MINISTRY OF HEALTH OF UKRAINE

KHARKIV NATIONAL MEDICAL UNIVERSITY

Medical and bioorganic chemistry department
Academic year 2021-2022

SYLLABUS OF EDUCATIONAL COMPONENT

"Medical chemistry"
(name of educational component)

Normative or optional component ___Normative___

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

Knowledge area 22 «Health Care»

Specialty 222 «Medicine», second (master) level

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

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

Protocol dated
30th of August 2021 No 19

Head of the department

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

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

Protocol dated
31th of August 2021 No 1

Chief

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

Educational subject description (abstract)

Subject matter of Medical chemistry is chemical fundamentals of life processes which keep in with the main chemical laws. Medical chemistry studies structure and reactivity of the most important biologically active molecules, theory of chemical bond in complex compounds of biometals with biolygands and role of biogenic elements in life processes. 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 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 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 chemistry are necessary to study biochemistry, physiology, phatophysiology, pharmacology and toxicology, ecology more deeply.

Link to the discipline page in MOODLE

http://distance.knmu.edu.ua/course/view.php?id=520

1. OBJECT AND PURPOSE OF ACADEMIC DISCIPLINE

1.1. The object of studying Medical chemistry is a preparation of medical student, assistance in obtaining knowledge necessary to understand functions of certain body systems, interaction of human body with environment and with ability to make different calculations for analysis one or another processes.

1.2. Key tasks of studying discipline "Medical 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:
Abbility 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 educational outcomes**:

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

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

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

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

PEO 6 To establish a preliminary clinical diagnosis of the disease

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

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

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

1. Social and communicative: communication skills, interpersonal skills, team working, leadership, social intelligence, responsibility, ethics of communication.

2. Cognitive: critical thinking, problem-solving skills, innovative thinking, management of intellectual load, self-education skills, information skills, time management.

3. Personality attributes and components of emotional intelligence: emotional intelligence, honesty, flexibility, creativity, motivation.

INFORMATION VOLUME OF ACADEMIC DISCIPLINE

Indicator description	Branch of knowledge, field of education, educational and qualification level	Characteristic of academic discipline	
		Full-time or in-person form of education	
Quantity of credits – 4	Field of education 22 Health Care	Compulsory daytime	
Total quantity of hours – 120	Specialty: 222 Medicine	**Year of study:**	
		1-st	
		Semester	
		1-st	2-nd
		Lectures	
Hours for full-time education: in-class – 70 student's self-work – 50	Educational and qualification level: "Master of Medicine", professional qualification "Doctor"	18 h	2 h
		Practicals, seminars	
		40 h	10 h (1st stream)
		36 h	14 h (2nd stream)
		Self-work	
		40 h	10 h
		Type of control: graded test	

2.1 Description of discipline

2.1.1 Lectures

Sr.No	Subject	Number of hours
1	Complex formation in biological systems. Fundamentals of chelatotherapy	2
2	Colligative properties of biological liquids	2
3	Protolytic equilibria in chemical and biological systems	2
4	Fundamentals of titrimetric analysis	2
5	Theoretical fundamentals of bioenergetics	2
6	Kinetics of biochemical processes	2

7	Electrode processes, their biological role and application in medicine	2
8	Physical-chemistry of surface phenomena. Fundamentals of adsorption therapy. Chromatography	2
9	Micro heterogeneous systems. Colloidal solutions. Coarsely dispersed systems	2
10	Physical-chemical properties of biopolymers solutions (HMWC)	2
Total		**20**

2.1.2 Laboratorial-practical classes

№	Subject	Number of hours
1.	Fundamentals of laboratory technology. Overview of the biogenic elements. Complex formation in biological systems.	4
2.	Values characterizing quantitative composition of solutions. Preparation of solutions. Colligative properties of solutions.	4
3.	Acid-base equilibrium in the organism. pH of biological liquids.	4
4.	Buffer solutions, classification and properties. Buffer systems of human body.	4
5.	Fundamentals of titrimetric analysis. Preparation and standardization of NaOH operating solution.	4
6.	Gastric juice acidity determination. Tap water hardness determination	4
7.	Chemical thermodynamics.	4
8.	Kinetics of biochemical reactions and catalysis. Chemical equilibrium.	4
9.	Oxidation-reduction reactions. Electrode potentials and mechanism of their origin. Role of electrochemical phenomena in biological processes. Potentiometry.	4
10.	Sorption of biologically active substances at a phase interface. Ion exchange. Chromatography.	4
11.	Preparation and properties of colloidal solutions. Coagulation of colloidal solutions. Colloidal protection.	4
12.	Properties of biopolymers solutions. Isoelectric point of protein. Course project defence «Chemistry of biogenic elements»	4
13.	**Graded test**	2
Total hours		**50**

2.2.3 Self-work

Sr. No	Subject	Number of hours
1.	Macroelements, microelements and impurity elements. Organogens. Application in medicine. Complexones and their use in medicine as antidotes for heavy metal poisoning (chelation therapy) and as antioxidants in the storage of	4

	drugs. Drawing up the formula of complex compounds and equations of complex formation reactions for understanding the role of natural complex compounds in the life of organisms. Method of molecular orbitals. Cyrochromes (cytochrome P450).	
2.	The role of solutions in the life activity of the organism. Solubility of gases in liquids. Dependence of gas solubility on pressure (Henry Dalton's law), nature of gas and solvent, temperature. Influence of electrolytes on gas solubility (Sechenov's law). Solubility of gases in the blood. Decompression sickness and mountain disease. One-sided and two-sided diffusion. The role of osmosis in biological systems.	4
3.	Electrolytes and non-electrolytes. Characteristics of electrolytes' properties: electrolyte strength, solubility, concentration of hydrogen and hydroxyl ions. pH values for various biological fluids in norm and pathology. The role of hydrolysis in biochemical processes. Factors influencing the shift of hydrolysis equilibrium.	4
4.	Acid-base theories: 1. Arrhenius theory; Bronsted-Lowry theory; Lewis theory. Preparation of buffer solutions. Buffer solutions of an organism. Buffer capacity, factors that affect it. The concept of acid-base state of the blood.	4
5.	Classification and principles of titrimetric methods of analysis (permanganatometry, iodometry and others). Indicators. Methods of titrimetric determination.	4
6.	Acidity of gastric juice and its types. Features of determination of gastric juice acidity by acid-base titration. Water hardness and its types.	4
7.	Energy characteristic of biochemical processes. Thermochemical calculations to estimate caloricity of food and compile rational and therapeutic diets. Macroergic compounds. Energetical coupling in living systems: exergonic and endergonic processes in the body. ATP – energetical currency of the human body.	4
8.	Main regularities of chemical reactions of different types. The concept of the reaction mechanism. Chain reactions. Photochemical reactions. Activation energy. Theory of active collisions. Arrhenius equation. The concept of the theory of transition state (activated complex).	4
9.	Electrode potentials and the mechanism of their origin. Nernst's equation. Types of electrodes. Indicating electrodes and reference electrodes. The role of redox reactions in life processes. Redox potential as a measure of oxidative and reducing capacity of systems. The essence of the potentiometry.	4
10.	Surface phenomena and their significance in biology and medicine. Surfactants and surfactants. Physico-chemical bases of adsorption therapy (hemosorption, plasma sorption, lymphosorption, enterosorption, application therapy). The role of adsorption and ion exchange in the vital processes of plants and organisms. Adsorbents and their application as medicinal products. Classification of chromatographic methods. Application of chromatography in biology and medicine.	4
11.	Methods of obtaining of lyophobic sols, their structure and properties.	4

	The concept of kinetic (sedimentation) and aggregative stability of dispersed systems. Methods of obtaining and purification of colloidal solutions. Dialysis, electrodialysis, ultrafiltration, compensatory dialysis, dialysis - medical aspects. Hemodialysis and "artificial kidney" apparatus. Clearance as operating characteristic of hemodialyzer. Physiotherapy as treatment method. Significance of colloidal protection for medicine.	
12.	Comparative characteristics of biopolymer solutions, true and colloidal solutions. Neutrality principle. Donnan equilibrium in the human body. The role of swelling in the physiology of the human body. Coacervation and its role in biological systems. Reviewing of scientific literature in "Biogenic role of elements".	4
13.	Work with lecture note, with electronic learning management system MOODLE. *Preparation for Graded Test*	2
Total number of hours		**50**

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

Control methods:

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

Final assessment: graded test.

Graded test (GT) is carried out on the last practical class according to the time table. Graded Test consists of two levels: 1 level is 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)

1. Which element is needed for thyroxine (thyroid gland hormone) synthesis?
   a) iodine; b)sulfur; c) potassium; d) calcium; e) carbon
2. Which of the following belongs to s-block elements?
   a) Na; b) Cl; c) Fe;d) C; e) S
3. Which element is involved in a macroergic bond formation?
   a) Phosphorus b) Calcium c) Sodium d) Iron e) Chlorine
4. What is the content of oxygen in the ambient air?
   a) 21% b) 1% c) 11% d) 0.1% e) 31%
5. Which of the following forms strong covalent bond?
   a) carbon b) iron c) chlorine d) sodium e) copper
6. Which biologically-active substances do not contain nitrogen?
   a) starch b) proteins c) nucleic acids d) lipids
7. 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
8. Sulfur is in composition of:
   a) VitaminB$_1$; b) Vitamin B$_6$; c) Vitamin A; d) Vitamin PP; e) Vitamin C
9. Which element in excess results in fluorosis?
   a) F, b) Cl, c) Fe, d) Ca, e) P
10. Which of the following is in composition of chlorophyll?
    a) Magnesium, b) Zink, c) Molybdenum, d) Chromium, e) Iron
11. Which of the following elements of I group main subgroup has maximal radius of hydrated ion?
    a) Litium b) Potassium c) Sodium d) Cesium e) Rubidium
12. In hemoglobin the coordination number of iron is:
    a) 6; b)3; c)4; d)2; e)8
13. In the complexes $[Fe(CN)_6]^{3-}$ and $[Cr(C_2O_4)_3]^{3-}$, 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
14. Which of the following is a main component of bone tissue?
    a) $Ca_5(PO_4)_3OH$ b) $Ba_3(PO_4)_3OH$ c) $NaCl$ d) $CaSO_4 \cdot 2H_2O$ e) $BaSO_4 \cdot 2H_2O$
15. 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 B$_{12}$ 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^{-2}%.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 $[Co(NH_3)_6]Cl_3$?
    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 $[Cr(H_2O)(NH_3)_4Cl]Cl$ is
    a)+2;   b)+3;   c)+4;   d)+5;   e)+6

23. The IUPAC name of $[Cu(NH_3)_4]SO_4$ is:
a)tetraammincopper(II) sulfate b) tetraammincopper (II) hydrosulfate
    c) amminecopper sulfate   d) tetraamminecuprum hydrosulfate

24. The oxidation state of Fe in $[Fe(H_2O)_5NO]SO_4$ is
    a)+2; b)+3; c)+4; d)+5; e)+6

25. Which of the following ions is the least stable?
    a) $K_{inst}([Ag(NO_2)_2]^-) = 1.3\cdot10^{-3}$ b) $K_{inst}([Ag(NH_3)_2]^+) = 6.8\cdot10^{-8}$
    c) $K_{inst}([Ag(S_2O_3)_2]^{3-}) = 1.0\cdot10^{-13}$ d) $K_{inst}([Ag(CN)_2]^-) = 1.0\cdot10^{-21}$

26. Which of the following is cationic complex?
    a) $[Ni(H_2O)_6]Cl_2$ b) $K_2[Zn(OH)_4]$ c) $[PtNH_3Br_5]$ d) $[Pt(NH_3)_2Cl_4]$

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) SO_4^{2-} b)H_2O; c)NO_2; d) F^-; e) Cl^-

30. Which of the following is bidentate ligand?
    a) $C_2O_4^{2-}$ b)H_2O; c)NH_3; 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)=58.5g/mol, f=1   b) M(E)=49.5g/mol, f=3   c) M(E)=81g/mol, f=4

d) M(E)=55.5g/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) Cα c) pKb d) K_{diss} e) pKa

49. How to calculate pH in KOH solution?

a) $pH=14+lgC_{base}$ b) $pH=14-lg C_{base} \cdot \alpha$ c) $pH=-lg[H^+]$ d) $pH=-lgC_{base} \cdot \alpha$

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) $[H^+]=[OH^-]=10^{-7}$ mol/L b) $[H^+]+[OH^-]=10^{-7}$ mol/L c) $[H^+]/[OH^-]=10^{-7}$ 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) $pH>7$; $[H^+]<10^{-7}$ b) $pH<10$; $[OH^-]<10^{-7}$ c) $pH=7$; $[H^+]=10^{-7}$
    d) $pH>3$; $[OH^-]=10^{-7}$ e) $pH<7$; $[H^+]>10^{-7}$

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) pH=6; b)pH=2; c) pH=0; d) pH=7; e) pH=9

60. How to calculate pH in NH_4OH solution?
    a) $pH=14+lgC_{base}\cdot\alpha$; b) $pH=-lg[H^+]$ c) $pH=14+lgC_{base}$ d) $pH=-lgC_{base}\cdot\alpha$

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) pH=14; b) pH=0.1; c) pH=1.0; d) pH=7; e) 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) $Fe(OH)_3$

66. How to calculate hydrogen ions concentration using pH?
    a) $[H^+]=10^{-pH}$ b) $[H^+]=10\cdot lgC\alpha$ c) $[H^+]=10^{-7}\cdot lgC\alpha$ d) $[H^+]=10^{-7}\cdot lnC\alpha$ 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) pOH=0;   b) pOH=0.1; c) pOH=1.0; d) pOH=7;   e) pOH=14

70. Which of the following is more acidic?
    a) pH=1 b) pH=5 c) pH=3 d) pH=7 e) pH=11

71. How to calculate pH in HCl solution?
    a) $pH=-lgC_{acid}$ b) $pH=14-lgC_{acid}$ c) $pH=-lgC_{acid}\cdot\alpha$ d) $pH=lgC_{acid}\cdot\alpha$

72. Which pH value corresponds to the maximum buffer capacity of phosphate buffer
    solution ($pK_{NaH2PO4}=6.8$)?
        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) $CH_3COOH+CH_3COOLi$ b) $NaOH+NaHS$ c) $CH_3COOH+CH_3COONH_4$
    d) $NH_4OH+NH_4HCO_3$ e) $HNO_3+NH_4NO_3$

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) $H^+ + HPO_4^{2-} \rightleftarrows H_2PO_4^-$

b) $HPO_4^{2-} + HOH \rightleftarrows H_2PO_4^- + OH^-$

c) $H_2PO_4^- + OH^- \rightleftarrows HPO_4^{2-} + H_2O$

d) $CH_3COO^- + H^+ \rightleftarrows CH_3COOH$

e) e) $HPO_4^{2-} \rightleftarrows H^+ + PO_4^{3-}$

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

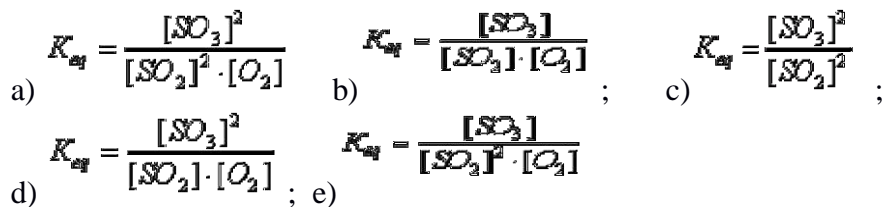85. The boiling point of a solvent containing a non-volatile solute:

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. Plasmolisys 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) $HCl+NaOH \rightarrow NaCl+H_2O$; b) $CuCl_2+Na_2CO_3 \rightarrow CuCO_3+2NaCl$;
   c) $CaCl_2+Cu(OH)_2 \rightarrow Ca(OH)_2+CuCl_2$; d) $NH_3(g)+HCl \rightarrow NH_4Cl$;
   e) $2H_2O+2Cl_2(g) \rightarrow 4HCl(g)+O_2(g)$

99. Which of the following means "titer of solution"?

a) ratio between mass of a substance dissolved and the volume of solution
b) ratio between mass of a substance dissolved and the mass of solution
c) ratio between quantity of a substance dissolved and the volume of solution
d) 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?
a) $H_2C_2O_4 2 H_2O$; 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?
a) $C(E)_a \cdot V_a = C(E)_b \cdot V_b$; 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) $C_a \cdot V_a = C_b \cdot V_b$;
e) $C(E)_a \cdot m_a = C(E)_b \cdot V_b$;

102.   Which indicator can be used in case of titration of a weak acid with a strong base?
a) 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?
a) methyl orange b) thymol blue c) phenolphthalein d) methyl red

104.   Which formula can be used for HCl concentration according to the titration data?
a) $C(E)_a \cdot V_a = C(E)_b \cdot V_b$; 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) $C_a \cdot V_a = C_b \cdot V_b$;
e) $C(E)_a \cdot m_a = C(E)_b \cdot V_b$;

105.   Which of the following is operating solution for gastric juice acidity determination?
a) 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?
a) $H_2C_2O_4 2 H_2O$; b) H_2SO_4; c) $Na_2B_4O_7 10 H_2O$; d) H_2O_2; e) Na_2CO_3

107.   In which case during titration the equivalence point is at pH=7?
a) 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?
a) 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?
a) 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?
a) 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?
a) 20-40; b) 5-10; c) 42-45; d) 45-50; e) 15-25

112.   In which case the titration jump is the greatest?
a) titration of a strong acid with a strong base; b) titration of a strong acid with a weak base;
c) 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?
a) 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
a) open system; b) closed system; c) isolated system; d) inert system; e) none of these

115.   For a spontaneous reaction, ΔG should be:
a) 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?
a) concentration b) rate of reaction c) time   d) catalyst

117.   The mechanism of energetic coupling is based on participating of
a) phosphate-ion   b) sulfate-ion c) carbonate-ion d) chloride-ion

118.   Enthalpy is:

a) 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=const; b) P=const; c) T=const; d) P=const, T=const; e) Vconst

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: $CO_{2(g)} + H_{2(g)} \underset{\leftarrow}{\overset{\rightarrow}{}} CO_{(g)} + H_2O_{(g)}$
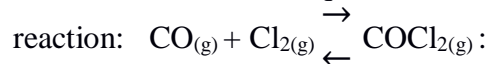   a) the equilibrium will not be affected;
   b) the equilibrium will be shifted to the left;
   c) the equilibrium will be shifted to the right;
   d) the equilibrium does not depend on pressure;
   e) reaction is irreversible

132. Write the equilibrium constant expression for the reaction: $2SO_{2(g)}+O_{2(g)} \underset{\leftarrow}{\overset{\rightarrow}{}} 2SO_{3(g)}$:

a) $K_{eq} = \dfrac{[SO_3]^2}{[SO_2]^2 \cdot [O_2]}$ b) $K_{eq} = \dfrac{[SO_3]}{[SO_3] \cdot [O_2]}$;   c) $K_{eq} = \dfrac{[SO_3]^2}{[SO_2]^2}$;

d) $K_{eq} = \dfrac{[SO_3]^2}{[SO_2] \cdot [O_2]}$;   e) $K_{eq} = \dfrac{[SO_3]}{[SO_3]^2 \cdot [O_2]}$

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

reaction: $CO_{(g)} + Cl_{2(g)} \underset{\leftarrow}{\overset{\rightarrow}{}} COCl_{2(g)}$:

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

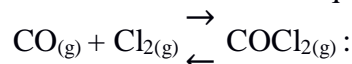135. In which direction the equilibrium will be shifted by increasing the concentration of
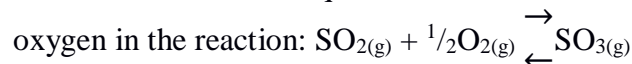
oxygen in the reaction: $SO_{2(g)} + {}^1/_2 O_{2(g)} \underset{\leftarrow}{\overset{\rightarrow}{}} SO_{3(g)}$

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 reaction:

$CO_{(g)} + Cl_{2(g)} \underset{\leftarrow}{\overset{\rightarrow}{}} COCl_{2(g)}$:

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) reaction is irreversible

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

a) $Ksp = [Ca^{3+}]^3 [PO_4^{3-}]^2$ b) $Ksp = [Ca^{3+}]^3 [PO_4^{3-}]$ c) $Ksp = [Ca^{3+}] [PO_4^{3-}]$

d) $Ksp = [Ca^{3+}] [PO_4^{3-}]^2$ e) $Ksp = [Ca^{3+}]^3 [PO_4^{3-}]^3$

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

hydrogen in the reaction: $CH_{4(g)} + 2H_2S_{(g)} \underset{\leftarrow}{\overset{\rightarrow}{}} CS_{2\,(g)} + 4H_{2(g)}$
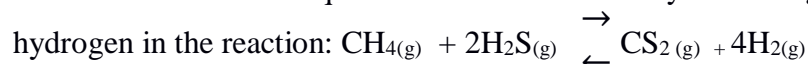
a) the equilibrium will be shifted to the left; b) the equilibrium will be shifted to the right; c) the equilibrium will not be affected; d) the equilibrium does not depend on concentrations; e) reaction is irreversible

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

a) $Zn|Zn^{2+}$; b) Hg, $Hg_2Cl_2|KCl$; c) $Pt|H^+_{quinhydrone}$; d) $Pt|\dfrac{MnO_4^-}{Mn^{2+}}, H^+$;
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, $Hg_2Cl_2|KCl$; b) $Zn|Zn^{2+}$; c) $Pt|H^+_{quinhydrone}$; d) $Pt|\dfrac{MnO_4^-}{Mn^{2+}}, H^+$; e) $Pt(H_2)|H^+$

143. Which of the following cells is used in the Linar probe?
   a. Sb, Sb_2O_3|H+||KCl|Hg_2Cl_2,Hg
   b. Pt(H_2)|H^+||KCl|AgCl, Ag
   c. Hg, Hg_2Cl_2|KCl||H^+quin|Pt
   d. glass|H^+||KCl| Hg_2Cl_2,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)Hg^{2+};   e) Cl^-

148. How to calculate potential of hydrogen electrode?
   a. e=-0.059pH; b) e=e^0+0.059pH; c) e= e^0-0.059lgC_{H+} ; d) e=-0.059(pH_2-pH_1);
   e) e=$\dfrac{0,059}{n}$ pH

149. Which galvanic cell is used in pH-meter?
   a) glass|H^+||KCl||AgCl, Ag ;   b) Pt(H_2)|H^+|| KCl|Hg_2Cl_2,Hg;
   c) Pt| $\dfrac{Cu^{2+}}{Cu^+}$||$\dfrac{Fe^{3+}}{Fe^{2+}}$| Pt;   d) Sb, Sb_2O_3|H+|| KCl|AgCl, Ag;
   e) Sb, Sb_2O_3|H+||KCl|Hg_2Cl_2,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) C_3H_7-NH_2 b) NaOH   c) NH_3 d) $AlCl_3$ e) NH_4OH

152. Which of the following substances is able to decrease the surface tension of water?
   a. $C_{15}H_{31}COONa$ b) $FeSO_4$ c) HNO_3 d) Na_3PO_4 e) $CaCl_2$

153. Which of the following substances has higher value of surface activity?
   a) C_4H_9COOH b) CH_3COOH c) C_2H_5COOH d) C_3H_7COOH e) HCOOH

154. Which of the following is the surface-active substance?
   a. $C_{17}H_{35}COONa$ b) Na_2SO_4 c) $BaCl_2$ d) $Cu(NO_3)_2$ e) H_2SO_4

155. Which ions will be adsorbed on the particles of silver iodide ppt obtained in the reaction $AgNO_3$ + KI?
   a. Ag^+ and I^- ..
   b. Ba^{2+} and NO_3^-
   c. SO_4^{2-} and K^+ .
   d. K^+ and NO_3^- .
   e. NO_3^- and I^-

156. Which of the following dissolves in water better?
   a. KCl b) C_6H_6 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) C_3H_7COOH

b. $C_5H_{11}-NH_2$

$$NH_2$$
$$|$$
e) $CH_3-CH_2-CH-COOH$

c. CH_3-C-CH_3
$$||$$
$$O$$

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 $FeCl_3 + K_4[Fe(CN)_6]$(excess)$\rightarrow$
   a. $\{(Fe_4[Fe(CN)_6]_3)m\ n[Fe(CN)_6]^{4-}\ (4n-x)K^+\}^{x-}xK^+$
   b. $\{(Fe_4[Fe(CN)_6]_3)m\ n[Fe(CN)_6]^{4-}4nK^+$
   c. $\{(Fe_4[Fe(CN)_6]_3)m\ nFe^{3+}3(n-x)Cl^-\}3xCl^-$
   d. $\{(Fe_4[Fe(CN)_6]_3)m\ nFe^{3+}3nCl^-\}$

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) $2NaCl + Pb(NO_3)_2 \leftrightarrow PbCl_2 + 2NaNO_3$ b) $H_2SO_4 + 2NaOH \leftrightarrow Na_2SO_4 + 2H_2O$;

  c) $Na_2CO_3 + H_2SO_4 \leftrightarrow Na_2SO_4 + CO_2 + H_2O$;

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) $pH = pI$;   b) $pH > pI$;   c) $pH < pI$

192. Polar polymer swells better in:
   a) polar solvent; b) benzene; c) non-polar solvent; d) non of these

3.3 Control questions

1. 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.
2. Modern ideas about the structure of complex compounds. Classification of complex compounds.
3. Instability and stability constants of complex ions. Fundamentals of complexometry.
4. Intracomplex compounds. Polynuclear complexes. Complex compounds in biological systems. Structure of hemoglobin.
5. Role of solutions in life activity. Enthalpy and entropic factors of dissolution and their connection with dissolution mechanism.
6. Solubility of gases in liquids. Henry's and Dalton's laws. Influence of electrolytes on gases solubility. Solubility of gases in blood.
7. Solubility of solid substances and liquids. Distribution of substances between to immiscible liquids. Nernst's distribution law, its significance for biological membranes permeability.
8. Equilibrium in electrolytes solutions. Ostwald's dilution law.
9. Water dissociation. Ionic product of water. pH of biological liquids.
10. Solubility product. Conditions of formation and dissolving of precipitates.
11. Types of proteolytic reactions. Neutralization, hydrolysis and ionization reactions.
12. Hydrolysis of salts. Degree of hydrolysis. Dependence of hydrolysis on the concentration and temperature. Hydrolysis constant.
13. Fundamentals of titrimetric analysis. Methods of acid-base titration. Acid-base indicators and principles of their selection.
14. Buffer systems and their classification. pH of buffer solutions.
15. Mechanism of buffer systems action.
16. Buffer capacity and factors which it depends on. Buffer systems of blood.
17. Colligative properties of diluted solutions. Raoult's law. Cryometry and ebulliometry.
18. Osmosis. Osmotic pressure. Van't-Hoff's law. Plasmolysis and hemolysis.
19. Isotonic coefficient. Hypo-, hyper- and isotonic solutions in medical practice. Role of osmosis in biological systems.
20. High-energy compounds. ATP as universal source of energy for biochemical reactions. Characteristic of macroergic bonds.
21. 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 weigh 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. Duclo-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.

3.4. Individual tasks

Individual work is estimated by additional points–up to 5 points and includes.
1) participation in All-Ukrainian Olympiad in Medical chemistry:

III place – 3 points;

II place – 4 points;

I place – 5 points.

2) participation in the work of exhibition held on the department:
- participation – 1 point;
- encouragement award – 2 points;

III place – 3 points;

II place – 4 points;

I place – 5 points.

3) creation schemes and educational tables:

black-white table – 1 points;

colored table – 2 points.

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

3.5 Grade challenge

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

4. POLICY OF DISCIPLINE

Teachers of medical and bioorganic chemistry set up a claims and rules to the students:
- All tasks covered by program must be done at a started time.
- Students must pass incoming and outcoming control, solve tasks, study theoretical questions, understand interdisciplinary integrations, master practical skills.
- If student is absent due to excusable reason, he/she shows done home-work and answer teacher's questions.

- During the class students must wear lab-coat and hair cover.

5.0 ACADEMIC HONESTY
Academic honesty should not be infringed at the carrying out of scientific projects and tasks.
- Presentations and reports must be original.
- Copying off, using of different software applications, mobile phones, tablet computers or other electronic gadgets is prohibited.
- Not be permitted to enter the class after lesson began.
When organizing the educational process, students and teachers act in accordance with:
- The Decree of KhNMU about the organization of educational process;
- The Decree of KhNMU about the criteria and rules of estimation;
- The Codex of Academic honesty of KhNMU.

For applicants for higher education and other persons involved in the educational process is **worthy**:
1. Respect the honor and dignity of others, even if their views are different from yours.
2. Responsible for their responsibilities, timely and conscientiously perform the tasks provided by the curriculum.
3. Actively work independently, using manuals, recommendations of teachers, additionally developing new literature, using all opportunities to obtain the necessary knowledge.
4. Effectively allocate time to search and study the materials needed to obtain education of high quality.
5. Honestly and responsibly prepare for the current, final control, making efforts to perform all tasks in time.
6. Use only referenced and reliable sources of information in educational or research activities and refer to them.
7. Submit for evaluation only self-performed work that is not borrowed or processed from another, performed by third parties.
8. In case of difficulties in performing educational or research tasks, turn to others for help that is within acceptable limits, etc.

6.0 RECOMMENDED LITERATURE
Basic
1. 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 / complited by G.O.Syrova, V.M.Petiunina, V.O.Makarov et al. – Kharkiv: KhNMU, 2019. – 162 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.

7. INFORMATION RESOURCE

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

8. OTHER INFORMATION

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

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

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