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Compendium of Physiology

Physiology of nervous system

67. The importance and the regulatory role of nervous system

- Unicellular versus multicellular organisms, compartmentalization
- Nervous system essential for multicellular organisms
 - Homeostasis maintenance
 - Bodily functions coordinations
- Regulation
 - Definition
 - Nervous vs. humoral
- Regulation vs. anticipation

68. Cellular base of nervous system

- Neuroglial cells
 - Classification and function overview
- Neuronal cells
 - Characterization, classification, anatomy
 - Functions of neurons
 - Maintenance activity (cytoplasm)
 - Synthesis (soma)
 - Transport (categorization, characterization)
 - Information processing and transmission (membrane)

69. Intracranial compartment, intracranial pressure

- Content of intracranial compartment
 - Brain
 - Blood
 - CSF
- Barriers among compartments
 - Meningeal
 - Hematoencephalic
 - Hematoliquor
- CSF
 - Function
 - Production, circulation, absorption
- Circumventricular organs
 - Definition, classification
- Intracranial pressure
 - Definition, equation, implications

70. Membrane voltage, action potential – generation and propagation through nerve fibers

- Membrane potentials in neurons
 - Resting potential (ionic mechanisms)
 - Action potential (ionic changes, localization)
- Signal conduction
 - Role of myelin, saltatory conduction
 - Classification of nerve fibres

71. Structure of synapse and integration of information on the synaptic level, neurotransmission vs. neuromodulation

- Synapse
 - Definition
 - Electrical vs. chemical
- Definition and basic classifications of neurotransmitters
- Excitatory/inhibitory postsynaptic potentials vs. action potential
 - Temporal and spatial signal summation
- Signal convergence vs. divergence
- Neurotransmission vs. neuromodulation
 - Examples of neuromodulatory systems

72. Receptors, receptor potential vs. action potential, receptive field

- Receptor definition (energy converter)
- Receptor potential vs. Action potential
 - RP – analogue (amplitude), AP – digital (frequency)
 - RP – different ionic mechanisms, AP - Na-K based
- Basic attributes of stimulus
 - Modality, localization, intensity, duration
 - The law of specific nerve energies (labeled line coding)
- Receptive field
 - Definition
 - Examples of large and small receptive fields, association with resolution
 - Lateral inhibition
 - Receptor adaptation (tonic and phasic response)
- Various classifications of receptors
 - Brief overview of the skin receptors

73. Basic functional comparison of somatosensitivity, viscerosensitivity and proprioception, the importance of sensitivity for immediate and long-term survival

- Somatosensitivity vs. viscerosensitivity vs. proprioception
 - Definition, functional comparison
- Brief overview of proprioception
 - Muscle spindles vs. Golgi tendon organs (Motor system I)
- Somatosensory pathways (three systems)
 - Function/resolution
 - Importance for survival (i.e. pain for immediate, proprioception for better adaptation)

74. Pain

- Definition of pain
- Classification of pain (physiological, pathological, acute, chronic)
- Somatosensory pathways involved in pain perception
 - Fast vs. slow pain
- Pain modulation
 - Overview of structures involved in pain modulation
 - Gate control theory
- Referred pain vs. phantom limb pain

75. The basic physiology of olfactory and gustatory system – brief characterization of the modality, basic information about signal detection and processing

- Chemical senses – detection of chemicals dissolved in air/saliva
- Olfaction and gustation are interconnected
- Evolutionary old – olfaction influenced neocortex evolution
- Analysis of odors requires memory and “advanced” information processing
- Basic overview of human olfactory and gustatory systems
 - Main characteristics of olfaction and taste in human
 - Human is microolfactoric...
 - Mention examples of some smell types
 - List taste types
 - Structure of olfactory epithelium
 - Mechanism of signal transduction
 - Brain structures associated with olfaction

76. The basic physiology of auditory and vestibular system – brief characterization of the modality, basic information about signal detection and processing

- The auditory and vestibular systems are interconnected by similar mechanisms of reception (“hair cells” activated by mechanical stimuli)
- Auditory system
 - Brief characteristic of sound
 - Overview of ear anatomy and physiology
 - Middle ear more in details
 - Inner ear in details (anatomy, hair cells categorization and function...)
 - Main structures involved in signal processing and source localization
- Vestibular system
- Overview of anatomy with respect to function (detection of position, linear and angular acceleration)
- Main projections from vestibular nuclei
- Nystagmus (presentation Vision II)

77. The basic physiology of visual system – light detection vs. image formation, circadian rhythms

- Brief characterization of light
- Functional overview of eye anatomy (camera obscura with a lens)
- Light detection (LD) vs. image formation (IF)
- LD - almost all the living organisms
 - one of the oldest functions
 - long evolution = long period of improvement – IF development
 - mainly for circadian activity synchronization
- Circadian rhythms
- Definition + importance
- Biological clock (cellular level, tissue level, central pacemaker)
- Brief overview of circadian rhythms in humans (“active” hours, “rest” hours, physiological changes, associated hormone oscillations...)

78. The basic physiology of visual system – rods and cones function, on/off receptive field, nervus opticus vs. tractus opticus

- Rods and cons function
 - Characterization and comparison
 - Phototransduction mechanism and adaptation
- Brief overview of retina organization (retina process receptor potential – analog, AP is generated in ganglion cells)
- Receptive field organization
 - On/off receptive fields
 - Magnocellular system (BW)
 - Parvocellular system (Color)
- Nervus opticus vs. tractus opticus
- Projections from tractus opticus (Main centers in the brain involved in visual signals processing)

79. Upper and lower motor neuron, neuromuscular junction, muscle contraction

- Upper and lower motor neuron localization and function
- Lower motor neuron
 - Only the structure responsible for muscle contraction
 - Part of local reflex circuit
 - Overview of structures and main pathways controlling lower motor neuron (proprioception, higher levels of CNS including upper motor neuron, medial system, lateral system tr. corticospinalis, corticobulbaris...)
 - Types of lower motor neurons (alpha, gamma, beta)
- Upper motor neuron
 - Primary motor cortex, homunculus
- Motor unit definition
- Neuromuscular junction description

80. Hierarchic organization of motor system – reflex vs. voluntary motor activity

- Hierarchy of movement
 - Reflex – economical, uniform, protective, fast
 - Rhythmic – economical solution for complex uniform actions (breathing, walking...)
 - Voluntary – non-economical, unique, relatively slow
- Classification and description of reflexes
- Fixed action pattern and rhythmic movement (definition and examples)
- Voluntary motor control
 - Overview of structures involved in planning and execution of voluntary motor activity
 - Motor cortex organization (primary, premotor and supplementary motor cortex...)
 - Brief description of pyramidal tract

81. The basic functions of basal ganglia

- Brief description of basal ganglia function (loops, motor, non-motor)
- Overview of basal ganglia nuclei and the connections
- Description of direct and indirect pathway

82. The basic division and functions of autonomic nervous system

- Definition of autonomic nervous system
- Somatic and autonomic nervous system comparison (function, synapsereflex circuit...)
- Comparison of sympathetic and parasympathetic division
- Basic characteristics of neurotransmitter and receptor systems (description of autonomic innervation of particular systems is covered in each organ system separately)
- Examples of brain centers controlling the autonomic nervous system (both in hypothalamus, brain stem...)
- Role of hypothalamus in essential regulations
- Brief characterization of enteric nervous system and its specifics

83. The importance of limbic system and brief characterization of basic functions – somatic and limbic arousal systems, sleep and wakefulness

- Concept, definition and structures of limbic system
 - Integration of information from inner and outer environment
 - Hypothalamus is a central structure...
- Somatic vs. limbic arousal system
- Habituation, association with reward punishing system, connections...
- Sleep/wakefulness – cooperation of somatic and limbic activation system via neuromodulation
- Phases of sleep, basic EEG characteristics

84. The importance of limbic system and brief characterization of basic functions – learning and memory, the influence of hypothalamus on neocortex, the role of amygdala

- Concept, definition and structures of limbic system
 - Integration of information from inner and outer environment
 - Hypothalamus is a central structure...
 - Brief overview of hypothalamic functions
 - Influence of hypothalamus on neocortex
- Learning and memory
 - Learning is based on plasticity, learning is forming of long-term memory
 - Explicit memory – hippocampus
 - Implicit memory - striatum
- Amygdala
 - Influence of information from outside (neocortex) on limbic system
 - Amygdal hijack, affective tags

85. The basic characterization of neocortical functions – primary vs. association areas, topographical overview of cortical functions

- Neocortex – majority of cerebral cortex - 95% (Paelo 1%, Archi 4%...)
- Basic overview of neocortical cytoarchitecture (6 layers, specific inputs/outputs to from each layer, both vertical and horizontal connections, local differences - Brodman)
- Definition and comparison of primary and association areas
 - Somatotopic vs. non-somatotopic
 - Unimodal and polymodal association areas
- Topographical overview of cortical functions (localization and function)
 - Primary areas (motor, somatosensory....)
 - Association (...Parietooccipital – „analytic“, frontal – „executive“, limbic – not a neocortex, but from functional point of view it is a regular and the most important association area – integration of information from inner and outer environment, neocortex is overridden by hypothalamus)
 - Lateralization of brain functions

86. The basic characterization of neocortical functions – language and social brain, basic overview of functional diagnostic methods used in neurology

- Communication and language
 - Language areas – localization and function including lobulus parietalis inferior, aphasia...
 - Lateralization of language functions, gender differences
- Social brain
 - Human is a social being, so the brain has to be designed accordingly
 - Frontal lobe – behavioral control....
- Functional diagnostic methods (EEG, SPECT, PET , fMRI)

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