests, and insists that vital power must be transferred from the "cell" to "living matter"; yet, after all, the disagreement, though ever so strenuously declared, is a mere verbal one: so long as both parties hold that "every higher animal presents itself as a sum of vital unities"—no matter what these unities are called or how defined. Hæckel, one of the most avowed advocates of "the protoplasm or sarcode theory," clings to Virchow's politico-physiological comparison, that every higher organism is like an organized social community or state, in which the individual citizens are represented by the "cells" [no matter how he may define these], each having a certain morphological and physiological autonomy, although on the other hand interdependent and subject to the laws of the whole. Heitzmann's views necessitate the comparison of the body to a machine, such as a watch or a steam-engine, in which, though there are single parts, no part is at all autonomous, but all combine to make up one individual. Even Huxley, the popular champion of protoplasm as the physical basis of life, quite recently delivered an address, before the International Medical Congress in London, August 9, 1881, in which he used the following language: "in fact, the body is a machine of the nature of an army, not of that of a watch, or of a hydraulic apparatus. Of this army, each cell is a soldier," etc., etc. According to Hæckel and Huxley, the body is composed of *colonies* of amoebæ; according to Heitzmann the body *is one com-*

The Beginnings of Life: being some account of the nature, modes of origin, and transformations of lower organisms. London, 1872, vol. i., p. 155.

¹ "Weitere Nachrichten über den Bau des Zellkerns." *Archiv f. mikrosk. Anatomie*, xiv, 1877, p. 103.

² "Observations on the Structure of Cells and Nuclei," *Quarterly Journal of Microscopical Science*, Jan., 1879, p. 128. "The intranuclear as well as the intracellular network having, of course three dimensions, includes fibrils that lie in the two dimensions of the plane of the field of the microscope, as well as fibrils placed vertically to it. The former appear, of course, as fibrils; but, I should like to ask, as what do the latter appear, *i. e.*, those situated vertically. Clearly as dots, because they are seen endwise; and for obvious reasons most of them lie in the nodes of the network."

¹ The Cell-Doctrine; its history and present state. Philadelphia, 1878, p. 128.

² "Physiologie, 1872," quoted by Drysdale, *loc. cit.*, p. 104.

¹ Die Cellularpathologie in ihrer Begründung auf physiologische und pathologische Gewebelehre, Berlin, 1858, p. 3. (Translation by Chance, London, 1859, p. 3.)

plex amœba. I am very anxious to really make the difference between the cell theory and the bioplason theory clear to every one of you. The essential point of the cell theory is, the idea that the body and each tissue of the body, every plant, and every animal, is made up of a number of distinct units, and the essential point of the bioplason theory is, the idea that all the masses of living matter of each tissue of plants and animals are uninterruptedly connected, and that every tissue is connected with every other tissue by filaments of living matter. To accept Mr. Huxley's comparison, we must imagine that every soldier is indissolubly connected, hand and foot with every neighboring soldier of the solid army!

There is no *better test* of the TRUTH of the bioplason doctrine than the structure of hyaline cartilage. If hyaline cartilage consisted, as "is generally believed," of "a homogeneous ground substance, in which are closed cavities harboring the corpuscles,"¹ the bioplason doctrine would certainly be erroneous. If it merely contained lymph, or juice-channels, no matter what their character, whether open or closed, whether lined or unlined, whether in "homogeneous basis-substance," or "between layers of cells," or "in cement-substance," then, too, the bioplason doctrine would be erroneous.

But the result of my observations, especially those illustrated in figs. 2, 3, and 4, admit of but one interpretation, and that an interpretation favorable to the bioplason doctrine. It is unnecessary to more than mention that although I have placed on record so few, I have made many different examinations, under many different circumstances, and with varying powers of amplification. I need occupy myself here with only the two fields drawn in figs. 3 and 4, with an amplification of 600 and 1200 respectively. The remarkable specimens from which they are taken show more conclusively than it was ever before shown *what* the structure or constitution of hyaline cartilage *really* is. I think I have *explained* this sufficiently, but its full significance appears in its *corroboration* of the *bioplason* doctrine.

To be able to uphold the cell-doctrine, cartilage would have to be, using a homely comparison, like a cake composed of hard dough with raisins. No matter how widely we may extend the definition, to remain within the boundary of the cell-doctrine this metaphor must be applicable. Innumerable painstaking researches have led to various modifications of notions entertained regarding the structure of the two constituents of the cake and their relation to each other. It may be seen by the most recent publications on the subject, that the acceptance of the existence in the dough of cleavage in certain directions, of interlaminary and interfibrillar spaces, and of offshoots, even ramifying prolongations of the raisin-substance, or, at all events, of an ingredient of the raisins, is held to be not incompatible with the cell-doctrine. If, however, we can represent cartilage as a filigree or framework of raisin-substance, in the meshes or interspaces of which framework blocks of dough are imbedded, certainly the fundamental view of the ultimate construction of the tissue is changed, and we are no longer in accord with the cell-doctrine, even though we be inclined to use that term in the widest possible sense. Look for a moment at the two illustrations on the black-board, as well as at figs. 2, 3, and 4. The upper figure represents a section of cartilage stained with gold chloride. This, as I have already alluded to, stains the living matter and leaves the basis-substance unstained. High powers exhibit the appearance, etc., etc. In regard to a NAME as a *substitute* for the term "*cell*," I would say that all corpuscular masses may be called, simply, corpuscles—thus we may speak of blood-cor-

puscles, pus-corpuscles, etc. For all the accumulations of living matter within the ordinary fields of basis-substance, but more especially for those smaller masses which, having as yet developed neither a network structure nor much vacuolation, are still homogeneous, or nearly so—I am quite willing to adopt either the designation of "*plastids*," proposed by Hæckel, or that of "*bioplasts*," proposed by Beale. Perhaps it would be well to restrict the word "*bioplast*" to a small mass of living matter exhibiting no differentiation, and distinguish from it as "*plastid*" the larger mass showing an interior structure more or less like the fully developed corpuscle. Thus, I would always use the term "*plastid*" in the place of "*cell*."

The result of my investigations as to the structure of cartilage is that in this tissue, beyond the possibility of a doubt, the living matter is arranged in the form of a network containing in its meshes the non-contractile matter. How is it with regard to the other proposition of the bioplason doctrine, viz., that the living matter of the different tissues is interconnected? Examinations with high powers of such a specimen as that represented in fig. 1, showing the perichondrium, of horizontal sections through the larynx, or the neck, with skin and more or less of other tissues included, enable me to answer this question to the effect that fine filaments of living matter pass from one tissue to another in connection with the network of living matter in each. The details of these examinations are reserved for another time! But it has been suggested to me that I ought not to conclude without saying a few words as to the *practical* advantages of the Bioplason Doctrine over the Cell-Doctrine. Well, *every exact* scientific investigation, even though at first of *theoretical value* only, sooner or later brings with it some practical benefit; and this doctrine of living matter, aside from the satisfaction which the perception of ABSTRACT truth grants—lying as it does at the foundation of our knowledge of living things—has advanced their physiology, and pathology at every point! In *Practical Medicine* it has already aided us in so many ways that their merest enumeration would require another hour's lecture. We know that the disposition of living matter is different in different persons, and that in the case of increased supply of food the *reaction* is different in strong and healthy people from that in the sick and weak. Upon this knowledge rests, to-day, the *whole doctrine of pulmonary consumption*. Now, the *amount of living matter* within the same bulk *varies greatly*, both in normal and morbid conditions. A small lump of bioplason in the urine or expectoration, taken from an individual of *good* constitution, will show a *close* network with coarse granulations, or perhaps be almost *homogeneous*-looking under the microscope—owing to the *large amount* of living matter in the small bulk; while a plastid from a weak, broken down or phthisical person will be finely granular and exhibit a *network with large meshes* on account of the *relatively small amount of living matter* in it. Sometimes we thus from the examination of a *drop of blood* gain an insight into the condition and vital power of the whole individual; sometimes, recognize a disease before it is sufficiently developed to do much harm, and thus come a step nearer to the *highest aim* of the physician:—the *prevention* of disease.

DISCUSSION.

Dr. B. N. Martin remarked on the great value and important bearing of this investigation.

Mr. A. C. Elliot enquired whether the blocks of non-living matter in the cartilage were entirely separated.

Dr. Elsberg explained that the blocks were separate, their only connection being the interposed threads of the *reticulum* of living matter, and to the former is due the opalescent character of hyaline cartilage. He further stated that the condition of health of an individual might be inferred in a degree from a study of the character of the

¹ This statement of the general belief is quoted from the introductory paragraph of Thin's memoir "On the Structure of Hyaline Cartilage," (*Quarterly Journal of Microscopical Science*, xvi, 1876) in which Thin's own views are laid down to the effect "that layers of cells epithelial in arrangement exist in the substance of cartilage," "that both the stellate and the parallel systems of lymph-channels exist," etc.

network, a thin section of a very minute portion of the body often showing a difference of network in different persons, *e. g.*, in the thickness of the threads, the size of the meshes, the character of the points of intersection, etc. From the uniformity in the size of the meshes, etc., or from their variability, or from the proportion of corpuscles presenting a normal and abnormal character in their network, a good or bad prognosis was deduced by the physician, and even an indication of the progress of disease.

Prof. E. H. Day remarked on the wonderful character of protoplasm in its wide results in the construction of the most varying textures in the vegetable and animal kingdoms. The speaker's observations have brought the protoplasm of cartilage tissue into correspondence with that in the tissues of the sponge, of the plant, and all the lower forms of life. In protoplasm we are brought face to face with the most astonishing substance in nature.

Mr. J. D. Warner offered objections to the vague views of Virchow on the soul of the cell and its relation to the soul of the individual.

Dr. Newberry said that, having been educated as a physician, and having studied microscopic anatomy under Dr. Charles Robin, he had followed with great interest the progress of modern research into the ultimate structure of organic tissue, and the discussions of the origin and seat of vitality to which it has given rise; and he regarded such investigations as those of Dr. Elsberg as of the highest scientific interest and practical value. If we ever learn the causes of malarial and infectious diseases, or the cure of the morbid growths which are the scourges of humanity, cancer and tubercle, it will be through such researches. But he thought that much of the discussion which had been excited by these investigations had been irrelevant and confusing, especially that in regard to the seat and nature of life, into which microscopists and chemists had entered with great earnestness and some acrimony, but with no satisfactory result. In this discussion some writers had made the ultimate cell the seat of life, and had glorified and almost deified it. Others claimed that the cells were only portions of a general vitalized and automatic tissue; while others still contended that the phenomena of vitality were the mere manifestations of chemical changes taking place in structure otherwise lifeless.

With none of these views could he sympathize as there had really been no approach to an end in the effort to localize or analyze life. Unless we accept the materialistic theory of spontaneous generation advocated by Dr. Bastian, but rejected by most biologists, we must confess that no more is now known of the origin, nature and seat of life than was known to Aristotle. All we have done is to acquire a better knowledge of the *machinery* by which the functions of life are accomplished; most important knowledge truly since it enables us to distinguish between normal and morbid life action in the tissues where this action begins, and promises to point the way for promoting the one, and preventing the other—but limited to the methods in which the life force acts, not reaching the inscrutable and intangible force itself.

The work done by a microscopic cell is wonderful and incomprehensible to us, yet all cells work not as independent individuals, but as members of a community, and for a common end. For example, the terminal cell of the fibril of a plant root is a delicate vesicle—the cell in its simplest form, and yet when new born, and having existed but the fraction of a minute, it begins its special work of supplying certain food elements to the plant above; and this it does with a discrimination which is infallible. Water it absorbs by endosmosis, and when deficient begets progeny to send for it. It also appropriates other things that are necessary to the growth of the plant to which it belongs, whatever that be; if tobacco, an unusual quantity of potash; if grass, of silica. It always works to a pattern determined by the character of the plant whose general economy it serves, and is controlled

by the influence which gives to that plant its special and recognizable leaf, flower and fruit, its noxious or alimentary qualities. So in all other parts of the structure the cell is doing its allotted work in a community of which it forms an integral part. It is therefore in no sense an independent individual. Our notions of what constitutes an individual or a community may seem to us quite clear, but they are in fact likely to be somewhat confused. Every man recognizes and asserts his own individuality, but we all know that men who live in communities often think and feel as one though many. A great grief crushes all alike, a great danger rallies all in defence. The social insects, ants and bees, retain their corporeal individuality, but are curiously linked together in a common life that makes each but a part of a whole. A tree is universally accepted as an individual, but as all know it may be divided to form an unlimited number of perfect trees which expand this individual into a forest and prolong its life indefinitely. The sponge is said to be a community of amoeboid individuals, but these share a common skeleton, fashioned for the wants of all, and all unite in the general function by which the inhalent and exhalent currents are maintained, a function on which the life of all depends. In the corals which live in communities we find the common skeleton covered with a vitalized gelatinous integument on which are set here and there the individual polyps. These live to a great degree each for itself; each throws out its tentacles and forages for its own support, but at the same time it shares a life with its neighbors; an injury done to one affects those about it, and a misfortune involving a sufficient number destroys the life of the colony.

The elusive and intangible nature of the life which pervades plant tissue is well shown in the growth and decay of a tree. From a microscopic germ a young *Sequoia* springs into existence, and for a thousand years or more lives its life. All this time it is inspired by a power which acts in antagonism to the affinities of inorganic chemistry, in opposition to the force of gravitation, and which builds up a mass hundreds of tons in weight, mostly obtained by the breaking up of one of the strongest bonds in chemistry, that of carbonic acid, appropriating the carbon and setting the oxygen free. Every part of the huge structure is pervaded by this peculiar creative and conservative influence; and every cell of root or stem or leaf contributes its part to the harmonious whole. At length the time arrives when this peculiar influence which we call life deserts the structure it has created. The affinities of inorganic chemistry now assert themselves, all the ephemeral fabric is rapidly disorganized, and soon a heap of ashes—the inorganic matter woven into its composition—alone remains to tell of its existence. Who can tell us what was the nature of the enchantment which created this Aladdin's palace—whence it came, where it dwelt during its sojourn, and whither it has gone? We may say it resided in the terminal root cells; but these are inseparably connected with the leaves hundreds of feet above. The tie that binds them is a vital one; neither could live without the other, nor without the intervening chain which connects them.

By studying the anatomy of plants and animals, we obtain a knowledge of the organs and laws, as we call them, of animal and plant life; that is, we get a knowledge of the machinery with which the functions of life are accomplished, a knowledge of the order and manner in which these functions are performed; but the *primum mobile*, the real "power behind the throne," remains as yet unseen and unknown to us.

SLIDES OF MARINE ALGÆ.—The Rev. A. B. Hervey, of Taunton, Mass., author of the very beautiful work on "Sea Mosses," will mail to any address for two dollars, a set of six slides showing the characteristic fruit of the six great groups into which Professor Agardh divides the Red Algæ.