LECTURE SCHEDULE

Discipline: 'Basics of Physiology'

Discipline Code: MFN-1203-2

Speciality: 'General Medicine'

Number of credits: 3 credits

Year and semester: 1st year, 2nd semester

Lecture classes: 5 hours

Shymkent, 2022

Head of the department: c.b.s., docent Zhakipbekova G.S.

Protocol of the meeting of the Department No. *10a* dated '*06*' *05* 2022

Lecture No.1

1. Theme: General Characteristics of Physiology as a science. Physiology of Excitable Tissues.

2. Learning goals: to be familirized with the main types of excitable tissues, to be familiarized with the following notions: excitability, excitation, threshold of irritation and functional lability.

3. Lecture thesis:

Physiology studies life processes, functions of the organism and its systems, organs, tissues, and cells.

The goal of physiology is to explain the physical and chemical factors that are responsible for the origin, development, and progression of life. Each type of life, from the simple virus to the largest tree or the complicated human being, has its own functional characteristics. Therefore, the vast field of physiology can be divided into viral physiology, bacterial physiology, cellular physiology, plant physiology, human physiology and many other subdivisions.

In human physiology, we attempt to explain the specific characteristics and mechanisms of the human body that make it a living being. The very fact that we remain alive is almost beyond our control, for hunger makes us seek food and fear makes us seek refuge. Sensations of cold make us look for warmth, etc.

Physiology helps us to understand the nature of the diseases or pathological processes and how to treat them. Physiology forms clinical meaning, and it's impossible to understand other clinical disciplines (for example, neurology, cardiology, gynecology etc.) without knowing principles of physiology. Thus, physiology is a fundamental discipline in medical education.

4. Visual material:

- presentation of lecture material;
- posters on the topic of the lesson;
- tables, schemes.

5. Bibliography: See appendix No. 1

6. Post-lecture feedback:

1. Name the main physiological states of the biological membrane;

2. Spicify the role of the concentration of sodium, potassium and chlorine for biopotentials being evoked;
3. List the methods of investigation of excitable tissues;
5. Define notion 'Action potentials';
6. Describe excitability change in different phases of the excitation process.

Lecture No. 2

1. Theme: Neuron, Its Types and Functions. Neuroglia, Nerve Fibers, Types, Mechanisms for Propagating Action Potentials. Synapses and Neurotransmitter of Central Nervous System. Reception.

2. Learning goals: to study structure and physiologic properties of different types of neurons and nerve fibers.

3. Lecture thesis:

Neurons may be different forms and sizes and consist of a cell body (soma), dendrites (short processes) and axon (long process).

Diameter of the neuron soma ranges from 4-6 microns up to 130 microns. Due to excitation transfers through the branches of the neuron in different parts ofa body, length of the branches also widely varies from several microns to 1-1.5 meters.

Propagation of the nervous impulse has opposite directions depending on the process it runs: through the axon it spreads from soma, through dendrites it goes to the soma.

All neurons have only one axon attaching to another neuron or organ (muscles, glands) with axon terminals. Number of dendrites varies from cell to cell. Dendrites usually branches. In some cases, there is special sensing apparatus (receptors) on the dendrite terminals.

Depending the number of extensions (processes), there are the following types of neurons: unipolar, pseudounipolar, bipolar, and multipolar. The unipolar neuron has a single denrite ending (some authors count it an axon) in a branch-like tuft. Bipolar neuron has two extensions. Bipolar cells are specialized sensoryneurons for the transmission of special senses. As such, they are part of the sensorypathways for smell, sight, taste, hearing and vestibular functions. A multipolar neuron (or multipolar neurone) is a type of neuron that possesses a single axon and many dendrites (with dendritic branches), allowing for the integration of a great

deal of information from other neurons. These processes are projections from the nerve cell body. Multipolar neurons constitute the majority of neurons in the central nervous system. They include motor neurons and interneurons and arefound mostly in the cortex of the brain, the spinal cord, and also in the autonomic ganglia. A pseudounipolar neuron ("pseudo" means "false", "uni" – "one") is a kind of sensory neuron in the peripheral nervous system. This neuron possesses an axon that has split into two branches; one branch runs to the periphery and the other to the spinal cord.

Mechanism for propagating the action potentials (nervous impulses) is depend on a structure of nerve fibers.

Nerve fibers are the processes of neurons which are covered with sheathes. Neuron processes are located in the centre of nerve fiber forming so-called axon (in other sense than neuron process). The axon is covered with the sheath consisting of neuroglia cells (*lemmocytes*, they also known as *Schwann cells*).

There are two types of nerve fibers: myelinated and unmyelinated.

4. Visual material:

- presentation of lecture material;
- posters on the topic of the lesson;
- tables, schemes.

5. Bibliography: See appendix No. 1

6. Post-lecture feedback:

1. Describe structure and classification of neurons;
2. Describe structure and properties of unmyelinated nerve fibers;
3. Describe structure and properties of myelinated nerve fibers;
4. Describe a mechanism of propagation of the excitation through nerve fibers;
5. Specify different types of nerve fibers (afferent and efferent);
6. What are the Features of propagating the excitations through mixed nerve;
7. What is Parabiosis. Characterize the phases of parabiosis.

Lecture No. 3

1. Theme: Physiological features of the skeletal, smooth and cardiac muscles

2. Learning goals: to study the features of cardiac muscle.

3. Lecture thesis:

There are three types of muscles in higher vertebrates and humans: skeletal muscles (striated muscle, which is under the 'voluntary' control of the somatic nervous system), smooth muscles ('involuntary' muscles of internal organs, vessels and skin) and cardiac muscle (striated muscle but under involuntary control). All these types of muscles carry out the function of movement.

About 40 per cent of the body is skeletal muscle and perhaps another 10 per cent is smooth and cardiac muscle. Some of the same basic principles of contraction apply to all these different types of muscle.

The sarcolemma is a cell membrane of the muscle fibre. The sarcolemma consists of a true cell membrane, called the *plasma membrane*, and an outer coat made up of a thin layer of polysaccharide material that contains numerous thin collagen fibrils. At each end of the muscle fibre, the outer surface of the sarcolemma fuses with a tendon fibre, and the tendons, in turn, collect into bundlesto form the muscle tendons that then insert into the bones.

In natural conditions, excitation and subsequent contraction of the muscles are evoked with nervous impulses coming from the central nervous system. Studying the properties of the muscles in experimental settings is performed by electricity which acts as a nervous impulse (an irritator).

Isometric and isotonic contractions

During a contraction, muscle might change such properties as tension, length and shapes. In an *isotonic contraction*, muscular fibres shorten (length changing), but tension is not changed. An isotonic contraction occurs when there is no any resistance against changing the muscle's length. In an *isometric contraction*, on contrary, muscular fibres do not change their length, but muscular tension rises. Such a contraction occurs if both ends of a muscle are strongly fixed, or one of the ends is fastened to something heavy. However, in the natural setting, muscular contraction might often be isotonic and isometric at the same time, since when a muscle shortens, its tension is changed as well.

Excitability and excitation of muscular fibres.

Excitability of skeletal muscles is lower than that of nerve fibres that supply these muscles. Consequently, the threshold of irritation for muscular fibres is higher than for nerve ones. Thus, in order to produce action potentials in muscular fibres, it's necessary to depolarize muscular membrane at more value than nervous tissue requires. Action potentials of muscular fibres are equal about 110-130 mV.

Singular contraction

If a muscle is undergone a single stimulus (irritation) of enough strength (threshold or supra-threshold), then this muscle responds with a singular contraction. There are three phases in a singular muscular contraction: latent phase,contraction phase and relaxation phase. As figure show, muscular contraction doesnot occur immediately after irritation, but in some time interval. This interval is called the latent period. Such a pattern is intrinsic for all excitable tissues. But the duration of the latent period is not similar among different excitable tissues. For instance, smooth muscles have a latent period longer than skeletal ones. For the human skeletal muscles, it lasts for a thousandth of a second (ms). Duration of the latent period depends on strength of an irritator: the stronger stimulus, the shorter latent period is.

The heart muscle, like any other muscle, possesses excitability, conductivity and contractility.

When it is exposed to electrical, mechanical, thermal or chemical stimuli, excitation appears in the heart muscle, and then it contracts. The cardiac muscle under the influence of the stimuli of the subthreshold force usually does notrespond with excitations. But the stimulation by the threshold force causes a maximum contraction that does not increase any more, even if the stimulus is increased. On the basis of such facts, the law "all or nothing" is formulated for the heart. In accordance with this law, the heart responds to threshold irritation withthe maximum possible contraction. The law "all or nothing" has, however, some limitations in the following sense: the amplitude of the maximum response to the threshold stimulation can vary depending on the temperature of the environment surrounding the heart, the composition of the physiological solution perfusing the heart, the degree of its fatigue, etc.

Refractoriness of the cardiac muscle. After excitation, the heart muscle, like any other, becomes for a certain time unexcitable to stimuli of any strength. Such a state of non-excitability is called absolute refractoriness, or absolute refractory phase, the duration of which is different for different muscles. For the heart, the absolute refractory phase lasts almost the entire period of the systole of the heart, i.e. about 0.3 second. At the end of the absolute refractory phase, the excitability of the cardiac muscle gradually restores to its initial level. This period is called the relative refractory phase, and it lasts about 0.03 second. At this time, the cardiac muscle responds with excitation only to stimulation of the supra-threshold force.

Then follows a very short period of increased excitability – the supernormal phase, when the muscle responds by contracting to subthreshold stimulation.

Then, its excitability returns to the initial value.

In the normal state, each following impulse comes from the pacemaker (sinoatrial node) to the heart muscle at the moment when the refractory phase is over and myocardium excitability has returned to the initial one.

4. Visual material:

- presentation of lecture material;

- posters on the topic of the lesson;

- tables, schemes.

5. Bibliography: See appendix No. 1

6. Post-lecture feedback:

1. Cardiomyocytes, their structure;
2. A conductive system of the heart.
3. The Law of the heart muscle.
4. The main properties of the heart muscle.
5. Research methods of cardiac activity. ECG

Lecture No. 4

1. Theme: Blood Physiology. Blood Composition, Blood Cells and Their Functions.

2. Learning goals: to study constituents and main indicators of the blood, to correctly estimate functional state of an organism.

3. Lecture thesis:

On the average, water comprises 60 per cent of adult human body weight. For example, a person weighing 70 kg has 4.2 liters of water. All volume of the water comprising an organism is divided into two main portions:

- Extracellular water is 20 per cent of body weight;
- Intracellular water is 40 per cent of body mass;

Extracellular water is additionally subdivided on:

- Intravascular water – 5 per cent of body mass (water of blood);

- Intercellular water (in a compound of tissue fluid) – 15 per cent (liquid of serous cavities, synovial joint fluid, the fluid of the anterior chamber of an eye, cerebrospinal fluid and lymph).

Blood, lymph, and tissue fluids surround all cells and tissues of an organism. They are characterized by stability of compound and properties. Such stability is provided by activity of special organs and systems supplying organism with substances necessary for living and removing final products of degrading.

Functions of the blood

Blood provides a number of important functions for an organism: 1) supplies the cells with nutrients from digestive tract (nutrient function); 2) delivers oxygen to cells from the lungs, and removes carbon dioxide (transporting it from cells to the lung); 3) delivers final products of degrading to the kidneys and other excretory organs; 4) via the blood, humoral regulation of an organism is provided due to hormones and other physiologic active substances; 5) fulfills defensive function due to leukocytes and immune antibody which protect an organism from germs, toxins, and foreign proteins; 6) possesses ability to coagulation (or clotting) which protects organism from blood loss.

Composition of the Blood

Blood consists of blood cells and blood plasma. If blood with anticoagulative substance (to prevent coagulation) is placed into the glass cylinder, after a certain period of time blood cells, being heavier, settle down on the bottom; thus, blood is divided into two layers: upper slightly yellowish layer is blood plasma and the lower red layer is blood cells. The volume of plasma is 55-60 per cent of blood volume; blood cells comprise 40-45 per cent.

4. Visual material:

- presentation of lecture material;

- posters on the topic of the lesson;

- tables, schemes.

5. Bibliography: See appendix No. 1

6. Post-lecture feedback:

1. General characteristics of body fluids. Intracellular and extracellular fluids;
2. Functional systems that provide the constancy of osmotic pressure and the acid-base homeostasis of the blood;

3. The main functions of the blood;
4. Depot of the blood, and their significance;
5. Composition and functions of plasma;
6. Proteins of the blood plasma, their significance.

Lecture No. 5

1. Theme: Hormonal Regulation of Physiologic Functions. Common Properties of Hormones, Classification. Hypothalamic-Pituitary-Suprarenal System.

2. Learning goals: to study the mechanism of influence of endocrine glands hormones on organs, tissues, and cells of the body, the chemical nature of the hormones and their role in the metabolism.

3. Lecture thesis:

General characteristics of humoral regulatory factors

The multiple activities of the cells, tissues, and organs of the body are coordinated by the interplay of several types of chemical messenger systems:

1. *Neurotransmitters* are released by axon terminals of neurons into the synaptic junctions and act locally to control nerve cell functions;
2. *Endocrine hormones* are released by glands or specialized cells into the circulating blood and influence the function of cells at another location in the body;
3. *Neuroendocrine hormones* are secreted by neurons into the circulating blood and influence the function of cells at another location in the body;
4. *Paracrines* are secreted by cells into the extracellular fluid and affect neighboring cells of a different type;
5. *Autocrines* are secreted by cells into the extracellular fluid and affect the function of the same cells that produced them by binding to cell surface receptors;
6. *Cytokines* are peptides secreted by cells into the extracellular fluid and can function as autocrines, paracrines, or endocrine hormones. Examples of cytokines include the *interleukins* and other *lymphokines* that are secreted by helper cells and act on other cells of the immune system. Cytokine hormones (e.g., *leptin*) produced by adipocytes are sometimes called *adipokines*.

General notion about endocrine glands

In humoral regulation of a body activity, hormones play the most significant role. The hormones are produced by the cells of endocrine glands. Hormones formed in

the endocrine organs then follows into a blood circulation (supplying endocrine glands). Then they spread by blood over the organism, influence different organs, increasing or decreasing their functions.

The *endocrine hormones* are carried by the circulatory system to cells throughout the body, including the nervous system in some cases, where they bind with receptors and initiate many reactions. Some endocrine hormones affect many different types of cells of the body; for example, *growth hormone* (from theanterior pituitary gland) causes growth in most parts of the body, and *thyroxine* (from the thyroid gland) increases the rate of many chemical reactions in almost allthe body's cells.

Other hormones affect only specific *target tissues*, because only these tissues have receptors for the hormone. For example, *adrenocorticotropic hormone (ACTH)* from the anterior pituitary gland specifically stimulates the adrenal cortex, causing it to secrete adrenocortical hormones, and the *ovarian hormones* have specific effects on the female sex organs as well as on the secondary sexual characteristics of the female body.

4. Visual material:

- presentation of lecture material;
- posters on the topic of the lesson;
- tables, schemes.

5. Bibliography: See appendix No. 1

6. Post-lecture feedback:

1. General characteristics of humoral (endocrine and non-endocrine) regulatory factors;
2. Endocrine functions of non-endocrine organs (kidneys, heart, lungs, muscles, and skin);
3. Structural and functional organization of the endocrine system;
4. Classification of hormones;
5. Mechanisms of the hormonal action;
6. Relations between the endocrine glands and the nervous system;
7. Local and systemic hormonal self-regulation;
8. Hypothalamic-pituitary system. Neurosecretes of the hypothalamus: liberins and statins.

Appendix No. 1.

In Russian:
main:

1. Косицкий Г.И.Физиология 1-2-3 том.- Эверо, 2014.
2. Нұрмұхамбетұлы, Ә. Орысша- қазақша медициналық (физиологиялық) сөздік = Русско-казахский медицинский - Алматы : Эверо, 2014.
3. Физиология человека: учебник / Л. З. Тель [и др.]. - Рек. Респ. центром инновационных технологий мед.образования и науки М-ва здравоохранения РК. - Алматы : Эверо, 2012. - 600 с.

supplementary:

1. Физиология человека: учебник / под ред. В. М. Покровского, Г. Ф. Коротько. - 2-е изд., перераб. и доп ; Рек. Департаментом образовательных мед.учр. и кадровой политики М-ва здравоохранения РФ. - М. : Медицина,2007. - 656 с.
2. Миндубаева, Ф. А. Руководство к практическим занятиям по физиологии: учеб.-методическое пособие / Ф. А. Миндубаева, А. М. Евневич, Т. И. Крекешева. - Алматы : Эверо, 2012. - 194 с.
3. Ситуационные задачи по курсу нормальной физиологии: учебно-методическое пособие / В. К. Касымбеков [и др.]. - Алматы : Эверо, 2016. - 144 с.
4. Нормальная физиология: Практикум : учеб. пособие / под ред. К. В. Судакова. - М. : МИА, 2008.

In Kazakh:

main:

1. Бабский Е.Б., Бабская Н.Е. Адам физиологиясы: Оқулық 1-2-3 том.-Эверо, 2015.
2. Қалыпты физиология: оқулық / РФ БҒМ ; ред. басқ. К. В. Судаков; қаз. тіліне ауд. және жауапты ред. Ф. А. Миндубаева. - ; И. М. Сеченов атындағы Бірінші ММУ ұсынған. - М. : ГЭОТАР - Медиа, 2015. - 864 бет. + эл. опт. диск

supplementary:

1. Қасымбеков, В. Қ. Қалыпты физиология бойынша ахуалдық есептер жиынтығы: оқу-әдістемелік құрал / В. Қ. Қасымбеков, Р. Е. Нұргалиева, А. Т. Қалдыбаева. - Алматы : Эверо, 2016. - 152 бет. с.
2. Қасымбеков, В. Қ. Физиологиялық зерттеу әдістері: оқу- әдістемелік құрал / В. Қ. Қасымбеков, Ф. К. Балмағанбетова, А. Т. Қалдыбаева. - Алматы : Эверо, 2016. - 176 бет. с.
3. Сәтбаева, Х. Қ. Адам физиологиясы: оқулық / Х. Қ. Сәтбаева, А. А. Өтепбергенов, Ж. Б. Нілдібаева. - 2-ші бас. түзетілген және толықтырылған. - Алматы : Эверо, 2010. - 664 бет. с.
4. Сайдахметова, А. С. Физиологиядан тәжірибелік сабақтарға нұсқаулар: оқу құралы / А. С. Сайдахметова, С. О. Рахыжанова. - Караганды : АҚНҰР, 2016. - 260 бет. с.
5. Қалыпты физиология: оқулық / РФ БҒМ ; ред. басқ. К. В. Судаков; қаз. тіліне ауд. және жауапты ред. Ф. А. Миндубаева. - ; И. М. Сеченов атындағы Бірінші ММУ ұсынған. - М. : ГЭОТАР - Медиа, 2015. - 864 бет. + эл. опт. диск
6. Нұрмұхамбетұлы, Ә. Орысша- қазақша медициналық (физиологиялық) сөздік = Русско-казахский медицинский (физиологический) словарь : словарь / Ә. Нұрмұхамбетұлы. - Алматы : Эверо, 2014. - 903 с.
6. Миндубаева, Ф. А. Физиология пәнінен практикалық сабақтарға арналған нұсқау: оқу-әдістемелік құрал / Ф. А. Миндубаева, А. Х. Абушахманова, А. Х. Шандаулов. - Алматы : Эверо, 2012. - 186 бет. с.

In English:

main:

1. Hall, John E. Guyton and Hall textbook of medical physiology: textbook / John E. Hall. - 13th ed. - Philadelphia : Elsevier, 2016. - 1145 p.

2. Babsky, Y. B. Human physiology. Volum 1.: textbook / Y. B. Babsky, Y. B. Babsky. - Almaty : "Evero" , 2017. - 308 p
3. Babsky, Y. B. Human physiology. Volum 2.: textbook / Y. B. Babsky, U. B. Babsky. - Almaty : "Evero" , 2017. - 296 p.
4. Babsky, Y. B. Human physiology. Volum 1.: textbook / Y. B. Babsky, Y. B. Babsky. - Almaty : "Evero" , 2017. - 308 p
5. Hall, John E. Guyton and Hall textbook of medical physiology: textbook / John E. Hall. - 13th ed. - Philadelphia : Elsevier, 2016. - 1145 p.
6. TannerThies, Roger Physiology- An IIIustrated Review: textbook / Roger TannerThies. - New York : Stuttgart, 2013. - 329 p

supplementary:

1. Smagulov , N. K.: textbook / N. K. Smagulov , N. M. Kharissova ; Ministry of public health of Republic of Kasakhstan; Karaganda state medical universitety. - Almaty : LLP "Evero", 2013.

Electronic resourses:

1. Нормальная физиология [Электронный ресурс] : учебник / под ред. Б. И. Ткаченко. - 3-е изд., испр. и доп. - Электрон.текстовые дан. (53,1Мб). - М. : ГЭОТАР - Медиа, 2017. - эл. опт.диск
2. Адам физиологиясы. Динамикалық сызбалар атласы [Электронный ресурс] : оқулық / К. В. Судаков [ж.б.] ; қазақ тіл. ауд. М. Қ. Қанқожа. - Электрон.текстовые дан. (105Мб). - М. : ГЭОТАР - Медиа, 2017. - 464б. с.
3. Қалыпты физиология [Электронный ресурс] : оқулық / қаз.тіл. ауд. Ф. А. Миндубаева ; ред. К. В. Судаков. - Электрон.текстовые дан. (1,42Мб). - М. : ГЭОТАР - Медиа, 2015. -864 бет.эл. опт. диск
4. Камкин, А. Г. Атлас по физиологии. В 2 т. Т. 1 [Электронный ресурс] : учеб.пособие / А. Г. Камкин, И. С. Киселева. - Электрон.текстовые дан. (58,4 Мб). - М. : ГЭОТАР - Медиа, 2010. - 408 с. эл. опт.диск
5. Камкин, А. Г. Атлас по физиологии. В 2 т. Т. 2 [Электронный ресурс] : учеб.пособие / А. Г. Камкин, И. С. Киселева. - Электрон.текстовые дан. (58,7 Мб). - М. : ГЭОТАР - Медиа, 2012. - 448 с.
6. Физиология пәнінен электронды оқу құралы [Электронный ресурс] : медициналық колледждерге арналған оқу құралы / ҚР денсаулық сақтау министрлігі; Техникалық және кәсіптік білім; Медициналық мамандықтарға арналған. - Электрон. текстовые дан. (22,3 Мб). - Түркістан : ОҚО, 2012. - эл. опт. диск

Electronic Databases

No.	Name	URL
1	Electronic library	http://lib.ukma.kz
2	Electronic catalog - for internal users - for external users	 http://10.10.202.52 http://89.218.155.74
3	Republican interuniversity electronic library	http://rmebrk.kz/
4	'Student Advisor' Electronic Library of Medical	http://www.studmedlib.ru

	University	
5	'Paragraph' information system 'Medicine' section	https://online.zakon.kz/Medicine
6	'Legal' electronic source of legal information	https://zan.kz
7	Scientific Electronic Library	https://elibrary.ru/
8	'BooksMed' Electronic Library	http://www.booksmed.com
9	'Web of science' (Thomson Reuters)	http://apps.webofknowledge.com
10	'Science Direct' (Elsevier)	https://www.sciencedirect.com
11	'Scopus' (Elsevier)	www.scopus.com
12	PubMed	https://www.ncbi.nlm.nih.gov/pubmed