MEDICAL BIOCHEMISTRY I.

Department of Medical Biochemistry

Credits: 5

Total number of hours: 70; lectures (hours): 42; practices (hours): 28

Type of the course: obligatory

Academic year: 2021/2022

Code of the course

Name of Head of the Department: Professor László Csanády M.D. Ph.D. D.Sc.

Contact details: H-1094 Budapest, Tűzoltó u. 37-47. **tel:** +36-1-459-1500#60010 e-mail: csanady.laszlo@med.semmelweis-univ.hu

Position: Temporary Head of Department

Date of Habilitation: 2013 Its number: 341

Objectives of the subject, its place in the medical curriculum:
The aim of this course is to examine biologically important molecules - namely amino acids, carbohydrates, lipids and nucleotides - identify their contributions to metabolic processes emphasized from a medical point of view, examine the structure and function of proteins, and address mechanisms of catalysis performed by enzymes. Furthermore, three basic biochemistry modules are outlined: The enzymology module, encompassing general principles of enzyme kinetics and how enzymes influence efficiency and controllability of chemical processes in biological systems, as well as how they affect structure and regulation of metabolic pathways; the bioenergetics module, addressing the relationships between mass-energy conversions in the human body emphasizing nutrional aspects, also elaborating on thermodynamic aspects of metabolism; and the 'first' intermediary metabolism module, presenting the salient features of carbohydrate and lipid metabolism which are essential for understanding physiological and pathological processes of the human body. During practices, students apply the theoretical knowledge acquired at lectures as part of case-oriented discussions in an effort to interpret - from a molecular point of view - medically relevant conditions.

Location of the course (lecture hall, practice room, etc.):
Premises located in the Basic Medical Sciences building (laboratory rooms located on the first floor and lecture halls located on the ground floor).

Successful completion of the subject results in the acquisition of the following competencies:
The knowledge of the structure, interactions and reactions of biological molecules and the interactions between organs of the higher integrated regulatory functions of the human body, is of paramount importance from a medical point of view and is essential for understanding physiological and pathological processes and, as a consequence, for making informed medical decisions.

Prerequisite (s) for admission to the course: Medical Chemistry

Number of students required for the course (minimum, maximum) and method of selecting students: Not applicable for compulsory subjects

How to apply for the course: Application is through the Neptun online system

Detailed curriculum:

Lectures: weekly 2x70 min (3 hours)

Lecturers: Prof. Csanády László (CSL), Prof. Kolev Kraszimir (KK), Dr. Christos Chinopoulos (CC), *Dr. Komorowicz Erzsébet* (KE), Dr. Kardon Tamás (KT), Dr. Törőcsik Beáta (TB), Prof. Tretter László (TL)

Practices (P): 2 hours every week

Week	Lectures	Practices (P): 2 hours every week
1	The chemical structure of the amino acids that make up proteins. Formation of peptide bonds and their spatial structure. Primary structure of proteins. (CSL) Hierarchical structure of proteins, secondary and tertiary structure. Process of unfolding of proteins, protein denaturation. (CSL)	Structural and chemical characteristics of amino acids from the point of view of physiological functions (pH and temperature dependent properties).
2	Quaternary structure and posttranslational modifications of proteins. Structure of collagen. Structural basis of protein-nucleic acid interactions. (CSL) Structure-function relationships of haemoglobin and myoglobin. (CSL)	Current protein diagnostic and structural analysis methods and their medical applications.
3	A description of the general properties of enzymes. The chemical nature of enzymes. Thermodynamics of catalysis. The role of activation energy. Isoenzymes. The role of coenzymes and vitamins. Mechanism of action of serine proteases. (KK) Kinetic models of enzyme function. Michaelis-Menten kinetics. Initial reaction rate criteria. Michaelis constant (Km) and its significance. Inhibition of enzyme reactions, kinetics of inhibition. The importance of inhibition types in drug design. (KK)	Interpreting protein structure-related pathological conditions in light of atomic resolution protein structures

Week	Lectures	Practices (P): 2 hours every week
4	Allostery and cooperativity. Levels of regulation of enzyme reactions: regulation by compartmentalization, regulation of gene expression, regulation by reversible modification of catalytic activity of enzymes. Regulation by proteolytic activity. (KK) Structure and kinetics of metabolic pathways. Principles of metabolic control. Strategies for identifying drug target enzymes. (KK)	Determination of enzyme kinetic parameters, regulation of enzyme activity
5	Thermodynamics of biochemical processes. Reversible and irreversible reactions. Compounds with high group transfer potential. The central role of ATP in cellular energy metabolism. Reducing equivalents. (TL) Substrate level phosphorylation as a possible mechanism for ATP synthesis. Reactions and regulation of the citrate cycle. Acetyl-CoA sources of the citrate cycle. Pyruvate dehydrogenase complex. (TL)	Identification of metabolic pathways.
6	Mechanism of ATP synthesis in mitochondria: oxidative phosphorylation. The so-called terminal oxidation, also known as respiratory chain redox reactions, and the enzyme complexes that catalyse these reactions. (CC) Transfer of energy released during exergonic redox reactions to the synthesis of ATP. Function of ATP synthase, reversibility. Respiratory control, P/O ratio. Mechanisms inhibiting oxidative phosphorylation. Physiological role of uncoupling. (CC)	The structure of carbohydrates. Carbohydrate components in the diet. Dietary fibers and additives.
7	Carbohydrates in food, their digestion, absorption of carbohydrates in the intestinal tract. Membrane transporters in general. Glucose transporters, their tissue localization, regulation. (TB) The process and regulation of glycolysis. (TB)	Experimental determination of P/O ratio (practice)
8	Metabolism and molecular pathology of fructose, galactose and lactose. Glycogen degradation and synthesis. (TB) Gluconeogenesis. Anaplerotic reactions. Energetics of gluconeogenesis, its significance in starvation. Cori cycle. Regulation of gluconeogenesis. Effect of glucagon. (TB)	Lactic acidosis
9	Regulation of blood glucose I. Glycogen mobilisation in liver and muscle. Phosphorylation cascade. Enzymes regulated by glucagon. Lactose synthesis (TB) Regulation of blood glucose II. Hyperglycaemia. Insulin secretion, its receptor and its effects on the organs (TB)	Structures and bioenergetic functions of the main lipids in the body and in foodstuffs
10	The biochemistry of diabetes. Type 1 and type 2 diabetes (TB) Dietary lipids, their digestion, absorption, metabolism of kilomicrons. Essential fatty acids (TL)	Measurement of blood glucose levels according to the oral glucose tolerance test. Non-enzymatic glycation of haemoglobin.
11	Mobilisation of fatty acids in adipose tissue and its regulation. Transport in the circulation. Free fatty acids, VLDL, IDL (TL) Oxidation of fatty acids and its regulation. Production and utilisation of ketone bodies (TL)	Role of insulin in metabolism and signal transduction
12	Synthesis and regulation of fatty acids. Saturated and unsaturated fatty acids. Synthesis and regulation of triglycerides and phospholipids (TL) Characterisation and grouping of biotransformation reactions: phase I reactions - microsomal cytochrome P450 isoenzymes, phase II reactions - glucuronidation, conjugation with glutathione. Regulation of biotransformation processes (KT)	The role of lipoprotein lipase in determining the metabolic profile of organs. Lipoprotein lipase deficiency.
13	Cholesterol metabolism, cholesterol transport in the circulation (KK) Synthesis, metabolism and role of bile acids in the digestion of fats. Cholesterol deposition and uptake in cells (KK)	Determination of cholesterol and triglycerides (medical implications of plasma cholesterol levels)
14	Steroid hormone synthesis in the adrenal cortex. Biochemical background of adrenocortical stratification. Synthesis of mineralocorticoids, prereceptor specificity. Types of steroid receptors and signal transduction, classical and non-genomic mechanisms of action. (KE) Synthesis of glucocorticoids, cortisol effects, regulation of cortisol synthesis. Synthesis of sex hormones. Progesterone and estradiol synthesis in the placenta. Testosterone synthesis in the testis, formation and significance of dihydrotestosterone. KE)	Membrane-forming lipids; precursors of signalling molecules.

Other subjects concerning the border issues of the given subject (both compulsory and optional courses!). Possible overlaps of themes: none

Special study work required to successfully complete the course: None.

Requirements for participation in classes and the possibility to make up for absences:
Practices and seminars are mandatory. It is not possible to make up for missed practices/seminars. In case of absences amounting to more than 3 occasions, the semester is not acknowledged. Arriving to a practice /seminar with a delay of more than 10 minutes is considered an absence.

Methods to assess knowledge acquisition during term time:

Practice/seminar participation performance will be evaluated by the tutor: as such, maximum 10 points per semester can be obtained that may count towards the semi-final grade, see under “Grading system”.

Midterms: A midterm will take place in the 6th and another in the 11th week, during the practice/seminar (allocated time per midterm: 20

minutes). Each midterm will consist of multiple choice questions (MCQs) from which max 20 points can be obtained (10 points per midterm).

It is not obligatory to pass a midterm in order to be allowed to sit for the semi-final exam. However, the midterm points will be added as "points" to the result of the semi-final exam, as detailed in "Grading system".

Lectures: At the end of each lecture, there will be a Kahoot on the topic of the lecture, consisting of 5 questions. Maximum 1 point can be earned per lecture, as outlined by the lecturer. Through the Kahoots, students may obtain points that will be added to the points earned at the semi-final exam, as detailed in "Grading system".

Competition: The competition is held on the last week and consists of 70 multiple choice questions (MCQs). Only students who amass 14 or more points from the midterms may participate in the competition. Points obtained from midterms, Kahoot quizzes, or practice/seminar performance (see below), do not count in the competition. Winners may be exempted from the semi-final exam.

Requirements for signature: No credit will be given for absences exceeding 6 hours (3 occasions).

Type of examination: Semi-final; Form: written and oral test based on material of the official textbooks, lectures and practices/seminars published at the department's Moodle e-learning system (https://itc.semmelweis.hu/moodle/). See under "Grading system" for further details.

Requirements of the examination:
The material covered in the exam is the material of the lectures and practices/seminars in the topic, with the corresponding textbook chapters.

Method and type of evaluation:

Grading system: The grade of the semi-final exam is based on the points obtained i) in Kahoot quizzes at the lectures, ii) during the seminars/practices, iii) at the two midterms, iv) at the written MCQ semifinal exam, and v) in an oral exam following the written MCQ exam. The written MCQ exam and the oral exam will take place on the same day of the examination period.

The grading system is as follows:

(i) Kahoot: maximum 1 point per lecture.

(ii) Seminar/practice points: maximum 10 points.

Total points from (i) and (ii) cannot exceed 20 points.

(iii) Two midterms: maximum 20 points.

(iv) Written MCQ exam: This test consists of multiple choice questions (MCQs) from which max 100 points can be obtained (allocated time: 100 minutes).

If the score of the MCQ exam is 49 or below, then the grade of the semi-final exam is 'fail'.

If students reach 50 points on the MCQ exam, the midterm points, practice/seminar performance points and lecture Kahoot points (total max. 40 points) will be added to the MCQ score.

Grade calculation of the written part of the semi-final exam from the total points (MCQ+semester):

95–140: grade 5 (excellent)

85–94: grade 4 (good)

70–84: grade 3 (satisfactory)

55–69: grade 2 (pass)

Only those students who obtained at least 50 points at the semifinal MCQ test will be invited for an oral exam. During the oral exam, the examiner will pick three questions from those MCQs that were correctly answered by the student. The student will have to elaborate properly on these questions. The final grade will be given based on the written and the oral part of the exam.

How to register for the examination?: The exam dates are announced on the 12th week of the semester. We provide at least one exam date each week. Applications are made in the Neptun system in accordance with the University Study and Exam Rules.

Possibilities for exam retake: an exam can be re-taken only after two calendar days.

Printed, electronic and online notes, textbooks, guides and literature (URL address for online material) to aid the acquisition of the material:

Harper's Biochemistry (30th edition, or latest)

Online material published in the department's website (http://semmelweis.hu/biokemia/en/)