

MINISTRY OF HEALTH OF UKRAINE
KHARKIV NATIONAL MEDICAL UNIVERSITY

Medical and bioorganic chemistry department
Academic year 2021-2022

SYLLABUS OF EDUCATIONAL COMPONENT

“Medical and 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 223 «Nursing» first (bachelor's) level

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

Syllabus of educational component was approved on the meeting of medical and bioorganic chemistry department

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

Protocol dated
28th of October 2021 No 24

Protocol dated
10th of November 2021 No 2

Head of the department


(signature) prof. Syrova G.O.
(name)

Chief


(signature) prof. Vovk O.Yu.
(name)

WRITERS:

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3. Savelieva O.V., as. prof., PhD of pharmacy.
4. Levashova O.L., as. prof., PhD of pharmacy.

INFORMATION ABOUT THE TEACHERS TEACHING THE EDUCATIONAL COMPONENT

Syrova Ganna Olegivna, doctor of pharmaceutical science, professor,
<http://distance.knmu.edu.ua/user/view.php?id=930&course=2948>

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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Lukyanova Larysa Volodymyrivna, PhD of pharmacy, ass. professor,

Professional interests:

- 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 roflicoxib), licopid and caffeine on central nervous system – on mnesic activity in rats at the conditions of formalin edema.

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- Chemical technology;
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Tishakova Tetyana Stanislavivna, PhD of chemistry, ass. Professor

Professional interests:

- Biochemical investigations of new pharmaceutical compositions containing caffeine, nonsteroidal anti-inflammatory drugs;
- problems of adaptation of foreign students while studying at a medical university.

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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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Savelieva Olena Valeriivna, PhD of pharmacy, senior teacher

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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Zavada Oksana Oleksandrivna, PhD of pharmacy, assistant

Professional interests:

- introduction of quality management standards in clinical diagnostic laboratories;

- study of ways to enhance the analgesic activity of the peripheral genesis of meloxicam

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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 “Medical and bioorganic chemistry” is prepared according the Educational and professional program “Nursing care” and Higher Education Standard (hereafter – Standard), first (bachelor’s) level, field of education 22 “Health Care”, specialty 223 “Nursing”.

Educational subject description (abstract)

Subject matter of Medical and bioorganic chemistry is chemical fundamentals of life processes which keep in with the main chemical laws. Medical and bioorganic chemistry studies structure and reactivity of the most important biologically active molecules, metabolic processes, molecular basis of functioning vital organisms under normal and pathological conditions. It studies processes which take place on the molecular and submolecular levels because this is can be reason of different diseases and specificity of hereditary features.

Interdisciplinary links: Medical and bioorganic chemistry is based on the studying of bioorganic chemistry, biophysics, medical biology by students and it is integrated with other disciplines; this subject forms the basis for studying of physiology, pathologic physiology, biologic chemistry, general and molecular pharmacology and toxicology, hygienic disciplines and ecology.

Prerequisite of discipline: The study of the discipline “Medical and 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 medical and 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=2938>

1. OBJECT AND PURPOSE OF ACADEMIC DISCIPLINE

1.1. The object of studying Medical and bioorganic chemistry is a preparation of medical student, assistance in obtaining knowledge necessary to understand functions of certain body systems, 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.

1.2. Key tasks of studying discipline “Medical and bioorganic chemistry” are support of scientific approach to the solution of problems, appearing during the study of normal and pathological processes in the human body, creation of basis for learning biochemistry, pharmacology, toxicology and other general and social disciplines.

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 physic-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 physic-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 learning outcomes**:

PLO 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).

PLO 4 Conduct training of junior medical staff on the performance of functional duties and labor protection; monitor compliance with safety rules by junior medical staff.

PLO 10 Perform the simplest methods of physiotherapy. Disease.

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 – 4.5	Field of education 22 Health Care	Compulsory daytime	
Total quantity of hours – 135	Specialty: 223 Nursing	Year of study:	
		1-st	
		Semester	
		1-st	-
		Lectures	
Hours for full-time education: in-class – 76 student's self-work – 59	Educational and qualification level: first (bachelor's) level	30 h	-
		Practicals, seminars	
		46 h	-
		Self-work	
		59 h	-
Type of control: graded test			

2.1 Description of discipline

2.1.1 Lectures

№	Subject	Hours
1	Complex formation in biological systems. Fundamentals of chelation therapy.	2
2	Acid-base equilibria in biosystems.	2
3	Buffer systems of the organism	2
4	Fundamentals of bioenergetics.	2
5	Kinetics of biochemical processes	2
6	Electrode processes and their biological role in stomatology	2
7	Microheterogeneous systems. Colloidal solutions. Coarsely dispersed systems	2
8	Physico-chemical properties of biopolymer solutions.	2
9	Bioorganic chemistry as a science. Classification, structure and reactivity of bioorganic compounds.	2
10	Structure, properties and biological significance of functional derivatives of carboxylic acids (hydroxy-, keto- and phenolic acids).	2
11	Classification, structure and chemical properties of carbohydrates	2
12	Structure and chemical properties of carboxylic acids. Lipids.	2
13	α -amino acids, peptides, proteins.	2
14	Classification, structure and significance of biologically important heterocyclic compounds.	2
15	Structure and biochemical functions of nucleosides, nucleotides and nucleic	2

	acids. Structure and biochemical functions of DNA. Differences in the structure, location and functions of RNA and DNA.	
	Total:	30

2.1.2 Laboratorial-practical classes

№	Subject	Number of hours
1.	Complex formation in biological systems.	2
2.	Values characterizing quantitative composition of solutions. Preparation of solutions.	2
3.	Colligative properties of solutions.	2
4.	Acid-base equilibrium in the organism. pH of biological liquids.	2
5.	Buffer solutions, classification and properties. Buffer systems of human body.	2
6.	Fundamentals of titrimetric analysis.	2
7.	Heat effects of chemical reactions. The direction of the processes.	2
8.	Kinetics of biochemical reactions and catalysis.	2
9.	Chemical equilibrium. The solubility product.	2
10.	Electrode potentials and mechanism of their origin.	2
11.	Sorption of bioactive substances at the interface.	2
12.	Preparation and properties of colloidal solutions.	2
13.	Coagulation of colloidal solutions. Colloidal protection.	2
14.	Properties of biopolymers solutions. Isoelectric point of protein.	2
15.	Classification, nomenclature and isomerism of bioorganic compounds. Mutual influence of atoms in bioorganic compounds.	2
16.	Classification of chemical reactions. Reactivity of bioorganic compounds.	2
17.	Structure, properties and biological role of functional derivatives of carboxylic acids (hydroxyacids, keto acids, and phenolic acids). Structure and properties of aldehydes and ketones.	2
18.	Amino acid composition of proteins and peptides. Structural organisation of proteins. Denaturation.	2
19.	Carbohydrates: monosaccharaides. Structure and functions of di- and polysaccharides.	2
20.	Higher fatty acids. Lipids. Phospholipids.	2
21.	Classification, structure and role of biologically important heterocycles.	2
22.	Structure and biochemical functions of nucleosides, nucleotides, and nucleic acids. Structure and biochemical functions of DNA. Differences in structure, functions of RNA and DNA.	2
23.	Graded test	2
Total hours		46

2.2.3 Self-work

№	subject	hours
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1.	Preparation for practical classes. Master skills of solutions' preparation	10
2.	Preparation for practical classes. Master the ability to interpret principles and explain the mechanisms of physicochemical processes occurring in solutions and at the interphase. Analyse the relationship between the mention above processes (phenomena). their biological significance and use in practical medicine, explain the principles of certain methods of quantitative determination of biologically active substances.	10
3.	Classification of chemical reactions.	10
4.	Theoretical aspects of bioorganic chemistry. The main classes of biological compounds.	10
5.	Structure and biological functions of heterocyclic compounds, alkaloids, nucleosides, nucleotides and nucleic acids.	10
6.	Preparation for <i>Graded Test</i>	9
Total:		59

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.

Objective control is used in all practical classes for the control of sel-work, theoretical knowledge and the mastering of practical skills.

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 45 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 carried out on the last practical class according to the time table. Graded Test consists of two levels: 1 level is 45 multiple choice questions (open database) and 2 level to check practical skills in the form of 3 tasks (closed database). 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 30 questions out of 45. More than 30 correct answers are evaluated by the following manner:

Number of correct answers	Points
31 – 35	51
36 – 40	52
41-45	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). 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)

- Which element is needed for thyroxine (thyroid gland hormone) synthesis?
a) iodine; b) sulfur; c) potassium; d) calcium; e) carbon
- Which of the following belongs to s-block elements?
a) Na; b) Cl; c) Fe; d) C; e) S
- Which element is involved in a macroergic bond formation?
a) Phosphorus b) Calcium c) Sodium d) Iron e) Chlorine
- What is the content of oxygen in the ambient air?
a) 21% b) 1% c) 11% d) 0.1% e) 31%
- Which of the following forms strong covalent bond?
a) carbon b) iron c) chlorine d) sodium e) copper
- Which biologically-active substances do not contain nitrogen?
a) starch b) proteins c) nucleic acids d) lipids
- Which of the following elements of II group main subgroup has maximal radius of hydrated ion?
a) Magnesium b) Calcium c) Strontium d) Barium e) Radium
- Sulfur is in composition of:
a) Vitamin B₁; b) Vitamin B₆; c) Vitamin A; d) Vitamin PP; e) Vitamin C
- Which element in excess results in fluorosis?
a) F, b) Cl, c) Fe, d) Ca, e) P
- Which of the following is in composition of chlorophyll?
a) Magnesium, b) Zinc, c) Molybdenum, d) Chromium, e) Iron
- Which of the following elements of I group main subgroup has maximal radius of hydrated ion?
a) Lithium b) Potassium c) Sodium d) Cesium e) Rubidium
- In hemoglobin the coordination number of iron is:
a) 6; b)3; c)4; d)2; e)8
- In the complexes $[\text{Fe}(\text{CN})_6]^{3-}$ and $[\text{Cr}(\text{C}_2\text{O}_4)_3]^{3-}$, the respective coordination numbers of iron and chromium are
a) 6 and 6; b) 6 and 3; c)3 and 3; d)3 and 6; e) 6 and 4
- Which of the following is a main component of bone tissue?
a) $\text{Ca}_5(\text{PO}_4)_3\text{OH}$ b) $\text{Ba}_3(\text{PO}_4)_3\text{OH}$ c) NaCl d) $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ e) $\text{BaSO}_4 \cdot 2\text{H}_2\text{O}$
- Which element enters the composition of all organic compounds?
a) carbon; b) oxygen; c) nitrogen; d) sulfur; e) phosphorus

16. What is the oxidation state of iron in hemoglobin?
a) +2, b)+3, c)+4, d)+5, e) +6
17. Vitamin B₁₂ contains:
a) cobalt; b) iron; c) nickel; d) copper; e) chromium
18. How many valence electrons are in chlorine atom?
a) 7; b) 2; c) 5; d) 3; e) 1.
19. The content of macrominerals in the human organism is more than 10⁻²⁰%. Which of the following is not a macromineral?
a) Iron b) Oxygen c) Potassium d) Magnesium e) Chlorine
20. What is the coordination number of cobalt in [Co(NH₃)₆]Cl₃?
a) 6; b)5; c)4; d)3; e)2
21. Compounds containing biogenic d-elements in the organism belong to:
a) complex compounds b) bases c) acids d) oxides e) simple compounds
22. The oxidation state of Cr in [Cr(H₂O)(NH₃)₄]Cl is
a)+2; b)+3; c)+4; d)+5; e)+6
23. The IUPAC name of [Cu(NH₃)₄]SO₄ is:
a)tetraammincopper(II) sulfate b) tetraammincopper (II) hydrosulfate
c) amminecopper sulfate d) tetraamminecuprum hydrosulfate
24. The oxidation state of Fe in [Fe(H₂O)₅NO]SO₄ is
a)+2; b)+3; c)+4; d)+5; e)+6
25. Which of the following ions is the least stable?
a) $K_{inst}([Ag(NO_2)_2]^-) = 1.3 \cdot 10^{-3}$ b) $K_{inst}([Ag(NH_3)_2]^+) = 6.8 \cdot 10^{-8}$
c) $K_{inst}([Ag(S_2O_3)_2]^{3-}) = 1.0 \cdot 10^{-13}$ d) $K_{inst}([Ag(CN)_2]^-) = 1.0 \cdot 10^{-21}$
26. Which of the following is cationic complex?
a) [Ni(H₂O)₆]Cl₂ b) K₂[Zn(OH)₄] c) [PtNH₃Br₅] d) [Pt(NH₃)₂Cl₄]
27. The IUPAC name of [Ni(CO)₄] is:
a) tetracarbonylnickel(0); b)tetracarbonylnickel(II);
c) tetracarbonylnickelate(II); d) tetracarbonylnickel(IV);e) tetracarbonylnickelate(0)
28. Coordination number is referred to:
a) complexing agent b) ligand c) complex ion d) anion e) neutral molecule
29. Which if the following is bidentate ligand?
a) SO₄²⁻ b)H₂O; c)NO₂; d) F⁻; e) Cl⁻
30. Which of the following is bidentate ligand?
a) C₂O₄²⁻ b)H₂O; c)NH₃; d) CN⁻; e) EDTA
31. The solubility of gases:
a) decreases with the rise of temperature; b) increases with the rise of temperature; c) does not depend on temperature; d) decreases with the rise of pressure; e) does not depend on pressure
32. What is Mole fraction?
a) ratio of the number of moles of a substance to the total number of moles of all substances in the solution
b) ratio between quantity of substance dissolved and the mass of solution
c) number of moles of dissolved substance per volume unity
33. One kilogram of water contains 4g of NaOH. The concentration of the solution is best expressed as:
a) 0.1molal; b) 0.1molar; c) decinormal; d) about 0.1 mole; e)4%
34. Equivalence factor in red-ox reaction depends on:
a) number of electrons participating in oxidation-reduction process
b) number of water molecules formed
c) number of hydrogen protons participating in oxidation-reduction process
d) number of molecules participating in oxidation-reduction process
35. 0.9% NaCl solution contains

- a) 0.9g of NaCl in 100 g of solution b) 0.9g of NaCl in 1L of solution
 c) 9 moles of NaCl in 1L of solution d) 9 g of NaCl in 100g of water
36. Which of the following means “molality”?
 a) ratio between quantity of substance dissolved and the mass of solvent
 b) ratio between quantity of substance dissolved and the mass of solution
 c) ratio between quantity of substance dissolved and the volume of solution
 d) ratio between quantity of substance dissolved and the volume of solvent
37. What are units for molar concentration of the equivalent?
 a) mol/L b) % c) mol/kg d) g/L e) mol/kg of solvent
38. What is the mass percent of solution containing 10g of ascorbic acid in 190g of water?
 a) 5% b) 10% c) 19% d) 20%
39. What is the equivalence factor and molar mass of equivalent of HCl?
 a) $f=1$, $M(E)=36,5$ g/mol; b) $f=3$, $M(E)=32.7$ g/mol; c) $f=2$, $M(E)=36,5$ g/mol;
 d) $f=2$, $M(E)=49$ g/mol; e) $f=2$, $M(E)=98$ g/mol;
40. What is the molar mass of the equivalent and equivalence factor for NaCl?
 a) $M(E)=58.5$ g/mol, $f=1$ b) $M(E)=49.5$ g/mol, $f=3$ c) $M(E)=81$ g/mol, $f=4$
 d) $M(E)=55.5$ g/mol, $f=2$
41. Which formula can be used for molar mass of equivalent calculation?
 a) $M(E) = f \cdot M(X)$ b) $M(E) = V \cdot C$; c) $M(E) = \omega \cdot C$; d) $M(E) = f \cdot V \cdot C$; e) $M(E) = f \cdot M(X) \cdot C$
42. The number of moles of NaCl in 3 litres of 3 M solution is
 a) 9 b) 1 c) 3 d) 18 e) 27
43. 5% glucose solution contains
 a) 5g of glucose in 100 g of solution
 b) 5g of glucose in 1L of solution
 c) 5 moles of glucose in 1L of solution
 d) 5 g of glucose in 100g of water
44. Which parameter is common for both molarity and molality?
 a) quantity of solute b) mass of solution c) volume of solution d) mass of solvent
45. The titer is
 a) a number of grams of solute per 1ml of solution;
 b) a number of grams of solute per 1L of solution;
 c) a number of moles of solute per 1L of solvent;
 d) a number of moles of solute per 1L of solution;
 e) a number of grams of solute per 1ml of solvent;
46. How to calculate the mass of substance needed to prepare solution with given molarity?
 a) $m=C \cdot V \cdot M$; b) $m=C \cdot V \cdot d$; c) $m=C \cdot V$; d) $m=C \cdot M$; e) $m=C \cdot \omega \cdot d$;
47. What are the molar mass of equivalent and equivalence factor for oxalic acid dihydrate ($H_2C_2O_4 \cdot 2H_2O$)?
 a) $M(E)=63$ g/mol; $f=\frac{1}{2}$; b) $M(E)=90$ g/mol; $f=\frac{1}{4}$; c) $M(E)=45$ g/mol; $f=\frac{1}{6}$;
 d) $M(E)=63$ g/mol; $f=\frac{1}{4}$; e) $M(E)=126$ g/mol; $f=\frac{1}{2}$
48. Which one is the measure of medium active acidity
 a) pH b) C_α c) pK_b d) K_{diss} e) pK_a
49. How to calculate pH in KOH solution?
 a) $pH=14+\lg C_{base}$ b) $pH=14-\lg C_{base} \cdot \alpha$ c) $pH=-\lg[H^+]$ d) $pH=-\lg C_{base} \cdot \alpha$
50. What is the pH of a 0.1M solution of the strong acid HCl?
 a) $pH=1.0$; b) $pH=0.1$; c) $pH=0$; d) $pH=7$; e) $pH=14$
51. Which of the following can be used for alkalosis treatment?
 a) ascorbic acid b) NaCl c) $NaHCO_3$ d) glucose
52. Which of the following is correct expression for water electrolytic dissociation at 25°C?

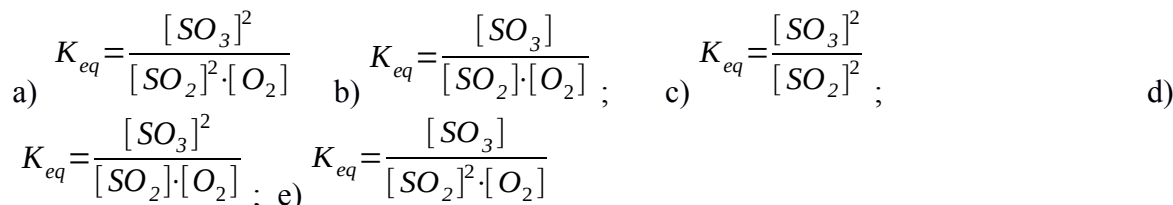
- a) $[H^+] = [OH^-] = 10^{-7} \text{ mol/L}$ b) $[H^+] + [OH^-] = 10^{-7} \text{ mol/L}$ c) $[H^+] / [OH^-] = 10^{-7} \text{ mol/l}$
53. Which of the following is interval of possible variations of blood pH?
a) 7.35-7.45; b) 7.15-7.24; c) 7.25-7.56; d) 7.24-7.48; e) 7.20-7.58
54. Alkalosis is a pathological condition which develops when:
a) blood pH increase more than 7.45 b) blood pH drops below 7.45
c) blood pH increases more than 7.35 d) blood pH drops below 7.35
55. Acidosis is a pathological condition which develops when:
a) blood pH drops below 7.35 b) blood pH drops below 7.45
c) blood pH increases more than 7.35 d) blood pH increase more than 7.45
56. Which sample of gastric juice has hypo acidity if pH is:
a) >3 ; b) 1-3; c) 3-4; d) <1 ; e) about 6
57. Which of the following is correct for the basic medium?
a) $\text{pH} > 7$; $[H^+] < 10^{-7}$ b) $\text{pH} < 10$; $[OH^-] < 10^{-7}$ c) $\text{pH} = 7$; $[H^+] = 10^{-7}$
d) $\text{pH} > 3$; $[OH^-] = 10^{-7}$ e) $\text{pH} < 7$; $[H^+] > 10^{-7}$
58. What is the normal pH value of blood?
a) 7.36; b) 7.26; c) 7.16; d) 7.46; e) 7.56
59. What is the value of zero acidity of gastric juice?
a) $\text{pH} = 6$; b) $\text{pH} = 2$; c) $\text{pH} = 0$; d) $\text{pH} = 7$; e) $\text{pH} = 9$
60. How to calculate pH in NH_4OH solution?
a) $\text{pH} = 14 + \lg C_{\text{base}} \cdot \alpha$; b) $\text{pH} = -\lg[H^+]$ c) $\text{pH} = 14 + \lg C_{\text{base}}$ d) $\text{pH} = -\lg C_{\text{base}} \cdot \alpha$
61. What is the normal pH value of saliva?
a) 6.75; b) 5.75; c) 6.25; d) 5.65; e) 7.65
62. What is acidosis?
a) drop of blood pH; b) increase of blood pH; c) drop of gastric juice pH; d) increase of gastric juice pH; e) none of these
63. Which of the following can be used for acidosis treatment?
a) NaHCO_3 b) HCl c) glucose d) NaCl
64. What is the pH of a 1M solution of the strong base NaOH ?
a) $\text{pH} = 14$; b) $\text{pH} = 0.1$; c) $\text{pH} = 1.0$; d) $\text{pH} = 7$; e) $\text{pH} = 0$;
65. Which solution has higher value of pH when molar concentrations are equal?
a) NaOH b) CH_3COOH c) NH_4OH d) HCl e) $\text{Fe}(\text{OH})_3$
66. How to calculate hydrogen ions concentration using pH?
a) $[H^+] = 10^{-\text{pH}}$ b) $[H^+] = 10 \cdot \lg C \alpha$ c) $[H^+] = 10^{-7} \cdot \lg C \alpha$ d) $[H^+] = 10^{-7} \cdot \ln C \alpha$ e) $[H^+] = 10^{C \alpha}$
67. What is the normal pH value of gastric juice?
a) 1.55; b) 1.25; c) 1.35; d) 1.0; e) 4.0
68. What is alkalosis?
a) increase of blood pH; b) drop of blood pH; c) drop of gastric juice pH;
d) increase of gastric juice pH; e) none of these
69. What is the pOH of a 1M solution of the strong base NaOH ?
a) $\text{pOH} = 0$; b) $\text{pOH} = 0.1$; c) $\text{pOH} = 1.0$; d) $\text{pOH} = 7$; e) $\text{pOH} = 14$
70. Which of the following is more acidic?
a) $\text{pH} = 1$ b) $\text{pH} = 5$ c) $\text{pH} = 3$ d) $\text{pH} = 7$ e) $\text{pH} = 11$
71. How to calculate pH in HCl solution?
a) $\text{pH} = -\lg C_{\text{acid}}$ b) $\text{pH} = 14 - \lg C_{\text{acid}}$ c) $\text{pH} = -\lg C_{\text{acid}} \cdot \alpha$ d) $\text{pH} = \lg C_{\text{acid}} \cdot \alpha$
72. Which pH value corresponds to the maximum buffer capacity of phosphate buffer solution ($\text{pK}_{\text{NaH}_2\text{PO}_4} = 6.8$)?
a) 6.8; b) 3.75; c) 4.75; d) 5; e) 7.35
73. Which of the given below is the buffer system?
a) $\text{CH}_3\text{COOH} + \text{CH}_3\text{COOLi}$ b) $\text{NaOH} + \text{NaHS}$ c) $\text{CH}_3\text{COOH} + \text{CH}_3\text{COONH}_4$
d) $\text{NH}_4\text{OH} + \text{NH}_4\text{HCO}_3$ e) $\text{HNO}_3 + \text{NH}_4\text{NO}_3$
74. Buffer capacity is:

- a) number of mol of a strong acid or a strong base which should be added to 1L of buffer solution in order to change its pH for 1; b) number of ml of a strong acid which should be added to 1L of buffer solution in order to change its pH for 1; c) number of ml of a strong base which should be added to 1L of buffer solution in order to change its pH for 1; d) number of mmol of acetic acid which should be added to 1L of buffer solution in order to change its pH for 1; e) number of mmol of ammonium hydroxide which should be added to 1L of buffer solution in order to change its pH for 1
75. Isoelectric point of amino acid is the pH at which:
- a) numbers of NH_3^+ and COO^- - groups are equal; b) number of NH_3^+ groups is greater than that of COO^- - groups; c) number of NH_3^+ groups is less than that of COO^- - groups; d) number of H^+ is greater than that of OH^- ; e) number of H^+ is less than that of OH^- ;
76. Which reaction takes place if a strong acid is added to phosphate buffer?
- a) $H^+ + HPO_4^{2-} \rightleftharpoons H_2PO_4^-$
 b) $HPO_4^{2-} + HOH \rightleftharpoons H_2PO_4^- + OH^-$
 c) $H_2PO_4^- + OH^- \rightleftharpoons HPO_4^{2-} + H_2O$
 d) $CH_3COO^- + H^+ \rightleftharpoons CH_3COOH$
 e) $HPO_4^{2-} \rightleftharpoons H^+ + PO_4^{3-}$
77. Acetic buffers contain 100ml of the acid solution and 100ml of the salt solution taken in the following concentrations:
- a) 0,1 mol/L of acid and 0,1 mol/L of salt; b) 0,02 mol/L of acid and 0,1 mol/L of salt; c) 0,01 mol/L of acid and 0,1 mol/L of salt; d) 0,01 mol/L of acid and 0,02 mol/L of salt; e) 0,02 mol/L of acid and 0,02 mol/L of salt
78. Which reaction occurs when limited amount of alkali is added to phosphate buffer solution?
- a) $OH^- + H_2PO_4^- \leftrightarrow HPO_4^{2-} + H_2O$; b) $H^+ + HPO_4^{2-} \leftrightarrow H_2PO_4^-$;
 c) $CH_3COOH + OH^- \leftrightarrow CH_3COO^- + H_2O$; d) $NH_4^+ + OH^- \leftrightarrow NH_4OH$
 e) $CH_3COO^- + H^+ \leftrightarrow CH_3COOH$
79. According to Raoult's law the vapor pressure of solvent above the solution is
- a) proportional to the mole fraction of solvent
 b) proportional to the mole fraction of solute
 c) does not depend on the presence of solute
 d) proportional to the molar concentration of solute
 e) proportional to the mass percent of solute
80. How many times the depression in freezing point in $CaCl_2$ solution is more than that in sucrose solution if molal concentrations are equal and electrolyte is completely dissociated?
- a) 3 times b) same c) 4 times d) 5 times
81. Hemolysis takes place when the erythrocyte is placed in:
- a) hypotonic solutions; b) hypertonic solutions; c) 5% glucose solution; d) isotonic solutions; e) 0.9% sodium chloride solution
82. What is osmotic pressure of blood?
- a) 700-800kPa b) 600-700 kPa c) 500-600kPa d) 800-900kPa e) 900-950kPa
83. What is the value of oncotic pressure?
- a) 3.5-3.9 kPa b) 2.9-3.5 kPa c) 4-4.5 kPa d) 5-5.5 kPa e) 5.5-5.9 kPa
84. Which of the following is not a colligative property?

- a) Solubility; b) Elevation in boiling point; c) Depression in freezing point; d) Relative lowering in vapour pressure; e) Osmotic pressure
85. The boiling point of a solvent containing a non-volatile solute:
a) is elevated; b) is depressed; c) does not change; d) does not depend on the presence of non-volatile solute; e) none of the above
86. Which way of expression of solution concentration is used for depression in freezing point calculation?
a) molal concentration b) molar concentration c) mass percent d) mol fraction e) molar concentration of the equivalent
87. Hemolysis is due to:
a) movement of water molecules inside the cell
b) movement of water molecules outside the cell
c) movement of intracellular ions outside the cell
d) movement of extracellular ions inside the cell
e) two-sided movement of water molecules
88. Plasmolysis is due to:
a) movement of water molecules outside the cell
b) movement of intracellular ions outside the cell
c) movement of water molecules inside the cell
d) movement of extracellular ions inside the cell
e) two-sided movement of water molecules
89. The colligative properties of solution depend on:
a) the number of particles of solute; b) the nature of the solvent;
c) the nature of the solute; d) the number of particles of solvent;
e) the quantity of solution
90. What would happen to erythrocyte when placed in 0.7% NaCl?
a) hemolysis b) nothing c) plasmolysis d) the state of cell does not depend on solution concentration
91. What would happen to erythrocyte when placed in water?
a) hemolysis b) plasmolysis c) nothing d) the state of cell does not depend on solution
92. A colligative property is:
a) osmotic pressure; b) boiling point; c) freezing point; d) vapour pressure; e) electrical conductivity
93. There are two solutions of equal molar concentrations: 1) true solution of calcium chloride; 2) colloidal solution of calcium phosphate. Which of these has higher osmotic pressure?
a) 1; b) 2; c) osmotic pressures are equal
94. Plasmolysis takes place when the cell is placed in:
a) hypertonic solutions; b) hypotonic solutions; c) 5% glucose solution;
d) isotonic solutions; e) distilled water
95. What is the percent by mass of NaCl in solution which is isotonic regarding blood?
a) 0,85-0,9% b) 0,75-0,8% c) 0,8-0,85% d) 0,7-0,75% e) 1-1,2%
96. What is the percent by mass of glucose in solution which is isotonic regarding blood?
a) 4.5-5% b) 3-3.5% c) 0,5-0,75% d) 0,85-0,9% e) 5.5-6.0%
97. Which statement about the standardized solution is true?
a) it's concentration is determined according to standard solution; b) it is made from standard substance; c) it is prepared from analyzed substance; d) it is a solution with the prepared titer; e) it's concentration is determined according to another standardized solution
98. Which of the following reactions is the basis of neutralization method?
a) $\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$; b) $\text{CuCl}_2 + \text{Na}_2\text{CO}_3 \rightarrow \text{CuCO}_3 + 2\text{NaCl}$;
c) $\text{CaCl}_2 + \text{Cu}(\text{OH})_2 \rightarrow \text{Ca}(\text{OH})_2 + \text{CuCl}_2$; d) $\text{NH}_3(\text{g}) + \text{HCl} \rightarrow \text{NH}_4\text{Cl}$;
e) $2\text{H}_2\text{O} + 2\text{Cl}_2(\text{g}) \rightarrow 4\text{HCl}(\text{g}) + \text{O}_2(\text{g})$

99. Which of the following means “titer of solution”?
- ratio between mass of a substance dissolved and the volume of solution
 - ratio between mass of a substance dissolved and the mass of solution
 - ratio between quantity of a substance dissolved and the volume of solution
 - ratio between mass of a substance dissolved and the volume of solvent
100. Which of the substances below can be used for standard solution preparation?
- $\text{H}_2\text{C}_2\text{O}_4 \cdot 2 \text{H}_2\text{O}$; b) NaOH ; c) KMnO_4 ; d) H_2SO_4 ; e) H_2O_2
101. Which of the following is correct expression of law of equivalents?
- $C(E)_a \cdot V_a = C(E)_b \cdot V_b$; b) $C(E)_a \cdot V_a = C(E)_b \cdot T$; c) $C(E)_a \cdot T = C(E)_b \cdot V_b$; d) $C_a \cdot V_a = C_b \cdot V_b$;
 - $C(E)_a \cdot m_a = C(E)_b \cdot V_b$;
102. Which indicator can be used in case of titration of a weak acid with a strong base?
- phenolphthalein b) methyl orange c) thymol blue d) methyl red
103. Which indicator can be used in case of titration of a weak base with a strong acid?
- methyl orange b) thymol blue c) phenolphthalein d) methyl red
104. Which formula can be used for HCl concentration according to the titration data?
- $C(E)_a \cdot V_a = C(E)_b \cdot V_b$; b) $C(E)_a \cdot V_a = C(E)_b \cdot T$; c) $C(E)_a \cdot T = C(E)_b \cdot V_b$; d) $C_a \cdot V_a = C_b \cdot V_b$;
 - $C(E)_a \cdot m_a = C(E)_b \cdot V_b$;
105. Which of the following is operating solution for gastric juice acidity determination?
- sodium hydroxide solution; b) oxalic acid solution; c) sulfuric acid solution; d) hydrochloric acid solution; e) any standard solution
106. Which substance can be used for NaOH solution standardization?
- $\text{H}_2\text{C}_2\text{O}_4 \cdot 2 \text{H}_2\text{O}$; b) H_2SO_4 ; c) $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10 \text{H}_2\text{O}$; d) H_2O_2 ; e) Na_2CO_3
107. In which case during titration the equivalence point is at pH=7?
- strong acid+strong base; b) strong acid+weak base; c) weak acid+ strong base; d) strong base+weak acid; e) weak acid +weak base
108. What is normal total acidity of gastric juice expressed in clinical units?
- 40-60; b) 70-72; c) 25-38; d) 68-70; e) 15-25
109. If weak acid is titrated with strong base what is pH in the equivalence point?
- pH>7 (basic); b) pH<7 (acidic); c) pH=7 (neutral); d) pH=0; e) pH=14
110. If weak base is titrated with strong acid what is pH in the equivalence point?
- pH<7 (acidic); b) pH>7 (basic); c) pH=7 (neutral); d) pH=0; e) pH=14
111. What is normal actual acidity of gastric juice expressed in clinical units?
- 20-40; b) 5-10; c) 42-45; d) 45-50; e) 15-25
112. In which case the titration jump is the greatest?
- titration of a strong acid with a strong base; b) titration of a strong acid with a weak base;
 - titration of a weak acid with a strong base; d) titration of a strong base with a weak acid; e) titration of a weak acid with a weak base;
113. What are the limits of titration jump in case of titration of a strong acid with a strong base?
- pH=4.3-9.7; b) pH=1.5-2.5; c) pH=1-1.5; d) pH=11-12.5; e) pH=12-13.5
114. A system which can exchange mass as well as energy with its surroundings is said to be a/an
- open system; b) closed system; c) isolated system; d) inert system; e) none of these
115. For a spontaneous reaction, ΔG should be:
- negative b) equal to zero; c) equal to unity ; d) positive; e) positive or negative;
116. Which of the following is the parameter of a system?
- concentration b) rate of reaction c) time d) catalyst
117. The mechanism of energetic coupling is based on participating of
- phosphate-ion b) sulfate-ion c) carbonate-ion d) chloride-ion
118. Enthalpy is:
- function characterizing the heat content in a system;

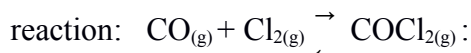
- b) function characterizing direction of a process in a system;
 c) function characterizing the rate of process in a system;
 d) function characterizing the feasibility of process in a system;
119. Which of the following is valid for the endergonic reactions?
 a) $\Delta G > 0$; b) $\Delta G < 0$; c) $\Delta H < 0$; d) $\Delta H > 0$; e) $\Delta S < 0$
120. Which of the following is true for isochoric process?
 a) $V = \text{const}$; b) $P = \text{const}$; c) $T = \text{const}$; d) $P = \text{const}$, $T = \text{const}$; e) $V = \text{const}$
121. Free energy change is related to enthalpy and entropy changes as:
 a) $\Delta G = \Delta H - T\Delta S$; b) $\Delta G = T\Delta S - \Delta H$; c) $\Delta G = \frac{\Delta H - \Delta S}{T}$; d) $\Delta G = \Delta H + T\Delta S$; e)
- $$\Delta G = \frac{\Delta S - \Delta H}{T}$$
122. Which of the following is correct if $\Delta H > 0$ and $\Delta S < 0$?
 a) The process is non-spontaneous at any temperature
 b) The process is spontaneous at high temperature
 c) The process is spontaneous at any temperature
 d) The process is spontaneous at low temperature
123. Which of the following is correct if $\Delta H < 0$ and $\Delta S > 0$?
 a) The process is spontaneous at any temperature
 b) The process is spontaneous at low temperature
 c) The process is spontaneous at high temperature
 d) The process is non-spontaneous at any temperature
124. Which of the following is valid for the exergonic reactions?
 a) $\Delta G < 0$; b) $\Delta H < 0$; c) $\Delta G > 0$; d) $\Delta H > 0$; e) $\Delta S < 0$
125. Which of the following is the mathematical statement of second law of thermodynamics?
 a) $\Delta S = \Delta Q/T$ b) $Q = \Delta U + A$ c) $H = U + p\Delta V$ d) $\Delta G = \Delta H - T\Delta S$
126. Which of the following is true for the reaction at equilibrium?
 a) $\Delta H = T\Delta S$; b) $\Delta H < T\Delta S$; c) $\Delta H > T\Delta S$; d) $\Delta H = \Delta S$; e) none of these
127. What parameter does reaction rate constant depend on?
 a) temperature; b) concentration of reacting substances;
 c) concentration of products; d) pressure
128. What does activation energy depend on?
 a) nature of reacting species b) concentration, c) pressure, d) volume
129. If the rate of reaction between A and B is expressed as $k[A][B]^2$, the reaction is:
 a) first order in A, second order in B, overall having third order (all are correct) b)
 first order in A, c) second order in B, d) all are wrong
130. The value of K_{eq} depends on:
 a) temperature; b) pressure; c) presence of catalyst; d) solubility product; e)
 concentration
131. In which direction the equilibrium will be shifted by decreasing the pressure in the
 reaction: $\text{CO}_{2(\text{g})} + \text{H}_{2(\text{g})} \rightleftharpoons \text{CO}_{(\text{g})} + \text{H}_2\text{O}_{(\text{g})}$
 a) the equilibrium will not be affected;
 b) the equilibrium will be shifted to the left;
 c) the equilibrium will be shifted to the right;
 d) the equilibrium does not depend on pressure;
 e) reaction is irreversible
132. Write the equilibrium constant expression for the reaction: $2\text{SO}_{2(\text{g})} + \text{O}_{2(\text{g})} \rightleftharpoons 2\text{SO}_{3(\text{g})}$:



133. What parameters influence the rate of enzymatic reaction?

- a) C(substrate), T, pH b) C(substrate), T, P c) pH, P, T d) pH, V, C(substrate)

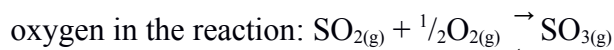
134. In which direction the equilibrium will be shifted by increasing the pressure in the



- a. the equilibrium will be shifted to the right; b) the equilibrium will be shifted to the left; c) the equilibrium will not be affected;

d) the equilibrium does not depend on pressure; e) reaction is irreversible

135. In which direction the equilibrium will be shifted by increasing the concentration of

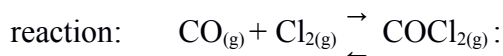


- a) the equilibrium will be shifted to the right; b) the equilibrium will be shifted to the left; c) the equilibrium will not be affected; d) the equilibrium does not depend on concentrations; e) reaction is irreversible

136. What is activation energy?

- a. energy needed to split (synthesize) chemical bonds in reacting molecules
b. energy needed for one reacting molecule activation
c. energy needed for electrically neutral molecules interaction
d. energy needed to overcome repulsion forces between molecules

137. In which direction the equilibrium will be shifted by adding the catalyst in the

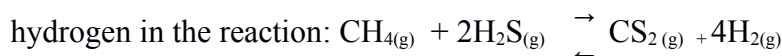


- a. the equilibrium will not be affected; b) the equilibrium will be shifted to the left; c) the equilibrium will be shifted to the right; d) reaction is irreversible

138. What is the correct expression for $Ca_3(PO_4)_2$ solubility product?

- a) $K_{sp} = [Ca^{2+}]^3 [PO_4^{3-}]^2$ b) $K_{sp} = [Ca^{2+}]^3 [PO_4^{3-}]$ c) $K_{sp} = [Ca^{2+}] [PO_4^{3-}]$
d) $K_{sp} = [Ca^{2+}] [PO_4^{3-}]^2$ e) $K_{sp} = [Ca^{2+}]^2 [PO_4^{3-}]^3$

139. In which direction the equilibrium will be shifted by increasing the concentration of



- a) the equilibrium will be shifted to the left; b) the equilibrium will be shifted to the right; c) the equilibrium will not be affected; d) the equilibrium does not depend on concentrations; e) reaction is irreversible

b) Which of the given below is the electrode of the first type?

- a) $Zn|Zn^{2+}$; b) $Hg, Hg_2Cl_2|KCl$; c) $Pt|H^+_{\text{quinhydrone}}$; d) $Pt|\frac{MnO_4^-}{Mn^{2+}}, H^+$; e) $Ag, AgCl|KCl$

140. In which case the value of hydrogen electrode potential is greater? $[H^+] =$

- a. 1 mol/L; b) 0.1 mol/L; c) 0.3 mol/L; d) 0.5 mol/L; e) 0.01 mol/L

141. How to calculate potential of quinhydrone electrode?

- a. $e = e^0 - 0.059pH$; b) $e = -0.059pH$; c) $e = e_+ + e_-$; d) $e = 0.059(pH_2 - pH_1)$

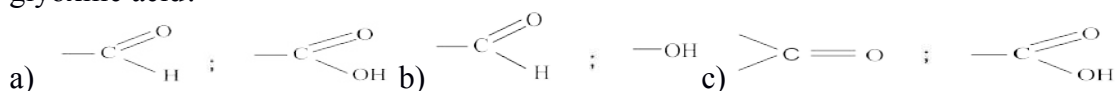
142. Which of the given below is the electrode of the second type?

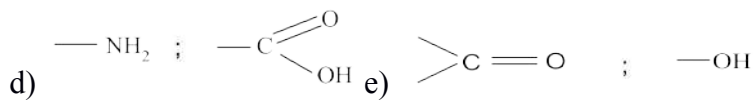
- a) Hg, Hg₂Cl₂|KCl; b) Zn|Zn²⁺; c) Pt|H⁺_{quinhydrone}; d) $Pt \left| \frac{MnO_4^-}{Mn^{2+}}, H^+ \right.$; e) Pt(H₂)|H⁺
143. Which of the following cells is used in the Linar probe?
 a. Sb, Sb₂O₃|H⁺||KCl|Hg₂Cl₂,Hg
 b. Pt(H₂)|H⁺||KCl|AgCl, Ag
 c. Hg, Hg₂Cl₂|KCl||H⁺quin|Pt
 d. glass|H⁺||KCl|Hg₂Cl₂,Hg
 e. glass|H⁺||KCl||AgCl, Ag
144. In galvanic cell electrons move:
 a) from anode to cathode b) from cathode to anode c) there is no movement of electrons
145. For a redox reaction to proceed in a cell, the e.m.f. must be:
 a. positive; b) negative; c) zero; d) fixed
146. Which expression is true for spontaneous reaction?
 a) $e_{cathode} - e_{anode} > 0$; b) $e_{cathode} - e_{anode} = 0$; c) $e_{cathode} - e_{anode} < 0$;
 d) $e_{reducing\ agent} - e_{oxidizing\ agent} < 0$.
147. Linar probe is used for pH measuring of gastric juice. Which ion is potential determining ion for indicating electrode used in Linar probe?
 a) H⁺; b) Ag⁺; c) Sb; d) Hg²⁺; e) Cl⁻
148. How to calculate potential of hydrogen electrode?
 a. $e = -0.059pH$; b) $e = e^0 + 0.059pH$; c) $e = e^0 - 0.059 \lg C_{H^+}$; d) $e = -0.059(pH_2 - pH_1)$;
 e) $e = \frac{0,059}{n} pH$
149. Which galvanic cell is used in pH-meter?
 a) glass|H⁺||KCl||AgCl, Ag ; b) Pt(H₂)|H⁺||KCl|Hg₂Cl₂,Hg;
 c) Pt| $\frac{Cu^{2+}}{Cu^+} || \frac{Fe^{3+}}{Fe^{2+}}$ | Pt; d) Sb, Sb₂O₃|H⁺||KCl|AgCl, Ag;
 e) Sb, Sb₂O₃|H⁺||KCl|Hg₂Cl₂,Hg
150. All chromatographic systems, as a rule, consist of:
 a. Two phases b) One phase c) phases d) Four phases e) Five phases
151. Which of the following substances is surface-active?
 a) C₃H₇-NH₂ b) NaOH c) NH₃ d) AlCl₃ e) NH₄OH
152. Which of the following substances is able to decrease the surface tension of water?
 a. C₁₅H₃₁COONa b) FeSO₄ c) HNO₃ d) Na₃PO₄ e) CaCl₂
153. Which of the following substances has higher value of surface activity?
 a) C₄H₉COOH b) CH₃COOH c) C₂H₅COOH d) C₃H₇COOH e) HCOOH
154. Which of the following is the surface-active substance?
 a. C₁₇H₃₅COONa b) Na₂SO₄ c) BaCl₂ d) Cu(NO₃)₂ e) H₂SO₄
155. Which ions will be adsorbed on the particles of silver iodide ppt obtained in the reaction AgNO₃ + KI?
 a. Ag⁺ and I⁻ ..
 b. Ba²⁺ and NO₃⁻
 c. SO₄²⁻ and K⁺ .
 d. K⁺ and NO₃⁻ .
 e. NO₃⁻ and I⁻
156. Which of the following dissolves in water better?
 a. KCl b) C₆H₆ c) O
157. What is adsorbent?
 a. the solid substance on the surface of which adsorption occurs

- b. the substance that is adsorbed on the solid surface
 c. solvent d) solute e) slightly soluble substance
158. Which one is surface-inactive agent?
 a. CuSO_4 d) $\text{C}_3\text{H}_7\text{COOH}$
 b. $\text{C}_5\text{H}_{11}\text{-NH}_2$
 e) $\text{CH}_3\text{-CH}_2\text{-CH}(\text{NH}_2)\text{-COOH}$
 c. $\text{CH}_3\text{-C}(\text{O})\text{-CH}_3$
159. Ions of which electrolyte will be preferentially adsorbed on the surface of NiS particles?
 a. Na_2S ; b) MgCl_2 ; c) CaCl_2 ; d) NaOH ; e) NH_4OH .
160. What is the method of adsorption chromatography based on?
 a. selective adsorption of substances from mixtures
 b. the difference in distribution of substances between immiscible liquids
 c. the ion exchange between solution and adsorbent
 d. formation of chemical compounds
 e. different solubility of substances composing the mixture
161. Freshly prepared precipitates can be easily dispersed by shaking it with dispersion medium. The process is called
 a. peptization; b) electrophoresis; c) dispersion; d) dialysis; e) dissolution
162. How are dispersed systems classified as aerosols and lyosols
 a. according to aggregative state of dispersion medium
 b. according to degree of dispersion
 c. according to degree of stability
 d. according to the strength of interphase interaction
163. Which value of electrokinetic potential makes sol more stable?
 a. $\zeta=120$ mV, b) $\zeta=50$ mV, c) $\zeta=10$ mV, d) $\zeta=0$ mV
164. Ability of the dispersed phase to keep degree of dispersity is called:
 a. aggregative stability; b) kinetic stability; c) thermodynamic stability; d) dispersity
165. Which ion has greatest influence on the coagulation of the negatively charged sol?
 a) Ba^{2+} ; b) SO_4^{2-} ; c) Na^+ ; d) PO_4^{3-}
166. The sharp increase of solubility of slightly soluble salts in colloidal solutions of SAS is called
 a) solubilization b) ionization c) coagulation d) sedimentation
167. The depression of colloidal solutions in respect with true solutions is
 a) less b) greater c) identical d) none of the above
168. Which of the following is correct micelle formula for the reaction
 $\text{FeCl}_3 + \text{K}_4[\text{Fe}(\text{CN})_6](\text{excess}) \rightarrow$
 a. $\{(\text{Fe}_4[\text{Fe}(\text{CN})_6]_3)_m \text{ n}[\text{Fe}(\text{CN})_6]^{4-} (4\text{n-x})\text{K}^+\}^{x-} \text{xK}^+$
 b. $\{(\text{Fe}_4[\text{Fe}(\text{CN})_6]_3)_m \text{ n}[\text{Fe}(\text{CN})_6]^{4-} 4\text{nK}^+\}$
 c. $\{(\text{Fe}_4[\text{Fe}(\text{CN})_6]_3)_m \text{ nFe}^{3+} 3(\text{n-x})\text{Cl}^-\} 3\text{xCl}^-$
 d. $\{(\text{Fe}_4[\text{Fe}(\text{CN})_6]_3)_m \text{ nFe}^{3+} 3\text{nCl}^-\}$
169. The presence of electric charge on the colloidal particle is indicated by the experiment:
 a. electrophoresis; b) electrolysis; c) dialysis; d) osmosis; e) precipitation
170. Particles of silver iodide are formed when equimolar solutions of silver nitrate and potassium iodide are mixed. What is the value of ζ -potential of these crystals?
 a. equal to zero; b) greater than zero; c) less than zero; d) none of these
171. How are dispersed systems classified as lyophobic and lyophilic?

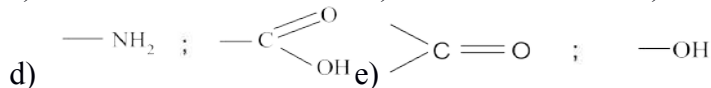
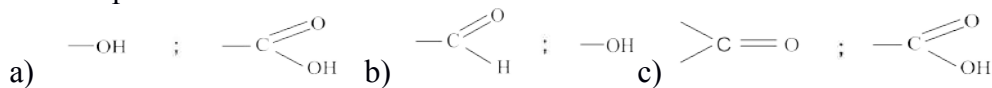
- a. according to the strength of interphase interaction
 b. according to degree of dispersion
 c. according to degree of stability
 d. according to aggregative state of dispersion medium
172. What is electrophoresis?
 a. the movement of solid phase of a sol in respect with liquid one in electric field
 b. the movement of liquid phase of a sol in respect with solid one in electric field
 c. the movement of a sol through capillary system
 d. the settling out of solid phase in liquid medium
173. Which factor inhibits coagulation?
 a. lyophilizing of granule by means of protein; b) decreasing of ζ -potential;
 c) increasing of added electrolyte concentration; d) shaking of sol
174. Which ion has lowest coagulating threshold in respect with negatively charged sol?
 a) barium, b) chloride; c) sodium; d) sulfate
175. Which factor promotes coagulation?
 a. decreasing of ζ -potential; b) increasing of ζ -potential; c) lyophilizing of granule by means of protein; d) reducing of added electrolyte concentration
176. What is the interaction between dispersed phase and dispersing medium in lyophilic dispersed systems?
 a) strong b) weak c) there is no interaction
177. Point the nucleus in micelle: $\{[Ca_3(PO_4)_2]_m \cdot nCa^{2+} (2n-x) Cl^-\}^{x+} xCl^-$
 a. $Ca_3(PO_4)_2$; b) Ca^{2+} ; c) Cl^-
178. In which reaction colloidal solution can be obtained?
 a) $2NaCl + Pb(NO_3)_2 \rightleftharpoons PbCl_2 + 2NaNO_3$ b) $H_2SO_4 + 2NaOH \rightleftharpoons Na_2SO_4 + 2H_2O$;
 c) $Na_2CO_3 + H_2SO_4 \rightleftharpoons Na_2SO_4 + CO_2 + H_2O$;
179. The size of colloidal particles is in the range of:
 a. 10^{-7} - 10^{-9} m; b) 10^{-10} - 10^{-9} m; c) 10^{-7} - 10^{-6} m; d) 10^{-6} - 10^{-5} m; e) 10^{-5} - 10^{-4} m
180. Fog is a colloidal solution of
 a. liquid in gas; b) gas in solid; c) gas in liquid; d) solid in gas; e) liquid in liquid
181. Which of the following are conditions for colloidal solution obtaining?
 a. the presence of two phases and a stabilizer, size of particles must be 10^{-7} - 10^{-9} m
 b. the presence of two phases and a stabilizer
 c. the presence of two phases, size of particles must be 10^{-7} - 10^{-9} m
 d. none of the above
182. The colloidal system in which the dispersed phase and dispersion medium are both liquids is known as
 a. an emulsion; b) an aerosol; c) a gel; d) a foam; e) a suspension
183. Cheese is a colloidal solution of
 a. liquid in solid; b) gas in liquid; c) gas in solid; d) solid in gas; e) solid in solid
184. Which ion has greatest influence on the coagulation of the positively charged sol?
 a) PO_4^{3-} ; b) Ba^{2+} ; c) Na^+ ; d) SO_4^{2-}
185. By means of measuring of viscosity, it is possible to determine:
 a. molecular mass of protein; b) size of protein molecule; c) shape of protein molecule
186. Ability of polymers solutions to condense their structure with separation of liquid phase is called:
 a. syneresis; b) thixotropy; c) coacervation; d) salting out; e) condensation
187. Non-polar polymer swells better in:
 a. non-polar solvent; b) water; c) polar solvent; d) none of these
188. Solutions of biopolymers are:
 a. homogeneous, thermodynamically stable systems

- b. heterogeneous, thermodynamically unstable systems; c) homogeneous, thermodynamically unstable systems; d) heterogeneous, thermodynamically stable systems;
189. Ability of a gel to restore its structure after mechanical demolition is called:
a. thixotropy; b) syneresis; c) coacervation; d) salting out
190. Feature which is common for polymers and true solutions is:
a. similarity of structural unit of solution; b) slow rate of diffusion; c) optical activity; d) electrophoresis phenomenon
191. The rate of salting out of proteins is maximal when:
a) $\text{pH} = \text{pI}$; b) $\text{pH} < \text{pI}$; c) $\text{pH} > \text{pI}$
192. Polar polymer swells better in:
a) polar solvent; b) benzene; c) non-polar solvent; d) non of these
195. 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
196. 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
197. Vitamine A is called “retinol”. Suffix –ol means that retinol is:
a) Alcohol b) Aldehyde c) Ketone d) Carboxylic acid e) Oxo acid
198. 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
199. 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
200. 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
201. Which of the following is true: sp^3 hybridized carbon atom
a) forms all 4° - bonds b) forms 3° - bonds and 1° -bond c) forms 2° - bonds and 2° - bonds d) is in the chain of alternating single and double bonds e) is bound with halogens
202. Which of the following is true: sp^2 hybridized carbon atom
a) forms 3° - bonds and 1° -bond b) forms all 4° - bonds c) forms 2° - bonds and 2° - bonds d) is in the chain of triple bonds e) is bound with halogens
203. Which of the following is true: sp hybridized carbon atom
a) forms 2° - bonds and 2° - bonds b) forms all 4° - bonds c) forms 3° - bonds and 1° -bond d) is in the chain of alternating single and double bonds e) is bound with halogens
204. 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
206. Which of the radicals is “ethyl”:
a) $-\text{C}_2\text{H}_5$ b) $-\text{CH}_3$ c) $-\text{C}_3\text{H}_7$ d) $-\text{C}_4\text{H}_9$ e) $-\text{C}_5\text{H}_{11}$
207. Which of the radicals is “methyl”:
a) $-\text{CH}_3$ b) $-\text{C}_2\text{H}_5$ c) $-\text{C}_3\text{H}_7$ d) $-\text{C}_4\text{H}_9$ e) $-\text{C}_5\text{H}_{11}$
208. Which of the radicals is “propyl”:
a) $-\text{C}_3\text{H}_7$ b) $-\text{CH}_3$ c) $-\text{C}_2\text{H}_5$ d) $-\text{C}_5\text{H}_{11}$ e) $-\text{C}_4\text{H}_9$
209. Which of the radicals is “butyl”:
a) $-\text{C}_4\text{H}_9$ b) $-\text{CH}_3$ c) $-\text{C}_2\text{H}_5$ d) $-\text{C}_3\text{H}_7$ e) $-\text{C}_5\text{H}_{11}$
- 210 Glyoxilic acid belongs to **aldo acids**. Which functional groups are in composition of glyoxilic acid?

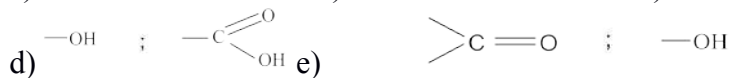
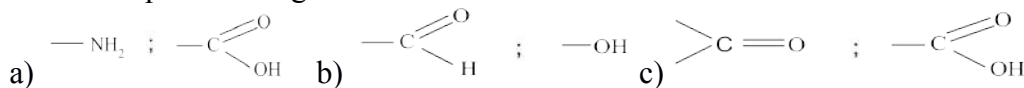




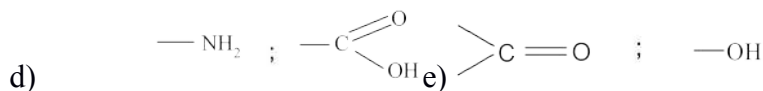
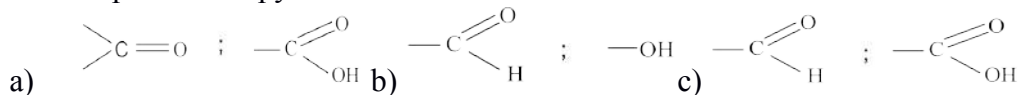
211. IUPAC name of malic acid is **2-hydroxybutandioic acid**. Which functional groups are in composition of malic acid?



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



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



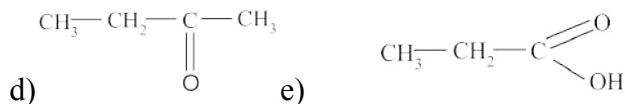
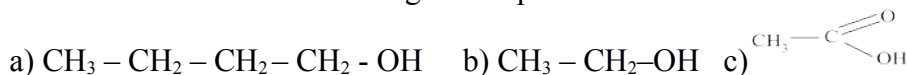
214. Which substance shows cis-trans isomerism?

- 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) $\text{CH}_3 - \text{C} \equiv \text{C} - \text{CH}_3$
 d) $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{CH}_3$ e) $\text{CH}_2 = \text{CH} - \text{CH}_2 - \text{CH}_3$

215. 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

216. Which of the following shows position isomerism?

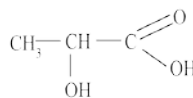


217. Which of the following are homologues?

- a) Propanal and butanal b) Propanal and propylamine c) Propanal and propanoic acid
 d) Propanal and butanoic acid e) Propanal and propanone

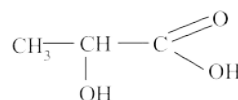
218. Choose the correct IUPAC name of the compound:

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



219. Choose the correct rational name of the compound:

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



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

220. 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

221. 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

222. 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

223. 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

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

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

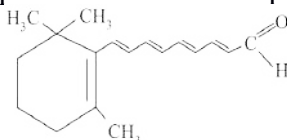
225. Which is the most favorable conformation for kolamine (2-aminoethan-1-ol)?

a) Staggered b) Eclipsed c) Gauche 60° d) Gauche 20° e) There is no favorable conformation

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

a) τ -bond ("banana-bond") b) σ - bond c) π - bond d) Covalent bond
e) there is no definite answer

227. 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

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

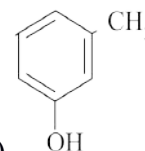
a) Cyclopropane and cyclobutane b) Cyclopentane and cyclohexane c) Cyclohexane
d) Cyclopropane and cyclohexane e) Cyclopentane

229. Conjugated systems are :

a) Thermodynamically stable b) Very reactive c) Thermodynamically unstable
d) Very unreactive e) There is no definite answer

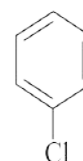
230. Give the definition of term "inductive effect"

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



231. What are the electronic effects of **OH-group** in *m*-methylphenol (*m*-cresol)

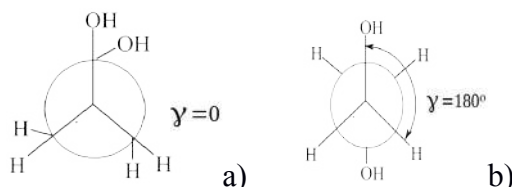
a) -I, + M; b) -I; c) -I, - M; d) +I; e) There is no definite answer



232. What are the electronic effects of chlorine atom in the chlorobenzene?

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

233. Name the pictured conformations. What is the compound?



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

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

- a) $-\text{I}$, $+\text{M}$ b) $+\text{I}$ c) $-\text{M}$, $+\text{I}$ d) $+\text{M}$, $+\text{I}$ e) $-\text{M}$

235. Which bond undergoes homolytic fission preferentially?

- a) Covalent nonpolar b) Covalent polar c) Ionic d) Hydrogen e) Donor-acceptor

236. Which particle is a free radical?

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

237. Which of the following is substitution reaction?

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

238. 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.

239. Which compounds enter addition reactions?

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

240. Which particle is carbocation?

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

241. 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) CH_3-COOH ?

242. Which reaction occurs with the breaking of π -bond:

- a) Addition; b) Substitution; c) Decomposition; d) Neutralization; e) Exothermic?

243. Which of the following is addition reaction?

- a) $\text{CH}_3-\text{CH}=\text{CH}-\text{CH}_3 + \text{Br}_2 \rightleftharpoons \text{CH}_3-\text{CHBr}-\text{CHBr}-\text{CH}_3$; b) $2 \text{CH}_3\text{OH} + 2 \text{Na} \rightleftharpoons 2 \text{CH}_3\text{ONa} + \text{H}_2$;
 c) $\text{C}_6\text{H}_6 + \text{Br}_2 \rightleftharpoons \text{C}_6\text{H}_5\text{Br} + \text{HBr}$; d) $\text{C}_6\text{H}_5\text{OH} + \text{NaOH} \rightleftharpoons \text{C}_6\text{H}_5\text{ONa} + \text{H}_2\text{O}$;
 e) $\text{C}_2\text{H}_6 + \text{Br}_2 \rightleftharpoons \text{C}_2\text{H}_5\text{Br} + \text{HBr}$?

244. What are the intermediates in lipids peroxide oxidation?

- a) Free radicals; b) Cations; c) Anions; d) Atoms; e) Molecules

245. Which reaction is typical for aromatic hydrocarbons?

- a) Substitution; b) Addition; c) Decomposition; d) Exchange; e) Neutralization

246. 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 π -bonds; d) The presence of σ -bonds; e) The absence of acidic properties

247. 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

248. Which compound participates in polymerization reaction?

- a) $\text{H}_2\text{C}=\text{CH}-\text{CH}=\text{CH}_2$; 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) $\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{NH}_2$?

249. Which of the following are acidic?

- a) Alcohols; b) Saturated hydrocarbones; c) Unaturated hydrocarbones;
d) Aromatic hydrocarbones; e) Amines.

250. Which reaction characterizes acidic properties of alcohols?

- a) $2 \text{CH}_3\text{-CH}_2\text{-CH}_2\text{-OH} + 2 \text{Na} \rightleftharpoons 2 \text{CH}_3\text{-CH}_2\text{-CH}_2\text{-ONa} + \text{H}_2$;
b) $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-OH} + \text{HBr} \rightleftharpoons \text{CH}_3\text{-CH}_2\text{-CH}_2\text{-Br} + \text{H}_2\text{O}$;
c) $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-OH} \rightleftharpoons \text{CH}_3\text{-CH=CH}_2 + \text{H}_2\text{O}$;
d) $\text{CH}_3\text{-CH}_2\text{-OH} + \text{HO-CH}_2\text{-CH}_3 \rightleftharpoons \text{CH}_3\text{-CH}_2\text{-O-CH}_2\text{-CH}_3 + \text{H}_2\text{O}$;
e) $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-OH} + \text{HOOC-CH}_3 \rightleftharpoons \text{CH}_3\text{-CH}_2\text{-CH}_2\text{-O-CO-CH}_3 + \text{H}_2\text{O}$?

251. 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

252. What are the products of primary alcohols oxidation?

- a) Aldehydes; b) Saturated hydrocarbones; c) Unaturated hydrocarbones;
d) Halogen derivatives; e) Esters

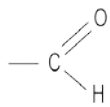
253. Which reaction characterizes basic properties of ethylamine?

- a) $\text{CH}_3\text{-CH}_2\text{-NH}_2 + \text{HCl} \rightleftharpoons \text{CH}_3\text{-CH}_2\text{-NH}_3^+ \text{Cl}^-$;
b) $\text{CH}_3\text{-CH}_2\text{-NH}_2 + \text{CH}_3\text{Br} \rightleftharpoons \text{CH}_3\text{-CH}_2\text{-NH-CH}_3 + \text{HBr}$;
c) $\text{CH}_3\text{-CH}_2\text{-NH}_2 + \text{Cl-CO-CH}_3 \rightleftharpoons \text{CH}_3\text{-CH}_2\text{-NH-CO-CH}_3 + \text{HCl}$;
d) $\text{CH}_3\text{-CH}_2\text{-NH}_2 + \text{HNO}_2 \rightleftharpoons \text{CH}_3\text{-CH}_2\text{-OH} + \text{N}_2 + \text{H}_2\text{O}$;
e) $\text{CH}_3\text{-NH}_2 + \text{HCl} \rightleftharpoons \text{CH}_3\text{-NH}_3^+ \text{Cl}^-$?

254. What electronic effect of alkyl radical increases basic properties of aliphatic amines as compare to aromatic ones?

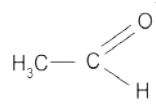
- a) +I; b) -I; c) -M; d) +M; e) There is no effect

255. Which of the following is the functional group of aldehydes?

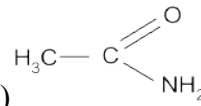


- a) $\begin{array}{c} \text{O} \\ \parallel \\ \text{---C} \\ \backslash \\ \text{H} \end{array}$ b) -OH; c) -COOH; d) -SH; e) -NH₂

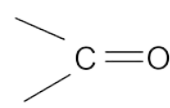
256. Which compound belongs to aldehydes?



- a) $\text{H}_3\text{C---C} \begin{array}{c} \text{O} \\ \parallel \\ \backslash \\ \text{H} \end{array}$ b) CH₃COOH; c) C₂H₅OH; d) CH₃NH₂; e)

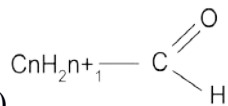


257. Which of the following is the functional group of ketones?



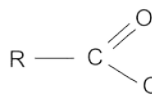
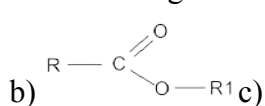
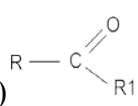
- a) $\begin{array}{c} \diagup \\ \text{C=O} \\ \diagdown \end{array}$ b) -NH₂; c) -COOH; d) -OH; e) -SH

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



- a) $\text{C}_n\text{H}_{2n+1}\text{---C} \begin{array}{c} \text{O} \\ \parallel \\ \backslash \\ \text{H} \end{array}$ b) C_nH_{2n}; c) C_nH_{2n+2}; d) C_nH_{2n-2}; e) (C₆H₁₀O₅)_n

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



- a) $\text{R---C} \begin{array}{c} \text{O} \\ \parallel \\ \backslash \\ \text{R}_1 \end{array}$ b) $\text{R---C} \begin{array}{c} \text{O} \\ \parallel \\ \backslash \\ \text{O---R}_1 \end{array}$ c) $\text{R---C} \begin{array}{c} \text{O} \\ \parallel \\ \backslash \\ \text{OH} \end{array}$ d) -SH; e) -OH

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

- a) Ammoniacal solution of Ag₂O; b) HNO₃; c) Bromine water;
d) Copper hydroxide (in the cold); e) Na₂CO₃

261. What is the product of acetaldehyde reduction?

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

262. Give IUPAC name for acetone:

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

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

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

264. 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

265. Which acid on reduction gives lactic acid?

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

266. 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.

267. 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.

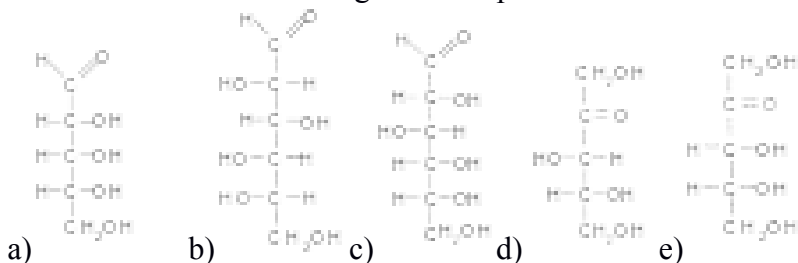
268. What is the classification of carbohydrates according to the number of monomers?

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

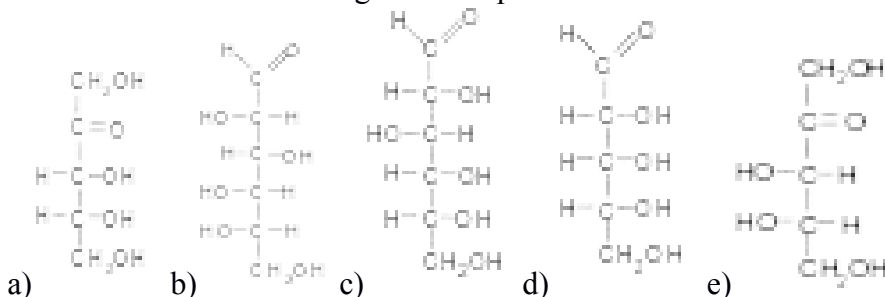
269. What classes of organic compounds do monosaccharides belong to (according to the structure)?

- 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

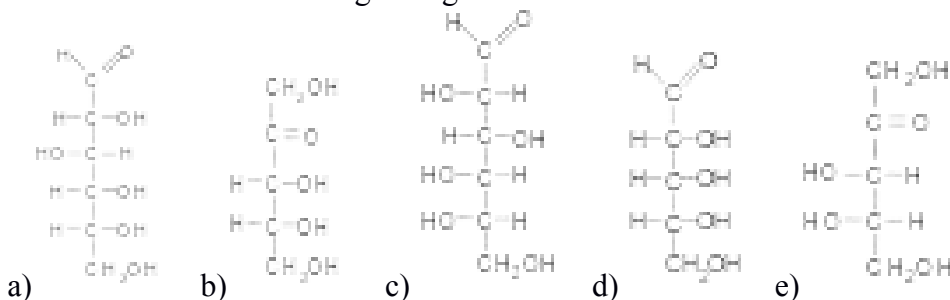
270. Which of the following is D-aldopentose:



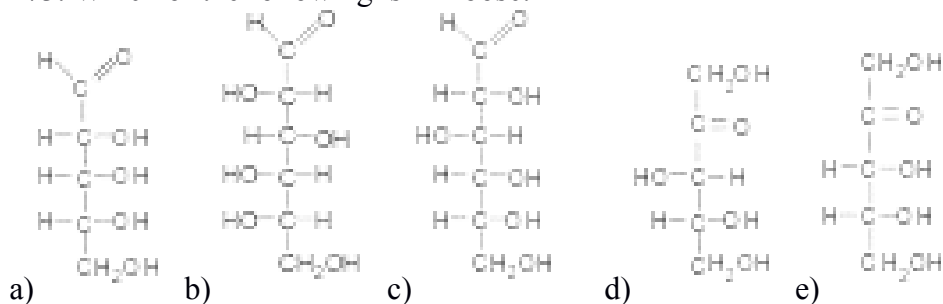
271. Which of the following is D-ketopentose:



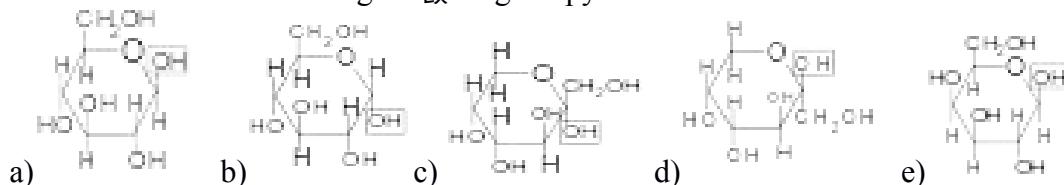
272. Which of the following is D-glucose:



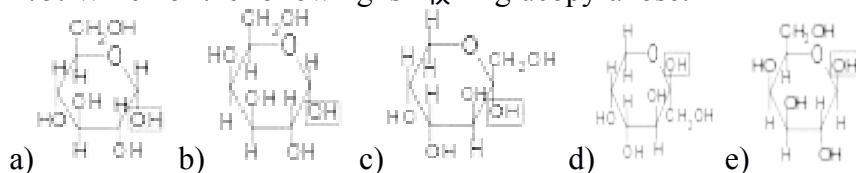
273. Which of the following is D-ribose:



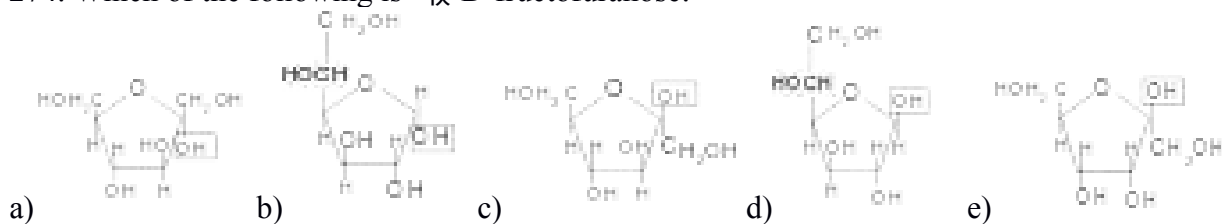
274. Which of the following is α -D-glucopyranose:



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



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



275. 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

276. Glycosidic linkage involves:

- Hemiacetal hydroxyl group;
- OH- group at C₅ carbon atom;
- OH- group at C₄ carbon atom;
- OH- group at C₆ carbon atom;
- OH- group at C₃ carbon atom;

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

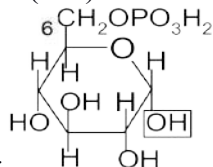
- 3 chiral carbons;
- 2 chiral carbons;
- 4 chiral carbons;
- 5 chiral carbons;
- There is no chiral carbons in fructose

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

- 4 chiral carbons;
- 2 chiral carbons;
- 3 chiral carbons;
- 5 chiral carbons;
- There is no chiral carbons in galactose

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

- Reaction with $\text{Ag}(\text{NH}_3)_2\text{OH}$;
- Reaction with NaHSO_3 ;
- Reaction with CH_3I ;
- Reaction with KOH ;
- Reaction with $\text{Cu}(\text{OH})_2$ on the cold.



280. What is the correct name of compound:

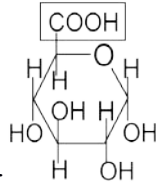
- a) 6-phosphate- α -D-glucopyranose; b) 1-phosphate- α -D-glucopyranose;
 c) 6-phosphate- α -D-fructofuranose; d) 6-phosphate- β -D-glucopyranose;
 e) 1-phosphate- β -D-glucopyranose

281. What is the product of glucose reduction?

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

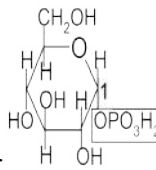
282. What is the product of D-glucose oxidation with bromine water?

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



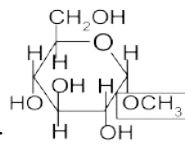
283. What is the correct name of compound:

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



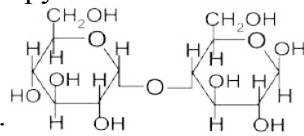
284. What is the correct name of compound:

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



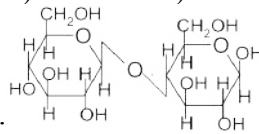
285. What is the correct name of compound:

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



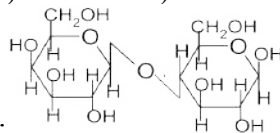
286. What is the name of disaccharide:

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



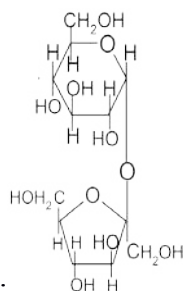
287. What is the name of disaccharide:

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



288. What is the name of disaccharide:

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



289. What is the name of disaccharide:

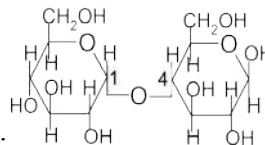
a) sucrose; b) maltose; c) cellobiose; d) lactose; e) trehalose

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

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

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

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



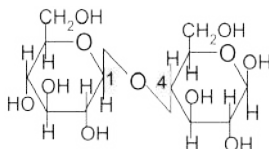
292. Give correct name of bond in the disaccharide maltose:

a) α - α -(1 \rightarrow 4)-Glycosidic linkage; b) β - β -(1 \rightarrow 4)- Glycosidic linkage;

c) α -(1 \rightarrow 3)- Glycosidic linkage; d) β -(1 \rightarrow 3)- Glycosidic linkage;

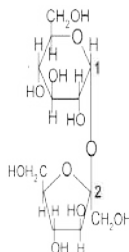
e) α -(1 \rightarrow 6)- Glycosidic linkage

293. 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

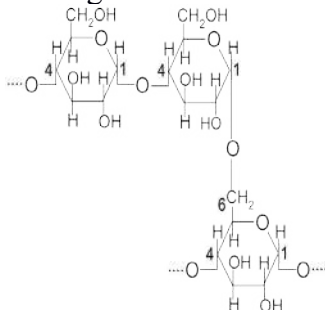
294. Give correct name of bond in the disaccharide sucrose



a) (1 \rightarrow 2)- 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

295. Which polysaccharide has the following structure:



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

296. What do glycogen and amylopectin have in common?

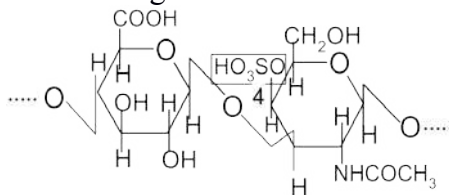
a) Have branched structures; b) Consist of monomer - galactose; c) Consist of molecules of α -D-glucofuranose; d) Consist of molecules of β -D-glucofuranose;

e) Consist of molecules of glucose, fructose and ribose

297. What are the fractions of starch?

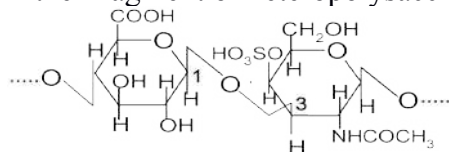
- a) Linear amylose and branched amylopectine; b) Homo- and hetero fractions;
 c) Only fraction of branched amylopectine;
 d) Fractions which move to anode and cathode in the electric field;
 e) Only fraction of linear amylose

298. Which polysaccharide has the following structure:



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

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



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

300. 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

301. What is the physiological function of glycogen?

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

302. Which heteropolysaccharide has anticoagulant properties?

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

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

- a) β -D-(1 \rightarrow 4)- glycosidic linkages and β -D-(1 \rightarrow 6)- glycosidic linkages (in places of branches);
 b) α -D-(1 \rightarrow 4)- glycosidic linkages only; c) β -D-(1 \rightarrow 6)- glycosidic linkages only;
 d) β -D-(1 \rightarrow 4)- glycosidic linkages everywhere; e) β -D-(1 \rightarrow 3)- glycosidic linkages

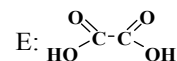
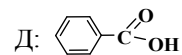
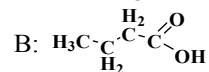
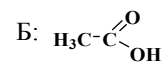
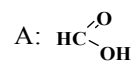
304. What are the monomers of starch?

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

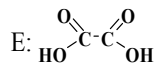
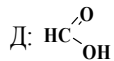
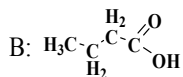
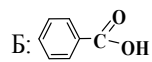
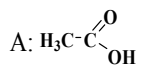
305. Which of the following is nonreducing disaccharide:

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

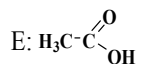
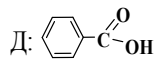
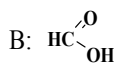
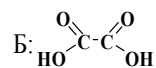
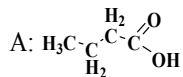
306. Which of the following is formic acid:



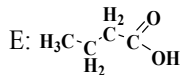
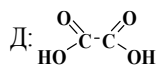
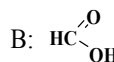
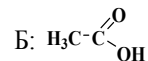
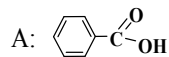
307. Which of the following is acetic acid:



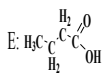
308. Which of the following is butyric acid:



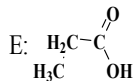
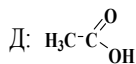
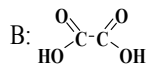
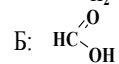
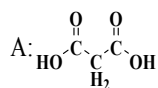
309. Which of the following is benzoic acid:



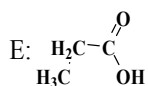
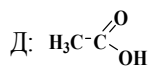
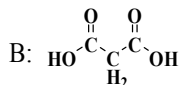
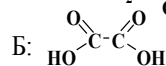
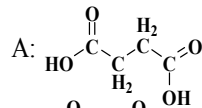
310. Which of the following is oxalic acid:



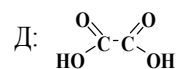
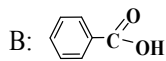
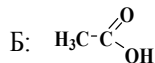
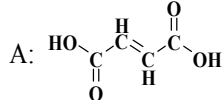
311. Which of the following is malonic acid:



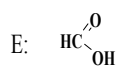
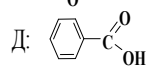
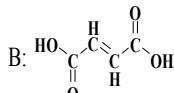
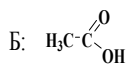
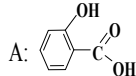
312. Which of the following is succinic acid:



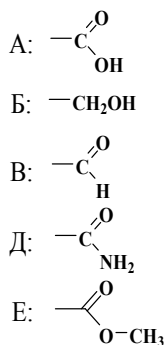
313. Which of the following is fumaric acid:



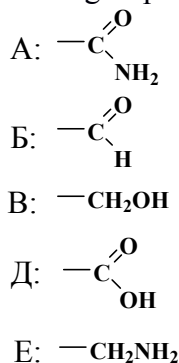
314. Which of the following is salicylic acid:



315. Which group is characteristic for carboxylic acids?



316. Which group is characteristic for amides?



317. 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

318. 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

319. 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

320. 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;

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

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

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

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

323. Decarboxylation reaction is typical for:

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

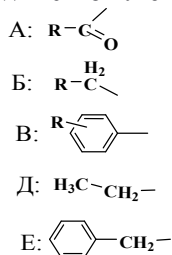
324. Salt formation reaction is typical for:

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

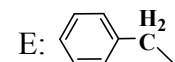
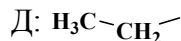
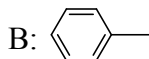
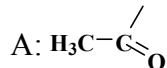
325. Which of the following is the reactive thiol ester which of great importance in the organism?

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

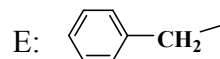
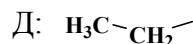
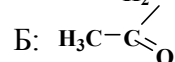
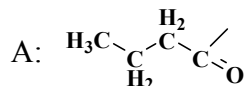
326. Which of the following is Acyl-radical?



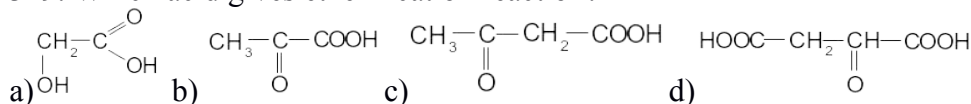
327. Which of the following is Acetyl-radical?



328. Which of the following is Butyryl-radical?



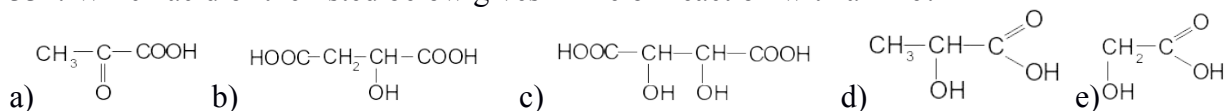
329. Which acid gives etherification reaction?



330. 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

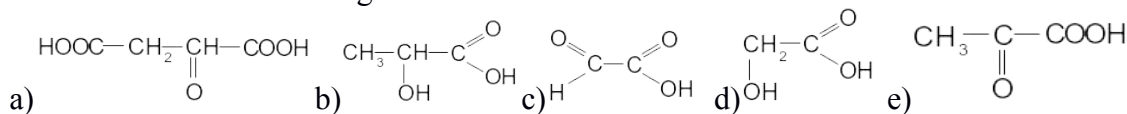
331. Which acid of the listed below gives imine on reaction with amine?



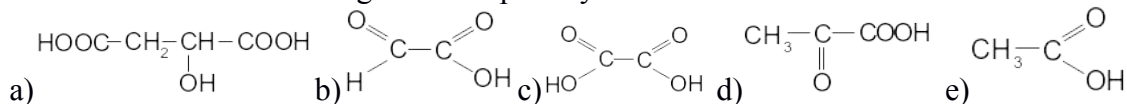
332. What is the mechanism of imine formation from pyruvic acid and amine?

a) Nucleophilic addition b) Nucleophilic substitution c) Aldol condensation
d) Electrophilic substitution e) Electrophilic addition

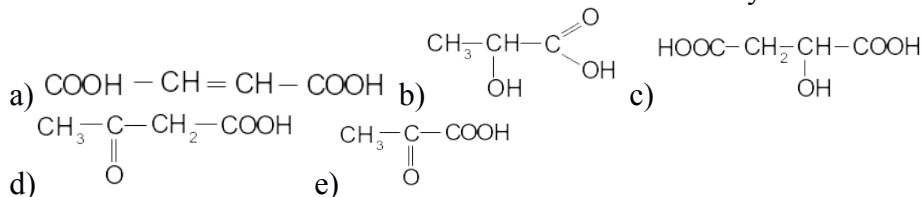
333. Which of the following acids show keto-enol tautomerism?



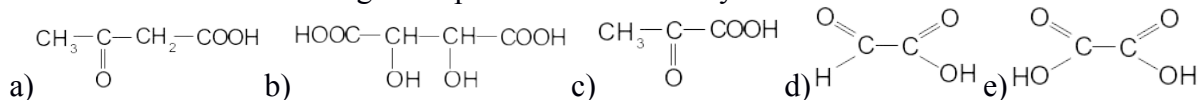
334. Which of the following acids is optically active?



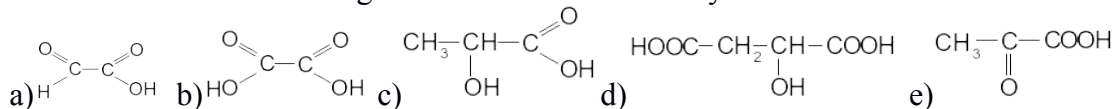
335. From which acid the malic acid forms in the Krebs cycle?



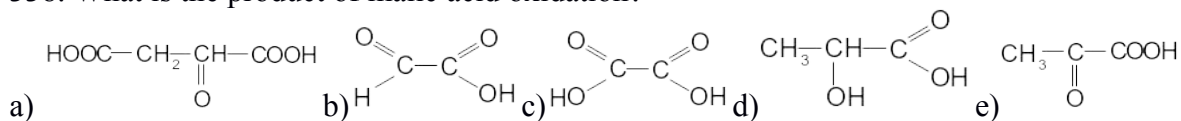
336. Which of the following acids possesses C-H acidity?



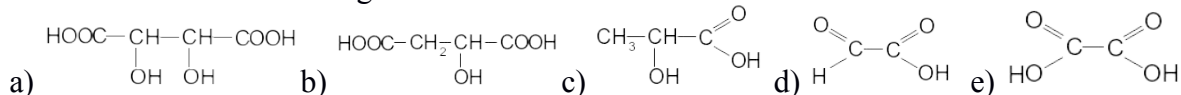
337. Which of the following acids can be discovered by "silver mirror test"?



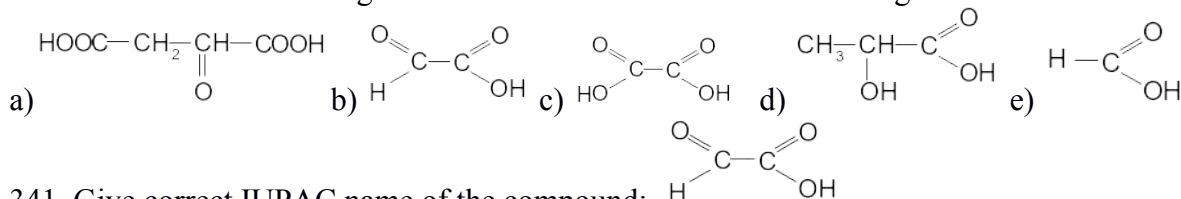
338. What is the product of malic acid oxidation?



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



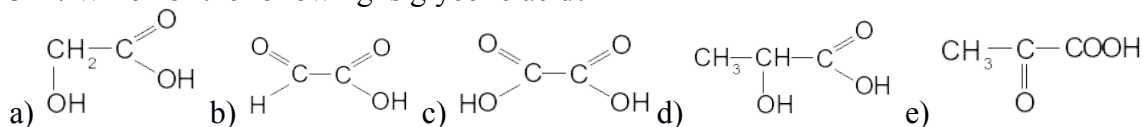
340. Which of the following acids enters aldol condensation in the organism?



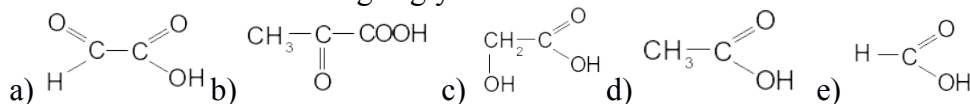
341. Give correct IUPAC name of the compound:

- a) Oxo ethanoic acid (formyl methanoic acid) b) Glyoxalic acid c) Aldo acid
d) Hydroxy ethanoic acid e) γ -Oxy glyoxalic acid

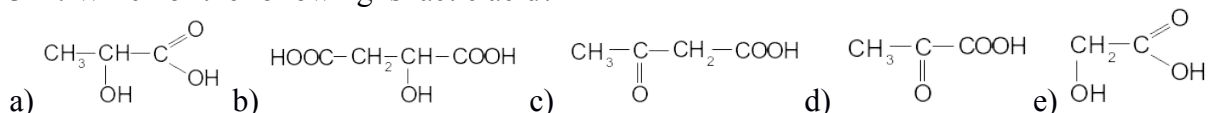
342. Which of the following is glycolic acid?



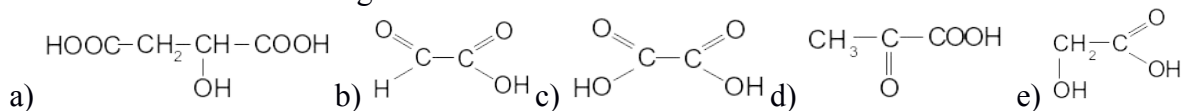
343. Which of the following is glyoxalic acid?



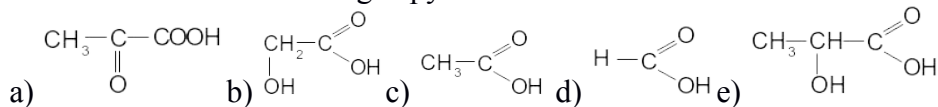
344. Which of the following is lactic acid?



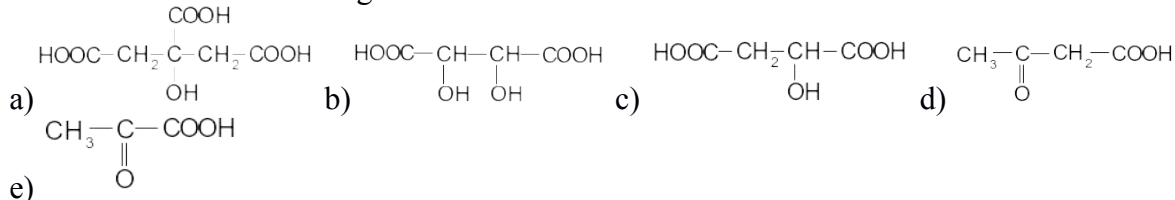
345. Which of the following is malic acid?



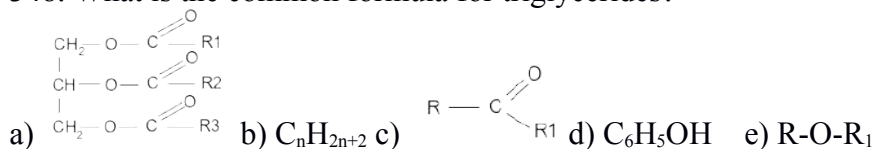
346. Which of the following is pyruvic acid?



347. Which of the following is citric acid?



348. What is the common formula for triglycerides?



349. 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.

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

- a) $\text{R}-\overset{\text{O}}{\parallel}{\text{C}}-\text{O}-\text{R}_1$ b) $\text{R}-\text{NH}_2$ c) $\text{R}-\text{OH}$ d) $\text{R}-\overset{\text{O}}{\parallel}{\text{C}}-\text{OH}$ e) $\text{R}-\overset{\text{O}}{\parallel}{\text{C}}-\text{H}$

351. 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.

352. 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.

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

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

354. Which salts are known as soaps?

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

355. 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

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

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

357. Which acid is unsaturated?

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

358. Which triglyceride does not enter hydrogenation reaction?

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

359. 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) $(\text{C}_{17}\text{H}_{33}\text{COO})_2\text{Mg}$.

360. 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) $\text{C}_{11}\text{H}_{23}\text{COOH}$

361. 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) $\text{C}_{17}\text{H}_{31}\text{COOH}$

362. 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) $\text{C}_{11}\text{H}_{23}\text{COOH}$

363. Which one is palmitic acid?

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

364. Which one is stearic acid?

- a) $\text{C}_{17}\text{H}_{35}\text{COOH}$ 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) $\text{C}_{11}\text{H}_{23}\text{COOH}$

365. Which one is oleic acid?

- a) $\text{C}_{17}\text{H}_{33}\text{COOH}$ b) $\text{C}_{17}\text{H}_{35}\text{COOH}$ c) $\text{C}_{15}\text{H}_{31}\text{COOH}$ d) $\text{C}_{17}\text{H}_{29}\text{COOH}$ e) $\text{C}_{17}\text{H}_{31}\text{COOH}$

366. Which one is linoleic 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) $\text{C}_{17}\text{H}_{29}\text{COOH}$ e) $\text{C}_{11}\text{H}_{23}\text{COOH}$

367. Which one is linolenic acid?

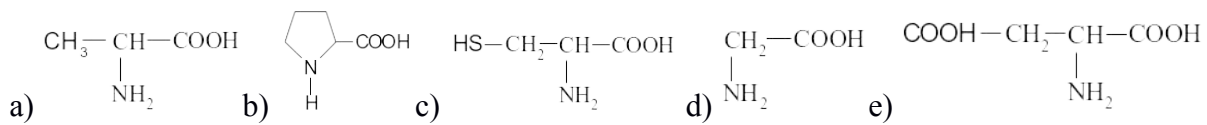
- a) $\text{C}_{17}\text{H}_{29}\text{COOH}$ b) $\text{C}_{17}\text{H}_{33}\text{COOH}$ c) $\text{C}_{17}\text{H}_{31}\text{COOH}$ d) $\text{C}_{13}\text{H}_{27}\text{COOH}$ e) $\text{C}_{15}\text{H}_{31}\text{COOH}$

368. Which one is glycine?

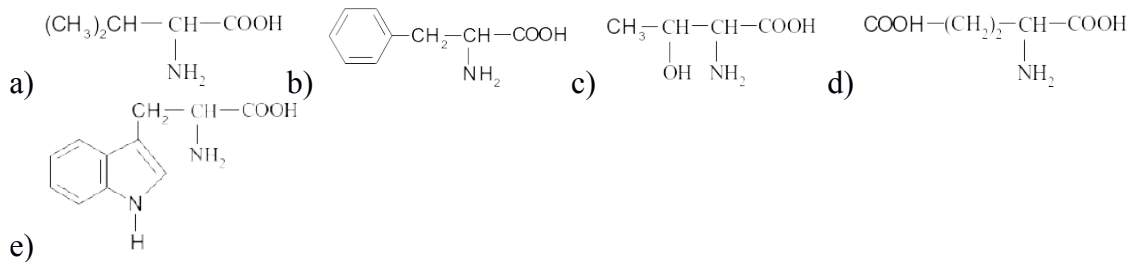
- a) CH_2-COOH
|
 NH_2 b) $\text{CH}_3-\text{CH}-\text{CH}-\text{COOH}$
| |
 OH NH_2 c) $\text{HO}-\text{CH}_2-\text{CH}-\text{COOH}$
|
 NH_2 d) $\text{CH}_3-\text{CH}-\text{COOH}$
|
 NH_2

- e) $\text{C}_6\text{H}_5-\text{CH}_2-\text{CH}-\text{COOH}$
|
 NH_2

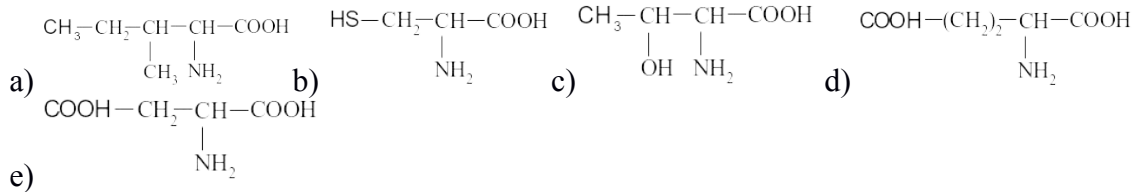
369. Which one is alanine?



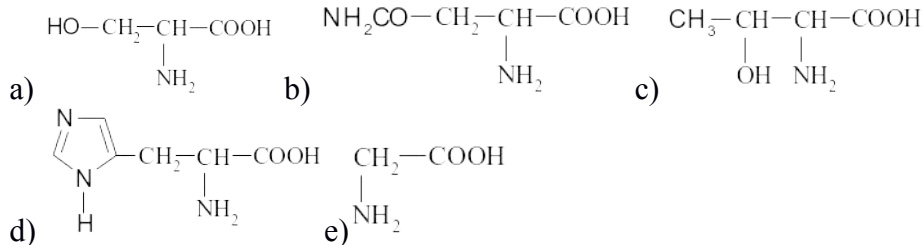
370. Which one is valine?



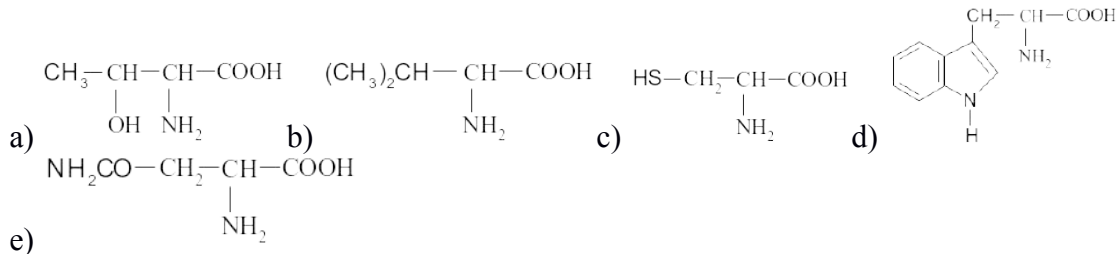
371. Which one is leucine?



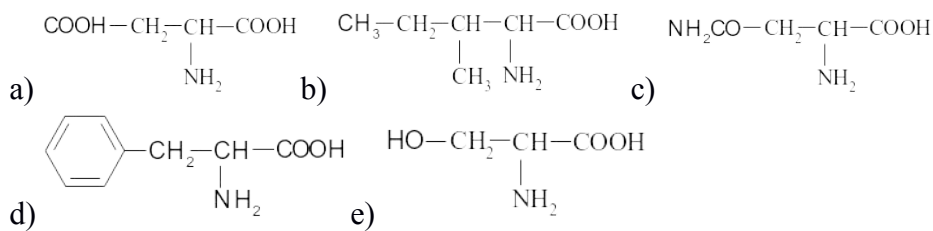
372. Which one is isoleucine?



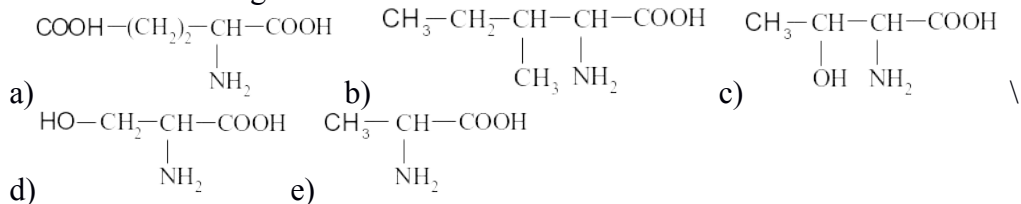
373. Which one is threonine?



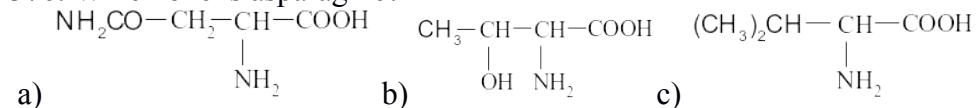
374. Which one is aspartic acid?

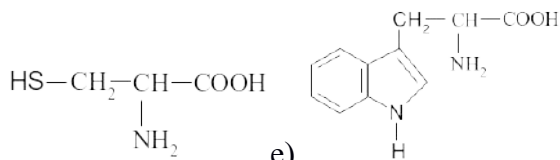


375. Which one is glutamic acid?

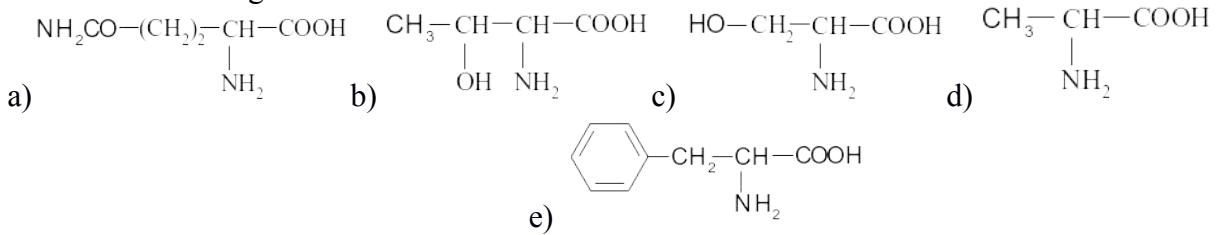


376. Which one is asparagine?

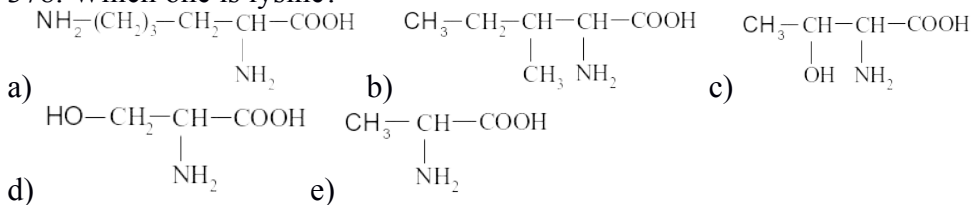




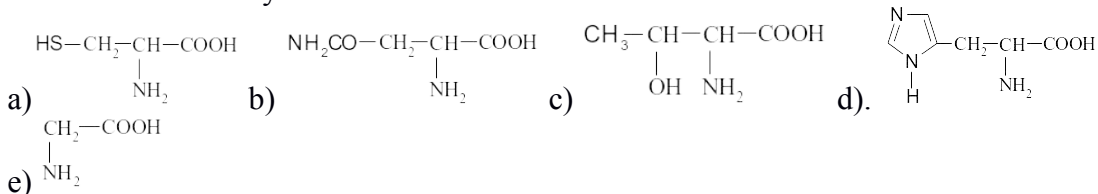
377. Which one is glutamine?



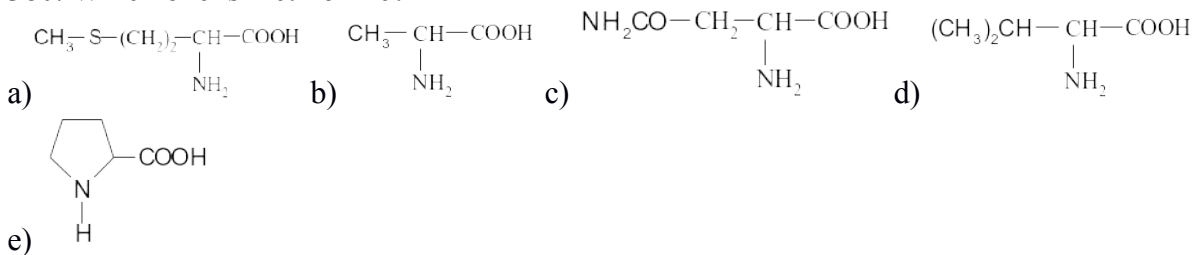
378. Which one is lysine?



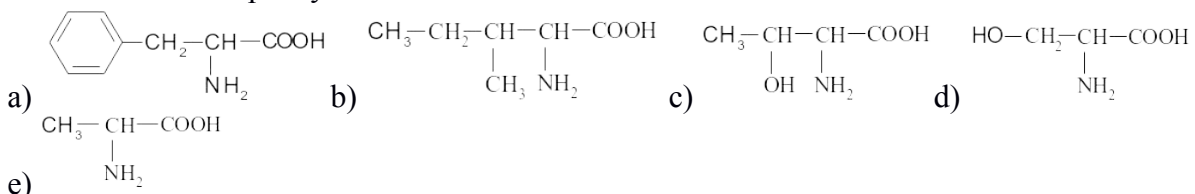
379. Which one is cysteine?



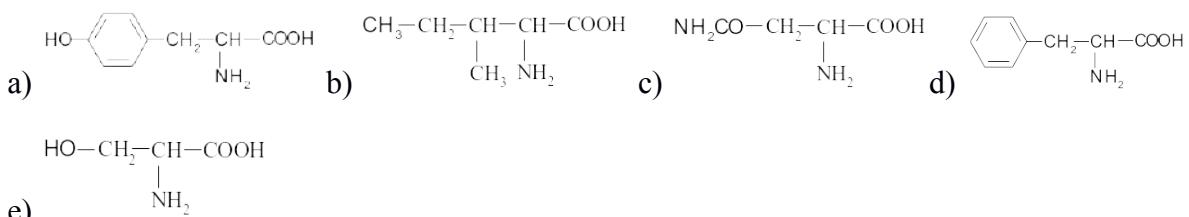
380. Which one is methionine?



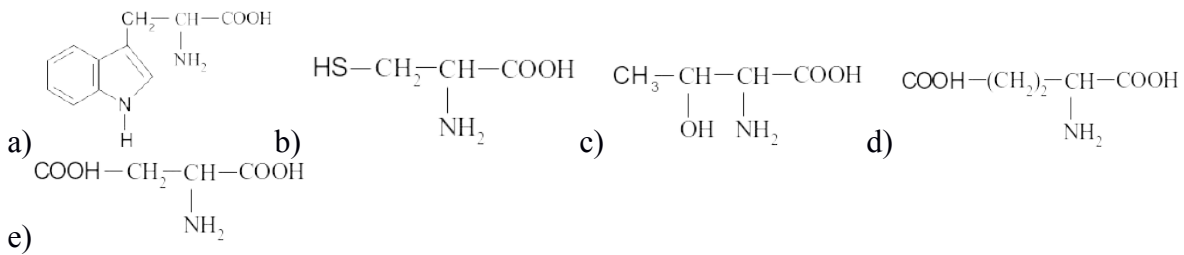
381. Which one is phenylalanine?



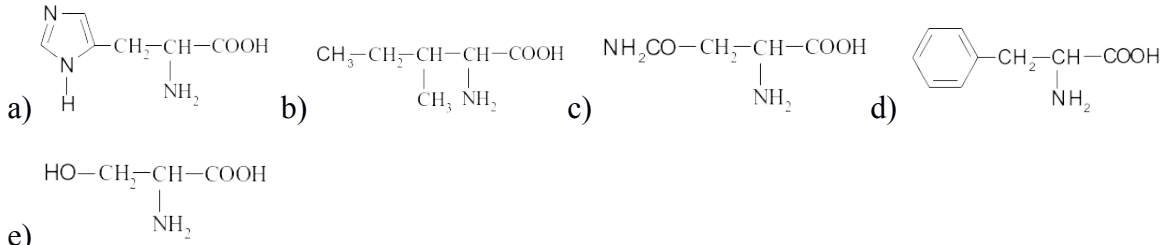
382. Which one is tyrosine?



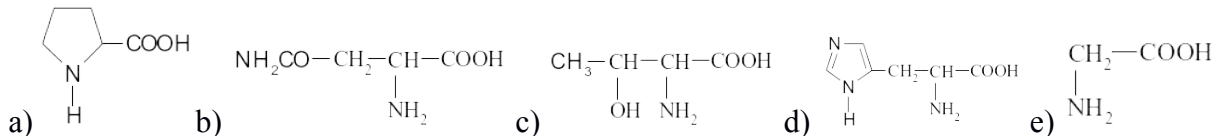
383. Which one is tryptophan?



384. Which one is histidine?



385. Which one is proline?



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

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

387. 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

388. What are the products of diamino acids decarboxylation?

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

389. 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

390. 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

391. Water solution of protein is:

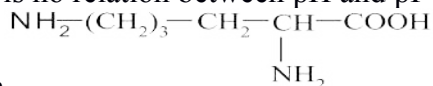
- a) True solution b) Colloidal solution c) Suspension d) Emulsion e) There is no answer

392. 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

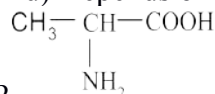
393. Isoelectric point of a protein (pI) is a pH at which:

- 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



394. What is the pH in lysine water solution

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



395. What is the pI of alanine?

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

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

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

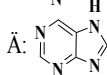
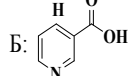
397. In acidic medium glycine molecule turns into: $\begin{array}{c} \text{CH}_2\text{—COOH} \\ | \\ \text{NH}_2 \end{array}$

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

398. Which of the following is pyridine?



399. Which of the following is pyrrole?



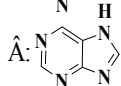
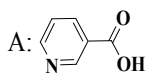
400. Which of the following is pyrimidine?



401. Which of the following is purine?



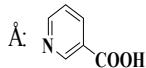
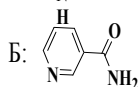
402. Which of the following is nicotinic acid?



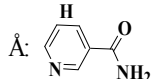
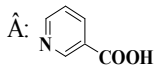
403. Which compound is five-membered heterocycle?

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

404. Which of the following is imidazole?



405. Which of the following is thiazole?

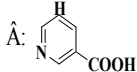
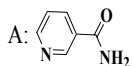


406. Which molecule contains pyrrole ring?



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

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

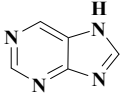


408. *Pyrimidine* contains:



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

409. Which molecule contains purine ring?



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

410. Which of the following is fused heterocycle?

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

411. Which molecule contains pyrimidine ring?



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

412. 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

413. Which of the following are purine bases?

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

414. Which compound is six-membered heterocycle?

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

415. Which molecule contains pyridine ring?



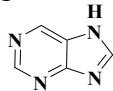
- a) nicotinic acid; b) hemoglobine; c) adenine; d) histidine; e) barbituric acid

416. Which molecule contains imidazole ring?



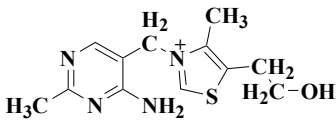
- a) histidine; b) hemoglobine; c) nicotinic acid; d) barbituric acid e) cytosine

417. Purine contains:



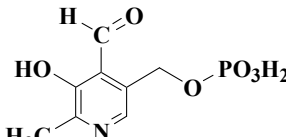
- a) 1 pyrrolic nitrogen and 3 pyridic nitrogens; b) 2 pyridic nitrogens;
c) 3 pyrrolic nitrogens and 1 pyridic nitrogen; d) 2 pyrrolic nitrogens and 2 pyridic nitrogens;
e) 2 pyrrolic nitrogens

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



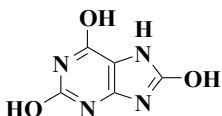
- a) thiazole; b) pyrrole; c) imidazole; d) pyridine; e) purine

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

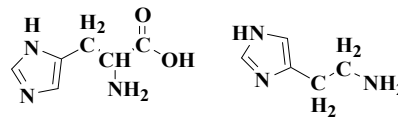


- a) pyridine; b) pyrrole; c) pyrimidine; d) purine; e) thiazole

420. 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



421. Histidine and histamine are derivatives of: imidazole;
a) indole; b) quinoline; c) pyrrole; d) pyridine



422. 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

423. 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

424. 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;
f) mRNA activates rRNA.

425. 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.

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

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

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

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

428. 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

429. What is the secondary structure of DNA?

- a) Double helix; b) α -pleated sheet c) β -helix d) cloverleaf e) straight chain

430. What is the secondary structure of transfer RNA (tRNA)?

- a) cloverleaf b) double helix c) β -helix d) α -pleated sheet e) Straight chain

431. Mononucleotides are the monomers of:

- a) Nucleic acids b) Proteins c) Starch d) Glycogen e) Heparin

432. Which of the following is macroergic compound?

- a) ATP b) NAD^+ c) NADP^+ d) NADH_2 e) cAMP

433. Which of the following is the coenzyme of dehydrogenases?

- a) NAD^+ b) AMP c) ADP d) ATP e) cAMP

434. Coenzyme NAD^+ catalyzes:

- a) Oxidation-reduction processes b) Decarboxylation processes c) Deamination processes
d) Transamination processes e) Dehydration processes

435. 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

436. Which of the following gives thymine on hydrolysis?

- a) DNA b) RNA c) Proteins d) Polysaccharides e) Lipids

437. Which of the following gives uracil on hydrolysis?

- a) RNA b) DNA c) Proteins d) Polysaccharides e) Lipids

438. NAD^+ is a derivative of:

- a) Nicotinic acid amide b) Novocainamid c) Ascorbic acid d) Pyridoxal e) Glucopyranose

439. 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
440. 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
441. Which reaction provides biological function of ATP?
 a) Hydrolysis b) Esterification c) Dehydration d) Transamination e) Decarboxylation
442. Which of the following contains guanine?
 a) DNA and RNA b) DNA c) RNA d) Proteins e) Polysaccharides
443. Which of the following contains adenine?
 a) DNA and RNA b) DNA c) RNA d) Proteins e) Polysaccharides
445. Which of the following contains cytosine?
 a) DNA and RNA b) DNA c) RNA d) Proteins e) Polysaccharides

3.3 Control questions

- Electronic structure of biogenic elements. Typical chemical properties of the elements and their compounds. Relation between location of s-, p-, and d-block elements in the periodic table and their content in the organism.
- Modern ideas about the structure of complex compounds. Classification of complex compounds.
- Instability and stability constants of complex ions. Fundamentals of complexometry.
- Intracomplex compounds. Polynuclear complexes. Complex compounds in biological systems. Structure of hemoglobin.
- Role of solutions in life activity. Enthalpy and entropic factors of dissolution and their connection with dissolution mechanism.
- Solubility of gases in liquids. Henry's and Dalton's laws. Influence of electrolytes on gases solubility. Solubility of gases in blood.
- Solubility of solid substances and liquids. Distribution of substances between to immiscible liquids. Nernst's distribution law, its significance for biological membranes permeability.
- Equilibrium in electrolytes solutions. Ostwald's dilution law.
- Water dissociation. Ionic product of water. pH of biological liquids.
- Solubility product. Conditions of formation and dissolving of precipitates.
- Types of proteolytic reactions. Neutralization, hydrolysis and ionization reactions.
- Hydrolysis of salts. Degree of hydrolysis. Dependence of hydrolysis on the concentration and temperature. Hydrolysis constant.
- Fundamentals of titrimetric analysis. Methods of acid-base titration. Acid-base indicators and principles of their selection.
- Buffer systems and their classification. pH of buffer solutions.
- Mechanism of buffer systems action.
- Buffer capacity and factors which it depends on. Buffer systems of blood.
- Colligative properties of diluted solutions. Raoult's law. Cryometry and ebulliometry.
- Osmosis. Osmotic pressure. Van't-Hoff's law. Plasmolysis and hemolysis.
- Isotonic coefficient. Hypo-, hyper- and isotonic solutions in medical practice. Role of osmosis in biological systems.
- High-energy compounds. ATP as universal source of energy for biochemical reactions. Characteristic of macroergic bonds.
- First law of thermodynamics. Internal energy. Enthalpy. Heat of isobaric and isochoric

- processes. Standard heat of formation and standard heat of combustion of the compound.
22. Thermochemistry. Hess's law. Thermochemical transformations.
 23. Thermochemical calculations and their application for energetic characteristic of biochemical processes.
 24. Second law of thermodynamics. Entropy. Gibbs energy.
 25. Chemical equilibrium. Thermodynamic conditions of equilibrium. Prognosis of direction of spontaneous processes. Exergonic and endergonic processes in the organism.
 26. Law of mass action. Chemical equilibrium constant. The ways of expression of chemical equilibrium constant. Le Chatelier's principle. Shifting of chemical equilibrium.
 27. Rate of a chemical reaction. Law of mass. Rate constant.
 28. Classification of chemical reactions. Photochemical reactions.
 29. Order of reaction. Half-reaction period.
 30. Dependence of rate of a chemical reaction on the temperature. Temperature coefficient. Van't-Hoff's rule. Peculiarities of biochemical processes.
 31. Arrhenius equation. Activation energy. Theory of effective collisions and activated state theory.
 32. Homogeneous and heterogeneous catalysis. Peculiarities of catalysts action. Mechanism of catalysis. Role of catalysis in metabolism.
 33. Enzymes as catalysts for biochemical reactions. Dependence of enzymes action on the concentration of enzyme and substrate, temperature and pH.
 34. Electrode potentials. Nernst's equation. Standard electrode potential. Standard hydrogen electrode.
 35. Measurement of electrode potentials. Indicating electrodes. Reference electrodes.
 36. Oxidation – reduction electrode potentials. Mechanism of their origin. Biological significance. Nernst-Peters's equation.
 37. Oxidation – reduction reactions in the organism. Prognosis of red-ox reactions direction according to standard values of Gibbs energy and values of oxidation – reduction potentials.
 38. Oxidation – reduction titration (oxidimetry). Permanganatometry, iodimetry.
 39. Potentiometry and its application in biomedical investigations.
 40. Diffusive and membrane potentials. Biopotentials. Ion-selective electrodes, their application for measurement of H^+ ions concentration (glass electrode), K^+ , Na^+ , Ca^{2+} ions concentrations in biological liquids.
 41. Peculiarities of high-molecular weight compounds solutions. Mechanism of swelling and dissolving of high-molecular compounds (HMWC). Dependence of HMWC swelling and dissolving on different factors. Role of swelling in physiology.
 42. Isoelectric point of proteins. Methods of IEP determination.
 43. Jellification of HMWC solutions. Properties of jellies.
 44. Abnormal viscosity of HMWC solutions. Viscosity of blood and other biological liquids. Osmotic pressure of biopolymers solutions. Galler equation. Oncotic pressure of blood plasma and serum.
 45. Donnan's membrane equilibrium.
 46. Surface activity. Duclou-Traube rule. Gibbs equation. Orientation of molecules in surface layer and structure of biological membranes.
 47. Langmuire equation.
 48. Adsorption from solutions on the surface of solids. Freundlich equation.
 49. Physico-chemical fundamentals of adsorption therapy.

50. Electrolytes adsorption (selective and ion-exchange). Panet-Faience rule.
51. Ionites and their application in medicine.
52. Classification of chromatographic methods. Application of chromatography in biomedical researches.
53. Dispersed systems and their classification. Methods of obtaining and purification of colloidal solutions. Dialysis, electrodialysis, ultra-filtration.
54. Molecular-kinetic properties of colloidal solutions. Optical properties of colloidal solutions. Ultramicroscopy.
55. Structure of colloidal particles.
56. Electrokinetic potential. Electrophoresis. Helmholtz-Smoluchowski equation.
57. Kinetic and aggregative stability of lyosols. Factors of stability. Mechanism of coagulating action of electrolytes.
58. Coagulation threshold, its determination. Hardy Schulze rule. Purification of drinking water and sewage water by coagulation. Colloidal protection, its biological role.
59. Coarsely dispersed systems. Preparation and properties.
60. Bioorganic chemistry as a science: definition, subject and tasks, sections, research methods. Significance in the system of higher medical education.
61. Classification of organic compounds according the structure of the carbon radical and the nature of functional groups.
62. Nomenclature of organic compounds: trivial, rational, international. Principles of formation of names of organic compounds according to the IUPAC nomenclature: substitutes, radical-functional.
63. The nature of the chemical bond in organic compounds: hybridization of orbitals, the electronic structure of carbon compounds.
64. Spatial structure of bioorganic compounds: stereochemical formulas; configuration and conformation. Stereoisomers: geometric, optical, rotary (conformers).
65. 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.
66. Types of reactions in bioorganic chemistry: classification by the result (direction) and reaction mechanism. Examples.
67. Carbonyl compounds in bioorganic chemistry. Chemical properties and biomedical significance of aldehydes and ketones.
68. Carboxylic acids in bioorganic chemistry: structure and chemical properties; functional derivatives of carboxylic acids (anhydrides, amides, esters). Decarboxylation reactions.
69. The structure and properties of dicarboxylic acids: oxalic, malonic, succinic, glutaric, fumaric.
70. Lipids: definition, classification. Higher fatty acids: palmitic, stearic, oleic, linoleic, linolenic, arachidonic. Simple lipids. Triacylglycerols (neutral fats): structure, physiological significance, hydrolysis.
71. Complex lipids. Phospholipids: phosphatidic acid, phosphatidylethanolamine, phosphatidylcholine, phosphatidylserine. Sphingolipids. Glycolipids. The role of complex lipids in the construction of biomembranes.
72. Amines: nomenclature, properties. Biomedical significance of biogenic amines (adrenaline, noradrenaline, dopamine, tryptamine, serotonin, histamine) and polyamines (putrescine, cadaverine).

73. Amino alcohols: structure, properties. Biomedical significance of ethanol amine (colamine), choline, acetylcholine.
74. Hydroxy acids in bioorganic chemistry: structure and properties of monocarboxylic (lactic and β -hydroxybutyric), dicarboxylic (malic, tartaric) hydroxy acids.
75. Carbohydrates: definition, classification. Monosaccharides (aldose and ketosis; triose, tetrose, pentose, hexose, heptose), biomedical significance of individual representatives.
76. Monosaccharides: pentoses (ribose, 2-deoxyribose, xylose), hexoses (glucose, galactose, mannose, fructose) - structure, properties. Qualitative reactions to glucose.
77. Structure and properties of monosaccharide derivatives. Amino derivatives: glucosamine, galactosamine. Uronic acids. L-Ascorbic acid (vitamin C). Products of reduction of monosaccharides: sorbitol, mannitol.
78. Oligosaccharides: structure, properties. Disaccharides (sucrose, lactose, maltose), their biomedical value.
79. Polysaccharides. Homopolysaccharides: starch, glycogen, cellulose, dextrans - structure, hydrolysis, biomedical value. Qualitative reaction to starch.
80. Heteropolysaccharides: definition, structure. Structure and biomedical significance of glycosaminoglycans (mucopolysaccharides) - hyaluronic acid, chondroitin sulfates, heparin.
81. Amino acids: structure, stereoisomerism, chemical properties. Biomedical role of L- α -amino acids. Reactions of biochemical transformations of amino acids: deamination, transamination, decarboxylation.
82. 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.
83. Proteins and peptides: definition, classification, biological functions. Types of bonds between amino acid residues in protein molecules. Peptide bond: formation, structure; biuret reaction.
84. Levels of structural organization of proteins: primary, secondary, tertiary and quaternary structures. Oligoproteins.
85. Physico-chemical properties of proteins; their molecular weight. Denaturation methods. Denaturation of proteins.
86. Heterocyclic compounds in bioorganic chemistry: structure, classification, chemical properties and biomedical significance.
87. Five-membered heterocycles with one heteroatom (pyrrole, furan, thiophene). Biomedical role of tetrapyrrole compounds: porphines, porphyrins, heme.
88. 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.
89. Five-membered heterocycles with two nitrogen heteroatoms. Pyrazole, pyrazolone; pyrazolone-5 derivatives as drugs (antipyrine, amidopyrine, analgin). Imidazole and its derivatives: histidine, histamine.
90. Five-membered heterocycles with two different heteroatoms: thiazole, oxazole. Thiazole as a structural component of the thiamine molecule (vitamin B1).
91. 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.
92. Six-membered heterocycles with two nitrogen atoms. Diazines: pyrimidine, pyrazine, pyridazine. Nitrogen bases are pyrimidine derivatives (uracil, cytosine, thymine).

93. Pyrimidine derivatives as drugs: 5-fluorouracil, potassium orotate. Barbituric acid; barbiturates as hypnotics and antiepileptics (phenobarbital, veronal).
94. Purine and its derivatives. Amino derivatives of purine (adenine, guanine), their tautomeric forms; biochemical significance in the formation of nucleotides and coenzymes.
95. Nucleosides, nucleotides. Nitrogen bases of purine and pyrimidine series, which are part of natural nucleotides. Minor nitrogenous bases.
96. Nucleosides. Nucleotides as phosphorylated derivatives of nucleosides (nucleoside mono-, di- and triphosphates). Nomenclature of nucleosides and nucleotides as components of RNA and DNA.
97. Structure and biochemical functions of free nucleotides: nucleotides-coenzymes; cyclic nucleotides 3', 5'-cAMP and 3', 5'-cGMP.
98. Nucleic acids (deoxyribonucleic, ribonucleic) as polynucleotides. Polarity of polynucleotide strands of DNA and RNA.
99. Structure and properties of DNA; nucleotide composition, complementarity of nitrogenous bases. Primary, secondary and tertiary structure of DNA.
100. RNA: structure, types of RNA and their role in protein biosynthesis.
101. 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) Creation schemes and educational tables:
- 1 black-white table – 1 points;
 - 1 colored table – 2 points.
- 2) participation in out-of-department events (conferences, congresses etc.) – up to 5 points.

3.5 Grade Appeal Process

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.

Educational process for students and teachers is organized in accordance with:

- Regulations of KhNMU on the organization of the educational process;
- Regulations of KhNMU on evaluation criteria and rules;
- Code of Academic Integrity of KhNMU.

5.0 Academic INTEGRITY

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. Medical chemistry: textbook / V.O. Kalibabchuk, V.I. Halynska, L.I. Hryshchenko et al.; edited by V.O. Kalibabchuk. — 5th edition, corrected. — Kyiv : AUS Medicine Publishing, 2017. — 224 p.
2. Fundamentals of medical chemistry: manual for students' self-work / A.O. Syrovaya, E.R. Grabovetskaya, L.G. Shapoval. – Kharkiv: KhNMU, 2015.–196 p.
3. Medical chemistry. Adapted concise course: manual for students' self-work / A.O. Syrovaya, E.R. Grabovetskaya, L.G. Shapoval. - Kharkiv: KhNMU, 2013. – 160 p.
4. Educational-methodical complex for first-year students' and self-work in Medical Chemistry / compiled by G.O.Syrova, V.M.Petiunina, V.O.Makarov et al. – Kharkiv: KhNMU, 2019. – 162 p.

5. 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.

6. Fundamentals of bioorganic chemistry: manual / A.O.Syrovaya, E.R.Grabovetskaya, V.N.Petiunina. – Kharkiv, KhNMU. – 2016. – p.

7. 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. Inorganic Chemistry: manual / V.O. Kalibabchuk, V.V. Ogurtsov, V.B.Emelianov, V.I.Galinska et all. - Kiev: BCB “Medicine”, 2017. - 300 p.

2. 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 disciplines “Medical chemistry” and “Bioorganic 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.