Syllabus of Physiology

Cellular membrane physiology

- Ion distribution in the cell membrane
- Transmembrane transport mechanisms
- Ion membrane channels
- Ion transport in excitatory cells

Mechanisms of membrane transport

- Ion distribution in epithelial cells
- Transport mechanisms in epithelial cells
- Mechanisms of secretion in epithelial cells

Physiology of body fluids

- Definition of water and solutes intake and output
- Body fluid compartments
- Development of body fluid compartments
- Measurement of body fluid compartments
Regulation of body fluids
composition
volume
Thirst

**Renal physiology**

Functional morphology of nephron

Renal blood flow
measurement
regulation

Glomerular filtration
functional properties of glomerular membrane
factors determining transport
glomerular filtrate
composition
volume
glomerular filtration rate
measurement of GFR
filtration fraction
Tubular transport mechanisms

Proximal tubule

Distal tubule

transport of solutes

transport of urea

transport of amino acids

transport of glucose

measurement of tubular transport mechanisms

regulation of tubular transport mechanisms

Glomerulotubular balance

Concentration of urine

function of loop of Henle

concentration gradient in medulla

function of the collecting duct

regulation of concentration and dilution mechanisms

measurements
Urine

composition

diuresis

Kidney and regulation of body fluids

Role of kidney in regulation of acid base status

tubular mechanism of transport of

proton

bicarbonate

buffer mechanisms in urine

Function of urinary bladder

transport of urine in the urethra

intrinsic mechanism of regulation of SM in urinary bladder

neural control of urinary bladder

mechanism and regulation of micturition

Circulation
Transport function of circulation

Physical basis of blood flow

Function of the heart

Mechanism of heart contraction
- isometric, isotonic contraction
- series and parallel elasticity
- homeometric, heterometric regulation

- preload, afterload
- pressure volume diagram
- volume - velocity curve, dP/dt

Mechanism of heart excitation
- action potential in the heart muscle
  - ion fluxes, channels
- sinus potential
  - ion fluxes
  - generation of rhythm
- spreading of stimulus
  - relative and absolute refractory period
heart rate
   regulation
ECG - origins
   measurement

Cardiac output
   regulation
   measurement
      Fick principle
      dilution methods
      electromagnetic flowmeter

Heart sounds

Heart work

Heart metabolism
   utilization of oxygen
   factors determining oxygen delivery
   coronary blood flow
Peripheral blood vessels

Physical concept of resistance

blood viscosity

resistance - blood flow - pressure

concept of closing pressure

compliance of vessels

arteriole

regulation

autoregulation

shear stress of endothelium

nerves

local factors

endothelial cells

local blood flow and metabolic needs

Blood pressure

systolic, diastolic, mean

determining factors

pressure curves
driving, intravascular and transmural pressures

effect of hydrostatic pressure

syphon effect

function of veins

measurement of blood pressure, catheterization

Capillaries

regulation of blood flow through capillaries

transport of solutes

balance between the capillary and interstitium

edema

lymph flow

Regulation of blood pressure (Prof. Herget)

Blood pressure and regional distribution of blood flow

volume of fluid compartments and

blood pressure

cardiac output
concept of Guyton

kidney - fluid balance - blood pressure

ANF

renin - angiotensin - aldosterone

baroreceptors

blood pressure and vascular morphology

**Lung function**

Lung ventilation

- partial pressure of gas
  - measurement
- gradients of respiratory gases
- concept of alveolar ventilation
  - composition of alveolar air
  - dead spaces
  - Bohr equation

Lung volumes
spirometer
measurement of FRC

Mechanism of inspiration and expiration
interpleural pressure
lung compliance
  pressure volume diagram
  surfactant
  concept of measurement
compliance of thorax wall
lung resistance
  alveolar pressure
  bronchial resistance
    mucus secretion
    regulation of bronchial smooth muscle
    nerves
    local factors
larynx
  concept of measurement of lung resistance
resistance of thorax
Regional pulmonary resistance and compliance

distribution of inspired gas
measurement
regional lung blood flow
matching the blood flow and ventilation
hypoxic pulmonary vasoconstriction
concept of alveolar dead space and venous admixture
Fehn and Rahn diagram
regional lung distribution of V/Q
effect of gravity

Function of pulmonary capillary
l lung diffusion of gases
transfer factor
relation of lung diffusion and V/Q
limitation of diffusion
limitation perfusion
metabolic function of pulmonary capillary
ion and water transport in lungs
Control of breathing

Neural

origin of rhythmicity
regulation of inspiration and expiration
feedback from the lung tissue
feedback from the chest wall
cortical influences
speech

Chemical

carotid and aortic bodies
mechanism of oxygen sensing
effect of hypoxia on lung ventilation
on lung volumes
central chemoreceptors
mechanism of CO2 sensing in central chemoreceptors
interaction of CO2 and O2 in control of breathing
breathing and acid base status
breathing in sleep
breathing in exercise
breathing at high altitude
voluntary apnoe
diving

Reflexes from the lungs
cough

Pulmonary circulation
blood pressures
measurement
compliance of pulmonary blood vessels
causes of low pulmonary vascular resistance
critical closing pressure of lung vessels
effect of gravity
mechanical interaction of breathing and lung blood flow
regulation of pulmonary vascular resistance

Foetal circulation
reconstruction of circulation after the birth
Heart - lung interactions

**Physiology of Blood**

Red blood cells

- production
- formation of haemoglobin
- destruction of red blood cells

Neutrophils and macrophages

- general characteristics
- defensive properties
  - adhesion, adhesive molecules
  - fagocytosis
  - mechanism of activation
- production of
  - ROS
  - enzymes and cytotoxic factors
- physiology of inflammation

Blood groups

- 0 - A - B
Rh transfusion

Hemostasis and blood coagulation

hemostasis

vasoconstriction

formation of platelet plug

coagulation

conversion of prothrombin - thrombin

conversion of fibrinogen - fibrin

formation of prothrombin activator complex

lysis of blood clot, plasmin

concept of procoagulation and anticoagulation balance

**Transport of blood gases**

Transport of oxygen

amount of oxygen in blood

function of hemoglobin

saturation, partial pressure

hemoglobin dissociation curve
adult

foetal

factors influencing oxygen dissociation curve

Types of hypoxia

Transport of carbon dioxide

Henderson - Hasselbalch equation

effects of carbonic anhydrase

forms of CO2 transport in the blood

Interaction of O2 and CO2 transport mechanisms

**Endocrinology**

autocrine, paracrine and endocrine regulations

hormones, types, structure

physiology receptors for hormones

Thyroid gland

hormones
iodine metabolism, trapping
transport of thyroid hormones
metabolism of thyroid hormones
effect of thyroid hormones
ontogenesis
regulation of thyroid secretion

Pancreas
insulin, secretion, metabolism
blood transport
receptors
effects
regulation
glucagon
effects
regulation

Endocrine regulation of carbohydrate metabolism

Adrenal gland
medulla
structure and metabolism of hormones
regulation of secretion
cortex
structure and metabolism of hormones
transport
ACTH
effects of glucocorticoids
role in inflammation
effects of mineralocorticoids
adrenalectomy
concept of stress

Regulation of calcium metabolism
metabolism of Ca and P
physiology of bone
calcitonin
parathormon
regulation of secretion
Vitamin D

Pituitary gland (hypophysis)
overview of pituitary hormones

hormones of the middle lobe

STH

structure, metabolism, regulation

receptors

somatomedins

physiology of growth

Gonads

ontogenetic development

puberty

hypophysial gonadotropins

System renin-angiotensin

erythropoetin

ANP

epiphysis

Physiology of sexual activity

function of male sexual organs
regulation
function of female sexual organs
regulation
menstruation
central regulation of sexual behaviour
physiology of coitus
contraception

**Physiology of energy metabolism and nutrition**

energy metabolism
measurement, RQ
energetic balance
physiology of nutrition
vitamins
minerals

**Physiology of gastrointestinal tract**

Mechanisms of digestion
Regulation of gastrointestinal tract
gastrointestinal hormones
mechanism of swallowing
function of the stomach
  secretion of pepsin
  secretion of HCl
  motility
  regulation of secretion and motility
exocrine secretion of pancreas

small intestine
  secretion
  regulation of secretion
  types of motility
  regulation of motility

large intestine
  resorption mechanisms
  regulation of motility
  defecation

physiology of intestinal immunologic mechanisms
Metabolic function of liver

Bile function and secretion

  Metabolism and excretion of bilirubin

Function and regulation of gallbladder

**Neurophysiology**

Introduction to neurophysiology.

Review of anatomical and histological principles of neurophysiology.

General neurophysiology

The neuron and the glial cell; the blood-brain barrier

Metabolism and nutrition of the neural tissue

Types of neurons (Golgi I and II) and neural circuits

Basic functions of synapses

Review of neurotransmitters and neuromodulators

Ionotropic and metabotropic mechanisms of synaptic transmission

G protein and second messengers

Electrophysiology of the neuron

  The resting membrane potential: Ionic and electric gradients

  Action potentials: Properties of excitable membranes

    The absolute and relative refractory periods
Myelinated nerves - saltatory conduction

Postsynaptic potentials, excitation and inhibition

Generator potentials in receptors

Accommodation of the nerve fibre and adaptation of the receptor

Recording and stimulation of neural cells

Electrical properties of a volume conductor, extracellular recording and stimulation.

EEG, event related potentials, chronaxy, the Pflüger's law.

Reflex and non-reflex activity

Learning and memory

Systemic neurophysiology

General design of the nervous system

The peripheral nervous system

Organization of the central nervous system

Principles of development of the central nervous system

Functions of the spinal cord

Physiology of the brain stem: the medulla, the pons, the mesencephalon

Functions of the thalamus and physiology of pain

Hypothalamus and the autonomic nervous system
Motor functions: The cerebral cortex, the basal ganglia and the cerebellum.
Pyramidal and extrapyramidal systems.

The cerebral cortex and intellectual brain functions

Sleep and wakefulness, modulatory systems of the brain.

Motivation and emotions.

Neurophysiology of vision and hearing.

The chemical senses of taste and hearing

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