**Federal State Budgetary Educational Institution**

**of Higher Education**

**"Orenburg State Medical University"**

**of the Ministry of Health of the Russian Federation**

**EVALUATION FUND OF**

**MONITORING OF ACADEMIC PERFORMANCE AND INTERMEDIATE CERTIFICATION STUDENTS**

**Speciality: 31.05.01 – General medicine**

**Discipline: BiochemistryPassport of fund of assessment means**

**FOR CURRENT PROGRESS MONITORING AND MIDTERM CERTIFICATION OF STUDENTS STUDYING ON DISCIPLINE**

**Characteristics of monitoring forms**

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| **Monitoring form** | **Characteristics** |
| **Report** | A report is a public announcement or document that contains information and reflects the essence of the issue or research in relation to a given situation. It can be written or oral. An oral presentation can be accompanied by a multimedia presentation or demonstration of any visual (material) objects.  Report allows you to assess the level of student`s theoretical knowledge on a given question, as well as to check the skills of analysis, synthesis, generalization and concretization, used by students while preparing a report. |
| **Project defense** | A project is a set of documents (calculations, drawings, etc.) for making any structure or product. Preliminary text of a document. Concept, plan. Independent student activity to solve the problem with the achievement of a practical result. It allows you to assess student`s knowledge level on the problem of the project, as well as the skills of planning, goal-setting, research, practical application of knowledge in typical and non-standard situations (for example, the material design of a project product or its separate component). To assess the skills of students, the project should have a practice-oriented nature, which would clearly show the ability of students to practically apply knowledge in typical and non-standard situations (for example, the material design of the project product or its separate component). |
| **Control of assignments in the workbook** | Control tasks in the workbook are aimed at identifying and comparing at a particular stage of learning the results of students' educational activities with the requirements set by the content of the discipline being studied. It can be used in IS OrSMU if the workbook with methodological instructions is placed in the work program of the discipline and students have the opportunity to complete tasks by filling out the notebook and sending it to the teacher for checking. It allows you to check and evaluate the knowledge of students, to determine the degree of their readiness for further education, as well as the skills level, if the tasks are of a practice-oriented nature. |
| **Test** | A test is one of the forms of written verification and assessment of the acquired knowledge, the level of independence and activity of students in educational activities. They can be carried out in the classroom and in the form of homework, current and final, graphic, practical, frontal (for all) and individual. Traditionally, the test involves the identification of knowledge on a specific topic (section), as well as an understanding of the essence of the studied phenomena, objects, their patterns (for example, assignments for comparison, insertion of missing words, etc.). To assess the skills of students primarily graphical and practical tests are used. The graphical test is aimed at identifying the ability of students to draw up a generalized visual model that reflects certain relationships, relationships in an object or in their totality. These can be graphics, pictures, drawings, diagrams, tables. Practical tests are carried out to identify the abilities and skills of students to carry out certain research, laboratory experiments, make measurements, perform appropriate operations and manipulations in educational and industrial conditions. One of the forms of testing practical skills and abilities is a control practical exercise lesson (in physics, chemistry, biology, anatomy, physiology, surgery, etc.), usually held at the end of the study of the topic or section of the discipline. |
| **Written questionnaire** | A written questionnaire is a type of written assessment of students' knowledge on certain questions or topics. It can be current and final, individual and frontal. It involves posing a number of questions to students, to which they give a detailed written answer. It allows you to assess the knowledge of students on the passed topic (or module) of the discipline. |
| **Presentation** | A presentation (computer presentation) is a demonstration in a visual form of the main provisions of the oral presentation, the degree of mastering the content of the problem. It allows you to assess the level of students` knowledge on a given question (topic, section), as well as to check their skills of analysis, synthesis, generalization and concretization, information and communication skills used by students in the process of preparing a presentation. |
| **Abstract** | Abstract is a summary, in writing or in the form of a public speech, of the content of a book, scientific work, and the results of studying a scientific problem, a report on a specific topic, including a review of relevant literary and other sources. As a rule, it is an independent student's work on revealing the essence of the problem under study, presenting various points of view and their own views on it. The defense of the abstract can be accompanied by a presentation. Since the main purpose of the essay is scientific and informational, this form of control is aimed mainly at assessing the knowledge of students on a specific topic (issue), although it allows us to identify the level of formation of the skills of analysis, synthesis, generalization and concretization used by the student in the process of preparing a report. |
| **Case-task completion** | Case-tasks are technology for teaching students. The students are given a set of educational material (case) and, as a result of acquaintance with it, they ought to comprehend the essence of the problem, which, as a rule, does not have an unambiguous solution, and offer their solution using the acquired knowledge and skills. It is widely used in practical classes in a foreign language, management, law, economics and other disciplines. In medicine, it can be used to teach students to write a medical history. It allows to evaluate, first of all, the students' skills to apply the acquired knowledge when solving specific practical situations. Knowledge assessment is present at the stage of collecting material for a case-task. |
| **Terminological dictation** | Terminological dictation is a type of students` written work to consolidate and test knowledge on a specific topic (issue). It can be checking or repetitive. The first is aimed at controlling knowledge, the second one is aimed at training students in the use of certain terms. It allows you to assess the students` knowledge. In this case, it should be used only if students have clear instructions on which terms are to be memorized. Otherwise, the student will write the term that he has learned from the literature he has. |
| **Testing** | Testing is a written way of testing students' knowledge. It can be current and final (by Module or discipline as a whole). Test items can include questions with one or more correct answers, assignments for matching and sequencing, as well as problem-situation tasks that require the selection of the correct (or several correct) answer options, as well as graphic images that require interpretation or definition. In most cases, testing is aimed at assessing students' knowledge. It allows to assess the students' skills when the test tasks are presented by problem-situational tasks, tasks with graphic (visual) images that require the use of a solution algorithm (action with an object). |
| **Recitation** | Recitation is a method of testing the knowledge and skills of students, which consists in the fact that students are invited to reproduce a certain content: empirical facts, theoretical positions, formulations of concepts, examples, classifications, scientific laws. It allows you to assess the level of knowledge of students on a particular issue, topic, section, discipline. Assessment of the students' skills is possible if, in the course of answering the question posed, the student needs to demonstrate the acquired knowledge in order to solve a problem question or problem-situational task. |
| **Practical task completion monitoring** | A practical task is a task that contains exercises and tasks that the student must solve (complete) visually (effectively), i.e. practically manipulating real objects or their substitutes. It is widely used in mathematics, computer science, physics, chemistry, economics, and other natural science disciplines. In medicine, it can be represented by the student performing direct practical manipulations with the "patient" both in the course of practical training and directly at the bases of practical training. It allows you to assess the ability of students to apply theoretical knowledge to solve (perform) a practical task in both standard and non-standard situations. |
| **Control norm administration** | A norm (from the Latin norm) is a regulatory rule indicating the boundaries of its application. Time, quantitative and qualitative indicators of students' performance of certain tasks, techniques and actions related to the content of the academic discipline. Administration of control standards is widely represented in the technical, engineering, military fields of knowledge, as well as in the field of physical culture and sports. In medicine, it can take place when assessing the performance by students of direct actions with a "patient" that have clear normative indicators (for example, cardiopulmonary resuscitation, the number of sutures, auscultation, palpation, percussion, injections, etc.). It allows you to assess the ability of students to apply the theoretical knowledge received (about certain standards) in standard and non-standard situations. |
| **Checking case histories** | A case history is an accounting and operational document drawn up for each patient in a medical and preventive treatment institution, designed to register information about the diagnosis, course and outcome of the disease, as well as diagnostic and medical-preventive activities taken during the patient's stay in the hospital. It allows you to assess the student's ability to apply the theoretical knowledge gained in direct professional learning situations (so-called contextual learning). |
| **Solving problem-situational tasks** | Problem-situational tasks are a kind of practical task that involves solving an issue in a certain situation. Both the question and the situation itself can be problematic. In most cases, problem-situational tasks have a professional focus. They allow assessing the ability of students to apply the obtained theoretical knowledge in various situations. |
| **Practical skills testing** | Testing of practical skills can be used to control the students' practical actions (medical manipulations) with the "patient". It allows you to assess the skills and abilities of students to apply the theoretical knowledge (about certain actions and manipulations) in standard and non-standard situations. |
| **Practice report** | A report is a message, a report on their actions, work. Practice report – is the information compiled in a certain form, data on the student's activities for a certain period based on practical training. It allows you to evaluate the practical experience achieved by students in the application of the theoretical knowledge, abilities and skills in the process of direct professional activity. |
| **Practice diary** | A diary is the records of everyday activity. The practice diary reflects the student's daily activities based on practical training. It allows to evaluate the dynamics of students' mastering of practical professional activity experience in the process of practical training (educational and industrial practice). |

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| **Monitoring form** | **Assessment criteria** |
| **Recitation** | On "FIVE POINTS" the answer is assessed, which shows solid knowledge of the main questions of the studied material, is distinguished by the depth and completeness of the disclosure of the topic; knowledge of the terminological apparatus; the ability to explain the essence of phenomena, processes, events, draw conclusions and generalizations, give reasoned answers, give examples; fluency in monologue speech, consistency and consistency of the answer. |
| On "FOUR POINTS" the answer is assessed, which reveals a solid knowledge of the basic questions of the studied material, differs in the depth and completeness of the disclosure of the topic; knowledge of the terminological apparatus; the ability to explain the essence of phenomena, processes, events, draw conclusions and generalizations, give reasoned answers, give examples; fluency in monologue speech, consistency and consistency of the answer. However, one or two inaccuracies in the answer are allowed. |
| On "THREE POINTS" the answer is assessed, which testifies mainly to the knowledge of the studied material, which is characterized by insufficient depth and completeness of the disclosure of the topic; knowledge of the basic issues of theory; poorly formed skills in analyzing phenomena, processes, insufficient ability to give reasoned answers and give examples; lack of fluency in monologue speech, logic and consistency of the answer. Several mistakes are allowed in the content of the answer. |
| On "TWO POINTS" the answer is assessed, revealing ignorance of the studied material, characterized by a shallow disclosure of the topic; ignorance of the main issues of theory, unformed skills in the analysis of phenomena, processes; inability to give reasoned answers, weak command of monologue speech, lack of consistency and consistency. Serious errors in the content of the answer are allowed. |
| ZERO POINTS" is given if there is no answer |
| **Testing** | "FIVE POINTS" is given on condition of 90-100% correct answers |
| "FOUR POINTS" is given on condition of 75-89% correct answers |
| "THREE POINTS" is given on condition of 60-74% correct answers |
| "TWO POINTS" is given on condition of 59% or less correct answers. |
| "ZERO POINTS" is given if there is no answer |
| **Written questionnaire** | "FIVE POINTS" is given to a student if he knows the conceptual apparatus, demonstrates the depth and complete mastery of the content of the educational material, in which he is easily oriented. |
| "FOUR POINTS" are given to the student for the ability to correctly present the material, but the content and form of the answer may have some inaccuracies. |
| "THREE POINTS" is awarded if a student discovers knowledge and understanding of the main provisions of the educational material, but expresses it incompletely, inconsistently, makes inaccuracies in the definition of concepts, does not know how to substantiate his judgments with evidence. |
| "TWO POINTS" is given if a student has scattered, unsystematic knowledge, does not know how to distinguish the main and the secondary, makes mistakes in the definition of concepts, distorts their meaning. |
| "ZERO POINTS" is set if there is no answer. |
| **Problem-situational tasks** | "FIVE POINTS" - the student correctly and fully conducts the initial assessment of the condition, independently identifies the satisfaction of which needs are violated, determines the patient's problems, sets goals and plans nursing interventions with their justification, conducts current and final assessment. |
| "FOUR POINTS" - the student correctly conducts the initial assessment of the condition, identifies the satisfaction of what needs are violated, determines the patient's problems, sets goals and plans nursing interventions with their justification, conducts the current and final assessment. Some minor difficulties in answering are allowed; justification and final assessment is carried out with additional comments from the teacher. |
| "THREE POINTS" - the student correctly but incompletely conducts the initial assessment of the patient's condition. Identifying the satisfaction of what needs are violated, determining the patient's problem is possible with leading questions from the teacher. Sets goals and plans for nursing interventions without justification, conducts ongoing and final assessment with leading questions from the teacher; Difficulties with a comprehensive assessment of the proposed situation. |
| "TWO POINTS" - wrong assessment of the situation; incorrectly chosen tactics of action. |
| "ZERO POINTS" is set if there is no answer. |
| **Practical skills** | "FIVE POINTS". The student has shown full knowledge of the program material, the workplace is equipped with all the requirements for preparation for performing manipulations; practical actions are performed sequentially in accordance with the algorithm for performing manipulations; all requirements for the safety of the patient and medical staff are observed; the time limit is observed; the workplace is cleaned in accordance with the requirements of the sanitary and epidemiological supervision; all actions are justified. |
| "FOUR POINTS". The student has shown complete knowledge of the program material, the workplace is not fully independently equipped to perform practical manipulations; practical actions are performed consistently, but not confidently; all requirements for the safety of the patient and medical staff are observed; time regulations are violated; the workplace is cleaned in accordance with the requirements of the sanitary and epidemiological regime; all actions are justified with clarifying questions of the teacher, made small mistakes or inaccuracies. |
| "THREE POINTS". The student showed knowledge of the basic program material in the amount necessary for the upcoming professional activity, but made no more than one fundamental mistake, the workplace is not fully equipped to perform practical manipulations; the sequence of their implementation is broken; unsure actions, leading and additional questions and comments of the teacher are needed to justify actions; all requirements for the safety of the patient and medical staff are observed; the workplace is cleaned in accordance with the requirements of the sanitary and epidemiological regime. |
| "TWO POINTS". The student discovered significant gaps in the knowledge of the practical skill algorithm, made more than one fundamental mistake, difficulties in preparing the workplace, the inability to independently perform practical manipulations; actions are taken that violate the safety of the patient and the medical staff, the requirements of the sanitary and epidemiological regime, safety measures when working with the equipment and materials used are violated. |
| "ZERO POINTS" is given if there is no answer |
| **Abstract defense** | "FIVE POINTS" is awarded if the student fulfills all the requirements for writing and defending the abstract: the problem is identified and its relevance is justified, a brief analysis of various points of view on the problem under consideration is made and their own position is logically stated, conclusions are formulated, the topic is fully disclosed, the volume is maintained, requirements for the external design, the correct answers to additional questions are given. |
| "FOUR POINTS" is given if the students meet the basic requirements for the abstract and its defense, but at the same time there are some mistakes. In particular, there are inaccuracies in the presentation of the material; there is no logical consistency in judgments; the volume of the abstract is not kept; there are omissions in the design; incomplete answers were given to additional questions during the defense. |
| "THREE POINTS" is given if the student allows significant deviations from the requirements for abstracting. In particular, the topic is covered only partially; factual errors were made in the content of the abstract or when answering additional questions; there is no output during protection. |
| "TWO POINTS" is given if the topic of the abstract is not disclosed to the students, a significant misunderstanding of the problem is revealed. |
| "ZERO POINTS" is given if there is no answer |
| **Presentation demonstration** | "FIVE POINTS" is awarded if there is a connection between the presentation and the program and curriculum, the corresponding section; the didactic and methodological goals and objectives of the presentation were achieved; provides reliable information about historical references and current events; all conclusions are confirmed by reliable sources; the language of the presentation is clear to the audience; the chronology is followed, the priorities are correctly set; logical transition to the conclusion; correct conclusions; the font is readable, the color (background, font, headers) is correctly selected, animation elements are present; no grammatical errors. |
| "FOUR POINTS" is given if the students meet the basic requirements for the presentation, but there are some mistakes. In particular, there are inaccuracies in the presentation of the material; a topic was chosen without taking into account the curriculum; there is no logical consistency in judgments; requirements for graphic content are not met; there are omissions in the design; incomplete answers were given to additional questions during the defense. |
| "THREE POINTS" is given if the student makes significant deviations from the requirements for presentation design. In particular, the topic is covered only partially; errors of fact were made in the content of the presentation or when answering additional questions; no output was presented during the demo. |
| "TWO POINTS" is given if the topic of the abstract is not revealed to the students, a significant misunderstanding of the problem is revealed. |
| "ZERO POINTS" is given if there is no answer. |
| **Practical tasks (Patient card)** | "FIVE POINTS" is awarded if the content corresponds to the given topic; the topic is fully disclosed and contains modern, reliable data; the text is written consistently, logically and correctly from the point of view of the norms of the Russian language; there are photographs, diagrams, according to the stated topic; matches the pictorial design. |
| “FOUR POINTS” is awarded if the student has issued a booklet that meets the same requirements as for the mark “excellent”, but made minor corrections in the text or image, which he himself corrects. |
| "THREE POINTS" is given if the content does not fully correspond to the declared theme; the topic is not fully disclosed and contains outdated data; the text is written consistently, logically, but there are mistakes from the point of view of the norms of the Russian language; not enough photos and diagrams are available; matches the pictorial design. |
| "TWO POINTS" is given if the content does not correspond to the declared topic; the topic is not fully disclosed and does not contain modern, reliable data; the text is not written consistently and logically, there are gross mistakes from the point of view of the norms of the Russian language; there are no photos and diagrams available; it does not match the pictorial design. |
| "ZERO POINTS" is given if there is no answer |

Fund of of learning on intermediate certification in form of exam.

Control assessment materials of the current monitoring of progress are distributed on the topics of the discipline and are accompanied by an indication of the used forms of control and evaluation criteria

Control – assessment materials for intermediate certification correspondence to a form of intermediate certification for the discipline defined in educational the plan of OPOP and are directed to check of formation of knowledge, skills of each competence established in the working program of discipline.

As a result of studying of discipline at the student the **following competences** are formed:

ОК-1 – способность к абстрактному мышлению, анализу, синтезу

ОПК-1 Готовностью решать стандартные задачи профессиональной деятельности с использованием информационных, библиографических ресурсов, медико-биологической терминологии, информационно-коммуникационных технологий и учетом основных требований информационной безопасности.

ОПК-7 – готовностью к использованию основных физико-химических, математических и иных естественнонаучных понятий и методов при решении профессиональных задач.

ПК-1 - способность и готовность к осуществлению комплекса мероприятий, направленных на сохранение и укрепление здоровья детей и включающих в себя формирование здорового образа жизни, предупреждение возникновения и (или) распространения заболеваний, их раннюю диагностику, выявление причин и условий их возникновения и развития, а также направленных на устранение вредного влияния на здоровье детей факторов среды их обитания.

1. **Assessment materials of current control of student performance**

**Assessment materials for each topic of the discipline**

**Module № 2 «General metabolism. Biological oxidation»**

**Topic 2.1 «General metabolism. Intermediary metabolism»**

**Form (s) of current performance control:** incoming writing control, oral poll, practical skills testing, control tasks in the workbook.

**Assessment materials of current control of student performance**

**Incoming writing control:**

Variant 1

1. What is metabolism? Metabolic pathways: central and specific, cyclic and

linear. Give examples.

2. Connections of anabolism and catabolism.

Variant 2

1. What is catabolism? Enumerate the stages of catabolism. Characteristic of

first stage of catabolism.

2. Draw structure of ATP. Biological functions.

Variant 3

1. What is biological oxidation? Enumerate the stages of biological oxidation.

Characteristic of first stage of biological oxidation.

2. Draw structure of key metabolites: pyruvate, oxaloacetate, α-ketoglutarate.

Variant 4

1. What is catabolism? Enumerate the stages of catabolism. Characteristic of

2nd stage of catabolism?

2. Draw structure of central key metabolite - acetyl CoA

Variant 5

1. What is biological oxidation? Enumerate the stages of biological oxidation.

Characteristic of 2nd stage of biological oxidation.

2. What is anabolism, its role? Connections of anabolism and catabolism.

Variant 6

1. What is catabolism? Enumerate the stages of catabolism. Characteristic of

3rd stage of catabolism?

2. Enumerate functions of metabolism

Variant 7

1. What is biological oxidation? Enumerate the stages of biological oxidation.

Characteristics of 3rd stage of biological oxidation.

2. Metabolic pathways: central and specific, cyclic and linear. Give examples.

Variant 8

1. What is metabolism? Metabolic pathways: central and specific, cyclic

and linear. Give examples?

2. Connections of anabolism and catabolism?

Variant 9

1. What is catabolism? Enumerate the stages of catabolism. Characteristic of

first stage of catabolism

2. Draw structure of ATP. Biological functions?

Variant 10

1. What is biological oxidation? Enumerate the stages of biological oxidation.

Characteristic of first stage of biological oxidation.

2. Draw structure of common key metabolites: pyruvate, oxaloacetate, αketoglutarate.

Variant 11

1. What is catabolism? Enumerate the stages of catabolism. Characteristic of

2nd stage of catabolism?

2. Draw structure of central key metabolite - acetyl CoA

Variant 12

1. What is biological oxidation? Enumerate the stages of biological oxidation.

Characteristic of 2nd stage of biological oxidation.

2. What is anabolism, its role? Connections of anabolism and catabolism.

Variant 13

1. What is catabolism? Enumerate the stages of catabolism. Characteristic of

3rd stage of catabolism?

2. Enumerate functions of metabolism

Variant 14

1. What is biological oxidation? Enumerate the stages of biological oxidation.

Characteristics of 3rd stage of biological oxidation.

2. Metabolic pathways: central and specific, cyclic and linear. Give examples?

Variant 15

1. What is metabolism? Metabolic pathways: central and specific, cyclic

and linear. Give examples.

2. Connections of anabolism and catabolism.

Variant 16

1. What is catabolism? Enumerate the stages of catabolism. Characteristic

of first stage of catabolism.

2. Draw structure of ATP. Biological functions.

**Questions for oral poll:**

1. Introduction to metabolism. Catabolism and anabolism.
2. The final common metabolic pathway. Central, cyclic and specific metabolic pathways.
3. Free energy, the standard state. High-energy compounds: structure and functions. ATP-cycle.
4. Metabolic pathways (central and specific, linear and cyclic).
5. Stages of catabolism and oxidation of foodstuffs.
6. General characteristic of biological oxidation. Stages of biological oxidation:

* The first phase of biological oxidation - the formation of acetyl - CoA
* The second phase of biological oxidation - the tricarboxylic acid cycle (TCA);
* The 3rd phase of biological oxidation - the terminal, the final - aerobic - tissue respiration. The role of oxygen in biological oxidation.

**Practical skills testing**

**Estimation of pyruvic acid concentration in blood**

Principle: pyruvic acid is condensed with 2,4-dinitrophenylhydrazine (DNPH) resulting in pyruvate hydrazone formation. The latter colors the solution into red-brown in the alkaline medium. The color intensity directly depends on pyruvate concentration in the sample. The colored solution is analyzed using photoelectrocolorimeter. Pyruvic acid concentration is calculated using the obtained optical density values.

Analysis manual: During the analysis two samples are prepared: experimental (1 ) and control (2).

*Experimental sample (1)*: 0.25 ml of blood is mixed with 0.7 ml of distilled water in the centrifuge tube to obtain hemolysis. 1 ml of 10% trichloracetic acid is added to hemolyzate. After 2-3 minutes the tube is centrifuged at 1500 rpm for 15 minutes. The obtained supernatant is removed into the glass tube. 0.5 ml of DNPH is added into the probe with subsequent mixing. The tube is incubated for 20 minutes in a dark place.

After the incubation, 1.0 ml of 12% NaOH is added into the tube. After 5 minute incubation, the optical density of the solution is estimated using photoelectrocolorimeter with blue color filter in 5 mm cuvette.

*Control sample (2)* is prepared using distilled water instead of blood. Other procedures are equal as for the experimental sample preparation.

Pyruvic acid concentration is calculated using the calibration curve.

The normal values for blood pyruvic acid concentration are: 0.4-0.8 mg/100 ml (0.0456-0.0912 mmol/l).

Coefficient for transformation of values into the International System of Units (SI) is 0.114.

*Diagnostic significance:* elevation of pyruvic acid blood levels is observed in a number of pathologies like deficiency of thiamine (vitamin B1), as well as after introduction of several drugs (camphor, adrenaline, strychnine). Pyruvic acid concentration is decreased under narcosis.

*Result:*

*Conclusion:*

**Independent work of students to the lesson.** Control tasks in the workbook.

1. Explain the purposes of the metabolism.

2. Draw scheme of foodstuffs’ catabolism.

3. Give the general characteristic of catabolism.

4. Give the general characteristic of anabolism.

5. Explain the energy relationships between catabolic and anabolic pathways.

6. Numerate the precursor molecules.

7. Numerate the energy- depleted end products.

8. Explain the central and specific metabolic pathways. Illustrate.

9. Explain the linear and cyclic metabolic pathways. Illustrate.

**Topic 2.2 « Biological oxidation. Electron transport chain»**

**Form (s) of current performance control:** incoming writing control, oral poll, practical skills testing, control tasks in the workbook.

**Assessment materials of current control of student performance**

**Incoming writing control:**

Variant 1

1. What are the main oxidation process occurring in a living cell. What class of

enzymes catalyzes oxidation-reduction reactions underlying biological oxidation.

2. Pyridine-dependent dehydrogenases. General characteristics of enzymes. The

role of vitamin PP in redox reactions. Block-structure of coenzyme NAD+

Variant 2

1. What is tissue respiration? Show the process of substrates’ hydrogen oxidation

in the respiratory chain with formation of endogenous water in cells.

2. Flavin-dependent dehydrogenases. The role of vitamin B2 in redox reactions.

Block-structure of coenzyme FAD.

Variant 3

1. Ubiquinone. Structure and its biological role.

2. Pyridine-dependent dehydrogenases. The role of vitamin PP in redox reactions.

Block-structure of coenzyme NADP+.

Variant 4

1. Cytochromes. General characteristics of enzymes.

2. Flavin-dependent dehydrogenases. The role of vitamin B2 in redox reactions.

Block-structure of coenzyme FMN.

Variant 5

1. What are the main oxidation process occurring in a living cell. What class of

enzymes catalyzes oxidation-reduction reactions underlying biological oxidation.

2. Pyridine-dependent dehydrogenases. General characteristics of enzymes. The

role of vitamin PP in redox reactions. Block-structure of coenzyme NAD+

Variant 6

1. What is tissue respiration? Show the process of substrates’ hydrogen oxidation

in the respiratory chain with formation of endogenous water in cells.

2. Flavin-dependent dehydrogenases. The role of vitamin B2 in redox reactions.

Block-structure of coenzyme FAD.

Variant 7

1. Ubiquinone. Structure and its biological role.

2. Pyridine-dependent dehydrogenases. The role of vitamin PP in redox reactions.

Block-structure of coenzyme NADP+.

Variant 8

1. Cytochromes. General characteristics of enzymes.

2. Flavin-dependent dehydrogenases. The role of vitamin B2 in redox reactions.

Block-structure of coenzyme FMN.

Variant 9

1. What are the main oxidation process occurring in a living cell. What class of

enzymes catalyzes oxidation-reduction reactions underlying biological oxidation.

2. Pyridine-dependent dehydrogenases. General characteristics of enzymes. The

role of vitamin PP in redox reactions. Block-structure of coenzyme NAD+

Variant 10

1. What is tissue respiration? Show the process of substrates’ hydrogen oxidation

in the respiratory chain with formation of endogenous water in cells.

2. Flavin-dependent dehydrogenases. The role of vitamin B2 in redox reactions.

Block-structure of coenzyme FAD.

Variant 11

1. Ubiquinone. Structure and its biological role.

2. Pyridine-dependent dehydrogenases. The role of vitamin PP in redox reactions.

Block-structure of coenzyme NADP+.

Variant 12

1. Cytochromes. General characteristics of enzymes.

2. Flavin-dependent dehydrogenases. The role of vitamin B2 in redox reactions.

Block-structure of coenzyme FMN.

Variant 13

1.What are the main oxidation process occurring in a living cell. What class of

enzymes catalyzes oxidation-reduction reactions underlying biological oxidation.

2. Pyridine-dependent dehydrogenases. General characteristics of enzymes. The

role of vitamin PP in redox reactions. Block-structure of coenzyme NAD+

Variant 14

1. What is tissue respiration? Show the process of substrates’ hydrogen oxidation

in the respiratory chain with formation of endogenous water in cells.

2. Flavin-dependent dehydrogenases. The role of vitamin B2 in redox reactions.

Block-structure of coenzyme FAD.

Variant 15

1. Ubiquinone. Structure and its biological role.

2. Pyridine-dependent dehydrogenases. The role of vitamin PP in redox reactions.

Block-structure of coenzyme NADP+.

Variant 16

1. Cytochromes. General characteristics of enzymes.

2. Flavin-dependent dehydrogenases. The role of vitamin B2 in redox reactions.

Block-structure of coenzyme FMN.

**Questions for oral poll:**

1. The definition and the stages of biological oxidation.

2. The characteristics of the enzymes’ class - oxidoreductases. Flavin- linked and niacin- linked dehydrogenases.

3. Cytochromes.

4. Co-enzyme Q.

5. Organization of electron transport chain.

**Practical skills testing**

**Reactions of oxidative phosphorylation**

*Principle of the method*. In oxidation of various substrates in the respiratory chain energy is released, a part of which is used for the reaction of oxidative phosphorylation. The degree of the latter (energetic value of substrates) is evaluated by the decrease of inorganic phosphate (ratio P/O = 1.5–2.5). Using various substrates (malate, succinate, ascorbate) we estimate the degree of oxidative phosphorylation. The content of phosphoric acid is determined in reaction with ammonia molybdate and reducing solution of ascorbic acid by the intensity of the resulted ―molybden blue‖.

*Procedure*. Introduce reagents into four test-tubes according to the scheme:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **№** | | **Content of test-tubes**  **Control** | | | | | **Test** |
| **1 (ml)** | | | | | **2 (ml)** | **3 (ml)** | **4 (ml)** |
| 1 | Incubation mixture | | | 1.0 | 1.0 | 1.0 | 1.0 |
| 2 | Saline solution | | | 0.5 | – | – | – |
| 3 | Malate solution | | | – | 0.5 | – | – |
| 4 | Succinate solution | | | – | – | 0.5 | – |
| 5 | Ascorbate solution + Cytochrom c | | | – | – | – | 0.5 |
| 6 | Mitochondria suspension | | | 0.5 | 0.5 | 0.5 | 0.5 |
| 10 min incubation at room temperature, then add: | | | | | | | |
| 7 | | | Trichloracetic acid (ТCA) | 1.0 | 1.0 | 1.0 | 1.0 |
| 8 | | | Ammonia molybdate solution | 0.5 | 0.5 | 0.5 | 0.5 |
| 9 Reducing solution of Fiske and Subarrow | | | | | | | |
| 10 Dilute the content of all test-tubes 1:8, 10 min incubation | | | | | | | |

Observed changes (staining intensity by four-point scale):

P/O ratio:

Conclusion:

**Independent work of students to the lesson.** Control tasks in the workbook.

1. Draw structure of NAD+ and acceptance of hydrogen scheme by NAD+.
2. Numerate NAD+ linked dehydrogenases.
3. Draw structure of FAD and acceptance of hydrogen scheme by FAD.
4. Numerate NAD+ linked dehydrogenases.
5. Draw structure of Co- enzyme Q and acceptance of hydrogen scheme by Co-enzyme Q.
6. Draw the scheme of electron transport chain I type.
7. Draw the scheme of electron transport chain II type.

**Choose the correct answer:**

1. Which one of the following pairs is **in**correct?

|  |  |
| --- | --- |
| A. Oxidation | is the loss of electron |
| B. Oxidation | usually accompanied by an increase in energy content of oxidized substance |
| C. Reduction | is the gain in electrons |
| D. Reduction | usually accompanied by an increase in energy content of reduced substance |
| E. Redox couple | exists both in the reduced state and in the oxidized state |

2. Which one of the following statements concerning the components of the electron transport chain is correct?

A. all of the components of the electron transport chain are present in large, multisubunit protein complexes embedded in the inner mitochondrial membrane;И

B. oxygen directly oxidized cytochrome c;

C. malat dehydrogenase directly reduces cytochrome c;

D. the electron transport chain contains some polypeptide chains coded for by the nuclear DNA and some coded for by mDNA;

E. cyanide inhibits electron flow, but not proton pumping or ATP synthesis.

3. The NAD+ linked dehydrogenases are… Choose the **IN**correct answer:

A. glyceraldehyde-3-phosphate dehydrogenase;

B. Isocitrate dehydrogenase;

C. glutamat dehydrogenase;

D. succinate dehydrogenase;

E. malate dehydrogenase

4. The FAD linked dehydrogenase is…

A. glyceraldehyde-3-phosphate dehydrogenase;

B. Isocitrate dehydrogenase;

C. glutamat dehydrogenase;

D. succinate dehydrogenase;

E. malate dehydrogenase

5. Which one of the following statements about the coenzyme Q is **in**correct?

A. the ubiquinone (Q) is reduced successively to semiquinone (QH) and finally to quinol (QH2);

B. it accepts a pair of electrons from NADH or FADH2;

C. mammals’ ubiquinone has 10 isoprene units;

D. ubiquinone transfers the two electrons to the cytochrome c;

E. ubiquinone transfers the two electrons and protons to the cytochrome c.

6. As prosthetic group cytochromes contain…

A. FAD;

B. NAD+;

C. Co-enzyme A;

D. heme;

E. Fe+2

7. The electron transport chain (I type) components’ sequence is the following:

A. NAD+ linked dehydrogenases → FAD linked dehydrogenase → ubiquinone → cytochrome b→ cytochrome c1 → cytochrome c → cytochrome a a3

B. NAD+ linked dehydrogenases → FMN linked dehydrogenase → ubiquinone → cytochrome b→ cytochrome c1 → cytochrome c → cytochrome a a3

C. NADP+ linked dehydrogenases → FAD linked dehydrogenase → ubiquinone → cytochrome b→ cytochrome c1 → cytochrome c → cytochrome a a3

D. NADP+ linked dehydrogenases → FMN linked dehydrogenase → ubiquinone → cytochrome b→ cytochrome c1 → cytochrome c → cytochrome a a3

E. FAD linked dehydrogenase → ubiquinone → cytochrome b→ cytochrome c1 → cytochrome c → cytochrome a a3

8. The electron transport chain (II type) components’ sequence is the following:

A. NAD+ linked dehydrogenases → FAD linked dehydrogenase → ubiquinone → cytochrome b→ cytochrome c1 → cytochrome c → cytochrome a a3

B. NAD+ linked dehydrogenases → FMN linked dehydrogenase → ubiquinone → cytochrome b→ cytochrome c1 → cytochrome c → cytochrome a a3

C. NADP+ linked dehydrogenases → FAD linked dehydrogenase → ubiquinone → cytochrome b→ cytochrome c1 → cytochrome c → cytochrome a a3

D. NADP+ linked dehydrogenases → FMN linked dehydrogenase → ubiquinone → cytochrome b→ cytochrome c1 → cytochrome c → cytochrome a a3

E. FAD linked dehydrogenase → ubiquinone → cytochrome b→ cytochrome c1 → cytochrome c → cytochrome a a3

9. Which one of the following pairs is **in**correct?

|  |  |
| --- | --- |
| A. Complex I to CoQ specific inhibitors | 1)hypotensive drug (guanethide)  2)insecticide (rotenone)  3)tranquilizer (chlorpromazine)  4)sedative (barbiturates)  5) antibiotic (piericidin) |
| B. Complex III to cytochrome c inhibitors | 1) naphthoquinone  2) antibiotic (antimycin) |
| C. Complex IV inhibitors | 1. carbon monoxide, inhibits cellular respiration 2. cyanide (CN-) 3. azide 4. hydrogen sulphide (H2S) |
| D. Inhibitors of oxidative phosphorylation | 1) antibiotic (oligomycin)  2) ionophores |
| E. Inhibitors of oxidative phosphorylation | 1. carbon monoxide, inhibits cellular respiration 2. cyanide (CN-) 3. azide 4. hydrogen sulphide (H2S) |

10.Physiological uncouplers of oxidative phosphorylation are…

A. carbon monoxide and azide;

B. hydrogen sulphide (H2S) and cyanide;

C. thermogenin and thyroxin;

D. thermogenin and carbon dioxide;

E. thyroxin and insulin.

**Topic 2.3 « Bioenergetics and oxidative phosphorilation»**

**Form (s) of current performance control:** incoming writing control, oral poll, practical skills testing,control tasks in the workbook.

**Assessment materials of current control of student performance**

**Incoming writing control**

Variant 1

1. Oxidative phosphorylation (ATP synthesis). P/O ratio.

2. Hypotheses for coupling mechanism. Mitchell’s chemiosmotic theory.

Variant 2

1. Inhibitors of electron transport chain and oxidative phosphorylation.

2. Enumerate the compounds affecting electron transport chain 1 type and oxidative phosphorylation.

Variant 3

1. Regulation of ATP synthesis. Respiratory control.

2. Enumerate the compounds affecting electron transport chain 2 type and oxidative phosphorylation.

Variant 4

1. Explain the energetics of oxidative phosphorylation.

2. Uncouplers of oxidative phosphorylation

**Questions for oral poll:**

1. Oxidative phosphorylation (ATP synthesis). P/O ratio.

3. Hypotheses for coupling mechanism. Mitchell’s chemiosmotic theory.

4. Regulation of ATP synthesis. Respiratory control.

5. Inhibitors of electron transport chain and oxidative phosphorylation.

6. Uncouplers of oxidative phosphorylation.

**Practical skills testing**

**Effect of 2,4-dinitrophenol (2,4-DNP) on oxidative phosphorylation**

*Principle of the method*. 2,4-DNP is an uncoupler of phosphorylation and oxidation. Oxidative phosphorylation is judged by the decrease of inorganic phosphate in the incubation medium, it is determined as described in work «Reactions of oxidative phosphorylation».

|  |  |  |  |
| --- | --- | --- | --- |
| **№** | **Content of test-tubes** | **Control (ml)** | **Experiment (ml)** |
| 1 | Malate solution | 0.5 | 0.5 |
| 2 | 2,4-DNP solution | – | 0.5 |
| 3 | Saline solution | 0.5 | – |
| 4 | Mitochondrium suspension | 0.5 | 0.5 |
| 10 min imcubation at room temperature | | | |
| 5 | ТCA solution | 1.0 | 1.0 |
| 6 | Ammonia molibdate solution | 0.5 | 0.5 |
| 7 | Reducing solution | 1.0 | 1.0 |

Observed changes (color):

Conclusion:

**Independent work of students to the lesson.** Control tasks in the workbook.

1. Explain Mitchell’s chemiosmotic theory.

2. Explain the energetics of oxidative phosphorylation.

3. Numerate the compounds affecting electron transport chain and oxidative phosphorylation.

**Topic 2.4 «Oxidative decarboxylation of pyruvic acid. Krebs cycle»**

**Form (s) of current performance control:** incoming writing control, oral poll, рractical skills testing, control tasks in the workbook.

**Assessment materials of current control of student performance**

**Incoming writing control**

Variant 1

1. Oxidative decarboxylation of pyruvate to acetyl-CoA. Structure of

multienzyme complex: enzymes, coenzymes.

2. Write a reaction of substrate phosphorylation of the Krebs cycle.

Variant 2

1. Write dehydration reactions in the Krebs cycle. Count the energy output

2. The biological role of oxidative decarboxylation of pyruvate

Variant 3

1. Mechanical oxidative phosphorylation of ATP biosynthesis

2.Anaplerotic reactions for the Krebs cycle.

Variant 4

1. Oxidative decarboxylation ofα- ketoglutarate to succinyl-CoA. Structure of

multienzyme complex: enzymes, coenzymes.

2. The biological role of the Krebs cycle.

Variant 5

1. Oxidative decarboxylation of pyruvate to acetyl-CoA. Structure of

multienzyme complex: enzymes, coenzymes.

2. Write a reaction of substrate phosphorylation of the Krebs cycle.

Variant 6

1. Write dehydration reactions in the Krebs cycle. Count the energy output

2. The biological role of oxidative decarboxylation of pyruvate

Variant 7

1. Mechanical oxidative phosphorylation of ATP biosynthesis

2. Anaplerotic reactions for the Krebs cycle.

Variant 8

1. Oxidative decarboxylation ofα- ketoglutarate to succinyl-CoA. Structure of

multienzyme complex: enzymes, coenzymes.

2. The biological role of the Krebs cycle.

Variant 9

1. Oxidative decarboxylation of pyruvate to acetyl-CoA. Structure of

multienzyme complex: enzymes, coenzymes.

2. Write a reaction of substrate phosphorylation of the Krebs cycle.

Variant 10

1. Write dehydration reactions in the Krebs cycle. Count the energy output

2. The biological role of oxidative decarboxylation of pyruvate

Variant 11

1. Mechanical oxidative phosphorylation of ATP biosynthesis

2. Anaplerotic reactions for the Krebs cycle.

Variant 12

1. Oxidative decarboxylation ofα- ketoglutarate to succinyl-CoA. Structure of

multienzyme complex: enzymes, coenzymes.

2. The biological role of the Krebs cycle.

Variant 13

1. Oxidative decarboxylation of pyruvate to acetyl-CoA. Structure of

multienzyme complex: enzymes, coenzymes.

2. Write a reaction of substrate phosphorylation of the Krebs cycle.

Variant 14

1. Write dehydration reactions in the Krebs cycle. Count the energy output

2. The biological role of oxidative decarboxylation of pyruvate

Variant 15

1. Mechanical oxidative phosphorylation of ATP biosynthesis

2. Anaplerotic reactions for the Krebs cycle.

Variant 16

1. Oxidative decarboxylation ofα- ketoglutarate to succinyl-CoA. Structure of

multienzyme complex: enzymes, coenzymes.

2. The biological role of the Krebs cycle.

**Questions for oral poll:**

1. Central metabolic pathway. Definition, localization in the cell.

2. Pyruvate dehydrogenase complex. Structure and regulation.

3. Biological significance of the oxidative decarboxylation of pyruvic acid.

4. Sources and utilization of acetyl CoA.

5. Functions of the citric acid cycle (CAC).

6. Reactions of the Krebs cycle.

7. Biological significance of the CAC.

8. Regulation of the CAC.

**Practical skills testing**

**TCA cycle functioning manifested by the formation of CO2.**

Principle of the method. When acetyl-CoA is oxidized in TCA cycle, CO2 is released. It binds with calcium hydroxide and is revealed, when sulfuric acid is added, by gas vesicles. Experiment scheme:

|  |  |  |  |
| --- | --- | --- | --- |
| № | Content of test-tubes | Control (ml) | Experiment (ml) |
| 1 | Phosphate buffer ph = 7.4 | 2,0 | 2,0 |
| 2 | Acetyl-CoA solution | 0,5 | 0,5 |
| 3 | Oxaloacetate solution | 0,5 | 0,5 |
| 4 | Malonic acid solution | 1,0 | 1,0 |
| 5 | Incubation solution | - | - |
| 6 | Ca(OH)2 solution | 1,0 | 1,0 |
|  | Homogenate of the liver | 0,5 | 0,5 |
| 10 min incubation at room temperature | | | |
| 8 | 0.1N solution of sulfuric acid | 1,0 | 1,0 |

Observed changes:

Conclusion:

**Independent work of students to the lesson.** Control tasks in the workbook.

1. Draw the pyruvate generation scheme.
2. Describe the pyruvate dehydrogenase reaction in detail

3. Give the summary of oxidative decarboxylation of the pyruvate. Characterize the enzymes and cofactors.

1. Characterize the lipoic acid.
2. Explain regulation of the pyruvate dehydrogenase reaction.
3. Draw the sources and scheme of acetyl CoA utilization.
4. Numerate the functions of the CAC. Illustrate.
5. Draw the reactions of the Krebs Cycle.
6. Explain the significance of CAC.
7. Numerate the ATP generation steps. Draw the reactions.

**Topic 2.5 «General metabolism. Biological oxidation» Module**

**Form (s) of current performance control:** computer test, written control work.

**Assessment materials of current control of student performance**

**Test control questions**

**Written control work**

Variant 1

1. The definition and the stages of biological oxidation. General characteristic the first stage of biological oxidation.
2. The electron transport chain in the oxidation of succinate. Oxidative phosphorylation. Definition. The equation of oxidative phosphorylation for II type of electron transport chain
3. Hydration reaction in Krebs cycle. Biological significance of the CAC.
4. Reactive oxygen species.

Variant 2

1. Metabolism. The purposes of the metabolism. Metabolic pathways (central and specific, linear and cyclic).
2. The electron transport chain in the oxidation of lactate. Oxidative phosphorylation (ATP synthesis). Give the equation and definition. P/O ratio. Biological significance.
3. Give the summary of Krebs cycle. Localization in the cell and biological significance
4. Stages of the lipid peroxidation.

Variant 3

1. The concept of metabolism. Catabolism and anabolism. Relationship of anabolism and catabolism. Chemical structure and function ATP.
2. The electron transport chain in the oxidation of malate. The mechanisms ATP synthesis (substrate phosphorylation and oxidative phosphorylation). Definitions, similarities and differences. Give the examples of substrate phosphorylation.
3. Isomerization reactions in CAC. Biological significance of the CAC.
4. Clinical significance of free radicals.

Variant 4

1. Metabolic pathways. Substrate, product and metabolism. Definitions. Central and specific, linear and cyclic metabolic pathways. Definitions and examples.
2. The electron transport chain in the oxidation of isocytrate. The equation of oxidative phosphorylation. Uncouples of oxidative phosphorylation. Thermoregulatory function of tissue respiration.
3. Give the summary of the CAC. Biological significance of the CAC.
4. Free radicals scavenger systems.

Variant 5

1. The definition and the stages of biological oxidation. General characteristic the second stage of biological oxidation.
2. The electron transport chain in the oxidation of lactate. The mechanisms ATP synthesis (substrate phosphorylation and oxidative phosphorylation). Definitions, similarities and differences. Give the examples of substrate phosphorylation.
3. Redox reactions in the CAC. Regulation. Biological significance of the CAC.
4. Full and partial reduction of the oxygen. Non-enzymatic mechanism of protection against radical damage.

Variant 6

1. The concept of metabolism. Catabolism and anabolism. Relationship of anabolism and catabolism. Chemical structure and function ATP.
2. The electron transport chain in the oxidation of malate. The mechanisms ATP synthesis (substrate phosphorylation and oxidative phosphorylation). Definitions, similarities and differences. Give the examples of substrate phosphorylation.
3. Isomerization reactions in CAC. Biological significance of the CAC.
4. Antioxidants. Vitamin C as antioxidant.

Variant 7

1. The definition and the stages of biological oxidation. General characteristic the first stage of biological oxidation.
2. The electron transport chain in the oxidation of active form of fatty acids.
3. Redox reactions in the CAC. Give the summary of the CAC. The mechanisms ATP synthesis Definitions. Reaction of substrate phosphorylation in CAC.
4. Free radicals scavenger systems. Enzymatic mechanism of protection against radical damage.

Variant 8

1. The definition and the stages of biological oxidation. General characteristic the second stage of biological oxidation.
2. The electron transport chain in the oxidation of malate. The equation of oxidative phosphorylation for I type of ETC. The definition of the P/O ratio. Biological significance.
3. Hydration reaction in the CAC. Biological significance of the CAC.
4. Peroxidation of poly unsaturated fatty acids.

Variant 9

1. The definition and the stages of biological oxidation. General characteristic the third stage of biological oxidation.
2. The electron transport chain in the oxidation of succinate. Oxidative phosphorylation. Definition. The equation of oxidative phosphorylation for II type of electron transport chain
3. Central metabolic pathway. Definition, biological significance localization in the cell. Summary of the CAC
4. Reactive oxygen species. Definition, generation scheme of free radicals.

Variant 10

1. The concept of metabolism. Catabolism and anabolism. Relationship of anabolism and catabolism. Chemical structure and function ATP.
2. The electron transport chain in the oxidation of malate. The mechanisms ATP synthesis (substrate phosphorylation and oxidative phosphorylation). Definitions. Give the examples of substrate phosphorylation.
3. Pyruvate dehydrogenase complex. Summary of oxidative decarboxylation of the pyruvate. Characterize the enzymes and cofactors.
4. Peroxidation of polyunsaturated fatty acids.

Variant 11

1. Metabolic pathways. Substrate, product and metabolism. Definitions. Central and specific, linear and cyclic metabolic pathways. Definitions and examples.
2. The electron transport chain in the oxidation of succinate. Oxidative phosphorylation. Definition. The equation of oxidative phosphorylation for II type of electron transport chain
3. Isomerization reactions in CAC. Biological significance of the CAC.
4. Clinical significance of free radicals.

Variant 12

1. The definition and the stages of biological oxidation. General characteristic the first stage of biological oxidation.
2. The electron transport chain in the oxidation of active form of high fatty acids. General characteristic of the biological oxidation enzymes. Aerobic and anaerobic dehydrogenases. Primary and secondary dehydrogenases. Definitions and examples.
3. Pyruvate dehydrogenase complex. Regulation of the pyruvate dehydrogenase reaction.
4. Free radicals scavenger systems. Enzymatic mechanism of protection against radical damage.

Variant 13

1. The definition and the stages of biological oxidation. General characteristic the second stage of biological oxidation.
2. The electron transport chain in the oxidation of active form of high fatty acids. General characteristic of the biological oxidation enzymes. Aerobic and anaerobic dehydrogenases. Primary and secondary dehydrogenases. Definitions and examples.
3. Isomerization reactions in CAC. Biological significance of the CAC
4. Free radicals scavenger systems.

Variant 14

1. The definition and the stages of biological oxidation. General characteristic the first stage of biological oxidation.
2. The electron transport chain in the oxidation of succinate. Oxidative phosphorylation. Definition. The equation of oxidative phosphorylation for II type of electron transport chain
3. Hydration reaction in Krebs cycle. Biological significance of the CAC.
4. Reactive oxygen species.

Variant 15

1. Metabolism. The purposes of the metabolism. Metabolic pathways (central and specific, linear and cyclic).
2. The electron transport chain in the oxidation of lactate. Oxidative phosphorylation (ATP synthesis). Give the equation and definition. P/O ratio. Biological significance.
3. Give the summary of Krebs cycle. Localization in the cell and biological significance
4. Stages of the lipid peroxidation.

**Module № 5 «Nitrogen- containing biomolecules. Metabolic pathway of amino acids nucleotide metabolism»**

**Didactic unit № 1 «Metabolic pathway of amino acids»**

**Topic 5.1 «** **Digestion of protein »**

**Form (s) of current performance control:** incoming writing control, oral poll, test of practical skills, control tasks in the workbook.

**Assessment materials of current control of student performance**

**Incoming writing control:**

Variant 1

1. Numerate the functions of the protein in organism

2. Putrefaction of Tryptophan. Reactions

Variant 2

1. Chemical score. Definition

2. Detoxification of indole

Variant 3

1. Nitrogen balance

2. Detoxification of toxic products of putrification

Variant 4

1. Classification of amino acids. Examples

2. Digestion of the proteins in stomach

Variant 5

1. Protein turnover

2. Hartnup’s disease

Variant 6

1. Explain protein degradation

2. Cystinuria

Variant 7

1. Numerate the functions of the protein in organism

2. Putrefaction of Tryptophan. Reactions

Variant 8

1. Chemical score. Definition

2. Detoxification of indole

Variant 9

1. Nitrogen balance

2. Detoxification of toxic products of putrification

Variant 10

1. Classification of amino acids. Examples

2. Digestion of the proteins in stomach

Variant 11

1. Protein turnover

2. Hartnup’s disease

Variant 12

1. Explain protein degradation

2. Cystinuria

Variant 13

1. Numerate the functions of the protein in organism

2. Putrefaction of Tryptophan. Reactions

Variant 14

1. Chemical score. Definition

2. Detoxification of indole

Variant 15

1. Nitrogen balance

2. Detoxification of toxic products of putrification

Variant 16

1. Classification of amino acids. Examples

2. Digestion of the proteins in stomach

**Questions for oral poll:**

1. Functions of the protein in organism.
2. Source of protein. Requirement in protein
3. Essential, non-essential, semi-essential amino acids.
4. Nitrogen balance.
5. Nutritional indices. Biological value of protein. Net protein utilization. Protein efficiency ratio. Chemical score.
6. General characteristics of proteases. Endopeptidases, exopeptidases.
7. Role HCl in digestion of protein.
8. Digestion in stomach, duodenum, small intestine. Specificity of enzymes.
9. Absorption of free amino acids.
10. Putrefaction of amino acids. Detoxification of toxic products.
11. Putrefaction of Tryptophan. Detoxification of indole.
12. Putrefaction of Tyrosine. Detoxification of phenol.

**Practical skills testing**

**Determination of gastric juice pH**

Add 2-3 drops of gastric juice on universal indicator paper. Сompare the color with the standard.

**Determination of gastric juice acidity**

Add 0,5 ml of gastric juice by a pipette into a flask; add 1 drop of dimethylaminoazobenzole When free hydrochloric acid is present in gastric juice, it is stained in red color with a rosy shade, when it is absent, orange staining appears.

1. Add 1 drop of gastric juice on congo red. When free hydrochloric acid is present in gastric juice, paper stained in blue color.

**Lactic acid reaction**

Add 1 ml of 1 % phenol; add 2 drops 1% FeCl3 until purple color; add drop by drop of gastric juice. When lacticacid is present in gastric juice, it is stained in yellow green color, when it is absent, the solution becomes colorless.

***Clinical and diagnostic value.*** In gastric diseases the acidity can be zero, decreased and increased. In ulcers and hyperacidic gastritis the content of free hydrochloric acid and total acidity increase (hyperchlorhydria). In hypoacidic gastritis or gastric cancer the decrease of free hydrochloric acid and total acidity occurs (hypochlorhydria). Sometimes in gastric cancer and chronic gastritis a complete absence of hydrochloric acid is observed (achlorhydria). In malignant anemia, gastric cancer a complete absence of hydrochloric acid and pepsin (achilia) are noted.

***Conclusion:***

**Independent work of students to the lesson.** Control tasks in the workbook.

1. Enumerate essential and semi-essential amino acids.

3. Enumerate and explain nutritional indices.

4. Draw action of proteases scheme.

5. Draw activation of proteases schemes.

6. Enumerate functions of HCl.

7. Explain mechanisms of putrefaction and detoxification of toxic products.

8. Draw putrefaction of tryptophan and Tyrosine scheme.

9. Detoxification of indole and phenol in details.

**Topic 5.2 « General ways of amino acid catabolism »**

**Form (s) of current performance control:** incoming writing control, oral poll, practical skills testing, control tasks in the workbook.

**Assessment materials of current control of student performance**

**Incoming writing control:**

Variant 1

1. Amino acid pool in the cell. Way use of amino acid in the organism.
2. Transamination. Chemical reactions this process. Characteristics enzymes (transaminase). Cofactor role of vitamin B6.

Variant 2

1. Conversion of α- NH2 group, α- COOH group and carbon skeleton.
2. Deamination for D- and L- amino acids. Oxidative deamination of glutamic acid. Chemical reactions this process. Biological significance

Variant 3

1. Role of pyruvate, oxaloacetate, ketoglutarate in process of transamination. Collector function of ketoglutarate and glutamate. Biological significance of reactions transamination.
2. Transdeamination. Scheme. Biological significance.

Variant 4

1. Biological significance of ALT and AST.
2. Reactions decarboxylation of α- carboxyl group. General characteristic of biogenic amines.

Variant 5

1. Amino acid pool in the cell. Way use of amino acid in the organism.
2. Biosynthesis of GABA in details. Biological significance.

Variant 6

1. Conversion of α- NH2 group, α- COOH group and carbon skeleton.
2. Biosynthesis of serotonin in details. Biological significance.

Variant 7

1. Role of pyruvate, oxaloacetate, ketoglutarate in process of transamination. Collector function of ketoglutarate and glutamate. Biological significance of reactions transamination.
2. Biosynthesis of histamine in details. Biological significance.

Variant 8

1. Biological significance of ALT and AST.
2. Biosynthesis of dopamine in details. Biological significance.

Variant 9

1. Amino acid pool in the cell. Way use of amino acid in the organism.
2. Deamination for D- and L- amino acids. Oxidative deamination of glutamic acid. Chemical reactions this process. Biological significance

Variant 10

1. Conversion of α- NH2 group, α- COOH group and carbon skeleton.
2. Biosynthesis of GABA in details. Biological significance.

Variant 11

1. Amino acid pool in the cell. Way use of amino acid in the organism.
2. Transamination. Chemical reactions this process. Characteristics enzymes (transaminase). Cofactor role of vitamin B6.

Variant 12

1. Conversion of α- NH2 group, α- COOH group and carbon skeleton.
2. Deamination for D- and L- amino acids. Oxidative deamination of glutamic acid. Chemical reactions this process. Biological significance

Variant 13

1. Role of pyruvate, oxaloacetate, ketoglutarate in process of transamination. Collector function of ketoglutarate and glutamate. Biological significance of reactions transamination.
2. Transdeamination. Scheme. Biological significance.

Variant 14

1. Biological significance of ALT and AST.
2. Reactions decarboxylation of α- carboxyl group. General characteristic of biogenic amines.

Variant 15

1. Amino acid pool in the cell. Way use of amino acid in the organism.
2. Biosynthesis of GABA in details. Biological significance.

**Questions for oral poll:**

1. Amino acid pool in the cell. Way use of amino acid in the organism.
2. Conversion of α- NH2 group, α- COOH group and carbon skeleton.
3. Transamination. Chemical reactions this process. Characteristics enzymes (transaminase). Cofactor role of vitamin B6.
4. Role of pyruvate, oxaloacetate, ketoglutarate in process of transamination. Collector function of ketoglutarate and glutamate. Biological significance of reactions transamination.
5. Biological significance of ALT and AST.
6. Deamination for D- and L- amino acids. Oxidative deamination of glutamic acid. Chemical reactions this process. Biological significance.
7. Transdeamination. Scheme. Biological significance.
8. Reactions decarboxylation of α- carboxyl group. General characteristic of biogenic amines.
9. Biosynthesis of GABA, serotonin, histamine, dopamine in details. Biological significance.

**Practical skills testing**

**Determination of alanine aminotransferase (ALT) activity**

Aminotransferases (transaminases) are enzymes that use phosphopyridoxal as a co-enzyme and catalyze a reversible amino group transfer from amino acids to ketoacids. Evaluation of formed α-ketoacids concentration underlies transaminase activity determination methods.

*Principle of the method.* Alanine is converted to pyruvate after transamination. Addition of acidic 2,4-dinitrophenylhydrasine stops the enzymatic process. In alkaline medium the formed hydrosone of pyruvate gives brown-red staining, the intensity of which is proportional to the amount of produced pyruvate.

Aminotransferase activity is expressed in micromoles of pyruvate produced in 1 incubation hour at 37 °C by 1 ml of blood serum. Normal aminotransferase activity in the blood is not high and is from 0.1 to 0.45 μM/h∙ml for AST and 0.1–0.68 μM /h∙ml for АLT.

*Procedure*. Apply 0.5 ml of substrate solution into a test-tube, then add 0.1 ml of studied serum and incubate it in the thermostat at 37 °C for 30 minutes. Then add 0.5 ml of dinitrophenyl-hydrasine solution and leave the samples for 20 minutes at room temperature. Then add 5 ml of 0.4 N NaOH, carefully stir and leave to stay for 10 minutes at room temperature for staining development. Measure optical density by photoelectrocolorimeter under a green light filter (530 nm) in a 10 mm wide cuvette versus a control sample for reagents. The control sample contains all ingredients of the tested sample excluding serum, it being substituted by 0.1 ml of distilled water.

Fix the pyruvate concentration in the serum sample by a readymade calibration graph. Calculate enzyme activity by the following formula:

ALT (μM/h∙ml) = a ∙ 10 ∙ 2 / 88,

where a — the amount of pyruvate in 0.1 ml of serum found by the calibration graph, in μg; 88 — the weight of 1 μM of pyruvate in μg; 2 — conversion factor to 1 incubation hour; 10 — conversion factor to 1 ml of serum.

**E = a = ALT (μM/h∙ml) =**

*Clinical and diagnostic value*. Aminotransferases belong to indicator enzymes and their activity evaluation is widely spread in diagnosing heart and liver diseases. In myocardial infarction the increase of serum AST level is observed in 4–6 hours, its maximum activity — in 24–36 hours. The serum activity of both aminotransferases, especially that of АLT, elevates in hepatitis. The diagnostic value of АLT evaluation in jaundiceless form of infectious hepatitis and during the incubation period is of particular importance.

*Conclusion:*

**Independent work of students to the lesson.** Control tasks in the workbook.

1. Draw transamination scheme. Explain biological significance.

2. Explain biological significance of ALT and AST.

3. Draw deamination scheme. Explain biological significance.

4. Draw transdeamination scheme. Explain biological significance.

5. Draw biosynthesis of GABA, dopamine, serotonin, histamine in details. Explain of biological significance and mechanisms of detoxifications.

**Dicide situational tasks**

1. In patients with hypoacidity gastritis found reduce pepsin activity in gastric juice.

1. To what class of enzymes belongs pepsin?

2. What kind of reactions catalyzed by this enzyme?

3. The structure of this enzyme is a simple or complex?

2. In patients with chronic gastritis observed decrease in activity of pepsin, gastric juice pH is 5.0.

1. Explain the reason for decreased activity of pepsin.

2. Reason for such patients previously administered to take weak solution of hydrochloric acid before meals?

3. What type specificity typical for this enzyme?

3. When deficiency of vitamin B6 in infants who were bottle-fed, described damage to the nervous system.

Explain the biochemical mechanisms development of pathology, recalling the role of this vitamin in the metabolism of neurotransmitters and amino acids. To do this:

a) list the major precursors of neurotransmitters and mediators themselves, which is associated with the metabolism of vitamin B6,

b) Give examples of reactions of formation some biogenic amines,

c) specify how the their inactivation by writing the appropriate reaction.

4. The patient complained of pain in the liver were determined activity alanine aminotransferase (ALT) and aspartate aminotransferase (ASAT) in the blood. Transferase activity which will increase to a greater extent with abnormal liver function, and why?

**Topic 5.3 « Ways of formation and disposal of ammonia in the organism»**

**Form (s) of current performance control:** incoming writing control, oral poll, practical skills testing,control tasks in the workbook.

**Assessment materials of current control of student performance**

**Incoming writing control**

Variant №1

1. Glycogenic, ketogenic and glycoketogenic amino acids.
2. Mechanism of toxic action of ammonia

Variant №2

1. Biosynthesis of catecholamines.
2. Ammoniogenesis in kidney.

Variant №3

1. Biological significance of transmethylation reactions.
2. Urea cycle.

Variant №4

1. Biosynthesis of melanin. Albinism
2. Biosynthesis of GABA

Variant №5

1. Metabolic fate of phenylalanine.
2. Biosynthesis of serotonin, histamine

Variant №6

1. Glycogenic, ketogenic and glycoketogenic amino acids.
2. Mechanism of toxic action of ammonia

Variant №7

1. Biosynthesis of catecholamines.
2. Ammoniogenesis in kidney.

Variant №8

1. Biological significance of transmethylation reactions.
2. Urea cycle.

Variant №9

1. Biosynthesis of melanin. Albinism
2. Biosynthesis of GABA

Variant №10

1. Metabolic fate of phenylalanine.
2. Biosynthesis of GABA, serotonin, histamine

Variant №11

1. Glycogenic, ketogenic and glycoketogenic amino acids.
2. Mechanism of toxic action of ammonia

Variant №12

1. Biosynthesis of catecholamines.
2. Ammoniogenesis in kidney.

Variant №13

1. Biological significance of transmethylation reactions.
2. Urea cycle.

Variant №14

1. Biosynthesis of melanin. Albinism
2. Biosynthesis of GABA

Variant №15

1. Metabolic fate of phenylalanine.
2. Biosynthesis of GABA, serotonin, histamine

**Questions for oral poll:**

1. Disposal of ammonia from tissues. Transport forms for ammonia.

2. Mechanism of toxic action of ammonia and detoxification of ammonia in the nervous tissue.

3. Local ammonia detoxification:

a) Reductive amination of ketoglutorate;

b) amidation of glutamate and aspartate;

c) Glucose- alanine cycle. Biological significance.

4. General ways of ammonia detoxification:

a) Ammoniogenesis in kidney. Biological significance.

b) Synthesis of urea. Ornithine cycle. Chemical reactions. Role aspartate in the process. The origin of atoms in urea.

5. Urea cycle. Regulation, biological significance, disorders of urea cycle. Connection of Urea cycle with Krebs cycle.

6. Violations of synthesis of urea. Hyperammonemia and its types

**Practical skills testing**

**Determination of urea in urine**

In a healthy person about 20–35 g or 333–583 mmol of urea are excreted with urine for 24 hours.

*The principle of the method*. The method is based on the ability of urea containing amino groups to form with paradimethylaminobenzaldehyde a complex compound in acid medium that is stained yellow. The staining intensity is proportional to urea concentration in the studied urine and is measured photometrically.

*Procedure*. Pipettes and test-tube must be dry. Apply per 0.2 ml of urine (test sample), 25 mg/l urea solution (standard sample) and water (control sample) respectively into 3 test-tubes, add per 1.2 ml of 2 % solution of paradimethylaminobenzaldehyde into each of them and carefully stir. In 15 minutes perform photometry of the test and standard samples in dry 3 mm wide cuvettes under a blue light filter versus a control sample.

*Calculation*. Calculate the urea content in the test sample according to a standard urea solution by the formula:

Ct = Сs ∙ Еt / Еs,

where Ct — urea concentration in the urine sample, mg/ml; Сs — urea concentration in the standard sample, 25 mg/ml; Еt — optical density of the sample; Еs — optical density of the standard urea solution.

Multiply the received value by diuresis (1200-1500 ml) and get the daily content of urea in the urine. Conversion factor to SI units (mmol/24 hours) is 0.0167.

**Еt = Еs = Ct = Urea content in daily urine =**

*Clinical and diagnostic value*. The decreased urea content in urine is noted in nephritis, acidosis, parenchymatose jaundice, liver cirrhosis, uremia, while the elevated one — in fasting, malignant anemia, fever, intensive break-down of proteins in the organism, after taking salicylates, in phosphorus poisoning.

*Conclusion*:

**Independent work of students to the lesson.** Control tasks in the workbook.

1. Numerate transport forms for ammonia.
2. Draw glucose- alanine cycle scheme. Explain biological significance.
3. Numerate stages of metabolic conversions for ammonia.
4. Draw ammoniogenesis in kidney scheme. Explain biological significance.
5. Draw urea cycle in details. Explain regulations. Disorders of urea cycle.

**Topic 5.4 « Specific metabolic pathways of amino acids and their violations»**

**Form (s) of current performance control:** incoming writing control, oral poll, practical skills testing, control tasks in the workbook.

**Assessment materials of current control of student performance**

**Incoming writing control**

Variant 1

1. Transmethylation. The role of S-adenosylmethionine.
2. Biosynthesis of carnitine and biological role.

Variant 2

1. Metabolic fate of methionine. Biological significance of transmethylation reactions.
2. Catabolism of tyrosine in liver. Alcaptonuria.

Variant 3

1. Synthesis of creatine. Biological significance of creatine phosphate.
2. Metabolic fate of tyrosine. Biosynthesis of catecholamines. Parkinsonism.

Variant 4

1. Transmethylation. The role of S-adenosylmethionine.
2. Metabolic fate of phenylalanine. Phenylketonuria.

Variant 5

1. Metabolic fate of methionine. Biological significance of transmethylation reactions.
2. Biosynthesis of melanin. Albinism.

Variant 6

1. Synthesis of creatine. Biological significance of creatine phosphate.
2. Metabolic fate of phenylalanine. Phenylketonuria.

Variant 7

1. Transmethylation. The role of S-adenosylmethionine.
2. Catabolism of tyrosine in liver. Alcaptonuria.

Variant 8

1. Metabolic fate of methionine. Biological significance of transmethylation reactions.
2. Metabolic fate of phenylalanine. Phenylketonuria.

Variant 9

1. Synthesis of creatine. Biological significance of creatine phosphate.
2. Biosynthesis of melanin. Albinism.

Variant 10

1. Transmethylation. The role of S-adenosylmethionine.
2. Metabolic fate of tyrosine. Biosynthesis of catecholamines. Parkinsonism.

Variant 11

1. Transmethylation. The role of S-adenosylmethionine.
2. Biosynthesis of carnitine and biological role.

Variant 12

1. Metabolic fate of methionine. Biological significance of transmethylation reactions.
2. Catabolism of tyrosine in liver. Alcaptonuria.

Variant 13

1. Synthesis of creatine. Biological significance of creatine phosphate.
2. Metabolic fate of tyrosine. Biosynthesis of catecholamines. Parkinsonism.

Variant 14

1. Transmethylation. The role of S-adenosylmethionine.
2. Metabolic fate of phenylalanine. Phenylketonuria.

Variant 15

1. Metabolic fate of methionine. Biological significance of transmethylation reactions.
2. Biosynthesis of melanin. Albinism.

Variant 16

1. Synthesis of creatine. Biological significance of creatine phosphate.
2. Metabolic fate of phenylalanine. Phenylketonuria.

**Questions for oral poll:**

1. Transmethylation. The role of S-adenosylmethionine.
2. Metabolic fate of methionine. Biological significance of transmethylation reactions.
3. Synthesis of creatine. Biological significance of creatine phosphate.
4. Metabolic fate of phenylalanine. Phenylketonuria.
5. Metabolic fate of tyrosine. Biosynthesis of catecholamines. Parkinsonism.
6. Biosynthesis of melanin. Albinism.
7. Catabolism of tyrosine in liver. Alcaptonuria.
8. Biosynthesis of carnitine, phosphotidylcholine, adrenaline.

**Practical skills testing**

**Determination of creatinine in the urine.**

Principle of the method: when interacting with picric acid in an alkaline medium, creatinine forms colored compounds, the color intensity of which is directly proportional to the end-effect of creatinine in urine.

0.1 ml of urine is poured into a measuring tube, 4 drops of 10% NaOH solution and 0, I 5 ml of saturated picric acid solution are added. At the same time put the control, pouring into a measuring tube instead of urine with 0.1 ml of distilled water. mix the contents of the tubes, leave for 5 minutes. Bring dist N.O up to a volume of 10 ml. Mix thoroughly and photometrically counter-control to FEC with a green filter in a 5 mm cuvette. Having obtained the optical density of the solution, the amount of creatinine in 0.1 ml of urine is determined using a calibration graph. Next, recalculate its concentration on the daily amount of urine. To convert to SI units (mmol / day), the coefficient is 8.84. In the normal content of creatinine in the urine is 4.4-17.7 mmol / day.

*Conclusion*:

**Independent work of students to the lesson.** Control tasks in the workbook.

1. Explain alternative pathways in phenylketonuria.
2. Draw metabolic fate of tyrosine scheme.
3. Draw biosynthesis of dopamine, adrenaline, noradrenaline in details.
4. Draw synthesis of melanin scheme.
5. Draw catabolism of tyrosine in details.
6. Give activation of methionine in details.
7. Numerate using of S- adenosyl methionine.
8. Draw synthesis of carnitine and phosphotidylcholine in details.

Draw fate of branched-chain amino acids scheme.

**Topic 5.5 «** **Metabolic pathway of amino acids final control » Module**

**Form (s) of current performance control:** computer test, written control work.

**Assessment materials of current control of student performance**

**Test control questions**

**Written control work**

Variant 1

1. Functions of the protein in organism. Source of protein. Requirement in protein. Essential, non-essential, semi-essential amino acids.
2. Role of pyruvate, oxaloacetate, ketoglutarate in process of transamination. Collector function of ketoglutarate and glutamate. Biological significance of reactions transamination.
3. General ways of ammonia detoxification. Ammoniogenesis in kidney. Scheme. Biological significance.
4. Metabolic fate of tyrosine. Biosynthesis of catecholamines. Parkinsonism.

Variant 2

1. Digestion in stomach. Specificity of enzymes. Role HCl in digestion of protein.
2. Amino acid pool in the cell. Way use of amino acid in the organism. Conversion of α- NH2 group, α- COOH group and carbon skeleton.
3. Write 1,2,3 chemical reactions of urea cycle. Regulation, biological significance, disorders of urea cycle. Connection of Urea cycle with Krebs cycle.
4. Biosynthesis of melanin. Albinism.

Variant 3

1. Nitrogen balance. Nutritional indices. Biological value of protein. Net protein utilization. Protein efficiency ratio. Chemical score.
2. Transamination. Chemical reactions this process. Characteristics enzymes (transaminase). Cofactor role of vitamin B6.
3. Violations of synthesis of urea. Hyperammonemia and its types.
4. Metabolic fate of phenylalanine. Phenylketonuria.

Variant 4

1. Putrefaction of Tyrosine. Detoxification of phenol.
2. Biological significance of ALT and AST.
3. Local ammonia detoxification. Glucose- alanine cycle. Biological significance.
4. Transmethylation. The role of S-adenosylmethionine.

Variant 5

1. Digestion in duodenum. Specificity of enzymes.
2. Oxidative deamination of glutamic acid. Chemical reactions this process. Biological significance.
3. Local ammonia detoxification. Reductive amination of ketoglutorate. Amidation of glutamate and aspartate.
4. Catabolism of tyrosine in liver. Alcaptonuria.

Variant 6

1. Absorption of free amino acids.
2. Reactions decarboxylation of α- carboxyl group. Characteristics of enzyme. Biosynthesis of GABA. Biological significance of GABA.
3. Disposal of ammonia from tissues. Transport forms for ammonia. Mechanism of toxic action of ammonia and detoxification of ammonia in the nervous tissue.
4. Metabolic fate of methionine. Biological significance of transmethylation reactions.

Variant 7

1. Digestion in small intestine. Specificity of enzymes.
2. Transamination. Chemical reactions this process. Characteristics enzymes (transaminase). Cofactor role of vitamin B6.
3. General ways of ammonia detoxification. Synthesis of urea. Chemical reactions.
4. Biosynthesis of carnitine.

Variant 8

1. General characteristics of proteases. Endopeptidases, exopeptidases.
2. Reactions decarboxylation of α- carboxyl group. Biosynthesis of serotonin. Biological significance of serotonine.
3. General ways of ammonia detoxification. Ammoniogenesis in kidney. Scheme. Biological significance.
4. Synthesis of creatine. Biological significance of creatine phosphate.

Variant 9

1. Putrefaction of Tryptophan. Detoxification of indole.
2. Transdeamination. Scheme. Biological significance.
3. General ways of ammonia detoxification. Synthesis of urea. Chemical reactions.
4. Biosynthesis of melanin. Albinism.

Variant 10

1. Digestion in stomach. Specificity of enzymes. Role HCl in digestion of protein.
2. Amino acid pool in the cell. Way use of amino acid in the organism. Conversion of α- NH2 group, α- COOH group and carbon skeleton.
3. Mechanism of toxic action of ammonia and detoxification of ammonia in the nervous tissue.
4. Biosynthesis of histamine. Biological significance.

Variant 11

1. Functions of the protein in organism. Source of protein. Requirement in protein. Essential, non-essential, semi-essential amino acids.
2. Role of pyruvate, oxaloacetate, ketoglutarate in process of transamination. Collector function of ketoglutarate and glutamate. Biological significance of reactions transamination.
3. General ways of ammonia detoxification. Ammoniogenesis in kidney. Scheme. Biological significance.
4. Metabolic fate of tyrosine. Biosynthesis of catecholamines. Parkinsonism.

Variant 12

1. Digestion in stomach. Specificity of enzymes. Role HCl in digestion of protein.
2. Amino acid pool in the cell. Way use of amino acid in the organism. Conversion of α- NH2 group, α- COOH group and carbon skeleton.
3. Write 1,2,3 chemical reactions of urea cycle. Regulation, biological significance, disorders of urea cycle. Connection of Urea cycle with Krebs cycle.
4. Biosynthesis of melanin. Albinism.

Variant 13

1. Nitrogen balance. Nutritional indices. Biological value of protein. Net protein utilization. Protein efficiency ratio. Chemical score.
2. Transamination. Chemical reactions this process. Characteristics enzymes (transaminase). Cofactor role of vitamin B6.
3. Violations of synthesis of urea. Hyperammonemia and its types.
4. Metabolic fate of phenylalanine. Phenylketonuria.

Variant 14

1. Putrefaction of Tyrosine. Detoxification of phenol.
2. Biological significance of ALT and AST.
3. Local ammonia detoxification. Glucose- alanine cycle. Biological significance.
4. Transmethylation. The role of S-adenosylmethionine.

Variant 15

1. Digestion in duodenum. Specificity of enzymes.
2. Oxidative deamination of glutamic acid. Chemical reactions this process. Biological significance.
3. Local ammonia detoxification. Reductive amination of ketoglutorate. Amidation of glutamate and aspartate.
4. Catabolism of tyrosine in liver. Alcaptonuria.

Variant 16

1. Absorption of free amino acids.
2. Reactions decarboxylation of α- carboxyl group. Characteristics of enzyme. Biosynthesis of GABA. Biological significance of GABA.
3. Disposal of ammonia from tissues. Transport forms for ammonia. Mechanism of toxic action of ammonia and detoxification of ammonia in the nervous tissue.
4. Metabolic fate of methionine. Biological significance of transmethylation reactions.

**Didactic unit № 2 «Metabolism of nucleotides»**

**Topic 5.6 «** **Metabolic pathway of nucleotides catabolism and anabolism»**

**Form (s) of current performance control:** incoming writing control, oral poll, control tasks in the workbook.

**Assessment materials of current control of student performance**

**Incoming writing control:**

Variant 1

1. Intake and digestion nucleorotheids in the gastrointestinal tract. Characteristic of nucleotidases.
2. Write chemical reactions degradation of AМP.

Variant 2

1. Absorption of nucleorotheids.
2. Write chemical reactions degradation of CМP

Variant 3

1. Synthesis of deoxyribonucleotides. Regulation.
2. Gout, symptoms, treatment.

Variant 4

1. Write chemical reactions degradation of GМP.
2. Lesch- Nyhan syndrome, symptoms, treatment.

Variant 5

1. Intake and digestion nucleorotheids in the gastrointestinal tract. Characteristic of nucleotidases.
2. Write chemical reactions degradation of TМP.

Variant 6

1. Absorption of nucleorotheids.
2. Write chemical reactions degradation of AМP.

Variant 7

1. Write chemical reactions degradation of GМP.
2. Gout, symptoms, treatment.

Variant 8

1. Synthesis of deoxyribonucleotides. Regulation.
2. Lesch- Nyhan syndrome, symptoms, treatment

Variant 9

1. Intake and digestion nucleorotheids in the gastrointestinal tract. Characteristic of nucleotidases.
2. Write chemical reactions degradation of AМP.

Variant 10

1. Absorption of nucleorotheids.
2. Write chemical reactions degradation of CМP

Variant 11

1. Synthesis of deoxyribonucleotides. Regulation.

2. Gout, symptoms, treatment.

Variant 12

* + - 1. Write chemical reactions degradation of GМP.
      2. Lesch- Nyhan syndrome, symptoms, treatment.

Variant 13

1. Intake and digestion nucleorotheids in the gastrointestinal tract. Characteristic of nucleotidases.
2. Write chemical reactions degradation of TМP.

Variant 14

1. Absorption of nucleorotheids.
2. Write chemical reactions degradation of AМP.

Variant 15

1. Write chemical reactions degradation of GМP.
2. Gout, symptoms, treatment.

**Questions for oral poll:**

1. Intake and digestion nucleorotheids in the gastrointestinal tract.
2. Absorption of nucleorotheids.
3. Degradation of purine nucleotides.
4. Gout, symptoms, treatment.
5. Degradation of pyrimidine nucleotides.
6. Biosynthesis *de novo* purine nucleotides. Regulation.
7. Biosynthesis *de novo* pyrimidine nucleotides. Regulation.
8. Synthesis of deoxyribonucleotides. Regulation.
9. Lesch- Nyhan syndrome, symptoms.

**Independent work of students to the lesson.** Control tasks in the workbook.

1. Draw degradation of purine nucleotides in details.
2. Explain treatment of gout.
3. Numerate stages of synthesis of purine nucleotides. Give formation of purine ring scheme.
4. Draw synthesis of phosphoribosyl pyrophosphate in details.
5. Draw synthesis of AMP and GMP from inosine monophosphate in details.
6. Explain salvage pathway for purines.
7. Draw synthesis of pyrimidime ribonucleotides in details.
8. Synthesis of deoxyribonucleotides from ribonucleotides in details.

10. Explain regulation of synthesis nucleotides.

**Topic 5.7 «** **Matrix biosynthesis. Biosynthesis of DNA and RNA** **»**

**Form (s) of current performance control:** incoming writing control, oral poll, control tasks in the workbook.

**Assessment materials of current control of student performance**

**Incoming writing control:**

Variant 1

1. Structure of nucleic acid and their biological role. Types RNA.
2. Enumerate conditions and enzymes of replication. Draw scheme of replication of DNA (initiation).

Variant 2

1. Enumerate types of genetic information transfer. Draw scheme of genetic information transfer.
2. Enumerate conditions and enzymes of transcription. Draw scheme of transcription (initiation).

Variant 3

1. Processing of mRNA.
2. Enumerate conditions and enzymes of replication. Draw scheme of replication of DNA (elongation).

Variant 4

1. Structure of nucleic acid and their biological role. Types RNA.
2. Enumerate conditions and enzymes of transcription. Draw scheme of transcription (elongation).

Variant 5

1. Enumerate types of genetic information transfer. Draw scheme of genetic information transfer.
2. Enumerate conditions and enzymes of replication. Draw scheme of replication of DNA (termination).

Variant 6

1. Processing of mRNA.
2. Enumerate conditions and enzymes of transcription. Draw scheme of transcription (termination).

Variant 7

1. Structure of nucleic acid and their biological role. Types RNA.
2. Enumerate conditions and enzymes of replication. Draw scheme of replication of DNA (initiation).

Variant 8

1. Enumerate types of genetic information transfer. Draw scheme of genetic information transfer.
2. Enumerate conditions and enzymes of transcription. Draw scheme of transcription (initiation).

Variant 9

1. Processing of mRNA.
2. Enumerate conditions and enzymes of replication. Draw scheme of replication of DNA (elongation).

Variant 10

1. Structure of nucleic acid and their biological role. Types RNA.
2. Enumerate conditions and enzymes of transcription. Draw scheme of transcription (elongation).

Variant 11

1. Enumerate types of genetic information transfer. Draw scheme of genetic information transfer.
2. Enumerate conditions and enzymes of replication. Draw scheme of replication of DNA (termination).

Variant 12

1. Processing of mRNA.
2. Enumerate conditions and enzymes of transcription. Draw scheme of transcription (termination).

**Questions for oral poll:**

1. Structure of nucleic acid and their biological role. Types RNA.
2. Types of genetic information transfer.
3. Replication of DNA (initiation, elongation, termination). Сonditions, enzymes.
4. Transcription (initiation, elongation, termination). Сonditions, enzymes.
5. Processing of mRNA.

**Independent work of students to the lesson.** Control tasks in the workbook.

1. Draw structure of polynucleotides:

a) A-G-C-U;

b) T-A-C-G

2. Draw semiconservative type of DNA replication scheme.

4. Draw leading strand and lagging strand with Okazaki pieces.

5. Give summary of DNA replication.

6. Draw structure of transcription unit.

7. Draw processing scheme.

**Topic 5.8 «** **Biosynthesis of protein and its regulation** **»**

**Form (s) of current performance control:** incoming writing control, oral poll, control tasks in the workbook.

**Assessment materials of current control of student performance**

**Incoming writing control:**

Variant 1

1. Enumerate stage of biosynthesis of protein (translation). Give characteristics of cytosol stage.
2. Modern ideas about the structure ribosome.

Variant 2

1. Enumerate stage of biosynthesis of protein (translation). Give characteristics of ribosomal stage.
2. Write activation of amino acids, formation of aminoacyl-tRNA, specificity of ARS-ase enzymes.

Variant 3

1. Give characteristics of tRNA, mRNA, rRNA.
2. Posttranslational processing. Chaperones.

Variant 4

1. Enumerate stage of biosynthesis of protein (translation). Give characteristics of cytosol stage.
2. Draw scheme of regulation of biosynthesis of protein on transcription’s level.

Variant 5

1. Give characteristics of tRNA, mRNA, rRNA.
2. Give characteristics of initiation. Draw scheme of initiation.

Variant 6

1. Modern ideas about the structure ribosome.
2. Give characteristics of elongation. Draw scheme of elongation.

Variant 7

1. Draw scheme of regulation of biosynthesis of protein on transcription’s level.
2. Give characteristics of termination. Draw scheme of termination.

Variant 8

1. Enumerate stage of biosynthesis of protein (translation). Give characteristics of cytosol stage.
2. Modern ideas about the structure ribosome.

Variant 9

1. Enumerate stage of biosynthesis of protein (translation). Give characteristics of ribosomal stage.
2. Write activation of amino acids, formation of aminoacyl-tRNA, specificity of ARS-ase enzymes.

Variant 10

1. Give characteristics of tRNA, mRNA, rRNA.
2. Posttranslational processing. Chaperones.

Variant 11

1. Enumerate stage of biosynthesis of protein (translation). Give characteristics of cytosol stage.
2. Draw scheme of regulation of biosynthesis of protein on transcription’s level.

Variant 12

1. Give characteristics of tRNA, mRNA, rRNA.
2. Give characteristics of initiation. Draw scheme of initiation.

**Questions for oral poll:**

1. Stage of biosynthesis of protein (translation):
2. Cytosol stage:

* activation of amino acids, formation of aminoacyl-tRNA, specificity of ARS-ase enzymes;
* characteristics tRNA, mRNA, rRNA;
* modern ideas about the structure ribosome.

1. Ribosomal stage:

* Initiation;
* Elongation;
* Termination.

1. Posttranslational processing. Chaperones.
2. Regulation of biosynthesis of protein on transcription’s level.

**Independent work of students to the lesson.** Control tasks in the workbook.

1. Numerate phases of translation process.

2. Give activation of amino acids in details.

3. Draw initiation, elongation and termination of translation scheme.