

Objectives: The student shall know the facts, understand the concepts, and be able to deduce the consequences for each of the following:

MEMBRANE TRANSPORT & MEMBRANE POTENTIAL

Distribution of Na⁺, K⁺, Cl⁻, glucose, and protein in interstitial and intracellular fluids

Sign and magnitude of the resting potential in mammalian nerve and skeletal muscle cells

Factors determining transport rate across biological membranes

Definitions of permeability and net driving force

Mechanism, permeability, selectivity, characteristics and roles of each of the following modes of membrane transport:

Dissolve in the lipid bilayer

Simple diffusion through membrane channels

Facilitated diffusion; uniport, symport, antiport

Active transport (primary & secondary); application to the resting neuron membrane and intestinal absorption of sodium, glucose, and water

Water transport; definitions of solution osmolarity and tonicity

Vesicular transport; endocytosis and exocytosis

Components of electrochemical (passive) driving force for membrane movement

Factors that determine the ion distribution and resting membrane potential of neurons and the relative contribution of each

EXCITABILITY & ACTION POTENTIALS

Components of neurons and their function(s)

Definitions of nerves, tracts, ganglia, and nuclei

Response of excitable tissue to depolarizing stimuli

Action Potential characteristics: shape and timing, threshold, all-or-none, refractory period, ion movements

Ion channels associated with the action potential and how their properties determine the action potential characteristics

Ionic basis of the action potential shape, threshold, and refractory period

Role of active transport in excitable tissue

Action potential (AP) propagation (conduction) in unmyelinated and myelinated axons; saltatory conduction

Speed of AP conduction and factors determining its value

Alterations in action potential propagation: action of local anesthetics, effect interstitial K⁺ concentration, effect of demyelination diseases

MEMBRANE TRANSPORT through AUDITORY SYSTEM

NEUROMUSCULAR TRANSMISSION (Skeletal Muscle)

Mechanisms of synaptic transmission

Functional anatomy of the nerve-skeletal muscle junction; motor endplate region

Steps in the transmission of excitation from the axon terminal to the muscle fiber membrane; neurotransmitter and receptor involved

Characteristics of the endplate potential (epp)

Termination of excitation

Relation between number of nerve APs and muscle cell APs

Control of skeletal muscle contraction by the nervous system

Mechanism of action of agents and conditions affecting neuromuscular transmission: botulinum toxin (Botax), curare, myasthenia gravis, depolarizing blockers, nerve gas, myotonia

SKELETAL MUSCLE

Characteristics of muscle contraction: isometric, isotonic, intermediate, twitch, summation, fusion & tetanus; shape and duration of contraction

Functional anatomy of skeletal muscle: fibers, sarcolemma, myofibril, sarcomere, filaments, striations and bands, transverse tubules, sarcoplasmic reticulum; basis of striations

Sliding filament model; role of myosin, actin troponin, tropomyosin, ATP, calcium

Sequence of contraction events

Cellular basis of muscle twitches, summation, tetanus

Classes of muscle fibers (fast, slow, glycolytic, oxidative) and their characteristics (speed, force, color, myoglobin content, energy source, vascularization, fatigue resistance, role)

Determination of maximum muscle force: size, length

Motor unit: definition, innervation ratio, recruitment pattern

Effect of training and aging

Pathophysiology: muscular dystrophy, disuse atrophy, rigor mortis

SENSORY RECEPTORS

Transducer function and general sequence of stimulus => action potentials; adequate stimulus and sensory receptor classification

Generator potential: define, characteristics, ionic basis

Mechanism of repetitive discharge, determination of firing rate

Adaptation: define, rapidly and slowly adapting receptors

MEMBRANE TRANSPORT through AUDITORY SYSTEM

SYNAPTIC TRANSMISSION

Chemical mediated and electrical synapses

Functional anatomy of synapses; convergence and divergence; axon hillock (initial segment)

General properties of chemical mediated synapses

Resting postsynaptic membrane potential & ion movements

Sequence of synaptic transmission; ionotropic & metabotropic synapses

Excitatory synapse: ion channels, EPSP characteristics, postsynaptic cell action potential, role of the initial segment (axon hillock)

Inhibitory synapse: postsynaptic inhibition, ion channels, IPSP characteristics, interaction with EPSPs

Inhibitory synapse: presynaptic inhibition mechanism

Synaptic transmitters and receptors (general characteristics)

Integration of synaptic transmission

SPINAL REFLEX

Anatomical elements of spinal reflexes

Characteristics of spinal reflexes

Flexion-crossed extension reflex: stimulus, response, pathway, role

Skeletal muscle sensory structures: muscle spindles, intrafusal fibers, afferent endings, gamma efferent system, Golgi tendon organs, proprioceptors

Response of muscle spindle sensory endings and Golgi tendon organs to muscle lengthening/shortening and to muscle tension

Stretch (myotatic) reflex: stimulus, response, pathway, role; tendon tap reflex; hyper- and hyporeflexia, clonus

Role of the gamma efferent system

Inverse myotatic (claspknife) reflex: stimulus, response, pathway, role

MEMBRANE TRANSPORT through AUDITORY SYSTEM

AUTONOMIC NERVOUS SYSTEM

Compare and contrast Somatic Nervous System and Autonomic Nervous System with respect to the following:

- Organs innervated
- Action (excitatory or inhibitory)
- Voluntary control
- Efferent (motor) pathways
- Effect of denervation

Compare and contrast the Sympathetic and Parasympathetic nervous systems with respect to the following:

- Efferent (motor) pathway
- Ganglionic and neuroeffector transmitters
- Adrenal medulla innervation, secretions
- Role in normal function
- Sequence of autonomic activation & inhibition
- Cholinergic and adrenergic synapses
- Effects on the eye, heart, vascular system, alimentary tract, skin, liver, and salivary glands

Autonomic receptors

- Normal agonists
- Nicotinic, muscarinic, alpha-1, beta-1, beta-2 receptors: locations, agonists and antagonists, agonist actions

SOMATIC SENSATION

Sequence: stimulus => conscious sensation; 1st, 2nd, etc. order neurons

Modality: definition and basis; adequate stimuli and receptor classification

Intensity and time course

- Role of firing frequency and recruitment
- Adaptation: define and effect on perceived intensity
- Sensitization and modulation/gating

Localization

- Basis, projection, receptive field
- Acuity: define, determinants

Affect: define, basis

Origin, characteristics, and modalities of somatic sensation

Mechanosensation endings and fiber types

- Acuity, two-point threshold
- Tactile information input

Thermoreceptor types and temperature sensitivities

- Adaptation properties of thermoreceptors
- Thermal sensation at high and low temperatures

Visceral sensation characteristics

SOMATIC SENSATION (continued)

Somatosensory pathways

Peripheral nerve regeneration

Peripheral nerve fields

Dermatome: define & characteristics

Dorsal column & anterolateral ascending divisions
Spinal cord pathways & effects of spinal cord lesions
Modalities subserved

Primary sensory cortex location and organization

PAIN

Modality

Endings and characteristics

Adequate stimuli

Stimulus-response mechanisms

Subtypes: "fast" and "slow" pain

Localization acuity

Referred pain

Pain intensity modulation; opioid peptides and opioid receptors; peripheral and central modulation

Adaptation and sensitization

Pain-induced reflexes

AUDITION (HEARING)

Sound parameters, loudness units, masking

Hearing frequency range, audiogram

Sequence for sound wave transmission to the cochlea; role of tympanic membrane, middle ear ossicles, tympanic reflex

Normal conduction, air conduction, and bone conduction; classification of deafness

Cochlear structure: basilar membrane, organ of Corti, hair cells, tectorial membrane, fluid compartments, auditory (cochlear) nerve axons

Basilar membrane vibration and traveling waves; inner and outer hair cell function

Determination of pitch and loudness

Auditory cortex, location and organization

Efferent nerve connections to the cochlea