

MINISTRY OF SCIENCE AND HIGHER EDUCATION  
OF THE RUSSIAN FEDERATION  
Federal State Budgetary Educational Institution of Higher Education  
Kemerovo State University

“APPROVED”  
Director of the Institute of Biology,  
Ecology and Natural Resources,  
Neverova O. A.



THE PROGRAM OF PROFILE ENTRANCE TESTS  
taken by KemSU independently,  
for bachelor's degree programs applicants, specializing in  
“FUNDAMENTALS OF BIOCHEMISTRY”  
in 2022

KEMEROVO, 2021

The purpose of the entrance tests is to identify the applicant's level of theoretical knowledge and practical skills in the field of biochemistry in order to consider the possibility of their further studies at the university.

The form of the entrance tests: test

The results are evaluated on a 100-point scale.

Each version of the entrance tests is represented by 39 tasks that test knowledge in the main sections of biochemistry.

The structure of test tasks and the assessment scale.

No	Test Task Type	Test Tasks Number	Number of Points for One Task	Total Points
1	Choosing one correct answer	15	2	30
2	Choosing two correct answers	10	2	20
3	Matching	6	3	18
4	Composing equations	4	4	16
5	Tasks with diagrams	4	4	16
	Total:			100

The minimum threshold level is 39 points. Further gradation is as follows:

0-38 points – unsatisfactory (D);

39-60 points – satisfactory (C);

61-80 points – good (B);

81-100 points – excellent (A).

The program includes:

- test samples;
- the content of topics on whose basis the tests are compiled;
- educational and methodical literature on theoretical and practical sections.

Entrance examinations appeals are accepted the day after the results are published.

# 1. SAMPLE TASKS

## Multiple-choice tasks

### 1. Bacterial cells have

- 1) cellulose cell wall
- 2) DNA in two-membrane organelles
- 3) DNA closed in a ring
- 4) large ribosomes

### 2. The function of carbon dioxide transfer in the human body and in many animals is performed by

- 1) chlorophyll
- 2) hemoglobin
- 3) enzyme
- 4) hormone

### 3. The cells of most autotrophs, in contrast to the cells of heterotrophs, are characterized by the process of

- 1) energy exchange
- 2) protein biosynthesis
- 3) ATP synthesis
- 4) photosynthesis

### 4. Storage and transmission of hereditary information is provided by molecules of

- 1) DNA
- 2) NAD
- 3) ATP
- 4) FAD

### 5. The main carbohydrate circulating in human tissues and blood is:

- 1) fructose
- 2) sucrose
- 3) glucose
- 4) maltose

### 6. Protein molecules are built from:

- 1) nucleotides
- 2) glycerin
- 3) amino acids
- 4) nitrogenous bases

### 7. In the human body, predominant percentage of body weight belongs to:

- 1) mineral salts
- 2) organic acids
- 3) water
- 4) proteins

### 8. Which compounds act as catalysts in living organisms?

- 1) hormones
- 2) enzymes
- 3) vitamins
- 4) mineral substances

**9. The biological value of proteins is determined by:**

- 1) caloric content
- 2) quantity
- 3) amino acids set
- 4) protein quality

**10. What is the term for the lack of a vitamin in the body?**

- 1) vitamin deficiency
- 2) hypervitaminosis
- 3) hypovitaminosis
- 4) no such term

**Tasks for choosing two correct answers**

**1. From the list suggested, select two statements specific to sucrose, as opposed to glucose.**

- 1) reacts with bromine water
- 2) is hydrolyzed in an acidic environment
- 3) does not give a "silver mirror" reaction
- 4) is a polyatomic alcohol
- 5) reacts with concentrated sulfuric acid

**2. From the list suggested, select two substances with which aminoacetic acid interacts**

- 1) ethan
- 2) methanol
- 3) sodium chloride
- 4) calcium
- 5) diethyl ether

**3. From the list suggested, select two properties characteristic of methylamine**

- 1) consists of 4 elements
- 2) liquid under normal conditions
- 3) is well soluble in water
- 4) is a stronger base than ammonia
- 5) interacts with alkalis

**4. From the list suggested, select two substances aniline reacts with under normal conditions**

- 1) bromine water
- 2) sodium hydroxide solution
- 3) nitrous acid
- 4) hydrogen
- 5) ammonia

**5. From the list suggested, select two statements that are valid for the hydrolysis of peptides**

- 1) hydrogen is released
- 2) water is released
- 3) water is consumed
- 4) ammonia is released
- 5) peptides with lower molecular weight and amino acids are formed

**6. From the list suggested, select two substances that undergo hydrolysis**

- 1) glucose
- 2) sucrose
- 3) fructose
- 4) ribose
- 5) starch

**7. From the suggested list of carbohydrates, choose two that give a "silver mirror" reaction.**

- 1) ribose
- 2) glucose
- 3) sucrose
- 4) cellulose
- 5) glycogen

**8. From the suggested list, select two substances that react with both strong acids and alkalis**

- 1) glycine
- 2) glucose
- 3) aniline
- 4) cysteine
- 5) ethylamine

**9. From the suggested list, select two monosaccharides**

- 1) ribose
- 2) maltose
- 3) lactose
- 4) fructose
- 5) cellulose

**10. From the suggested list, select two substances that can be formed during the hydrolysis of dipeptides**

- 1) alanine
- 2) glycine
- 3) fructose
- 4) ribose
- 5) glucose

### Matching tasks

**1. Match the name of the substance and the class/group this substance belongs to: for each position indicated by a letter, select corresponding position indicated by a number.**

Substance Name	Class/Group
a) methylbenzene	1) aldehydes
b) aniline	2) amines
c) 3-methylbutanal	3) amino acids
	4) hydrocarbons

**2. Match the substance formula and the class (group) of organic compounds it belongs to: for each position indicated by a letter, select the corresponding position indicated by a number**

Substance Formula	Class (group) of Compounds
a) C <sub>4</sub> H <sub>8</sub> O	1) limit monatomic alcohol

b) C <sub>4</sub> H <sub>10</sub> O c) C <sub>4</sub> H <sub>6</sub>	2) alkene 3) ultimate aldehyde 4) alkadiene
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**3. Match the name of the substance and the homological series (class of compounds this substance belong to): for each position indicated by a letter, select the corresponding position indicated by a number**

Substance Name	Homological Series (Class)
a) propanediol-1,2 b) ethyl propyl ether c) butanol-2	1) marginal monatomic alcohols 2) limit diatomic alcohols 3) ketones 4) simple esters

**4. Match the name of the substances and the trivial name of the substance representing it: for each position indicated by a letter, select the corresponding position indicated by a number.**

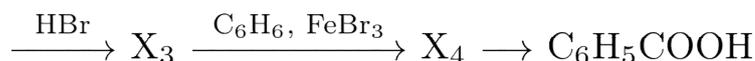
Structural Class	Common Name
a) alcohols b) carbohydrates c) hydrocarbons	1) toluene 2) starch 3) ethylene glycol 4) aniline

**5. Match the name of the compound and its functional group: for each position indicated by a letter, select the corresponding position indicated by a number.**

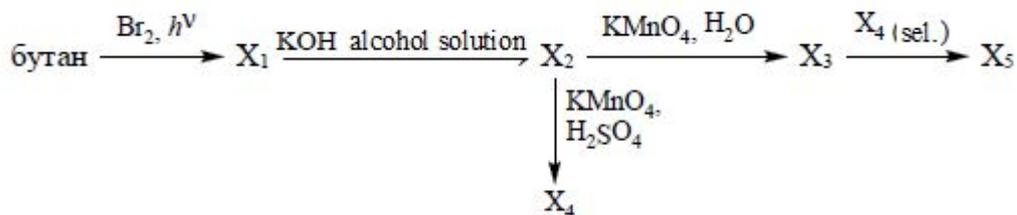
Compound Name	Functional Group
a) dimethylamine b) butanoic acid c) metanal	1) carboxyl group 2) nitro group 3) amino group 4) aldehyde group

### Composing equations

**1. Write the reaction equations with which the following transformations can be carried out:**



**2. Write the reaction equations the following transformations can be carried out with:**



### Tasks with Diagrams

1. The following scheme of substance transformation is given:



Determine which of these substances are X and Y.

- 1)  $\text{H}_2$
- 2)  $\text{CuO}$
- 3)  $\text{Cu}(\text{OH})_2$
- 4)  $\text{NaOH}(\text{H}_2\text{O})$
- 5)  $\text{NaOH}$  (alcohol)

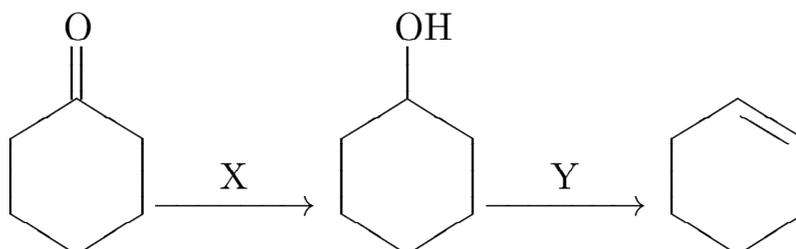
2. The following scheme of substance transformation is given:



Determine which of these substances are X and Y.

- 1)  $\text{HCl}$
- 2)  $\text{Br}_2$
- 3)  $\text{KOH}$  alc.
- 4)  $\text{KOH}$  aqu.
- 5)  $\text{H}_2\text{SO}_4$  conc.

3. The following scheme of substance transformation is given:



Determine which of the substances are X and Y.

- 1) H<sub>2</sub>
- 2) H<sub>2</sub>O
- 3) NaOH
- 4) H<sub>2</sub>SO<sub>4</sub> conc.
- 5) CuO

4. The following scheme of substance transformation is given:



Determine which of the substances are X and Y.

- 1) chloroacetic acid
- 2) 2-chloropropionic acid
- 3) acetic acid
- 4) propionic acid
- 5)  $\beta$ -amino propionic acid

## 2. CONTENT OF TOPICS IN THE DISCIPLINES IN THE TESTING PROGRAM

### **Chemical composition of living organisms**

Characteristics of the main classes of chemical compounds that make up living matter, their content in the body. Plastic and energy substances. Bioactive compounds. Modern ideas about the composition and fine structure of the cell.

Regulation of metabolism in the body. Bioenergetics of the cell. Cellular structures and their role in life. Their structure and function. Biological membranes. Chemical signaling in the body. Photosynthesis. The cycle of tricarboxylic acids. The Calvin Cycle. Photo breathing.

### **The main classes of bioorganic compounds**

Proteins. The elementary composition of proteins. Methods of isolation and purification. Amino acid composition of proteins. Peptides. Polypeptide theory of protein structure. The concept of proteins as high-molecular biopolymers, their chemical composition, structural organization, properties, functions. Automatic and molecular genetic methods for determining the primary structure of proteins. Classification of proteins, characteristics of representatives of the main groups. Molecular computer modeling of proteins.

Enzymes. The history of enzymes discovery and study. Similarities and differences of enzymes with catalysts of non-protein nature. Structure and physicochemical properties of enzymes. Coenzymes. Functionally active centers of enzymes. Hypotheses of interaction with substrates. Mechanisms of enzyme action, regulation of their activity, nomenclature, classifications, areas of practical use.

Nucleic acids. The history of nucleic acids discovery and study. Chemical composition. Nucleotides, nucleosides: structure, nomenclature, biological role. The concept of the structure of nucleic acids. Types of nucleic acids. Comparative characteristics of DNA and RNA. DNA functions. The relationship between DNA and the gene. Characteristics of RNA species and their functions. The "Human Genome" Project.

Carbohydrates. General characteristics of carbohydrates and their classification. Complex carbohydrates. Oligosaccharides (disaccharides, trisaccharides, etc.) Types of structure, properties, the most important representatives (maltose, sucrose, cellobiose, lactose, etc.). Polysaccharides: classification (homopolysaccharides, heteropolysaccharides), chemical structure, properties. The most important functions performed by complex carbohydrates in the body.

Lipids. Characteristics of lipid classes: structure, biological role. Triglycerides. Waxes. Representatives. Formation of steroids (hormones). Characteristics of phospholipids. The role of lipids in the structuring of biological membranes.

### **Metabolism and energy exchange in living systems**

General ideas about metabolism. Metabolism and energy are integral properties of living systems. Types and sides of metabolism. Characteristics of factors affecting the intensity of metabolic processes. Energy metabolism. The concept of the

level of free energy in an organic compound. Macroergic connections and macroergic compounds. The role of ATP in energy exchange.

Protein metabolism. Protein breakage and amino acid metabolism as sources of biologically active compounds. Ways and mechanisms of protein synthesis in nature. Matrix system of protein biosynthesis. Structure and models of ribosomes. Mechanisms of protein biosynthesis regulation. Protein biosynthesis multienzyme mechanism.

The breakdown of nucleic acids to free nucleotides with the participation of nucleases. Decay of nucleotides, nucleosides and nitrogenous bases. Biosynthesis of nucleoside mono-, nucleoside di- and nucleoside triphosphates. The mechanism of DNA biosynthesis (replication). Biosynthesis of RNA (transcription).

Carbohydrate metabolism. Ways of decomposition of polysaccharides and oligosaccharides. Catabolism of 6 monosaccharides. Glucose-6-phosphate metabolism (dichotomous and apotomic pathways, their ratio in the body). Pyruvic acid metabolism. Glycolysis and glycogenolysis. Oxidative decarboxylation of pyruvic acid. The cycle of di- and tricarboxylic acids.

Lipid metabolism. Hydrolysis of fats. Glycerin metabolism. The mechanism of  $\beta$ - and  $\alpha$  oxidation of fatty acids. Biosynthesis of higher fatty acids. Mechanism of triglyceride biosynthesis. The energy balance of triglycerides breakage.

Biological oxidation. The history of developing ideas of biological oxidation mechanisms. Classification of biological oxidation processes. The mechanism of oxidative phosphorylation. Substrate phosphorylation. Free oxidation.

### 3. EDUCATIONAL AND METHODOLOGICAL LITERATURE ON THEORETICAL AND PRACTICAL SECTIONS (AD LIB)

1. Чернобильская, Г.М. Чертков, И.Н. Химия: учебник: 2-е издание переработанное и дополненное. – Москва.: Медицина, 2018. (Chernobelskaya, G.M. Chertkov, I.N. Chemistry: textbook: 2nd edition revised and supplemented. - Moscow.: Medicine, 2018.)
2. Габриелян, О.С. Органическая химия: учебник. – М.: Просвещение, 2007. (Gabrielyan, O.S. Organic chemistry: textbook. - M.: Prosveschenie, 2007).
3. Тюкавкина, Н.А. Биоорганическая химия: учебник. – М.: Дрофа, 2004. (Tyukavkina, N.A. Bioorganic chemistry: textbook. - M.: Drofa, 2004).
4. Ауэрман Т.Л. Основы биохимии : учеб. пособие / Т.Л. Ауэрман, Т.Г. Генералова, Г.М. Сусянок. - М.: ИНФРА-М, 2017. - 400 с. <http://znanium.com/bookread2.php?book=760160> (Auerman T.L. Fundamentals of biochemistry : textbook. manual / T.L. Auerman, T.G. Generalova, G.M. Suslyanok. - M.: INFRA-M, 2017. - 400 p.)
5. Основы биохимии: Учебное пособие / Т.Л. Ауэрман, Т.Г. Генералова, Г.М. Сусянок. - М.: НИЦ Инфра-М, 2013. (Fundamentals of biochemistry: Textbook / T.L. Auerman, T.G. Generalova, G.M. Suslyanok. - M.: SIC Infra-M, 2013).
6. Титов, В. Н. Клиническая биохимия жирных кислот, липидов и липопротеинов [Электронный ресурс] / В. Н. Титов. - М., Тверь: Триада, 2008. - 272 с. - ISBN 978-5-94789-279-6. <http://znanium.com/bookread.php?book=451702> (6. Titov, V. N. Clinical biochemistry of fatty acids, lipids and lipoproteins [Electronic resource] / V. N. Titov. - M., Tver: Triada, 2008. - 272 p. - ISBN 978-5-94789-279-6).
7. ЕГЭ-2021, Химия, 10 тренировочных вариантов экзаменационных работ для подготовки к единому государственному экзамену / ФИПИ. – М., 2020. (USE-2021, Chemistry, 10 training variants of examination papers for preparation for the unified state exam / FIPI. - M., 2020).
8. Сайт «Федеральный институт педагогических измерений»: кодификаторы, спецификация. URL: <http://www.fipi.ru> (Website of the Federal Institute of Pedagogical Measurements: codifiers, specifications).
9. ЕГЭ-2019. Федеральный банк экзаменационных материалов (открытый сегмент). Химия / ФИПИ – М.: Эксмо, 2018. (USE-2019. Federal Bank of Examination Materials (open segment). Chemistry / FIPI - M.: Eksmo, 2018).
10. Открытый банк заданий ЕГЭ / «Федеральный институт педагогических измерений» (ФИПИ). – <https://fipi.ru/ege/otkrytyy-bank-zadaniy-ege> (Open bank of USE tasks / "Federal Institute of Pedagogical Measurements" (FIPI)).