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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)
      - Synhtesis (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 convergendce vs. divergence
- Neurotransmission vs. neuromodulation
  - Examples of neruomodulatory 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 mechansims, 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

- Somatosensitivty vs. viscerosensitivty vs. proprioception
  - Definition, fuctional 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, proprioceptirn 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
- Olfaciton 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

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# 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 fucnction (detection of position, linear and angular acceleration)
- Main projections from vestibular nuclei
- Nystagmus (presentation Vision II)

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# 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 rhytms in humans (“active”hours, “rest” hours, physiological changes, associated hormone oscilations…)

# 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 – nalog, AP is generated in ganglion cells)
- Reeptive 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 (protprioception, higher leves of CNS including upper motor neuron, medial system, lateral system tr. corticospinalis, sorticobulbaris…)
  - Types of lower motor neurons (alpha, gamma, beta)
- Upper motor neuron
  - Primary motor cortex, homunculus
- Motor unit definition
- Neuromuscular junction descrition

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

- Hierarchy of movement
  - Reflex – economical, uniform, protective, fast
  - Rhytmic – 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 supplementray motro 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 conncetions
- 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 charateristics of neurotransmitter and receptor systems (description of autonomic inervation 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 environemnt
  - 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 environemnt
  - 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

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# 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
  - Somathotopic vs. non-somathotopic
  - Unimodal and polymodal association areas
- Toppographical overview of cortical functions (localization and fuction)
  - Primary areas (motor, somatosensory….)
  - Association (…Parietooccipital – „analytic“, frontal – „executive“, limbic – not a neokortex, but from functional point of view it is a regullar and the most important association area – integration of information from inner and outer environment, neocortex is overrided by hypothalamus)
  - Lateralization of brain functions

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# 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 fuctuion including lobulus parietalis inferior, aphasia…
  - Lateralization of language functions, gender differences
- Social brain
  - Human is a social beeing, so the brain has to be designed accordingly
  - Frontal lobe – behavioral control….
- Functional diagnostic methods (EEG, SPECT, PET , fMRI)

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