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PROFESSOR O. B. LEPESHINSKAYA'S DISCOVERIES

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By decision of the Soviet government, Professor Olga Borisovna Lepeshinskaya was awarded the Stalin First Prize for "outstanding scientific investigations of noncellular forms of life and of the origin of cells". (The decision of the Council of Ministers USSR was published in Pravda, 21 September 1950.) The essence of the discoveries made by Professor Lepeshinskaya is presented in the scientific work The Origin of Cells From Living Matter and the Role of Living Matter in the Organism. (The first edition of this work was published in 1945; the second edition was issued in 1950 by the Publishing House of the Academy of Medical Sciences USSR.)

The work of Stalin Prize Laureate Lepeshinskaya represents an important discovery in biology. She delivered a shattering blow to the reactionary Weissmann and Virchow cell theories, and, as the Stalin Prize Committee stated, opened "new prospects in the matter of effectively dealing with a number of most important biological problems" (Pravda, 19 September 1950).

Lepeshinskaya began her outstanding investigations already in 1933, setting herself the task of studying the problems of cell theory and those of the origin and development of plant cells, as well as of living organisms.

To understand properly the significance of the task set by Lepeshinskaya and the importance of her discoveries, it is necessary to recall the entire previous development of this problem, which started in the first half of the 19th century, when the cell theory was founded. This was indeed the greatest theoretical generalization in biology. The cell theory set forth the unity of the organic world. The new theory became the basis of teachings about the development of life, the evolution of animals and plants. Friedrich Engels compared the contents of this theory to such first-rate achievements of science as the law of conservation of energy and Darwin's law of the historical development of the organic world.

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Nevertheless, this progressive theory was snatched up and then perverted by the reactionary scholars of that time. The anti-Darwinist R. Virchow, perverting the thoughts of the cell theory, made it the basis of his own conservative idealistic theory. The reactionary theory of Virchow contained two main theses: "The cell is the ultimate morphological element which is capable of life processes," and life begins only with the cell, and "each cell originates only from a cell." The Virchow theory became the basis of biology and retarded the development of progressive natural science.

In the capitalist countries at present, the Virchow cell theory continues to dominate science. This is not surprising, since the cell theory, as perverted by Virchow, confirms the immutability of the "divine origin" of life. At some time or other, it is alleged, life was established by God's will, and therefore it is developed from cell to cell. Just as the atomic theory at its time produced alarm in the ranks of the reactionary scientists, the cell theory an attempt on the "fundamental basis", had to alarm the church, the main pillar of capitalist society at that time.

In the Soviet Union, Virchowism was dealt a shattering blow. It must be emphasized that even up to recent times, Virchowism had open defenders in the USSR, who were violently opposed to the recognition of the valuable discoveries of Lepeshinskaya, discoveries which were not merely theoretical but also practical refutations of Virchow's dogma.

Lepeshinskaya's achievements are recognized clearly if one acquaints himself with the most interesting experiments which she performed in her laboratory and on which she reported in her published works. (Lepeshinskaya, The Cell, Its Life and Its Origin, Moscow, 1950.)

To demonstrate that life can originate not only from cells, Lepeshinskaya undertook a thorough study of regenerative properties of a minute animal, the hydra. Its hardiness has been known for a long time, but the basis of its unusual regenerative capacities had not been investigated prior to Lepeshinskaya's studies.

Why does a hydra grow back from a fragment of a hydra? The cell multiplies and gives rise to a new complex organism -- that is the answer of the natural scientists.

Is only the cell of the hydra endowed with this capacity? To answer this question, Lepeshinskaya and her associates performed the following experiment. They made a thick paste out of hydras and rubbed it through silk fabric; nevertheless, new hydras grew from the mass obtained after this filtration. This phenomenon had been studies earlier by scientists who had determined that in the mass obtained after filtration originally some kind of globules of microscopic size are formed, which later turn into cells and then finally into the organism of the hydra. However, it was not known just what these globules are. It was assumed that they were obtained from the cells which in some way had been preserved during the filtration through the silk fabric.

This explanation did not satisfy the keen Soviet scientist. Lepeshinskaya decided to study thoroughly the role of these globules and all aspects of their development.

First of all, the following problem was set: not a single cell of the mashed-up hydra should pass through the silk fabric. For that purpose, the hydras were not only chopped up into tiny particles, but the mass obtained was pulverized in a mortar. To separate any cells which might have accidently survived, the paste of protoplasm and cell nuclei thus obtained was centrifuged. By this method, the lighter particles of the gelatinous mass were thrown out, and the heavier ones, among which were the surviving cells, remained in the residue.

For the investigation, the lightest particles were used. They were studied carefully under the microscope. No cells were discovered; the microscope showed a transparent gelatinous mass. But the paste did not remain in this condition for a long time. Within about an hour there already appeared spots, scarcely visible to the naked eye. They were minute, no larger than a pinpoint.

Under close observation, it could be noted that these spots gradually grew larger. After a while, the entire observation field showed active colorless corpuscles of various sizes. Among them, globules of yello-orange color could be distinguished. They were undoubtedly droplets of fat.

While experimenting from day to day with the gelatinous mass, Lepeshinskaya and her co-workers noticed a curious circumstance. Under ordinary conditions, the globules suddenly died upon reaching a certain stage of development; it was assumed that the medium was not suitable. The researchers began to feed the globules of this gelatinous mass. The juice pressed out from aquatic animals, cyclopes, was used as food. Cyclopes are the usual food of the hydras, and it could be assumed that the juice of the cyclopes could maintain the viability of the globules. This assumption proved to be perfectly justified; the globules no longer perished.

The researchers devised an ingenious method of observing the further transformation of the globules, having created a living preparation isolated from the external medium. For that purpose, they placed a drop of the gelatinous mass on a cover glass, adding to it a little of the extract made from cyclopes, then inverted the cover glass and placed it on a thick microscope slide with a small depression.

In addition to the usual observations, slow-motion microcinematography was undertaken in the laboratory. In taking the motion picture, the frame was changed every 5 seconds.

The unusual film which resulted represents documentary evidence of the facts given by Lepeshinskaya in her writings. Several frames are reproduced in her book. They are an excellent supplement to the report on the laboratory experiments.

The picture of the origin of life unfolds before us: life emerges visibly.

At the beginning, spots appear, then the spots grow, acquire brightness and coloring. Then we notice that some of the globules appear to become turbid. According to Lepeshinskaya's expression, a dustlike granularity is produced in them. Three or four hours after the start of the observation, a brilliant vacuole can be seen in the grown globules. It grows and grows and finally turns into a nucleus.

A cell has been born. Virchow's statement to the effect that "the cell grows from a cell" has been refuted. The cell originates without any divine command and spontaneously. It is created as a result of the appearance of suitable relationships which are repeated, from day to day, from hour to hour, and every second, in different variations.

This self-conceived cell lives, moves, now coagulates, then straightens out and revolves around its axis. Finally, the cell begins to divide, at first in two, then each new cell also divides in two, and so on. Multiplication of cells takes place. The aim of this multiplication is formation of an organism.

Finally, before the experimenters' eyes there emerges a globule of 30-35 cells. We see this in the photographs shown in the book. Thus, a living organism emerges.

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Lepeshinskaya experimentally proved the unforgettable words of Engels, that life "is a process which is self-contained, intrinsic, and innate to its bearer, the proteins". (F. Engels, Anti-Duhring.)

However, the outstanding experiments carried on for years in the Cytology Laboratory of the Institute of Experimental Biology of the Academy of Medical Sciences USSR were not limited to this.

Of great interest among these experiments was observation of the growth of cells in chicken eggs. It was established that the so-called yolk globules formed in the egg turn into cells in the course of their development. The observations on the formation of blood cells, i.e. red blood corpuscles (erythrocytes), turned out to be especially important.

With the ingenuity natural to the workers of the Cytology Laboratory, a method for observing processes taking place in chicken eggs was worked out.

Lepeshinskaya, in The Origin of the Cells From Living Matter and the Role of Living Matter in the Organism, pp 153-54, first edition, 1945, reports the following on these experiments and on the manner in which they were set up:

To examine the development of the embryo under an ultrapack, it was essential, first of all, to have a thermostat specially adapted for this purpose. I designed an electric thermostat with a constant temperature of 38°C, which was built by our workshop. At its upper wall it has a round opening for a Koch dish, and inside the thermostat there is a plate with a screw for adjusting the height.

"The Koch dish with the egg is placed on this plate. The eggshell is removed. The dish is moved by means of the screws to the top opening. From above, the egg placed under the objective of the ultrapack and the objective itself are protected by a cover of cotton wool, and thus the observation takes place at the proper optimum temperature.

"To observe the development of the blood islets in vivo under large magnification, viz., under immersion of the ultrapack, it is necessary after removal of the top third or even half of the shell and white of the egg to cover the yolk containing the embryo either with a cover glass or with mica. But both glass and mica, under the slightest pressure by the objective, will break the membrance of the yolk, and the contents of the yolk will flow out, covering the glass or the mica and destroying the integrity of the embryo. Conditions under which an observation can no longer be conducted will thus be produced. Reacting to this difficulty, I worked out, in collaboration with my assistant Ye. P. Lapisova, a valuable and ingenious method. So that the sharp edges of the glass or of the mica would not damage the membrane of the yolk, Lapisova glued the glass or the mica onto an opening cut in very thin rubber. The gluing is done with the aid of collodion. My assistant covered the yolk with this rubber and the glued-on glass or mica. The ends of the rubber hang down from the edges of the shell. In this manner, the entire yolk and the remaining white of the egg are almost hermetically sealed. In addition to this, she constructed a small device with three screws and a ring, which serves to level the glass and to make it immovable, thus greatly facilitating observations under immersion.

"For reducing friction between the glass and the embryo, the glass or the mica was greased with a fine layer of liquid vaseline which was, of course, sterilized. Under these conditions, observations of the development of the embryo over 36 hours were successful. This period is fully sufficient for in-vivo observations, to follow the development and the transformation of one yolk globule into a blood islet."

Lepeshinskaya indicates that the most "demonstrative pictures" of the development of blood and of the islets in the yolk globules of chicken embryos can be obtained from 36-hour embryos, and some of them also from embryos in later stages (6-8 days' incubation). In particular, observations of the development in 8-day embryos was successful.

Thus, the many observations with the use of the most variegated and modern method of investigation have cleared up formerly disputable questions on the origin of the blood islets.

It should be pointed out that up to the time of Lepeshinskaya's remarkable experiments, a considerable part of the scientists, going out from the Virchow thesis of cells from cells, were convinced that the globules under discussion here have no nucleus and represent a lifeless mass of food material. As far as the globules with nuclei were concerned, scientists considered them either cells derived from the embryo or took them for modified spermatozoa. Lepeshinskaya's experiments have shown that globules which have nuclei develop from globules without nuclei by way of the gradual development of a structure, including the nucleus, which is characteristic for cells.

In this manner, reviewing everything said above, it must be stressed that by her tenacious, carefully worked out experiments, accompanied by the ingenuity and cleverness characteristic of this particular laboratory, Lepeshinskaya has shown undeniably that the formation of new cells in the organism takes place not only by the multiplication of cells, but also by the development of cells from noncellular living matter.

Lepeshinskaya's conclusions in regard to the role which living matter plays in the process of healing of wounds acquire special theoretical and practical importance.

The work of Lepeshinskaya and her school in this field not only reveal a chapter in wound healing which has not been clear up to now, but opens wide prospects for the regulations of processes taking place in the tissue of the organism. They also explain the mechanism of the influence of blood in the healing process. Observations have shown that blood is an important factor in accelerating the healing of tissue wounds; it is a medicinal agent.

As early as 1945, T. D. Lysenko predicted that Lepeshinskaya's work would become highly important. This prediction has now been fulfilled.

Lepeshinskaya's work has great practical importance in a number of fields of science, primarily in biology and medicine. It has a bearing on questions like the origin and the development of malignant tumors, inflammation, regeneration of tissue and recovery of organs, etc.

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