



## Course Regime

Course: MEDICAL BIOCHEMISTRY AND MOLECULAR GENETICS

Study Programme: Medicine

Year of the Course: 2

Semester: Winter

Course type: Compulsory

Number of ECTS credits: 11

Lecturer(s): Vita Dolžan, Katarina Trebušak Podkrajšek

Participating Organisational Units (Departments and Institutes): Institute of Biochemistry

Parts (Modules) of the Course: /

Date of Issue: 15.9.2019

## A. General part

### 1. Course objectives

The course aims to give the student an understanding and basic knowledge of life processes and their regulation at the molecular level. It introduces theoretical and practical aspects of basic biochemistry and molecular biology processes. The course deals with special topics concerning the maintenance of cell constituents, body fluids and the processes involved in tissue growth and reproduction. Students will get the knowledge of basic concepts in molecular genetics that will help them to understand the molecular basis of genetic disorders.

### 2. Comprehensive outline of the course organisation

The course regime is prepared in accordance with the Rules for the assessment and grading of skills for the Master's Degree Programs in Medicine and Dental Medicine, accepted on 8 October 2018 (*Rules*).

The course is scheduled in winter semester. The courses are held by lecturers, teaching assistants and technicians in the form of lectures, seminars, tutorials, laboratory courses and problem based learning / guided discussions (DOŠ).

**Lectures** are held three times a week during all semester in Lecture Hall 1 at Faculty of Medicine, Korytkova 2:

Tuesdays 8 AM - 10 AM

Wednesdays 13 AM - 14 AM

Thursdays 10 AM - 12 AM

**Problem based learning, guided discussions** (DOŠ) in organized in small groups in the Seminar at the Institute for Biochemistry, Vrazov trg 2 and last 2.5 school hours once per week according to the published timetable. During DOŠ the topics from the lectures are discussed in more depth and in the context of clinical correlations. Guided discussions on the lectures and exams' topics are intended to help prepare the students for the partial and final exams. In addition, the results of the partial exams are also discussed.

**Practical laboratory courses & seminars** are held in small groups once per week in the seminars/laboratories at the Institute for Biochemistry, Vrazov trg 2.

**Seminars** are scheduled before the laboratory courses and last for 2.5 school hours (see published timetable). The seminars are organised as tutorials and student seminars presentations. The schedule for student seminars presentations is published at the beginning of the academic year. Each student must prepare a seminar / presentation on one chosen topic either alone or in pair with a fellow student from the group. Each student (or the pair, respectively) must prepare a written report on the seminar topic, present the seminar orally to their fellow students in the group and answer the questions relevant to the topic during discussion. The written report on the seminar (Word document, a maximum of 800 words, font size 12, line spacing 1.5) should also include short conclusions (e.g., 3 to 4 points) with the most important findings as well as the most relevant figures from the seminar materials (articles). The student must submit this written report to the teaching assistant at least 14 days ahead of the scheduled oral presentation. The teaching assistant reviews the seminar in 7 days. A revised summary must be submitted to the fellow students from the group at least 5 days prior to the oral presentation, so that they can actively participate in the discussion. Oral presentation of the seminar should last 20 minutes at most, and must be accompanied by relevant slides (PowerPoint). The presentation is followed by discussion with the

active participation of all students. During the discussion the teaching assistant also assesses the understanding of the seminar topic by asking additional questions.

**Practical laboratory courses** last for 4 school hours (see published timetable). Only students who are enrolled in the second study year can participate at the practical courses. Student can participate in the practical course if he understands the theoretical foundations and principles of the practical work. All students must actively participate at practical laboratory work. After the end of the practical laboratory course the student has to write the report and answer the questions in the course syllabus book. The student has satisfactorily passed this particular practical course, if he is prepared for the course, has actively participated at practical laboratory work and when the teaching assistant has approved the report by signing.

**The attendance** at the practical laboratory courses & seminars is compulsory and is checked by keeping the attendance list. The exception is warranted in case of illness, drafting in the military, etc., which should be confirmed with an appropriate certificate. Students with a justifiable cause for not participating in the practical laboratory courses & seminars are allowed to substitute at most two missed courses in the current academic year; if they missed more than two courses they need to send the request for permission to substitute more courses to the head of the Institute of Biochemistry. The student will be notified on the further proceedings by e-mail, so the student's e-mail address should be given in the request.

If the student was not allowed to participate at the practical course because failing short written assessment, he or she may replace maximum of one exercise with the oral defense to the assistant at the next exercise.

Exceptionally, a student may take a seminar and an exercise in another group if there is a valid reason for doing so and he or she is allowed by an assistant in the other group. Prior to this (at least one week before substitution), the student must check with the assistant or be able to substitute in the selected group - when checking by email, he / she must indicate his / her group and the group in which he / she wants to substitute for teaching.

### **3. Description of on-going assessment of knowledge and skills**

#### **Written assessment for exercises and seminars**

The readiness for the practical laboratory courses and seminars is assessed by 10-minute written assessment that entails answering 3 short questions, each awarded 1 point (study material: Instructions for the practical laboratory courses at Medical Biochemistry and Laboratory Medicine, articles and seminar summaries). Achieving at least 1.5 points out of 3 (passed) confirms that the student has sufficiently mastered the theoretical foundations and understands the principles of the practical work to be carried out and can participate in the practical course. The student that did not achieve at least 1.5 points (failed) have to demonstrate that they mastered the topic satisfactorily in discussion with the teaching assistant during the next practical course.

Students that failed the short assessment more than twice in the semester must pass a repeated written assessment that includes 5 short essay questions that cover the topics of all seminars (5 short essay questions) and laboratory courses (5 short essay questions). The assessment is held at the end of the semester, usually in the week following the completion of seminars and exercises and lasts 45 minutes.

Similarly, student who failed to complete the laboratory courses before the end of the course must pass the same repeated written assessment before they can be admitted to the final examination.

### **Evaluation of seminars**

The student seminar is assessed according to the rating scale for examinations (see below). Student's oral presentation is graded by the fellow students (40 points) and by the teaching assistant (60 points). The fellow students' grade assesses: the structure of the seminar and the logical sequence (10 points), the manner of presentation (clarity, speech/reading, use of learning tools -10 points), timing of presentations (10 points) and interaction/encouragement of discussion with students (10 points). In addition, the teaching assistant assesses these same points as well as the knowledge of the topic (10 points) and the quality of the first of the written report on the seminar (10) points. If the written report for the seminar is not in accordance with the instructions from the course regime, this lowers the final grade of the seminar for half of a grade. In case of copying the seminars (plagiarism) the final grade is negative. If the assessment is not positive, the student has to defend the seminar topic again in discussion with the teaching assistant.

The final grade of the student seminar may contribute to the overall average grade of the three partial exams, but only when a student passed all short written assessments before the laboratory courses. The grade of the student seminar is added to the average score of the three partial written exams, so that:

- Seminar grade of 10 adds additional 5% to the average score of the three partial written exams
- Seminar grade of 9 adds additional 3%
- Seminar grade of 8 adds additional 1%

### **4. Required conditions for the final examination (Course Exam)**

Student has fulfilled the conditions to take the final exam when the practical laboratory courses and student seminar are completed and approved.

The practical laboratory courses requirement are met when all the practical courses are performed and the reports are signed by the assigned demonstrator and short written assessment are passed. The student seminar requirement are met when there was a successful oral presentation of the seminar and successful discussion that followed.

### **5. Final assessment and examination of knowledge and skills (Course Exam)**

The final exam is written and oral. The exam questions cover the topics of lectures, seminars, laboratory courses, problem based learning and guided discussions. Written examination comprises 40 multiple choice questions and takes 90 minutes. Each question has only one correct answer, which is scored by 1 point. Unanswered question is scored with 0 points, wrong answer or selection of multiple answers (correct and incorrect) is scored with 0 points.

To pass the written exam the student must achieve 60% of all scores. The student has to pass the written exam to be admitted to the oral exam. At the third attempt to pass the exam, the student can be admitted to oral exam regardless of the number of collected points in the written exam.

In the case of testing knowledge or skills, the score scale without the negative deductions is used as given below:

| <b>grade</b>            | <b>percentage achieved at the examination</b> |
|-------------------------|---|
| unsatisfactory (1 do 5) | 0,00 % to 59,99 %                             |
| satisfactory (6)        | 60,00 % to 67,99 %                            |

|                |                    |
|----------------|--------------------|
| good (7)       | 68,00 % to 75,99 % |
| very good (8)  | 76,00 % to 83,99 % |
| very good (9)  | 84,00 % to 91,99 % |
| excellent (10) | 92,00 % to 100 %   |

### **Possibility to pass a written exam with partial written exams:**

The student can pass the final written exam with three partial written exams during the semester according to Article 6 of the Regulations for assessment of knowledge and skills for the uniform master's study programmes of medicine and dental medicine; each one consisting of 20 multiple-choice exam questions with one single correct answer. There are no repetitive examination dates for each partial written exams. Students who achieve at least 60% as the sum of the average of the three partial exams and the grade of the seminar presentation of at least 8, can be admitted to the final oral exam without the written exam if they also successfully passed all the laboratory courses.

The final grade of the exam is determined at the oral exam. If the student fails the oral exam he/she is no more exempt from the written examination the next time.

The students who apply for the exam and do not show up for any justifiable reason are considered to have failed the exam.

### **Insights into exam materials**

Exercise and seminar readiness is reviewed as part of an ongoing exercise.

The examination of the results of the partial written examinations is carried out after the partial examination within the DOŠ. Written exams can be accessed by prior agreement with the teacher.

### **Improving rating**

If a student passes the exam with a positive grade but wants to improve the grade (in accordance with the rules), he / she must retake the exam by oral examination with the same examiner.

## **6. Other provisions**

### **Examination regulations:**

Students are obliged to observe ethical principles and the general rules of the examination regulations, set out in Article 34 of the *Regulations*, during written or oral exams.

Before the exam, the student has to identify him/herself with the photo identification document. When taking any type of written exams or assessments, the student can only bring the pencil, rubber, a basic calculator and an identification document. Silenced mobile phones and other electronic devices enabling taking pictures, as well as food, drinks and other personal belongings should be left in the student lockers or at the assigned spaces. During the exam, any communication between the students or any copying of the exam is forbidden. The students can start writing the exam only when allowed by the assigned lecturer or teaching assistant. Any type of exams and assessments can only be taken by the student him/herself and for any other arrangement both parties will be severely sanctioned. The students are obliged to leave all exam materials with the lecturer or teaching assistant immediately after finishing the exam.

### **Violation of the examination regulations:**

The violation of the examination order is determined by the supervising lecturer or teaching assistant. In the event a student fails to follow examination regulations, described in Article 34 of

the regulation, he or she shall be immediately prohibited from further examination in accordance with Articles 35 and 37 of the regulation. The exam shall be assessed unsatisfactory (5). Any unauthorized acquisition of exam materials by the students shall be considered as a disciplinary offense and sanctioned according to the Article 37 of the regulation.

#### **Exam before the committee:**

Exam before the committee is conducted in accordance with the regulation. It is composed of the written and oral part. When taking the exam for the fourth and fifth time, the student has to take the oral exam before a committee consisting of at least three members; an examiner and two members. In the case of the fifth examination, one member of the committee is from another department or institute of the Faculty of Medicine. For taking the fifth examination, a student must submit a formal written request to the Student Affairs Committee of the UL MF. In the case the request is approved, we highly advice the student to contact the course lecturer for consultations regarding the exam topics before applying for the exam.

#### **7. Fundamental study material and Supplement reading**

- Marks DB et al., Basic Medical Biochemistry, A Clinical Approach, 2013 (I)
- Devlin TM, Textbook of Biochemistry with Clinical Correlations, new editions (I)
- Instructions for the practical laboratory courses at Medical Biochemistry and Laboratory Medicine 2017, 3<sup>rd</sup> edition (I)
- Publications on the selected topics of the student seminars for 2019/2020 (S)

## 8. Exam topics, clinical presentations and skills

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| 1. Transmission of genetic information: DNA replication | <ul style="list-style-type: none"> <li>· Fundamental mechanisms of DNA replication, enzymes and proteins in regulation of DNA replication</li> <li>· DNA replication in prokaryotes</li> <li>· Genomic DNA replication in eukaryotes</li> <li>· Replication of telomeric DNA</li> <li>· Mitochondrial DNA replication</li> <li>· Accuracy of DNA replication</li> <li>· DNA repair during replication</li> <li>· Differences in prokaryotic and eukaryotic DNA replication in medical context</li> <li>· DNA replication inhibitors in medical context</li> </ul> | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> <li>• I: Isolation and characterization of genomic DNA from blood</li> <li>• DOŠ: Molecular basis of the premature aging syndromes</li> </ul> |
| 2. DNA repair   | <ul style="list-style-type: none"> <li>· Factors influencing the DNA damage</li> <li>· Mechanisms of DNA repair</li> <li>· Consequences of non-functional enzymes involved in DNA repair in human</li> </ul>  | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> </ul>   |
| 3. RNA synthesis  | <ul style="list-style-type: none"> <li>· Characteristics of prokaryotic and eukaryotic nucleotide sequences in RNA synthesis</li> <li>· RNA synthesis, enzymes and proteins in regulation of RNA synthesis in prokaryotes and eukaryotes</li> <li>· Similarities and differences in DNA replication and RNA synthesis</li> <li>· RNA synthesis inhibitors in medical context</li> </ul>   | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> </ul>   |
| 4. RNA processing                                       | <ul style="list-style-type: none"> <li>· synthesis of functional mRNA</li> <li>· synthesis of functional rRNA and tRNA, their role in organisms</li> <li>· synthesis of functional siRNA in miRNA, their role in organisms</li> </ul>   | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> </ul>   |

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| 5. Protein synthesis                      | <ul style="list-style-type: none"> <li>·Genetic code</li> <li>·Amino acid activation and its accuracy in protein synthesis</li> <li>·Steps in the synthesis of cytosolic and other proteins</li> <li>·Protein synthesis inhibitors and their use in medicine</li> </ul>  | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> </ul>   |
| 6. Protein processing                     | <ul style="list-style-type: none"> <li>·Glycosylation of proteins, impact in organisms</li> <li>·Amino acid modifications, impact in in organisms</li> <li>·Processing of collagen and insulin, consequences of non-functional processing in human</li> </ul>  | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> </ul>   |
| 7. Regulation of gene expression          | <p>Mechanisms of regulation of gene expression in prokaryotes and eukaryotes at the level of:</p> <ul style="list-style-type: none"> <li>· RNA synthesis and stability</li> <li>· co-and post-trasncriptional level</li> <li>- protein synthesis level</li> </ul>  | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> </ul>   |
| 8. Recombinant DNA technology in medicine | <ul style="list-style-type: none"> <li>·Restriction enzymes in molecular biology</li> <li>·Recombinant DNA: production, replication and analysis</li> <li>·Site directed mutagenesis in cells and tissues</li> <li>·Nucleic acids hybridization for specific DNA molecules detection in medicine</li> <li>·Polymerase chain reaction (PCR) in medicine</li> <li>·DNA sequencing</li> <li>·Molecular genetics in medical diagnostics and treatment</li> </ul> | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> <li>• I: PCR detection of glutathione-S-transferase gene deletion</li> <li>• I: Methods for recombinant vector analysis</li> <li>• I: On-line tools for protein analysis</li> </ul> |
| 9. The molecular biology of cancer        | <ul style="list-style-type: none"> <li>·Cancer as a genetic disorder</li> <li>·Molecular mechanisms in carcinogenesis</li> </ul>   | <ul style="list-style-type: none"> <li>• Lecture</li> </ul>   |



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|  | <ul style="list-style-type: none"> <li>·Molecular mechanisms of oncogenes and tumor-suppressor genes</li> <li>·Molecular genetics basis of targeted cancer treatment</li> </ul>  | <ul style="list-style-type: none"> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> <li>• DOŠ: Targeted therapies in cancer</li> </ul>   |
| 10. Metabolism                                 | <ul style="list-style-type: none"> <li>·Characteristics of catabolic and anabolic processes</li> <li>·Substrate activation in metabolism</li> <li>·Coenzymes in metabolism</li> <li>·Regulation of metabolism</li> </ul>   | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> <li>• I: Experimental methods for the studies of the metabolism</li> <li>• DOŠ: Vitamins and coenzymes in metabolism</li> </ul>       |
| 11. Cell signaling in regulation of metabolism | <ul style="list-style-type: none"> <li>·Chemical messengers and their role in gene expression in metabolic pathways</li> <li>·Hormones as chemical messengers, hormone receptors</li> <li>·Mechanisms of hormone cell signalling in metabolism</li> <li>·Important kinases in cell signalling</li> <li>·MAP-kinases pathways in regulation of gene expression</li> </ul> | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> <li>• S: Signal transduction</li> <li>• I: On-line tools for protein analysis</li> <li>• DOŠ: Targeted therapies in cancer</li> </ul> |
| 12. Biochemical overview of selected hormones  | <ul style="list-style-type: none"> <li>·Hypothalamic hormones: biosynthesis, release and mechanism of action</li> <li>·Pituitary hormones: biosynthesis, release and mechanism of action</li> <li>·Thyroid and parathyroid hormones: biosynthesis, release and mechanism of action</li> </ul>  | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> </ul>   |

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|  | <ul style="list-style-type: none"> <li>·Pancreatic hormones (insulin, glucagon): biosynthesis, release and mechanism of action</li> <li>·Adrenal medulla hormones(adrenaline): biosynthesis, release and mechanism of action</li> <li>· Steroidogenic hormones (Glucocorticoids, mineralocorticoids, sex hormones): biosynthesis, release and mechanism of action</li> <li>·Adipokines: role in metabolism</li> <li>·Hormones of the gastrointestinal tract, role in metabolism</li> <li>·Eicosanoids: biosynthesis and mechanism of action</li> <li>·Inactivation of hormones</li> </ul>  |   |
| 13. Fuel oxidation and ATP               | <ul style="list-style-type: none"> <li>·Metabolic fuels and ATP synthesis</li> <li>·Oxygen in fuel oxidation</li> <li>·Sources and fate of acetyl-CoA in metabolism</li> <li>·The tricarboxylic acid cycle (products, regulation, amphibolic role)</li> <li>·Electron transport chain and oxidative phosphorylation</li> <li>·Inhibitors of the electron transport chain and oxidative phosphorylation</li> <li>·Mechanism of uncoupling proteins and ionophores</li> <li>·Additional ATP synthesis processes (substrate-level phosphorylation, creatine-kinase and adenylate-kinase reactions)</li> <li>·Oxidations not involved in electron transport chain and oxidative phosphorylation</li> <li>·Cytochrome P-450 family enzymes in metabolism</li> </ul> | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> <li>• DOŠ: AcCoA in mitochondria, cytosol and nucleus. Isocitrate dehydrogenase isoenzymes and their importance in medicine. Cytochrome P450 and their importance in medicine. Inherited disorders of pyruvate, tricarboxylic acid cycle and respiratory chain</li> </ul> |
| 14. Reactive oxygen and nitrogen species | <ul style="list-style-type: none"> <li>·Reactive oxygen (ROS) and nitrogen (RNS) species formation</li> <li>·Metals in ROS formations</li> <li>·ROS and RNS characteristics</li> <li>·Damage in biomolecules caused by ROS and RNS</li> <li>·Cellular defence against ROS and RNS</li> <li>·ROS and RNS in medicine</li> </ul>   | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> <li>• S: ROS</li> </ul>   |

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|   |  | <ul style="list-style-type: none"> <li>• I: Activity of anti-oxidative enzymes and lipid peroxidation in erythrocyte hemolysate</li> </ul>  |
| 15. Metabolic fuels and dietary components          | <ul style="list-style-type: none"> <li>· Role of digestion in the organism</li> <li>· Characteristics and role of digestive enzymes</li> <li>· Digestion regulation and hormones</li> <li>· Proenzymes of digestive enzymes and their activation</li> <li>· Absorption of basic nutrient constituents in enterocytes</li> <li>· Transport of the digestion products to the organs and tissues</li> <li>· Enzyme deficiency in relation with the digestion</li> </ul> | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> </ul>   |
| 16. Sources of carbohydrates and their digestion    | <ul style="list-style-type: none"> <li>· Exogenous sources of glucose</li> <li>· Enzymes in carbohydrates digestion</li> <li>· Carbohydrates digestion products, absorption</li> <li>· Enzyme and transporters deficiency in relation with carbohydrates digestion</li> </ul>  | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> <li>• S: Digestion of carbohydrates</li> <li>• I: Digestion of carbohydrates</li> </ul> |
| 17. Glucose as the major metabolic fuel, glycolysis | <ul style="list-style-type: none"> <li>· Hexokinase/glucokinase</li> <li>· Schematic overview of the aerobic degradation of glucose to the CO<sub>2</sub> and H<sub>2</sub>O</li> <li>· Glycolysis: source of the pyruvate</li> <li>· Anaerobic glycolysis and its role</li> <li>· Regulation of the aerobic glycolysis</li> <li>· Regulation of the anaerobic glycolysis</li> <li>· Enzyme deficiency in glucose degradation</li> </ul>                             | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> <li>• S: Glucokinase and glucose homeostasis</li> </ul>                                 |
| 18. Gluconeogenesis                                 | <ul style="list-style-type: none"> <li>· Gluconeogenesis and glucose blood homeostasis</li> <li>· Gluconeogenesis substrates</li> <li>· Cori cycle in glucose-alanine cycle</li> <li>· Regulation of the gluconeogenesis</li> <li>· Enzyme deficiency in gluconeogenesis</li> </ul>  | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of</li> </ul>   |

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|  | <ul style="list-style-type: none"> <li>·Ethanol metabolism and the relation to the gluconeogenesis</li> </ul>  | <p>Biochemistry with Clinical Correlations, 2011</p> <ul style="list-style-type: none"> <li>• DOŠ: The impact of the ethanol metabolism to the other metabolic pathways</li> </ul>   |
| 19. Glycogen metabolism                                      | <ul style="list-style-type: none"> <li>·Glycogen as an endogenous source of energy</li> <li>·Glycogen degradation and regulation</li> <li>·Glycogen biosynthesis and regulation</li> <li>·Glycogen storage in liver and muscles and its role</li> </ul>  | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> <li>• I: Quantitative analysis of the glycogen in tissues</li> </ul> |
| 20. Metabolism of selected monosaccharides and disaccharides | <ul style="list-style-type: none"> <li>·Fructose and galactose in glycolysis</li> <li>·Enzyme deficiencies in fructose and galactose metabolism</li> <li>·Biosynthesis of lactose and regulation</li> <li>·Biosynthesis of glucuronic acid</li> <li>·Glucuronic acid in detoxification of endogenous and exogenous substrates</li> </ul> | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> <li>• DOŠ: Fructose metabolism.</li> </ul>                            |
| 21. Pentose phosphate pathway                                | <ul style="list-style-type: none"> <li>·Oxidative and non-oxidative phase</li> <li>·Important products of the pathway</li> <li>·Role of the pentose phosphate pathway</li> <li>·Enzyme deficiency in the pentose phosphate pathway</li> </ul>  | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> </ul>  |
| 22. Digestion of lipids                                      | <ul style="list-style-type: none"> <li>·Exogenous origin of fatty acids</li> <li>·Lipids in the diet</li> <li>·Enzymes in lipids digestion</li> <li>·Bile acids: role in digestion and absorption of lipids</li> <li>·Digestion products of lipids and their absorption in enterocytes</li> <li>·Synthesis of chylomicrons</li> </ul>    | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> </ul>  |

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|   | <ul style="list-style-type: none"> <li>·Transport of the digestion products of lipids to the organs and tissues</li> </ul>  | <ul style="list-style-type: none"> <li>• S: Lipids digestion</li> <li>• I: Lipids digestion</li> </ul>  |
| 23. Triacylglycerols (TAG) as an energy source              | <ul style="list-style-type: none"> <li>·Characteristics and importance of TAG storage</li> <li>·Degradation of endogenous lipids, regulation</li> <li>·Lipases: characteristics and role in lipid metabolism</li> </ul>   | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> </ul> |
| 24. Fatty acids (FA): utilization for the energy production | <ul style="list-style-type: none"> <li>·Schematic overview of the FA oxidation to CO<sub>2</sub> and H<sub>2</sub>O</li> <li>·β-oxidation of FA</li> <li>·β-oxidation products</li> <li>·Regulation of β-oxidation</li> <li>·Enzyme deficiency in β-oxidation</li> <li>·Additional pathways in FA degradation</li> </ul>                | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> </ul> |
| 25. Ketone bodies: utilization for the energy production    | <ul style="list-style-type: none"> <li>·Schematic overview of the biosynthesis of ketone bodies in liver</li> <li>·Regulation of the biosynthesis of ketone bodies</li> <li>·Activation and degradation of ketone bodies in peripheral tissues</li> <li>·Ketone bodies and their role in selected conditions of the organism</li> </ul> | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> </ul> |
| 26. Biosynthesis of fatty acids (FA)                        | <ul style="list-style-type: none"> <li>·Enzymes in FA biosynthesis</li> <li>·Regulation of FA biosynthesis</li> <li>·FA chain elongation and desaturation</li> <li>·Comparison of β-oxidation and FA biosynthesis</li> </ul>  | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> </ul> |
| 27. Triacylglycerol (TAG) metabolism                        | <ul style="list-style-type: none"> <li>·Biosynthesis of TAG</li> <li>·Regulation of the TAG biosynthesis</li> <li>·Enzyme deficiency in TAG metabolism</li> <li>·Glyceroneogenesis: the origin of the glycerol-3-phosphate</li> </ul>   | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of</li> </ul>   |

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|                                      | <ul style="list-style-type: none"> <li>·Comparison of the TAG biosynthesis in the liver and in the adipose tissue</li> </ul>   | Biochemistry with Clinical Correlations, 2011  |
| 28. Metabolism of the complex lipids | <ul style="list-style-type: none"> <li>·Biosynthesis and degradation of phospholipids</li> <li>·Biosynthesis and degradation of glycolipids</li> <li>·Enzyme deficiency in the metabolism of complex lipids</li> </ul>   | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> <li>• DOŠ: Fabry disease.</li> </ul>   |
| 29. Cholesterol metabolism           | <ul style="list-style-type: none"> <li>·Role of cholesterol in human body</li> <li>·Sources of cholesterol in human</li> <li>·Schematic overview of cholesterol and isoprenoids biosynthesis</li> <li>·Inhibitors of cholesterol biosynthesis and their role in medicine</li> <li>·Biosynthesis of bile acids</li> <li>·Excretion of bile acids and enterohepatic circulation</li> </ul>                           | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> </ul>  |
| 30. Metabolism of the lipoproteins   | <ul style="list-style-type: none"> <li>· Chylomicrons and VLDL in the transport of exogenous and endogenous TAG</li> <li>·LDL in cholesterol transport</li> <li>·HDL in reverse cholesterol transport</li> <li>·Apolipoproteins in the metabolism of the lipoproteins</li> <li>·Receptors, transporters and enzymes in the metabolism of the lipoproteins</li> <li>·Disorders of lipoprotein metabolism</li> </ul> | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> <li>• I: On-line databases for the demonstration of the lipoproteins and their metabolism</li> </ul> |
| 31. Metabolism of the eicosanoids    | <ul style="list-style-type: none"> <li>·Polyunsaturated fatty acids in eicosanoid metabolism</li> <li>·Schematic overview of the biosynthesis of prostaglandins, thromboxane, leukotrienes and eicosanoids</li> <li>·Regulation of metabolism of eicosanoids</li> <li>·Inhibitors of eicosanoid biosynthesis and their role in medicine</li> </ul>   | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> </ul>  |

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|  |   | <ul style="list-style-type: none"> <li>• DOŠ: Inhibitors of the eicosanoid metabolism and their mechanism of action.</li> </ul>  |
| 32. Dietary proteins and their digestion                     | <ul style="list-style-type: none"> <li>·Dietary proteins</li> <li>·Enzymes in the digestion of dietary proteins and their activation</li> <li>·Digestion products and absorption</li> <li>·Regulation of protein digestion</li> </ul>   | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> <li>• S: Digestion of proteins</li> <li>• I: Digestion of proteins</li> </ul>  |
| 33. Metabolism of the endogenous proteins                    | <ul style="list-style-type: none"> <li>·Metabolic turnover of proteins</li> <li>·Degradation of endogenous proteins</li> <li>·Protein defects in degradation of endogenous proteins and their role in medicine</li> </ul>   | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> </ul>  |
| 34. Metabolism of Amino acids                                | <ul style="list-style-type: none"> <li>·Pathways of elimination of the amino acid nitrogen</li> <li>·Transamination and oxidative deamination in degradation of the amino acids</li> <li>·Toxicity of ammonia</li> <li>·Alanine and glutamine in ammonia blood transport</li> <li>·Urea cycle: origin of nitrogen for urea synthesis</li> <li>·Regulation of urea synthesis</li> <li>·Enzyme deficiency in urea cycle</li> <li>·Schematic overview of amino acid degradation</li> <li>·Enzyme deficiency in amino acid degradation</li> <li>·Schematic overview of the biosynthesis of the non-essential amino acids</li> </ul> | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> <li>• S: Amino acid metabolism</li> <li>• I: Alanine-transaminase enzyme activity in biological samples</li> <li>• DOŠ: Phenylketonuria</li> </ul> |
| 35. Amino acids as the source compounds for the biosynthesis | <ul style="list-style-type: none"> <li>·Biosynthesis of the glutathione</li> <li>·Biosynthesis of hem, regulation and inhibition</li> <li>·Bilirubin and its secretion</li> </ul>   | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach,</li> </ul>   |

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|  | <ul style="list-style-type: none"> <li>·Biosynthesis of biogenic amines, their role</li> <li>·Tyrosine: biosynthesis of thyroid hormones</li> <li>·Tyrosine: biosynthesis of catecholamine</li> </ul>   | 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011   |
| 36. Metabolism of nucleotides                                | <ul style="list-style-type: none"> <li>·Biosynthesis of the nucleotides, substrates</li> <li>·Schematic overview of the biosynthesis of the ribonucleotides</li> <li>·PRPP biosynthesis of the ribonucleotides <i>de novo</i> and in recycling</li> <li>·Biosynthesis of the deoxynucleotides</li> <li>·Schematic overview of degradation of ribonucleotides and deoxyribonucleotides</li> <li>·Regulation of metabolism of nucleotides</li> <li>·Enzyme deficiency in metabolism of nucleotides</li> <li>·Inhibitors of the deoxyribonucleotides synthesis and their role in medicine</li> </ul> | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> </ul>  |
| 37. Metabolic characteristics of selected tissues and organs | <ul style="list-style-type: none"> <li>·Liver and adipose tissue role in fuel availability</li> <li>·Liver in homeostasis of glucose and cholesterol</li> <li>·Liver and detoxification of ethanol, xenobiotics, endogenous nitrogen, bilirubin)</li> <li>·Metabolic characteristics of skeletal and heart muscle</li> <li>·Metabolic characteristics of erythrocytes, kidney, bones and brain</li> <li>·Metabolic characteristics of cancer cells</li> </ul>   | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> </ul>  |
| 38. Integration of the metabolism                            | <ul style="list-style-type: none"> <li>·Metabolic processes after the ingestion of the metabolic fuels and between the meals</li> <li>·Metabolic processes at prolonged starvation</li> <li>·Metabolic processes at over-feeding</li> <li>·Metabolic processes during physical activity</li> </ul>  | <ul style="list-style-type: none"> <li>• Lecture</li> <li>• T: Marks DB in sod., Basic Medical Biochemistry, A Clinical Approach, 2013 or Devlin TM, Textbook of Biochemistry with Clinical Correlations, 2011</li> <li>• DOŠ: Metabolic characteristics of the cancer cells.</li> </ul> |



## 9. Other information

The exam procedure and application process is defined in the *regulation*. A student, who applied for the exam but later does not take the exam or withdraws from the exam, shall be considered as having failed the exam. There is no need to apply for partial written exams.

### **Regulations at the laboratories for the practical laboratory course**

For safety reasons, the students must follow the laboratory safety rules. Clothes and bags must be stored in the lockers. No food or drinks are allowed in the laboratories. Students must wear laboratory coats while performing experiments. In certain exercises, students should wear the gloves they receive in the classroom.

E-mail questions will be answered during business hours.