

Learning Objectives: ANP1105

2. Cellular Physiology of Nerve and Muscle (5 lectures)

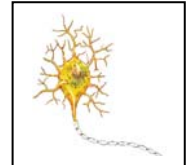


Fig. 11.4; Marieb & Hoehn. 2007

2.1. Membrane Transport

- 2.1.1. Describe the structure of the plasma membrane
 - 2.1.1.1. Summarize the main features of the fluid mosaic model of plasma membrane structure making use of the following terms: phospholipid bilayer, hydrophilic, hydrophobic
 - 2.1.1.2. Associate functions with each of the following plasma membrane components: peripheral proteins, integral membrane proteins, cytoskeleton, glycocalyx, cholesterol
 - 2.1.1.3. Distinguish (structurally and functionally) between: tight junctions, desmosomes, gap junctions
 - 2.1.1.4. List 4 functions of plasma membranes
- 2.1.2. Describe and differentiate among the various types of transport across the plasma membrane
 - 2.1.2.1. List 4 types of passive transport mechanisms
 - 2.1.2.2. Define diffusion and indicate how diffusion is influenced by gradient slope, molecule size and temperature
 - 2.1.2.3. Describe the mechanism of simple diffusion across the plasma membrane for lipid-soluble versus lipid-insoluble small molecules (give examples of each)
 - 2.1.2.4. Describe the process of facilitated diffusion, using a physiological example; list 4 characteristics of this transport mechanism
 - 2.1.2.5. Distinguish between primary and active secondary transport, giving a physiological example of each; indicate the main differences between active and passive transport; differentiate between a symport and an antiport
 - 2.1.2.6. Define: exocytosis, endocytosis (as active transport mechanisms)
- 2.1.3. Describe osmosis and explain its role in fluid homeostasis
 - 2.1.3.1. Define osmosis; distinguish between osmolarity and tonicity in terms of effects on cell volume
 - 2.1.3.2. Distinguish between pairs of solutions that are: isotonic, hypertonic or hypotonic

2.2. Neurons

- 2.2.1. Identify the different regions of the neuron and associate each region with the functions of reception, propagation and transmission of nerve impulses
 - 2.2.1.1. Justify 3 special properties of neurons that set them apart from most other cells in the body
 - 2.2.1.2. Referring to Fig. 11.4, label and indicate the functions of the receptive, conducting and secretory regions of the neuron
 - 2.2.1.3. Distinguish between the central (CNS) and peripheral (PNS) nervous systems; differentiate between a nucleus and a ganglion in the CNS vs PNS; define: dendrite, axon, axonal terminal, telodendria, tract, nerve, axon hillock
 - 2.2.1.4. Distinguish between anterograde and retrograde transport
- 2.2.2. Explain the phenomena (diffusion of ions, types of ion channels) that are responsible for the electrical activity of neurons (resting membrane potential and action potential)
 - 2.2.2.1. Describe the resting membrane potential (RMP) of an excitable cell in terms of the differential permeability of the cell membrane to Na^+ and K^+ ions; indicate which of these ions is primarily found inside cells and which is found primarily in the ECF
 - 2.2.2.2. Describe the Na^+/K^+ ATPase in terms of its role in maintaining the RMP of a neuron
 - 2.2.2.3. Define electrochemical gradient and indicate which of the two above positive ions has its passive diffusion enhanced by the charge gradient and which has it inhibited

- 2.2.2.4. Distinguish between passive (leakage) and active (gated) channels; list and describe the functioning of the 2 types of gated channels
- 2.2.2.5. Distinguish between depolarization and hyperpolarization
- 2.2.2.6. Describe and graph a typical action potential, illustrating the 3 consecutive, overlapping changes in membrane permeability to specific ions; define: threshold, hyperpolarization undershoot, absolute refractory period, relative refractory period
- 2.2.3. Describe the factors that influence propagation of the action potential along an axon
 - 2.2.3.1. Justify the unidirectional propagation of an action potential and the description of an action potential as an “all-or-none” event; indicate how stimulus intensity is coded in the production of action potentials
 - 2.2.3.2. Describe the production of myelin sheaths round peripheral neurons and indicate their role in action potential propagation; define: Schwann cell, node of Ranvier, saltatory conduction, oligodendrocytes, multiple sclerosis as a disease affecting the myelin sheath
- 2.2.4. Explain the mechanisms of synaptic transmission (synapse, post-synaptic potentials, synaptic integration)
 - 2.2.4.1. Differentiate between electrical and chemical synapses in terms of relative frequencies, distributions, mechanisms, speed and properties of inter-neuron communication
 - 2.2.4.2. Illustrate and describe the main features of chemical synaptic transmission; briefly describe 3 means by which chemical synaptic transmission can be terminated
 - 2.2.4.3. Define synaptic delay
 - 2.2.4.4. Distinguish between excitatory and inhibitory postsynaptic potentials (EPSPs and IPSPs) in terms of channels opened and end-results in terms of membrane potential/ease of generating an action potential
 - 2.2.4.5. Define (in terms of EPSPs and IPSPs): temporal summation, spatial summation; justify the role of the axon hillock as the “neural intergrator”

2.3. Muscles

- 2.3.1. Describe the microscopic structure of skeletal muscle fibers and explain the cellular mechanisms of excitation-contraction coupling
 - 2.3.1.1. In table form, compare and contrast skeletal, smooth and cardiac muscles
 - 2.3.1.2. List & briefly describe 4 muscle functions as well as 4 functional characteristics of muscle
 - 2.3.1.3. Describe the microscopic anatomy of a typical skeletal muscle fiber; define: sarcolemma, sarcoplasm, myoglobin, myofibril, sarcoplasmic reticulum, T-tubule, actin, myosin, A band, I band, Z disc, H zone, M line
 - 2.3.1.4. Differentiate between endomysium, perimysium and epimysium
 - 2.3.1.5. Differentiate between G-actin and F-actin; describe the roles of tropomyosin and troponin in permitting crossbridge attachment
 - 2.3.1.6. Delineate the role of the T-tubule and sarcoplasmic reticulum system in facilitating the synchronized contractile response of a single skeletal muscle cell
 - 2.3.1.7. Describe the sliding filament mechanism of skeletal muscle contraction, indicating the roles of Ca^{++} and ATP in this process; your description should include an indication of how muscle relaxation occurs
- 2.3.2. Describe the neuromuscular junction
 - 2.3.2.1. Describe the structural organization of the neuromuscular junction; justify the latent period of excitation-contraction coupling
- 2.3.3. Describe the contractile properties of skeletal muscle (motor unit, isotonic & isometric contractions, spatial & temporal summation, etc)
 - 2.3.3.1. Define motor unit; describe the influences of wave summation and motor unit summation on the contractile response of skeletal muscle; define tetanus in terms of muscular contraction

- 2.3.3.2. Differentiate between isotonic and isometric contractions, giving an example of each
- 2.3.3.3. Define the optimal length-tension relationship for muscle in terms of muscle anatomy
- 2.3.3.4. Indicate the influence of load on the velocity and duration of skeletal muscle contraction
- 2.3.4. Associate various muscle types with their metabolism and their speed of contraction and rate of fatigue
 - 2.3.4.1. List the 4 sources of energy for muscle contraction and the conditions under which each energy source would be used
 - 2.3.4.2. Define muscle fatigue
- 2.3.5. Compare the properties of smooth muscle with those of skeletal muscle
 - 2.3.5.1. Compare and contrast the structural organization as well as the contractile response of smooth muscle with that of skeletal muscle
 - 2.3.5.2. Distinguish between single-unit and multiunit smooth muscle in terms of prevalence, mechanism of stimulation, special features of the contractile response