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ФИО: Таскаев Сергей Валерьевич  
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МИНОБРАЗОВАНИЯ РОССИИ Федеральное государственное бюджетное образовательное учреждение высшего образования «Челябинский государственный университет» (ФГБОУ ВО «ЧелГУ»)	
Фонд оценочных средств по дисциплине «Спецглавы химических наук – Экологическая биохимия» по направлению подготовки 06.04.01 «Биология» ФГБОУ ВО «ЧелГУ»	стр. 1

**Фонд оценочных средств  
промежуточной аттестации  
по дисциплине**

**Спецглавы химических наук – Экологическая биохимия**

Направление подготовки (специальность)  
**06.04.01 Биология**

Направленность (профили)  
Микробиология и вирусология, Генетика, Радиационная биология,  
Гистология

Присваиваемая квалификация  
**Магистр**

Форма обучения  
**Очная**

Год набора: 2025

Челябинск, 2025

**1. ПАСПОРТ ФОНДА ОЦЕНОЧНЫХ СРЕДСТВ**Направление подготовки: **06.04.01 Биология**

Направленность (профиль): «Микробиология и вирусология, Генетика, Радиационная биология, Гистология».

Дисциплина: **Спецглавы химических наук – Экологическая биохимия**

Семестры изучения: 3

Форма промежуточной аттестации: экзамен

**2. ПЕРЕЧЕНЬ ФОРМИРУЕМЫХ КОМПЕТЕНЦИЙ****2.1. Компетенции, закреплённые за дисциплиной**

Изучение дисциплины «Спецглавы химических наук – Экологическая биохимия» направлено на формирование следующих компетенций:

Коды компетенции (по ФГОС)	Содержание компетенций согласно ФГОС	Коды и содержание индикаторов	Перечень планируемых результатов обучения по дисциплине
1	2	3	4
УК-4	Способен применять современные коммуникативные технологии, в том числе на иностранном(ых) языке(ах), для академического и профессионального взаимодействия	УК-4.1. Обладает знаниями особенностей и правил личной и профессиональной устной и письменной коммуникации, в том числе на иностранном(ых) языке(ах) УК-4.2. Демонстрирует умение применять современные коммуникативные технологии для академического и профессионального взаимодействия в ситуации устной и письменной коммуникации, в том числе на иностранном (ых) языке(ах) УК-4.3. Имеет навыки академического и профессионального взаимодействия, в том числе на иностранном(ых) языке (ах)	Для реализации УК-4.1 знать: особенности англоязычной научной-технической терминологии и понятийного аппарата в области биологических наук. Для реализации УК-4.2 уметь: понимать тексты, аудио- и видеоматериалы на английском языке, посвященные современным проблемам биологических наук; корректно формулировать запросы для поиска в англоязычных научных интернет-ресурсах. Для реализации УК-4.3 владеть: навыками корректного перевода специальных научных текстов, посвящённых современным проблемам биологических наук; навыками поиска информации в англоязычных базах биомедицинских данных

<p><b>ПК-1</b></p>	<p>Способен использовать знание нормативных документов, регламентирующих организацию проведения научно-исследовательских работ для руководства рабочим коллективом и обеспечения мер производственной безопасности</p>	<p>ПК-1.2 Анализирует нормативные документы, регламентирующие организацию и методику проведения научно-исследовательских и производственно-технологических работ биологического профиля.                  ПК-1.3 Планирует организацию и проведение научных исследований по актуальным биомедицинским проблемам                  ПК-1.4 Использует профессиональные умения и навыки работы в лабораториях биомедицинского профиля и других учреждениях биологического профиля.</p>	<p>Для реализации ПК-1.2 знать: теоретические основы биохимии                  Для реализации ПК-1.3 уметь: творчески использовать фундаментальные и прикладные знания биохимии для профессиональной деятельности                  Для реализации ПК-1.4 владеть: навыками научно-исследовательской деятельности и самостоятельного проведения биохимических экспериментов.</p>
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### 3. СОДЕРЖАНИЕ ОЦЕНОЧНЫХ СРЕДСТВ ПО ДИСЦИПЛИНЕ

#### 3.1 Виды оценочных средств

№ п/п	Код компетенции/планируемые результаты обучения	Контролируемые темы/разделы	Наименование оценочного средства для текущего контроля	Наименование оценочного средства на промежуточной аттестации № задания
1	Для реализации УК-4.1 знать: особенности англоязычной научной технической терминологии и понятийного аппарата в области биологических наук. Для реализации УК-4.2 уметь: понимать тексты, аудио- и видеоматериалы на английском языке, посвященные современным проблемам биологических наук; корректно формулировать запросы для поиска в англоязычных научных интернет-ресурсах. Для реализации УК-4.3 владеть: навыками корректного перевода специальных научных текстов, посвященных современным проблемам биологических наук; навыками поиска информации в англоязычных базах биомедицинских данных	1. Biochemical interactions between organisms of different systematic groups 2. Some problems of biochemical ecology	Report business game	Final test variant 1 variant 2 Situational task
2	Для реализации ПК-1.2 знать: теоретические основы биохимии Для реализации ПК-1.3 уметь: творчески использовать фундаментальные и прикладные знания биохимии для профессиональной деятельности Для реализации ПК-1.4 владеть: навыками научно-исследовательской деятельности и самостоятельного проведения биохимических экспериментов.	1. Biochemical interactions between organisms of different systematic groups 2. Some problems of biochemical ecology	Report Test Situational task	Final test variant 1 variant 2 Situational task

*Примечание: типовые задания, критерии и показатели оценивания в рамках текущего контроля представлены в рабочей программе дисциплины (модуля). Полные комплекты оценочных средств и контрольно-измерительных материалов хранятся на кафедре.*

### **3.2 Содержание оценочных средств**

Оценочные средства промежуточной аттестации по дисциплине «Спецглавы химических наук – Экологическая биохимия» представлены перечнем вопросов для экзамена, вопросами для итогового тестирования: вопросы с одним вариантом ответа, вопросы с несколькими правильными ответами, вопросы на сопоставление, вопросы с открытым ответом и перечнем ситуационных задач.

#### **3.2.1 Вопросы для экзамена по дисциплине «Спецглавы химических наук – Экологическая биохимия»**

1. Subject and object of ecological biochemistry. The place of ecological biochemistry in the system of natural sciences.
2. Classification of the types of chemical effects of the body on the environment.
3. Basic ecological and biochemical interactions between organisms of various systematic groups (fungi, algae, higher plants and animals).
4. The main chemomediators of fungi.
5. Allelopathy - ecological and biochemical interactions between higher plants. The role of allelopathy in successions. Prospects for the use of allelopathically active substances in agriculture and biotechnology
6. Main plant chemomediators (classification): Chemoregulators of the feeding behavior of phytophages.
7. Main plant chemomediators (classification): Chemoregulators of development and fertility of phytophages.
8. Main plant chemomediators (classification): plant pigments (chlorophylls, carotenoids).
9. Main plant chemomediators (classification): anthocyanins.
10. Main animal chemomediators (classification): Pheromones (releasers and primers)
11. Major animal chemomediators (classification): Interaction between animals of different species involving allomones and kairomones
12. Brief description of toxins and poisons of animal origin. Practical application of animal poisons
13. Classification of xenobiotics, properties of xenobiotics, biodegradability.
14. Classification of xenobiotics. Benz (a) pyrene, formaldehyde. LD. Symptoms of poisoning.
15. Classification of xenobiotics. Nitrates. LD. Symptoms of poisoning.
16. Classification of xenobiotics. Cyanites, solanine. LD. Symptoms of poisoning.
17. Classification of xenobiotics. Heavy metals. LD. Symptoms of poisoning.
18. Classification of xenobiotics. Dioxins. LD. Symptoms of poisoning
19. Classification of xenobiotics. Methylmercury. LD. Symptoms of poisoning
20. Classification of xenobiotics. PAH. LD. Symptoms of poisoning
21. Stages of biotransformation of xenobiotics. Reactions of the first phase of biotransformation.
22. Stages of biotransformation of xenobiotics. Reactions of the second phase of biotransformation.
23. Biological systems that carry out the biotransformation of xenobiotics 24. Microsomal enzymatic system
25. Ethanol metabolism
25. Folate Cycle
27. Drug Metabolism

28. Monitoring of xenobiotics in clinical practice.

29. Drug monitoring. Basic methods.

*Final test «Итоговое тестирование» (правильные ответы отмечены знаком +)*

Variant I

**1. The term "ecology" suggested:**

- A. E. Haeckel; (+)
- B. V. I. Vernadsky;
- C. Ch. Darwin;
- D. A. Tensley

**2. Choose from the proposed functions of chemo-regulators:**

- A. consumer protection
- B. Signal acting as a recruiting factor
- C. Regulation of interactions within populations
- D. Attack factor
- I. all of the above (+)

**3. Natural substances produced by plants and animals and attracting organisms are called:**

- A. attractants. (+)
- B. deterrents.
- C. kairomones.
- D. hormones

**4. Atmospheric pollutants according to their state of aggregation are divided into:**

- A. Hot and cold.
- B. Chemical and physical.
- C. Gaseous, liquid and solid substances. (+)
- D. Gaseous, liquid and aerosol.
- E. Organic and inorganic

**5. Substances that cause increased sensitivity of the body to the effects of environmental factors:**

- A. toxins;
- B. allergens; (+)
- C. carcinogens.

**6. The color of anthocyanins depends on:**

- A. on the content of substituents, pigment concentration, the formation of complexes with metals
- B. on pH, pigment concentration, formation of complexes with metals, number and nature of substituents (+)
- C. on pH, pigment concentration, number and nature of substituents
- D. the formation of complexes with metals, the number and nature of substituents

**7. Lycopene - a pigment of watermelons, tomatoes, which protects plant parts from sunlight and oxidative stress, by chemical nature is:**

- A. carotenoid (+)
- B. anthocyanin
- C. phycobilin
- D. chlorophyll

**8. The function of ecological chemoeffectors that regulate the division of the energy flow in the ecosystem into pasture and detrital food chains is characteristic of:**

- A. mycotoxins (+)
- B. plant toxins (+)

C. invertebrate pheromones

D. synomones

**9. Cadeine - a compound, a derivative of morphine with a methyl radical, belongs to the class:**

A. true alkaloids (+)

B. terpenes

C. cyanogenic glycosides

D. phenols

**10. Amygdalin - a compound containing in the seeds of bitter almonds, belongs to the class:**

A. cyanogenic glycosides (+)

B. alkaloids

C. cardiac glycosides

D. aflatoxins

**11. Lotavstralin - an organic compound, methyl ethyl ketone cyanohydrin glucoside, contained in some leguminous plants (*Trifolium repens*, *Lotus australis*, *Phaseolus lunatus*), plants of the genera *Rhodiola* (*Rhodiola rosea* and *Rhodiola cyrillic*) and *Mánihot esculénta*, as well as a number of other plants belongs to the class:**

A. cyanogenic glycosides (+)

B. alkaloids

C. cardiac glycosides

D. xanthophylls

**12. The trace pheromone produced by leaf-cutting ants:**

A. is highly specific. (+)

B. has group specificity

C. is perceived by ants at a dose of 0.08 pg/cm.

D. all answers are wrong.

**13. Anxiety pheromones include**

A. D-bornyl acetate.

B. bombycol.

C. disparlure.

D. isoamyl acetate. (+)

**14. In the body of animals and humans, the detoxification system is the most studied**

A. in the liver. (+)

B. in the muscles.

C. in bone tissue.

D. in the lungs.

**15. Choose one wrong answer Ethanol oxidation:**

A. Occurs mainly in the liver

B. Catalyzed by alcohol dehydrogenase

C. Slows down with an increase in NADH + / NAD in the cell

- D. Can proceed under the action of the microsomal ethanol-oxidizing system
- E. Leads to the formation of an intermediate product of the citrate cycle (+)

**16. The functional role of microsomal oxidation is:**

- A. in using the energy of oxidation for the synthesis of ATP
- B. in the formation of oxygen-containing organic compounds with "plastic" purposes
- C. in the hydroxylation of hydrophobic compounds for "detoxification" purposes (+)

**17. Indicate a mechanism that does not belong to the protective ones against reactive oxygen species:**

- A. Antioxidant enzymatic systems
- B. Antioxidants of the tocopheral type
- C. reduced glutathione
- D. glutathione peroxidase
- E. easily self-oxidizing compounds (+)

**18. Choose the most complete answer. Reactions occur in the liver:**

- A. Conjugations involving UDP-glucuronate
- B. Hydroxylation of xenobiotics
- C. Conjugation with 3'-phosphoadenosine-5'-phosphosulfate (PAPS)
- D. Neutralization of toxic substances (+)
- E. Formation of bilirubinglucuronide

**19. Choose one wrong answer Cytochrome P450:**

- A. Can be induced by many substances
- B. Binds lipophilic molecules
- C. Simple protein (+)
- D. Localized in the membrane of the endoplasmic reticulum
- E. Hemoprotein

**20. The root of which plant (sweet, fragrant) contains the poisonous substance cicutotoxin:**

- A. *Hyoscyamus niger*;
- B. *Atropa belladonna*;
- C. *Cicuta virosa*; (+)
- G. *Conium maculatum*

**21. The reason for the development of methemoglobinemia in humans can be the introduction into the soil:**

- A. potash fertilizers;
- B. phosphate fertilizers;
- C. nitrogen fertilizers; (+)
- D. pesticides.

**22. Name the enzyme catalyzing this reaction  $C_2H_5OH + HAD^+ \leftrightarrow CH_3CHO + NADH + H^+$ . NAD-dependent alcohol dehydrogenase**

**23. Establish a correspondence**

- A. Cytochrome P450
- B. Cytochrome P450 reductase

B. Both

G. none

1. Has O<sub>2</sub> binding sites
2. FAD- or FMN-dependent enzyme
3. Enzyme of the monooxygenase system
4. Participates in the neutralization of nitrates

1. a

2. g

3. in

4. b

**24. Detoxification of ethyl alcohol in the liver is carried out in the following ways: bgd**

A. conjugation;

B. microsomal oxidation;

C. hydrolysis;

D. non-microsomal oxidation;

E. mitochondrial oxidation

**25. With prolonged use of alcohol, the following deviations occur:**

A. accumulation of NAD<sup>+</sup> and NADP<sup>+</sup>;

B. increased breakdown of glycogen;

C. hypoglycemia;

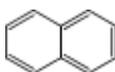
D. increased energy metabolism;

E. lactate accumulation.

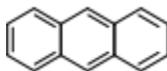
**26. What are the names of organic substances whose structural formulas are presented below: polyaromatic hydrocarbons**

**Chemical substance**

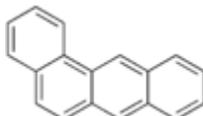
Naphthalene



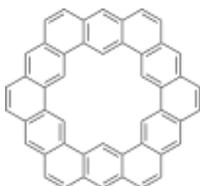
Anthracene



Benzantracene

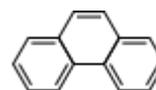


Kekulen

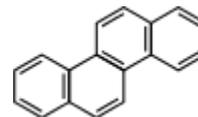


**Chemical substance**

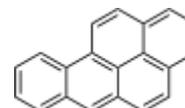
Phenanthrene



Chrysen



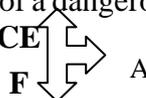
Benzpyrene



Koranulen



**27. Make up a food chain leading to the accumulation of a dangerous compound of methylmercury from the following components::** **BDCE**



A. Bluefin tuna, B. anaerobic soil bacteria, C. Krill, D. phytoplankton, E. schooling pelagic fish living near the surface of the water (sardine, mackerel, anchovy, herring), F. cephalopods (Teuthida).

**28.** During the Vietnam War from 1961 to 1971, as part of the Ranch Hand devegetation program, Agent Orange, a mixture of 2,4-dichlorophenoxyacetic acid (2,4-D) and 2,4,5-trichlorophenoxyacetic acid, was used as a defoliant. (2,4,5-T) containing impurities of polychlorobenzodioxins. As a result, a significant number of both Vietnamese and soldiers who had contact with Agent Orange suffered from the effects of the disintegration of Agent Orange. What substances are formed? **Dioxins**

**29.** This substance is an inhibitor of the enzyme cytochrome c-oxidase (aa3) in the IV complex of the respiratory chain of electron transport (in eukaryotes it is localized on the inner membrane of mitochondria). It binds to Fe, which is part of the enzyme, which prevents the transfer of electrons between cytochrome c oxidase and oxygen. As a result, electron transport is disturbed, and, consequently, aerobic ATP synthesis stops. What is the name of? **Cyanides, hydrocyanic acid**

**30. Establish a correspondence.**

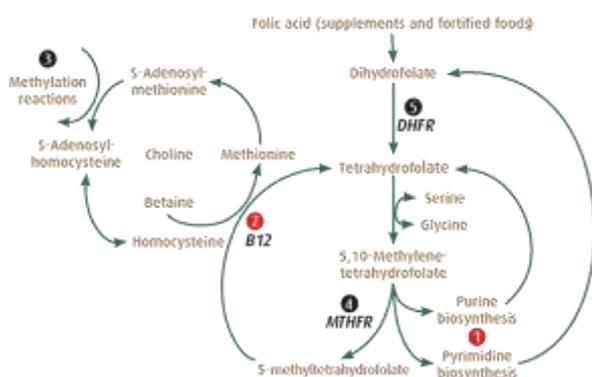
According to the ability to accumulate nitrates, vegetables, fruits and fruits are divided into 3 groups:

- |  |   |
|--|---|
| <b>A.</b> cauliflower, zucchini, pumpkins, turnips, radish, white cabbage, horseradish, carrots, cucumbers | <b>1.</b> Vegetables, fruits and fruits with a high content (up to 5000 mg / kg wet weight) |
| <b>B.</b> Brussels sprouts, peas, sorrel, beans, potatoes, tomatoes, onions, fruits and berries            | <b>2.</b> Vegetables, fruits and fruits with an average content (300 - 600 mg)              |
| <b>C.</b> lettuce, spinach, beets, dill, leafy cabbage, radishes, green onions, melons, watermelons        | <b>3.</b> Vegetables, fruits and fruits with low content (10 - 80 mg)                       |

**Answer: 1-c 2-a 3-b**

**31. Deficiency of what vitamin develops in violation of the folate cycle?**

Schematically depict the sequence of the folate cycle



**Answer: B9**

**32.** Make an algorithm for performing a qualitative reaction with diphenylamine. What connections are defined?

**Answer:** Reaction with diphenylamine (pharmacopoeia). The reaction is carried out in concentrated sulfuric acid. First, the irreversible oxidation of diphenylamine to diphenylbenzidine occurs:  $2C_6H_5NHC_6H_5 - C_6H_5 - NH - C_6H_4 - C_6H_4 - NH - C_6H_5 + 2H^+ + 2e^- \rightarrow$  diphenylamine diphenylbenzidine (colorless). Two molecules of diphenylamine donate two electrons to the oxidizing agent and lose two hydrogen ions. Then

there is a reversible oxidation of the benzidine molecule by the present oxidizing agent to a blue-colored diphenyldiphenylquinonediimine, in which the diphenylbenzidine molecule also donates two electrons to the oxidizer and loses two hydrogen ions: When the blue mixture stands, its color gradually changes first to brown, and then to yellow, due to the irreversible destruction of the blue reaction product. Nitrate - NO<sub>3</sub> ion - gives a similar reaction with diphenylamine. The detection of nitrates can be carried out in various plants. The method is based on the property of diphenylamine, when interacting with nitrates, to give a blue color, characteristic of the resulting aniline dye. By the intensity of blueing, one can approximately judge the amount of nitrates in the object under study. The purpose of the experiment is to compare the content of nitrates in different parts of the plant. Objects and equipment. Plant objects\* (cabbage, carrots, etc.), a solution of diphenylamine in sulfuric acid (0.1 g of diphenylamine is dissolved in 10 ml of strong sulfuric acid and stored in a dark bottle); pipettes, mortar and pestle, glass slide, glass rods. \* (If a carrot is used as a plant object, then take the tip of the carrot, the outer part and the core. If dill is used, then take the roots and leaves (you can take the stems as well).) Setting up and conducting the experiment. 1. Prepare control solutions with a known concentration of diphenylamine in order to build a color scale. Various plants are taken: in comparison, fresh and boiled or pickled. A solution of diphenylamine is dripped onto pieces of plants. The content of nitrates is judged by the change in color. With a small amount of nitrates, a drop of vegetable juice acquires a light blue color, with a large amount of nitrates, a dark blue color appears.

*Примечание:* при тестировании один верный ответ соответствует 1 баллу.

#### Variant II

**1. The term "biosphere" was first used in 1875:**

- A. E. Zyuss; (+)
- B. J. Cuvier;
- C. L. Paster;
- D. T. Malthus

**2. Select a group of pheromones from the proposed list:**

- A. primers
- B. releasers
- C. Aphrodisiacs
- D. all of the above (+)

**3. Which of the following substances is part of the secretion of the anal glands of a skunk?**

- A. isoamyl acetate.
- B. undecan.
- C. methylcrotyl sulfide. (+)
- D. formic acid.

**4. Substances that cause structural changes in liver tissues are called:**

- A. neurotoxic;
- B. cardiotoxic;
- C. hepatotoxic; (+)
- G. hematotoxic.

**5. What substances are called carcinogens:**

- A. Causing allergic diseases.
- B. Causing chronic diseases.
- C. Causing infectious diseases.
- D. Causing cancer. (+)
- D. Causing tuberculosis

**6. Anthocyanins are concentrated in:**

- A. vacuoles (+)
- B. chromoplasts
- C. Golgi vesicles
- D. cytoplasm

**7. Lutein - pigment - the main component of yellow pigments in leaves, flowers, fruits and buds of higher plants, as well as in many algae and microorganisms, by chemical nature belongs to the class:**

- A. carotenoids
- B. xanthophylls (+)
- C. anthocyanins
- D. chlorophylls

**8. Endophytes are:**

- A. symbiotic fungi or bacteria living inside plants (+)
- B. Symbiotic fungi or bacteria living on the surface of plants
- C. Animal symbionts
- D. none

**9. Morphine - a compound isolated in 1833, is a strong pain reliever and belongs to the class:**

- A. terpenoids
- B. saponins
- C. anthocyanides
- D. alkaloids (+)

**10. Solanine - a compound, a steroidal alkaloid, found in:**

- A. flowers and berries of tomatoes
- B. potatoes
- C. flowers, berries and shoots of potatoes (+)
- D. flowers and berries of *Solanum rantonnetii*

**11. Linamarin - an organic compound found in the leaves and roots of plants (cassava, lima beans, flax), belongs to the class:**

- A. cyanogenic glycosides (+)
- B. alkaloids
- C. cardiac glycosides
- D. xanthophylls

**12. Volatile compounds used for communication within a species are called:**

- A. hormones.
- B. pheromones. (+)
- C. kairomones.
- D. attractants

**13. Sex pheromones 1) are highly specific 2) have a molecular weight of more than 400 Da 3) are volatile 4) are stereospecific 5) a slight modification of the molecule does not lead to a decrease or disappearance of activity 6) have group specificity.**

- A. 1,2,3.
- B. 2,3,4,6.
- C. 1,3,4. (+)
- D. 3,4,5,6.
- E. 1,2,3,4,
- F. 1,2,3,4,5.

**14. Microsomal oxidation system does not carry out reactions**

- A. epoxidation.
- B. S-oxidation and desulfurization.

- C. sterol oxidation.
- D. oxidation of alcohols.
- E. oxidative deamination (+)

**15. Microsomal oxidation is carried out by enzyme systems localized mainly:**

- A. in the outer membrane of mitochondria
- B. in the cytosol
- C. in the endoplasmic reticulum (+)
- D. in the mitochondrial matrix

**16. Superoxide radicals are toxic to the body because:**

- A. spontaneously accelerate chain reactions of lipid peroxidation (+)
- B. hydroxylate hydrophobic endogenous compounds
- C. react with proteins and nucleic acids, causing a change in their conformation
- D. destroy phagocytosed microorganisms

**17. Choose one wrong answer. I phase of neutralization of xenobiotics**

- A. Carried out by enzymes of the endoplasmic reticulum
- B. Requires the presence of NADPH
- C. Leads to an increase in the polarity of the compound
- D. Occurs under anaerobic conditions (+)
- E. Occurs with the participation of cytochrome P450

**18. Choose one wrong answer. As a result of the biotransformation of drugs with the participation of the microsomal oxidation system, it is possible:**

- A. Reducing their pharmacological activity
- B. Formation of intermediate metabolites of the common pathway of catabolism (+)
- C. Increase in their activity
- D. Formation of toxic metabolites
- E. The emergence of soluble products

**19. Choose one wrong answer. Have carcinogenic activity:**

- A. Aromatic amines
- B. Eicosanoids (+)
- C. Aflatoxins
- D. Polycyclic carbohydrates
- E. Nitrosamines

**20. A chemical compound that in high concentrations causes the formation of malignant tumors:**

- A. carbon monoxide;
- B. sulfur oxides;
- C. benzo(a)pyrene; (+)
- D. carbon dioxide

**21. Product causing solanine poisoning:**

- A. Amanita;
- B. Hyoscyamus niger;
- B. sprouted, green potatoes (+)
- G. "drunken bread."

**22. Name the enzyme catalyzing this reaction  $C_2H_5OH + NADPH + H^+ + O_2 \rightarrow CH_3CHO + NADP^+ + 2H_2O$  - cytochrome P450 - dependent microsomal ethanol-oxidizing system**

**23. Choose the right answers. The following are involved in the functioning of the microsomal oxidation system: A, B, C, D**

- A. Cytochrome P450-reductase
- B. O<sub>2</sub>
- C. Cytochrome P450

D. NADPH

E. CO<sub>2</sub>

**24. Match:**

A. Cytochrome P450

B. Cytochrome P450-reductase

C. Cytochrome b<sub>5</sub>

D. NADPH

E. Cytochrome b<sub>5</sub> reductase

1. Oxidized by Cytochrome b<sub>5</sub> reductase

2. Restores cytochrome b<sub>5</sub> Fe

3. Hydroxylates a lipophilic substance 1-d 2-e 3-a

**25. The following enzymes take part in non-microsomal oxidation of xenobiotics:**

A. NADH dehydrogenase;

B. NADPH-cytochrome P450 reductase;

C. monoamine oxidase;

D. cytochrome c reductase;

E. pyridine-dependent dehydrogenases

**C D**

**26. Establish a match. Toxins and their producing organisms: 1-b 2-a 3-d 4-c**

**A.** conotoxin

**1.** some types of ordinary sponges

**B.** Latrunculin

**2.** mollusks of the family Cones (Conidae)

**C.** geraniol

**3.** Mature seeds of African plants *Strophanthus gratus* (*Strophanthus*) and in bark *Acokanthera ouabaio* (*Akokanthera*)

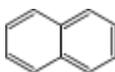
**D.** ouabain

**4.** bees of the genus *Trigona*

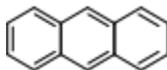
27. What adverse effect on living organisms do epoxides of organic substances have, the structural formulas of which are presented below:

**Chemical substance**

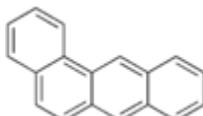
Naphthalene



Anthracene



Benzantracene

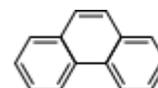


Kekulen

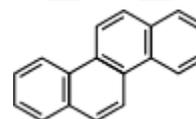


**Chemical substance**

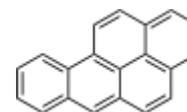
Phenanthrene



Chrysen



Benzpyrene



Koranulen



**Answer: carcinogenic**

28. What dangerous compound is found in large quantities in the following species: Bluefin tuna, Sea pike, King mackerel, Marlin **Answer: methylmercury**

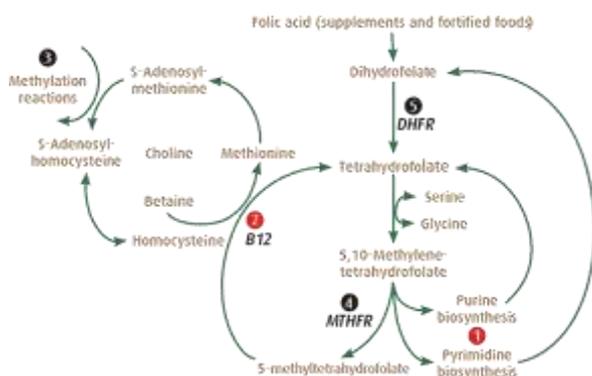
29. What is the name of the organic compound, a colorless gas with a pungent odor, highly soluble in water, alcohols and polar solvents, having a carcinogenic, toxic effect, formed during the reduction of a compound produced by ants of the genus Formica.

**Answer: formaldehyde**

30. Low-toxic salts of thiocyanic (thiocyanic) acid that can affect the thyroid gland are called ...

**Answer: thiocyanates**

31. Violation of what cycle leads to the accumulation of homocysteine? Schematically depict the sequence of the cycle. **Answer: folate cycle.**



32. Draw up an algorithm for performing microchemical analysis of the main ions in plant ash.

**Answer:** Microchemical analysis is based on the property of some salts to form crystals of a characteristic shape, which can be used to judge the presence of one or another chemical element in the composition of the ash. Purpose: to study the composition of plant tissue ash. We carried out control reactions for the detection of ions of chemical elements of calcium, iron, phosphorus, sulfur (as part of sulfate ions), potassium, magnesium and chlorine. As a control, ready-made solutions of salts

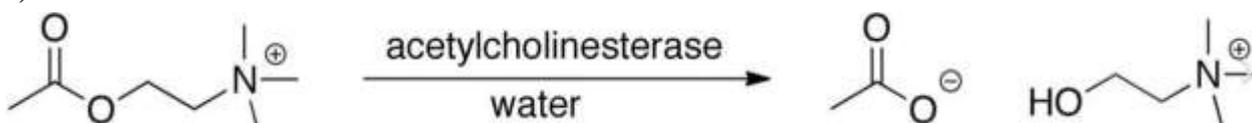
containing these elements were used: 1) two drops were placed side by side on a glass slide with a glass rod - the test solution and the required reagent; 2) using a clean glass rod with a pointed end, both drops were connected with a jumper (as a result of the interaction of solutions, reaction products are formed); 3) the preparations were slowly dried over the fire (as a result, the reaction products precipitate with the formation of crystals of a characteristic shape); Attention! During the control reactions it turned out that: 1) complete mixing of drops of solutions should be avoided: the largest and most regular crystals are formed in thin bridges between drops; 2) it is very important to dry the preparation correctly: high above the flame until the water has completely evaporated, moving slightly from side to side. 4) the crystals formed after evaporation were examined under a microscope (magnification 80x - 200x) on a dry preparation without a cover slip and sketched. Detection of calcium with oxalic acid: crystals in the form of octahedrons, cubes and crosses. These are calcium oxalate crystals (salts of oxalic acid - oxalates). Detection of iron - using a reagent (potassium hexacyanoferrate). The result was a blue precipitate of a substance called Prussian blue. This is a qualitative reaction to the presence of iron ions in solution. Detection of sulfur with a drop of silver nitrate, with slow heating, crystals in the form of elongated hexagons and rhombuses fell out. These are silver sulfate crystals.

*Примечание:* при тестировании один верный ответ соответствует 1 баллу.

### Ситуационные задачи

1. A few years ago, terrorists sprayed one of the most powerful toxic substances, sarin, in the Tokyo subway. Many passengers lost consciousness, some died as a result of respiratory arrest. What is the nerve agent based on? the effect of sarin? : a) The activity of which enzyme and how it will change in the blood in case of poisoning with this substance; b) Write the reaction whose rate is changed by sarin. Solution Organic fluorophosphates such as diisopropylfluorophosphate (DFP) are poisonous because they bind covalently to a serine residue in the active site of enzymes that use the serine residue for hydrolytic cleavage. Symptoms of poisoning with organic fluorophosphates are mainly associated with irreversible inhibition of the enzyme - acetylcholinesterase (AChE). Acetylcholinesterase accelerates the hydrolysis of acetylcholine, which functions as a neurotransmitter. The breakdown products of acetylcholine, acetate and choline, are incapable of acting as neurotransmitters. An increase in the amount of acetylcholine in the synaptic cleft during AChE inhibition leads to persistent depolarization of the postsynaptic membrane and can cause paralysis. DPP and similar fluorophosphates form a covalent bond with the serine residue in the AChE active site. The inhibition is irreversible, and AChE activity is restored only after the synthesis of new enzyme molecules.

b)



2. In some people in Japan and China, after drinking very small amounts of alcohol, blood vessels dilate and the heart rate increases. The cause of these symptoms is high blood levels of acetaldehyde, a compound that is toxic to the brain. Explain why the same amounts of alcohol do not have the same effect in Europeans. a) Write the reaction for the conversion of acetaldehyde to acetate, indicate the enzyme; b) Which form of the enzyme is absent in some people of Japan and China, if it is found that there are two forms of this enzyme: mitochondrial with low CM and cytosolic with high CM. the neutralization of alcohol occurs in two stages: the first under the action of alcohol dehydrogenase - ethanol is broken down to acetaldehyde. This is the so-called fast type of enzymes. The second stage occurs under the action of slow enzymes - acetaldehyde dehydrogenases, which work more slowly in these representatives. This characteristic of the enzymes, and the accumulation of excess acetaldehyde, which is the cause of this condition, is a genetically determined, but left by the EO, mutation of certain ethnic groups.

Write the reaction for the conversion of acetaldehyde to acetate, indicate the enzyme



||

H O-R

What form of the enzyme is missing?

ANSWER: mitochondrial.

3. In people who drink alcohol for a long time, the effectiveness of certain drugs, as well as narcotic drugs, decreases during surgery. Why does the rate of drug biotransformation change in these people? For an answer: Write the reactions of ethanol catabolism in the liver; Explain how ethanol affects the activity of microsomal oxidation in the liver. Answer: A. The main role in the metabolism of ethanol is played by a zinc-containing NAD<sup>+</sup>-dependent enzyme - alcohol dehydrogenase, which is localized mainly in the cytosol and mitochondria of the liver (95%). During the reaction, ethanol dehydrogenation occurs, acetaldehyde and the reduced coenzyme NADH are formed. Alcohol dehydrogenase catalyzes a reversible reaction, the direction of which depends on the concentration of acetaldehyde and the ratio of NADH/NAD<sup>+</sup> in the cell.  $\text{C}_2\text{H}_5\text{OH} + \text{NAD}^+ \rightleftharpoons \text{CH}_3\text{CHO} + \text{NADH} + \text{H}^+$ . The enzyme alcohol dehydrogenase is a dimer consisting of identical or similar in primary structure polypeptide chains encoded by alleles of one gene. There are 3 isoforms of alcohol dehydrogenase (ADH): ADH1, ADH2, ADH3, differing in the structure of protomers, localization and activity. Europeans are characterized by the presence of ADH and ADH3 isoforms. In some eastern peoples, the ADH2 isoform, which is characterized by high activity, predominates; this may be the reason for their increased sensitivity to alcohol. In chronic alcoholism, the amount of the enzyme in the liver does not increase, that is, it is not an inducible enzyme. B. Oxidation of ethanol with the participation of cytochrome P450-dependent microsomal ethanol-oxidizing system The cytochrome P450-dependent microsomal ethanol-oxidizing system (MEOS) is localized in the membrane of the smooth ER of hepatocytes. MEOS plays a minor role in the metabolism of small amounts of alcohol, but is induced by ethanol, other alcohols, drugs such as barbiturates, and becomes significant when these substances are abused. This pathway of ethanol oxidation occurs with the participation of one of the P450 isoforms, the P450 II E1 isoenzyme. In chronic alcoholism, ethanol oxidation is accelerated by 50-70% due to ER hypertrophy and induction of cytochrome P450 II E1.  $\text{C}_2\text{H}_5\text{OH} + \text{NADPH} + \text{H}^+ + \text{O}_2 \rightarrow \text{CH}_3\text{CHO} + \text{NADP}^+ + 2 \text{H}_2\text{O}$ . The acetic acid obtained during the reaction is activated by the action of the enzyme acetyl-CoA synthetase. The reaction proceeds with the use of coenzyme A and an ATP molecule. The formed acetyl-CoA, depending on the ratio of ATP/ADP and the concentration of oxaloacetate in the mitochondria of hepatocytes, can "burn" in the TCA, go to the synthesis of fatty acids or ketone bodies.

4. Water-nitrate methemoglobinemia develops when drinking water with a large amount of nitrates. In infants, a lethal outcome is possible with pronounced phenomena of tissue hypoxia (cyanosis of the lips and skin, shortness of breath). Violation of what biochemical processes underlies the development of methemoglobinemia? To answer this question: Write a diagram of nitrate catabolism in the human body; under the action of the microbiota contained in the oral cavity and intestines, nitrates are microbiologically reduced to nitrites, and nitrites to nitrosyl ions, in as a result, nitrite ions ( $\text{NO}_2^-$ ) and nitrosyl ions ( $\text{NO}^+$ ) enter the blood.  $\text{NO}_2^- + \text{H}^+ \longleftrightarrow \text{NO}^+ + \text{OH}^-$ . Indicate the structure of which compounds in the child's body is affected by the products of nitrate catabolism; Explain why children have hypoxia. methemoglobin, unable to form a coordination bond with  $\text{O}_2$ ; 2)  $\text{NO}$  is formed - a secondary messenger, the excess of which is also undesirable for the body. With the transition of  $\approx 60\%$   $\text{Fe(II)}$  to  $\text{Fe(III)}$ , severe cyanosis (cyanosis) develops and death occurs. Infants in the first weeks of life are especially sensitive to the nitrosyl ion. Hemoglobin reductase, which reduces  $\text{Fe(III)}$  to  $\text{Fe(II)}$ , does not yet work in their blood, and hemoglobin is different, it is called fetal ( $\text{HbF}$ ).

## 4. ПОРЯДОК ПРОВЕДЕНИЯ И КРИТЕРИИ ОЦЕНИВАНИЯ ПРОМЕЖУТОЧНОЙ АТТЕСТАЦИИ

### 4.1. Порядок проведения промежуточной аттестации

Экзамен проводится в 3 этапа (общая продолжительность – 1 час 20 минут).

1. На первом этапе студент решает 26 тестовых вопросов закрытого типа. Продолжительность – 45 минут.
2. На втором этапе студент решает тесты открытого типа со свободным ответом, которые не предполагают вариантов ответа, правильный ответ требуется написать самостоятельно. Всего 3 вопроса. Продолжительность – 15 минут.
3. На третьем этапе студент решает ситуационную задачу. Продолжительность – 20 минут

### 4.2. Критерии оценивания промежуточной аттестации по видам оценочных средств

#### 4.2.1. Критерии оценивания теста

Оценка	Неудовлетворительно	Удовлетворительно	Хорошо	Отлично
Набранная сумма баллов (% выполненных заданий) (максимум – 100)	Менее 60	60-70	71-81	81-100

#### 4.2.2. Критерии оценивания решения ситуационных задач

1. Оценка «**отлично**» ставится, если ответ на вопросы задачи дан правильно; объяснение хода её решения подробное, последовательное, грамотное, с теоретическими обоснованиями (в том числе из лекционного курса). Ответы на дополнительные вопросы верные, чёткие.
2. Оценка «**хорошо**» ставится, если ответ на вопросы задачи дан правильно, объяснение хода её решения подробное, но недостаточно логичное, с единичными ошибками в деталях, некоторыми затруднениями в теоретическом обосновании); Ответы на дополнительные вопросы верные, но недостаточно чёткие.
3. Оценка «**удовлетворительно**» ставится, если ответы на вопросы задачи даны правильно; объяснение хода её решения недостаточно полное, непоследовательное, с ошибками, слабым теоретическим обоснованием, в том числе лекционным материалом. Ответы на дополнительные вопросы недостаточно четкие, с ошибками в деталях.
4. Оценка «**неудовлетворительно**» ставится, если ответы на вопросы задачи даны неправильно. Объяснение хода её решения дано частичное, непоследовательное, с грубыми ошибками, без теоретического обоснования. Ответы на дополнительные вопросы не даны.

Итоговая оценка формируется как среднее арифметическое оценок за тест и решение ситуационной задачи.

### 4.3. Результаты промежуточной аттестации и уровни сформированности компетенций

При подведении итогов учитываются результаты текущей аттестации.

Особенности проведения процедуры оценивания результатов обучения инвалидов и лиц с ограниченными возможностями здоровья обозначены в рабочей программе дисциплины (модуля).

«**Отлично**» («5») - студент глубоко и полно владеет содержанием учебного материала, полно и подробно отвечает на теоретические вопросы, правильно решает

ситуационные задачи и может проанализировать их решение. Студент должен владеть биохимической терминологией, уметь определять ключевые метаболиты, ферменты биохимических процессов, составлять уравнения химических реакций, лежащих в основе обменных процессов, характеризовать классы соединений (химическое строение, биологическую роль), метаболические процессы клетки и их биохимическую функцию, объяснять взаимосвязь обменных процессов, направление протекания биохимических реакций, механизм ферментативных реакций.

**«Хорошо» («4»)** - студент правильно решает ситуационные задачи, но допускает незначительные ошибки и неточности в теоретических вопросах, терминологии, номенклатуре и в решении задачи; ответ отличается меньшей обстоятельностью, глубиной и полнотой; допущенные ошибки исправляются студентом после дополнительных вопросов экзаменатора.

**«Удовлетворительно» («3»)** - студент отвечает на теоретические вопросы и решает задачи, но допускает при ответе существенные ошибки, неточности, ответ не полон, не последователен; студент не умеет обосновать свои суждения; ответ отличается низким уровнем самостоятельности

**«Неудовлетворительно» («2»)** - студент имеет разрозненные, бессистемные знания: не умеет выделять главное и второстепенное; не владеет биохимической терминологией, допускает грубые ошибки в истолковании и употреблении понятий, формулировке теоретических положений, не умеет применять теоретические знания для решения ситуационных задач.

**06.04.01 Биология, ОПОП Микробиология и вирусология,  
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Протокол заседания № 6 от 21.02.2025

Председатель Ученого совета

биологического факультета      согласовано      Д.С. Сташкевич

**Заседанием кафедры микробиологии, иммунологии и общей биологии**

Протокол заседания № 6 от 21.02.2025

Заведующий кафедрой      согласовано      А. Л. Бурмистрова

Автор (составитель)      Д.С. Сташкевич

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