Manual

Cellular Physiology

**Lesson 1,2 Сell structure. Transport across Cell Membranes**

**Issues for consideration.**

1. Volume and composition of body fluids. Distribution of water in the body fluid compartments. Composition of body fluid compartments.
2. Characteristics of cell membranes. Phospholipid component of cell membranes. Protein component of cell membranes.
3. Transport across cell membranes. Simple diffusion. Facilitated diffusion. Primary active transport. Secondary active transport. Osmosis.

**Home work (writing)**

1. List the major body fluid compartments.
2. Fill in the table: Approximate Compositions of Extracellular and Intracellular Fluids

|  |  |  |
| --- | --- | --- |
| **Substance and Units** | **Extracellular Fluid** | **Intracellular Fluid\*** |
| Na+ (mEq/L) |  |  |
| K+ (mEq/L) |  |  |
| Ca2+, ionized (mEq/L) |  |  |
| Cl- (mEq/L) |  |  |
| HCO3- (mEq/L) |  |  |
| pH‡ |  |  |
| Osmolarity (mOsm/L) |  |  |

1. Draw the cytoplasmic membrane and mark its basic elements
2. List types of mechanisms are responsible for transport of substances across cell membranes
3. Explain the term "simple diffusion"
4. List variables that affect the rate of diffusion of non-electrolytes
5. Explain the meaning of "facilitated diffusion"
6. Explain the meaning of “primary active transport”. Give examples
7. Explain the meaning of “secondary active transport”. Give examples
8. Give a definition of osmosis

**Practical work**

1. Simple diffusion

2. Facilitated diffusion

3. Simulating osmotic pressure

4. Simulating filtration

5. Simulating active transport

**Lesson 3 General physiology of excitable cells. Resting Membrane Potential. Action Potentials.**

**Issues for consideration.**

1. Diffusion potentials and equilibrium potentials. Ion channels. Diffusion potentials. Equilibrium potentials. Nernst equation.
2. Resting membrane potential.
3. Action potentials. Terminology. Characteristics of action potentials.
4. Ionic basis of the action potential. The nerve Na+ channel .
5. Refractory periods. Absolute refractory period. Relative refractory period. Accommodation
6. Propagation of action potentials. Conduction velocity. Changes in conduction velocity

**Home work (writing)**

1. Name and describe the types of ion channels.
2. Give a definition of the diffusion potential?
3. Give a definition the equilibrium potential?
4. Write the Nernst equation and typical values for equilibrium potential for common ions (Na+,Ca2+, K+, Cl-), calculated and assuming typical concentration gradients across cell membranes.
5. Give a definition of the resting membrane potential? What is the average resting membrane potential of excitable cells?
6. Give a definition of the action potential.
7. List characteristics of action potentials.
8. Draw and label the action potential Time course of voltage and conductance changes (Na+, K+) during the action potential of nerve.
9. Draw voltage-gated Na+ channel and draw how the state of the channel gate in the generation of an action potential.
10. Give a definition of absolute refractory period, relative refractory period and accommodation.

**Practical work**

1. Electrical stimulation. Mechanical stimulation
2. Thermal stimulation
3. Chemical stimulation

**Lesson 4 Cell signaling. Synaptic and Neuromuscular Transmission**

**Issues for consideration.**

1. Cell receptors and their properties. Сlassification of cell receptors (for localization and mechanism). Regulation of the amount of cellular receptors (up- and down-regulation)
2. Primary and second messengers. G proteins. Adenylyl cyclase mechanism. Phospholipase C mechanism. Steroid and thyroid hormone mechanism
3. Synaptic and neuromuscular transmission. Types of synapses.
4. Neuromuscular junction-example of a chemical synapse.
5. Types of synaptic arrangements.
6. Synaptic input-excitatory and inhibitory postsynaptic potentials.
7. Integration of synaptic information. Neurotransmitters.

**Home work (writing)**

1. Ways of Signals relayed between cells
2. Stages of Cell Signaling
3. Cell Communication Systems with Surface Receptors
4. Cell Communication Systems. Intracellular Receptors
5. Give the definition of the concept of a cellular receptor
6. List types of Receptors in the Plasma Membrane
7. Give the definition of primary and secondary messengers
8. List the second messengers
9. Draw a diagram of the transmission signal of G-receptor.
10. Give the definition of synapse.
11. Give the classification of synapses.
12. Draw a chemical synapse, and show the main steps of synaptic transmission.
13. Draw graphics EPSP and IPSP.
14. List the excitatory and inhibitory neurotransmitters

**Practical work**

1. Localization of fatigue in neuromuscular preparation
2. Violation of excitation transfer in the neuromuscular junction
3. Testing the Effects of Curare

**Lesson 5 Nerve cell physiology. Propagation of action potentials.**

**Issues for consideration.**

1. Morphofunctional characteristic of nerve cells.
2. Propagation of action potentials. Spread of depolarization down a nerve fiber by local currents.
3. Conduction velocity. Cable properties. Time constant. Membrane resistance. Membrane capacitance. Length constant
4. Changes in conduction velocity from nerve diameter, myelination. Saltatory conduction

Integration of synaptic information. Spatial summation. Temporal summation.

**Home work (writing)**

1. Draw a neuron, specify the major structural elements, list the physiological properties of the neuron.
2. What is time constant (τ)?
3. What is length constant (λ)?
4. Draw a spread of depolarization down a nerve fiber by local currents.
5. Explain the terms: spatial summation, temporal summation.

**Practical work**

1. Testing the Effects of Ether
2. Testing the Effects of Lidocaine
3. Measuring Nerve Conduction Velocity

**Lesson 6 Skeletal Muscle**

**Issues for consideration.**

1. Muscle filaments. Structure of thick and thin filaments of skeletal muscle. Transverse Tubules and the Sarcoplasmic Reticulum
2. Excitation-contraction coupling in skeletal muscle. Temporal sequence of events in excitation-contraction coupling in skeletal muscle. Steps of excitation-contraction
3. Mechanism of tetanus. Length-tension relationship in skeletal muscle. Passive tension. Total tension. Active tension. Force-velocity relationship.

**Home work (writing)**

1. List the types of muscles and their basic physiological properties.
2. List the types of muscle contractions and define it.
3. Draw a sarcomere and label its major parts
4. List the steps involved in excitation-contraction coupling in skeletal muscle
5. Define tetanus and write it the main types
6. Explain the mechanism of tetanus
7. Draw a graph Length-tension relationship in skeletal muscle.
8. Define motor unit

**Practical work**

1. Single stimulus
2. Identifying the latent period
3. Identifying the threshold voltage
4. Effect of increases in stimulus intensity
5. Treppe (staircase phenomenon)

**Lesson 7 Smooth Muscle.**

**Issues for consideration.**

1. Types of smooth muscle. Unitary smooth muscle. Multiunit smooth muscle
2. Excitation-contraction coupling in smooth muscle. Steps in excitation-contraction coupling in smooth muscle
3. Mechanisms that increase intracellular Ca2+ concentration in smooth muscle

**Home work (writing)**

1. List and describe the types of smooth muscle
2. List and describe the steps in excitation-contraction coupling in smooth muscle
3. List the mechanisms that increase intracellular Ca2+ concentration in smooth muscle

**Practical work**

1. Summation
2. Tetanus
3. Fatigue
4. Isometric Contractions
5. Isotonic Contractions

**Lesson 8** Exam on the Cellular Physiology

stages:

1.PC testing (50 questions)

2. Written work (10 questions)

the minimum passing result is 70% for the PC test and 70% for the written work