

Schedule – Faculty of Medicine - Department of Physiology and Pathophysiology.

Department of Physiology

WINTER SEMESTER 2021/2022

Classes:

1. Homeostasis. Cell to - cel communication. Membrane dynamics /6-7.10.2021/

Definition of homeostasis and the internal environment in the human body.

Mechanisms of homeostasis -local control, *reflex control* using long-distance pathway - response loops, feedback loops, positive and negative feedback, feedforward feedback.

Cell to-cell communication. Signal pathways - stages, types of cell receptors, biological signal transduction. Modulation of signal pathways. Signal pathways that maintain homeostasis.

Membrane dynamics. Osmosis. Osmotic Equilibrium in the body. Osmotic pressure. The body's water compartments. Tonicity. Osmosis and Tonicity - clinical implications.

Transport through membranes - types and features of particular types of transport.

Clinical issue: Cystic fibrosis as an example of impaired membrane transport.

2. Nervous system – Excitability /13-14.10.2021/

The functional organization of the nervous system.

Neurons - structural and functional classification. Parts of the neuron and their functions.

Resting membrane potential – Genesis and factors that influence resting membrane potential . Equilibrium potential for ions - Nernst and GHK equations.

Electrical signals in neurons - graded potential and action potential. Conduction of action potentials through the nerve fiber – factors that affect velocity of conduction.

Synapses – types of synapses their formation; stages of conduction in the synapse.

Neurotransmitters - the main classes of neurotransmitters and their characteristics: synthesis and release of neurotransmitters, target receptor and its location for neurotransmitters; agonist/antagonists and termination of neurotransmitter activity.

Integrative processes in the nervous system: divergence and convergence, temporal and spatial summation, synaptic plasticity, fast and slow postsynaptic potentials, excitatory and inhibitory postsynaptic potentials.

Glial cells: types and functions.

Clinical issue: Selected demyelinating diseases as an example of nerve conduction disorders.

3. Nervous system – Sensory physiology. Sensory organs /20-21.10.2021/

General properties of sensory systems.

Somatic senses - sensory receptors: division, mechanisms of excitation, sensory transduction of a signal in the receptor, sensory conduction pathways, somatosensory cortex.

Explanation of adequate stimulus, excitability, threshold, receptor potential, sensory modality, receptive field, lateral inhibition, 1:1 coding - labeled line coding, population coding.

Somatic senses of touch, temperature, proprioception, nociception - characteristics of receptors, conduction pathways, ways of testing.

Specific and non-specific systems of sensory transmission.

Special senses:

- Smell - functional anatomy of the olfactory organ, transduction of the olfactory signal.
- Taste - types of taste, functional anatomy of the taste organ, taste transduction.
- Hearing - functional anatomy of the ear; Properties of the sound. Sound transduction. Air and bone conduction of sound – ways of testing. Presbycusis - causes, procedures.
- Vision - functional anatomy of the eye. Optical system of the eye. Phototransduction at the retina, visual pathway and the cerebral cortex. Presbyopia, myopia, hyperopia - causes and procedures.

Clinical Issue: Menier's Disease.

4. Review. Partial test 1 /27-28.10.2021/

5. Nervous system - Control of body movement /3-4.11.2021/

Somatic locomotor system - features of somatic motorways, neuromuscular junction.

The spinal cord - organization and functions of individual structures.

Skeletal muscle reflexes. Types and function of proprioceptors. Muscle tone. Stretch reflex, flexion reflex.

Control of body movement - types of movements, levels of nervous motor control. Function of the spinal cord, brain stem (postural reflexes), basal ganglia. Cortical control of involuntary movements: cortical motor areas, pyramidal system (corticospinal tract). Smooth muscle movement control.

Cerebellum - functional structure and activity.

Vestibular apparatus - functional anatomy of the vestibular apparatus. Static and dynamic equilibrium. Mechanism of vestibular receptors stimulation. Integration of stimuli from different receptors in order to maintain balance.

Clinical Issue: Parkinson's Disease.

6. Nervous system – brain activity /17-18.11.2021/

Parts of the brain and their functions.

Functional organization of cerebral cortex.

Physiological basis of EEG. Dream.

Emotions and motivations. Memory, learning. Language.

Circadian rhythms. Function of pineal gland.

Cerebro-spinal fluid. Blood-brain barrier.

Functions of hypothalamus.

7. Autonomic nervous system (ANS). /24-25.11.2021/

Physiological role of the ANS and division of the ANS. Differences between autonomic and chemical synapses and its physiological consequences.

Autonomic neurotransmitters - synthesis and breakdown. Types, properties and location of receptors in the ANS, modifying substances, agonists/ antagonists of ANS. Target organ

effects of ANS activity. The role of adrenal medulla in autonomic control. Regulation of ANS activity by the central nervous system (CNS). Autonomic reflexes. Ways of ANS activity assessment.

8. Review. Partial test 2 /1-2.12.2021/

9. Muscles /8-9.12.2021/

Skeletal muscles – skeletal muscle organization. Motor unit. Sliding theory of contraction. Excitation-contraction coupling. Energy sources in skeletal muscles. Fatigue - types, causes. Skeletal muscle classification - characteristics of individual types of muscle fibers. Factors determining the force of contraction: initial fiber length, summation, recruitment.

Mechanics of isotonic and isometric contraction. The load-velocity relationship in skeletal muscles. Causes of skeletal muscle dysfunction - examples.

Smooth muscles - classification according to localization, contraction pattern, communication with neighboring cells. Structure of smooth muscles. Molecular mechanism of contraction and relaxation.

Smooth muscles with unstable membrane potential. Characteristics of smooth muscles that distinguish them from skeletal muscles. Chemical factors influencing smooth muscle function.

Clinical Issue: Tetanus.

10. Hormones /15-16.12.2021/

Hormone - definition, cellular mechanism of its action. Classification of hormones. Control of hormones secretion: metabolic, nervous and hormonal regulation. Neurohormones - definition, main groups. Hypothalamic - pituitary – endocrine gland pathway. Long and short feedback loops in the regulation of hormone secretion.

Hormonal interactions: synergism, antagonism, permissiveness.

Disturbances in hormone secretion: hypersecretion, hyposecretion, abnormal tissue response to hormones. Primary and secondary hormone secretion disorders.

Trophic hormones of hypothalamus and anterior pituitary gland.

Adrenal glucocorticoids. Thyroid hormones. Growth hormone.

Bone physiology: functional anatomy of bone tissue, determinants of bone growth.

Calcium - phosphate balance: functions of calcium and phosphates in the body, factors maintaining calcium - phosphate homeostasis.

Parathyroid hormone. Calcitonin, Vitamin D₃ - mechanism of action, regulation of synthesis, deficiency symptoms.

Male and female sex hormones. Menstrual cycle. Hormones secreted during pregnancy.

Childbirth - hormonal control.

Lactation - hormonal regulation.

Clinical Issue: Osteoporosis

11. Metabolism. Body temperature regulation /12-13.01.2022/

Energy balance in the body - ways of energy intake and energy expenditure. Measurement of energy consumed and energy produced.

Metabolism: factors affecting the rate of metabolism, anabolic and catabolic processes, fed - state metabolism and fasted-state metabolism.

Homeostatic control of metabolism: role of insulin and glucagon.

Thermoregulation – normal body temperature and its different values within the human body. Heat gain and heat loss in the body. Homeostatic mechanisms that regulate body temperature. The body's response to changes in ambient temperature.

Clinical issue: Diabetes mellitus: types of diabetes, diagnostic criteria, disorders occurring in diabetes.

12. Partial test 3. Practical skills test /19- 20.01.2022/

13. Practical skills test /26-27.01.2022/

Lectures (all lectures are held remotely on ZOOM platform):

Monday at 8:00 am – 9:30 am

1. /4.10.21/ Introductory lecture. Homeostasis.
2. /11.10.21/ Nervous system - introduction.
3. /18.10.21/ Nervous system – sensory systems.
4. /25.10.21/ Nervous system – senses.
5. /8.11.21/ Nervous system – control of body movement.
6. /15.11.21/ Nervous system – brain activity.
7. /22.11.21/ Nervous system – autonomic nervous system ANS.
8. /29.11.21/ Muscles.
9. /6.12.21/ Hormones – hypothalamus, pituitary gland.
10. /13.12.21/ Hormones – thyroid gland, glucocorticoids, PTH, calcitonin.
11. /20.12.21/ Development and reproduction.
12. /10.01.22/ Metabolism (insulin/glucagon). Body temperature regulation.