THE CENTROSOMES OF ANIMAL CELLS SHOWN TO BE LIVING ORGANISMS.

Remarkable Discovery of Dr. Gustav Eisen.

SAN FRANCISCO SCIENTIST.

It Will Revolutionize All Modern Thought and Study.

Greatest Advance in the Field of Physiology for the Last Fifteen Years.

On this page, in the following columns, THE CALL presents to the world its first inkling of a scientific discovery which will undoubtedly revolutionize all scientific thought and methods of research.

Dr. Gustav Eisen, an eminent member of the California Academy of Sciences and one of the best-known microscopists in the world, has discovered, after many months of patient toil, that the centrosome of animal cells is a living organism.

Slowly but surely the secrets of nature are being revealed by science. Men are at work in all parts of the world searching with the microscope for the least bit of fact that will guide the way to something else. Most of the great discoveries in biology have been made in Germany and France, but the last, and possibly the most important, has just been made here in San Francisco by Dr. Gustav Eisen of the California Academy of Sciences. The importance of the discovery will not be apparent to the average person without an explanation, but before proceeding it might be as well to state that it is the most important fact the microscope has revealed for the last fifteen years. It has a direct bearing on the cell theory of biology, although the experiments have been made with blood corpuscles.

There was a time when our ancestors looked upon blood as a fluid akin to red ink. They knew of course that it was important to life, but had no idea of what it was composed. About the year 1660 the red blood corpuscles were discovered by Swannerdam, and for more than a hundred years the idea prevailed that they were solid particles like aniline dye in a dry state. The discovery of the white corpuscles in 1770 somewhat upset this idea, but it was not until about fifty years ago that the real nature of the blood began to be understood. Improved microscopes and methods of staining revealed the fact that each corpuscle was a perfect cell, with its different parts as cleanly divided as the shell, white and yelk of an ordinary bird's egg.

As the years went by the discovery of the cell grew in importance, and it soon became known that all animal substance was a composition of myriads of cells. It was found that all cells, whether of nerve, brain or blood, were substantially the same. All had the outer covering corresponding to the eggshell, and within this a substance that was named the cytoplasm. Within the cytoplasm, like the yelk of an egg, was found a small substance called the nucleus. After this was found nothing new turned up until about fifteen years ago, when the centrosome was discovered. This was a small speck of matter that adhered to the nucleus. Later investigation showed it to be surrounded by a substance that was called the archoplasm. From this a series of rays were found that ran off in all directions through the cytoplasm.

Since the discovery of the centrosome a great deal has been found out about its action. It was found that in some unknown way the centrosome divided itself and became two. One remained in its original place and the other passed around to the opposite side of the nucleus. In time the centrosomes, by the aid of the rays, accomplished the division of the nucleus, after which the balance of the cell also divided and eventually formed two distinct cells, ready to repeat the process ad infinitum.

All the diagrams of cells that have heretofore been made have been some from figure 1 in the accompanying group of cuts.

The centrosome was thought to be an organ of each cell, but Dr. Eisen has shown it to be a distinct organism, capable of individual action and surviving in the blood serum long after the rest of the cell has perished.

In making his experiments Dr. Eisen used the blood of the Batrachiseps attenuatus, or water dog, as that reptile's red corpuscles are about 500 times the bulk of those of a human being. He made a number of slides and at first thought the blood must have been filled with parasites. Gradually the facts dawned on him and after several months' work he is at last able to say that he has found something new. The set of microscopic slides that he has show numerous phases of the transformation of the centrosome from a constituent of the cell to an independent organism, but four of the accompanying group will give an idea of the principal changes. No. 2 shows the centrosomes preparing to leave the cell. In No. 3 they have stretched to a considerable distance from the nucleus and the cytoplasm has disappeared. In No. 4 one of them has already freed itself and the other is seen hanging by a protoplasmic shaft. No. 5 shows the centrosome as a complete individual, possessing nearly all the properties of a cell.

That the liberated centrosome is capable of independent action Dr. Eisen has also ascertained. He has discovered them in the blood serum by the hundreds, and several of them are in the act of devouring foreign matter. There are several slides showing the new element wrapped around the fragments of disintegrating cells like the tentacles of a devil-fish. These slides are dependent on color for their effect and cannot be reproduced in black and white.

What does all this prove? some might ask. in the first place, it proves beyond the shadow of a doubt that the centrosome is the center of life of all animal cells. It is proved to be a distinct entity with a vital center that may be similar to a brain. This explains how the centrosome is able to pass from one side of the nucleus to the other. As an independent organism it may be as well able to direct its movements as an insect crawling on the outside of an apple.

The importance of the discovery may be realized from the fact that it will change the whole course of work of every microscopist in the world. Many theories of a week ago have been made facts, or have been proved to be untenable. Dr. Eisen's investigations have been so successful and his slides have turned out so perfectly that there is no room for thinking that phenomenon he has observed might mean anything else. The reason the investigations have turned out as they have is due to the state of the blood of the animal from which it was taken and also to the methods of staining.

For the scientific students of the world Dr. Eisen has given THE CALL a few extracts from the work he is preparing on the subject. The following selections refer only to the principal phases of the discovery; the details will make a book of hundreds of pages:

The elements of the blood of Batrachiseps attenuatus are in several respects most interesting, differing in some points as do the corresponding elements of any other species of batrachian which has come under my observation, directly or indirectly. Batrachiseps attenuatus is one of the most common batrachians in this part of California and material for study may be had anywhere almost and at any time except during the dryest part of the summer when specimens are scarce. The elements in the blood of this interesting animal are in short as follows: Erythocites or red blood corpuscles. They differ in three points from the red corpuscles in any other batrachian. First the vast majority, less than one per cent at any time, do not possess any nucleus. The percentage which is nucleated is somewhat uncertain as I have not made a sufficient number of counting to ascertain the average, but I believe that one per cent is not much out of the way. In some animals, especially in early spring, the nucleated red cells are so scarce that on a well spread coverglass I have only found one single red corpuscle with a nucleus. At other times they are more numerous, so that in a field viewed under less power—say Zeiss A, we may count 100 to 200 nucleated cells, all the others having no nucleus.

Second—The red bloodcells are of greatly varying size, not in different animals, but in the same blood. Thus while many corpuscles are very large others are very small. We frequently meet with red bloodcells as small as those of the human blood, while the largest may have five times this diameter. And this variation in size is apparently not dependent on the size of the animal, but appears uniform in the respective individuals investigated.

Third—The red blood corpuscles vary very materially as regards their shape. The majority of corpuscles are ovoid, as batrachian blood in general, but many are almost round or pear shaped, and between these and the ovoid ones there are all possible gradations and variations.

As regards the nucleated red cells again, it is not by any means the largest ones that are furnished with nucleus, but the smallest as well.

Polymorphic leucocytes, similar to those generally seen in batrachian blood.

Noronuclear leucocytes, smaller than the former, or lymphocytes.

Easynophile leucocytes, of the same size as the polynuclear ones, smaller in most batrachian blood, but varying in size.

Fusiform elements, or degenerating nucleated red corpuscles.

Degenerating leucocytes, of various forms and sizes, generally larger than the regular leucocytes. They occur in all stages of decomposition.

Plasmocytes. I apply this name to a hitherto undescribed element in the blood, so far only as observed by me in the blood of batrachiseps. These new elements are much smaller than the average erytheocytes, and only slightly larger than the smallest erytheocytes. They are somewhat larger than the erytheocytes of the human blood. They are characterized by the absence of cell membrane. They occur in considerable numbers and are more numerous than the nucleated red bloodcells.

The object is to establish the identity of these plasmocytes, to trace their origin, to follow their development, and to demonstrate and prove that they constitute the centrosomes and sphere of the nucleated red cells, which have disengaged themselves from the degenerating and dissolving cells, surviving in the blood serum as free and independent elements, capable of growth and assimilation of food.

A. B. Macallum was the first one to determine satisfactorily that the fusiform elements or corpuscles in the blood of Necturus derive their origin directly from the red blood corpuscles, that they constitute in fact disintegrating red nucleated corpuscles, the cell wall of which have been destroyed and the hæmoglobin of which has been liberated. As regards the blood of batrachiseps this origin of the fusiform corpuscles is so apparent that few, if any, comments are necessary. On my slides I have frequently found nucleated cells that had been injured or in which from some other cause the nucleated cell membrane had been ruptured or in which the hæmoglobin had escaped, leaving only the cell membrane as a ring around the nucleus, but at the proper distance away. Such nuclei were surrounded by exactly the same cytoplasm and stained in exactly the same way as that of the fusiform corpuscles, and I could in them discern all the different spheres that I have found in the fusiform corpuscles. In other words the protoplasmic projections at the anchor poles resembled exactly the plasmocytoblasts of the fusiform corpuscles. On this account alone I am satisfied of the correctness of Macallum's demonstration as regards the origin of the fusiform corpuscles.

But, furthermore, if a drop of batrachiseps blood be mixed with a drop of salt solution, 0.6, and observed, we soon see how the red cells lose their hæmoglobin, the cell membranes collapse, and the nuclei with adhering cytoplasm are set free. These remains of the red blood corpuscles resemble exactly the fusiform elements, or at least some of them, as it is evident that the fusiform corpuscles are present in all stages of disintegration.

A fusiform corpuscle stained with tuloidin blue mounted in thus-xylol and viewed under a high-power oil immersion presents the following structure: A large, central nucleus of rather irregular, oblong form. The two long sides are always convex, while the two opposite short sides are generally flat or even concave. The nucleus itself requires little description. It is a nucleus in degeneration, and we find all the various stages between a distinct network with well-defined chromosomes to an irregular mass of dark, staining globules, more or less concentrated or diffuse. What attracts us most is the cytoplasmic elements which adhere to the nucleus as a thin coating, which is thicker at the short nuclear sides.

This cytoplasmic coat is different at the poles of the nucleus from what it is at the long sides. Thus the long sides are covered by a very thin layer of faintly staining cytoplasm, so thin in places that I am not certain if it is always present. This is the rule, though occasionally the cytoplasm on the sides is found much broader, showing two distinct layers. But at the poles, or at least at one of the poles, though generally at both poles, the cytoplasm is greatly accumulated, showing a number of distinctly staining zones or spheres. The tuloidin has a marked and distinct affinity for this part of the cell, and without this stain I could not possibly have attained any result in the study of these elements. The tuloidin differentiates in a way that no other stain does the respective zones of the cytoplasm, and nearly always in the same manner, though always distinctly. In a general way it will be seen that the cytoplasmic projection, or plasmocytoblast, at one or both poles is much darker in the center or at the base, while at the apex or along the outside margin it is lighter. The outside also is always pale blue, while the central or basal part is violet. At the very base or at the very center are seen one or more dark dots, which even a cursory study satisfied me constituted the centrosomes of the cell. They are nearly always present. As might be naturally expected we meet with some variation in the form and size of these cytoplasmic zones, but as a rule they are quite or even very constant. At the outset I find that the cytoplasmic projections or plasmocytoblasts are of two kinds, between which there are gradations. In one kind, the dark staining part, with the centrosomes, is situated at the base close to the nucleus. In this form the layers or zones superpose each other as a series of hollow cones placed one over the other on a plane, the centrosomes resting on this plane. In the other form the zones surround each other as the various layers in a seed. I can nearly always distinguish six distinct zones, and in order to treat of them intelligently I have named them as follows, counting from the exterior to the interior or to the base. Ectoplasm—(1) Plasmosphere; (2) Annulus or hyalosphere; (3) Granosphere; Microcentrum—(4) Centrosphere (or archoplasm); (5) Somosphere with (6) Centrosomes.

The following diagram of the cone-shaped polar projection of the cytoplasm will more clearly illustrate this, and requires but little additional explanation:

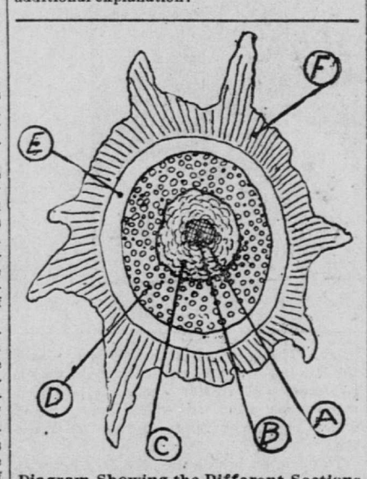


Diagram Showing the Different Sections of a Plasmocyte.

A—Centrosome, *B*—Somosphere, *C*—Centrosphere } Archoplasm; *D*—Granosphere, *E*—Hyalosphere, *F*—Plasmosphere

In the above diagram the nucleus is represented as being below the base line. Immediately above it in the center is the annulus or hyalosphere, while on the sides of the nucleus extends the outer layer or plasmosphere. In general the effect of the tuloidin stain is as follows: The plasmosphere stains faintly blue, with darker blue blotches along the outer margin. The hyalosphere or annulus almost pure white. The centrosphere more or less deep violet. The microsphere either pale whitish or deeper violet or blue than the centrosphere. The somosphere dark with the centrosomes darkest. From this general rule there are, however, a few exceptions.

If we study this figure closer we see that the cytoplasmic projection is especially prominent at the upper pole, while at the lower pole it is quite small. We have no difficulty in recognizing the outer plasmosphere, with its fringe-like margin, the hyalosphere next to it, almost unstained, and the granosphere, which is very large at the upper pole, while at the lower pole it is very narrow. The microsphere again is in this corpusole stained dark, while the somosphere and centrosomes are stained the darkest of the spheres.

In the other class of fusiform corpuscles again we find that the microsphere, at either end, has traveled away from the base of the cone, toward the apex, much more so at the pole. We find that at the pole *b* the spheres are arranged in the cone-like type, while at pole *a* the spheres have assumed the star type, that is, they have traveled away from the base, there being about as much centrosphere on each side surrounding the microsphere. As I have stated, we find fusiform corpuscles in all stages between the two extremes, and the individuality of each is such that two corpuscles are never found exactly alike. Still there is such a great general similarity that we are rarely in doubt as regards the identity of the respective zones or spheres. I will now refer to each of the three spheres in detail, beginning with the outer one on the plasmosphere.

PLASMOSPHERE.—The plasmosphere is especially developed at the poles. It may be much larger at one pole than at the other, and this inequality in size corresponds also with the inequality in size of the other spheres. In other words, the spheres increase in size together, and in such a way that the largest spheres are always those which surround the centromes and centrosphere. The plasmosphere appears always fringed, partly from actually being so, partly from dark staining cytoplasm arranged as a dotted border. This fringed appearance resembles greatly the plasma projections of an amœba, and in a general way the direction of the rays are from the center outward, like the rays of a star. The plasmosphere gives the impression as if it sometimes were in rest, while at other times it appears as if it had been fixed while in amœboid activity.

HYALOSPHERE OR ANNULUS.—Treated with tuloidin this sphere appears always transparent and well defined as a narrow, even, generally highly refractive annulus, which surrounds both the centrosphere and the nucleus. Stained with Erlich-Biondi no difference is seen between the plasmosphere and the annulus, both staining deeply and without any differentiation.

This is by far the most prominent one outside of the nucleus, especially on account of the violet color given by the tuloidin blue, or by its size. The violet color, however, is not always constant. But this sphere is also distinguished on account of its granulated protoplasm, which may in most instances be readily discerned. This granulation is not regular, but quite uneven, some of the granules being large, others smaller and of irregular color. The periphery of this sphere is even and sharply defined, making a strong contrast between it and the hyalosphere. As regards size this sphere is variable. Frequently it is very large or it may constitute only a narrow crescent. It frequently happens that at one pole of the corpuscle the granosphere is very large, while at the other pole again it is small or even wanting. While the plasmosphere and probably the hyalosphere extend all round the nucleus, the granosphere is confined to the two poles. It is this granosphere which evidently presses on the nucleus at each pole and causes the dell in the nucleus. By this I do not mean that it always lies nearest to the nuclear dell, but simply that it is the outermost of the spheres which press around the nucleus at certain points and cause a dell or flattening at this point.

Between the granosphere and the nucleus there is always a very thin layer of hyalosphere, but as this sphere extends all around the nucleus it is evident that it cannot be the one that causes the dell.

The granosphere at times is situated much further away from the nucleus, and when in this state it has also a more round form. The contact with the nucleus then causes the granosphere to flatten out, while it causes a cavity in the nucleus. The granosphere must, therefore, be composed of a denser protoplasm than the nucleus. But this greater density would probably not in the absence of a cell wall be able to impress the nucleus except for the elasticity and tenacity of the outer layers, the plasmosphere and the hyalosphere, which prevent the granosphere from escaping.

CENTROSPHERE.—This is the largest of the most interior spheres. It is nearly always well defined from the granosphere and frequently surrounded by a light irregular body. Its position in the granosphere is variable; it may be situated at the base of the cone, or it may form the center of the rounded granosphere. It appears to be the movability, the position of the centrosphere, which determines the form and position of the sphere. Thus in all cone-shaped plasmocytoblasts the centrosphere is always situated close to the base, while in the rounded plasmocytoblasts the centrosphere is situated in the center, or nearer the center of the granosphere. The centrosphere then determines the shape of the plasmocytoblast. The form of the centrosphere is variable. It is generally round, or at least rounded, but sometimes it is starlike. There may be one or more, sometimes three, rarely, for centrospheres in each plasmocytoblast. In the case of a plurality of centrospheres there can be little doubt but that they are parts of the original centrosphere, parts which have separated and which carry away, each one respectively, a part of the granosphere as a kind of envelope.

As regards staining, the centrosphere stains generally more faintly than the granosphere. But by some unaccountable reason the rebus sometimes occurs. In successful stains with eosin and thiorin or eosin and methylblue O, the centrosphere is frequently stained pale pink.

SOMOSPHERE AND CENTROSOMES.—We now come to the innermost of the spheres, which again contains one or more darker staining minute bodies. I think there be no doubt as to the nature of these and that we here have to deal with the centrosomes of respective investigators, whether use will distinguish the somosphere as separate from the centrosomes or not. It is certain that the dark granules are seldom entirely free, but that they are surrounded by a dark staining irregular sphere, to which I have given the name somosphere, as being the one that nearest incloses the centrosomes. The relationship of the somosphere and centrosomes with the centrosphere is not always plain. It would be incorrect to state that the centrosphere surrounds the somosphere, as frequently the somosphere is seen to lie at one edge of the centrosphere. While the plasmocytoblast is in a resting stage I could frequently detect several darker granules in the somosphere, and which, judging from more advanced plasmocytoblasts, probably never exceed three or four in number. At least I have never, with any certainty, found more than four centrosomes in any plasmocytoblast, and rarely more than three.

DEVELOPMENT OF THE PLASMOCYTOBLASTS.—I have already pointed out that by arranging a series of drawings of the plasmocytoblasts it soon becomes evident that they are in different stages of development. Not only are some much larger than others, but these larger ones show a division of the inner spheres. And this division appears to be caused by the separation of the centrosomes, carrying with them each one an envelope of one or two spheres. A further stage yet and this granosphere surrounds itself with a shell of hyalosphere and plasmosphere.

NO CELL MEMBRANE.—The plasmocytes are not surrounded by any cell membrane, the outer zone or plasmosphere being entirely uncovered. I could not find any signs of the formation of a new membrane except in one or two instances. In this instance the plasmocyte was so rounded and the plasmosphere showed no amœboid projections. A thin membrane bounded the sphere outwardly.

Another point of considerable interest is, I have observed, concerning the staining of the endoplasmic sphere. When there are two distinct divisions of the centrospheres or of the granospheres, one frequently stains different from the other.

The final effort of the centrosome appears to me to be to separate itself entirely and to form the center of a plasmocyte. But if such separation takes place, as I know it does, it is mostly confined to the plasmocytoblast and cases very pale and unstained, while the centrosomes are very sharply defined. In order not to repeat myself too much I will not now describe the respective figures or discuss the variations of the respective spheres.

Concerning the final inclosures of the centrosomes, I can only say that they vary to considerable extent as regards location. But I have frequently seen them lying in a half-circle and connected by a thin somosphere. Or the division may be more perfect, in which case we find three distinct centrospheres, each with a centrosome.

The new element has increased in size, and as it has moved away it has also changed its form. The various envelopes of the new plasmocyte do not show a bearing apart and an irregularity of form, but show a surprising regularity, or as much as could be expected in any element. But, moreover, the final step in the development of the plasmocytoblast is to surround itself with a regular and complete covering of the exterior zone, the plasmosphere. It is the closing of this sphere which decides the time when the new element, the plasmocyte, is complete.

THE PLASMOCYTES.—In the foregoing I have set forth how the inner spheres of the plasmocytoblasts have gradually receded from the immediate vicinity of the nucleus, how they have clothed themselves with envelopes of the outer or ectoplasmic layers, and finally how they have entirely separated themselves from the fusiform corpuscles existing as new entities in the blood serum, with all signs of increase in size, assimilation of food, or phogocytosis, exhibiting amœboid movement just as the originally independent leucocytes.

GROWTH OF THE PLASMOCYTES.—While a large number of plasmocytes are not any larger than the largest divisions of the plasmocytoblast many of them are much larger, and from this I draw the conclusion that they must have grown. Between these the largest plasmocytes and their yet attached progenitors there are all possible grades. I have seen plasmocytes which were as large as the nucleus of the erythrocyte. The majority, however, are much smaller, as will be seen by the measurements given below.

This growth must be caused by the assimilation of food of various kinds. Probably most of the food supply is derived from the blood serum direct, but some of it at least is attained by a direct process of phogocytosis. Thus I have found many times plasmocytes which had engulfed small erythrocytes—of course only those of the smallest kind. This is especially interesting, because we find enclosed in the erythrocyte a parasitic protozoa, the life history of which I have made out. It is not difficult to see it if we have an instance of phogocytosis, or if simply one blood element has been superposed on the other, as frequently occurs. I find repeatedly plasmocytes which lie on top of a red corpuscle and it would at a hasty examination appear as if the plasmocyte was inclosed in the former. But when a simple overlapping occurs I find that there is always a halo around the edges of the superposed element, caused by the pressing back of the protoplasm of the underlying one. In case of real phogocytosis this halo never occurs.

From the foregoing observations it will be seen that in the fusiform elements, of the blood at least, the centrosomes, or perhaps the microcentrum—as we cannot well separate them—show an independent life history and life; surviving, growing and changing long after the other constituents of the cell have disintegrated as such. As far as I can see the plasmocyte occupies the same position as would a real cell, showing with it all the general qualities of the cell as understood by modern cytologists, except one, the power to produce new cells. At least, no instance of unqualified plasmocyte division has come under my notice. The question now arises, in what relationship stands the microcentrum, or the centrosome, to the nucleus and the center of the cell? As is well known, there are two opposite views on this matter.

One regards the centrosome as an original constituent of the cell always present and of paramount importance to the life history of the cell. The adherents of the other theory claim that the centrosome is only an organ of the cell, like the heart of the animal body, either always present or temporarily created at the time of mitosis or cell division.

According to the latter theory the only function of the centrosome and microcentrum would be to carry off and mechanically direct the complicated forces of mitosis, and when this is accomplished the function would be gone.

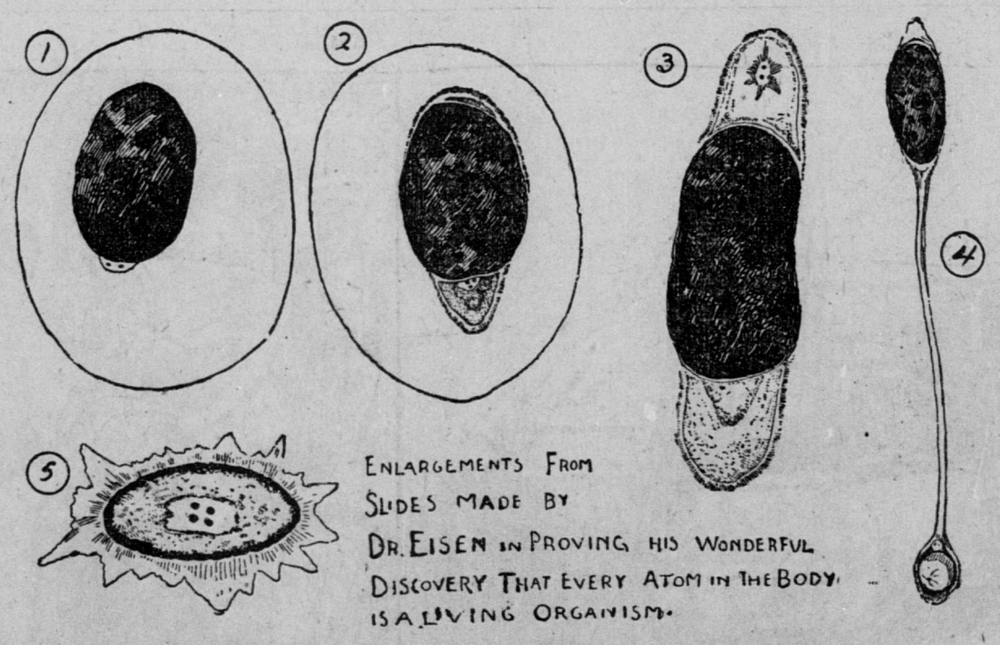
This theory would suffice as long as centrosomes were not found in cells which had lost their power of mitosis, or at least would never again divide by kanyokinesis.

I will now point out that if we not only recognize that probably the microcentrum is always present in every cell, but also can prove that the microcentrum in some cells, as in the fusiform corpuscles of the batrachiseps, survive all other parts; that they clothe themselves with various envelopes of cytoplasmic spheres; that they increase in size and assimilate food, and that they remain independent of the former cell—then I think we cannot help coming to the conclusion that the centrosome is something else than a large microsome, which is situated at the junction of the attraction sphere, and whose temporary function is to assist the chromosomes and in other ways accomplish kanyokinesis.

I hold, therefore, as I think, a logical conclusion from my observations of the batrachiseps blood, that the centrosome is not a tempory organ of the cell, but a most important vital centrum, capable under certain conditions to exist as an independent element in the blood, capable of growth, assimilation of food and probably of movement.

GUSTAV EISEN, Ph. D.

Gustav Eisen, Ph.D., the Eminent San Francisco Biologist and Microscopist, Member of the Academy of Natural Sciences, Whose Remarkable Discovery of Life in the Centrosome of the Blood Is Now Presented to the World by "The Call."



DIAGRAMS SHOWING THE TRANSFORMATION OF THE CENTROSOMES.

No. 1 shows a cell as it was known before Dr. Eisen's discovery. The centrosomes appear as two specks at the bottom of the dark spot in the center.

No. 2 shows the centrosomes preparing to separate from the nucleus.

No. 3 shows them stretched to some length.

No. 4 shows one held only by a protoplasmic shaft.

No. 5 shows a centrosome as an independent organism in the blood serum.

Dr. Jerome A. Anderson On Its Importance.

A BIG STEP IN ADVANCE.

It Demonstrates That There Is a Scientific Life Basis.

The Discoverer an Eminent Member of the California Academy of Sciences.

THE CALL having shown me proofs of a review of a new book by Dr. Gustav Eisen, and having requested an opinion as to the importance of the histological discoveries therein outlined, I have only to say that, if correctly presented, there is no question that Dr. Eisen has added to scientific knowledge that which will make his name familiar to all students of physiology hereafter.

Put plainly the discovery amounts to this:

In both reproduction and cell prolification for nutritive or growth purposes, new cells are provided for by the division or segmentation of an already existing cell. In other words, all cells are cell-born, no spontaneous generation of even the most humble beginnings of life being admitted. A perfect type of a cell (many believe all cells) contains a nucleus, and within this, again, a nucleolus, or, in reproductive cells, a germinal spot. The division of cells is brought about by a splitting of the cell-substance, the active agent in which is the nucleolus or centrosome.

The process is well described by Dr. Eisen and need not be repeated here. But this centrosome, which has been held to be only an essential portion, or by others, only a function of a cell, by Dr. Eisen's discovery suddenly reverses its position and the cell becomes of secondary importance—in fact only an annex to this strange little body. The real point upon which turn all the mighty and secret processes by which life appears and is maintained is shown to be this centrosome; and the cell takes quite a secondary position.

The importance of this discovery, if verified, will be most apparent to scientists, and more particularly to histologists and embryologists. The lay mind, however, can appreciate the fact that a step definitely in advance has been taken in the attempt to solve the mystery of being from its physical aspect.

To some of the deductions, however, the writer begs leave to demur. For instance, it is implied that the migrating of centrosomes to opposite poles of the nucleus may be a voluntary act on their part. This inference is not justifiable and is the result of an overeagerness on the part of modern scientists to demonstrate a physical basis for life; to leave consciousness, which refuses to be weighed or measured, out of account.

All such efforts must fail, and not until scientists recognize the aptness of the old symbol of the serpent biting its own tail will they ever succeed in solving the riddle of physical existence. Consciousness and matter must be recognized as coequal and conjoined in every physical manifestation or the problem is but half solved and the student fails. For the centrosomes to thus deliberately change their positions to bring about cell division would imply a consciousness far exceeding their functions in the animal economy, and would further imply the body of man to be the result of the conscious action of entities infinitely below him in the scale of conscious evolution.

In other words, it would be practically the same thing as to fancy bricks and mortar in a confused heap suddenly of their own volition sorting themselves out, each taking its proper position and thus constructing a building without the supervision of an architect, or under workmen.

Electricity is the nearest approach to that which we recognize as "vital action," or life. Many believe it to be a lower aspect of the same thing. If one studies the process of cell division in these cuts, with this idea in mind, he will discover many things which remind him of electrical action. Two poles, two centers of force, evidences of positive and negative attraction are plainly apparent.

Dr. Eisen will, in the opinion of the writer, be much nearer the true theory if, recognizing the mutual dependence and interaction of consciousness and matter, he will see in the change in position of his centrosomes the intelligent result of electrical (vital) action directed by and from the conscious aspect of a universe which is not all material. This would not necessarily mean that man supervises these functional changes in his own body. He does not; but the general mode of action being conceived of in—let us say—the oversoul of the world would be impressed upon every particle of matter within that world, and each particle, when it reached the stage of the cell, would strive, however blindly, to carry out and obey this its inner guiding force.

For as matter and consciousness cannot be divided (cannot be thought of even as separated) each particle or atom of substance would carry with it its informing soul, thus derived from the impress of the great Over Soul. Of course this implies a pantheistic conception of the universe; but, unless this is recognized, how is man to ever solve these riddles of the sphinx? It is not what some one else believes, but truth that the scientist wants, and it is with the honest endeavor to help that these suggestions are offered to such learned and intelligent students as Dr. Eisen.

His discovery takes us one step nearer the physical basis of reproduction and nutrition, but this is but half the mystery. Unless we believe that the stream can rise higher than its source; that out of blind force playing through senseless matter all the divinely conscious states of compassion, love, reason and so on, can arise, there must be looked for the conscious as well as the physical basis of human hopes and fears. Electricity is a possible mode or force by which consciousness may act upon and through matter, an agent which may unite and co-ordinate these two poles of absolute unity, and even in the behavior of these mysterious centrosomes may be detected the mode of action of this which would seem to be the obedient servant of the creative gods.

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