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O. B. Lepeshinskaya

regular member of the Academy of Medical Sciences

winner of the Stalin Prize

THE CELL AND ITS ORIGIN

State Publishing House

for Agricultural

Literature

Moscow \* 1951

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## INTRODUCTION

All phenomena that are alive in nature should necessarily be considered as one whole: in their mutual relationships and interdependency, in their constant development, transformation and growth, in their appearance and disappearance.

Soviet science, i.e. the followers of dialectical materialism, has made a tremendous leap in the direction of a real understanding of nature.

Our government, the party, and Comrade Stalin in person have created all necessary conditions for the development of the most progressive science in the world - Soviet science.

Academician T. D. Lyenko in his report to the August session of the All-Union Academy of Agricultural Sciences, named after Lenin, in 1948 presented a penetrating analysis of the current status of biological science (a science teaching about living nature, its birth and development). He presented a summation of the struggle by Michurin-biologists against the diametrically opposed movement in biology, against the reactionary and idealistic teachings of Weisman-Mendel-Morgan.

The scientists who are materialists-biologists, armed with the dialectical methodology, have studied the construction and life of the cell and have reached extremely important discoveries and results.

On the basis of the latest data, it is possible to conclude that each little drop, even the smallest particle

of albumin having the aptitude for transformation of matter, is alive and can under certain circumstances develop into a visible cellular structure.

This position radically rejects Virchow's reactionary theory to the effect that life can only begin from a cell and that apart from the cell nothing is alive.

In the present book, the authoress has set herself the task of briefly presenting new data which has been found by studying the cell at the cytological laboratory attached to the Institute for Experimental Biology, USSR Academy of Medical Sciences.

## THE CELL AND ITS LIFE

The discovery of the cell is connected with the invention of the microscope. The naked eye can see the organs and tissues of a human being, animals, or plants; i.e. the heart, lungs, muscles, bones, stem, leaf, et. al. It was the microscope which showed that organs and tissues consist of very small particles, which are called cells.

How were the scientists able to establish the existence of cells, and what was the significance for science of this discovery?

Prior to the time when cells were discovered, scientists had a very sad and also false, mystical conception of living nature. Living nature appeared to them to be divided into two evenly separate "empires" - "an empire of animals" and "an empire of plants," which, as was thought, nothing could unify.

The microscope, discovered about 300 years ago, enabled the observation to be made that there is much in common among all living beings. The common characteristic, important above all others, is found in their cellular structure.

In 1667, Robert Hook was working on the improvement of the microscope. Desiring to test its magnifying power, he placed a thin section of cork under the microscope and noticed that it was comprised of very fine compartments, reminding a honey comb. He named these compartments cells.

(Figure 1).

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Figure 1. Microscopic section of cork.

Picture of cells.

Later, scientists discovered the existence of cells in plant as well as animal organisms. In 1827, the Russian scientist P. F. Goryaninov first came out with a theory according to which all higher plant organisms consist of cells. In 1837, this theory was confirmed by the German botanist Schleiden, and a year later it was confirmed by the zoologist Schwann.

The discovery of the cell and the development of a cellular theory for the construction of living organisms had a tremendously progressive influence upon the sciences of biology and medicine.

"It was only from the time of this discovery," wrote F. Engels, "that the research into organic, living products of nature stood on solid ground... The cover of secrecy hiding the process of origination, growth, and structure

of organisms was torn asunder. The miracle, which had been impenetrable until that time, had to operate according to a process taking place in accordance with essentially identical laws for all multicellular organisms."<sup>1</sup>

The cell consists of a membrane of living matter, the so-called protoplasm, surrounded by a casing. Inside of the cell is a body, the cellular nucleus.

The nucleus plays a very important role in the life of the cell. If the nucleus is damaged, the cell may die. The shape of the nucleus is usually related to the shape of the cell itself. In an elongated and thin cell, the nucleus will also be elongated and thin; in a spherical cell, the nucleus is spherical; in a flat one, it will be flat. During the continuation of the cell's life, the nucleus changes its appearance. Singularly great changes take place in a nucleus at the time of so-called mitotic (indirect) fission of cells, which will be described below.

Usually only one nucleus is found in a cell. However, there do exist living structures with a multiplicity of nuclei. The muscular fibre belongs to such structures. Cells completely devoid of nuclei also exist, as for example the red blood corpuscles in a human being. These are so-called erythrocytes

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1. The Dialectics of Nature (Leningrad: State Publishing House for Political Literature, 1949), page 155.



which, in the organism, play the part of oxygen carriers from the lungs to the tissues.

In the cells of bacteria, the nuclear substance is distributed evenly throughout the whole cell; when the bacteria become old, the nuclear substance collects in clusters.

That part of the protoplasm which surrounds the nucleus is usually called the cytoplasm. In the cytoplasm of a cell, it is possible to see a multiplicity of granules in varying sizes and shapes. They apparently have considerable importance for the transformation of matter in the life of a cell. The living matter of a cell can be observed very well by placing under a microscope, for example, a part of a stem or leaf from a nettle. The edge of such a piece of nettle, with its burning hairs, can serve as an excellent subject for observation. Usually the hair consists of only one cell of large dimensions. On the exterior, a fat and strong casing made from cellulose<sup>1</sup> can be seen. All growing cells are usually surrounded by such cellulose walls.

Looking at the living and burning nettle hair, it is easy to observe that living matter does not fill all of the cell but is concentrated around the cellulose walls on the

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1. The cellular tissue made of cellulose is matter which appears to be the principal component part of membranes in the cells of plants (O.L.).

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inside of the casing and extends apparently more heavily from one wall to the other. Such a distribution of the protoplasm is only found in the cells of plants. In ~~the~~ animal cells, the protoplasm fills the whole cell. ✓

The protoplasm, or the living substance in a cell, is a very heavy fluid having rigidity as a characteristic. In the cell of a hair from the nettle, the rigidity of the protoplasm can be noted well according to the movements of hard particles which float in it in one or the other direction.

The protoplasm of a cell consists of many substances, but the principal one among them appears to be albumin or, more correctly, albumins (a very large number of different albumins are found in an organism). Albumin represents in itself a very complex substance, the basic characteristic of it apparently being the ability to transform matter. A living particle of albumin continually changes, simultaneously decomposing and regrouping in its various parts.

A more simple transformation of matter takes place in the nature that does not live. For instance, the process whereby iron is oxidized - this is an interchange of matter occurring between iron and the surrounding atmosphere. However, in the dead part of nature, the interchange between substances leads to decomposition; when rust is formed, iron does not remain iron any longer but transforms into another substance - iron oxide.

As a result of this metabolism, the living organism not only~~x~~ is preserved but also develops, grows, and multiplies thanks to the albumin which through interaction with other substances appears to be the main component part in the organism's process of metabolism.

Due to its unstability, the albumin can pass from one physical form to another: it appears in the liquid stage, in a gelatinous state, or appearing as a fibrous or granular sediment. Such transformations of the albumin can all take place in the cell as a result of interaction with these ~~or~~ other substances in the process of normal activity. These phenomena can be observed, for example, during the time of cellular fission. Similar changes can be precipitated in the cell's nucleus also artificially, by means of mechanical irritation or the action of different substances upon the cell.

Depending upon the role that is played in the whole organism by these or other cells, the latter possess<sup>s</sup> a character which corresponds to their structure. Muscular fibres, blood corpuscles (red and white blood vessels), the cells of the skin - all are sharply differentiated one from the other in the way they are constructed as well as in the work to which~~x~~ they are adapted and which is fulfilled by a given type of cell (Figure 2).

Figure 2. Different types of cells in the living organism.

In what manner do the cells in an organism assume this or another structure, adapted to the character of work being conducted by them or, as is said, their functions? Science has not as yet provided a complete answer to this question. However, on the basis of examining what biologists know in this connection, we can state that apparently this or the other form is assumed by the cell due to the interaction of its albumin with other substances and the influence upon this cell of the various conditions in the surrounding atmosphere or environment: the different types of substances, the neighboring cells, the influence of electricity, and

many other conditions in the organism which we do not as yet know. All of this leads to the development of such a type of metabolism which is necessary for the fulfillment by the cell of its designated work; for instance, the secretions of glandular cells.<sup>1</sup> Depending upon the character of the metabolism, a cell will produce these or other products: certain types of glandular cells secrete saliva, others bile, a third type - gastric juice, etc. Metabolism may be of such a type that the activity of the cell is expressed in its attribute for contracting and weakening, which is observed in the muscular fibre.

In the organism of the most complicated animals, especially in the organism of the human being, the most important role is played by the nervous system - in part by the nerve cell. The great Russian physiologists, Sechenov and Pavlov, discovered the role of the nervous system as the main regulator of living processes and of the psychic activity of man. The nerve cells can fulfill their duties on the one hand due to the peculiar type of metabolism they have and ~~thanks~~ to which the nerve cell is possessed of a strongly expressed capability for stimulation; on the other hand, as

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1. The secretions of glands are substances produced and secreted by the glandular cells in the body of human beings and animals (for example, gastric juice, saliva) (O.L.)

a result of the special way in which the nerve cell is constructed. Nerve cells have long branches, along which the nervous impulse is conducted. If the nerve branch comes into contact with the muscular fibre, then the impulse precipitates a contraction of the fibre. Under different conditions, the same nervous impulse precipitates a different type of action. If it should come, for example, into contact with a glandular cell then it will precipitate in the latter a secretion.

The attribute of movement is possessed <sup>not</sup> ~~only~~ by the muscular cells; this ability is also a characteristic of other cells, for instance, white blood corpuscles. Extending part of its amorphous body forward and gradually pouring all of its protoplasm from one place to the next, the white blood vessel can move between other cells in the organism. The famous Russian scientist Ilya Ilich Mechnikov minutely examined the properties of white blood corpuscles. It became apparent that they can seize, with the aid of their branches, fine particles extraneously. White blood vessels are extraordinarily useful to the organism. They seize and devour harmful microbes and in this way save us from infections during illnesses. They appear in infinite numbers at an infected wound, devour at this place particles of dirt and bacteria, appearing in the form of so-called pus.

A cell, for the most part, has a casing on its surface. This cellular membrane represents an external layer of living matter covering the cell's protoplasm; it changes under the influence of its surroundings, and it is somewhat more solid than the living substance inside ~~of~~ the cell itself.

The membranes separate between themselves the individual cells within the animal organism. A thin layer of casing is not always visible, when in a live and unimpaired condition. Only after undergoing special treatment and ~~examination~~ <sup>examination</sup> of the membranes do these become easily discernible.

In a growing organism, as has already been stated, each cell secretes around itself thick and very strong walls which consist for the most part of cellulose. This cellulose or the cellular tissue represent matter which is unusually resistant to all possible chemical reactions. The properties of cellulose provide the possibility for its broad utilization in light industry to manufacture artificial silk, artificial wool, celluloid, ~~et. al.~~ <sup>et. al.</sup>

The membranes of <sup>plant</sup> ~~animal~~ cells will first attract the attention of anybody who is observing this growth under the microscope. Due to their strength, the walls of plant cells usually remain unchangeable even when their live contents dry out, die, or are destroyed in some other way (for instance, from bacteria during decomposition). It is unfortunate that the first scientists, regardless of the poor quality of their microscopes and the absence of knowledge concerning lower

living objects, noticed first of all the cellulose walls; at that time, they did not pay any attention to the living matter within the cells. Figure 1 portrays namely those thick walls of the cellular tissue in a plant.

At one time, scientists even thought that the membrane was the most important thing ~~in~~<sup>in</sup> a living organism. When it was discovered that the content of cells appeared to be alive and that the walls themselves only served the living plant cell as a casing consisting of non-living products from the secretions of the cell, the scientists went to the other extreme: they began to discount the importance of the cell membrane in <sup>n</sup>animals.

However, careful research conducted in our laboratory on the problem of membranes showed that the animal cell is surrounded by a casing which is formed already on the surface of young cells. At first it seems to be porous and little noticeable; in order to locate it, it is sufficient to break it by one means or another (Figure 3). When a membrane

Figure 3. Various stages in the decomposition of membranes.



is torn, the fluid contained inside of the cell flows out. If a solution of coloring is added to the preparation, it is possible to color the membrane in one way and the contents of the cell in another way.

When it ages, the membrane becomes thinner and more solid.

Membranes play a very important part in the life of cells and consequently in the lives of all organisms. They serve as a deterrent to substances which could otherwise fall into the inside of the cell and as an obstacle to the matter within the cell itself which might pass into the surrounding habitat. These substances can be important and necessary to the activities of the cell or, on the other hand, repulsive and poisonous and lead the cell to its destruction or to some impairment of its metabolism.

The membrane is possessed of the property to permit some substances to pass through it and to stop and change the appearance of others. This property of the membrane is called selective penetrability.

What is selective penetrability dependent upon? The membrane of the cell can be compared to a certain extent to a piece of parchment paper which, also like the cellular membrane, lets certain substances through and stops others. Parchment is an inanimate object having very small openings or pores, through which very fine particles (molecules)

pass through it like through a sieve, whereas larger ones are held. This is utilized in practice for the separation of substances, for example the washing away of sodium chlorides from albumins.

The cell's membrane also is endowed with these properties very often. However, exceptions occur. Certain substances, the molecules of which are very small in dimension, can not penetrate into the cell. Other substances, having comparatively large molecules, pass into the cell. This unusual conduct of the membrane is explained by the fact that it is a part of the cell's living matter and consists of albumins and fatty substances - lipoids. Characteristic of albumins is their unstableness, the ability to change their properties under the influence of action by their surroundings, and this ~~is~~ has a telling effect on the properties of membranes.

The membranes of animal cells respond so strongly and sharply to any external influence that, knowing the substance and how it influences the membrane, it is possible to control the membrane's changes, precipitate swelling, the appearance of granules or fibres (Figure 4). When passing through the membrane, some substances can change themselves and ~~in~~ transform the membrane itself.

Figure 4. The membranes of cells: (1) thin and uniform;  
(2) granulous; (3) vacolizirized.

In view of the foregoing, it is possible to state that the cell's membrane is a living structure in a living cell.

But, what is the origin of the cell itself? What is the history of the cell?

## THE ORIGIN OF CELLS

Despite the fact that scientists have long studied the cell, its structure, feeding, breathing, growth and propagation - much is still unclear to the present time concerning the question of the cell. This is explained by ... ..ascertaining that the development of the cell had not been studied from the beginning of its formation. Some "scientists" believed that the cell was created by the almighty divine power and for this reason considered the problem of its origin as a secret and not a subject for research. Thus, a German scientist in the second half of the last century, Virchow, concluded that life begins only in the cell and that apart from the cell there is nothing alive and that all cells are formed only by means of fission from other cells.

The followers of Virchow further developed his cellular theory and brought it to absurdity. According to their representations, a complex organism - i.e. constructed of many blocks - of cells disposes of certain designated functions that are independent one from the other. In such a manner, in the eyes of Virchow's followers, the life of an organism is reduced to the life of its individual cells. Such a presentation radically simplifies and distorts the cellular theory as well as all more complicated processes which exist in the organism: it does not in any way contribute to the development of a scientific biology, nor does it explain a multiplicity of phenomena.

Now, for example, from this point of view can one explain the development of the living from the non-living or growth from an egg (a mammal, a bird, or from the spawn of a fish) into a complex organism with a multiplicity of cells having various functions, complicated inter-relationships among themselves and with the external surroundings.

Virkhov's followers claimed that at some time in the very far away past, at the dawn of life, in some sort of way the first cell appeared. By means of mechanical fission, it gave forth a multiplicity of cells.

From this colony of cells were derived all complex organisms, their tissues and organs, representing in themselves endless columns of fissionable cells. They [Virkhov's followers] considered that cells in our times are never created and never develop from organic substances.

The Virkhov false teaching about the unchanging character of everything living opened the way for religion to fool the people. From the point of view of this false promise, it was concluded that an explanation of the existing varied forms of life can only be made by the introduction of the almighty powers.

On the basis of Virkhov's ideas, there developed the bourgeois falsehood about heredity - the old so-called formal genetics<sup>1</sup> of Weismann, Mendel, and Morgan. This teaching

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1. Genetics is the science of heredity and its transformations (C. L.).

attempted to support the exploitation of man by man, gave rise to the humanly despicable "race" theory, which justifies the annihilation of human beings for the interests of imperialism.

Opposing Virkhov were Goryaninov, Schleider, and Schwann who attempted to prove that new cells in an organism are formed by development from non-cellular substances which were called "cytoblastic" by them. These attempts were ridiculed by the followers of Virkhov; the teachings concerning the development of cells from non-cellular substances was rejected by the Virkhov supporters as being without sufficient substantiation and was forgotten.

The formation of cells is described by Schleiden as a process of creating granulousness in a slimy-albumin mass. Around the individual granules, formed in this mass, there accumulate other granules. Gradually from this cluster of albuminous granulousness, according to the observations of this scientist, a cell develops.

It was later discovered that new cells can be formed also by other means, by means of multiplication of earlier created cells. Later on, under the influence of Virkhov, this presentation about the formation of cells from non-cellular substance was completely eliminated from biology. Until very recently, the opinion reigned in biology that an expansion in the number of cells within an organism takes place only on account of fission by the existing cells.

Now we will briefly discuss the process of cellular fission. The simplest method of fission~~xxx~~ appears to be gemmulation. A particle is separated from the nucleus, and it passes into the plasma<sup>1</sup> of the cell - i.e. on the edge, and it forms a bud from which there grows a new cell similar to the mother cell.

Other cells multiply by direct fission, where the nucleus of the cell and the plasma inter-lace each other at the middle and become two approximately equal parts. Finally, the majority of cells multiply ~~themselves~~ by means of indirect fission which is called karyokinesis (Figure 5).

Figure 5. Successive stages of indirect cellular fission.

1. Plasma or protoplasm~~x~~ is a living substance of any animal or plant cell, having the appearance of a semi-fluid, colorless, viscous mass and consisting primarily of albumins (O. L.).

Studying the indirect (mitotic) fission of cells, scientists to date have turned their attention for the most part toward changes in the nucleus. The nucleus in an unfissioned cell resembles a transparent uniform vesicle. During the period of fission, there are revealed at first thin and then thick threads, sticks and ~~cores~~ - so-called chromosomes which means "colored bodies." If a special coloring agent is added to the cell undergoing fission (a so-called "nuclear" color), then the chromosomes alone will be colored <sup>while</sup> the surrounding fluid will remain colorless.

The chromosomes during an indirect fission of cells separates into two distinct clusters which form new nuclei. Between the nuclei in the cytoplasm partitions appear. This is the end of the fission. The nuclei in each of the two cells thus obtained soon assume the appearance of uniform transparent vesicles.

On Figure 5, portraying an indirect fission, it can be seen that the greatest part in this fission is played by a small body from which threads or so-called raylike spheres are emitted. The bodies together with the ray-like sphere also are divided during the fission.

What significance do these complicated transformations, which take place in the nucleus, have; and what processes are involved in this connection - these questions have not been answered to date. There is no doubt, however, that this problem of nature will be solved. In order to obtain a solution,



it is not necessary to enter upon the slippery road of fantasy without any foundation, similar to the one on the basis of which the geneticists-Morganites operate. Not having

Figure 5. Successive stages in the indirect fission of a cell.

any scientific foundations, these bourgeois scientists have endowed the chromosomes, which are created in the cell during the process of fission, the exclusive property of transmitting hereditary qualities from cell to cell.

Academician T. D. Lyenko has proven the incorrectness of these representations. Hereditary qualities are transmitted not only by means of chromosomes; this property is possessed by any particle of live matter. Our work, as will be seen later, corroborates Lyenko's position.

Research, conducted by us, permits the observation of the fission process and leads to conclusions totally unlike those represented by the Virkhovites or the geneticists-Morganites. According to these persons, the cell is divided mechanically into two parts of equal value. In actual fact, the process of fission gives birth to a new cell within the womb of the old mother-cell. Of the two new cells, one after a fashion appears to be the mother-cell and the other the daughter-cell.

In such a manner, individual development (ontogenesis) of the cell begins with its formation through a series of stages, from the non-cellular living substance or from the living matter of the mother-cell at the time of its fission.

Life does not begin with the cell, as was presented by Virkhov, but with more simple formations - from non-cellular living matter. "The most simple type observed in all of organic nature," states Engels, "appears to be the cell; and it really lies at the basis of higher organisms. However, among lower organisms we find a multitude of those which are situated even considerably lower than the cell; for instance the protameba is a simple cluster of albuminous matter without any differentiation, as well as a whole series of others and all tubular algae."

Or further: "The lowest live substances which are known to us do not represent more than simple clusters of albuminous matter, and they already show all the essential

appearances of life."<sup>1</sup>

It is clear from these words of Engels that he did not consider the beginning of life to be in the cell but in forms much more simple, in a cluster of albuminous matter which we call a living substance.

Darwin, who by his teachings on the development of nature destroyed religious superstitions and provided a rational explanation for expeditious constructions of organisms, did not touch upon the question of cell development at all~~s~~. In this connection, a large lacuna was left in Darwin's teachings about evolution.

A whole line of scientists has grown up with the theories of <sup>Virchow</sup> Virchow, which have reigned for over 75 years, so that it is difficult for them to reject accustomed ideas. The followers of <sup>Virchow</sup> Virchow do not want to observe the existence in nature of a variety of simpler forms having nothing in common with the cell.

The blinding effect of Virchow's theory and the slavish adherence to it on the part of certain biologists is so great that they protest in all possible ways against even posing the problem of the cell's origin, rejecting the possibility that the cell has originated along the path of evolution from a living substance.

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1. Anti-Dühring (Leningrad: State Publishing House for Political Literature, 1950), pages 74 and 77.

In order to discredit this new question, the Virkhovites identify~~x~~ it with the unscientific fantasies of Paracelsus (XVI century) concerning the formation of a highly organized being, like a mouse and fish, from stagnant water. Paracelsus, as is known, came up with a recipe for the preparation of a homunculus, i.e. a little man. "Take a known human fluid (this means urine - O.L.) and allow it to decompose at first in a sealed gourd, later in the stomach of a horse until it begins to live, rise and move - which is easy to observe. What has been obtained still does not resemble a human being, since it is transparent and without body. However, if later every day and in secret, carefully and with wisdom, the thing will be fed human blood and kept constantly during forty weeks in the same even temperature of a horse's stomach, then a real live baby will be obtained..., only it will be of small stature."<sup>1</sup>

Van Helmont in the XVI century presented a recipe of the same type for the preparation of a mouse out of seeds soaked in fluid wrung out of a soiled shirt. Similar foolish ideas concerning the self-birth of highly organized beings from decomposing water and any other garbage has nothing in common obviously with the scientific theory of the cell's origin from a living substance.

It is well known that new progressive ideas countering the old ones have always met with and meet mass opposition

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1. Cited by Lun'evich, The Foundations of Life (Moscow: 1920), volume I, page 85.

on the part of reactionary scientists. Especially rabid opposition to these leading ideas has been shown by the bourgeois science of the capitalist countries, which is under the strong influence of idealism and the church. Idealism rejects the dialectical-materialist theory of development, "takes issue with the possibility of knowing the world and its laws, does not believe in the authenticity of our knowledge, will not concede that objective being exists, and considers that the world is full of 'substances in themselves' which can never become known to science."<sup>1</sup>

Namely, because of this, bourgeois science to the present refuses to accept the position that the self-birth of simpler living substances is connected with the development of cells.

In <sup>n</sup>contrast to idealism, the philosophy of dialectical materialism considers that "...there are no things unascertainable in the world; there are only things which have not yet become known, which will be discovered and revealed by the powers of science and practice."<sup>2</sup>

Soviet scientists, innovators, educated in the spirit of dialectical materialism, freely create the leading science in the world.

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1. History of the All-Union Communist Party, Short Course

(Moscow: State Publishing House for Political Literature, 1950), p. 107.

2. Ibid.

The achievements of Soviet science are very great. Thus, for example, our biochemists Academician N. D. Zelinskii, N. I. Gavrilov, B. I. Zbarskii and others have come close to solving the very important problem concerning the sequence in which amino-acids (complex organic substances) decompose within the molecule (particle) of albumin and what the structure of the albuminous molecule is like. This question ~~stands~~ stands in direct relationship to a second one which is even more important - how to construct an albumin by artificial means.

The first successful efforts at obtaining an artificial substance similar to albumin were recently conducted ~~at~~ at Leningrad by Professor S. E. Bresler.

The task of constructing an albumin has considerable significance for industry (the manufacture of artificial fibres, artificial wool, artificial food products, etc.). This ~~problem~~ problem has great significance also for science - biology, medicine and agricultural biology, in part also for the problem of the living substance. The albumin enters into the composition of living matter as the most important part. ~~However~~ However, from the simple albumin to the living cell is still a considerable distance. Only when this distance will have been fundamentally mastered, only then ~~will~~ will there be hope for the possibility of utilizing an artificially obtained albumin for the creation of simpler organisms, cells, and ~~the~~ tissues.

The problems involved in the development of the live cell until very recently were being examined only at the

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Cytological Laboratory, attached to the Institute for Experimental Biology directed by me.

"It is impossible to proceed forward," states Comrade Stalin," and to develop science without first undertaking a critical analysis of the old positions and writings of known authorities."<sup>1</sup>

Basing our problem concerning the origin of the cell upon the living substance, we undertook first to criticise the false teachings of Virkhov whose dogmatic statement about the impossibility of life outside of the cell chained the mind of the researcher.

Engels wrote: "Only by means of observation is it possible to explain how the process of development takes place from the simple plastic albumin to the cell and, successively, to the organism."<sup>2</sup>

Our laboratory set itself the task of studying the origin of cells from the live plastic albumin, from the living matter.

If one has a complex albuminous substance, in which apart from the albumin there are also nuclear acids (entering into the composition of the cell's nucleus) as well as certain other substances; if this albuminous substance still does not possess the form of a cell, but is already prepared

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1. "Reply of Comrade Stalin to the Letter from Comrade Razin," *Bolshevik*, No. 3 (1947), page 7.

2. *Anti-Dühring*, *op. cit.*, page 322.

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to undergo a metabolism, then this is certainly a live substance which under favorable circumstances can not remain without transformation, without development. In developing, it should provide new, qualitatively higher forms, passing into the pre-cell or moner and then into the cell.

If, however, the protoplasm~~ix~~ or the albuminous substance does not possess the ability for metabolism or if the surroundings do not dispose of the appropriate conditions for this - then it will die or deteriorate into its more simple component parts, or under favorable circumstances it can conserve itself, hide its possibilities for development (anabiosis).

One of the biologists (Professor Nemilov) has written: "Nowhere, neither in the terrible deep<sup>s</sup> of the ocean nor on the cold peaks of the highest mountains, neither in the dense forests of hot lands nor anywhere else that life is so full - nowhere can matter be born again from the dead, but everywhere it originates from other and only other living matter. It is clear and it follows that we should forever give up the hope of directly observing the birth of life."<sup>1</sup>

If under self-birth we understand the formation of highly developed organisms from dead matter, then necessarily such self-birth can not exist. Similarly a living albumin must first develop from inorganic matter, i.e. a living

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1. New Concepts in Biology (1924), Collection No. 16, "Education" edition.



substance, and from the living substance one can expect the development of cells which will be of the most simple type.

Engels considered that "If at any time it will be possible to make by chemical means albuminous bodies, then they will certainly reveal the appearance of life and will complete their metabolism no matter how weak or transitory they will be."<sup>1</sup>

To reject the birth of life at the present time, as is done by certain scientists, only on the basis that nobody has yet observed this birth; or, as other scientists do, to claim that contemporary highly organized micro-organisms would devour all newly formed simple living matter - is slightly naive and unfounded.

Helmholtz many decades ago wrote: "If all of our attempts to create organisms from inanimate matter are unsuccessful, then we - it seems to me - have the right to ask ourselves the question: was life ever created?"

Engels for this reason answered him: "When Helmholtz speaks of the failure on the part of all attempts to create life artificially, this talk of his sounds simply child-like."<sup>2</sup>

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1. *Dialectics of Nature* (Moscow: State Publishing House for Political Literature, 1929), page 244.

2. *Ibid.*

Apart from the fact where to find that division, that border line after which living matter ceases its development and stops to create - there is another problem. What physico-chemical reasons could establish immediately the development of a living substance from inorganic matter?

The elements from which the live protoplasm develops continue to exist; the temperature and air must remain comparatively little changed. In old times, the living substance could develop only under conditions where the temperature was not too high, since at high temperatures the albumins <sup>contract</sup> ~~roll up~~ and life becomes impossible.

In such a manner, it is difficult to state that after the development of cells on the earth there has disappeared the possibility of forming a live substance and develop from it new cells.

### WHAT IS LIVING MATTER?

In order to explain the derivation of a cell from living matter, it is necessary first of all to study the living substance itself and accurately keep in mind what the concept "living matter" signifies. Various researchers approach an understanding of the term "living matter" in different ways. It is necessary above all to throw away harmful teachings.

We do not have to waste any time <sup>on</sup> for an explanation of the origin of the living substance from the religious point of view, in view of its unscientific basis and idiotism. The vitalists did not go much further than the religious representatives. They explained the phenomenon of life by the presence in live organisms of a special life-giving power, a non-materialistic "entelekhia," which is the name given by the vitalists to their non-materialistic origin of all life.

The vitalists consider that the living organism is not subordinate to the general laws of nature, that biologic laws can not be studied, that they are impossible to learn, since they are allegedly ruled by non-materialistic forces.

The teachings of Darwin and new advances of biology contributed destructive blows to the vitalist teaching, so that at the <sup>r</sup>current time uncamouflaged vitalist delirium is met with only rarely.

During the struggle against vitalism in science, there arose another extremist theory - the mechanistic direction of thought, which in reality did not proceed far from the idealistic teachings of the vitalists. The mechanisticists consider living processes only as a numerical combination of unchangeable particles.

They look upon the organism as a simple sum of all cells, whereas in reality the organism is a complex system with many differing internal and external connections.

The mechanistic teaching does not accept the idea of qualitative, revolutionary leaps in the development of nature; it is a most harmful, anti-Marxist teaching against which a most decisive struggle should be waged.

Unfortunately, mechanisticism in biology occupies even at the present time quite a large place. To the present day, some biologists continue to blindly bow before the authority of the mechanistic Virchow. Until very recently, new work in cytology<sup>1</sup> directed against the old traditions provoked rabid attacks on the part of the Virchowites.

How does that part of the scientists approach the problem of the living substance?

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1. Cytology - the science concerning the formation and living manifestations on the part of plant and animal cells (O. L.).

Certain biologists (for example, A. P. Kizel and H. K. Koltsov), relying upon mechanistic positions, do not believe at all in the possibility that an artificial albumin can be created. They base their disbelief upon the fact that the albumin, as is known, consists of twenty amino-acids which repeat themselves many times. In what way the amino-acids join to comprise the albumin is unknown.

These scientists assume that the only way artificially to obtain an albumin is the blind combination of amino-acids. The number of combinations possible is considerable and perhaps millions of years would be needed for the mechanistic scientists to hit upon the right combination that would give a living albumin. This, of course, is a retardation of science. Certainly, when attempting to make an albumin or a living substance, definite rules must be maintained and adhered to. It is impossible to mix the amino-acids blindly. The protoplasm is subordinate not only to physical but also to chemical laws, and also biological laws. Some scientists forget this and consider that the protoplasm is a simple mixture of chemical substances.

Engels himself did not make any experiments but made use of the colossal amount of factual data that had been collected by science. He systematized it and came to the following conclusion: "The conditions for the existence of the albumin are necessarily more complex than the conditions for the existence of any other union with carbon known to us, because here we have to do with not only new physical and

Figure 14. Development of cells in albumin of chicken's egg.

chemical properties but also with~~the~~ functions of feeding and breathing.,<sup>1</sup> that is with biological properties.

Armed with a dialectical-materialist outlook upon the world, directed by the teachings of Marx, Engels, and their geniuses-continuers Lenin and Stalin, the leading Soviet scientists pose anew the problems of the albumin and the living substance.

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1. Dialectics of Nature, *op. cit.*, page 243.

"In contrast to metaphysics, dialectics looks upon nature not as a maintenance of peace and motionlessness but as a state of continuous movement, ceaseless regeneration and transformation, where things originate and develop or decompose and die having lived their time."<sup>1</sup>

Soviet biochemists have attained considerable achievements in the area of studying the metabolism in living substances, where processes of formation and decomposition occur. They have come close to the solution of the riddle how to delicately construct an albumin. They have been successful in building, under artificial conditions, substances similar to albumins. These are very close in their properties to the real albumin.

In our laboratory, cells were obtained which had developed from non-cellular living matter. The living substance is a material consisting for the most part of albumins which explains the processes of metabolism, i.e. simultaneous building and decomposition. Living matter is present in each cell as well as outside of it. Under favorable conditions the living substance ~~inside~~<sup>out</sup> of the cell through a number of stages develops into cells. Under unfavorable conditions, the live albuminous mass does not develop and passes on into more

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1. History of the All-Union Communist Party, Short Course, op. cit., page 101.

simple form which does not produce cells but decomposes and may serve as food for a developing live substance and for cells.

\* \* \*

The well-known researcher into being who lived in the middle of the XIX century, the materialist Hegel, divides the history of the origin of cells into two parts: the formation of a living substance from the inorganic world (the derivation of life) and the development of cells from living matter.

"To reject spontaneous creation (i.e. self-birth - C.L.), means," writes Hegel, "to accept a miracle or divine creation of life. Either life is self-created on the basis of these or other legal norms or it is created by the almighty powers."<sup>1</sup>

Placing considerable importance upon the hypothesis concerning the original self-birth of life, Hegel proved the necessity of accepting pre-cellular forms of life. A similar pre-cell form of existence on the part of living matter is the monera, preserved - according to Hegel - also in our times. The monera, as Heron writes, is the simplest "organism without organs. Only such homogeneous (i.e. uniform - C.L.), really still undifferentiated organisms, being very close to

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1. E. Hegel, Natural History of the World's Creation (St. Petersburg, 1909).



inorganic crystals in their molecular structure, could have originated and by means of a first birth become the pre-ancestors of all simple organisms. Further in the development of these probionts (procursons of the cell - O.L.) a more important process was above all the formation of the nucleus in the structureless cluster of the plasson.<sup>1</sup> Physically this could be pictured in view of the strengthening of the internal, central particles of the albumin accompanied by changes in the chemical composition."<sup>2</sup>

And so, in the opinion of Hegel, it follows that we differentiate among two elementary types of organisms in their historical sequence: non-nuclear plasmatie clots, which he calls moneras or cytodes (pre-cells); and cells - plasmatie masses, holding themselves firmly.

Engels, on the subject of moneras, writes as follows:  
"~~And~~ Non-cellular things begin their formation from a simple albuminous cluster, emerging in this or another form from the pseudo-bottom <sup>monera</sup> - from the monera."<sup>3</sup>

Our laboratory basically is engaged in studying the processes in the transformation of living substances, the foundations for which as we have seen are albuminous bodies - in the moneras and in the cells.

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1. Hegel had in mind living matter in the term plasson (O.L.).
  2. E. Hegel, op. cit.
  3. Dialectics of Nature, op. cit., page 245.

DEVELOPMENT OF CELLS FROM LIVING MATTER

The development of cells during the ontogenetic period, i.e. during the period from their birth to their death, has in part been studied. Our efforts have shown that the ontogenetics of a cell should be understood as its development from a living substance. It is more difficult to study the so-called phylogenesis of the cell, i.e. the history of its development from the original living substance and how this process gradually took place millions of years ago. Is it possible to approach this problem along an experienced path?

Observations that have been made of the development of organisms indicate that the ontogenetics is a brief, changed repetition of the phylogenesis; ~~namely~~ (c) that in the development process of the multicellular living substance of an animal or plant there repeats itself in a somewhat different appearance (in correspondence with the new conditions of the surroundings) the basic moments in the history of creation of the given appearance on the part of the animal or plant.

As an example, we may take the so-called stage of the ~~little-bag~~ (the stage of the double-stratum kit), which is pertinent to a whole series of animals in the birth period of their development. The ~~little-bag~~ in highly organized animals (in this category, also man) is comparable with the formation of the polyp or the hydra, <sup>animal</sup> ~~living~~ water organisms. The body of these animals, just like the ~~little-bag~~, represents in itself a ~~double-stratum~~ kit. A second example in this

branchia  
connection appear to be the/~~fish~~ apertures at the birth of a man; they remind one of the gills of a fish. Similar instances are many and can be cited.

On the basis of these observations, a so-called biological law was evolved. According to this law, individual development (ontogenetics) of each person is realized through this series of forms, which comprises his total appearance, in the process of Phylogenetic evolution from a simpler form to the latest characterization.

However, the ontogenetics do not completely repeat the phylogenesis. This is similar to the way in which the development of any organism; on the one hand it changes under the influence of transformations in the conditions of the surroundings; on the other hand it is subject to heredity which also is influenced by external surroundings.

At any rate, undoubtedly, the basic lines in the ontogenetics of each separate organism repeat the phylogenesis in appearance. Since this is the case, then why can not the process of cell formation be repeated in the organism as the very earliest step in the phylogenetic (historical) development of the organism?

There is no doubt but that in very old times, life was to be found on this first step of development at which there were still no cells but where only non-cellular living substances existed. From these in the course of time, there developed the earliest moneras and later cells. This stage

should have its reverberation in the ontogenetic development of contemporary organisms. In their individual development there should be such a stage at which no real cells exist - the stage of a non-nuclear monera.

Our laboratory traced the beginning stages in the individual development of various vertebrate animals. The eggs of frogs were also observed and also the eggs of fish and certain birds.

It is usual in manuals or books on the development of life to begin this process by describing birth as an indirect fission of eggs, arising after its fecundation. As a result of this, the egg is divided ("splinters") into ever smaller parts - blastomeres.

However, more accurate observations showed that at the beginning of an egg's development, <sup>it</sup> does not reduce itself to ~~the breaking down~~ <sup>a splintering</sup>. This splintering process should not be considered as indirect fission. The process of egg development and the formation of the future organism from it begins with the living substance of the egg. This takes place even prior to the fecundation of the egg and the entry into it of the male half of the cell - the spermatozoon.

In the egg, as in any other cell, there is a nucleus which here according to old traditions <sup>is</sup> called the ~~blast~~ <sup>embryonic</sup> vesicle. ✓  
Still during the last century, the Russian scientist V. V. Zolenski observed that in the early stages of the egg's development, the ~~blast~~ <sup>embryonic</sup> vesicle is lacking and appears only later. ✓

Zalenskii wrote: "During one-half to one-quarter of an hour after depositing the embryo, ~~embryo~~ it is possible to note even before its fecundation the absence of the <sup>embryonic</sup> birth vesicle (the nucleus of the egg cell). The <sup>embryonic</sup> birth vesicle has disappeared. After the disappearance of the <sup>embryonic</sup> birth vesicle the egg represents a cell devoid of a nucleus."<sup>1</sup>

In much later works of other researchers, the fate of the chromatin (nuclear substance) was traced. At first, there takes place a strong dispersion of the chromatin, which can be seen only after careful study of the minute nuclear remains. It is necessary to add that prior to the fecundation in the egg, very little chromatin is available. The quantity of the latter grows in proportion to the development and growth of the <sup>embryonic</sup> birth vesicle. Our observations, undertaken during the very earliest stages of development in artificially inseminated sturgeon eggs provided us with analogous results. If the early stages in the development of eggs are really observed, one sees the absence of a formed nucleus and this is in all certainty the pre-cellular stage in the formation of an egg cell. After fecundation, there takes place another stage, accompanied by the formation of the nucleus, the stage of the "female pronucleus," i.e. the formation of the egg cell. In such a manner, the egg cell in its development can pass through the stage of the zonera (Figure 6, 1).

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1. V. V. Zalenskii, History of the Development of the Starlet - I. Embryonic Development (Kazan University: Works by the Society for Research into Being), volume VIII, No. 3, 1873.

We shall now pass on to a description of the numerous phases in the development of the nucleus from the disseminated remains of chromatin.

During, the 33 minutes after artificial fecundation of the egg (roe) of the sturgeon, one can observe only the cytoplasm<sup>1</sup> in its animal part (in that part of the egg, where the formation of cells takes place); this cytoplasm has the appearance of <sup>granules!</sup> granulousness (having been colored only with cytoplasmatic color). The nuclear substance (chromatin) does not manifest such an <sup>a</sup> appearance. The cytoplasm decomposes evenly or after the fashion of separate islands (Figure 6, 2), which are found among a very fine granulousness.

Figure 6. Development of the egg cell.

1. egg cell without nucleus (monera stage until fecundation);
2. protoplasmatic islands (during 35 minutes after fecundation);
3. ray-like distribution of granulousness (during 20 minutes);
4. Commencement of nuclear formation; 5. nucleus formed.

1. Cytoplasm - protoplasm of cellular body, surrounding nucleus (O.L.).

In the so-called vegetative part of the egg overlaid by the yolk, which until this time had been considered only as material for feeding, the yolk's granulousness - lightly colored by the nuclear coloring - lies in the midst of the protoplasm which is similar to threads. The granulousness, as it approaches the animalistic pole, becomes finer and finer. Part of it becomes colored by the nuclear pigment, and the other part by the cytoplasmatic pigment.

During the 30 minutes after fecundation, the picture changes. The cytoplasmatic granulousness concentrated in the form of rays within the central point of the egg. At the ends of the "rays" fine grains of the nuclear type are found (Figure 6, 3).

Later on, in the center of the ray-like area, there appears a ~~small bag~~ <sup>gastula</sup> which becomes colored by the cytoplasmatic pigment. The bag represents the initial stage in the formation of the nucleus and is called a "linear frame" or a homogeneous (uniform) nucleus (Figure 6, 4). It does not yet contain the nuclear substance - chromatin. The linear frame grows; the granulousness found around it in the protoplasm fills the linear frame and while filling the linear frame, disappears from the surrounding part. The "granular nucleus" (Figure 6, 5) makes such a picture. The nucleus, disappearing at the time the egg cell matures, it is next formed again.

This process of nuclear development in the egg cell on a higher level reminds one of the development process of

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a nuclear cell described by Minchin (1923) and Hegel (1870) in their research on the phylogenetic (historical) development of cells. Minchin calls such a "granular nucleus" by the name "curious" nucleus.

The nucleus of the egg cell develops in the animalistic part<sup>1</sup> of the whole egg cell. The question may be asked as to how<sup>1</sup> the development process takes place in the vegetative part<sup>2</sup> of the egg, whether this part of the egg really is devoted only for feeding the egg cell or are new cells formed there which participate in the construction and formation of the embryo.

The question as to how the growth of the nuclear substance proceeds and how this growth affects the morphological<sup>3</sup> changes in the yolk mass, is very interesting.

After reading a whole series of literature on this subject, it is possible to conclude that the yolk has such substances as phosphoric acid, nucleoproteins, and lipoids (also containing phosphorus in their composition), i.e.

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1. The animalistic part of the egg cell - the part with little yolk (O.L.).
  2. The vegetative part of the egg cell - that part in which the largest amount of yolk has been collected (O.L.).
  3. Morphological - pertaining to the internal appearance and structure (O.L.).



the substance which can serve as material for the construction of cellular nuclei.

On the basis of our experiments, it became clear that the membranes of yolk particles contain as part of their composition nucleic acids which are usually rich in phosphorus and are a part of the cellular nucleus.

Other observations of ours showed that the yolk granulousness may be of two types. On the one hand, granules are present in the yolk; they are colored with such pigments as usually color parts of the nucleus in the cell. This granulousness has been named nuclear granulousness by us.

On the other hand, along with the nuclear granulousness, there appears a granulousness that is colored with a pigment usually coloring the cellular cytoplasm. Such a granulousness has been designated by the name cytoplasmatic (Figure 7) by us.

What later takes place with this, dual type, granulousness?

Cytoplasmatic granulousness concentrates in the midst of a mass of yolk granules. In the center of a cytoplasm, formed in such a way, the nuclear granulousness collects itself in clusters. The clusters of nuclear granulousness unite and transform into bags; from these latter, nuclear lobules are formed, and later the whole nucleus. The nucleus further on divides itself just like the nucleus of a regular cell, i.e. by indirect fission. This whole process takes place in the vegetative part of the egg. Such is the recorded picture of

cellular development from granulousness and the whole process of cellular formation in the egg of a sturgeon. How does the process look in connection with the development of cells in the egg of birds? Whereas in the eggs of fish the yolk is mixed with protoplasm and distributed in a granulous appearance that is concentrated for the most part in one (vegetative) half of the egg, in the eggs of birds the yolk represents a mass of spheres surrounded by the albumin which is closed in a calciferous cell. It is always possible to find a trace of albumin in the yolk - this is the embryonic disk, in which the fragmentation processes take place. Up to the present, it was considered that all cells of the embryo are formed only from materials in the embryonic disk.

The above described observations, undertaken on material from the eggs of fish, have shown that the yolk represents not only feeding material but also a living substance which after development transforms into ~~X~~ cells used for the construction of the embryo.

These data allow us to assume that the yolk of birds also represent a living substance which has the capacity, under favorable circumstances, for development into cells.

This assumption explains the reason for the known fact that cells are found in the yolk of birds. These cells, met with during the early stages in the egg's development, have been accepted by many scientists as cells which are developing from the spermatozoon which has entered into the

egg. As is known, during fecundation, not one but a multitude of spermatozoons enter into a bird's egg. However, a careful study of the yolk in unfecundated birds' eggs has shown that there exists inside of them a number of cells of mysterious origin.

Figure 7. Formation of cells from yolk granules in a sturgeon's egg.

1. yolk granules decomposing into a fine granulousness;

2. - 6. fine granulousness collects into clusters from which cells develop; 7. completed cells; 8. a cell, developed

from yolk granules, by way of indirect fission.

In such a manner, the hypothesis on the origin of these cells from spermatozoons must necessarily be rejected.

The yolk of a bird's egg, after a magnification of 400 times, represents in itself a mass of yolk granules surrounded by membranes. The membranes of the yolk granules, according to our observation, comprise a substance of ~~various~~ cellular nuclei - a nuclear acid. The yolk granules in a bird's egg unite to form yolk spheres, the dimensions of which are along the same order as the dimensions of cells.

It is still necessary to mention that between the embryonic disk and the yolk mass in a bird's egg there exists an aperture which is called the sub-embryonic nodule. This sub-embryonic nodule is filled with fluid; our observations have shown that the yolk spheres frequently fall out of the mass of the yolk and into the subembryonic nodule. It became apparent that these fallen spheres develop and in this development pass through a series of successive stages. In the ~~the~~ middle of the sphere, in the midst of the yolk granules, a protoplasmic center is formed (a nucleus) which consists of a fine granulousness; then the granulousness decomposes into rays, and in its center there appears a microscopic point of a bag <sup>filled</sup> colored with cytoplasmic pigment. This bag grows to the size of a mature nucleus. We call such a bag, following Minchin, a "linear framework," i.e. a nuclear beginning; the latter then is filled with a nuclear granulousness and forms a "granulous nucleus." Under the eyes of the observer

who is studying this process with a microscope on the basis of a drop taken from the yolk, the nuclear granulousness moves again from the nucleus to the cytoplasm; and a young cell is formed from the nuclear granulousness in the cytoplasm and from a nucleus without any chromatin, which is characteristic for the young cell (Figure 8 and 9).

In such a way, we have observed how a cell develops from a yolk sphere in a chicken's egg. The same results were achieved in our laboratory through the utilization of processes which took place in the yolk spheres of a sparrow's eggs. It appeared that the capability of forming cells was present in the yolk spheres of all of the surface of the yolk. Part of the spheres, however, decompose and serve apparently as feeding material for the embryo.

Cells, obtained from yolk spheres, possess nuclei with chromosomes which in quantity and quality are not differentiated from the chromosomes in the ordinary cells of bird organisms. This fact has provided yet another blow against Weismanism-Morganism, which bases its reactionary presentations pertaining to the "eternity of the embryonic substance" and concerning the allegation that heredity is capable of transmitting itself only by means of the chromosomes due to the claim that each new chromosome originates only from an old chromosome and that new formations of chromosomes allegedly never take place. The work of our laboratory shows that chromosomes can originate not only from other chromosomes but also from the living substance in the yolk spheres.

Figure 8. Development of a cell from yolk spheres.

1 and 2. - separate spheres falling from the yolk mass;

3, 4, 4a - beginning of nuclear formation; 5 - completed

cell; 6 - a cell which has developed from a yolk sphere,

in the course of indirect fission.

In order to eliminate the possibility of error and in order to finally corroborate that the yolk spheres transform into cells, we began to observe one and the same sphere (the culture was developing under the microscope in a thermostat,<sup>1</sup> maintaining the temperature of a chicken's body) and

Figure 9. Schematic on the origin of cells from yolk spheres:

1. - the yolk sphere; 25 - complete cell, in process of fission.

became confirmed in the correctness of our preceding observations. Three yolk spheres, without any traces of the nucleus, were photographed over a period of one hour and 35 minutes. When they would change, we photographed them

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1. Thermostat - a box which maintains a constant temperature with the aid of special equipment (O' L. ).

again: one sphere now was in the stage of a linear framework, the second in the stage of a young cell, and the third remained without any changes. These observations undoubtedly proved to us that yolk spheres in their development can provide fully formed young cells (Figure 10).

Apart from the preceding, we traced that yolk spheres that have fallen not into the subembryonic nodule, but between two layers of cells in the embryo, develop along different lines: the cells are formed not totally from the yolk sphere but from each granule locked in this yolk sphere.

We were able to trace how a little blood island is formed in the embryo from the yolk sphere that has fallen between the embryo's layers, how later this blood island grows; it builds the walls of a vessel, whereas the internal granulous construction decomposes into separate cells; and finally under the eyes of the observers .. a completely formed vessel appears and inside of it are blood cells or erythrocytes (Figure 11).

In order to check on the observations concerning the process of development on the part of blood-carrying vessels and blood from the yolk, we have worked out a special methodology for observation through a micaceous aperture placed in the shell of a living egg which was developing inside of a thermostat. The observation was conducted with the aid of a microscope - an ultra-opaque one (Figure 12), under which the object being observed is lighted not from



below, ~~in contrast~~ as is the case with a regular microscope, but from above, which provides the possibility of utilizing not only thin cross sections or individual cells but also untransparent objects. For example, under an ultra-opaque microscope one can observe a human hand and see the skin cells, blood-carrying vessels, and even the blood carried inside of them. With the aid of this methodology, we were able to trace the way in which yoke spheres and yoke granules are transformed into cells, how hemoglobin<sup>1</sup> is formed in

Figure 10. Development of cells from yolk spheres.

1 - yolk spheres a, b, c; 2 - from a photograph taken during one hour and 35 minutes. The spheres "a" and "c" transformed into cells "a<sub>1</sub>" and "c<sub>1</sub>," sphere "b<sub>1</sub>" remained without change.

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1. Hemoglobin - the redder substance in blood, contained in the red blood bodies ("corpuscles") - erythrocytes (O.L.).

these cells, and how they develop into red blood cells and walls.

Research on the living substance which appears during the decomposition of the cells themselves also has a considerable role to play.

According to Engels, "... a truly structureless albumin fulfills all of the existing functions of life: preparation of food, secretion, movement, contraction, reaction<sup>1</sup> to irritation, multiplication."<sup>2</sup>

Engels closely connects life with the albumin, which does not appear in the process of decomposition - deterioration. Engels was certain that living substance was also available where there was no cell.

The existence of non-cellular forms of life in the organism corroborates a whole number of histologists who have studied the tissues of the organism: V. K. Schmidt, A. Bogdanov, V. D. Lepeshkin, N. Ya. Rubashkin, Megali, Styd-nichka, M. Heidenhein, et.al. They reject the allegation that "the cell is the last morphological element capable

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1. Reaction - response of the organism to external or internal irritation (C. L. ).

2. Dialectics of Nature, *op. cit.*, page 13.

of life activities," as was claimed by Virchow. The above listed histologists claim that the finest particles of the protoplasm can, under favorable conditions, manifest living

vessels

Figure 11. Origin of blood and ~~vessels~~ from yolk spheres of chicken's egg.

- 1 - yolk sphere between two leaves of embryo; 2 - little blood island consisting of granules (syngranule); 3 - little blood island developed from uniting of cells (syncoytia); 4 - cells begin to disperse; 5 - cells disperse but are still united by bridges; 6 - regular ~~vessels~~ vessel, filled with blood cells.

properties. If this is so, then the protoplasm, secreted from the cells of the organism by means of mechanistic decomposition - under favorable conditions- can develop and produce a qualitatively different form of organization, the cell.

With this as a point of departure, we decided to study the development of a living substance, secreted by the organism. We intentionally selected a lower organized animal consisting of a two-layer <sup>gastrula</sup> bag - a hydra about which we have spoken previously.

Certain researchers rubbed the hydra through a silk material, observing how microscopic spheres developed from this viscous mass - and hydras developed again from the spheres. What were these spheres? It was assumed that they consisted of non-decomposed cells from the hydra, which had penetrated through the openings in the silk material. However, this phenomenon was not observed in detail.

It was to the benefit of our work if we could obtain not separate cells but a complete decomposition of the cellular structure; therefore, we put the hydra through a small beater. In order to remove any cells, that had been able to maintain themselves as units, from the living substance - it was decided to put the gelatinous mass through a centrifugal process after mixing it with water. After this treatment, the cells that had preserved their entities settled at the bottom.

For purposes of observation, we took not the sediment but the liquid above it. Under the microscope, the latter represented a transparent gelatinous mass truly lacking in any formed phenomena.

During one hour after taking the sample from the upper part of the liquid, we were able to observe the appearance of fine shining dots which grew in dimensions under our very eyes. The whole field of observation under the microscope was covered by colorless, glittering spheres of different sizes. Among them were visible in small quantity spheres of an orange color which easily dissolved in alcohol, ether, and dimethyl benzene. They were drops of fat. ✓

Observations concerning the colorless protoplasmatic spheres showed that, if they were placed in water and not given food substance, they would begin to develop but then rather quickly die. When food substance was added to the water, in the form of secretions from the cyclops<sup>1</sup> which the hydra usually feeds from, then the spheres quickly developed. Developed cells, beginning to divide, at times give spheres comprised<sup>by</sup> from 30 to 35 cells. ✓

What do the spheres represent from which the cells grow? What do they consist of, and what is their structure?

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1. Cyclops - very fine crustacean animals living in fresh waters (C. L.).

In order to explain these questions, we took a drop from the sediment, containing similar spheres in large quantity, and observed it.

Figure 12. The ultra-opaque microscope for observation of untransparent objects:

1 - general appearance; 2 - opening in the egg shell for observing the development of the embryo.

Treating this drop with nuclear pigment (red) and with cytoplasmatic green pigment (light green), we proved that the greater part of the spheres took on the green color. On the other hand, a comparatively small number of spheres

with finely distributed granules were colored with a rich red pigment. And so, upon coloring with a boracic red and light green among the observed spheres, it became impossible to find a developed nucleus; a dispersed nuclear substance under no circumstances can be considered to be a nucleus.

What are the reasons leading to the formation of living substances of hydras in the guise of spheres? A. Bogdanov (1883) shows that even the most minute of particles, separated from the principal mass of protoplasm, after falling into water attempts to contract and assume the form of a sphere in connection with any irritation.

In our experiments, there is also irritation occurring in the rubbing and in the water surroundings. These are namely the conditions which are necessary to the protoplasm in order for it to assume the form of a sphere. First there appear small glittering spheres. However, this development does not proceed far in all spheres but only in those in which we located a nuclear substance when we added the pigment. If experiments are conducted carefully, it is possible to find the spheres (without the coloring process) which have the nuclear substance.

Wanting to prove that these spheres really have albuminous bodies in them, we conducted a series of experiments which showed that under the influence of alcohol and tannic acid - substances coagulating albumin - the spheres coagulate.

In order to establish a protracted observation over the development of these protoplasmatic spheres, we placed a drop of the fluid from the rubbed hydras on a thin glass and added an extract from some cyclops. Then we turned the glass with the drop upside down and placed it upon a fatty microscopic slide with a depression. Such a preparation is very convenient for protracted observation of the changes taking place in the spheres.

At the beginning, the protoplasmatic spheres have the appearance of fine granulousness. Gradually, the granules become larger but this is not an even process. The fatty spheres remain unchanged for a long time. Slowly they open and disappear. The protoplasmatic spheres - colorless and uniform - over the period of some time also remain unchanged. However, after three or four hours there appears a glittering drop in the sphere; this drop grows and transforms itself into a nucleus.

Here in front of us is a complete cell. In preparation for fission, it contracts, straightens out, and becomes elongated. Finally, it becomes divided by direct fission and forms a sphere comprising, as we have already mentioned above, from 30 to 35 cells.

When the new methodology was being worked out for obtaining protracted cultures, in which development proceeds with the constant change in the feeding surroundings over a period of three to four months, we were able to observe how



new cells are built from protoplastic spheres; further, how from these cells by means of fission a layer is formed - a whole stratum of cells with nuclei. In such a manner, new proofs were obtained <sup>that there were</sup> ~~and~~ living cells which could multiply and provide a layer of cells united among themselves, i.e. a whole tissue.

The whole process of cell formation and the stages in their development and fission was recorded on the film of a movie camera, connected with the microscope and equipped with an attachment which permitted automatic taking of pictures at intervals desired by the observer. Showing the film at regular speed, it was possible to see on the screen the whole process of development 80 times faster.

Separate frames from this film in temporal sequence are shown on Figure 13.

Everybody who will consider seriously the facts described by us, facts pertaining to the development of a living substance secreted by cells (facts which are very easily established), will come to the conclusion that this phenomenon should find wide distribution throughout nature. But where can it take place? Above all the thought arises that the process of pulverization of living substances can take place in connection with wounds. For this reason, we decided to set ourselves the aim of studying the process taking place in a wound - concentrating our attention on the transformation of living substance secreted from the decomposing cells. In reality,

we proved that the blood cells which poured into the wound decomposed into granulousness. From this granulousness, new cells developed in a series of stages. These cells play a considerable role in the healing of wounds and in the formation of scars. This research was entrusted to Ya. E. Pilus and was successfully conducted in practice for the healing of wounds with the aid of hemo-bandages (bandages saturated with blood) at hospitals during the period of the Great Fatherland War [World War II].

Our laboratory studied phenomena taking place in the albumin of birds. It appeared that not only the yolk but also the albumin in the eggs of ducks, geese, pigeons, sparrows, pheasants, parrots and other birds represent living substances which are capable of developing into complete cells (for the separate stages in this process, see Figure 14).

The experiments and observations made during the study on the development of ~~simple~~ protozoas<sup>1</sup> showed that they multiply not only through fission, which was the accepted theory until now, but also by means of secreting a very fine granulousness which forms new protozoan organisms. This explains the reason for the rapid multiplication of protozoas.

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1. To protozoas belong the most simply organized living substances (the ameba, vorticella and other microorganisms) (C. L.).

In the course of other research, we were able to establish that nuclear acids (necessary component substances in the protoplasm) play a large role in the process of formation of cells from living substances. Apart from this, these substances possess the ability to decompose molecules of globular albumins<sup>1</sup> and in such a way increase the rate of their metabolism and consequently their living activities. Of considerable significance in this work was the fact that ~~they~~ it has brought us still closer to the solution of the problem concerning how albumins pass on to active life activity in the process of cellular development, the transformation of a substance into a being, and the solution of the problem common to everything - the problem of life's origin.

Finally, our laboratory conducted work toward investigating the "contracting activity of the skeletal-muscular fibres as related to nervous influences."

This work appears to be a development of the ideas of nervism, undertaken by the great Russian scientists Sechenov and Pavlov who proved that the nervous system plays a leading role in the physiological reflexes of the organism. The muscular fibres and their activity, as was established in our laboratory, depends upon the conditions

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1. Globular albumins - those albumins of the living substance which are well distributed in water solutions. They consist of molecules, representing as scientists believe, coagulated coils of elongated little chains which comprise amino-acids connected with one another.

*Gastrula*  
Figure 13. Development of a cell from the little-bag of  
protoplasm, secreted from the cells of a hydra: fission  
of cells and the formation of multicellular spheres, con-  
sisting of from 25 to 30 cells (moving picture).

in the surroundings which influence the muscular fibres  
through the nervous system of the organism. This poses  
the problem concerning the necessity of studying the in-  
fluence of the nervous system upon the process of develop-  
ment of cells from pre-cellular living substances.

On the basis of work in the research conducted to study the development of living substances, it is possible to think that the phenomena connected with the passing of a living substance from the non-cellular condition into a cellular one and the opposite has wide practice and a very important role in the life of organisms. This theory in latest times has been corroborated widely in the work of many scientists throughout the Soviet Union. They used as a basis for their research our scientific thinking on the development of living substances. For example, Professor K. A. Lavrov (city of Rostov-on-the-Don-River) proves (and supports his observations with numerous preparations and microphotographic) that the living substance in muscular fibres can transform into red blood cells, that the cells in the organism can be transformed as a result of the development and growth of the finest granules inside of other cells, and that the living so-called intercellular substance of the embryo can transform itself into cells of blood, etc. Professor P. S. Revutskaya (city of Stavropol) has observed the new formation of cells in fluid collecting in the stomach nodule of man during certain illnesses. Professor N. I. Zazybin (city of Dnepropetrovsk) showed that not only cells but also some non-cellular living substances obtain fuel and are serviced by the nervous system in the organism.

Scientific observations and experiments in our laboratory, part of which were conducted here, allow us to make the following conclusion: the cells can be formed not

only from cells but also from living substance which is found inside the organism or outside of it. These experiments and scientific theories on the development of living substance support the significant theoretical teachings of Engels that "Everywhere, where we meet with any kind of albuminous body, which is not in the stage of decomposition, without exception we meet with the phenomena of life," or furthermore: "the most simple living substances which are known to us represent in themselves nothing more than simple clusters of albuminous substance, and they ~~themselves~~ already manifest all existing phenomena of life."<sup>1</sup>

\* \* \*

Tremendous tasks stand before the Soviet scientists-biologists. At present the necessity arises to study a whole series of new problems connected with the practical questions involved in Michurinist biology, the origin of life, the origin of cells in the organism, the origin of cancerous cells, the healing of illnesses, etc.

The task arises to study the role of the living substance in the development of viruses, bacteria and their original causes, which is all-important for combatting epidemics.

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1. Anti-Dühring, op. cit., page 177.

Problems arise which necessitate the tracing of the role of living substances in the origin of various non-contagious diseases.

Sicknesses should be studied from the point of view of the whole organism, the importance of the living substance in the development of illness, and the influence of factors connected with external surroundings.

The new theory of cells will direct us toward the study of the role of living substance in all processes which create tissues (in wounds) and also whole organs. It will provide new perspectives in the field of studying the role of the living substance in connection with methods of grafting tissues and tissue therapy.

The cellular theory of ~~Virchow~~ should finally pass out of the picture and be replaced by the new dialectical-materialist theory of cellular origin and the development of cells from living substance.