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THE STRUCTURE AND FUNCTIONAL ADAPTATION OF TISSUES IN THE HUMAN BODY

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Abstract: This article analyzes the intrinsic relationship between the morphological structure of human tissues and their functional adaptation characteristics. The study examines how the specific histological structures of epithelial, connective, muscular, and nervous tissues are adapted to perform particular physiological functions. Furthermore, the mechanisms of tissue regeneration and functional adaptation under the influence of external and internal environmental factors are discussed. The conclusions presented in the article provide a deeper understanding of pathological processes at the tissue level and enable the practical application of modern advancements in histology.

Keywords: Histology, morphology, functional adaptation, regeneration, extracellular matrix, homeostasis.

Introduction

The human body has a complex and perfect structure, and as a result of the harmonious interaction of various tissues, it has the opportunity to live and develop. Changes in the ecological environment during evolutionary development force the organism to adapt to these changes. The cell plays a key role in this adaptation process of the organism. As the cell adapts to the external environment, the organism undergoes external morphological changes. Such changes can be clearly observed, for example, in species of animals belonging to different classes. Thus, as cells change under the influence of the external environment, the same process of change occurs in the tissues composed of them. So, what is fabric?

The phenomenon of tissue preservation is called determination [3; P. 103].

Tissue is a structure formed during the historical phylogenetic development of a multicellular organism, consisting of a complex of cells and intercellular elements specialized in performing a specific physiological function. Tissues are the main morphological units of the organism and differ from each other in their origin, structure, and functions. Tissue is also a kind of system. Because, as mentioned, it consists not of one, but of several elements: cell and intercellular substances. If we consider tissue as a system relative to a cell, we can consider it as an element relative to organs. Because tissues combine to form a specific organ. However, the tissues of all organs do not always have the same structure. Tissues coexist with the external and internal environment through the nervous system. The human body has four types of tissues: epithelial, muscular, nervous, and connective.

Among the above-mentioned tissues, the earliest are epithelial and connective tissues. In the final stage of development, along with the increasing complexity of the animal's structure, muscle and nerve tissues became more complex (differentiated). However, such a process has occurred in humans as well. Generally speaking, the process of formation of all our tissues is called histogenesis.

Methodology

Histology studies the microscopic structure, development, and functional properties of tissues. This science occupies an important place in the field of medicine and serves as the main theoretical basis for understanding and explaining the mechanisms of the origin of diseases. Many serious diseases (cardiovascular, musculoskeletal, and neurodegenerative diseases) are based on impaired functional adaptation of tissues. Prevention of these diseases and finding solutions to them is one of the urgent problems today. Now let's get specific information about these mentioned tissues and get closely acquainted with their specific characteristics.

Results And Discussion

Epithelial tissue - First-formed epithelial cells ensure the exchange of substances between the maternal organism and the fetus. Creates conditions for the development of the fetus.

During early fetal development, epithelial tissue is formed from all three fetal layers (ecto-, ento-, and mesoderm) [4; p. 161].

This tissue is a layer of cells with a certain thickness, one surface facing the external environment, and the other surface touching the connective tissue. Epithelial tissue has different origins and functions and differs from other tissues in its specific characteristics. Specifically:

1. Epithelial tissue consists of a collection of cells in the form of densely packed layers with almost no intercellular substance;

2. Epithelial tissue is always located on the basement membrane;

3. Since the epithelial tissue is located on the basement membrane, the cells in its composition have the property of polar differentiation, that is, the apical and basal parts of the cell are distinguished;

4. Epithelial tissue does not have blood vessels; its cells receive nutrients through the basement membrane from the underlying connective tissue by diffusion.

5. Epithelial tissue has a high degree of regeneration.

6. Epithelial tissue is supplied with nerve vessels.

Let's list the functions of tissue in the body one by one:

1) Protective function: Since epithelial tissue is a limiting tissue, it protects various tissues and organs located beneath it from external influences (mechanical, chemical, physical). At the same time, it covers the body surface, the inner surface of the digestive tract, and the respiratory and urinary tracts. The serous membranes are also covered with epithelium. Undamaged, healthy skin epithelium does not transmit harmful substances and microbes to the body. This characteristic of the tissue is its specific function.

2) Absorption function: In the digestive tract, mainly in the intestinal lumen, complex proteins, carbohydrates, and fats from food, broken down by enzymes in the form of monomers, as well as water and mineral salts from chyme, are absorbed into the blood and lymph through intestinal epithelial cells.

3) Secretory function: Since epithelial tissue constitutes the main working part of most glands in the body, these cells produce secretions containing biologically active substances. The product of the epithelial tissue lining the gastric mucosa protects the stomach from mechanical and chemical influences, while the epithelial cells located along the gastrointestinal tract play an important role in the breakdown and absorption of nutrients.

4) Excretory function: waste products formed as a result of metabolism in the body are also expelled from the body through epithelial tissue.

Excretion is mainly observed in the lungs (carbon dioxide and partially water are excreted), kidneys (urea, uric acid are excreted), skin (water with sweat and 5-10% urea) [4; P. 160].

Epithelial tissue has been classified several times based on its development, structure, and function, among which phylogenetic and morphofunctional classifications are widely used. According to phylogenetic classification, epithelial tissue is divided into 5 types: cutaneous epithelium, intestinal epithelium, renal epithelium, coelomic epithelium, ependymal epithelium.

According to the connection of epithelial tissue cells with the basement membrane, they are divided into: single-layered and multi-layered, multi-row epithelium. Single-layered epithelium, in turn, was divided into: single-row, multi-row. Depending on the shape of single-row epithelial cells, we can find: flat, cuboidal, cylindrical. Multilinear epithelium has a cylindrical shape with a mixture of only callus cells.

Special structures of the stratified epithelium include ciliated eyelashes, edges - microvilli, and flagella [1; 189 p.].

Stratified epithelium can be keratinized, non-keratinized, and variable. Because the cells of the upper layer of the stratified squamous keratinizing epithelium transform into horny bodies, it is called keratinizing epithelium (Fig. 1).

Figure 1. Microscopic image of stratified squamous epithelium.

In placental mammals, they are present in the skin, oral cavity, esophagus, cornea of the eye, and excretory organs.

Muscle tissue - The movement of the organism and individual organs is connected with the activity of muscle tissue. The movement of blood in blood vessels, respiratory activity, the movement of food along the gastrointestinal tract, and eye movement occur only due to the contraction of various muscle groups (smooth and striated muscles). Contractile activity occurs through special contractile structures - myofibrils - present in muscle tissue. This tissue can include smooth muscle, striated muscle, and cardiac muscle.

Muscles are divided into the following groups according to their morphological and functional characteristics (Fig. 2).

1) Skeletal muscle tissue consists of multinucleated symplasts, formed by elongated cells with transverse striations. The contraction of such muscles is fast, strong, and usually voluntary. The striated skeletal muscle consists of long, cylindrical multinucleated muscle fibers with a diameter from 10 to 100 μm [3. p. 161].

2) Cardiac muscle also has transverse striations and consists of cylindrical, elongated branched cells arranged parallel to each other. Thus, it forms the myocardial layer of the heart. In the area of their interconnected ends, structures unique to the heart muscle - intermediate discs - are located. The contraction of the heart muscle occurs rhythmically and is not subject to human will.

Figure 2. Microscopic view of muscle tissue types.

3) Smooth muscle tissue consists of a collection of spindle-shaped cells without transverse striations. This muscle is innervated by the autonomic nervous system and therefore contracts involuntarily. The contraction of these muscles is slow and very weak. In all types of muscles, contraction occurs due to the sliding of thin actin filaments relative to thick myosin filaments. Smooth muscle tissue participates in the formation of the walls of internal organs - respiratory and gastrointestinal tract, genitourinary organs, blood and lymphatic vessels.

Based on Figure 2, we can see an illustration of all the types of muscle tissue mentioned above and further reinforce our knowledge of this tissue.

Nerve tissue - Nerve tissue is the newest tissue in phylogenetic development, consisting only of cells, without intercellular substance. In nerve tissue, the function of intercellular substance is performed by specific cells called neuroglia. All cells of nervous tissue are tumor cells.

Nerve tissue performs two interconnected functions in the body:

- regulates, combines, and coordinates the activity of all cells, tissues, organs, and functional systems;

- ensures the organism's connection with the external environment and adapts the activity of cells, organs, and functional systems to environmental conditions.

Nerve tissue is the most highly specialized form of matter, which allows a person not only to control the environment and the external world, but also to understand themselves. The main activity of nervous tissue is carried out by receiving and processing external and internal stimuli, storing information.

Figure 1.3. Structure and parts of a neuron.

Nerve tissue forms the basis of the nervous system. The nervous system consists of a network of numerous organs and structures distributed throughout the entire organism, mainly composed of two types of cells.

The first type of cells is called neurons or neurocytes. These cells receive external and internal stimuli, convert them into nerve impulses, and ensure their distribution throughout the organism. The second type of cell, neuroglia, performs a number of auxiliary functions [6; P. 172].

Since the structure of nerve tissue, which constitutes the nervous system, is largely connected with its development, it is advisable to briefly familiarize ourselves with the development of this tissue before studying its structure.

Connective tissue Connective tissues are very widespread in the body and are grouped into a common group (protective-trophic supporting tissues) due to their development from a common source - mesenchyme, performing protective, trophic, supporting, and mechanical functions. These tissues, especially blood, lymph, and connective soft tissues, are considered the internal environment of the organism.

The most diverse and widespread connective tissues can be divided into two groups, albeit conditionally: the protective-trophic group - blood, lymph, endothelium, connective soft and reticular tissues; the supporting-mechanical group - dense connective tissues, cartilages, and bones [3; P. 90].

Blood is a liquid tissue composed of formed elements and plasma. It contains erythrocytes, leukocytes, and blood platelets. Plasma, having a liquid consistency, is the intercellular substance of blood tissue. Its main component is water, containing proteins (albumins, globulins, fibrinogen), salts, and other substances. The biochemical and physiological study of plasma is the task of relevant sciences.

Lymph - certain components of blood plasma constantly leak through the walls of blood capillaries and pass into tissue fluid. With the help of the system of lymphatic capillaries and vessels, this fluid is released back into the blood. The fluid in the lymphatic vessels is called lymph.

Lymph (lympha - water, moisture) has a specific gravity of 1.012-1.026 and can coagulate due to the presence of fibrinogen [3; P. 104].

The composition of lymphoplasm is not uniform in different places, for example, intestinal lymph is rich in fats. The composition of lymph also changes depending on the size of the vessels (capillaries, vessels before and after the lymph node, main vessels). The composition of lymphoplasm is similar to the composition of blood plasma and tissue fluid,

but there are also significant differences. For example, there are few proteins in the lymphocyte. Lymph contains lymphocytes, monocytes, and a very small number of granulocytes and erythrocytes.

Cartilage tissue performs a supporting function and is found in various parts of the skeleton, as well as in the respiratory organs. The turgor state of cartilage cells (chondrocytes) is elevated, and the intercellular substance (chondromyoid) has a dense consistency. From the outside, cartilage is surrounded by connective tissue - perichondrium (cartilage membrane), rich in collagen fibers and young cartilage cells - chondroblasts. Near the perichondrium, chondrocytes are still similar to chondroblasts, and further inside the cartilage, although elongated, they are located perpendicular to the perichondrium. The surface of chondrocytes has microvilli that can only be examined by electron microscopy. Their nucleus is round, not rich in chromatin, the cytoplasmic reticulum is developed, and the cytoplasm also contains fat, glycogen inclusions, and a large amount of water. Younger cartilage cells divide by moving towards the center of the cartilage and form isogenous groups (derived from the same pathway, i.e., the division of a single cell).

Three types of cartilage are distinguished: hyaline (vitreous, transparent), elastic, and fibrous [3; P. 115].

Bone tissue - this type of tissue is found only in vertebrates, is very strong, and has a high degree of intercellular substance mineralization. While performing a supporting function, it plays a significant role in mineral metabolism. Calcium in bones is not inert and continuously participates in metabolism. Bone tissue performs all the functions characteristic of supporting trophic tissues.

Mineral salts accumulate in the skeleton in large quantities (in the amount of 65-70% of the dry weight of bones), in particular, up to 97% of the body's calcium accumulates in bone tissue [3; P. 117].

Conclusion

In conclusion, there is not a single randomly structured tissue in the human body. Tissues arose on the basis of a certain perfect structure. Each cell and tissue, adapting its morphological structure to perform a specific function, ensures the integrity of the organism. The structure of tissues fully meets their vital needs: where resistance is needed, dense tissue is formed, where metabolism is necessary, thin and conductive structures are formed. This balance is the main guarantee of human health and guarantees the stable functioning of the body throughout life. One of our greatest tasks is to protect human health, that is, to lead a healthy lifestyle. Only for this reason can we preserve and protect the tissues that make up our body.

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