

MINISTRY OF HEALTH OF UKRAINE
KHARKIV NATIONAL MEDICAL UNIVERSITY

Medical and bioorganic chemistry department
Academic year 2021-2022

SYLLABUS OF EDUCATIONAL COMPONENT

“Bioorganic chemistry”
(name of educational component)

Normative or optional component Normative

Form of study Full time mode of study
(full time mode; extramural form; distance)

Knowledge area 22 «Health Care»

Specialty 222 «Medicine», second (master) level

Educational and professional program Medicine
for specialist training of second level (master)
1 course

Syllabus of academic discipline was approved on the meeting of medical and bioorganic chemistry department

Protocol dated
30th of August 2021 No 19

Head of the department




(signature)

prof. Syrova G.O.
(name)

It was approved by the KhNMU methodological commission in regard to general and pre-professional training

Protocol dated
31th of August 2021 No 1

Chief


(signature)

prof. Vovk O.Yu.
(name)

WRITERS:

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3. Makarov V.O. as.prof., PhD of chemistry.
4. Tishakova T.S., as. prof., PhD of chemistry.

INFORMATION ABOUT THE TEACHERS TEACHING THE EDUCATIONAL COMPONENT

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Professional interests:

- Creation and quantum-chemical and experimental substantiation of new domestic pharmaceutical compositions with anti-inflammatory and analgesic effects based on heterocyclic compounds.

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Petiunina Valentina Mykolaivna, PhD of pharmacy, ass. professor,

Professional interests:

- chemical-pharmaceutical substantiation of pharmacological properties of compositions containing caffeine;
- Investigation of adaptation of first-year students to studying in medical higher educational establishment of Ukraine.

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- Nanomaterials in medicine
- Study of the properties of plastics and their application in dentistry and surgery.

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- investigation of the effect of pharmaceutical compositions containing caffeine, nonsteroidal anti-inflammatory drugs on the work of central nervous system using emotive behavior reactions on rats in the open field test;
- experimental research of the effect of coxibs (celecoxib and rofcoxib), licopid and caffeine on central nervous system – on mnesic activity in rats at the conditions of formalin edema.

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- Cognitive psychology;
- Methodology of alternative provision.

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- Biochemical investigations of new pharmaceutical compositions containing caffeine, nonsteroidal anti-inflammatory drugs;
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 Professional interests:

- application of quantum calculations to study the potential activity of biologically active compounds;
- study of plant raw materials as a source of biologically active substances;
- pharmacological research.

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 Professional interests:

- determination of biochemical parameters (level of ceruloplasmin, C-reactive protein, sialic acids);
- pharmacognostic and pharmacological research of plant raw materials

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- molecular modeling of potential nonsteroidal anti-inflammatory drugs with different chemical groups;
- experimental study of analgesic and antiexudative action of new pharmaceutical compositions of nonsteroidal anti-inflammatory drugs with caffeine, licopid;
- quantum pharmacology

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Professional interests:

- chemical technology of inorganic substances;
- research of processes of extraction of heavy metals from wastes of chemical productions;
- development of resource-saving technologies;
- chemical technology of refractory non-metallic and silicate materials

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Consultations are performed according the approved timetable from 9 till 17 on the medical and bioorganic chemistry department with teacher both face-to-face and online, using available IT technologies, for example Moodle

<http://31.128.79.157:8083/course/view.php?id=487>.

Location: Nauky av, 4, building A.

INTRODUCTION

Syllabus of discipline “Bioorganic chemistry” is prepared according the Educational and professional program “Medicine” and Higher Education Standard (hereafter – Standard), second (master) level, field of education 22 “Health Care”, specialty 222 “Medicine”.

Educational subject description (abstract)

Subject matter of “Bioorganic chemistry” is chemical fundamentals of the structure and functions of major classes of biomolecules, metabolic processes, molecular basis of functioning vital organisms under normal and pathological conditions.

Interdisciplinary links: “Bioorganic chemistry” as studying discipline is based on learning medical biology, biophysics, medical chemistry, morphological disciplines; establish a basis for the study of molecular biology and professionally oriented disciplines (genetics, physiology, pathology physiology, pharmacology, propaedeutics of clinical disciplines).

Prerequisite of discipline: The study of the discipline “Bioorganic chemistry” is based on the principles of chemistry, elementary mathematics and physics in the scope of complete general education.

Corequisites of discipline: Knowledge of theoretical principles of bioorganic chemistry are necessary to study biochemistry, physiology, pathophysiology, pharmacology and toxicology, ecology more deeply.

Link to the discipline page in MOODLE

<http://distance.knmu.edu.ua/course/view.php?id=504>

1. OBJECT AND PURPOSE OF ACADEMIC DISCIPLINE

1.1. The object of teaching the discipline “Bioorganic chemistry” is the systematic study of the chemical composition, structural organization and properties of bioorganic compounds - the components of cells, tissues and organs of the human body, patterns of metabolic processes at the molecular level in healthy and sick organisms and the formation clinical and biochemical and scientific thinking, necessary for the successful development of professionally oriented medical and theoretical disciplines (pathological physiology, physiology, clinical disciplines).

1.2. Key tasks of discipline “Bioorganic chemistry” study is providing scientific approach for interpretation of physiological processes mechanism at molecular level, biochemical mechanisms of the pathological states development and solving problems of their diagnosis and correction.

1.3 Competencies and learning outcomes, which can be formed as a result of discipline studying (interconnection with regulatory content of graduate students training, formulated in terms of the learning results in the Standard).

- *integral:*

Ability to solve common and complex specialized tasks and real-world problems in professional activities in the field of health care or in process of training that includes

investigation performing and/or innovations. It is characterized by the complexity and uncertainty of conditions and requirements.

- *general:*

- Abilities for abstract logical reasoning, analysis and synthesis.
- Ability to learn and master state-of-the-art knowledge.
- Knowledge and understanding of subject field and understanding of professional activities.
- Ability to use knowledge in real world situations.
- Ability to take decision.
- Ability to work in team.
- Interpersonal skills.
- Ability to communicate in Ukrainian language both orally and written form.
- Informative technology and communicative technology skills.
- Pursuance of environmental protection.

- *special (specialized, objective):*

- To interpret main types of chemical equilibrium for formation of holistic physico-chemical approach for studying living processes.
- To apply qualitative and quantitative chemical methods.
- To classify chemical properties and transformation of bioinorganic compounds in the course of living activity.
- To interpret main physico-chemical regularities which underlie in the life processes.

1.3.2 The study of the discipline provides students with the acquisition of the following **program educational outcomes:**

PEO 1 To have general and special fundamental and profession-oriented knowledge, skills, competences necessary to perform typical professional tasks, related to activities in the medical field in the relevant position

PEO 2 Collect information about the general condition of the patient, assess the psychomotor and physical development of the patient, the condition of the maxillofacial area, based on the results of laboratory and instrumental studies to assess information about the diagnosis (list 5).

PEO 3 Assign and analyze additional (mandatory and optional) examination methods (laboratory, radiological, functional and / or instrumental) according to list 5, patients with diseases of the organs and tissues of the oral cavity and maxillofacial region for differential diagnosis of diseases (for list 2).

PEO 5 To evaluate the results of surveys, physical examinations, laboratory and instrumental research data

PEO 6 To establish a preliminary clinical diagnosis of the disease

PEO 7 To determine the nature, principles of treatment of diseases

PEO 17 Maintain a healthy lifestyle, use the techniques of self-regulation and self-control.

1.3.3. The study of the discipline provides students with the following **social skills (Soft skills)**:

1. Social and communicative: communication skills, interpersonal skills, team working, leadership, social intelligence, responsibility, ethics of communication.
2. Cognitive: critical thinking, problem-solving skills, innovative thinking, management of intellectual load, self-education skills, information skills, time management.
3. Personality attributes and components of emotional intelligence: emotional intelligence, honesty, flexibility, creativity, motivation.

INFORMATION VOLUME OF ACADEMIC DISCIPLINE

Indicator description	Branch of knowledge, field of education, educational and qualification level	Characteristic of academic discipline
		Full-time or in-person form of education
Quantity of credits – 3	Field of education 22 Health Care	Compulsory daytime
Total quantity of hours – 90	Specialty: 222 Medicine	Year of study: 1 st
		Semester 2 nd
		Lectures 10 hours
		Practicals, seminars 30 hours
Hours for full-time education: in-class – 40 student’s self-work – 50	Educational and qualification level: “Master of Medicine”, professional qualification “Doctor”	Self-work 50 hours
		Type of control: graded test

2.1 Description of discipline

2.1.1 Lectures

№	Subject	Number of hours
1	Bioorganic chemistry, Classification, structure and reactivity of bioorganic compounds.	2
2	Classification, structure and chemical properties of carbohydrates.	2
3	Structure and chemical properties of carboxylic acids. Lipids.	2
4	α -amino acids, peptides, and proteins.	2
5	Heterocyclic compounds. Structure, properties and biological role of nucleic acids.	2
	Total	10

2.1.2 Laboratorial-practical classes

№	Subject	Number of hours
1	Classification, nomenclature and isomerism of bioorganic compounds. Nature of chemical bond. Spatial structure of organic molecules. Mutual influence of atoms in bioorganic compounds. Application the computer program Quantitative Structure-Activity Relationship (QSAR) to predict the quantitative relationship between the structure of a bioorganic compound and its properties.	4
2	Classification of chemical reactions. Reactivity of alkanes, alkenes, arenes, alcohols and phenols.	4
3	Structure and properties of aldehydes and ketones. Structure, properties and biological role of carboxylic acids and amines.	4
4	Structure, properties and biological role of functional derivatives of carboxylic acids (hydroxyacids, keto acids, and phenolic acids). Amino acid composition of proteins and peptides. Structural organisation of proteins. Denaturation.	4
5	Carbohydrates. Structure and chemical properties of monosaccharides. Structure and functions of di- and polysaccharides.	4
6	Higher fatty acids. Lipids, Phospholipids.	4
7	Classification, structure and role of biologically important heterocycles. Predicting the toxicity of heterocyclic compounds using computer program GUSAR (General Unrestricted Structure-Activity Relationships). Structure and biochemical functions of nucleosides, nucleotides, and nucleic acids. Structure and biochemical functions of DNA. Differences in structure, functions of RNA and DNA.	4
8	Graded test.	2
Total hours		30

2.2.3 Self-work

№	Subject	Number of hours
1	Types of hybridization of the carbon atom. Newman's conformations. Inductive and mesomeric effect. Conjugate and aromatic systems. Application the computer program Quantitative Structure-Activity Relationship (QSAR) to predict the quantitative relationship between the structure of a bioorganic compound and its properties. Application of computer program GUSAR (General Unrestricted Structure-Activity Relationships) to estimate toxicity of bioorganic compounds.	6
2	Types of chemical reactions in organic chemistry. Reactivity of alkanes, alkenes, arenes.	5

3	Polymerization and polycondensation reactions of aldehydes and carboxylic acids. To be able to interpret the results of laboratory tests of biological fluids for the content of aldehyde, glucose, ketone bodies.	5
4	Interconversion of ketone and hydroxy acids (reduction reactions, oxidation, decarboxylation, aldol addition. Keto-enol tautomerism Optical activity of heterocyclic compounds. Be able to interpret the results of laboratory studies of biological fluids on the content of amino acids, peptides and proteins.	6
5	Stereoisomerism and tautomerism of monosaccharides. D, L-stereochemical series. To be able to distinguish enantiomers and diastereomers among the given compounds. Anomers, epimers. silver mirror test. Glycosides, their structure and biological role of anthraglycosides and cardio glycosides. Neuraminic acid. Reducing and non-reducing disaccharides. Heteropolysaccharides: hyaluronic acid, chondroitin sulfate, heparin.	6
6	Simple and complex saponifiable lipids. The reactivity of lipids that provides their functional properties and metabolic transformations. Triglycerides. Cholesterol: LDL and HDL. Atherosclerosis. Low molecular weight bioregulators - terpenes, carotenoids and steroids	6
7	Five-membered and six-membered heterocycles with one and two heteroatoms. Lactime-lactam and azole tautomerism. Predicting the toxicity of heterocyclic compounds using computer program GUSAR (General Unrestricted Structure-Activity Relationships). Alkaloids: structural peculiarities and biological role. Structure and biochemical functions of nucleosides, nucleotides, and nucleic acids. The structure of the coronavirus. Medical and biological aspect.	6
5	Work with lecture note, with electronic learning management system MOODLE. <i>Preparation for Graded Test</i>	10
	Total	50

Methods of studying: story-explanation, conversation, lecture, illustration, demonstration, presentation, videos, videos, discussion, modeling of processes and situations, project method, debate, method "Brainstorming", virtual consultation.

Control methods:

Current control is made on every practical class in accordance with concrete goals and involves the use of the following methods: oral examination (individual and frontal); written survey; test control; individual tasks; abstracts; self-control; report; declamation; poster report and others. Control of practical skills and abilities provides that students do chemical experiments individually and come to conclusions; it also provides that students are able to perform individual operations, write schemes of chemical reactions and transformations, solve calculations and situational problems.

Final assessment: graded test.

Graded test (GT) is carried out on the last practical class according to the time table. Graded Test consists of two levels: 1 level is 30 multiple choice questions (open database) and 2 level to check practical skills in the form of 3 tasks (closed database).

3. CRITERIA OF ESTIMATION

3.1 Evaluation of the success of education of students is carried out on the basis of the current "Instructions for evaluating the educational activities of students of KhNMU"

Form of summative assessment of success in medical and bioorganic chemistry is graded test. Admission to graded test is determined according to the learning activity points: min - 70, max - 120 points. Graded Test is evaluated from 50 to 80 points. Mark for the discipline is the sum of points for current learning activity and Graded Test from min – 120 to max – 200.

Graded Test is evaluated from 50 to 80 points. In order to pass and get minimal number of points (50) it is needed to answer correctly 20 questions out of 30. More than 20 correct answers are evaluated by the following manner:

Number of correct answers	Points
21 - 24	51
25 - 27	52
28 - 30	53

Student can be admitted for the second level of graded test if he or she has average mark for current learning activity is not less than 3.5 and all questions of the first level. Student gets 9 points for every correctly solved task (totally 27 points) and on the condition of having knowledge of chemical structures, mechanisms of chemical reactions, including qualitative, for different classes of organic compounds, methods of laboratory research, if he/she is able to evaluate research results and interpret them to control practical skills. Thus, it is possible to get from 50 to 80 points for the Graded Test.

If student gets "excellent" he must prove his mark on the interview with commission consisting of the head of department, assistant professors and teacher of the corresponding group. If student fails this interview commission has a right to decrease his/her final result till mark "good".

3.2. Questions for graded test.

Correct answer is a)

- Amino acid tyrosine is a derivative of benzene. Which group of compounds does benzene belong to?
a) Aromatic b) Heterocyclic c) Acetylene series d) Ethylene series e) Cycloalkanes
- Hemoglobin – is a tetrapyrrole derivative. Which class of compounds does pyrrole belong to?
a) Heterocyclic b) Acetylene series c) Ethylene series d) Cycloalkanes e) Alkadienes
- Vitamine A is called "retinol". Suffix –ol means that retinol is:
a) Alcohol b) Aldehyde c) Ketone d) Carboxylic acid e) Oxo acid
- Nitrogen bases – derivatives of pyrimidine enter the composition of nucleic acids. Which class of compounds does pyrimidine belong to?
a) Heterocyclic b) Acetylene series c) Ethylene series d) Cycloalkanes e) Alkadienes
- Nitrogen bases – derivatives of purine enter the composition of nucleic acids. Which class of compounds does purine belong to?
a) Heterocyclic b) Acetylene series c) Ethylene series d) Cycloalkanes e) Alkadienes
- Cyclohexane – is a parent structure for many natural compounds. What kind of substance is it?
a) Carbocyclic b) Heterocyclic c) Aromatic d) Alkene e) Alkadiene
- Which of the following is true: sp^3 hybridized carbon atom
a) forms all 4 σ - bonds b) forms 3 σ - bonds and 1 π -bond c) forms 2 σ - bonds and 2 π - bonds
d) is in the chain of alternating single and double bonds e) is bound with halogens
- Which of the following is true: sp^2 hybridized carbon atom
a) forms 3 σ - bonds and 1 π -bond b) forms all 4 σ - bonds c) forms 2 σ - bonds and 2 π - bonds
d) is in the chain of triple bonds e) is bound with halogens
- Which of the following is true: sp hybridized carbon atom

a) forms 2 σ - bonds and 2 π - bonds b) forms all 4 σ - bonds c) forms 3 σ - bonds and 1 π - bond d) is in the chain of alternating single and double bonds e) is bound with halogens

10. What is the hybridization state of carbon atom in benzene?

a) sp^2 b) sp^3 c) sp d) sp^2d e) sp^2d

205. What is the hybridization state of carbon atom in pyridine?

a) sp^2 b) sp^3 c) sp d) sp^2d e) sp^2d

11. Which of the radicals is "ethyl":

a) $-C_2H_5$ b) $-CH_3$ c) $-C_3H_7$ d) $-C_4H_9$ e) $-C_5H_{11}$

12. Which of the radicals is "methyl":

a) $-CH_3$ b) $-C_2H_5$ c) $-C_3H_7$ d) $-C_4H_9$ e) $-C_5H_{11}$

13. Which of the radicals is "propyl":

a) $-C_3H_7$ b) $-CH_3$ c) $-C_2H_5$ d) $-C_5H_{11}$ e) $-C_4H_9$

14. Which of the radicals is "butyl":

a) $-C_4H_9$ b) $-CH_3$ c) $-C_2H_5$ d) $-C_3H_7$ e) $-C_5H_{11}$

15 Glyoxilic acid belongs to aldo acids. Which functional groups are in composition of glyoxilic acid?

a) $\begin{array}{c} \text{O} \\ \parallel \\ -C \\ \diagdown \\ \text{H} \end{array}$; $\begin{array}{c} \text{O} \\ \parallel \\ -C \\ \diagdown \\ \text{OH} \end{array}$ b) $\begin{array}{c} \text{O} \\ \parallel \\ -C \\ \diagdown \\ \text{H} \end{array}$; $-\text{OH}$ c) $\begin{array}{c} >C \\ \parallel \\ \text{O} \end{array}$; $\begin{array}{c} \text{O} \\ \parallel \\ -C \\ \diagdown \\ \text{OH} \end{array}$

d) $-\text{NH}_2$; $\begin{array}{c} \text{O} \\ \parallel \\ -C \\ \diagdown \\ \text{OH} \end{array}$ e) $\begin{array}{c} >C \\ \parallel \\ \text{O} \end{array}$; $-\text{OH}$

16. IUPAC name of malic acid is 2-hydroxybutandioic acid. Which functional groups are in composition of malic acid?

a) $-\text{OH}$; $\begin{array}{c} \text{O} \\ \parallel \\ -C \\ \diagdown \\ \text{OH} \end{array}$ b) $\begin{array}{c} \text{O} \\ \parallel \\ -C \\ \diagdown \\ \text{H} \end{array}$; $-\text{OH}$ c) $\begin{array}{c} >C \\ \parallel \\ \text{O} \end{array}$; $\begin{array}{c} \text{O} \\ \parallel \\ -C \\ \diagdown \\ \text{OH} \end{array}$

d) $-\text{NH}_2$; $\begin{array}{c} \text{O} \\ \parallel \\ -C \\ \diagdown \\ \text{OH} \end{array}$ e) $\begin{array}{c} >C \\ \parallel \\ \text{O} \end{array}$; $-\text{OH}$

17. IUPAC name of glutamic acid is 2-aminopentanedioic acid. Which functional groups are in composition of glutamic acid?

a) $-\text{NH}_2$; $\begin{array}{c} \text{O} \\ \parallel \\ -C \\ \diagdown \\ \text{OH} \end{array}$ b) $\begin{array}{c} \text{O} \\ \parallel \\ -C \\ \diagdown \\ \text{H} \end{array}$; $-\text{OH}$ c) $\begin{array}{c} >C \\ \parallel \\ \text{O} \end{array}$; $\begin{array}{c} \text{O} \\ \parallel \\ -C \\ \diagdown \\ \text{OH} \end{array}$

d) $-\text{OH}$; $\begin{array}{c} \text{O} \\ \parallel \\ -C \\ \diagdown \\ \text{OH} \end{array}$ e) $\begin{array}{c} >C \\ \parallel \\ \text{O} \end{array}$; $-\text{OH}$

18. IUPAC name of pyruvic acid is 2-oxopropanoic acid. Which functional groups are in composition of pyruvic acid?

a) $\begin{array}{c} >C \\ \parallel \\ \text{O} \end{array}$; $\begin{array}{c} \text{O} \\ \parallel \\ -C \\ \diagdown \\ \text{OH} \end{array}$ b) $\begin{array}{c} \text{O} \\ \parallel \\ -C \\ \diagdown \\ \text{H} \end{array}$; $-\text{OH}$ c) $\begin{array}{c} \text{O} \\ \parallel \\ -C \\ \diagdown \\ \text{H} \end{array}$; $\begin{array}{c} \text{O} \\ \parallel \\ -C \\ \diagdown \\ \text{OH} \end{array}$

d) $-\text{NH}_2$; $\begin{array}{c} \text{O} \\ \parallel \\ -C \\ \diagdown \\ \text{OH} \end{array}$ e) $\begin{array}{c} >C \\ \parallel \\ \text{O} \end{array}$; $-\text{OH}$

19. Which substance shows cis-trans isomerism?

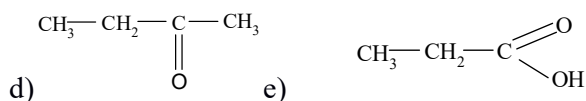
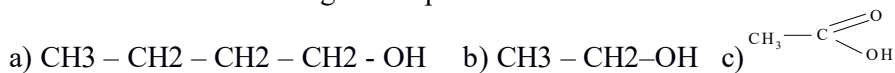
a) $\text{CH}_3 - \text{CH} = \text{CH} - \text{CH}_3$ b) $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH}_3$ c) $\text{CH}_3 - \text{C} \cdot \text{C} - \text{CH}_3$
d) $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{CH}_3$ e) $\text{CH}_2 = \text{CH} - \text{CH}_2 - \text{CH}_3$

20. Which of the following are homologues?

a) Butanedioic acid and pentanedioic acid b) Butenedioic acid and butynedioic acid
c) Butanoic acid and butanedioic acid d) Pentanoic acid and pentanedioic acid

e) Propanoic acid and pentanedioic acid

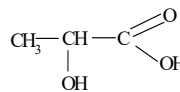
21. Which of the following shows position isomerism?



22. Which of the following are homologues?

Propanal and butanal b) Propanal and propylamine c) Propanal and propanoic acid

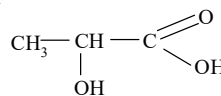
d) Propanal and butanoic acid e) Propanal and propanone



23. Choose the correct IUPAC name of the compound:

a) 2 - hydroxypropanoic acid b) Lactic acid c) α - hydroxypropionic acid

d) 2 - hydroxypropionic acid e) α - hydroxypropanoic acid



24. Choose the correct rational name of the compound:

α - hydroxypropionic acid b) Lactic acid c) α - hydroxypropanoic acid

d) 2 - hydroxypropionic acid e) 2 - hydroxypropanoic acid

25. What are the electronic effects of functional groups in the molecule of hydroxybutanoic acid? 4-

a) -I b) +M c) +M, +I d) -M, - I e) +I

26. What is the kind of conjugation in the molecule of aniline (aminobenzene) between functional group and aromatic ring?

a) p, π b) π, π c) p, p d) there is no conjugated system e) there is no definite answer

27. What kind of substituent hydroxygroup in phenol is?

a) Electron-donor b) Electron-acceptor c) has no electronic effect d) there is no definite answer e) there is no hydroxyl group in phenol molecule

28. What is the characteristic of aromatic system?

a) It is a closed conjugated system which carries $(4n + 2)$ electrons b) It has flat cycle

c) It contains heteroatom d) It is a heterocyclic compound e) there is no definite answer

29. What are the electronic effects of chlorine atom in the chloroethene?

a) -I, + M b) +I, - M c) + M, + I d) +M e) +I

30. Which is the most favorable conformation for kolamine (2-aminoethan-1-ol)?

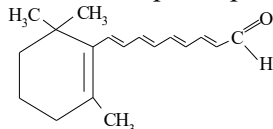
a) Staggered b) Eclipsed c) Gauche 600 d) Gauche 200 e) There is no favorable conformation

31. Which bond is typical for sp^3 - hybridized carbon atoms in the small cycles?

a) τ -bond ("banana-bond") b) π - bond c) σ - bond d) Covalent bond

e) there is no definite answer

32. Retinal participates in the vision process. It contains open chain conjugates system:



What are the electronic effects of aldehyde group?

a) -I, - M b) -I c) +M, + I d) -M, + e) -I, + M

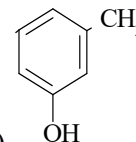
33. τ -bonds ("banana-bonds") are typical for:

a) Cyclopropane and cyclobutane b) Cyclopentane and cyclohexane c) Cyclohexane

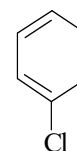
d) Cyclopropane and cyclohexane e) Cyclopentane

34. Conjugated systems are :

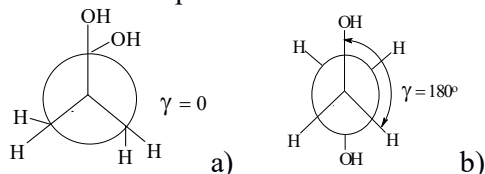
- a) Thermodynamically stable b) Very reactive c) Thermodynamically unstable
 d) Very unreactive e) There is no definite answer
 35. Give the definition of term "inductive effect"
 a) Shift of electronic density by more electronegative atom along the chain of σ - bonds
 b) Shift of electronic density by carbon atom from any substituent
 c) Shift of electronic density at delocalization
 d) Shift of π - electrons in the conjugated system e) There is no definite answer



36. What are the electronic effects of OH-group in *m*-methylphenol (*m*-cresol)
 a) $-I, +M$; b) $-I$; c) $-I, -M$; d) $+I$; e) There is no definite answer



37. What are the electronic effects of chlorine atom in the chlorobenzene?
 a) $-I, +M$ b) $+I$ c) $+M, +I$ d) $-M, +I$ e) $-M$
 38. Name the pictured conformations. What is the compound?



- Eclipsed – a, staggered – b; ethane-1,2-diol
 Staggered – a, Eclipsed – b; ethane-1,2-diol
 Gauche, ethane-1,2-diol
 Staggered, ethane-1,2-diol
 There is no definite answer

39. In the molecule $\text{CH}_2 = \text{CH} - \text{Cl}$ chlorine atom shows:

- a) $-I, +M$ b) $+I$ c) $-M, +I$ d) $+M, +I$ e) $-M$
 40. Which bond undergoes homolytic fission preferentially?
 a) Covalent nonpolar b) Covalent polar c) Ionic d) Hydrogen e) Donor-acceptor
 41. Which particle is a free radical?

- a) $\text{CH}_3\text{-C}(\text{CH}_3)\text{-CH}_3$; b) $(\text{CH}_3\text{-CH}_2)^+$; c) CH_3COO^- ; d) CH_3OH ; e) $\text{CH}_3\text{-CH}_2\text{Cl}$?

42. Which of the following is substitution reaction?

- a) $\text{CH}_3\text{-CH}_3 + \text{Cl}_2 \rightarrow \text{CH}_3\text{-CH}_2\text{Cl} + \text{HCl}$; b) $\text{CH}_3\text{-CH}=\text{CH}_2 + \text{Cl}_2 \rightarrow \text{CH}_3\text{-CHCl-CH}_2\text{Cl}$;
 c) $\text{CH}_3\text{-CH}_3 \rightarrow \text{H}_2\text{C}=\text{CH}_2 + \text{H}_2$; d) $\text{C}_2\text{H}_5\text{-NH}_2 + \text{HCl} \rightarrow [\text{C}_2\text{H}_5\text{-NH}_3]\text{Cl}$; e) $\text{CH}_4 \rightarrow \text{C} + 2\text{H}_2$?

43. Free radicals are:

- a) Atoms or groups of atoms which have unpaired electrons;
 b) Particles which have electron pair on the external level; c) Positively charged particles;
 d) Atoms with free orbitals; e) Negatively charged particles.

44. Which compounds enter addition reactions?

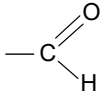
- a) Unsaturated hydrocarbons; b) Saturated hydrocarbons; c) Aromatic hydrocarbons;
 d) Alcohols; e) Amines

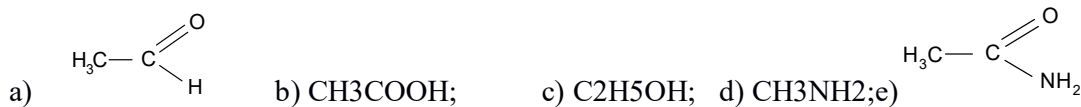
45. Which particle is carbocation?

- ($\text{CH}_3\text{-CH}_2$) $^+$; b) ($\text{CH}_3\text{-NH}_3$) $^+$; c) CH_3COO^- ; d) C_6H_6 ; e) $\text{C}_3\text{H}_7\text{OH}$?

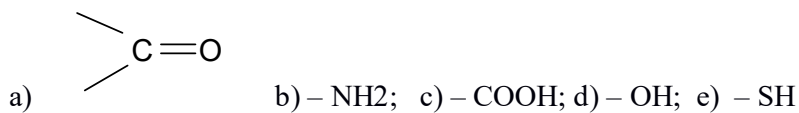
46. Which compound enters addition reactions?

- a) $\text{CH}_3\text{-CH}=\text{CH}_2$; b) $\text{CH}_3\text{-CH}_2\text{-CH}_3$; c) $\text{CH}_3\text{-CH}_2\text{-OH}$; d) $\text{CH}_3\text{-CH}_2\text{-NH}_2$; e) $\text{CH}_3\text{-COOH}$?

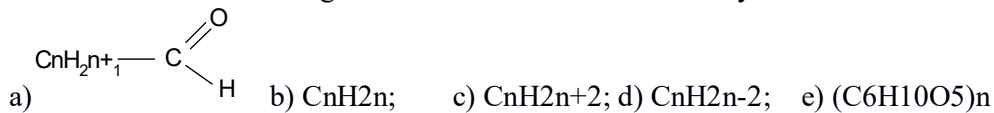
47. Which reaction occurs with the breaking of π -bond:
 a) Addition; b) Substitution; c) Decomposition; d) Neutralization; e) Exothermic?
48. Which of the following is addition reaction?
 a) $\text{CH}_3\text{-CH=CH-CH}_3 + \text{Br}_2 \rightarrow \text{CH}_3\text{-CHBr-CHBr-CH}_3$; b) $2 \text{CH}_3\text{OH} + 2 \text{Na} \rightarrow 2 \text{CH}_3\text{ONa} + \text{H}_2$; c) $\text{C}_6\text{H}_6 + \text{Br}_2 \rightarrow \text{C}_6\text{H}_5\text{Br} + \text{HBr}$; d) $\text{C}_6\text{H}_5\text{OH} + \text{NaOH} \rightarrow \text{C}_6\text{H}_5\text{ONa} + \text{H}_2\text{O}$;
 e) $\text{C}_2\text{H}_6 + \text{Br}_2 \rightarrow \text{C}_2\text{H}_5\text{Br} + \text{HBr}$?
49. What are the intermediates in lipids peroxide oxidation?
 a) Free radicals; b) Cations; c) Anions; d) Atoms; e) Molecules
50. Which reaction is typical for aromatic hydrocarbons?
 a) Substitution; b) Addition; c) Decomposition; d) Exchange; e) Neutralization
51. What is the reason of benzene ring resistance towards addition reactions?
 a) The presence of closed conjugated system; b) The presence of six-membered cycle;
 c) The presence of σ -bonds; d) The presence of π -bonds; e) The absence of acidic properties
52. Electrophilic reagents are:
 a) Positively charged particles b) Particles having a pair of electrons on the external level;
 c) Atoms or groups of atoms having unpaired electron d) Negatively charged particles
 e) Molecules with double bonds
53. Which compound participates in polymerization reaction?
 a) $\text{H}_2\text{C=CH-CH=CH}_2$; b) $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-CH}_3$; c) C_6H_6 ; d) $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-OH}$;
 e) $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-NH}_2$?
54. Which of the following are acidic?
 a) Alcohols; b) Saturated hydrocarbons; c) Unaturated hydrocarbons;
 d) Aromatic hydrocarbons; e) Amines.
55. Which reaction characterizes acidic properties of alcohols?
 $2 \text{CH}_3\text{-CH}_2\text{-CH}_2\text{-OH} + 2 \text{Na} \rightarrow 2 \text{CH}_3\text{-CH}_2\text{-CH}_2\text{-ONa} + \text{H}_2$;
 $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-OH} + \text{HBr} \rightarrow \text{CH}_3\text{-CH}_2\text{-CH}_2\text{-Br} + \text{H}_2\text{O}$;
 $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-OH} \rightarrow \text{CH}_3\text{-CH=CH}_2 + \text{H}_2\text{O}$;
 $\text{CH}_3\text{-CH}_2\text{-OH} + \text{HO-CH}_2\text{-CH}_3 \rightarrow \text{CH}_3\text{-CH}_2\text{-O-CH}_2\text{-CH}_3 + \text{H}_2\text{O}$;
 $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-OH} + \text{HOOC-CH}_3 \rightarrow \text{CH}_3\text{-CH}_2\text{-CH}_2\text{-O-CO-CH}_3 + \text{H}_2\text{O}$?
56. What electronic effect of OH-group in phenol molecule increases the electronic density in benzene ring?
 a) +M; b) -M; c) -I; d) +I; e) There is no effect
57. What are the products of primary alcohols oxidation?
 a) Aldehydes; b) Saturated hydrocarbons; c) Unaturated hydrocarbons;
 d) Halogen derivatives; e) Esters
58. Which reaction characterizes basic properties of ethylamine?
 $\text{CH}_3\text{-CH}_2\text{-NH}_2 + \text{HCl} \rightarrow [\text{CH}_3\text{-CH}_2\text{-NH}_3]\text{Cl}$;
 $\text{CH}_3\text{-CH}_2\text{-NH}_2 + \text{CH}_3\text{Br} \rightarrow \text{CH}_3\text{-CH}_2\text{-NH-CH}_3 + \text{HBr}$;
 $\text{CH}_3\text{-CH}_2\text{-NH}_2 + \text{Cl-CO-CH}_3 \rightarrow \text{CH}_3\text{-CH}_2\text{-NH-CO-CH}_3 + \text{HCl}$;
 $\text{CH}_3\text{-CH}_2\text{-NH}_2 + \text{HNO}_2 \rightarrow \text{CH}_3\text{-CH}_2\text{-OH} + \text{N}_2 + \text{H}_2\text{O}$;
 $\text{CH}_3\text{-NH}_2 + \text{HCl} \rightarrow [\text{CH}_3\text{-NH}_3]\text{Cl}$?
59. What electronic effect of alkyl radical increases basic properties of aliphatic amines as compare to aromatic ones?
 a) +I; b) -I; c) -M; d) +M; e) There is no effect
60. Which of the following is the functional group of aldehydes?

- a) -C(=O)H b) -OH ; c) -COOH ; d) -SH ; e) -NH_2
61. Which compound belongs to aldehydes?



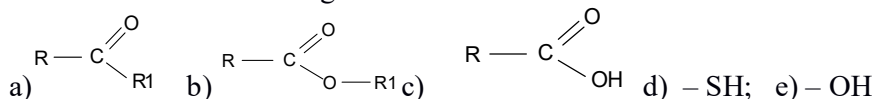
62. Which of the following is the functional group of ketones?



63. Which of the following is the common formula for aldehydes?



64. Which of the following is the common formula for ketones?



65. What reagent can be used for qualitative determination of aldehydes?

- a) Ammoniacal solution of Ag_2O ; b) HNO_3 ; c) Bromine water;
d) Copper hydroxide (in the cold); e) Na_2CO_3

66. What is the product of acetaldehyde reduction?

- a) Monohydric alcohol; b) Polyhydric alcohol; c) Ester; d) Ether; e) Lipid.

67. Give IUPAC name for acetone:

- a) Propanone; b) Propanal; c) Ethanal; d) Butanal; e) Methanal.

68. What process is the basis for "silver mirror test"?

- a) Oxidation of aldehydes to carboxylic acids;
Reduction of aldehydes to primary alcohols;
Hydration of alkenes in the presence of H_2SO_4 conc.
Oxidation of primary alcohols to aldehydes;
Reduction of ketones to secondary alcohols.

69. What formalin can be used for?

- a) Conservation of anatomic preparations; b) Treating of seeds; c) Preparation of medicines;
d) Storage of medicines; e) Preparation of dyes

70. Which acid on reduction gives lactic acid?

- a) Pyruvic; b) Oleic; c) Oxalo-acetic; d) α -ketoglutaric; e) Propenoic.

71. What is the name of compound $\text{CH}_3-\text{CH}(\text{CH}_3)-\text{CH}_2-\text{CH}_2-\text{COH}$?

- a) 4-methylpentanal; b) 2-methylpentanal; c) Butanoic aldehyde; d) Pentanoic aldehyde;
e) Hexanoic aldehyde.

72. How aldehydes can be transformed into alcohols?

- a) By reaction with hydrogen; b) By reaction with oxygen; c) By reaction with halogens;
d) By reaction with acid; e) By reaction with base.

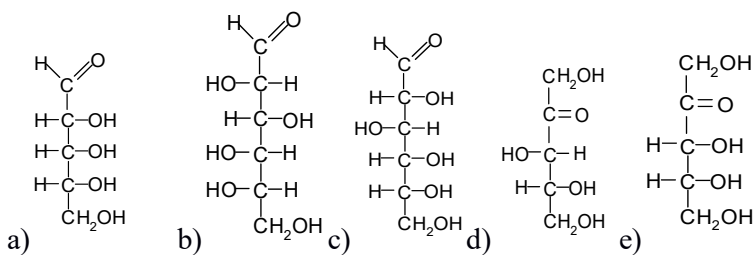
73. What is the classification of carbohydrates according to the number of monomers?

- a) Monosaccharides, disaccharides, oligosaccharides and polysaccharides;
b) Homo- and heteropolysaccharides; c) Monosaccharides and hemiacetals;
d) Aminosaccharides and glycosides; e) Monosaccharides and their derivatives

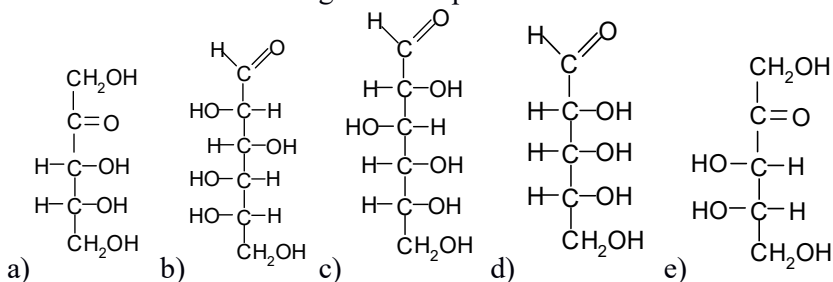
74. What classes of organic compounds do monosaccharides belong to (according to the structure)?

- a) Polyhydroxyaldehydes and Polyhydroxyketones; b) Ethers of trihydroxyalcohol glycerine;
c) Aminoderivatives of glucose; d) Hydroxyketones which have six-carbon atoms chain;
e) Hydroxyaldehydes which have five-carbon atoms chain

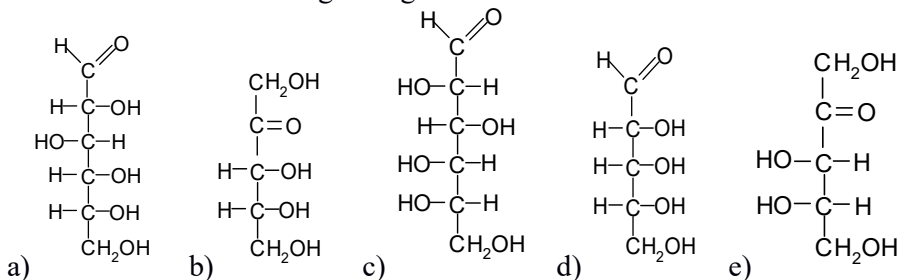
75. Which of the following is D-aldopentose:



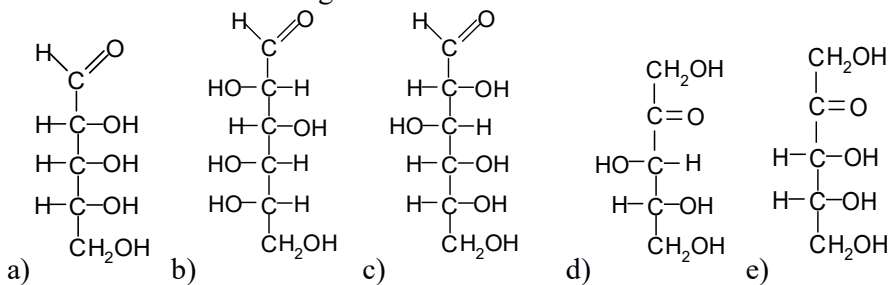
76. Which of the following is D-ketopentose:



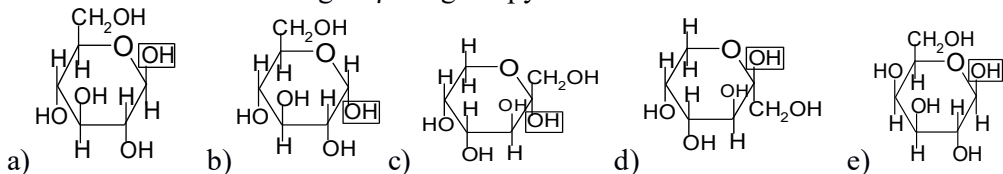
77. Which of the following is D-glucose:



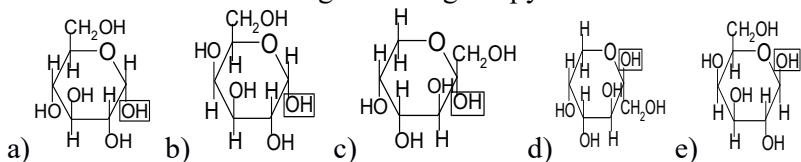
78. Which of the following is D-ribose:



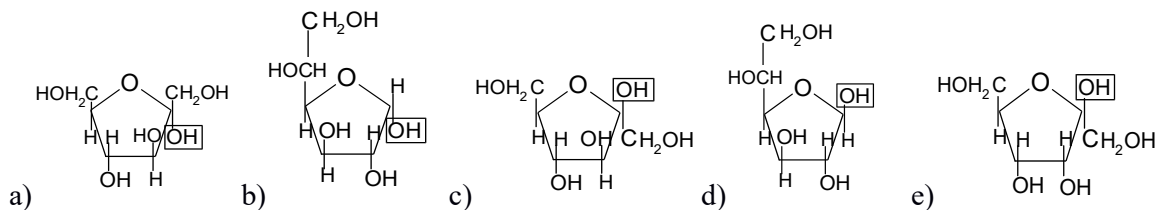
79. Which of the following is β -D-glucopyranose:



80. Which of the following is α -D-glucopyranose:



81. Which of the following is α -D-fructofuranose:



82. What is cyclic hemiacetal?

Product of intramolecular interaction of aldehyde and alcohol groups;

Product of reduction of aldehyde or keto group in monosaccharide;

Product of interaction of aldehyde with alcohol;

Product of oxidation of monosaccharide into acid;

Product of interaction of ketone with alcohol

83. Glycosidic linkage involves:

a) Hemiacetal hydroxyl group; b) OH- group at C5 carbon atom;

c) OH- group at C4 carbon atom; d) OH- group at C6 carbon atom;

e) OH- group at C3 carbon atom;

84. How many chiral carbons are there in fructose molecule?

a) 3 chiral carbons; b) 2 chiral carbons; c) 4 chiral carbons; d) 5 chiral carbons;

e) There is no chiral carbons in fructose

85. How many chiral carbons are there in galactose molecule?

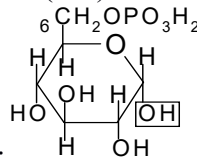
a) 4 chiral carbons; b) 2 chiral carbons; c) 3 chiral carbons; d) 5 chiral carbons;

e) There is no chiral carbons in galactose

86. Which reaction can prove the presence of aldehyde group in monosaccharides?

a) Reaction with $\text{Ag}(\text{NH}_3)_2\text{OH}$; b) Reaction with NaHSO_3 ; c) Reaction with CHI_3 ;

d) Reaction with KOH ; e) Reaction with $\text{Cu}(\text{OH})_2$ on the cold.



87. What is the correct name of compound:

a) 6-phosphate- α -D-glucopyranose; b) 1-phosphate - α -D- glucopyranose;

c) 6-phosphate - α -D-fructofuranose; d) 6-phosphate - β -D- glucopyranose;

e) 1-phosphate - β -D- glucopyranose

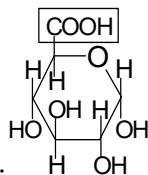
88. What is the product of glucose reduction?

a) Sorbite; b) Xilite; c) Mannitol; d) Dulcitol; e) Gluconic acid.

89. What is the product of D-glucose oxidation with bromine water?

a) D-gluconic acid; b) D-glucaric acid; c) D-gluconic acid; d) L-iduronic acid;

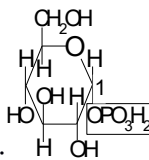
e) L- gluconic acid.



90. What is the correct name of compound:

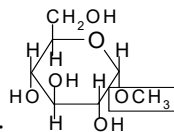
a) D-gluconic acid; b) D-glucaric acid; c) D-gluconic acid; d) L-iduronic acid;

e) gluconic acid.



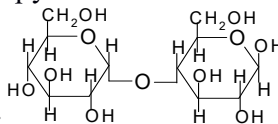
91. What is the correct name of compound:

- a) 1-phosphate α -D- glucopyranose; b) 6-phosphate α -D- glucopyranose;
 c) 6-phosphate α -D- fructofuranose; d) 6-phosphate α -D- glucopyranose;
 e) 1-phosphate α -D- glucopyranose.



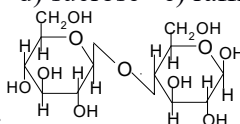
92. What is the correct name of compound:

- a) methyl- β -D-glucopyranoside; b) acetyl- α -D- glucopyranoside; c) α -D-fructose diphosphate;
 d) β -D- glucopyranose; e) β -D-fructopyranose.



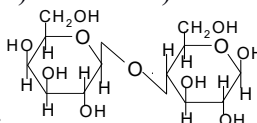
93. What is the name of disaccharide:

- a) maltose b) cellobiose c) lactose d) sucrose e) raffinose



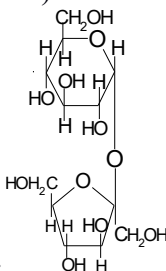
94. What is the name of disaccharide:

- a) cellobiose b) maltose c) lactose d) sucrose e) raffinose



95. What is the name of disaccharide:

- a) lactose b) maltose; c) cellobiose d) sucrose e) raffinose



96. What is the name of disaccharide:

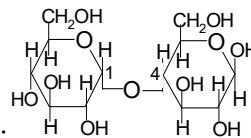
- a) sucrose; b) maltose; c) cellobiose; d) lactose; e) trehalose

97. Which disaccharide contains D-fructose in furanose form?

- a) sucrose; b) maltose; c) cellobiose; d) lactose; e) gentianose

98. Which disaccharide contains D-galactose in pyranose form?

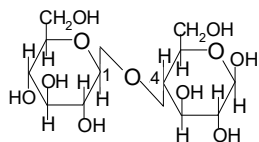
- a) lactose; b) maltose; c) cellobiose; d) sucrose; e) trehalose



99. Give correct name of bond in the disaccharide maltose:

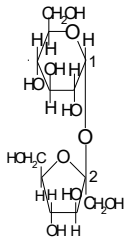
- a) α -(1 \rightarrow 4)-Glycosidic linkage ; b) β -(1 \rightarrow 4)- Glycosidic linkage;
 c) α -(1 \rightarrow 3)- Glycosidic linkage; d) β -(1 \rightarrow 3)- Glycosidic linkage;
 e) α -(1 \rightarrow 6)- Glycosidic linkage

100. Give correct name of bond in the disaccharide cellobiose:



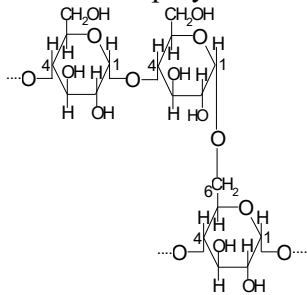
- a) β -(1 \rightarrow 4)- Glycosidic linkage; b) α -(1 \rightarrow 4)- Glycosidic linkage; c) α -(1 \rightarrow 3)- Glycosidic linkage;
 d) β -(1 \rightarrow 3)- Glycosidic linkage; e) α -(1 \rightarrow 6)- Glycosidic linkage

101. Give correct name of bond in the disaccharide sucrose



- a) (1→2)- Glycosidic linkage; b) β-(1→4)- Glycosidic linkage; c) α-(1→3)- Glycosidic linkage; d) β-(1→3)- Glycosidic linkage; e) α-(1→6)- Glycosidic linkage

102. Which polysaccharide has the following structure:



- a) Amylopectine; b) Amylose ; c) Cellulose; d) Hyaluronic acid; e) Chondroitine sulfate

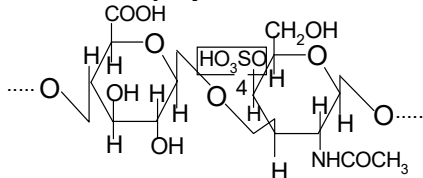
103. What do glycogen and amylopectine have in common?

- a) Have branched structures; b) Consist of monomer - galactose; c) Consist of molecules of α-D-glucofuranose; d) Consist of molecules of β-D-glucopyranose; e) Consist of molecules of glucose, fructose and ribose

104. What are the fractions of starch?

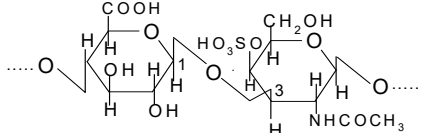
- a) Linear amylose and brunched amylopectine; b) Homo- and hetero fractions; c) Only fraction of brunched amylopectine; d) Fractions which move to anode and cathode in the electric field; e) Only fraction of linear amylose

105. Which polysaccharide has the following structure:



- a) Chondroitine-4-sulfate; b) Starch; c) Cellulose; d) Hyaluronic acid; e) Glycogen

106. Give correct name of bond in the fragment of heteropolysaccharide:



- a) β-(1→3)- Glycosidic linkage; b) β-(1→4)- Glycosidic linkage; c) α-(1→3)- Glycosidic linkage; d) β-(1→4)- Glycosidic linkage; e) α-(1→6)- Glycosidic linkage

107. Which organs and tissues contain glycogen?

- a) Liver and skeletal muscles; b) Bones and blood; c) Brain and spleen; d) Skin and tendons; e) Kidneys and thyroid gland

108. What is the physiological function of glycogen?

- a) Energetic and storage; b) Structural; c) Catalytic; d) Immuno-protective; e) Buffering

109. Which heteropolysaccharide has anticoagulant properties?

- a) Heparin; b) Chondroitine sulfate; c) Hyaluronic acid; d) Muramin; e) Pectic acid

110. What kind of bonds are in starch and glycogen between D-glucose residues?

- a) α-(1→4)- glycosidic linkages and α-(1→6)- glycosidic linkages (in places of branches);

- b) β -(1 \rightarrow 4)- glycosidic linkages only; c) α -(1 \rightarrow 6)- glycosidic linkages only;
 d) α -(1 \rightarrow 4)- glycosidic linkages everywhere; e) α -(1 \rightarrow 3)- glycosidic linkages

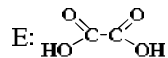
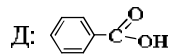
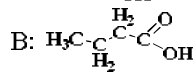
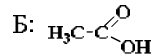
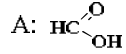
111. What are the monomers of starch?

- α -D-glucose; b) α -D-galactose; c) Fructose and glucose; d) α -D-ribose; e) α -D-mannose

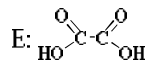
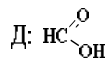
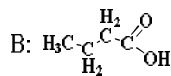
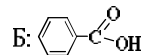
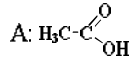
112. Which of the following is nonreducing disaccharide:

- a) Sucrose; b) Maltose; c) Cellobiose; d) Lactose; e) Trehalose

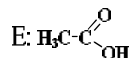
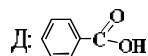
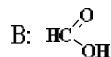
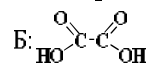
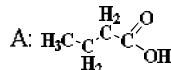
113. Which of the following is formic acid:



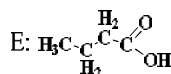
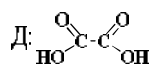
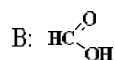
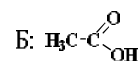
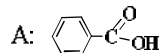
114. Which of the following is acetic acid:



115. Which of the following is butyric acid:



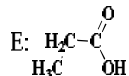
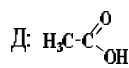
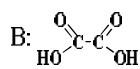
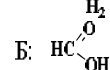
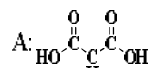
116. Which of the following is benzoic acid:



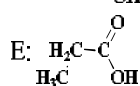
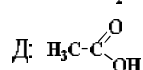
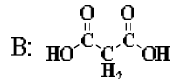
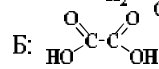
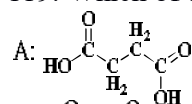
117. Which of the following is oxalic acid:



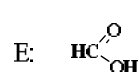
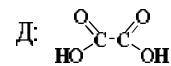
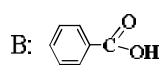
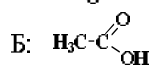
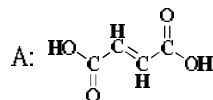
118. Which of the following is malonic acid:



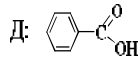
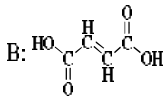
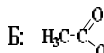
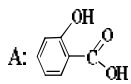
119. Which of the following is succinic acid:



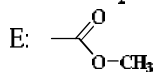
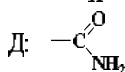
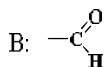
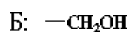
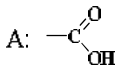
120. Which of the following is fumaric acid:



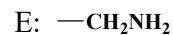
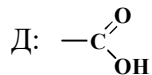
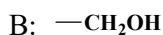
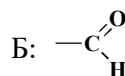
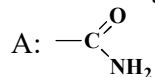
121. Which of the following is salicylic acid:



122. Which group is characteristic for carboxylic acids?



123. Which group is characteristic for amides?



124. Esters are products of interaction of:

- a) Carboxylic acids with alcohols; b) Carboxylic acids with aldehydes;
c) Carboxylic acids with water; d) Carboxylic acids with bases; e) Alcohols with alcohols

125. Amides are products of interaction of:

- a) Acid chlorides with amines; b) Aldehydes with amines; c) Carboxylic acids with amines;
d) Water with ammonia; e) Alcohols with ammonia

126. What type of conjugation is in the carboxyl group?

- a) p,π; b) p,p; c) π,π; d) special; e) there is no conjugation

127. What is the change in acidic strength of carboxylic acid if the length of hydrocarbon radical increases?

- a) Decreases; b) Increases; c) Does not change; d) Decreases at the beginning and increases then; e) Increases at the beginning and decreases then;

128. Esterification reaction takes place in the course of synthesis of:

- a) lipids; b) amino acids; c) proteins; d) carbohydrates; e) all of the above

129. Amide bond forms in the course of synthesis of:

- a) proteins; b) amino acids; c) lipids; d) carbohydrates; e) all of the above

130. Decarboxylation reaction is typical for:

- a) carboxylic acids; b) carbohydrates; c) alcohols; d) aldehydes; e) hydrocarbons

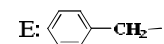
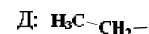
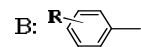
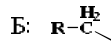
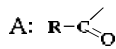
131. Salt formation reaction is typical for:

a) carboxylic acids; b) monosaccharides; c) disaccharides; d) aldehydes; e) hydrocarbons

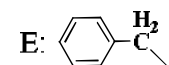
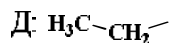
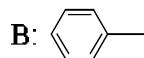
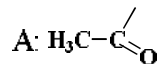
132. Which of the following is the reactive thiol ester which of great importance in the organism?

a) Acetyl-CoA; b) Propionyl-CoA; c) Butyryl-CoA; d) Amyl-CoA; e) Thiol esters are unreactive

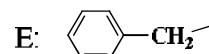
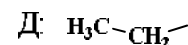
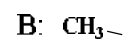
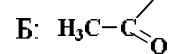
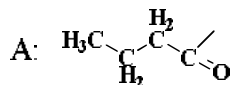
133. Which of the following is Acyl-radical?



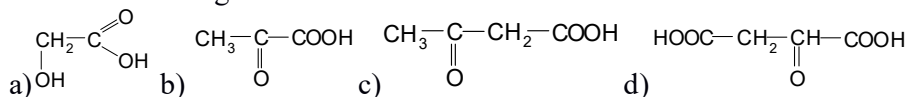
134. Which of the following is Acetyl-radical?



135. Which of the following is Butyryl-radical?



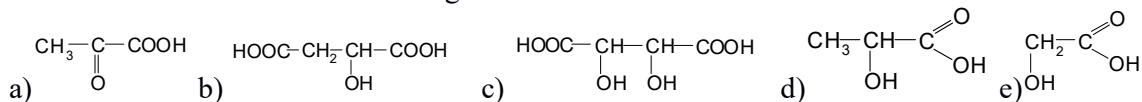
136. Which acid gives etherification reaction?



137. What is the product of intramolecular dehydration of β -hydroxyacid on heating?

a) Unsaturated acid b) Saturated acid c) Oxo acid d) Cyclic acid e) Amino acid

138. Which acid of the listed below gives imine on reaction with amine?

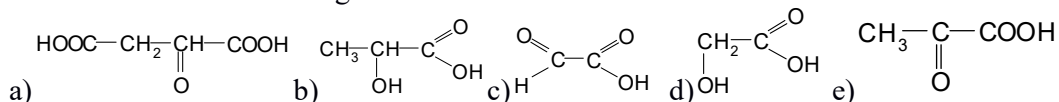


139. What is the mechanism of imine formation from pyruvic acid and amine?

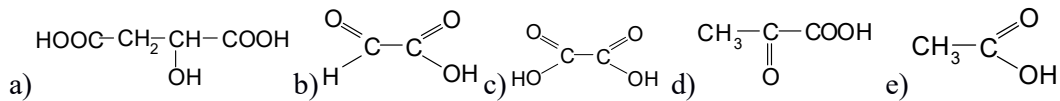
a) Nucleophilic addition b) Nucleophilic substitution c) Aldol condensation

d) Electrophilic substitution e) Electrophilic addition

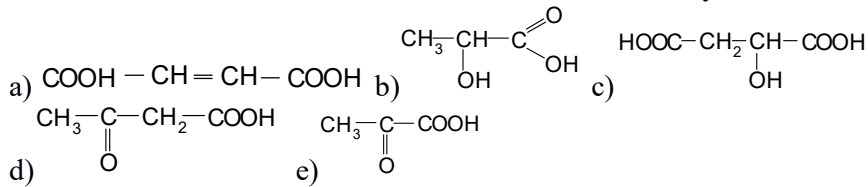
140. Which of the following acids show keto-enol tautomerism?



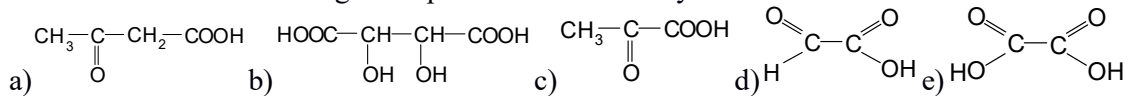
141. Which of the following acids is optically active?



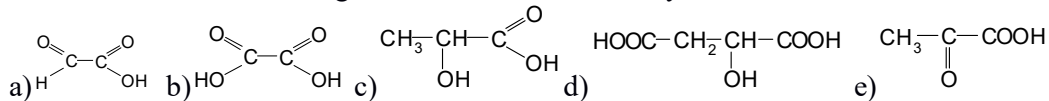
142. From which acid the malic acid forms in the Krebs cycle?



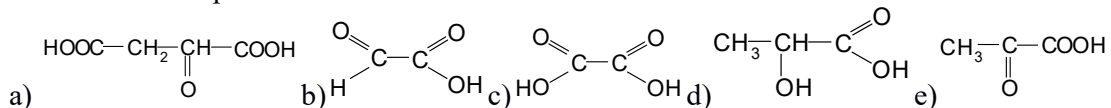
143. Which of the following acids possesses C-H acidity?



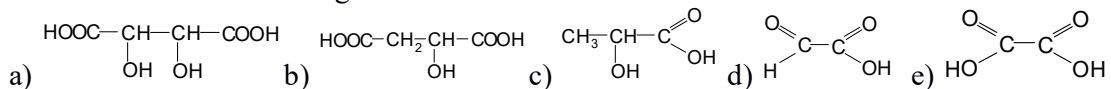
144. Which of the following acids can be discovered by "silver mirror test"?



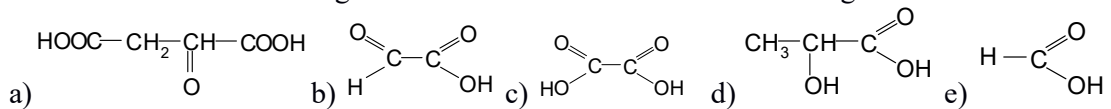
145. What is the product of malic acid oxidation?



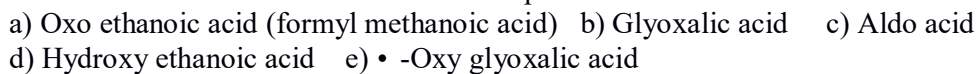
146. Which of the following acids has two chiral centers?



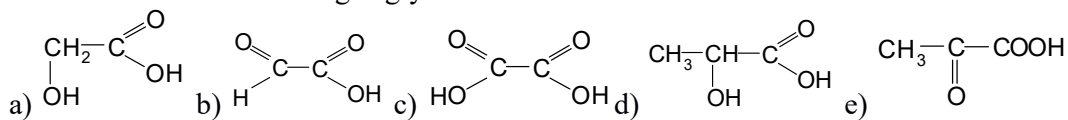
147. Which of the following acids enters aldol condensation in the organism?



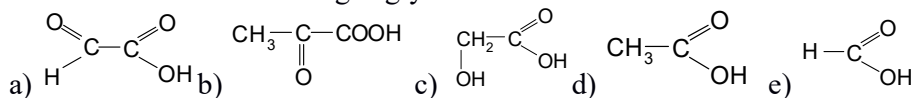
148. Give correct IUPAC name of the compound:



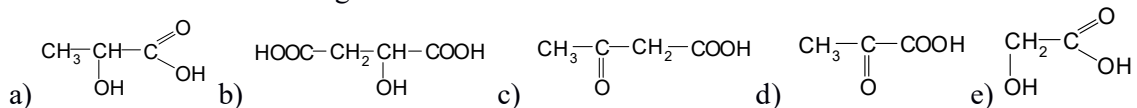
149. Which of the following is glycolic acid?



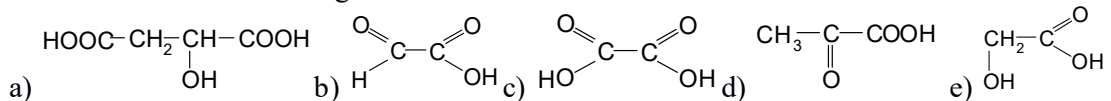
150. Which of the following is glyoxalic acid?



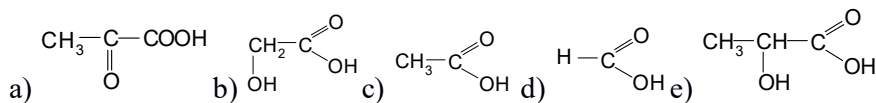
151. Which of the following is lactic acid?



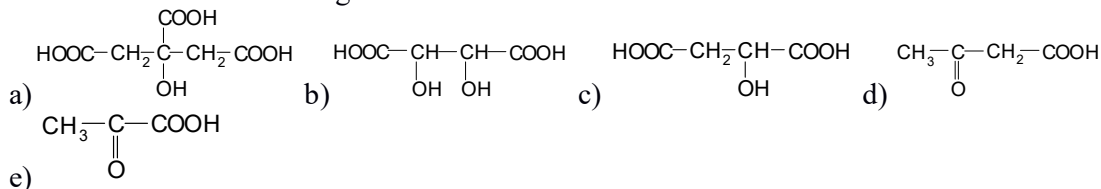
152. Which of the following is malic acid?



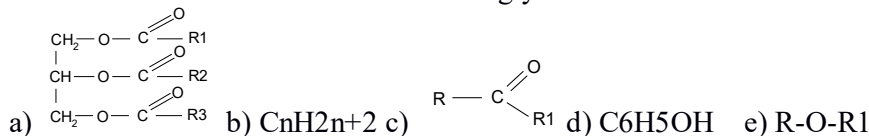
153. Which of the following is pyruvic acid?



154. Which of the following is citric acid?



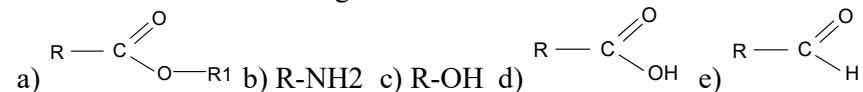
155. What is the common formula for triglycerides?



156. Which substances are needed for triglyceride obtaining?

- a) Glycerine and higher fatty acids; b) Acetic acid and ethanol;
 c) Propionic aldehyde and propionic acid; d) Formic acid and methanol;
 e) Propionic acid and propanol.

157. Which of the following is the common formula for esters?



158. What are the products of basic hydrolysis of fats?

- a) Glycerine and soap; b) Glycerine and carboxylic acid; c) Water and carboxylic acid;
 d) Glycerine and water; e) Glycerine and base.

159. Which reagent is needed to convert liquid lipid into solid fat?

- a) Hydrogen; b) Potassium permanganate solution; c) Water with concentrated sulfuric acid;
 d) Sodium hydroxide solution; e) Oxygen.

160. Which of the following acids can be found in the composition of fats?

- a) Oleic; b) Formic; c) Acetic; d) Benzoic; e) Phosphoric.

161. Which salts are known as soaps?

- a) Stearates; b) Benzoates; c) Formiates; d) Oxalates; e) Propanoates.

162. Which isomer of oleic acid is in composition of lipids?

- a) Cis-isomer; b) Trans-isomer; c) D (+) – isomer; d) L (-) – isomer; e) Cis- and trans- isomers

163. What is the consistency of lipid if the iodine number equals 98?

- a) Liquid; b) Solid; c) Soft; d) Porous; e) Colloidal.

164. Which acid is unsaturated?

- a) Oleic; b) Myristic; c) Palmitic; d) Stearic; e) Lauric.

165. Which triglyceride does not enter hydrogenation reaction?

- a) Tristearine; b) Palmitodioleine; c) Trioleine; d) Trilinoleine; e) Trilinolenine.

166. Which of the following soaps is the liquid one?

- a) $\text{C}_{17}\text{H}_{35}\text{COOK}$; b) $\text{C}_{17}\text{H}_{35}\text{COONa}$; c) $\text{C}_{17}\text{H}_{31}\text{COORb}$; d) $\text{C}_{17}\text{H}_{35}\text{COOLi}$; e) $(\text{C}_{17}\text{H}_{33}\text{COO})_2\text{Mg}$.

167. Which of the following is essential fatty acid?

- a) $\text{C}_{17}\text{H}_{31}\text{COOH}$; b) $\text{C}_{17}\text{H}_{35}\text{COOH}$ c) $\text{C}_{15}\text{H}_{31}\text{COOH}$ d) $\text{C}_{13}\text{H}_{27}\text{COOH}$ e) $\text{C}_{11}\text{H}_{23}\text{COOH}$

168. Which one is lauric acid?

- a) $\text{C}_{11}\text{H}_{23}\text{COOH}$ b) $\text{C}_{17}\text{H}_{35}\text{COOH}$ c) $\text{C}_{15}\text{H}_{31}\text{COOH}$ d) $\text{C}_{13}\text{H}_{27}\text{COOH}$ e) $\text{C}_{17}\text{H}_{31}\text{COOH}$

169. Which one is myristic acid?

- a) $\text{C}_{13}\text{H}_{27}\text{COOH}$ b) $\text{C}_{17}\text{H}_{33}\text{COOH}$ c) $\text{C}_{17}\text{H}_{31}\text{COOH}$ d) $\text{C}_{15}\text{H}_{31}\text{COOH}$ e) $\text{C}_{11}\text{H}_{23}\text{COOH}$

170. Which one is palmitic acid?

- a) C₁₅H₃₁COOH b) C₁₇H₃₅COOH c) C₁₇H₃₁COOH d) C₁₃H₂₇COOH e) C₁₁H₂₃COOH

171. Which one is stearic acid?

- a) C₁₇H₃₅COOH b) C₁₇H₃₃COOH c) C₁₇H₃₁COOH d) C₁₅H₃₁COOH e) C₁₁H₂₃COOH

172. Which one is oleic acid?

- a) C₁₇H₃₃COOH b) C₁₇H₃₅COOH c) C₁₅H₃₁COOH d) C₁₇H₂₉COOH e) C₁₇H₃₁COOH

173. Which one is linoleic acid?

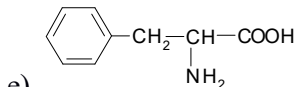
- a) C₁₇H₃₁COOH b) C₁₇H₃₅COOH c) C₁₅H₃₁COOH d) C₁₇H₂₉COOH e) C₁₁H₂₃COOH

174. Which one is linolenic acid?

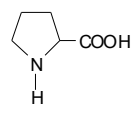
- a) C₁₇H₂₉COOH b) C₁₇H₃₃COOH c) C₁₇H₃₁COOH d) C₁₃H₂₇COOH e) C₁₅H₃₁COOH

175. Which one is glycine?

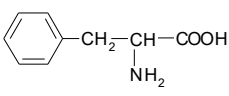
- a) $\begin{array}{c} \text{CH}_2\text{---COOH} \\ | \\ \text{NH}_2 \end{array}$ b) $\begin{array}{c} \text{CH}_3\text{---CH---CH---COOH} \\ | \quad | \\ \text{OH} \quad \text{NH}_2 \end{array}$ c) $\begin{array}{c} \text{HO---CH}_2\text{---CH---COOH} \\ | \\ \text{NH}_2 \end{array}$ d) $\begin{array}{c} \text{CH}_3\text{---CH---COOH} \\ | \\ \text{NH}_2 \end{array}$

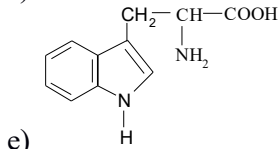


176. Which one is alanine?

- a) $\begin{array}{c} \text{CH}_3\text{---CH---COOH} \\ | \\ \text{NH}_2 \end{array}$ b)  c) $\begin{array}{c} \text{HS---CH}_2\text{---CH---COOH} \\ | \\ \text{NH}_2 \end{array}$ d) $\begin{array}{c} \text{CH}_2\text{---COOH} \\ | \\ \text{NH}_2 \end{array}$ e) $\begin{array}{c} \text{COOH---CH}_2\text{---CH---COOH} \\ | \\ \text{NH}_2 \end{array}$

177. Which one is valine?

- a) $\begin{array}{c} (\text{CH}_3)_2\text{CH---CH---COOH} \\ | \\ \text{NH}_2 \end{array}$ b)  c) $\begin{array}{c} \text{CH}_3\text{---CH---CH---COOH} \\ | \quad | \\ \text{OH} \quad \text{NH}_2 \end{array}$ d) $\begin{array}{c} \text{COOH---(CH}_2)_2\text{---CH---COOH} \\ | \\ \text{NH}_2 \end{array}$

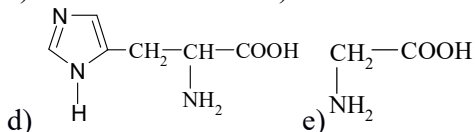


178. Which one is leucine?

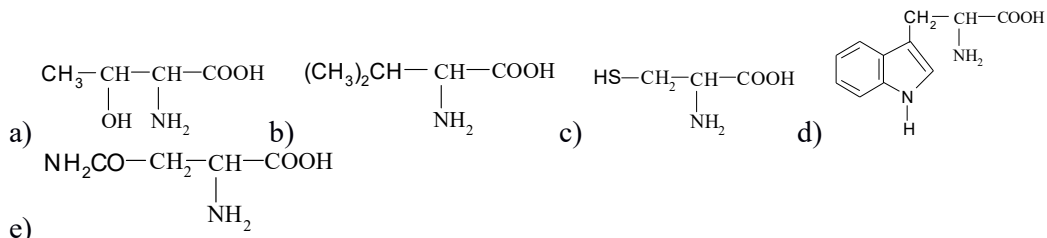
- a) $\begin{array}{c} \text{CH}_3\text{---CH}_2\text{---CH---CH---COOH} \\ | \quad | \\ \text{CH}_3 \quad \text{NH}_2 \end{array}$ b) $\begin{array}{c} \text{HS---CH}_2\text{---CH---COOH} \\ | \\ \text{NH}_2 \end{array}$ c) $\begin{array}{c} \text{CH}_3\text{---CH---CH---COOH} \\ | \quad | \\ \text{OH} \quad \text{NH}_2 \end{array}$ d) $\begin{array}{c} \text{COOH---(CH}_2)_2\text{---CH---COOH} \\ | \\ \text{NH}_2 \end{array}$
- e) $\begin{array}{c} \text{COOH---CH}_2\text{---CH---COOH} \\ | \\ \text{NH}_2 \end{array}$

179. Which one is isoleucine?

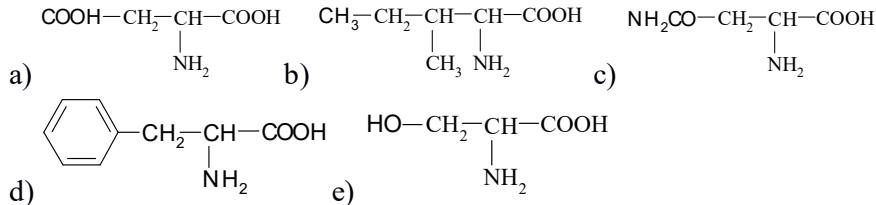
- a) $\begin{array}{c} \text{HO---CH}_2\text{---CH---COOH} \\ | \\ \text{NH}_2 \end{array}$ b) $\begin{array}{c} \text{NH}_2\text{CO---CH}_2\text{---CH---COOH} \\ | \\ \text{NH}_2 \end{array}$ c) $\begin{array}{c} \text{CH}_3\text{---CH---CH---COOH} \\ | \quad | \\ \text{OH} \quad \text{NH}_2 \end{array}$



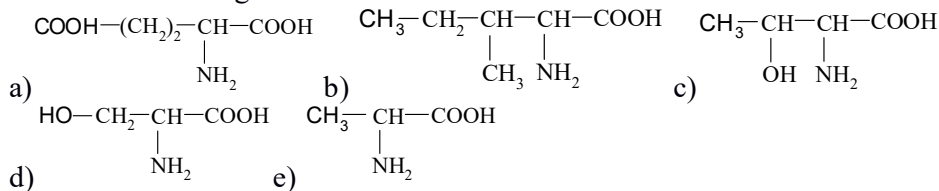
180. Which one is threonine?



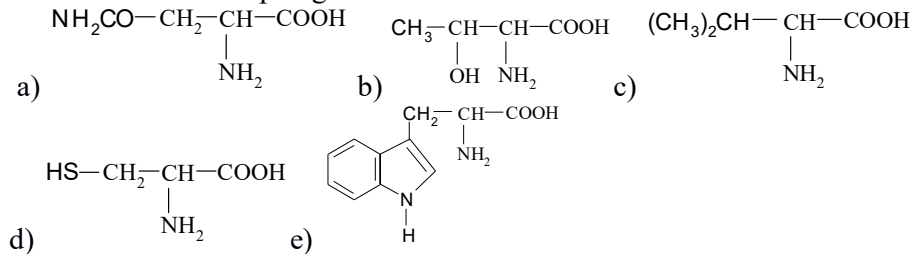
181. Which one is aspartic acid?



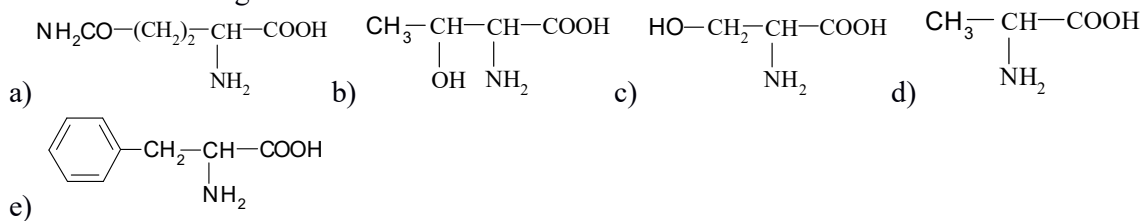
182. Which one is glutamic acid?



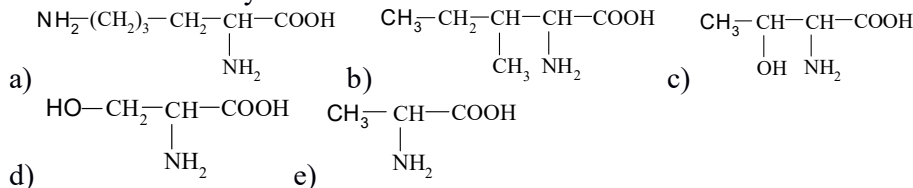
183. Which one is asparagine?



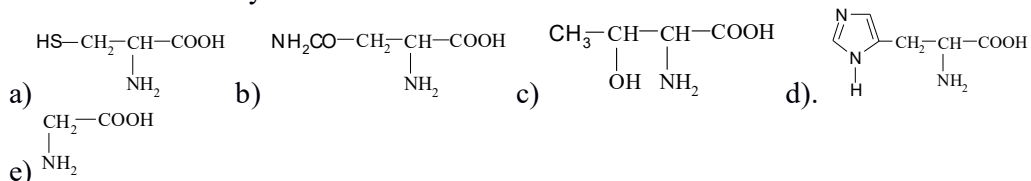
184. Which one is glutamine?



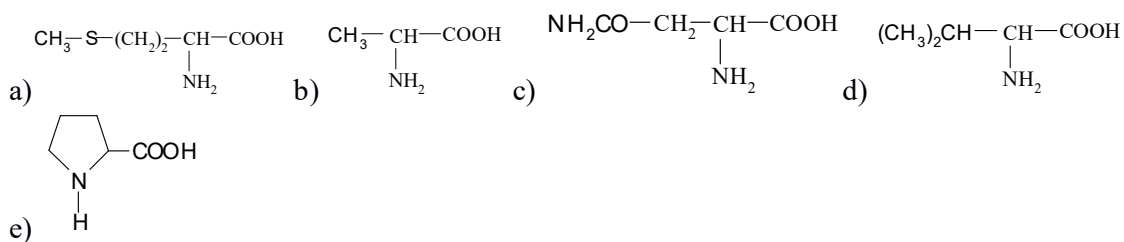
185. Which one is lysine?



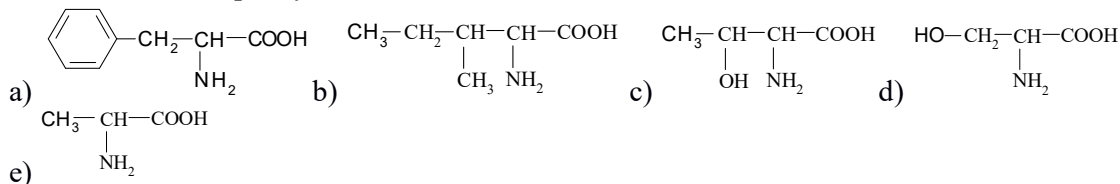
186. Which one is cysteine?



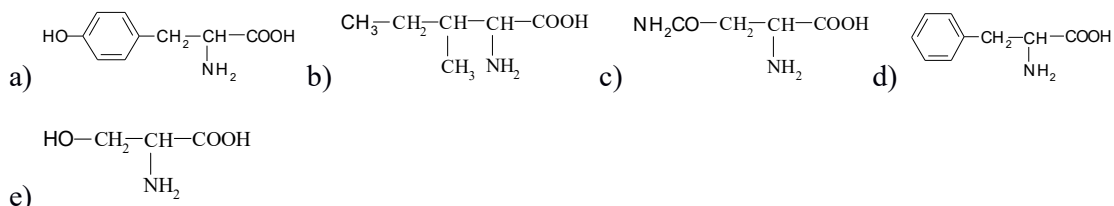
187. Which one is methionine?



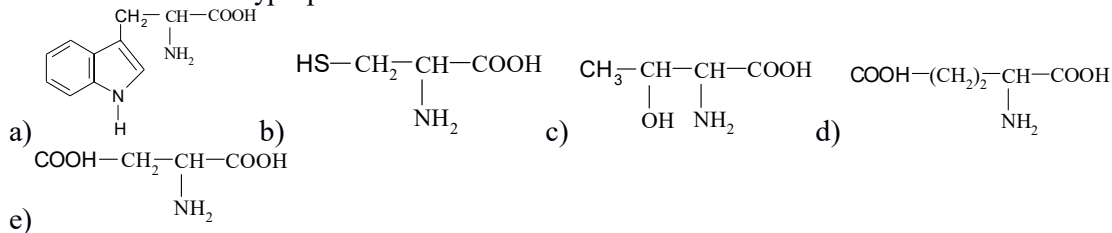
188. Which one is phenylalanine?



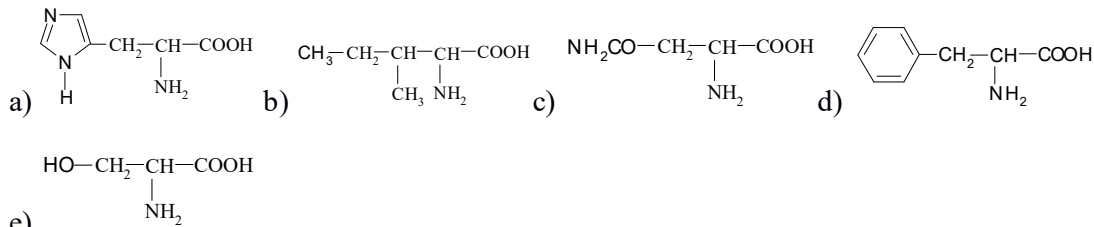
189. Which one is tyrosine?



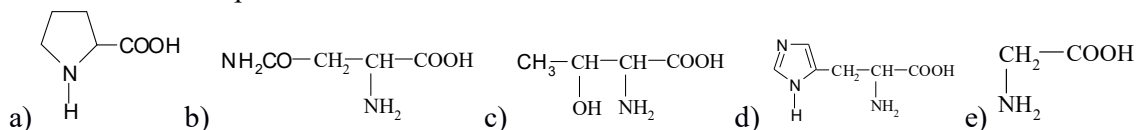
190. Which one is tryptophan?



191. Which one is histidine?



192. Which one is proline?



193. Which α -amino acid gives biogenic amine histamine on decarboxylation?

a) Histidine b) Glycine c) Tyrosine d) Serine e) Alanine

194. Which reaction is the basis for quantitative determination of amino acids by Van Slyke method?

a) Reaction with nitrous acid b) Reaction with formaldehyde c) Reaction with copper hydroxide
 d) Reaction with sodium hydroxide e) Reaction with sulfuric acid

195. What are the products of diamino acids decarboxylation?

a) diamines b) monoamino acids c) keto acids d) hydroxy acids e) there is no answer

196. Monobasic monoamino acid in water solution exists in the form of:

a) Dipolar ion b) Cation c) Anion d) there is no answer e) Molecule

197. Xanthoprotein reaction is a qualitative reaction for:

a) Aromatic amino acids b) Sulfur containing amino acids c) Peptide bond
d) Dibasic amino acids e) Aliphatic amino acids

198. Water solution of protein is:

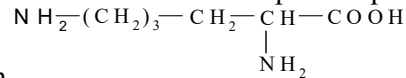
a) True solution b) Colloidal solution c) Suspension d) Emulsion e) There is no answer

199. The main bonds which stabilize secondary structure of protein are:

a) Hydrogen bonds b) Peptide bonds c) Ionic bonds d) Hydrophobic bonds e) Disulfide bonds

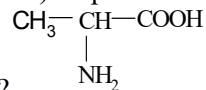
200. Isoelectric point of a protein (pI) is a pH at which:

a) Protein is electrically neutral b) Protein is positively charged c) Protein moves in electric field
d) Protein is negatively charged e) There is no relation between pH and pI



201. What is the pH in lysine water solution

a) Basic b) Acidic c) Neutral d) Depends on conditions e) About 6

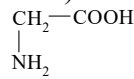


202. What is the pI of alanine?

a) pI ~ 7 b) pI > 7 c) pI < 7 d) pI=0 e) It has no pI

203. What is the characteristic reaction for peptide bonds detection?

a) Biuret b) Xanthoprotein c) Ninhydrine d) Fol's e) No characteristic reaction



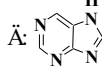
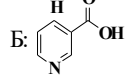
204. In acidic medium glycine molecule turns into:

a) Cation; b) Anion; c) Zwitterion; d) Non-charged molecule; e) There is no answer

205. Which of the following is pyridine?



206. Which of the following is pyrrole?



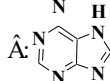
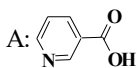
207. Which of the following is pyrimidine?



208. Which of the following is purine?



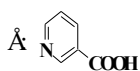
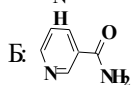
209. Which of the following is nicotinic acid?



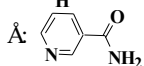
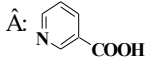
210. Which compound is five-membered heterocycle?

a) Furan; b) Pyrimidine; c) Pyridine; d) Nicotinic acid; e) Purine

211. Which of the following is imidazole?



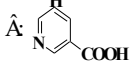
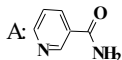
212. Which of the following is thiazole?



213. Which molecule contains pyrrole ring?

a) Hemoglobine; b) Uric acid; c) Adenine; d) Nicotinic acid; e) Vitamine PP

214. Which of the following is Vitamine PP (nicotinic acid amide):

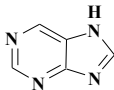


215. Pyrimidine contains:



a) 2 pyridic nitrogens; b) 2 pyrrolic nitrogens; c) One pyrrolic and one pyridic nitrogens;
d) 3 pyridic nitrogens; e) 3 pyrrolic nitrogens

216. Which molecule contains purine ring?



a) Adenine; b) Hemoglobine; c) Histidine; d) Nicotinic acid; e) Vitamine PP

217. Which of the following is fused heterocycle?

a) Purine; b) Pyrimidine; c) Pyridine; d) Furan; e) Pyrrole

218. Which molecule contains pyrimidine ring?



a) Barbituric acid; b) Hemoglobine; c) Histidine; d) Nicotinic acid; e) Benzoic acid



219. Imidazole contains:

a) One pyrrolic and one pyridic nitrogens; b) 2 pyridic nitrogens; c) 2 pyrrolic nitrogens;
d) 3 pyridic nitrogens; e) 3 pyrrolic nitrogens

220. Which of the following are purine bases?

a) Adenine, guanine; b) Cytosine, uracil; c) Adenine, thymine; d) Guanine; cytosine;
e) Thymine, cytosine

221. Which compound is six-membered heterocycle?

a) Pyridine; b) Pyrrole; c) Furan; d) Thiophene; e) Imidazole

222. Which molecule contains pyridine ring?

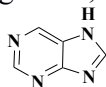


a) nicotinic acid; b) hemoglobine; c) adenine; d) histidine; e) barbituric acid



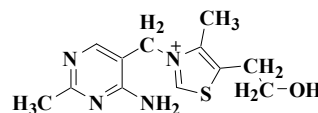
223. Which molecule contains imidazole ring?

- a) histidine; b) hemoglobine; c) nicotinic acid; d) barbituric acid e) cytosine



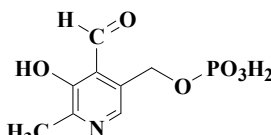
224. Purine contains:

- a) 1 pyrrolic nitrogen and 3 pyridic nitrogens; b) 2 pyridic nitrogens;
c) 3 pyrrolic nitrogens and 1 pyridic nitrogen; d) 2 pyrrolic nitrogens and 2 pyridic nitrogens;
e) 2 pyrrolic nitrogens



225. Vitamin B1 (thiamin) – is a derivative of:

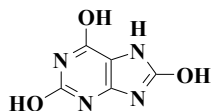
- a) thiazole; b) pyrrole; c) imidazole; d) pyridine; e) purine



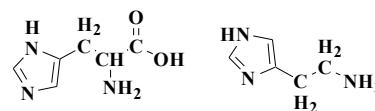
226. Vitamin B6 (pyridoxal phosphate) – is a derivative of:

- a) pyridine; b) pyrrole; c) pyrimidine; d) purine; e) thiazole

227. Uric acid is the final product of nucleic acids catabolism. Uric acid - is a derivative of:



- a) purine; b) pyrimidine c) pyrrole; d) pyridine; e) thiazole



228. Histidine and histamine are derivatives of: imidazole;

- a) indole; b) quinoline; c) pyrrole; d) pyridine



229. Which of the following are pyrimidine bases:

- a) Cytosine and uracil; b) Adenine and guanine; c) Adenine and thymine;
d) Guanine and cytosine; e) Adenine and guanine

230. What is the biological function of DNA?

- a) Storage and transmission of hereditary information b) Transport of amino acids
c) Decarboxylation of oxo acids d) Deamination of amino acids e) Oxidation of hydroxy acids

231. What is the biological function of messenger RNA (mRNA)?

- a) mRNA is a matrix for biosynthesis of proteins; b) mRNA transports amino acids
c) mRNA hydrolyzes proteins; d) mRNA catalyzes peptide bonds formation;
mRNA activates rRNA.

232. What is the biological function of transfer RNA (tRNA)?

- a) tRNA transports amino acids to ribosomes; b) tRNA is a matrix for biosynthesis of proteins;
c) tRNA hydrolyzes proteins; d) tRNA catalyzes peptide bonds formation;
e) tRNA activates rRNA.

233. Which carbohydrate is present in the composition of RNA?

- a) Ribose; b) Deoxyribose; c) Glucose; d) Fructose; e) Mannose

234. Which carbohydrate is present in the composition of DNA?

- a) Deoxyribose; b) Ribose; c) Glucose; d) Fructose; e) Mannose

235. Which acid forms ester bond with hydroxyl group of monosaccharide in the composition of mononucleotide?

- a) Phosphoric b) Nitric c) Nitrous d) Sulphurous e) Sulfuric

236. What is the secondary structure of DNA?
 a) Double helix; b) β -pleated sheet c) α -helix d) cloverleaf e) straight chain
237. What is the secondary structure of transfer RNA (tRNA)?
 a) cloverleaf b) double helix c) α -helix d) β -pleated sheet e) Straight chain
238. Mononucleotides are the monomers of:
 a) Nucleic acids b) Proteins c) Starch d) Glycogen e) Heparin
239. Which of the following is macroergic compound?
 a) ATP b) NAD^+ c) NADP^+ d) NADH_2 e) cAMP
240. Which of the following is the coenzyme of dehydrogenases?
 a) NAD^+ b) AMP c) ADP d) ATP e) cAMP
241. Coenzyme NAD^+ catalyzes:
 a) Oxidation-reduction processes b) Decarboxylation processes c) Deamination processes
 d) Transamination processes e) Dehydration processes
242. Which of the following processes yields in formation of DNA primary structure?
 a) Polycondensation of mononucleotides b) Polymerization of mononucleotides
 c) Isomerization of mononucleotides d) Hydrolysis of mononucleotides
 e) Phosphorylation of mononucleotides
243. Which of the following gives thymine on hydrolysis?
 a) DNA b) RNA c) Proteins d) Polysaccharides e) Lipids
244. Which of the following gives uracil on hydrolysis?
 a) RNA b) DNA c) Proteins d) Polysaccharides e) Lipids
245. NAD^+ is a derivative of:
 a) Nicotinic acid amide b) Novocainamid c) Ascorbic acid d) Pyridoxal e) Glucopyranose
246. Which of the following is a complementary pair?
 a) Adenine and thymine b) Thymine and uracil c) Adenine and guanine
 d) Thymine and guanine e) Cytosine and adenine
247. Which of the following is a complementary pair?
 a) Cytosine and guanine b) Thymine and uracil c) Adenine and guanine d) Thymine and
 guanine e) Cytosine and adenine
248. Which reaction provides biological function of ATP?
 a) Hydrolysis b) Esterification c) Dehydration d) Transamination e) Decarboxylation
249. Which of the following contains guanine?
 a) DNA and RNA b) DNA c) RNA d) Proteins e) Polysaccharides
250. Which of the following contains adenine?
 a) DNA and RNA b) DNA c) RNA d) Proteins e) Polysaccharides
251. Which of the following contains cytosine?
 a) DNA and RNA b) DNA c) RNA d) Proteins e) Polysaccharides

3.3 Control questions

1. Bioorganic chemistry as a science: definition, subject and tasks, sections, research methods. Significance in the system of higher medical education.
2. Classification of organic compounds according the structure of the carbon radical and the nature of functional groups.
3. Nomenclature of organic compounds: trivial, rational, international. Principles of formation of names of organic compounds according to the IUPAC nomenclature: substitutes, radical-functional.
4. The nature of the chemical bond in organic compounds: hybridization of orbitals, the electronic structure of carbon compounds.
5. Spatial structure of bioorganic compounds: stereochemical formulas; configuration and conformation. Stereoisomers: geometric, optical, rotary (conformers).

6. Optical isomerism; chirality of molecules of organic compounds. D / L- and R / S- stereochemical nomenclatures. Enantiomers and diastereoisomers of bioorganic compounds. Relationship of spatial structure with physiological activity.
7. Types of reactions in bioorganic chemistry: classification by the result (direction) and reaction mechanism. Examples.
8. Carbonyl compounds in bioorganic chemistry. Chemical properties and biomedical significance of aldehydes and ketones.
9. Carboxylic acids in bioorganic chemistry: structure and chemical properties; functional derivatives of carboxylic acids (anhydrides, amides, esters). Decarboxylation reactions.
10. The structure and properties of dicarboxylic acids: oxalic, malonic, succinic, glutaric, fumaric.
11. Lipids: definition, classification. Higher fatty acids: palmitic, stearic, oleic, linoleic, linolenic, arachidonic. Simple lipids. Triacylglycerols (neutral fats): structure, physiological significance, hydrolysis.
12. Complex lipids. Phospholipids: phosphatidic acid, phosphatidylethanolamine, phosphatidylcholine, phosphatidylserine. Sphingolipids. Glycolipids. The role of complex lipids in the construction of biomembranes.
13. Amines: nomenclature, properties. Biomedical significance of biogenic amines (adrenaline, noradrenaline, dopamine, tryptamine, serotonin, histamine) and polyamines (putrescine, cadaverine).
14. Amino alcohols: structure, properties. Biomedical significance of ethanol amine (colamine), choline, acetylcholine.
15. Hydroxy acids in bioorganic chemistry: structure and properties of monocarboxylic (lactic and β -hydroxybutyric), dicarboxylic (malic, tartaric) hydroxy acids.
16. Carbohydrates: definition, classification. Monosaccharides (aldose and ketosis; triose, tetrose, pentose, hexose, heptose), biomedical significance of individual representatives.
17. 76. Monosaccharides: pentoses (ribose, 2-deoxyribose, xylose), hexoses (glucose, galactose, mannose, fructose) - structure, properties. Qualitative reactions to glucose.
18. Structure and properties of monosaccharide derivatives. Amino derivatives: glucosamine, galactosamine. Uronic acids. L-Ascorbic acid (vitamin C). Products of reduction of monosaccharides: sorbitol, mannitol.
19. Oligosaccharides: structure, properties. Disaccharides (sucrose, lactose, maltose), their biomedical value.
20. Polysaccharides. Homopolysaccharides: starch, glycogen, cellulose, dextrans - structure, hydrolysis, biomedical value. Qualitative reaction to starch.
21. Heteropolysaccharides: definition, structure. Structure and biomedical significance of glycosaminoglycans (mucopolysaccharides) - hyaluronic acid, chondroitin sulfates, heparin.
22. Amino acids: structure, stereoisomerism, chemical properties. Biomedical role of L- α -amino acids. Reactions of biochemical transformations of amino acids: deamination, transamination, decarboxylation.
23. Amino acid composition of proteins and peptides; classification of natural L- α -amino acids. Chemical and physicochemical properties of proteinogenic amino acids. Ninhydrin reaction, its importance in the analysis of amino acids.

24. Proteins and peptides: definition, classification, biological functions. Types of bonds between amino acid residues in protein molecules. Peptide bond: formation, structure; biuret reaction.
25. Levels of structural organization of proteins: primary, secondary, tertiary and quaternary structures. Oligoproteins.
26. Physico-chemical properties of proteins; their molecular weight. Deposition methods. Denaturation of proteins.
27. Heterocyclic compounds in bioorganic chemistry: structure, classification, chemical properties and biomedical significance.
28. Five-membered heterocycles with one heteroatom (pyrrole, furan, thiophene). Biomedical role of tetrapyrrole compounds: porphines, porphyrins, heme.
29. Indole and its derivatives: tryptophan and reactions of formation of tryptamine and serotonin; indoxyl, skatol, skatol forces - importance in the processes of putrefaction of proteins in the intestine.
30. Five-membered heterocycles with two nitrogen heteroatoms. Pyrazole, pyrazolone; pyrazolone-5 derivatives as drugs (antipyrine, amidopyrine, analgin). Imidazole and its derivatives: histidine, histamine.
31. Five-membered heterocycles with two different heteroatoms: thiazole, oxazole. Thiazole as a structural component of the thiamine molecule (vitamin B1).
32. Six-membered heterocycles with a nitrogen atom: pyridine. Nicotinamide (vitamin PP) as an integral part of redox pyridine coenzymes. Pyridoxine and molecular forms of vitamin B6.
33. Six-membered heterocycles with two nitrogen atoms. Diazines: pyrimidine, pyrazine, pyridazine. Nitrogen bases are pyrimidine derivatives (uracil, cytosine, thymine).
34. Pyrimidine derivatives as drugs: 5-fluorouracil, potassium orotate. Barbituric acid; barbiturates as hypnotics and antiepileptics (phenobarbital, veronal).
35. Purine and its derivatives. Amino derivatives of purine (adenine, guanine), their tautomeric forms; biochemical significance in the formation of nucleotides and coenzymes.
36. Nucleosides, nucleotides. Nitrogen bases of purine and pyrimidine series, which are part of natural nucleotides. Minor nitrogenous bases.
37. Nucleosides. Nucleotides as phosphorylated derivatives of nucleosides (nucleoside mono-, di- and triphosphates). Nomenclature of nucleosides and nucleotides as components of RNA and DNA.
38. Structure and biochemical functions of free nucleotides: nucleotides-coenzymes; cyclic nucleotides 3', 5'-cAMP and 3', 5'-cGMP.
39. Nucleic acids (deoxyribonucleic, ribonucleic) as polynucleotides. Polarity of polynucleotide strands of DNA and RNA.
40. Structure and properties of DNA; nucleotide composition, complementarity of nitrogenous bases. Primary, secondary and tertiary structure of DNA.
41. RNA: structure, types of RNA and their role in protein biosynthesis.
42. Vitamins: general characteristics; the concept of the coenzyme action of vitamins. Structure and properties of vitamins B1, B2, B6, PP.

3.4. Individual tasks

Individual work is estimated by additional points—up to 5 points and includes.

1) participation in students' conference «Chemistry. Ecology. Medicine»:

.thesis preparation – 2 points;

.thesis preparation and report presentation – 5 points;
 .encouragement award («The best presentation», «Declamation prize», «For connection with chemistry» etc.) – additionally 1 point.

2) creation schemes and educational tables:

1 black-white table – 1 points;

1 colored table – 2 points

3) participation in department and out-of-department events (conferences, congresses etc.) – up to 5 points.

3.5 Grade challenge

If student is not satisfied with his/her mark, he/she can ask his/her teacher about criteria. If teacher's explanation do not satisfy him/her student has a right to ask dean office for permission to pass discipline again. In case if dean office agrees department sets up a commission. On the commission are head of department and two teachers, Make-up examination is allowed only one time.

4. POLICY OF DISCIPLINE

Teachers of medical and bioorganic chemistry set up a claims and rules to the students:

- All tasks covered by program must be done at a started time.
- Students must pass incoming and outgoing control, solve tasks, study theoretical questions, understand interdisciplinary integrations, master practical skills.
- If student is absent due to excusable reason, he/she shows done home-work and answer teacher's questions.
- During the class students must wear lab-coat and hair cover.

5.0 ACADEMIC HONESTY

Academic honesty should not be infringed at the carrying out of scientific projects and tasks.

- Presentations and reports must be original.
- Copying off, using of different software applications, mobile phones, tablet computers or other electronic gadgets is prohibited.
- Not be permitted to enter the class after lesson began.

When organizing the educational process, students and teachers act in accordance with:

- The Decree of KhNMU about the organization of educational process;
- The Decree of KhNMU about the criteria and rules of estimation;
- The Codex of Academic honesty of KhNMU.

For applicants for higher education and other persons involved in the educational process is **worthy**:

1. Respect the honor and dignity of others, even if their views are different from yours.
2. Responsible for their responsibilities, timely and conscientiously perform the tasks provided by the curriculum.
3. Actively work independently, using manuals, recommendations of teachers, additionally developing new literature, using all opportunities to obtain the necessary knowledge.
4. Effectively allocate time to search and study the materials needed to obtain education of high quality.

5. Honestly and responsibly prepare for the current, final control, making efforts to perform all tasks in time.
6. Use only referenced and reliable sources of information in educational or research activities and refer to them.
7. Submit for evaluation only self-performed work that is not borrowed or processed from another, performed by third parties.
8. In case of difficulties in performing educational or research tasks, turn to others for help that is within acceptable limits, etc.

6.0 RECOMMENDED LITERATURE

Basic

1. Biological and Bioorganic Chemistry : textbook : in 2 books. Book 1. Bioorganic Chemistry / B.S. Zimenkovsky, V.A. Muzychenko, I.V Nizhenkovska, G.O. Syrova ; edited by B.S. Zimenkovsky, I.V Nizhenkovska. — 3rd edition. — Kyiv : AUS Medicine Publishing, 2020. — 288 p.
2. Fundamentals of bioorganic chemistry: manual / A.O.Syrovaya, E.R.Grabovetskaya, V.N.Petiunina. – Kharkiv, KhNMU. – 2016. – p.
3. Biologically important classes of bioorganic compounds. Biopolymers and their structural components : workbook for self-work of first year students of medical and dentistry faculties / draftsmen: G. O. Syrovaya, V. M. Petunina, T. S. Tishakova, S. M. Kozub, V. O. Makarov. – Kharkiv : KhNMU, 2018. – 60 p.

Additional

1. Fundamentals of bioorganic chemistry : textbook / S. E. Zurabyan. — 3rd edition. – Moscow, 2021. – 304 p.

7. INFORMATION RESOURCE

1. <http://www.knmu.kharkov.ua/>
2. <http://distance.knmu.edu.ua/my/>

8. OTHER INFORMATION

There is a museum on the department of medical and bioorganic chemistry that was created by the 205-th anniversary of Kharkiv National Medical University and 55-th anniversary of medical and bioorganic chemistry department. Here you can find:

- 1) Collection of minerals.
- 2) Collection of laboratory glassware.
- 3) Collection of students' research papers, who took part in students' conference in university and outside the KNMU.
- 4) Students' posters.
- 5) Exhibits of students' exhibition that was carried out on the medical and bioorganic chemistry department.
- 6) Literature in discipline "Medical chemistry".
- 7) Photocollage "History of the development of medical and bioorganic chemistry department".

All these materials can be used at the students' preparation for participation in students' scientific conferences that is very important for first-year students.