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<https://doi.org/10.32014/2019.2519-1629.28>**K. Saparov, S. Aken, A. Aitenova, Zh. Olzhabayeva, D. Turlybekova**

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E-mail: saparov42@mail.ru**ULTRASTRUCTURE OF THE LUNGS OF VERTEBRATES
IN HABITING MOUNTAIN AND STEPPE ZONES**

Abstract. This article describes the features of the ultrastructure of the lungs of vertebrates belonging to different biotopes. Due to the habitat in the fine structure of the lung tendon spines (amphibians, reptiles, small mammals), significant differences were detected by electron and scanning electron microscopy. In the study of light amphibians living in various biotopes, the presence of "living" formations and "mixed" cells was observed. In addition, type I pneumocytes predominate, and type II is rarely common. Amphibians (tailed frog) living in the steppe zone actively excrete mixed cells in the lungs, and in amphibians living in mountainous areas (the Central Asian salamander), such an active secretion does not take place. When studying with the help of electron microscopy of the ultrastructure of light reptiles living in various biotopes, it was observed that the nuclei of the first type of pneumocyte of the oval form and large. Type I of pneumocytes occupies a large number of respiratory epithelium and is involved in the creation of the air-circulating membrane. In reptiles (thyroid snake) living in the steppe zone, there were well observed "bubbles" in type I of pneumocyte. Using electron microscopy of small mammals, I and II types of alveolocytes contained in the respiratory epithelium are distinguished. The form of alveolocytes type II is diverse, the nucleus is hyperchromic, and a complex of surfactants is found. This article presents morphometric studies of the adaptation of animals of different habitats depending on their habitat, thickness of air-blood membranes.

Key words: lungs, pneumocyte, alveolocyte, biotope, electron microscope, scanning electron microscope, vertebrate.

1. Introduction. The ultrastructure of adaptive reactions of the lungs has not yet been studied. In the process, an ultrastructural description of the adaptive reactions of the respiratory part of the lungs when exposed to various external environments is given. The subtle morphofunctional mechanism of the reciprocal-profile reactions found in this work helps to better understand the adaptation of the lungs to various environmental conditions.

Designed to determine the ultrastructure and environmentally established features of structural and functional transformations occurring in the lungs of animals of various environmental specializations, ultrastructures and environmentally defined features of the adaptation of the lungs to various environmental factors of the respiratory part of one mammal and amphibian species. The relationship between the organism and the environment manifests itself in various adaptive reactions of animals, while manifestations of morpho-functional or behavioral flexibility depend not only on the environment, but also on the characteristics of the organization of the animal. With functional load, the degree of morpho-physiological maturity of the organism, organ systems, and organs as a whole is most pronounced. Adaptation reserves of the respiratory organs during an increase in physical activity or hypoxia of representatives not only of different groups of animals, but of the same species, of different age, physical condition, etc., are significantly different. In reptiles, there are primitive air bags that are a continuation of the lungs and contribute to easier conversion of gases. The sharp growth of the respiratory surface due to the formation of many small bronchioles, alveolar sacs and alveoli, the improvement of respiratory motility, especially during flight, dramatically increases the intensity of gas exchange in birds and is an aromatic transformation.

The energy supply of living organisms is due to the combination of oxidation reactions occurring in all living cells. Animals belonging to aerobic organisms use free oxygen for breathing. The free source of oxygen is air and water. Oxygen in the air is used by animals living on land. In connection with the adaptation-regulatory mechanisms of animals living on land, the habitat is diverse, and there are structural features of the organs, thanks to adaptation to the habitat. For example, due to insufficient oxygen content in animals living in mountainous areas, the ultrastructure of the lungs has ultrastructural differences compared to the lungs of animals living in the steppe zone.

2. Materials and research methods. To study the ultrastructure of lungs of vertebrates belonging to different biotopes on land, the following animal representatives were taken. The tailed frog, the Danatin's toad, the Central Asian salamander were taken from amphibians, the Gloydus halys, fast lizard, the viper, the Ablepharus from the reptiles, and the northern red-backed vole, the rabbit from small mammals. To study the ultrastructure of cells using electron microscopy, a very thin piece of material is produced. Initially, the material is fixed, dehydrated, injected liquid polymers and cut through ultratome. To obtain thin pieces of tissue are fixed in two stages in a volume of 1.0-1.5 ml. Initially contained in 0.15 M phosphate buffer in a 2.5% glutaraldehyde solution and kept in phosphate buffer in a 1% OsO₄ solution in a refrigerator at + 40 °C. The material is washed from phosphate fixative in buffer, dried in the refrigerator for 20 minutes at concentrations of 50-96% alcohol, followed by drying, and drying in 100% alcohol at room temperature for 20 minutes. To obtain rigid and elastic pieces (block) for cutting on an ultratome, polymer epoxy resin (Araldite, Epon) or water-soluble mixtures are used. The process of filling the material in epoxy resin takes 1-2 days. The polymerisation of the blocks is maintained in a thermostat of 600 °C for 48 hours. The end of the block is honed in the form of a pyramid. From the tip of the pyramid on the ultratome very thin segments are obtained with the help of a glass knife. Cuts 300-350 Å are placed in electroplating grids covered with porcelain film [25].

For research at a comparative morphological level, lungs of amphibians, reptiles, and mammals living in various biotopes were selected. The animals were kept in the steppe and mountainous areas of the Almaty region (Balkhash, Raiymbek areas, Mountain Turgen valley at an altitude of 2800 m above sea level). For the study of the lungs by histological methods, small particles are placed in the whole attachment. 10% neutral formalin was used as a fixative. After separation of the segments with a thickness of 3-5 µm from the paraffin, hemotoxylin-eosin and van gieson are painted. To study the lung sections using an electron microscope, they were fixed for 2.5 hours in 2.5% glutaraldehyde (pH 7.4 - 7.6) and 2 hours in 1% osmic acid solutions. Then treated with ethanol and acetone and poured into epon (812). Morphometric studies were carried out from electron diffraction patterns, statistical processing was carried out using Student's method (G. Lakin, 1990). Delicate cuts were treated with uranyl acetate and lead citrate (Reynolds method). Thin sections were investigated and photographed on an electron microscope computer-100L. For a scanning electron microscope study, pieces of the lungs (5x3x3 mm) were processed through alcohols and acetone with dehydration, then dried. The pieces were studied in the raster mode of the Super - probe 733 instrument of an accelerated gold electronic microanalyzer. Samples were enlarged to 800-4000x and photographed [3].

3. Research results and discussion. In the study of the respiratory epithelium of caudate amphibians (*Amphibia*), including the tailed frog (*Listotritonn vulgaris*) living in the steppe zone, under an electron microscope, hyperplasia of very rare mucous cells is observed in its structure. Such cells have a large volume, a pronounced layer of the nucleus, and chromatin in large quantities occupies the outermost layer of the nucleus. The central and extreme parts of these cells are filled with dense electronic small mucous membranes. In addition, there are "mixed" cells, rich in many mucous granules and having single osmiophil bodies. The granules are synthesized, in addition to the perikaryon zone, and in the peripheral parts of the cell. Membranes of the endothelium and epithelium are not connected in the air-blood (air-hem) zones. The thickness of the air-circulatory system is quite significant.

Thanks to the research conducted using a scanning electron microscope, an active tapping of mucous cells was detected. A smooth spherical structure appears on the upper surface of the central and peripheral sides of the pneumocytes. Most of the "mixed" cells indicate that the juice is actively secreted, which indicates a multitude of formations on its upper surface. It was shown that in many secret cells there existed the last phase of juice extraction.

A representative of caudate amphibians of the Central Asian salamander (*Ranodon sibiricus*) living in mountainous areas, living under hypoxia and water temperature (+8 – + 12°C) and air temperature (+12 – + 20°C), the volume of the respiratory part of the lung is greater than that of the tailed frog, and the air-blood membrane, which facilitates the diffusion of gases, is much thinner. The reason for this is a combination of the main membranes of the endothelium and epithelium in some parts of the air-circulatory system. Type II pneumocyte and the number of mucous cells is seen very little compared with the tailed frog. In the respiratory part of the lungs of the Danatin's toad, dwelling in the steppe zones, sets of imperfect pneumocytes of type II were observed, which are closely spaced to each other. The nuclei of these cells are large, long, and the shell of the nucleus is smooth, sometimes cut, and the collected chromatin is located on its edges (figure 1 – the Danatin's toad (mountain zone)).



Figure 1 – Danatin's toad (mountain population).
The shell structure of the surfactant (SF) in the area of respiration of the lungs. X 1600

Cytoplasm of II type of well mature pneumocytes is filled with large osmophilic layered bodies and evenly layered substances. Due to the fact that some of them are free, they are also electron-transparent. In dense electron cytoplasm, many mitochondrial edemas are filled with obscure endoplasmic reticulum tubes that are little-known, and tightly packed with membranes.

In the study with a scanning electron microscope, a large number of small cones were observed on the upper (terminal) surfaces of types II and type I of pneumocytes. Small bumps help maintain a yurt-shaped surfactant structure in the respiratory part of the lungs.

There are type II pneumocytes with imperfections and release of active juices on the upper surface. Studies using an electron microscope showed that a slight manifestation of type II pneumocytes is observed in the mountainous area in the respiratory part of the lungs of the Danatin's toad. In the cytoplasm of these cells there is a small number of osmiophil bodies containing homogeneous compaction substances. The dense electron cytoplasm contains numerous tubes and ribosomes of the granular endoplasmic reticulum. Matrix mitochondria with low electron density are located under the nucleus.

As part of the respiratory epithelium of reptiles living in the steppe zone, including the fast lizard (*Eremias velox*), it is clear that type II pneumocytes, which synthesize the surfactant complex, are significantly concentrated. Euchromatin, which has a layer of nucleus type II pneumocytes, has a large volume. In addition to osmiophil layered bodies, the cytoplasm contains tubes of the endoplasmic reticulum, dense matrix mitochondria of oval origin, a well-mature Golgi complex, free ribosomes and poly-ribosomes. The main membrane of the air-blood system consists of homogeneous fibrous components, as in combination with a combination of epithelium and endothelium.

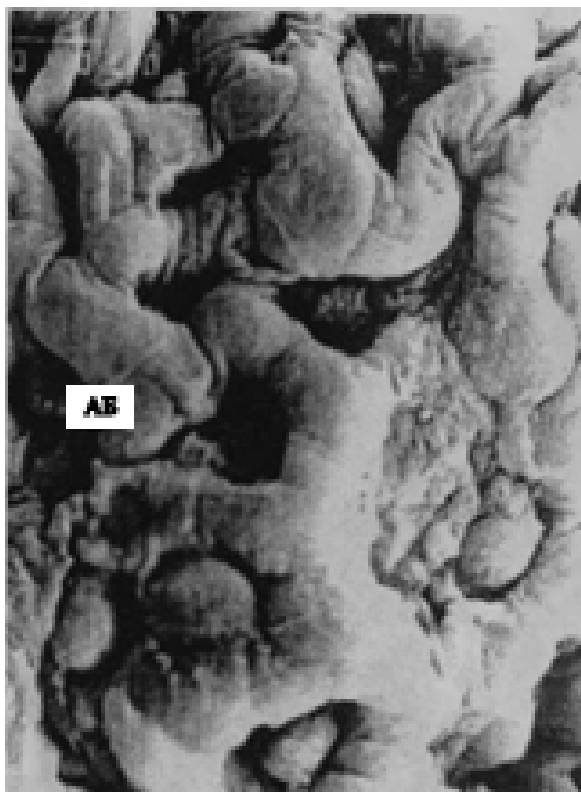


Figure 2 – Danatin's toad (mountain population). Flat and convex apical surface of pneumocytes type I.X 1600

It is noted that high-speed necks are "layer" networks, which reduce the length of the air-blood barrier and therefore reduce the loss of moisture in the respiratory part of the lungs. There were observed small pinocytosis vesicles involved in the transudation of gases and fluids of epithelial cells of the respiratory surface and vascular endothelium cells.

When studying using the electron microscope of the steppe viper and the thyroid snake (*Gloydius halys*) living in the steppe zone, hypertrophy of surfactant kecheen was observed. In this case, there is a large number of "mixed" cells, forming a fragile structure, similar to type II pneumocytes and mucous cells. These cells have a different shape of the nucleus, an increased content of chromatin, the dismemberment of the perinuclear space, a large number of ribosomes are observed in the inner membrane of the nucleus. Among the large osmiophil bodies there are electron dense mucous granules. Small osmiophilic matrix mitochondria are observed in the cytoplasm. It is believed that under conditions of moisture preservation in the respiratory part, the mucoïd structure can enhance the synthesis of surfactant. In the cytoplasm of epithelium cells and the endothelium of the blood necks, small pinocytosis vesicles and layers of the air-circulatory system are observed.

Microscopic examination of the respiratory epithelium of the *Ablepharus alaicus* (*Ablepharus alaicus*) living in the mountainous regions did not show a decrease in type II pneumocytes. However, due to the fusion of the main membrane of the respiratory epithelium and the membrane of the endothelium, a thinning of the air-vascular membrane was observed and an increase in the length of the respiratory surface was observed due to the swelling of the loop of throat grids.

A small number of type II pneumocytes and “mixed” cells were observed in the respiratory epithelium of the shield-mord, belonging to the order of snakes living in highlands. In the cytoplasm of type II pneumocytes, there are very few osmiophilic layered bodies (figure 3 – a thyroid snake (mountainous region)). In the lower part of the nucleus, such bodies are located above the main membrane. In the cytoplasm of “mixed” epithelium cells, small osmiophilic puffed bodies and mucous granules were observed.

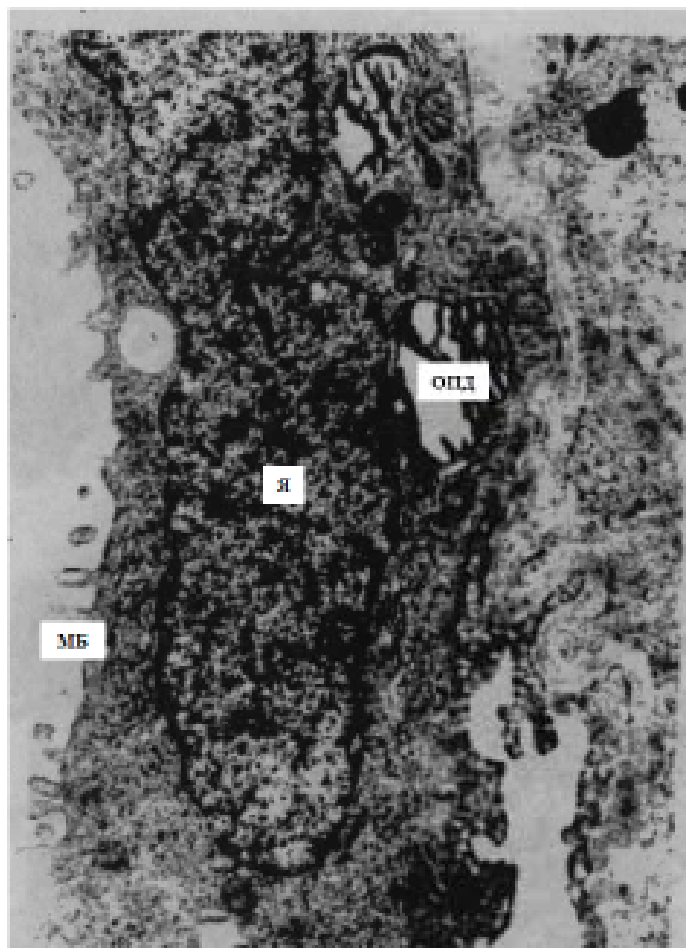


Figure 3 – A thyroid snake (mountainous region).
The second type of pneumocytes with single osmiophilic bodies.X7000

At the end of the bronchi, opposite to the mammalian alveoli, the structures in which gas exchange takes place and called the alveoli, open into the air cavity of the lungs. On close inspection, the lung structure is determined by internal protuberances and partitions resembling a sponge in cross section. Of great importance is the general anatomy of the turtle's lower respiratory tract.

Gas exchange in turtles occurs through various ways of passing gases through breathing. It depends on the type of differences, as well as on whether it is an aquatic or terrestrial turtle. Inhalation and exhalation are generally active processes [5].

Studies using a scanning electron microscope revealed a cluster of yurt-shaped surfactant as part of the respiratory part of reptiles (fast lizard, viper, thyroid snake) living in steppe zones. In addition to the secretion of the surfactant, the mucous secretion of the small mucous membrane was observed on the cell surface. The peculiarity of the respiratory part of the lungs is the presence of “layers” in its composition, which reduce the length of the air-blood barrier of throat grids (figure 4 – the thyroid snake (steppe zone)).



Figure 4 – The thyroid snake (steppe zone).
The network of "folded" capillaries. Respiratory department. X200

In the study of the pulmonary epithelium of reptiles living in mountainous areas with a scanning electron microscope, a small surfactant structure was observed. In the sets of pneumocytes, activity of the secret was not observed. All surfaces of type II pneumocytes are covered with small bumps. One of the features of the respiratory epithelium is swelling in the form of "leaflets" of the shape of hooks of capillary networks. The narrowing of the air-blood barrier allows you to separate the contours of red blood cells inside blood vessels. All of these structures increase the volume of the respiratory surface of reptiles.

Studies performed with an electron microscope have shown that the nucleus of the first type of alveolocytes contained in the respiratory epithelium of small mammals has a large contour of the shell of the nucleus. Completed chromatins are grouped in the envelope of the nucleus and karyoplasm. In the electron dense cytoplasm, small osmiophil mitochondria, endoplasmic mesh tubes, free ribosomes and polyribosomes are located.

The general division of alveolocytes occupies a large number of respiratory epithelium.

The form of alveolocytes type II is diverse, the nucleus is hyperchromic. Perinuclear space is cramped. In the cytoplasm of the tube, the granular endoplasmic reticulum and matrix are large white mitochondria and many osmiophilic layered bodies are free, some are filled with osmiophilic substances. Small vesicles were observed, such as bubble vesicles covered with membranes. The central and peripheral compartments of the alveolocytes are covered with many small buds. Endothelium blood cells have a large nucleus, one occurs, sometimes two nuclei. Completed chromatins are located on the edges of the nuclei. The core of the nucleus is a zigzag, deep invagination of the karyoplasm. The endothelium of the blood vessels has a large number of small pinocytosis vesicles. The core of the alveoli macrophage has a different shape. From their cytoplasm, it is possible to determine secondary, sometimes the first types of lysosomes involved in the process of decomposition of osmiophil granular substances.

According to the data of comparative studies of small mammals living in steppe zones carried out with the help of electron microscopes, hypertrophy of surfactant was observed in this connection. The whole cytoplasm of alveolocytes of the common vole (*Microtus arvalis* Pallas), inhabiting the steppe zone, is filled with large and small osmiophilic folded bodies containing osmiophil substances (figure 5 is the common vole). The peculiarity of the respiratory part of the lungs of mammals living in the steppe is the “folding” of their networks of capillaries, in connection with this slowing down of some cells (alveoli) and reducing the process of evaporation of moisture through the respiratory surfaces of the lungs.



Figure 5 – Common vole. Type II alveolocytes with osmiophilic plates (OPD).X 14000

The absence of hypertrophy of the surfactant complex – the difference of mammals in the steppe zones (common vole) from type II alveolocytes in the respiratory part of the lungs of the Tien Shan ordinary vole (*Clethrionomys centralis* Miller), living in the mountainous area. In addition, the main difference in the study of submicroscopy is a narrowing of the air-blood barrier and an increase in the volume of respiratory surfaces. The connection of the main membranes of the endothelium and epithelium among themselves. Epithelial cells of the blood necks are devoid of organs, turned into a dense electron table (figure 6 – Tian-Shan vole).

Morphometric studies have shown that the thickness of the air-blood membrane of animals living in various biotopes depends on their habitat (table 1 – thickness of the air-blood (aeroHEME) membrane of some vertebrates (nm)).

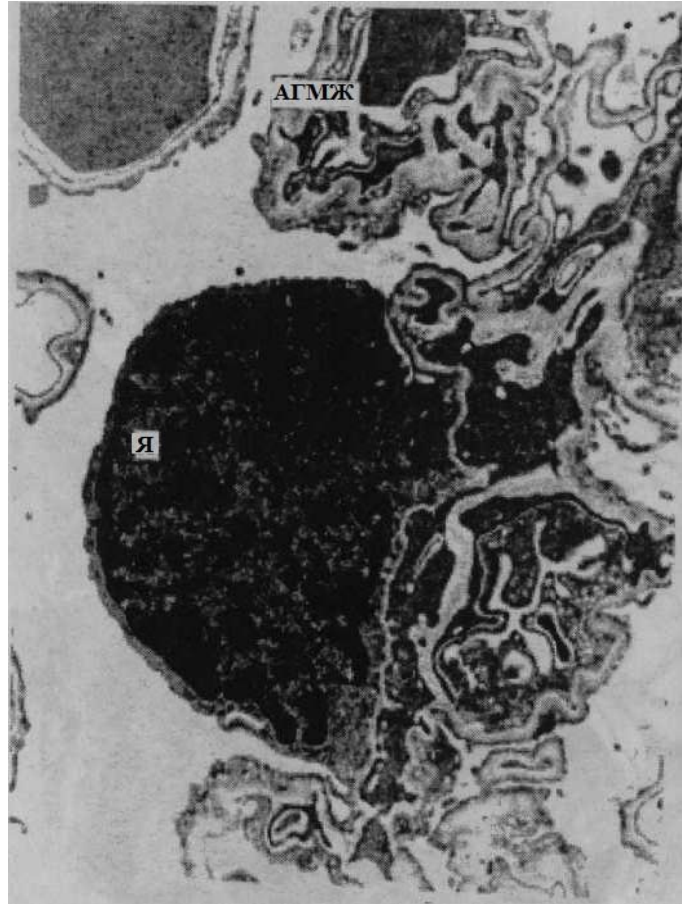


Figure 6 – Tien-Shan vole.
Toned aerohematomatic membrane system (AGMS).
Fusion of capillary endothelium with epithelial basement membranes.X 9000

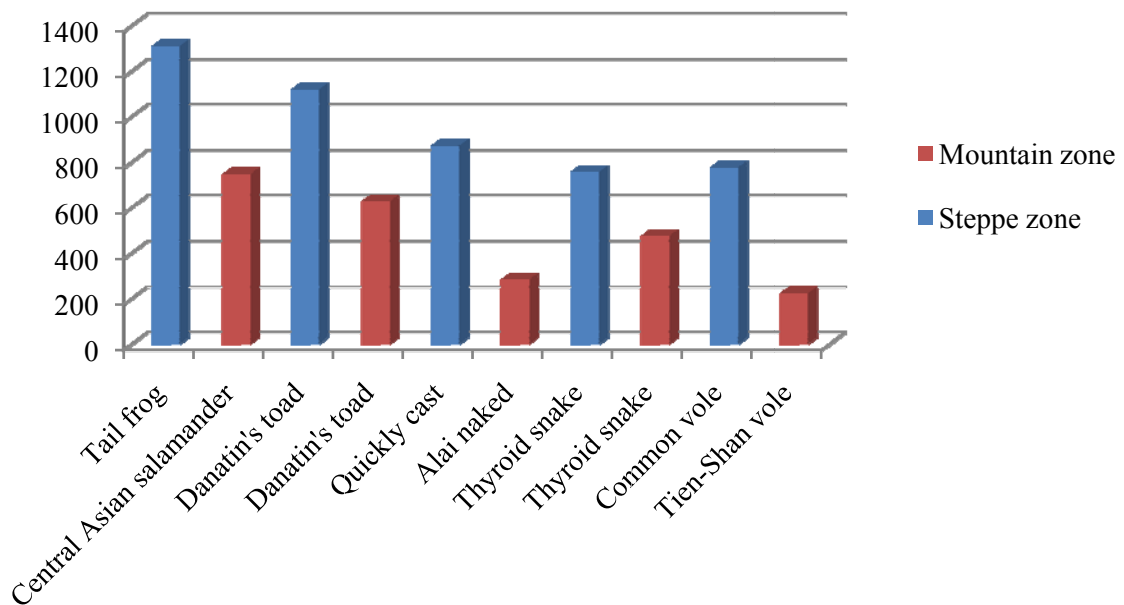


Table 1 – The thickness of the air duct (airgel) of some vertebrates (nm)

In the study of the respiratory part of the lung of rabbits with limited movement, an I type of alveolocytes with serpented envelope of the nucleus and a hyperchromic nucleus was observed under an electron microscope. The cytoplasm contains short tubes of the endoplasmic reticulum, small mitochondria, ribosomes, and narrow fibers. The surface of type I alveolocytes is not smooth. In the peripheral part there are small organelles and ribosomes. The main membrane is relaxed and in some compartments they are connected to the main membranes of the endothelial cells. However, it is not noticeable that the clearly marked air-blood barrier has thinned. In most cases, longitudinal fibroblasts are located between the epithelium and the endothelium of the blood inlets. The nucleus of type II alveolocytes is large, it contains a large number of chromins, the shape of the shell of the nucleus is zigzagged. Cytoplasm is often rich in dense matrices and crystals, elongated mitochondria, granular endoplasmic mesh tubes, empty ribosomes and polyribosomes. Not so many osmiophilic layered bodies. In the cytoplasm of macrophages in the alveoli, in addition to small first lysosomes, there is a second type of lysosome with osmiophilic layered substances.

When studying the respiratory compartment of Desert hare's lung that is in constant motion with the electron microscope, it has been found that the compartment contains type I of large nuclear alveolocytes, which occupy most of the perikaryon cytoplasm zone. There are chromatins collected along the edges of thin nuclear envelope, and euchromatins are found in large quantities. The invagination of nuclear envelope has been observed, the perinuclear space is narrow. On the cytoplasm tubes of the rough endoplasmic reticulum filled with cotton fibers, and numerous ribosomes are located. Elongated cytoplasmic formations are observed on the surface of the plasmalemma's terminal parts. The main membrane of alveolar type I cells is connected to the main membrane of the endothelium. The nucleus of type II alveolocytes is not in the correct form, and chromatin is densely located. In the cytoplasm large mitochondria are observed, in which there are often electron dense crystals of the matrix. Most of the cytoplasm is filled with an osmiophilic layered structure containing electronic transparent substances. Some layered structures are osmiophilic and homogeneous. The location of these bodies on the terminal and main surfaces of the plasma membrane shows that the secretion process is actively going into the space of the alveoli, as well as into the space of the blood capillaries. Active synthesis of surfactant indicates the presence of phagocytic osmiophilic layered bodies in large quantities in the alveolar macrophage's cytoplasm.

The endothelial cells of the blood capillaries of type II alveolocytes' main membrane have a large nucleus, in the cytoplasm ribosomes in large quantities and their connection with the alveoli's surfaces are observed. The interstitial space is narrow.

These studies have shown that adaptive responses of animals – amphibians, reptiles, mammals, belonging to different species or one species, living in different biotopes, are associated with their habitat. It has been proved that the adaptive reaction is associated with the harmonious flow of surfactant synthesis and the structure of pulmonary capillaries.

4. Conclusion. When viewing adaptation reactions of caudate amphibians' representative – the tailed frog living in the steppe zones, at the ultrastructural level, it has been found that the presence of mucous cells and hyperplasia of "mixed" cells similar in structure to type II pneumocytes and mucous cells prevent the disappearance of moisture. Many small buds were observed on the upper surface of the cell. Acceleration of secretion formation from the mucous and "mixed" cells has been proved by scanning electron microscope.

The complex of surfactants and the synthesis of mucus of pneumocytes of type II, contained in the epithelium of the Danatin's toad dwelling in the steppe zones, manifests the effects of adaptation reactions. In addition, an increase in the "folds" of blood capillaries helps to reduce the loss of endogenous liquid substances from the respiratory part of the lungs.

A decrease in the number of pneumocytes of type II of the Danatin's toad living in the mountain zone is observed. In addition, an insignificant amount of osmophilic layered substances was observed in the cytoplasm of these cells. The air-blood system has become thinner. Its thickness at the Danatin's mountain toad is narrow compared to the Danatin's toad living in the steppe zone (628.4 ± 11.5 and 1120.2 ± 20.5 nm, respectively, $P < 0.001$).

The peculiarities of the adaptation of the lungs of reptiles of the steppe zones to the external environment are the main factors due to the absence of moisture loss of the respiratory surfaces of the lungs and the powerful synthesis of surfactant. In addition, hypersecretion of the mucous components of "mixed"

cells and an increase in the interstitial layers of the vascular network, reducing the length of the respiratory surfaces contributes to the preservation of endogenous fluid. In addition to reducing the production of surfactant reptiles in the highlands, we are seeing a narrowing of the air-circulatory system and an increase in the respiratory surfaces of the lungs. For example, it has been established that the air-circulatory membrane system of a shield-mord living in a mountainous area is narrowed in comparison with a shield-ear of a steppe zone (475.4 ± 8.7 and 757.8 ± 14.14 nm, respectively, $P < 0.001$).

The peculiarities of ultrastructure of the lungs of vertebrates belonging to different biotopes are determined by their habitat, which is confirmed by electron microscopy and scanning electron microscopy. During the study of light amphibians living in various biotopes, "fence" structures and "mixed" cells, numerous type I pneumocytes and number II type pneumocytes were found. In addition, it is known that mixed cells of the tailed frog living in the steppe zone secrete secretion, while such secretion is absent in the Central Asian salamander living in the highlands.

In the study of ultrastructure of the lungs of reptiles using electron microscopy, it was observed that the nucleus of a type I pneumocyte are oval in shape, they are large. In the lungs of the thyroid snake living in the steppe zone, the phenomenon of "foaming" was well observed. Using electron microscopy of small mammals, I and II types of alveolocytes contained in the respiratory epithelium are distinguished. Type II alveolocytes have a diverse form, the nucleus is hyperchromic and there is a complex of surfactants. In this article, morphometric studies are clearly expressed, which show that the thickness of the air-blood membrane of animals with different habitats depends on their habitat.

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ТАУЛЫ ЖӘНЕ ДАЛА АЙМАҒЫНДА ТІРШЛІК ЕТЕТІН ОМЫРТҚАЛЫЛАРДЫҢ ӨКПЕЛЕРІНІҢ УЛЬТРАҚҰРЫЛЫМЫ

Аннотация. Берілген мақалада әр түрлі биотопқа жататын омыртқалылардың өкпелерінің ультрақұрылымдарының ерекшеліктері жайлы жазылған. Тіршілік ету ортасына байланысты құрғақтағы омыртқалылардың (амфибиялар, бауырмен жорғалаушылар, ұсақ сүтқоректілер) өкпелерінің нәзік құрылымында айтарлықтай өзгешеліктер электронды және сканды электронды микроскопия арқылы анықталған. Әр түрлі биотоптарда мекендейтін амфибиялардың өкпелерін зерттеу барысында «шарбақ» тәрізді құрылымдар мен «аралас» клеткалардың кездесетіндігі байқалды. Сонымен қатар, пневмоциттердің I түрі басым, ал II түрі сирек таралған. Далалы аймақта мекендейтін амфибиялар (құйрықты бақа) өкпелерінде аралас клеткалар белсенді түрде секрет бөледі, ал таулы аймақтарда мекендейтін амфибияларда (Жетісу аяқты балығы) бұндай белсенді секреция орын алмайды. Әр түрлі биотоптарда мекендейтін бауырмен жорғалаушылардың өкпелерінің ультрақұрылымдарын электронды микроскопия арқылы зерттегенде пневмоциттің I түрінің ядроларының сопақша пішінді, ірі екендігі байқалды. Пневмоциттердің I түрі тыныс эпителийінің үлкен көлемін алып жатады және ауа-қан жарғақшасын құруға қатысады. Далалы аймақта мекендейтін бауырмен жорғалаушыларда (калқантұмсық жылан) пневмоциттің I түрінде «көпіршіктену» жақсы байқалды. Ұсақ сүтқоректілердің электронды микроскопия көмегімен тыныс эпителийінің құрамындағы альвеолоциттердің I және II түрі ажыратылған. Альвеолоциттердің II түрінің пішіні әр түрлі, ядросы гиперхромды болып келген және сурфактант кешені табылған. Бұл мақалада тіршілік ортасы әр түрлі жануарлардың ауа-қан жарғақшасының қалыңдығы олардың өмір сүру ортасына байланысты бейімделуін морфометриялық зерттеулер көрсетті.

Түйін сөздер: өкпе, пневмоцит, альвеолоцит, биотоп, электронды микроскоп, сканды электронды микроскоп, омыртқалы.

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УЛЬТРАСТРУКТУРЫ ЛЕГКИХ ПОЗВОНОЧНЫХ, ОБИТАЮЩИХ В ГОРНЫХ И СТЕПНЫХ БИОТОПАХ

Аннотация. В статье рассматриваются особенности ультраструктуры легких наземных позвоночных. С помощью электронной микроскопии, сканэлектронной микроскопии были выявлены характерные отличия ультраструктуры легких наземных позвоночных (амфибии, рептилии, мелкие млекопитающие) в связи с местом их обитания. Исследования легких амфибии, обитающих в разных биотопах показали структуры в виде «решеточек» и клетки «смешанного» типа. Вместе с тем, отмечилось большое количество пневмоцитов I типа, и незначительное количество пневмоцитов II типа. У амфибий, обитающих в степной зоне (хвостатая лягушка), клетки смешанного типа активно выделяют секрет, а у амфибий, обитающих в горной зоне (семиреченский лягушкозуб), такая активная секреция не наблюдается. Электронномикроскопические исследования ультраструктуры легких пресмыкающихся показали, что ядра пневмоцитов I типа имеют овальную крупную форму. Пневмоциты I типа занимают большую часть дыхательного эпителия и участвуют в формировании аэрогемотического мембран в цитоплазме. У пресмыкающихся, обитающих в степной зоне (гладкий щитомордник), обнаружилось «вспенивание». При исследовании легких мелких млекопитающих с помощью электронной микроскопии были выделены в дыхательном эпителии альвеолоциты I и II типов. Альвеолоциты II типа разной формы с гиперхромным ядром, также обнаружился комплекс сурфактанта. В этой статье морфометрические исследования показали, что у животных, обитающих в разных зонах, имеется разная толщина аэрогемотических мембран в связи с их местом обитания и приспособлением к окружающей среде.

Ключевые слова: легкие, пневмоцит, альвеолоцит, биотоп, электронная микроскопия, скан-электронная микроскопия, позвоночные.

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REFERENCES

[1] Saparov K.A., Nurtazin S.T. Ul'trastrukturnye adaptivnye reakcii respiratornogo otdela legkih pri dolgovremennoj gipoksicheskoj gipoksii. Almaty: NIC «Fylym», Seriya biologicheskaya i medicinskaya. 1-2. 2001 2002. P. 63-69.

[2] Saparov K.A. Omyrtkalylardyn okpelerinin morfologiyalyk turgydan beyimdeluinin negizi. Almaty: Kazak universiteti, 2015. 49 P.

[3] Kartashov N. et N., V. E. Sokolov Shilov. I.A Omnium- Workshop ex Zoological specimens. M.: Aspekt Press, 2004. 305 P.

[4] Konstantinov Dóminum Shatalov SP Anatomia comparata vertebrates. M.: Academy, 2004. 304 P.

[5] Saparov A. Alicui bases lux adaptationem ad terrestres veniamus vertebrates. Almaty: Kazak universiteti, 2002. 176 p.

[6] Smith J.A., McGuire N.C., Mitchell M.A. Cardiopulmonary physiology and anesthesia in crocodilians. Proc Assoc Reptil Amphib Vet, 1998. P. 17-21.

[7] Holz P.H. The reptilian renal portal system: a review // Bull Assn Reptil Amphib Vet. 1999. 9(1). P. 4-9.

[8] Anderson J.B., Rourke B.C., Caiozzo V.J., Bennett A.F., Hicks J.W. Postprandial cardiac hypertrophy in pythons // Nature. 2005. (434). P. 37-38.

[9] Beauchamp G.K. Sensory and receptor responses to umami: an overview of pioneering work // The American Journal of Clinical Nutrition. 2009. 90 p.

- [10] Rose K.D. The Beginning of the Age of Mammals. Baltimore: Johns Hopkins University Press, 2006. 448 p. P. 179-186.
- [11] McKarns S.C., Bombick D.W., Morton M.J., Doolittle D.I. Gap junction intercellular communication and cytotoxicity in normal human cells after exposure to smoke condensates from cigarettes that burn or primarily heat tobacco // *Toxicol. in vitro*. 2000. Vol. 14, No. 1. P. 41-51.
- [12] Eugstrom G., Headband B., Valind S., Jansson. Asymptomatic leg and carotid atherosclerosis in smokers is related to degree of ventilator capacity. Longitudinal and cross-sectional results from Men born in 1914 // Sweden, *Cancer Res*. 2001. P. 778-784.
- [13] Shiripova S. Quo motus aptum prementibus diversae altitudinis normobaric hypoxic smesi Avtoref. dis. kand. med. nauk felis. Almaty, 2000. 24 p.
- [14] Udartseva etc. Organicum iuncturam motus ad machinas et recta accommodatio obtineri vozdeystviyuvintsa. Almaty, 2001. 226 p.
- [15] Ustyuzhaninova I.L., Shishkin G.S., Milovanov A.P. In Gas commutationem basics of mutat alicui rei respiratoriorum in pulmonica, zhiteley Severa // *Fr. Carmina of Academiae Medical Scientiarum URSS*, 1977. P. 106-112.
- [16] Popov I.L. Quod autem effectus fumigans in physica development, cardiovascular systema, in re publica adulescentes et autónomo // ed. permanere. Kirov, 2009. P. 39-46.
- [17] Anderson K.E., Carmella S.G., Ye M., Bliss R. L. et al. Metabolites of a tobacco-specific lung carcinogen in non smoking women exposed to environment ae tobacco smoke // *Cancer Treat Res*. 2001. Vol. 105. P. 31-52.
- [18] Nesterov D.V., Sipaylova O.Yu., Lebedev S.V. Microparticles ad effectum de cadmiae sulfate et broiler tok. himicheskikh commutationem elementa per os. Orenburg: Acta publica University, 2012. P. 176-179.
- [19] Nesterov D.V. Praeparata cadmiae-toxicus effectus commutationem elementum utebatur.
- [20] Nesterov D.V. Latinitatis Nederlandicae Spaylova / vestigium elementa in medicina honoribus. 2011. P. 12. N 3-4. P. 80-82.
- [21] Lizurchik L.V. Dione umbra effectus cigarette fumus a contentus a mures inclusi essent toxicus elementa in corpore. Orenburg: Orenburg Acta publica University, 2014. P. 73-91.
- [22] Kagazezheva N.S., Kolomiytseva N.S. Indicatores de cardiorespiratory passivnogotabakokureniya super adolescentulis in montuosa area // *Herald de re publica Adygeya universiteta*. Adygea, 2013. P. 39-52.
- [23] Katashinskaya L.V. Gubanov Quod munus impulsus in fumigans status de respiratoriorum / Caroli a Tyumen publica University. Tyumen, 2014. P. 171-177.
- [24] Lupenko M. Metabolicae processus refrigerationis corpora integra Fiziol // *La. M.*, 2007. P. 61-67.
- [25] Maruschak M.I., Volkov. Yarema N.I. Ultrastructural izmeneniya respiratornogo department rat pulmone in primis temporibus cum pulmone vitium est communis // *Herald biologices medicinae problems*. Kioviensis. P. 122-131.
- [26] Hirao T., Nelson H.H., Ashok T.D., Wain J.C., et al. Tobacco smoke induced DNA damage and early age of smoking initiation induce chromosome loss at 3 p 21 in lung cancer // *Eur. J. Cancer Prev*. 2000. Vol. 9, N 6. P. 395-400.
- [27] Nurtazin S. Ultrastructural features tsitofosfoliposom pulmo incisus etiam in variis vertebrates mestoorbitany // *Math. MES RK, NAN RK. Ser. biol. i mel. MM*. P. 52-58.
- [28] Philippenko L.N. Compensatory pulmonis statu Morfofunktsionalnoe surfactant ratio per processus of hypertension: Avtoref. dis. ... kand. biol. nauk. M., 2001. 27 p.
- [29] Shishkin G.S. Tela cellulosa, alterum stomachum lining respiratoriorum departments // *Facile norme*. Novosibirsk: Nauka, 2005. P. 38-59.
- [30] Shishkin G.S., Sobolev A.D., Ustyuzhaninova N.E., Shakutin N.A. In mechanism de actio ad fideles accommodandi respiratoriorum et frigidus aer // 4 International. Symp. Secundum prepolyarnoy medicina. Novosibirsk, de editoria Academiae Medical Scientiarum, 2007. P. 103-104.
- [31] Meban C. Localization of phosphatidic acid phosphatase activity in granular pneumocytes // *J. Cell. Biol*. 2002. Vol. 27, N 3. P. 247-254.
- [32] Meban C. The pneumocytes in the lunge of *Xenopus laevis* // *J. Anat*. 2003. Vol. 64, N 2. P. 235-244.
- [33] Sobolev A.D. Facile vasis pulmonis // *norme. Nauka Vozduhnosnye vias*, Novosibirskum. 2005. P. 14-29.
- [34] De Dominii V.I. Garani reptilia et amphibians in subsidiis studio. M.: Panchenko Amphiprion, et reptilia, quicumque confugerint territorii, 2005. P. 8-24.
- [35] Dinesman Lumen gentium, M. L. DE MODIS Kalecki quantifying amphibiorum, et reptilia, Opera // *Supra et nazemnyh pozvonochnyh Geographicis distributio*. M.: A, 2002. P. 329-341.
- [36] Tarquinius F.F. Sultanov Hyperthermia, ultricies ac defectum / habitus psychologicos. AH Babaevoy. Ashgabat: Ylym, 2008. P. 224.
- [37] Beauchamp G.K. Sensory and receptor responses to umami: an overview of pioneering work // *The American Journal of Clinical Nutrition*. 2009. 90 p.
- [38] Rose K.D. The Beginning of the Age of Mammals. Baltimore: Johns Hopkins University Press, 2006. 179, 186 p.
- [39] Tarquinius F.F. Sultanov Hyperthermia, ultricies ac defectum / habitus psychologicos. AH Babaevoy. Ashgabat: Ylym, 2008. 224 p.
- [40] Avtandilov G.G. Medical morphometry. Manual. M.: Nisl, 2000. P. 202-214.
- [41] Konstantinov V.M. Dóminum Vertebrate Collections / LCD Televisions Konstantinov, S.P Naumov, S.P Shatalov ucheb. dlya universities. M.: Academy, 2006. 125 p.

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