

MEDICAL BIOCHEMISTRY I.

Department of Medical Biochemistry, Faculty of Medicine, Semmelweis University
II. (spring) semester of 2017/2018 academic year

Neptune code: ÁOKOBI463_1A

Credit: 3

Director of the course: Professor László Tretter M.D., Ph.D., D.Sc.

End semester requirement: practice mark

Description of the curriculum

The aim of the curriculum is to learn and understand the structure-function aspects of biologically important macromolecules (proteins, nucleic acids, lipids and complex carbohydrates) and that of their building blocks (amino acids, nucleotides, sugars and lipids). The enzymology module deals with the mechanism and efficiency of the in vivo biochemical reactions focusing on their organization into metabolic pathways, their regulation and effectivity. The bioenergetics module focuses on the energy and metabolite fluxes of the human body and also settles the basis of the thermodynamic approach of intermediary metabolism.

Module 1A Biologically important molecules and macromolecules

- **Amino acids, peptides, proteins**

- The role of proteins in the living world. The chemical structure of proteinogenic amino acids.
- The peptide bond. The primary, secondary and tertiary structure of proteins.
- The quaternary structure of proteins. The biochemical basis of protein-nucleic acid interactions. Covalent modifications of proteins
- Preprotein forms of proteins e.g. procollagen-collagen. Comparison of the structure-function aspects of myoglobin and haemoglobin.

Module 2 Enzymology

- General characteristics of enzymes. The thermodynamics of enzymatic reactions. Activation energy, transitional state. Isoenzymes. The role of coenzymes in the enzymatic reactions.
- Enzyme kinetics. The initial rate. The Michaelis-Menten equation. The Michaelis-Menten constant and its meaning. Double reciprocal representation of the Michaelis-Menten equation.
- Serine proteases and their mechanism of action. Reversible and irreversible inhibition of enzymes. Competitive, non-competitive and uncompetitive inhibition of enzyme activities. The theory of allostery and cooperativity.
- Different levels of the regulation of enzymatic activities: regulation through compartmentalization, by the transcriptional regulation of enzyme protein expression and with the modification of their catalytic activities. Regulation of enzyme activity by proteolysis. The enzyme

kinetics and thermodynamics of metabolic pathways. The strategy to find the regulated step(s) of metabolic pathways.

Module 3 Bioenergetics

- The thermodynamics of biochemical pathways Reversible and irreversible reactions. The coupling of endergonic and exergonic reactions in the human body. High energy compounds. The central role of ATP in the energetics of cells. Reducing equivalents.
- The synthesis of ATP. ATP production by substrate level phosphorylation. Oxidative phosphorylation, the production of ATP in mitochondria. The redox reactions of terminal oxidation (electron transport chain, ETC). The enzyme complexes of ETC.
- Exergonic reactions in the ETC and the production of ATP. The mechanism of action of ATP synthase. The regulation of ATP production by the energy demand of cells. The P/O ratio. The inhibitors of oxidative phosphorylation. Uncoupling agents. Heat production in special tissues of the body.
- The reactions of the citric acid cycle and the regulation of the pathway.

Module 1B Biologically important molecules, topics of seminars

- Carbohydrates a. The most important carbohydrates of the body and their presence in foodstuffs.
- Lipids a. The most important lipids of the body and their distribution in various foodstuffs.

Seminars

- Nucleotides and their carbohydrate components.
- Acid-base characteristics of amino acids, their titration curves. The isoelectric point of amino acids and their calculation.
- Important methods in protein chemistry.
- Methods of protein purification and the determination of concentrations of proteins.
- Pathological conditions based on mutated protein structures. Amyloid proteins, prions, changes in the glycation of proteins.
- Determination of kinetic parameters of enzymes
- Enzyme kinetics: Biological role of kinetic parameters of enzymes
- Enzyme kinetics: Theory and clinical practice → Bioenergetics I. The connections of mitochondrial energy production and different biochemical pathways of cells.
- Bioenergetics II. The sources of acetyl-CoA in the citric acid cycle.
- Enzymes – bioenergetics: summary and consultation.
- Carbohydrate and lipid components of nutrients.
- Role of the structures of carbohydrates and lipids in the human body. Requirements

Participation at seminars

Participation at the seminars is obligatory. Missed seminars cannot be made up for. In the case of more than three absences from seminars the semester cannot be acknowledged. Arriving at seminars more than 10 minutes late counts as an absence.

Seminar reports

During seminar time through weeks 3-12, - 10 times in total - students will have to report on the lecture and practical topics of the previous week. Missed reports cannot be made up for, students having failed to meet the requirements by week 12 may sit for a written or oral exam during weeks 13-14.

Acknowledgement of the semester

- Three or less absences in spring semester.
- The total score of the weekly reports has to reach at least 30 points or 50 % of the maximum total score.
- Acknowledgement (and evaluation) of the semester can be obtained by successful completion of the weekly reports. Alternatively, an opportunity for a written exam on the material of weeks 1-12 will be given during week 13. In case of failure at the written exam students will be given a final opportunity to obtain a "pass" score at an oral exam during week 14. Grading Weekly reports during seminars will be held continuously.

The 6 test questions containing written test may result in 0-6 points.¹ Evaluation of semester performance will be based on these reports. Failed or missed reports cannot be made up for. A three-scaled evaluation of semester performance will be based on these reports:

- 75- % = Excellent
- 50-74 % = Satisfactory
- 0-49 % = Unsatisfactory

Failed students have to repeat the semester. Students having failed to meet the semester requirements based on the weekly reports by week 12 will be given the opportunity to pass a written exam on the material of weeks 1-12 during week 13, or, in case of failure of the written exam, an oral exam during week 14. Failure to appear at the written or oral exam must be justified within three business days by submission of appropriate documents.

Textbooks, manuscripts, handouts:

- Harper's Illustrated Biochemistry (30th edition)
- PowerPoint files of lectures and seminars
- [http://semmelweis.hu/biokemia/en/ ENGLISH / FOR STUDENTS / BIOCHEMISTRY \(MED\) 1/DOWNLOADS](http://semmelweis.hu/biokemia/en/ENGLISH/FOR_STUDENTS/BIOCHEMISTRY(MED)1/DOWNLOADS) (password can be obtained from seminar teacher)
- Students' own lecture notes

¹ 10 weekly reports result in 60 points as maximal number of scores. For groups *EM08&EM09*, *EM05&EM06* and *EM13&EM14&EM15* is the maximal number of scores is 54, as 15th of March is a holiday. The maximal number of scores is calculated individually for students who were registered later as the third week.