| Module title: | Biochemistry (2) | ECTS | 6 |
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| Polish translation: | Biochemia (2) | | |
| Course: | **Veterinary Medicine** | | |

| Module language: English | | Stage: JM-FVM | |
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| Form of studies: ■ intramural ☐ extramural | Type of module: ■ basic ☐ directional ■ mandatory ☐ elective | Semester: 3 | ■ winter semester ☐ summer semester |
| Academic year: | **2023/2024** | Catalogue number: | **FVM-V-JMSS-03W-B09_23** |

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| Module coordinator: | **dr hab. Małgorzata Gajewska, prof. SGGW** |
| Teachers responsible for the module: | **Academic teachers of the Institute of Veterinary Medicine; Department of Physiological Sciences/Division of Biochemistry and Dietetics; PhD students in accordance to the internal legal acts; visiting professors; other specialists in the field of study** |
| Objectives of the module: | The aim of the second semester of Biochemistry course is to teach students about the most important biochemical processes necessary for proper functioning of animal organisms. Students are taught about the metabolic pathways of the main groups of biochemical compounds (carbohydrates, lipids, proteins, nucleic acids, porphyrins), about pathologies connected with the disorders concerning these metabolic pathways, as well as biochemical aspects of cellular signalling. The metabolic pathways are also presented in the aspect of proper functioning of specific organs and tissues. During the practical part of the course students are performing qualitative and quantitative analyses, that are used in biochemical diagnostics, and are important for veterinary medicine. Biochemistry course (2) prepares students for other future courses e.g.: pharmacology, toxicology, animal physiology as well as veterinary diagnostics. |
| Teaching forms, number of hours: | a) Lectures; hours **30**;<br>b) Laboratory classes; hours **45**; |
| Teaching methods: | **Lectures**: multimedia presentations prepared by lecturers of IVM who are responsible for the theoretical part of the course; the lectures present topics of basic metabolism of biochemical compounds as well as practical and clinical aspects of biochemistry.<br>**Laboratory classes**: theoretical introduction to each class is made by teachers supervising the practical part of the Biochemistry course using multimedia presentations; practical experiments are performed by students working in teams (2-3 students). Students learn to do qualitative as well as quantitative analyses. By the end of each class results and conclusions for each of the performed experiments are presented and discussed with teachers.<br>**Consultations for students** - 1h/week. Detailed organization of consultations will be defined by the coordinator of the course at the beginning of semester. |
| Formal prerequisites and initial requirements: | Students should finish **Chemistry course and Biochemistry (1) course** with a positive grade to enter the Biochemistry (2) course. |

| Learning effects | | Course outcomes: | Learning outcomes relative to the course outcomes | Impact on the course outcomes* |
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| Knowledge: | 1 | Student knows and understands the main metabolic pathways of the most important biochemical compounds: carbohydrates, amino acids, proteins, lipids, porphyrins, nucleic acids | A.W.4<br>A.W.10 | 3<br>2 |
| | 2 | Student knows and understands connection between improper functioning of metabolic pathways and metabolic diseases (e.g. ketosis, diabetes, phenylketonuria, gout, etc.) | A.W.4<br>A.W.10, A.W.11<br>B.W.1 | 3<br>2<br>1 |
| | 3 | Student knows and understands specificity of metabolic pathways in distinct organs and tissues in relation to synthesis/catabolism of specific biochemical compounds | A.W.4<br>A.W.10, A.W.11,<br>A.W.12<br>B.W.1, B.W.2 | 3<br>2<br>2<br>1 |
| | 4 | Student knows and understands signal transduction pathways induced by different compounds belonging to hormones or growth factors | A.W.4<br>A.W.9, B.W.1 | 3<br>1 |
| | 5 | Student knows and understands biochemical composition and characteristics of semen, milk and urine | A.W.4<br>A.W.2<br>B.W.4 | 3<br>2<br>1 |
| Skills: | 1 | Student is able to identify specific metabolites of biochemical compounds and determine their properties based on characteristic reactions | A.U.2<br>A.U.4<br>B.U.6 | 3<br>2<br>1 |
| | 2 | Student is able to use the main laboratory techniques, such as: qualitative analyses, titration, colorimetric measurements, diagnostic tests | A.U.2<br>B.U.6; B.U.7 | 3<br>1 |
| | 3 | Student is able to predict direction of metabolic processes depending on the energetic status of the organism (availability of proteins, lipids, carbohydrates in diet) | A.U.5<br>A.U.4 | 3<br>2 |
| | 4 | Student is able to point differences among species in regard to metabolic changes in animal organisms | A.U.5<br>A.U.2, A.U.7 | 3<br>2 |

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| | | | B.U.6 | 1 |
| | 5 | Student is able to point differences among species in regard to physiological and pathological values of biochemical parameters in animals' blood and urine | A.U.2, A.U.5<br>A.U.7<br>B.U.6 | 3<br>2<br>1 |
| Competences: | 1 | Student is ready to share his/her knowledge and practical skills with other team members | KS.9 | 3 |
| | 2 | Student is ready to interpret results obtained and make conclusions based on performed analyses or observations, and is able to explain the results in a clear and factual manner using arguments based on available scientific literature regarding veterinary sciences | KS.4, KS.5 | 3 |
| | 3 | Student is critical to his/her knowledge and understands the necessity of constant upgrading this knowledge using the most up to date publications and data | KS.7<br>KS.8 | 3<br>2 |
| | 4 | Student is ready to use his/her knowledge and skills in further steps of education | KS.8 | 2 |

Objectives of the module required to obtain learning effects:

Detailed description of the course:

**Lecture topics (2 h each):**

- Cellular respiration – high-energy phosphate bonds, ATP, phosphagenes; electron transport chain; oxidative phosphorylation; inhibitors of electron transport chain and oxidative phosphorylation; energy balance of NADH and $FADH_2$ oxidation; regulation of electron transport chain action.
- Krebs cycle – oxidative decarboxylation of α-keto acids; Krebs cycle - energy balance and regulation; substrate phosphorylation.
- Carbohydrates metabolism, part I – carbohydrates digestion and absorption in digestive tract; glycolysis; gluconeogenesis.
- Pentose phosphate pathway and the role of NADPH, synthesis and metabolism of glycogen.
- Metabolism of lipids- lipids digestion and absorption in digestive tract, *de novo* synthesis and elongation of fatty acids – the main sources of NADPH; beta-oxidation and its energy balance; eicosanoids synthesis; ketones synthesis.
- Cholesterol metabolism: biosynthesis of cholesterol and its regulation; bile acids and salts synthesis; lipoproteins in blood serum and their metabolism; metabolism of chylomicrons; metabolism of VLDL, LDL and HDL; metabolism of steroid hormones; vitamin D metabolism.
- Proteins metabolism: proteins digestion and absorption in digestive tract; protein degradation in cells; nitrogen balance, transamination reactions, urea cycle .
- Amino acids and proteins metabolism: common amino acids reactions: decarboxylation, deamination; synthesis biogenic amines; hereditary diseases connected with improper amino acids metabolism.
- Metabolism of purine and pyrimidine nucleotides, diseases connected with improper catabolism of purines.
- Porphyrins metabolism –step by step synthesis of heme and hemoglobin; heme catabolism; role of the degradation products of heme: bilirubin, urobilinogen, stercobilinogen; diseases connected with improper heme synthesis and catabolism.
- Signal transduction pathways in cells and their role in cellular activity. Molecular mechanisms of hormone-induced signals in cells.
- Metabolic autonomy of kidneys.
- Metabolic autonomy of liver and muscles.
- Biochemistry of milk.
- Biochemistry of semen.

**List of topics presented during laboratory classes:**

- Cellular respiration: detection of catalase activity in blood; detection of ceruloplasmin oxidative activity in blood serum; detection of aldehyde oxidase activity in milk (3 h);
- Carbohydrates metabolism: detection of glucose concentration in blood by Hultman colorimetric method; detection of amylolytic activity of blood serum; detection of amylase activity in saliva;gradual acidic hydrolysis of glycogen; enzymatic hydrolysis of starch (2 x 3 h);
- Lipids metabolism: detection of bile acids; emulsifying properties of bile ; detection of lipases activity in pancreatic juice; detection of total cholesterol and its fractions (HDL, LDL) by diagnostic tests (2 x 3 h);
- Amino acids and proteins metabolism: detection of α – amino nitrogen in blood serum by ninhydrin method; separation of albumins from globulins using a salt method; detection of trypsin activity in pancreatic juice by Gross and Fuld method; detection of proteolytic activity of gastric and duodenum content; detection of AST and ALT activity by diagnostic tests (2 x 3 h);
- Purines and pyrimidines metabolism: quantitative detection of uric acid using diagnostic test; different methods of detection of reducing properties of uric acid (3 h);
- Porphyrins metabolism : detection of bilirubin in blood serum using Molloy's and Evelyn's method; detection of urobilinogen and urobilin in urine; qualitative detection of haemoglobin by Drabkin's cyanmethemoglobin method (3 h);
- Metabolic autonomy of kidney: physical properties of urine; pathological urine; detection of urine pigments, proteins sugar, ketones, haemoglobin and bile pigments in urine sample (2 x 3 h);
- Metabolic autonomy of liver and muscles: detection of creatinine in urine by quantitative test; detection of lactate dehydrogenase, blood urea nitrogen using diagnostic tests (2 x 3 h);
- Milk composition: detection of milk proteins, lactose and lipids (2 x 3 h).

The content of the lectures supplements the content of the laboratory classes.
Topics of lectures and laboratory classes, as well as the form of their presentation may be modified, based on current legal regulations of Polish authorities connected with unforeseen, unusual circumstances in the country (e.g. pandemic).

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| Assessment methods: | Verification tests of the knowledge gained during lectures and practical part of the course; points for preforming properly chosen qualitative and quantitative analyses during laboratory classes; final exam, which verifies the theoretical knowledge of the entire course (Biochemistry 1 and Biochemistry 2) based mainly on the lecture topics presented during both semesters of the course.<br><br>In case of unforeseen, unusual circumstances mandatory remote teaching and remote assessment methods might be adopted. However, practical skills connected with the course can be verified only during laboratory classes. |
| Detail description of assessment methods; | **Assessment of laboratory classes:**<br>Student is obliged to be theoretically prepared for each laboratory class. This theoretical preparation is verified during **short entry tests (1 open question, each for 1 point).** Seven entry tests are planned during semester, which gives a **total of 7 points** added to the sum of points obtained during the practical part of the Biochemistry (1) course.<br>Before each practical teachers gives a short introduction of the current topic in which most important theoretical and practical aspects are discussed. Next, students begin the practical part of class using experimental protocols provided by the module coordinator. Each experiment is performed in teams of 2-3 students. By the end of each laboratory class teacher is discussing the results obtained by students and their conclusions. Each practical class is regarded as finished when teacher verifies the results and conclusions and approves them. In the case of quantitative analyses each student is able to obtain 1 point for final result if is it is the same or close (10% error) to the correct answer. There are 5 experiments assessed in such manner in winter semester, thus student can obtain 5 additional points for laboratory classes, which are added to the sum of points obtained during the practical part of the Biochemistry (2) course.<br>Student is obliged to participate in laboratory classes, but has the right to be absent from 3 classes (20% of all scheduled practical) without giving explanation.<br><br>**Main verification tests**:<br>Detailed knowledge of topics presented during laboratory classes and corresponding lectures is verified during **3 main verification tests** (list of topics for each test is presented at the beginning of semester). Each test consists of 7 open questions, each for 0-3 points (21 points max.). Each verification test is passed when a student obtains **at least 11 points** (52% of the total number of points). Each main verification test can be repeated once during the semester, allowing students to correct the grade. Students must pass EACH of the 3 verification tests in order to be qualified for the final exam.<br><br>**FINAL GRADE FOR THE SEMESTER:**<br>The total number of points that students can obtain during the semester**:**<br>**21 points (main verification test) * 3 = 63 points**<br>**1 point (short entry test) * 7 = 7 points**<br>**1 point (practical experiment) * 5 = 5 points**<br>**∑75 points**<br>**Point scale and corresponding grade scale for the semester:**<br>0 – 37.5 2.0 (**not passed**)<br>38.0 – 45.0 3.0 (sufficient)<br>45.5 – 52.5 3.5 (sufficient +)<br>53.0 - 60.0 4.0 (good)<br>60.5 - 67.0 4.5 (good +)<br>67.5 – 75.0 5.0 (very good)<br><br>**SEMESTRAL – last chance verification test**<br>If a student is left with failed main verification tests (two or three tests) by the end of the semester he/she has a final chance to correct the results by writing a SEMESTRAL covering all topics presented during the course. The SEMESTRAL verifies lecture topics and consists of 10 open questions (each for 0-3 points). The SEMESTRAL is passed when 15,5 points are obtained (>50%). The points obtained serve to calculate the equivalent number of points that student should have obtained passing all three separate verification tests (63 points maximum). This means that the number of points for the SEMESTRAL is multiplied by **a coefficient equal 2.1**. Next, these points are added to the points obtained for short entry tests and practical experiments according to the description presented above (**description of the final grade for the semester**). The total number of points obtained determines the grade for the practical part of the Biochemistry (2) course.<br><br>**FINAL EXAM:**<br>At the end of the Biochemistry (2) course students must take the FINAL EXAM, which verifies the theoretical knowledge of the entire course (Biochemistry 1 and Biochemistry 2). The final exam, consists of 45 multiple choice questions with one correct answer (each question for 0-1 point) and 5 open questions (each for 0-3 points). The exam is passed when at least 36 points are obtained (60%). FINAL EXAM can be repeated once, allowing students to correct the grade.<br><br>**Point scale and corresponding grade scale for the FINAL EXAM:**<br>0.0 – 35.5 2.0 (not passed)<br>36.0 – 39.5 3.0 (sufficient)<br>40.0 – 45.0 3.5 (sufficient +)<br>45.5 – 47.0 4.0 (good)<br>47.5 – 51.5 4.5 (good +)<br>52.0 – 60.0 5.0 (very good)<br><br>Students must pass the final exam in order to obtain the final grade from Biochemistry (2) course.<br><br>Students obtain one grade based on the results of ALL tests during the semester and the results of the final exam.<br><br>**Additional information:**<br>In case of justified absence at the exam student maintains the possibility of two exam dates, which will be arranged by the Module Coordinator.<br><br>No extra assessment methods are anticipated. |

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| Formal documentation of learning outcome: | eHMS entry.<br>Records collected in the course portfolio i.e. individual records of student results, presence lists, database of oral and written questions, written assessments of the students. |
| Elements impelling final grade: | **Student obtains one grade finishing the Biochemistry (2 )course.**<br>The final grade for Biochemistry course (2) is based on the average of two grades:<br>- for the semester (sum of points from main verification tests, entry tests and practical experiments) – 50% of weight<br>- for the FINAL EXAM – 50% of weight |
| Teaching base: | Lecture rooms of IVM, didactic laboratory of Biochemistry and Dietetics Division at Department of Physiological Sciences (room 136/137, building 24) |
| Mandatory and supportive materials :<br>1. Lippincott's Illustrated Reviews Biochemistry (sixth or seventh edition) by Denise R. Ferrier ; Lippincott Williams & Wilkins;<br>2. Harper's Illustrated Biochemistry by V.W. Rodwell, D. Bedner, K.M. Botham, P.J. Kennelly, P.A. Weil; McGraw Hill Education, a Lange Medical book.<br>3. Biochemistry, 5th edition by J. M. Berg, J. L. Tymoczko, and L. Stryer; New York; ISBN-10: 0-7167-3051-0<br>4. Marks' Basic Medical Biochemistry: A Clinical Approach by M. Lieberman, A. Peet; Wolters Kluver<br>5. Clinical Biochemistry of Domestic Animals, sixth edition, by J.J. Kaneko, J. W. Harvey, M. L.Bruss; Academic Press 2008<br>6. Handouts for laboratory classes prepared by module coordinator<br>7. Relevant scientific publications, including those of the module coordinator.<br><br>Relevant scientific publications including those of the module coordinator. | |
| ANNOTATIONS<br>Lab coats are mandatory during laboratory classes. Students who show symptoms of cold (sneezing, coughing) must also ware face masks. In case of state of pandemic in the country face masks are mandatory during laboratory classes. | |

* 3 – complete and detailed, 2 – moderate, 1 – basic.

Quantitative summary of the module:

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| Estimated number of work hours per student (contact and self-study) essential to achieve presumed learning outcomes of the module - base for quantifying ECTS: | **150 h** |
| Total ECTS points, accumulated by students during contact learning: | **4 ECTS** |