

# **Pathological physiology II**

## **Detailed syllabus**

### **General medicine**

**Department of Pathophysiology, Faculty of Medicine in Pilsen, Charles University**

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The subject pathological physiology II follows the subject pathological physiology I. The subject pathological physiology II includes in full extent knowledge and skills of the subject pathological physiology I. Individual topics can be moved between the courses Pathological Physiology I and II.

### **General pathophysiology II**

#### **Stress**

The definition of stress, the concept of general adaptation syndrome and its history

Basic concepts - stress, stressor, eustress, distress

Stress phases

Stress response scheme, mechanisms, roles of components of the stress axes in individual stress phases

Humoral and metabolic changes during the stress response

The importance of stress for the organism

Relation of stress to pathogenesis of disease

Stress diseases - definition, mechanisms of origin, examples

Stress axes disturbances

The relationship between stress and shock

Psychosomatic and behavioral medicine, psychoneuroimmunology

### **Special pathophysiology II**

#### **Pathophysiology of the excretory system**

Assessment of renal function (examination of dilution and concentration function, determination of renal blood flow and glomerular filtration, clearance of important substances)

Anuria, oliguria, polyuria - definitions of terms, causes and mechanisms of their origin

Autoregulation of kidney perfusion and glomerular filtration and its disorders

The role of the kidneys in blood pressure regulation under physiological and pathological conditions

Disorders of kidney perfusion, glomerular and tubular functions – etiology, pathogenesis, consequences

Pathophysiology of acute renal failure

- Prerenal, renal and postrenal causes and their mechanisms

- Oliguric and polyuric form of renal failure and their impact on the organism

Pathophysiology of chronic renal failure

- Causes, pathogenesis, mechanisms of compensation for decreased functional renal capacity, mechanisms of renal failure progression
- Uremic syndrome - pathogenesis, manifestations
- Nephrotic and nephritic syndromes
- Pathophysiology of endocrine functions of the kidneys
- Methods of substitution of renal functions –principle of hemodialysis and peritoneal dialysis, pathophysiology of the dialysis disequilibrium syndrome
- Pathophysiology of inflammatory diseases of the kidneys
- Hemolytic uremic syndrome
- Proteinuria – causes and consequences
- Hematuria and its causes
- Infections of the uropoietic system – risk factors, manifestations and consequences
- Urolithiasis – etiology, risk factors, factors supporting concrement development, consequences
- Obstruction of the urinary tract – causes, consequences, hydronephrosis

### **Pathophysiology of the respiratory system**

Breathing description, process of gas exchange between external environment and the tissue cells, external and internal breathing, basic processes in the lungs (ventilation, diffusion, perfusion) and factors determining them under physiological and pathological conditions

Definitions of basic concepts (hypoxia, hypoxemia, asphyxia, hypercapnia, hypocapnia, dyspnea, orthopnea)

Hypoxic, transport, circulatory and histotoxic hypoxia

- Characteristics of individual types, causes, mechanisms of origin
- Manifestations and consequences, response of the organism, compensatory mechanisms and their efficiency, role of compensatory responses of the organism in pathogenesis of negative consequences of and complications of the primary pathology

Central and peripheral cyanosis - definition, mechanism of origin, factors determining its development

Respiratory insufficiency partial and global - definition, etiology and pathogenesis, mechanisms of changes of respiratory gases

Disorders of lung ventilation

- Characteristics of obstructive and restrictive disorders including spirometric diagnosis
- Description of particular diseases, their etiology and pathogenesis

Disorders of lung diffusion and perfusion

- Relation between ventilation and perfusion and its changes in pathological states
- Description of individual diseases, their etiology, pathogenesis

Disorders of breathing control, disorders of respiratory muscles and their innervation

Pathophysiology of the asthma bronchiale

Pathophysiology of the chronic obstructive pulmonary disease

Pathophysiology of emphysema

Pathophysiology of the acute respiratory distress syndrome

Pathophysiology of altitude sickness

Pathophysiology of the pleural cavity

- Pneumothorax – definition, mechanisms of origin, classification (open, closed and tension pneumothorax), pathogenesis and consequences of individual types
- Hemothorax, hydrothorax, chylothorax

Pathophysiology of the lung edema

Pathophysiology of the lung (pneumonia) and airway (rhinitis, sinusitis, epiglottitis, laryngitis, tracheitis, bronchitis) inflammation

Consequences of aspiration, drowning

Pathophysiology of lung fibrosis

Lung manifestation of the cystic fibrosis

Pathophysiology of the syndrome of sleep apnea

Pathophysiology of symptoms of respiratory diseases and respiratory reflexes (cough, chest pain, dyspnea, cyanosis)

### **Pathophysiology of metabolism**

Homeostasis, its mechanisms and general principles of homeostasis disturbances

Pathophysiology of energetic metabolism, basal metabolism and its changes, excessive and insufficient energetic intake, obesity, emaciation

Pathophysiology of protein and amino acid metabolism

- Proteins as a nutrient, importance of essential aminoacids and consequences of their deficiency, protein malnutrition
- Protein and aminoacid digestion and resorption disorders
- Pathological proteins
- Nitrogen balance and its disorders, metabolism of nitrogenous substances and its disorders, azotemia
- Hereditary disorders of amino acid metabolism

Pathophysiology of lipid metabolism

- Importance of lipids and lipid-soluble substances in nutrition, causes, manifestations and consequences of their deficiency or excess
- Disorders of digestion and absorption of lipids and lipid substances – their causes, pathogenesis, manifestations and consequences, context with fat soluble vitamins and essential fatty acids
- Disorders of metabolism of apolipoproteins and cholesterol, hypercholesterolemia and its causes and consequences
- Lipidoses – etiology, pathogenesis, manifestations, examples of diseases

Pathophysiology of carbohydrate metabolism

- Carbohydrates in the nutrition, causes and consequences of their deficit or excess, aerobic and anaerobic glycolysis
- Disorders of carbohydrate digestion and absorption - causes, pathogenesis, manifestations and consequences
- Disorders of metabolism of particular carbohydrates (galactosemia, fructosuria, lactose intolerance, glycogenoses, mucopolysaccharidoses etc.) – causes, pathogenesis, manifestations

Disorder of glycaemia regulation

- Mechanisms of glycemia regulation and their disorders
- Causes, manifestations and consequences of hyperglycemia
- Causes, manifestations and consequences of hypoglycemia, hypoglycemic coma
- Maintenance of glycaemia during starvation and excessive saccharide intake

Diabetes mellitus

- Definition, classification, characteristics of each type
- Impaired glucose tolerance and diabetes mellitus – their principle and laboratory characterization
- General pathogenesis and acute and chronic manifestations of the diabetes mellitus
- Pathophysiology of diabetes mellitus type 1
- Pathophysiology of diabetes mellitus type 2
- MODY, gestation diabetes, steroid diabetes, secondary diabetes, renal diabetes and other types of diabetes mellitus

- Acute complications of the diabetes mellitus, diabetic hyperosmolar and ketoacidotic coma - their occurrence, pathogenesis, manifestations
  - Chronic complication of diabetes mellitus – general pathogenesis, diabetic angiopathy, diabetic nephropathy, diabetic retinopathy, diabetic neuropathy, diabetic foot ulcers and other complications – pathogenesis, manifestations, consequences
  - Pathophysiologic aspects of the treatment of the diabetes mellitus, diabetic coma and correction hyperglycemia, hyperosmolarity and acidosis
- Metabolic syndrome and its pathophysiology, insulin resistance – definition, components of the metabolic syndrome, causes and risk factors, pathogenesis, consequences and complications, relation to the diabetes mellitus
- Disorders of purine metabolism – hyperuricemia, arthritis uratica
- Pathophysiology of trace elements
- Disorders of trace element metabolism
  - Causes and mechanisms of lack or excess of trace elements
  - Manifestations of lack or excess of trace elements

### **Pathophysiology of metabolism of minerals**

#### Pathophysiology of calcium metabolism

- Distribution and forms of calcium in an organism, the role of pH
- Regulation of calcium metabolism and its disorder, role of parathormone, calcitonin and D vitamin
- The Role of the kidneys and disorders of their function in calcium metabolism
- Syndrome of hypercalcemia and hypocalcemia – causes, mechanisms of their development, manifestations and consequences
- Impact of calcium metabolism disorders on the bones
- Tetany – characteristics, causes and mechanisms of its origin
- Calcification of the tissues and its causes

#### Pathophysiology of sodium, potassium and chloride metabolism

- Metabolism of sodium, potassium and chlorides, disorders of its regulation
- Disorders of sodium, potassium and chloride intake
- Causes and mechanisms of development of increased or decreased content of the ions in the organism and increased and decreased concentrations of the ions in body fluids
- Manifestations and consequences of disorders of sodium, potassium and chloride metabolism

### **Pathophysiology of body fluids**

#### Compartments of body water

Osmolality of body fluid, its principle, factors determining body fluid osmolality in individual compartments under physiological and pathological conditions

#### Changes in volume and osmolality of body fluids

- Factors determining transfer of water between individual compartments under physiological and pathological circumstances
- Dehydration and hyperhydration hypoosmolar, isoosmolar, hyperosmolar - their causes, mechanisms, characteristics, consequences

#### Edema

- Definition
- Basic mechanisms (factors) leading to the formation of edema - hydrostatic pressure, oncotic pressure, vascular wall permeability, lymphatic drainage
- Situations and processes leading to the involvement of the basic mechanisms of the formation of edema

- Types of edema by cause (cardiac, renal, inflammatory, lymphatic, venostatic, hepatic, cytotoxic, angioneurotic – Quincke’s edema) - characteristics, examples of a particular diseases, mechanisms
- Local impact of the edema on the tissue (perfusion, metabolism, transport of substances etc.), systemic impacts of severe edema on the organism, specific impacts of edema of particular tissues and organs
- Special types of edema and fluid accumulation in body cavities – examples (ascites, expansion of fluid in the pleural cavity, pericardium, joints, anasarca etc.), their causes, mechanisms of their development, manifestations and consequences

### **Disorders of acid-base balance**

Definition of basal concepts, components and parameters of acid-base balance

Mechanisms of acid-base balance maintenance

Buffer systems

- Buffer definition, mechanisms of action, buffer capacity
- Examples of buffers, importance of bicarbonate buffer

The role of lungs in maintaining acid-base balance

The renal role in maintaining acid-base balance

Acidosis, acidemia, alkalosis, alkalemia

Types of acid-base balance disorders

- Respiratory disorders of acid-base balance
- Metabolic disorders of acid-base balance
- Combined acid-base balance disorders

Compensation of individual types of acid-base balance disorders

Causes of individual types of acid-base balance disorders and their combinations

Symptoms and consequences of acid-base balance disorders

### **Pathophysiology of nutrition**

Food intake disorders, malnutrition, anorexia, bulimia

Pathophysiology of starvation

Obesity - causes, types including obesity of endocrine origin, health risks

Rational diet - composition, importance of individual components, consequences of lack and excess of individual components, including essential substances and fiber

Carbohydrates, fats and proteins as food components – sources, disorders of their intake

Vitamins

- Fat soluble vitamins and water-soluble vitamins
- List of individual vitamins, their importance for the organism, sources of vitamins
- Hypovitaminoses and hypervitaminoses - causes, consequences, manifestations and mechanisms of their development

Minerals, trace elements (sodium, potassium, calcium, magnesium, phosphorus, chlorine, iron, zinc, copper, selenium)

- List of important substances and their importance for the organism
- Sources of minerals and trace elements
- Causes, manifestations and consequences of their lack and surplus

### **Pathophysiology of the liver**

Indicators of hepatic function and its deterioration

Causes and mechanisms of hepatic disorders

Symptoms and consequences of hepatic dysfunction, acute and chronic hepatic insufficiency

Hepatic encephalopathy

Hepatorenal syndrome

Liver cirrhosis - etiology, pathogenesis, symptoms and consequences

Alcoholic liver injury

Viral and autoimmune hepatitis

Portal hypertension

- Causes, pathogenesis, symptoms and consequences

- Pathophysiologic aspects of portocaval anastomoses

Ascites - causes, pathogenesis, symptoms and consequences

Hyperbilirubinemia and prehepatic, hepatic and posthepatic icterus, conjugated and non-conjugated hyperbilirubinemia

- Causes, pathogenesis, consequences, differential diagnosis and its explanation

Pathophysiology of the bile tract – obstruction, cholelithiasis, inflammation – causes, pathogenesis, manifestations and consequences

### **Pathophysiology of the nervous system**

Specifics of the nervous system from pathophysiology point of view, components and functions of the nervous system, general principles of disorders of the nervous system,

Methods of examination of the nervous system and its functions and their pathophysiological context

Basic concepts of neuropathophysiology, general characteristics of disorders of the nervous system, excitatory (irritation) and extinction (inhibition) disorders of the afferent and efferent systems

Neural plasticity and compensation, the role of adequate stimulation in normal and pathological development of the nervous system

Mitochondrial dysfunction in pathogenesis of nervous system diseases

Excitotoxicity

Causes of disorders and illnesses of the nervous system, functional, organic and metabolic affections of the nervous system

Developmental disorders of the nervous system

- Factors determining appropriate and inappropriate development of the nervous system structure and function

- Inborn developmental disorders of the nervous system

- Developmental disorders of nervous system function

- Perinatal injuries of the nervous system, developmental disorders of the nervous system in childhood

Genetically determined diseases of the nervous system

Metabolic and endocrine disorders affecting the nervous system

Secondary brain injuries (intracranial hypertension, depolarization, biochemical cascade)

Cerebrovascular disorders – ischemia, hemorrhage, intracranial venous thrombosis – their causes, risk factors, pathogenesis, consequences

Vascular disorders of the spinal cord

Vascular disorders of the peripheral nerves

Mechanical injuries of the nervous system

- Craniocerebral injuries, spinal cord injuries, injuries of the peripheral nerves

Tumors of the nervous system

Immune-mediated diseases of the nervous system, inflammation of the nervous system, neuroinfections

Neurodegenerative diseases – general characteristics, causes and mechanisms of neurodegeneration, classification, examples of diseases (Alzheimer disease, Parkinson disease, amyotrophic lateral sclerosis etc.)

Demyelinating and dysmyelinating disorders

Toxic damage of the nervous system

Radiation injury of the nervous system

Pathophysiology of the cerebrospinal fluid

- Hydrocephalus – definition, classification, causes, pathogenesis, manifestations and consequences

- Loss of the cerebrospinal fluid – causes, manifestations

- Changes of character of the cerebrospinal fluid and their importance for disease diagnosis

Disorders of the synaptic and non-synaptic transmission, receptors, neurotransmitters and channels

Abnormal excitation and inhibition and their role in pathologic states

Disorders of peripheral nerves

- Causes and mechanisms of peripheral nerve damage

- Mononeuropathy, polyneuropathy, neuritis

- Guillaine-Barré syndrome

- Manifestations of damage of peripheral motor, sensitive, vegetative and mixed nerves, specific manifestations of damage of important cranial and spinal nerves

- Process of degeneration of an injured nerve fiber and its manifestations

- Causes and manifestations of spinal root affection

Pathophysiology of the spinal cord

- Causes and mechanisms of spinal cord damage and illnesses

- Spinal shock - definition, manifestations, dynamics of functional changes

- Manifestations of damages of particular spinal cord structures in sensitive, motor and vegetative functions

- Manifestations of transversal spinal cord lesion

- General symptoms below and on the lesion level

- Specific manifestations according to damage of particular spinal segments

- Brown-Sequard spinal hemisyndrome

- Spinal ataxia

- Amyotrophic lateral sclerosis

- Poliomyelitis anterior acuta

- Syringomyelia

Pathophysiology of the brain stem

- Causes and mechanisms of brain stem damage and disease

- Disorders of the respiratory center

- Disorders of the cardiovascular center

- Alternating brain stem syndromes, bulbar and pseudobulbar paralysis

- Pathophysiology of the reticular formation

- Manifestations of functional disturbance of ascending and descending reticular formation, system, decerebrate and decorticate rigidity, „cerveau isolé“ and „encéphale isolé“ syndromes, apallic syndrome

Pathophysiology of the cerebellum

- Causes and mechanisms of cerebellar damages

- Overview of hereditary cerebellar diseases

- Extinction cerebellar syndrome

- Cerebellar motor syndrome – cerebellar ataxia, tremor, passivity, their manifestations

- Cerebellar cognitive affective syndrome

- Variability of extinction cerebellar syndrome in dependence on damage localization

- Cerebellar irritation syndrome

Pathophysiology of the hypothalamus – causes and manifestations of hypothalamic damages

Pathophysiology of the thalamus, subthalamus and epithalamus – causes, manifestations and pathogenesis of their damages

Pathophysiology of the basal ganglia

- Causes and mechanisms of affection of the basal ganglia and changes of their function
- Hypotonic-hyperkinetic syndromes
- Hypertonic-hypokinetic (parkinsonian) syndrome

Pathophysiology of the brain cortex – mechanisms, causes and manifestations of individual areas of the brain cortex

Pathophysiology of the hippocampus – causes and manifestations of hippocampal disorders

Pathophysiology of the limbic system – causes and manifestation of disorders of particular parts of the limbic system

Pathophysiology of vegetative nervous system

- Control of vegetative functions and its disorders, vegetative imbalance
- Functional characteristics and anatomical arrangement of sympathetic and parasympathetic nervous system, general manifestations of their disorders, specific manifestations of damages of particular structural components of the vegetative system
- Pharmacologically induced disorders of vegetative system function

Pathophysiology of the motor system

- Paralysis
  - Definition, types of paralysis - (spastic) and peripheral paralysis (flaccid), pathophysiological background for of the classification
  - Causes of central and peripheral paralysis
  - Characteristics of central and peripheral paralysis and their manifestations
  - Distribution of central and peripheral paralysis on the body and its relation to localization of the lesion in the motor system
- Ataxias
  - Definition, cerebellar, spinal and vestibular ataxia
  - Causes, mechanisms and character of particular types of ataxias, differential diagnosis
- Extrapyramidal disorders, hyperkinetic and hypokinetic symptoms, muscle tone disorders, tremor, central and peripheral convulsions – classification, etiology, pathogenesis, consequences

Pathophysiology of neuromuscular transmission

- Functional and structural characteristics of the neuromuscular plate in relation to mechanism of its function disturbances
- Mechanisms of neuromuscular transmission disorders, examples of particular types of disorders
- Pathophysiology of the myasthenia gravis
- Pharmacological and toxic influence on neuromuscular transmission
- Pathophysiology of calcium modulation of neuromuscular excitability

Pathophysiology of behavior and affectivity

- Disorders of drives, motivations, instincts and emotions
- Depression, mania, neurotic disorders, posttraumatic stress disorder
- Mental disorders of organic origin
- Symptoms of disorders of the prefrontal cortex, limbic system, amygdaloid nucleus
- Pathophysiology of the schizophrenia
- Autism spectrum disorders

Pathophysiology of learning and memory

- Fundamental terminology
- Causes and mechanisms of learning and memory disorders
- Dementias, mental retardations



Disorders of phatic functions – aphasias, aprosodia, agraphia, alexia, dyslexia

Disorders of gnostic functions - agnosias

Disorders of practice functions – apraxias

Qualitative and quantitative disorders of consciousness, coma – characteristics, classification, causes and pathogenesis

Pathophysiology of sleep and biological rhythms

- Terminology, classification of biological rhythms

- Control of biological rhythms, inner period, synchronization with external conditions

- Disorders of biological rhythms

- Sleep disorders – causes, mechanisms of origin, hypersomnia, insomnia, examples of disorders

- Sleep hygiene

Pathophysiology of the epilepsy

- Definition of epilepsy as an illness, definition of an epileptic seizure

- Causes and pathogenesis of the epilepsy and mechanisms of epileptic seizure development, epileptogenesis

- Classification of epileptic seizures, characteristics of their particular types

Intracranial hypertension

- Definition, origin of the phenomenon

- Causes and mechanisms of intracranial hypertension

- Consequences of the intracranial hypertension, its impact on brain perfusion and metabolism of the brain tissue, brain conuses and their consequences

Brain edema pathophysiology

- Types, causes and mechanisms of the brain edema origin and development

- Symptoms and consequences of the brain edema

## **Pathophysiology of the sensory systems**

Pathophysiology of vision

- Pathophysiology of the eye

- Disorders of the optic system of the eye – changes of transparency and optical power, disorders of accommodation, hypermetropia, myopia, astigmatism

- Diseases of the retina

- Pathophysiology of the glaucoma

- Injuries of the eye ball, inflammatory and autoimmune eye affections

- Oculomotor disorders, strabism, diplopia

- Exophthalmos, enophthalmos, Claude-Bernard-Horner's syndrome

- Argyll-Robertson's syndrome, inverted Argyll-Robertson's syndrome

- Pathophysiology of the visual pathway and visual cortex

- Causes and consequences of affection of particular parts of the visual tract

- Disorders of cortical processing of the visual stimuli

Pathophysiology of the auditory system

- Perceptive and conductive hearing disorders – causes, mechanisms, manifestations, differential diagnosis

- Disorders of the auditory pathway and cortical processing of auditory stimuli

Pathophysiology of the vestibular system

- Causes and pathogenesis of vestibular system disorders

- Manifestations of vestibular disorders – nystagmus (including methods of its experimental provocation), vestibular ataxia, kinetosis

Pathophysiology of the somatosensory system

- Modalities of the somatosensory system, their receptors and pathways in relation to their disorders
- Basic terms naming abnormal perceptions or disorders of somatic perception
- Causes, pathogenesis and manifestations of disorders of somesthesia originating on individual levels of the somatosensory system
- Complex and dissociated disorder of perception (tabic and syringomyelic dissociation of sensation)

Pathophysiology of olfaction and taste

Pain

- Definition of pain and related basic terms
- Aspects and biological and clinical importance of pain
- Processes of nociception
  - Transduction
    - Nociceptors – characteristics and classification
    - Nociceptive stimuli
    - Mechanisms of transduction (TRPV1, H<sup>+</sup>-activated channels, purinergic receptors, mechanically activated ion channels)
  - Transmission – nociceptive pathways and their disorders
- Pain modulation
  - Peripheral and central sensitization
  - Historical importance of the gate control theory
  - Stress analgesia - opioid and non-opioid
- Pain types
  - According to its duration
  - According to its cause
  - According to its localization, explanation of the referred pain phenomenon
- Disorders of pain perception (inborn and acquired diseases, disorders and syndromes with missing or reduced pain sensation)
- Neuropathic (neurogenic) pain – central and peripheral
  - Definition and characteristics
  - Causes and mechanisms of origin of the neuropathic pain, examples of neuropathic pain
- Painful syndromes and states (anesthesia dolorosa, phantom pain, thalamic pain, radicular pain) – characteristics, causes and mechanisms
- Pathophysiological aspects of (pharmacological, surgical, neuromodulation, psychological) pain treatment
- Headache - primary (functional – migraine, cluster headache, tension cephalgia) and secondary (organic)

## **Practical knowledge and skills II**

Knowledge of the problem including its relations to theoretical knowledge, practical application of the knowledge, ability to perform correctly practical tasks

### **Examination of body fitness and response of the cardiovascular system to physical load**

Step test, Letunov's test – procedure, principle, pathophysiological aspects of individual types of response

Changes of the heart rate and blood pressure in response to physical activity, stress, changes of posture, diving reflex, principle of these changes and reactions

### **Examination of pulmonary ventilation**

Definition and description of pulmonary ventilation

Spirometry and its principles

Basic measured parameters - definitions, normal values

Obstructive and restrictive disorders of lung ventilation - definitions, examples, spirometric findings

### **Electroencephalography**

Methods of electrophysiological examination of the brain, ways and principles

Basic EEG rhythms - frequency, occurrence, relationship between frequency and amplitude

Evoked potentials

EEG diagnosis of the epilepsy

### **Stereotaxis**

Definition, principles

Use in medicine and biomedical research

Stereotaxic apparatus

Orientation in the stereotaxic atlas

## **Varia**

Practicing, extension of knowledge and skills in the topics of pathological physiology I and their explanation in the context of new knowledge