

# THE CONTENT OF EDUCATION OF THE SUBJECT „MEDICAL CHEMISTRY“ (study branch Dentistry) the 1<sup>st</sup> year, summer term, 2023-2024

## 1. WEEK

**Lecture:** *RNDr. L. Andrezálová, PhD.*

Chemical composition of living systems. Biogenic elements.

Physiological functions of biogenic elements, free radicals, elements and their significant compounds from the toxicological viewpoint.

**Seminar:**

- Organization of laboratory practices.
- Conditions for getting the credit from medical chemistry
- Organizational schedule of seminars and practical exercises
- Principles of safety and security when working in a chemical laboratory
- Principles of laboratory praxis
- Pipetting technique

## 2. WEEK

**Lecture:** *Mgr. Monika Dvořáková, PhD.*

Dispersed systems in relation to the organism

- true dispersed systems
- colloidal dispersed systems
- crude dispersed systems

The cell as a colloidal and crude dispersed system

**Seminar:**

- physico-chemical methods used in laboratories – spectrophotometry – analytical curve, molar extinction coefficient
- separation methods - centrifugation

**Practical exercise:**

Determination of Fe<sup>2+</sup> ions concentration in serum using analytical curve

## 3. WEEK

**Lecture:** *Mgr. Monika Dvořáková, PhD. / RNDr. Zuzana Országhová, PhD.*

Chemical reactions in living systems

- kinetics of chemical reactions,
- redox events and their meaning.

Chemical balances in living systems

- balance of chemical and biochemical events, Le Chatelier's principle.

**Seminar:**

Biogenic elements

- biogenic elements as part of important bioorganic and bioinorganic compounds and their chemical forms in the organism,

- biological significance of ionic forms of biogenic elements. Elements and their compounds significant from a toxicological point of view,
- biological significance of transient elements in radical reactions. Reactive metabolites derived from oxygen and nitrogen.

## **4. WEEK**

**Lecture:** *RNDr. Z. Országhová, PhD.*

Acids, bases, pH, buffer systems, acid-base balance, maintenance of pH in the body.

The organism as a thermodynamic system

- acquisition and conversion of energy in biological systems, 1st and 2nd law of thermodynamics
- the meaning and transfer of free energy, entropy and orderliness of biological systems
- macroergic compounds

**Seminar:**

- expression and calculation of the solution concentration
- colligative properties of solutions – osmosis and dialysis. Osmotic pressure – biological importance. The main ions of blood
- osmotic fragility of red blood cells
- calculation of osmotic pressure, osmolarity and ionic strength of solution.
- Preparation of NaCl solutions - demonstration

**Practical exercise:**

Examination of hypotonic haemolysis (osmotic fragility) of erythrocytes

## **5. WEEK**

**Lecture:** *Prof. Ing. Z. Ďuračková, PhD.*

Organic compounds

- structure and biochemically significant reactions of bioorganic compounds
- the relationship between the structure, properties and biological function of organic compounds - toxicologically significant organic compounds
- clinically important products of metabolism, formation of ketone bodies and urea
- organic components of teeth and saliva
- active substances in dental hygiene

**Seminar:**

Theory of acids and bases. Buffer solutions

- biochemical significance of protolytic reactions, K and pK values of weak acids and bases, pH and its importance
- buffer solutions, their composition and effect, capacity of buffer solutions, biochemically significant buffer systems, acid-base balance
- the principle of measuring pH - colorimetrically and potentiometrically
- the effect of pH on the dental caries formation
- calculations of composition, osmolarity and ionic strength of solutions
- calculations of pH solutions of strong and weak acids, bases and buffer solutions

## **6. WEEK**

**Lecture:**  
***EASTER***

**Seminar:**  
**EASTER**

## **7. WEEK**

**Lecture:** *Prof. Ing. Z. Ďuračková, PhD.*

Structure, properties and biological function of carbohydrates.

- biochemically significant reactions of monosaccharides (oxidation-reduction, formation of important esters, aminosaccharides, deoxysaccharides, ascorbic acid, glucuronic acid),
- polysaccharides, classification and structure,
- homopolysaccharides (starch, glycogen), heteropolysaccharides, glycoproteins, proteoglycans
- carbohydrates as a risk factor for dental caries,
- the effect of diet on the quality of dental tissue.

**Seminar:**

Organic chemistry

- overview and chemical properties of characteristic groups
- the main types of biochemically significant reactions of alcohols, thiols, quinones, carbonyl compounds, carboxylic acids and their substituted and functional derivatives
- organic acids in blood and urine
- clinically important products of metabolism, formation of ketone bodies and urea

## **8. WEEK**

**Lecture:** *Assoc. Prof. RNDr. J. Muchová, PhD.*

Structure and biological function of lipids and their derivatives

- the structure of complex lipids. Composition and properties of human fat. Glycerophospholipids, sphingophospholipids, ceramides, glycolipids
- their biological function, structure of biological membranes
- arachidonic acid and its oxidation derivatives, eicosanoids, prostaglandins - structure and biological function. Thromboxanes, prostacyclins, leukotrienes - significance in medicine
- dental waxes

Terpenes, Steroids

**Seminar:**

Saccharides

- reactions of monosaccharides (oxidation, reduction, methylation, esterification, reactions with non-oxidizing mineral acids), formation of cyclic forms of monosaccharides, detoxification importance of glucuronic acid
- monosaccharide derivatives and their biological significance
- non-enzymatic glycation of proteins, glycohemoglobin, glucose toxicity
- oligosaccharides (disaccharides, glycosidic bond)
- polysaccharides (homopolysaccharides, heteropolysaccharides)

**Practical exercise:**

Detection of the presence of reducing carbohydrates in urine.

## **9. WEEK**

**Lecture:** *Prof. Ing. Z. Ďuračková, PhD.*

Amino acids (AA) and peptides

- biochemically significant AA reactions

- characteristics of the peptide bond, its influence on protein conformation
- biologically significant peptides and polypeptides (carnosine, anserine, glutathione, proteohormones, antibiotics, toxins)

### Proteins

- physico-chemical properties of proteins (electrical properties, isoelectric point, salting out, denaturation), biological function
- colloidal properties of proteins
- holoproteins - biological function
- heteroproteins - distribution and characteristics of individual groups
- structural proteins, blood plasma proteins, hemocoagulation system, fibronectin, complement system, protein inhibitors
- immunoglobulins - structure and biological function
- connective tissue proteins – collagen, elastin, non-collagenous proteins and calcium-binding proteins

### Seminar

#### Lipids - simple and complex

- physico-chemical properties of lipids and their application in the construction and function of biomembranes. Membrane lipid peroxidation
- Steroids
- basic structure, terminology. Division according to functional significance and according to the number of carbon atoms
- basic hydrocarbons of steroids (C18 - C29). Sterols, provitamins and vitamins D. Bile acids, cholic acid. Steroid hormones

#### Terpenes

### Practical exercise:

Determination of serum lipid concentration

## **10. WEEK**

**Lecture:** Prof. Ing. I. Žitňanová, PhD.

#### Introduction to enzymology

##### General characteristics of enzymes

- mechanism of action of enzymes - effect on reduction of activation energy. Kinetics of enzyme reactions
- active (catalytic) site of the enzyme. The importance of apoenzyme and coenzyme in enzyme activity
- specificity of effect and substrate specificity
- the influence of factors on enzyme activity
- the significance of the Michaelis-Menten ( $K_M$ ) constant for the catalytic activity of enzymes
- mathematical and graphical evaluation of the  $K_M$  constant

### **Seminar:** Amino acids, proteins

- structure and physico-chem. properties of proteinogenic AA, amphoteric character, isoelectric point
- biochemically significant reactions of AA, reactions used in diagnostics
- structures and properties of proteins (denaturation, colloidal properties, isoelectric point), their use in protein separation and purification

### **Practical exercise:**

Separation of amino acids by thin layer chromatography (TLC).

## 11. WEEK

**Lecture:** Prof. Ing. I. Žitňanová, PhD.

Activation and inhibition of enzymes. Different way of enzymes activation

- competitive, non-competitive, uncompetitive and allosteric inhibition
- allosteric enzymes - their regulatory role in cell metabolism and function
- induction and repression of enzymes - the role of these processes in the regulation of cell metabolism

Classification of enzymes

- trivial and systematic nomenclature

Enzymes in the oral cavity, their function, diagnostic significance

**Seminar:** Enzymes

- classification of enzymes
- specificity of enzymes, examples of substrate and effect specificity
- factors affecting enzyme activity (influence of pH, temperature, enzyme concentration and substrate concentration, calculation and practical significance of the Michaelis constant)
- expression of enzyme activity, calculations of enzyme activity

## 12. WEEK

**Lecture:** Prof. Ing. I. Žitňanová, PhD.

Vitamins as biologically important nutrients and coenzyme systems

- water- and fat-soluble vitamins
- vitamins, an important part of coenzymes
- coenzyme transporting hydrogen, electrons and groups of atoms
- antivitamins

**Seminar:** Activation and inhibition of enzymes

- activation and inhibition of enzymes, examples of individual types of inhibition important in medicine (competitive, non-competitive, uncompetitive and allosteric), expression of inhibition of enzyme activity graphically.

**Practical exercise:**

- Determination of the Michaelis constant of lactate dehydrogenase

## 13. WEEK

**Lecture:** Prof. Ing. Z. Ďuračková, PhD.

Nucleotides and nucleic acids, nucleoproteins

- biologically significant free nucleotides,
- composition, structure and biological importance of DNA and RNA

Oxidative stress - its effect on the structure and function of biologically significant macromolecules,

- the positive role of free radicals in the body,
- antioxidant systems in the organism - their distribution and function in protecting the organism from damage by reactive oxygen metabolites.

**Seminar:** Substitution of seminars and practical exercises

Acceptation of teaching and practical exercises in the subject Medicinal Chemistry for Dentistry.

## **STUDY LITERATURE**

### **Obligatory:**

**Országhová, Z., Žitňanová, I. et al.** Textbook of Medical Chemistry [online]. Bratislava: Comenius University, 2018. 299 p. ISBN 978-80-223-4512-5.

[https://zona.fmed.uniba.sk/uploads/media/Textbook\\_of\\_Medical\\_Chemistry\\_01.pdf](https://zona.fmed.uniba.sk/uploads/media/Textbook_of_Medical_Chemistry_01.pdf)

### **Recommended:**

**Harvey, R.A. and Ferrier, D.** Lippincott's Illustrated Reviews: Biochemistry. 6th ed. J.B. Wolters Kluwer, Lippincott Williams & Wilkins, ©2013. 560 p. Lippincott Illustrated Reviews Series. ISBN 978-1-4511-7562-2

### **Protocols for laboratory practices:**

Protocols will be provided on the web of institute