EDUCATIONAL AND METHODICAL COMPLEX OF DISCIPLINE
MiF1202 «Morphology and human physiology»
Course – 1 Semester – 2
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Lecture 8 The muscular system I

The Functions of Muscles;
The Nerve-Muscle Relationship;

Outcomes:

1. Summarize the functions of muscular tissue;
2. Describe the structure of a skeletal muscle fiber and relate this to its function;
3. Describe the nerve–muscle relationship in skeletal muscle.

Muscle is the tissue in animals that allows for active movement of the body or materials within the body. There are three types of muscle tissue: skeletal muscle, cardiac muscle, and smooth muscle. Most of the body's skeletal muscle produces movement by acting on the skeleton. Cardiac muscle is found in the wall of the heart and pumps blood through the circulatory system. Smooth muscle is found in the skin, where it is associated with hair follicles; it also is found in the walls of internal organs, blood vessels, and internal passageways, where it assists in moving materials.
Skeletal muscles contain connective tissue, blood vessels, and nerves. There are three layers of connective tissue: epimysium, perimysium, and endomysium. Skeletal muscle fibers are organized into groups called fascicles. Blood vessels and nerves enter the connective tissue and branch in the cell. Muscles attach to bones directly or through tendons or aponeuroses. Skeletal muscles maintain posture, stabilize bones and joints, control internal movement, and generate heat.
Skeletal muscle fibers are long, multinucleated cells. The membrane of the cell is the sarcolemma; the cytoplasm of the cell is the sarcoplasm. The sarcoplasmic reticulum (SR) is a form of endoplasmic reticulum. Muscle fibers are composed of myofibrils which are composed of sarcomeres linked in series. The striations of skeletal muscle are created by the organization of actin and myosin filaments resulting in the banding pattern of myofibrils. These actin and myosin filaments slide over each other to cause shortening of sarcomeres and the cells to produce force.
Contraction of skeletal muscle is under voluntary control. Each skeletal muscle cell is innervated by a branch of a motoneuron. The process of muscle contraction begins at the site where a motor neuron's terminal meets the muscle fiber—called the neuromuscular junction (NMJ). Every skeletal muscle fiber in every skeletal muscle is innervated by a motor neuron at a NMJ. Excitation signals from the motor neuron are the only way to functionally activate muscle fibers to contract.

Action potentials are propagated down the moto- neuron, as described previously. Local currents depolarize each adjacent region to threshold. Finally, the presynaptic terminal is depolarized, and this depolarization causes voltage-gated Ca^{2+} channels in the presynaptic membrane to open. the Ca^{2+} permeability of the presynaptic terminal increases, and Ca^{2+} flows into the terminal down its electrochemical gradient. Ca^{2+} uptake into the terminal causes release of the neurotransmitter acetylcholine (ACh), which has been previously synthesized and stored in synaptic vesicles. To release ACh, the synaptic vesicles fuse with the plasma membrane and empty their con- tents into the synaptic cleft by exocytosis. ACh diffuses across the synaptic cleft to the post- synaptic membrane. This specialized region of the muscle fiber is called the motor end plate, which contains nicotinic receptors for ACh. ACh binds to the α subunits of the nicotinic receptor and causes a conformational change. It is important to note that the nicotinic receptor for ACh is an example of a ligand-gated ion channel: It *also* is an Na^+ and K^+ channel. When the conformational change occurs, the central core of the channel opens, and the per- meability of the motor end plate to both Na^+ and K^+ increases. Depolarization of the motor end plate (the EPP) then spreads by local currents to adjacent muscle fibers, which are depolarized to threshold and fire action potentials. Although the motor end plate itself cannot fire action potentials, it depolarizes sufficiently to initiate the process in the neighboring "regular" muscle cells. Action potentials are propa- gated down the muscle fiber by a continuation of this process. The EPP at the motor end plate is terminated when ACh is degraded to choline and acetate by acetyl- cholinesterase (AChE) on the motor end plate. Approximately 50% of the choline is returned to the presynaptic terminal by Na^+-choline cotransport, to be used again in the synthesis of new ACh.

Review questions

1.What is the function of neuromuscular junction?

2.Describe the importance of T-tubules?

Basic literature:

1. Saladin, Kenneth S: Essentials of Anatomy & Physiology. (2018, McGraw-Hill Education)
2. Costanzo, Linda S.: BRS Physiology. Board Review Series.7 edition. -Wolters Kluwer Health, 2018.- 307p. - ISBN 1496367693, 9781496367693
3. Leslie P. Gartner: Color Atlas and Text of Histology. - 7th Edition. - Wolters Kluwer, 2017. ISBN 1496346734, 9781496346735
4. Russell K. Hobbie, Bradley J. Roth: Intermediate Physics for Medicine and Biology. - Springer, 2015. - ISBN 3319126822, 9783319126821
5. Andersson D, Medical Terminology: The Best and Most Effective Way to Memorize, Pronounce and Understand Medical Terms: Second Edition, ISBN-13 : 978-1519066626, 2016