УДК 616.74

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БИОХИМИЯ МЫШЕЧНОЙ ТКАНИ В НОРМЕ И ПАТОЛОГИИ

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Вплоть до настоящего времени сохраняется актуализация проблемы мышечных заболеваний, их причины и условия развития. В данной статье проводится обзор литературы о биохимических изменениях в мышечной ткани при различных патологиях, а также биохимических маркеров для диагностики заболеваний мышечной системы.

Ключевые слова: мышцы, белки мышечного волокна, ферменты реакций, механизм, патология.

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BIOCHEMISTRY OF MUSCLE TISSUE IN NORMAL AND PATHOLOGICAL CONDITIONS

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Up to the present day, the problem of muscle diseases, their causes and conditions of development remains relevant. This article reviews the literature on biochemical changes in muscle tissue in various pathologies, as well as biochemical markers for diagnosing diseases of the muscular system.

Key words: muscles, muscle fiber proteins, reaction enzymes, mechanism, pathology.

Occupying about 40% of body weight, muscle tissue is the site of intense biochemical processes that affect the general condition of the body. Muscle movement is a process by which chemical energy is transformed into mechanical energy, occurring under stable internal environmental conditions, including constant pressure and temperature. Pathology of the muscular system is widespread in the population and is one of the most common diseases.

The aim

This work is an analysis of the molecular mechanisms of functioning, pathochemistry and biochemical diagnosis of muscle tissue pathology.

Material and methods

Review and analysis of literary sources.

Results and discussion

There are three types of muscle tissue functioning in the human body: skeletal, smooth and cardiac. A distinctive feature of skeletal and cardiac muscles is the presence of transverse striations, while smooth muscles do not have this.

Cardiac muscles, which have transverse striations, occupy an intermediate position between skeletal and smooth muscles due to their specific characteristics. Myocytes are muscle cells that are long and elongated elements derived from myoblasts. Depending on their location, myocytes are classified as cardiomyocytes (cardiac), as well as skeletal and smooth muscle myocytes. Each type of myocyte has unique functions.

In order for the mechanical work of muscles to be effective, a number of conditions must be met: a constant supply of chemical energy, in this case ATP and creatine phosphate ; regulation of mechanical activity, including speed, duration and strength of contractions; control by the neurohormonal system; and the presence of a mechanism for energy recovery, allowing energy potential to be reused.

Composition of muscle tissue: water is 75–77%, proteins – approximately 20%, lipids – 1–3%, carbohydrates – 0.5–3.0%, extractives – 1.5–2.0%, and mineral salts – about 1%. The protein component of muscle tissue is divided into three main categories: sarcoplasmic proteins, myofibrillar proteins and stromal proteins, each of which plays a different role in the function and structure of muscle tissue.

The mechanism of muscle contraction is a complex process that includes five stages, starting with the hydrolysis of ATP by the myosin head, which does not release hydrolysis products, and ending with the interaction of myosin with actin, which leads to the movement of actin towards the center of the sarcomere and subsequent relaxation of the muscle. Then the cycle resumes.

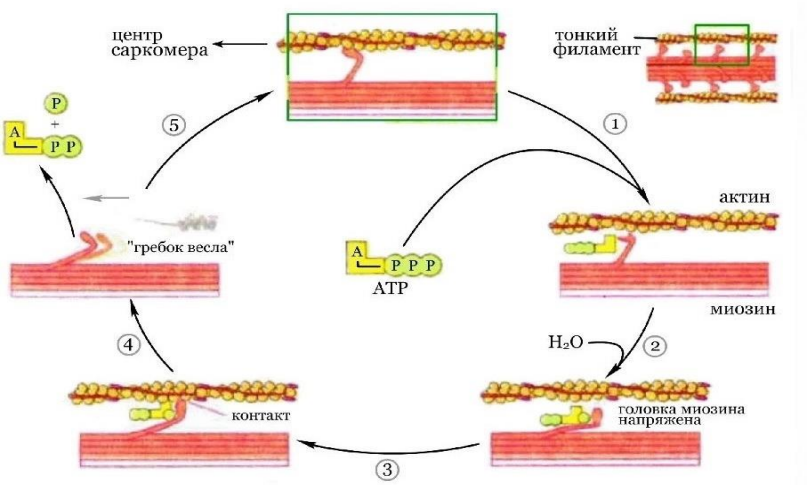

Fig. 1. Mechanism of muscle fiber contraction

The dynamics of muscle activity is a complex energy process, the basis of which is the metabolic conversion of adenosine triphosphate (ATP) into adenosine diphosphate (ADP) and inorganic phosphate. During this process, ADP is converted back into ATP, with a key role played by the interaction with creatine phosphate . This process is catalyzed by a specialized enzyme - creatine kinase , which ensures effective and rapid restoration of ATP, necessary for the continuation of muscle work:

$$\text{креатинфосфат} + \text{АДФ} \underset{\text{креатинкиназа}}{\rightleftarrows} \text{креатин} + \text{АТФ}.$$

In many diseases of muscle tissue, such as progressive muscular dystrophies, atrophies due to denervation, polymyositis and some vitamin deficiencies, there is a significant decrease in the content of myofibrillar proteins and an increase in the amount of stromal proteins and some sarcoplasmic proteins. These pathological changes are accompanied by a decrease in the level of ATP and creatine phosphate . In cases of muscle breakdown, changes in the phospholipid composition of muscle tissue are often documented, including decreased levels of phosphatidylcholine and phosphatidylethanolamine and increased levels of sphingomyelin and lysophosphatidylcholine . Many forms of muscle pathology are characterized by impaired metabolism of creatine, which leads to increased excretion in the urine, known as creatinuria . This is a consequence of impaired creatine retention and phosphorylation in skeletal muscle. Shifts in the activity of various enzymes also serve as indicators of pathological changes in muscle tissue: a decrease in the activity of sarcoplasmic enzymes, minor changes in mitochondrial enzymes and a significant increase in the activity of lysosomal enzymes. Changes in the cyclic adenosine monophosphate (cAMP) system are also observed, including decreased levels in muscle tissue, increased phosphodiesterase activity, and impaired ability of adenylate cyclase to be activated by adrenaline.

Biochemical diagnosis of muscle tissue pathology. Study of biochemical markers:

Lactate dehydrogenase (LDH) plays a key role in the diagnosis of myocardial infarction, in which there is an increase in the activity of the LDH1 and LDH2 isoenzymes in the blood plasma. In the context of progressive muscular dystrophy, also known as myopathy, there is a significant decrease in the activity of LDH4 and LDH5, while the activity of LDH1, LDH2 and LDH3 increases.

Creatine kinase (CPK) serves as an important marker for various muscle pathologies. An increase in CPK-MM in the blood indicates diseases of the skeletal muscles, while an increase in CPK-MM is a characteristic sign of myocardial infarction.

Aldolase activity in blood serum increases markedly with serious dystrophic changes in the muscular system. Particularly high levels of this enzyme are observed in patients with progressive muscular dystrophy, as well as in patients with myocardial infarction, where hyperaldolasemia is recorded.

Troponin T stands out as a highly specific biochemical marker for the diagnosis of acute and subacute phases of myocardial infarction, providing an accurate assessment of the condition of the heart muscle.

Myoglobin, as an indicator, responds to destructive changes in the muscular system, rapidly increasing in the blood serum during myocardial infarction - changes are noticeable within 4-6 hours from the onset of the disease, with normalization of the indicator approximately 22 hours after the onset of a heart attack.

C-reactive protein (CRP) is often used diagnostically to determine the presence of bacterial infection, myocardial infarction, malignancy, lymphogranulomatosis and nephritis, as well as certain forms of collagen diseases, including rheumatism, systemic lupus erythematosus and infectious nonspecific polyarthritis.

Creatine and its urinary metabolites, such as creatinuria, become important in various muscle tissue pathologies, including myopathies and progressive muscular dystrophy. Damage to muscle tissue is often accompanied by a decrease in potassium levels in the blood and increased excretion of amino acids in the urine, which is also important for the diagnostic process.

Muscular dystrophies are an inherited group of genetic diseases characterized by progressive muscle weakness and wasting, as well as a decrease in skeletal muscle mass until its destruction due to a primary defect in muscle cells. To diagnose MD, modern diagnostic methods are used: anticoagulant blood test (EDT); muscle biopsy; histopathological analysis of muscles - general tissue structure. Typically, features observed on biopsies of all dystrophic muscles include changes in fiber size, rounded muscle fibers, atrophic, regenerating, and degenerating fibers, fiber splitting, connective tissue proliferation, and increased number of internal nuclei.

Conclusion

During this research work, we found out that the development and course of diseases of the muscular system requires a number of the following factors: changes in the fractional composition of muscle proteins, a decrease in the level of ATP, creatine phosphate, shifts in the phospholipid and creatine kinase composition of muscles, a shift in the level of muscle fiber proteins. To prevent and prevent the diseases mentioned in the article, it is necessary to maintain active physical activity and full muscle trophism, which is ensured by a balanced diet with the correct ratio of proteins, fats, carbohydrates and nutrients.

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