APPROVED
by Academic Council of Institute of Medicine, Ecology and Physical Culture of Ulyanovsk State University
Protocol № ____ from «____»_____2020__.
Chairman _____/V.I. Midlenko/_
(signature)

WORKING PROGRAM

Subject:	Chemistry
Department:	General and Biological Chemistry

Speciality: 31.05.01 "General Medicine"
(код специальности (направления), полное наименование)

Qualification – specialist, term of training-6 years, form of training-full-time.

The date of implementation of the program: «_____»_____2020__y.

The program updated at the meeting of the department: protocol №_____ from _____ 20_____ yr.

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Information about the developers:

Name	Department	Academic degree, academic title
Lubov Fedorovna Yenikeyeva	General and Biological Chemistry	Associate professor

APPROVED	APPROVED
Head of the Department, realizing discipline	Head of the graduating department
_____/Shroll O.J./ *Signature* *Name*	_____/Vise-Chripunova M.A./ *Signature* *Name*
« » 2020	« » 2020

1. AIMS AND OBJECTIVES OF THE DISCIPLINE.

The purpose of mastering the discipline “Chemistry" is the formation of systemic knowledge of the Chemistry is one of the components in complex learning course materials program.
Chemistry is the basis of all biological processes among the sciences, which constitute the foundation of medicine. Methods of chemical analysis are constantly used in the diagnosis of diseases and preventive medicine surveys.
Of particular importance is the sections of chemistry in the study of normal and pathological processes in humans at the molecular and cellular levels, in the appearance and development of such disciplines as molecular biology, quantum chemistry, molecular kinetics, molecular pathology, clinical pharmacology, which is the theoretical basis of modern medicine.
Training of medical students requires knowledge and understanding of the functions of individual systems in the body, and as a whole, body interaction with the environment, and the ability to use different calculations for quantitative analysis of various processes is the aim and objective of this discipline.

2. PLACE OF DISCIPLINE IN MAIN PROFESSIONAL EDUCATION PROGRAM.

The discipline “Chemistry" refers to the basic part of main professional education program of speciality.

The process of studying the discipline is aimed at the formation of the following competencies:
The process of studying the discipline is aimed at the formation of the following competencies:
- readiness to use basic physico-chemical, mathematical and other natural-scientific concepts and methods in solving professional problems (GPC-7);

3. LIST OF EXPECTED RESULTS OF TRAINING OF THE SUBJECT (MODULES), CORRELATED WITH THE EXPECTED RESULTS OF THE PROGRAM

Code and name of the implemented competence	The list of planned learning outcomes of subjects (modules), correlated with indicators of achievement of competencies
GPC – 7 Readiness to use basic physical, chemical, mathematical and other natural science concepts and	To know: -basic concepts, laws, and modern scientific theories of chemistry; - the basic provisions of thermodynamics, kinetics and catalysis, not necessary for understanding the peculiarities of biochemical reactions;

methods in solving professional problems	- fundamentals of the doctrine of solutions that are necessary for proper understanding of biochemical processes; - the main provisions of electrochemistry, physics and chemistry of surface phenomena and disperse systems necessary for understanding the structures and properties of biological membranes, and methods of medical practice: dialysis, electrophoresis, electroosmosis and others.; - the structure of the major classes of natural organic compounds before macromolecules and structural elements of cells and areas of metabolic process in the body; - predicting chemical behavior of natural organic compounds in certain environments; - possible ways and conditions of conversion of functional groups in important classes of natural organic compounds and the basis of their genetic connectivity in biochemistry; - structure and functions of biologically active substances in living systems; -metabolism at the level of metabolism of the main substrates and biosynthesis of compounds necessary for the body; - To be able to: -use the acquired knowledge to solve situational problems; -evaluate the course of chemical processes in living systems, based on theoretical provisions; - To posess: - the ability to work independently with educational, scientific and reference literature on the subject; - the ability to search for the necessary information and make generalizing conclusions; - to determine the structure of the molecules in the presence of reaction centers, to determine their nature: acidic, basic, electrophilic or nucleophilic and qualitatively assess the possibility of reactive organic compounds - present experimental data in graphs and tables - solve common practical problems - confidently navigate the information flow (use reference data and bibliography on a particular problem)

Volume of the discipline is 6 credit units (144 **hours**.)

4.VOLUME OF THE DISCIPLINE.

4.1. Volume of the discipline and types of educational work:

Type of educational work	Number of hours (form of training-full-time)		
	Total	By semester	
		1	
Classroom lessons:	72	72	
Lectures	18	18	
Practical works	54	54	
Self - study	36	36	
Type of certification (exam)	36	36	
Total volume of the discipline	144	144	

4.2. Distribution of hours by topics and types of educational work:

Form of training-full-time

Title of sections and topics	Total	Types of educational work			
		Classroom lessons			Self - study
		Lectures	Classes	Practical work	
Section 1. Acid-base equilibrium and formation of complexes in biological liquids.					
1. Introduction. Safety in chemical laboratory. Periodical system by D.I. Mendeleev. Electronic structure of elements and ions. Control test of initial knowledge.	3,5	0,5		1	2
2. Biogenic s - elements: chemical properties, biological role, uses in medicine.	3,5	0,5		1	2
3. Biogenic p - elements: chemical properties, biological role, uses in medicine.	3,5	0,5		1	2
4. Biogenic d - elements: chemical properties, biological role, uses in medicine.	3,5	0,5		1	2
5. Formation of complexes in	3,5	0,5		1	2

biological systems					
Section 2. Acid-base equilibrium in biological liquids					
6. Methods of expression of solutions concentration. Preparation of solutions.	5	1		3	1
7. Acid-base equilibrium in the organism. pH scale of biological liquids.	5	1		3	1
8. Volumetric analysis. Neutralization method. Alkalimetry.	5	1		3	1
9. Neutralization method. Acidimetry.	5	1		3	1
10. Buffer systems: classification, mechanism of the action.	5	1		3	1
11. Buffer capacity. Role of the buffer systems in biological systems.	5	1		3	1
12. Colligative properties of solutions. Osmosis.	5	1		3	1
Section 3. Thermodynamics of solutions and electrode processes					
13. Thermal effects of the chemical direction of the processes.	6	1		3	2
14. Kinetics of biochemical reactions.	5	1		3	1
15. Chemical equilibrium. Solubility equilibrium.	5,5	0,5		3	2
16. Potentiometric method of analysis.	5	1		3	1
17. Determination of oxidation-	5	1		3	1

reduction (redox) potential.					
Section 4. Equilibriums in biologocal systems on the border of the phases.					
18. Absorption of biological active compounds on the layer liquid - gas.	5	1		2	2
19. Absorption of biological active compounds on the layer solid compound - solution.	5,5	0,5		3	2
20. Ion exchange. Chromatography.	5	1		2	2
21. Preparation, purification and properties of colloidal solutions.	4,5	0,5		2	2
22. Coagulation of colloidal solutions. Colloidal stability.	4,5	0.5		2	2
23. Properties of biopolymers. Isoelectric point of proteins.	4,5	0,5		2	2
Total	108	18		54	36

5. THE CONTENT OF THE DISCIPLINE.

Content module 1. Chemistry of biogenic elements. Formation of complex in biological liquids

Theme 1. Biogenic s- and p-elements; biological role, application in medicine.

General information about biogenic elements. High-quality and quantitative maintenance of biogenic elements in the human body. Macroelements, microelements and mixed elements. Organogens. The concept is about the studies of V.I. Vernadskiy, about a biosphere and role of living matter (living organisms). The connection is between maintenance of biogenic elements in the human body and their maintenance in an environment. Endemics, their connection with the features of biogeochemical provinces (districts with a natural deficit or surplus of certain chemical elements in a sial). Problems of contamination and cleaning of biosphere from the toxic compounds of technogenic origin.

Electronic structure and electronegativity of s– and p– elements. Typical chemical properties of s– and p– elements and their bonds (reactions are without the change of degree of oxidation). Bond between the location of s– and p– elements in the periodic system and by their

maintenance in an organism. Application is in medicine. Toxic action of connections.

Theme 2. Biogenic d-elements, biological role, application in medicine

Metal life. Electronic structure and electronegativity of d-elements. Typical chemical properties of d–elements and their bonds (reactions with the change of degree of oxidation, formation of complexes). Biological role. Application in medicine. The toxic action of d-elements and their connections.

Theme 3. Formation of complex in biological systems

Reaction of complex formation. The coordinating theory of A.Verner and modern pictures of structure of complex bonds. The concept is about complex formation (central ion). Nature, coordinating number, hybridization of orbitals of complex formation. The concept is about ligands. Coordinating capacity (dentatnist') of ligands. Internal and external spheres of complexes. Geometry of complex ions. Nature of chemical connection is in complex connections. Classification of complex connections on the charge of internal sphere and by

natural ligands. Inside connections. Half cell complexes. Iron-, cobal't- and zinc- biocomplex connections. The concept is about a metaloligands homoeostasis. Violation of homoeostasis. Complexes and their application in medicine as antidotes of heavy metals by poisoning (chelation therapy) and as antioxidants in storage of medicinal preparations.

Contens module 2. Acid-basic equilibrium in biological liquids

Theme 4 Sizes which characterize quantitative composition of solutions. Preparation of solutions

Role of solutions in the vital functions of organisms. Classification of solutions. Mechanism of processes of dissolution. Thermodynamics in process of dissolution. Solubility of matter. Solubility of gases in liquids. Dependence of solubility of gases on pressure (law of Henry-Dalton), nature of gas and solvent, temperature. Influence of electrolytes on solubility of gases (law of Sechenov). Solubility of gases in blood. The curve. Solubility of liquids and hard matter in liquids. Dependence of solubility on a temperature, nature of permeate and solvent. Distributing of matter between two liquids which are unmixed. The law of Nernst and his value in the phenomenon of permeability of biological membranes. Sizes which characterize quantitative composition of solutions. Preparation of solutions with the set quantitative composition.

Theme 5. Bases of titrimetric analysis

Bases of titrimetric analysis. Methods of titrimetric analysis. Method of acid-basic titration. Acid-basic indicators.

Theme 6. Acid-basic equilibrium in an organism. PH-value of biological liquids

Solutions of electrolytes. Electrolytes in human organisms. Degree and constant of dissociation of weak electrolytes. Properties of solutions of strong electrolytes. Activity and coefficient of activity. Ionic force of solution. Water-electrolyte balance is a necessary condition of homeostasis.

Dissociation of water. Ionic property of water. pH value of Hydrogen. Value of pH for the different liquids of human organism in normal and in pathology. Theories of acids and bases. Types of protolitic reactions: reactions of neutralization, hydrolysis and ionization. Hydrolysis of salts. Degree of hydrolysis, dependence of it on concentration and temperature. Constant of hydrolysis. Therole of hydrolysis in biochemical processes.

Theme 7. Buffer systems, classification and mechanism of action

Buffer solutions, their classification. Equalization of Genderson-Gassel'bah. Mechanism of buffer action.

Theme 8. Determination of buffer capacity. Role of buffers in the biosystems

Buffer capacity. Buffer systems of blood. Bicarbonate buffer, phosphatic buffer. Albuminous buffer systems. Concept of acid-base state of blood.

Theme 9. Colligative properties of solutions

Colligative properties of the dissociated solutions of nonelectrolites. A relative decline of pressure of saturated pair of solvent above solution. Law of Raul. Ideal solutions. A decline of temperature of freezing and heating temperature of boiling of solutions in comparison to the solvents. Osmose and osmasis. Law of Shrouds-Goff. Colligative properties of the dissociated solutions of electrolytes. Isotonic coefficient. Hypo-, hyper- and isotonic solutions

Cryometry, ebulliometry, osmometry, their application, is in medico-biologic researches. A role of osmosis is in the biological systems. Osmosis of blood plasma. Equation of Galler. Oncotic pressure. Plasmolysis and hemolysis.

Module 2 EQUILIBRIUMS IN BIOLOGICAL SYSTEMS ON LIMIT OF DIVISION OF PHASES.

Semantic module 3. Thermodynamics and kinetic conformities to law of motion of processes and electrokinetic phenomena in the biological systems.

Theme 10. Thermal effects of chemical reactions. Orientation of processes

Article of chemical thermodynamics. Basic concepts of chemical thermodynamics: thermodynamic systems (isolated, closed, opened, homogeneous, heterogeneous), parameters of the state (extensive, intensive), thermodynamic processes (circulating, irreversible). Living organisms – the thermodynamic systems are opened. Irreversibility processes of vital functions.

First law of thermodynamics. Enthalpy Thermo-chemical equations. Standard heat and combustion. Law of Hess. Method of calorimetry. Power description of biochemical processes. Thermo-chemical calculations for the estimation of calorie content of food and drafting of rational and medical diets. Arbitrary and nonarbitrary processes. Second law of thermodynamics. Entropy. Thermodynamic potentials: energy of Gibbs, energy of Helmholtz. Thermodynamic terms of equilibrium. Criteria of orientation

Application of substantive provisions of thermodynamics is to the living organisms. ATP as an energy source for biochemical reactions. Macroenergetic bonds. Power supranational in the living systems: exergonic and endergonic processes in an organism.

Theme 11. Kinetics of biochemical reactions

Chemical kinetics as basis for the study of speed and mechanism of biochemical reactions. Speed of reaction. Dependence of speed of reaction on concentration. The law of operating the masses for speed of reaction. Constant of speed. Order of reaction. Kinetic equations of reactions of the first, second and zero order. The period of semitransformation is quantitative description of change of concentration in the environment of radio nuclides, pesticides, and others like that. The concept of the mechanism of reaction. Molecularity of reaction.

Dependence of speed of reaction on temperature. Rule Shrouds-Goff. Temperature coefficient of speed of reaction for biochemical processes. Energy of activation. Theory of collision. Equation of Arrenius. This concept is about the theory of the transitional state (activated complex).

Imagination of kinetics of difficult reactions: parallel, successive, circulating, competitive, chain. The concept of antioxidants. Free-radical reactions in living organism. Actinic reactions, photosynthesis. Catalysis and catalysts. Features of action of catalysts. Homogeneous, heterogeneous and microheterogeneous catalysis. Acid-basic catalysis. Autocatalysis. Mechanism of action of catalysts. Promotor and catalytic poisons.

Theme 12. Chemical equilibrium. Work of solubility is the chemical equilibrium.

Constant of chemical equilibrium and methods of its expression. Displacement of chemical equilibrium in the change of temperature, pressure and concentration of matters. Principle Lai Shatel'e. Reactions of besieging and dissolutions. Work of solubility. Terms of fall and dissolution of fallouts. Role of heterogeneous equilibrium is and participation of salts in the general homeostasis of organism.

Theme 13. Determination oxidation restoration to potential

Role of the electrochemical phenomena in biological processes. Electrode potentials and mechanism of their origin. Equation of Nernst. Normal (standard) electrode potential. Hydrogen half-cell. Measuring of electrode potentials. Electrodes for determination and electrodes for comparison. Chlorine is a silver electrode. Ions are selective electrodes. Glass electrode. Galvanic elements.

Diffusion potential. Diaphragm potential. Biological role of diffusion and diaphragm potentials. Damage Potential. Rest Potential. Action Potential. Role of oxidation-reduction reactions in the processes of vital functions. Oxidation-reduction potential as measure of oxidizing and reduction ability of the systems. Equalization of Peters. Normal oxidation-reduction potential.

Prognostication of direction of oxidation-reduction reactions after sizes of oxidation-reduction potentials. Equivalent of oxidant and repairer. Value oxidation restoration potentials in the mechanism of processes of biological oxidation. Helipot. Potenciometric determination of pH, activity of ions. Potenciometric titration.

Contens module 4. Physico-chemical superficial phenomena.
Lyophilic and lyophobic dispersible systems

Theme 14. Persorption bioactive matters on verge of division of phases

Superficial phenomena and their values in biology and medicine. Superficial properties of liquids and solutions. Isotherm of superficial pull. Surface activity and superficially nonactive matters. Superficial activity. Rule of Dyuklo-Traube.

Absorption on the verge of division of liquid-gas and liquid-liquid. Equation of Gibbs. An orientation of molecules of surface-active matters is in a superficial layer. Picture of structure of biological membranes. Absorption on the verge of division of hard body-gas. Equation of Lengmyur. Absorption is from solution on the spot solid. Physical and chemical adsorption. Conformities to law of adsorption of permeate, pairs and gases. Equation of Frendlih.

Physical and chemical bases of absorption therapy (hemosorbtion, plazmosorbtiuon, limphosorbtion, enterosorbtion, applique therapy). Immunoabsorbents.

Theme 15. Ionic exchange. Chromatography

Absorption of electrolytes: specific (electrical) and ionic exchange. Rule of Panet-Fayans. Ion-exchanges: natural and synthetic. Role of absorption and ionic exchange in the processes of vital functions of plants and organisms.

Chromatography. Classification of chromatographic methods of analysis on the basis of the aggregate state of phases, technique of execution and distributing mechanism. Absorption, ion exchange and distributive chromatography. Application of chromatography in biology and medicine.

Theme 16. Receipt cleaning and properties of colloid solutions

Organism as difficult aggregates of dispersible systems. Classification of dispersible systems is on the degree of dispersion. Colloid state. Lyophilic and lyophobic colloid systems. Structure of colloid parts. Double electric layer. Electrokinetic potential of colloid part**.**

Methods of receipt and cleaning of colloid solutions. Dialysis, electrodialysis, ultra filtration, compensative dialysis, vivi dialysis. Hemodialysis and vehicle as an "artificial bud". Molecular kinetic properties of the colloid systems. Brownian motion, diffusion, osmosis. Optical properties of the colloid systems.

Electrokinetic phenomena. Electrophoreses. Equation of Helmholtz-Smoluhovskiy. Application of electrophoreses in research, clinical and laboratory practice. Electrophorogrammes.

Theme 17. Coagulation of colloid solutions. Colloid defence

Kinetic (sedimentation) and aggregative firmness of dispersible systems. Factors of firmness. Coagulation. Mechanism of coagulation of electrolytes. Threshold of coagulation. Rule Schulce-Gardi. Intercoagulation. Processes of coagulation in drinkable water and flowing waters treatment. Colloid defence

The dispersible systems and a gaseous dispersible environment. Classification of aerosols, methods of receipt and property. Application of aerosols in clinical and sanitary-hygenic practice. Toxic action of some aerosols. Powders. The coarse-particle systems and a liquid dispersible environment. Suspensions, methods of receipt and property. To apply them medically. Emulsions, methods of receipt and property. Types of emulsions. Emul'gatores. Application of emulsions in clinical practice. Biological role of emulsilication. Semicolloid soap, detergents. Micelle formation in certain colloidal electrolyte solutions.

Theme 18. Properties of solutions of biopolymers. Isoelectric point of albumen

High molecular bonds are basis of living organisms. Globular and fibril structure of albumens. Comparative description of solutions of high molecular bonds, veritable and colloid solutions. Swelling and dissolution of polymers. Swelling mechanism. Influence of pH environment, temperature and electrolytes, on swelling. Role of swelling in physiology of organism. Galantine of solutions of VMS. Mechanism of galantine. Influence of pH environment, temperature and electrolytes, on speed of galantine. Thixotropy. Syneresis. Diffusion of galantines. The salting-out of biopolymers from solutions. Coacervation and its role is in the biological systems. Anomalous viscidity solutions of HMC. Viscidity of blood. Diaphragm equilibrium of Donnan. Isoelectric state of albumen. Isoelectric point and methods of its determination. The ionic composition of biopolymers in water solutions.

6. THEMES AND QUESTIONS FOR PREPARING TO CLASSES.

1.ELEMENTS OF CHEMICAL THERMODYNAMICS

1. Subject and tasks of chemical thermodynamics. Chemical thermodynamics as the basis of bioenergetics. Isolated, closed and open systems.
2. The first law of thermodynamics. Internal energy, heat and work. Isobaric and isochoric thermal processes. Enthalpy.
3. Hess's law and its corollaries. Standard formation and combustion heat. Thermochemical calculations and their usage for energetic characteristic of biochemical processes.
4. Interconnection between the processes of metabolism and energy exchange. Caloric value of main constituents of food and some food products. Energy consumption at different modes of moving activity.
5. Thermodynamically reversible and irreversible processes. The second law of thermodynamics. Entropy. Statistic and thermodynamic explanation of entropy. Standard entropy.
6. The Gibbs free energy (isobaric-isothermal potential). Enthalpy and entropy factors. Ex - and

endergonic processes in the organism.

7. Thermodynamics of chemical equilibrium. Reversible and irreversible reactions. Concept of chemical equilibrium. Constant of the chemical equilibrium. The interconnection between the constant of chemical equilibrium and the Gibbs free energy. Equations of isotherm and isobaric curve of a chemical reaction.

2.ELEMENTS OF CHEMICAL KINETICS

1. Main concepts of chemical kinetics. Simple and complex, homogeneous and heterogeneous reactions.
The speed of homogeneous chemical reactions and methods of its measuring.

2. The main postulate of chemical kinetics. The order of reaction and the reaction speed constant. The
Law of mass action for the speed of the reaction and its sphere of application.

3. Kinetic equations of the reactions of zero, first and second order. Period of semi-transformation. Mo- lecularity of the reaction.

4. Theory of active collisions. Arrhenius' equation. Energy of activation. Vant-Hoff's rule. Temperature
coefficient of the reaction speed for enzymatic processes.

5. Catalysis and catalysts. The theories of catalysis. The mechanism of homogeneous and heterogeneous catalysis. Enzymes as biological catalysts, peculiarities of their action.

3.COLLIGATIVE PROPERTIES OF SOLUTIONS

1. Thermodynamics of solution formation.

2. Osmose and osmotic pressure of solutions. Vant-Hoff's law.

3. Osmotic pressure, osmolarity and osmolality of some biological fluids. The concept of isotonic, hypertonic and hypotonic solutions.

4. The role of osmotic phenomena in biological processes.

5. The pressure of saturated vapor of solvent above the solution. Raoul's first law.

6. Boiling and freezing temperatures of solvents. Raoul's second law. Cryoscopy. Ebullioscopy.

7. Colligative properties of electrolyte solutions. Isotonic coefficient.

4.ELEMENTS OF TITRATION ANALYSIS

1. Titration analysis, its methods and tasks.

2. Classification of titration analysis methods.

3. Requirements to the methods used in titration analysis.

4. Standard solutions. Primary standards and requirements made to them. Secondary standards.

5. ELECTROLYTE SOLUTIONS. ACIDITY AND BASICITY OF AQUEOUS SOLUTIONS pH.

1. The theory of weak electrolyte solutions. Main characteristics of a weak electrolyte: α, K_{ion}, pK_{ion}.

2. The theory of strong electrolyte solutions. Main characteristics of a strong electrolyte: a, f_a, I.

3. Protolytic theory of acids and bases.

4. The ion product of water. Hydrogen index pH.

5. Calculation of solution pH of weak and strong acids and bases.

6. Determination of hydrogen ion exponent.

7. Role of hydrogen ions in biological processes.

6.BUFFER SYSTEMS

1. Buffer systems, their classifications.

2. Calculation of pH of acid and basic buffer solutions.

3. Mechanism of action of buffer systems.

4. Buffer capacity.

5. Basic buffer systems of the organism. Acidosis. Alkalosis.

6. Hydrocarbonate buffer system, mechanism of action.

7. Hemoglobin buffer system, mechanism of action.

8. Phosphate buffer system, mechanism of action.

9. Protein buffer system, mechanism of action.

7.BASES OF COLOIDAL CHEMISTRY

1.Conception of disperse systems & their classification.

2.Disperse systems & their classification on the base of dispersity degree. The nature of colloid stage. Methods of preparation & purification of colloid solutions. Artificial kidney.

3.Molecular-kinetic properties of colloid systems: Brownian movement, diffusion, osmotic pressure.

4.Methods of preparation of colloid solutions & their purification from LMC impurities.

5.Mechanism of colloid particle formation. The structure of double electric layer. Micelle, nucleus, granule.

6.Kinetic & aggregative stability of soles. Factors of stability. Conception of the theory of coagulation proposed by Deryagin-Landau & others.

7.Soles coagulation. Electrolytes influence on the soles stability. The coagulation threshold. Schulze-Hardy rule.

8.Coagulation of colloid compounds. The threshold of coagulation. Schulze-Hardy rule. Mutual soles coagulation.

9.Kinetic coagulation during the electrolytes action. Hidden slow & quick coagulation. Soles coagulation by the mixtures of electrolytes. Mutual coagulation of colloids.

Types of tasks

1. Calculation of Gibbs free energy.
2. Thermal chemical calculating solubility.
3. Calculating the speed of chemical reactions.
4. Calculations of equilibrium constants and displacement of equilibrium.
5. Calculations for the product solubility.
6. Calculations of redox - potential.
7. Calculations of largest Rf.
8. Micelle structure. Coagulation threshold.

7. PRACTICAL PART (LABORATORY WORKS).

№	Topic and content of laboratory classes
1	Fundamentals of chemical thermodynamics. Determination of the thermal effect of the neutralization reaction.
2	Chemical kinetics and chemical equilibrium
3	Solutions. Preparation of sodium chloride solution of a given concentration.
4	Solutions of electrolytes, the pH of strong and weak electrolytes. Ionic reactions and heterogeneous equilibria in electrolyte solutions. Hydrolysis of salts.
5	Preparation of buffer solutions with a given pH.
6	Titrimetric methods of analysis
7	Redox systems
8	Electrochemical process. Determination of pH, the activity coefficient of the strong electrolyte and the degree of dissociation of the weak electrolyte
9	Complex compound
10	Disperse system.
11	Polyfunctional connections
12	Heterofunctional connections
13	Amino acids (a-amino acids. Peptides.)
14	Heterocyclic compound
15	Carbohydrates
16	Lipid

8. SUBJECTS OF COURSE PAPERS, CONTROL WORKS, ABSTRACTS

This type of work does not provide by the program.

9. QUESTIONS TO THE EXAM OF CHEMISTRY.

1. Subject and tasks of chemical thermodynamics. Chemical thermodynamics as the basis of bioenergetics. Isolated, closed and open systems.

2.The first law of thermodynamics. Internal energy, heat and work. Isobaric and isochoric thermal processes. Enthalpy.

3. Hess's law and its corollaries. Standard formation and combustion heat. Thermochemical calculationsand their usage for energetic characteristic of biochemical processes.

4. Interconnection between the processes of metabolism and energy exchange. Caloric value of main constituents of food and some food products. Energy consumption at different modes of moving activity.

5.Thermodynamically reversible and irreversible processes. The second law of thermodynamics. Entropy. Statistic and thermodynamic explanation of entropy. Standard entropy.

6. The Gibbs free energy (isobaric-isothermal potential). Enthalpy and entropy factors. Ex - and endergonic processes in the organism.

7. Thermodynamics of chemical equilibrium. Reversible and irreversible reactions. Concept of chemical equilibrium. Constant of the chemical equilibrium. The interconnection between the constant of chemical equilibrium and the Gibbs free energy. Equations of isotherm and isobaric curve of a chemical reaction.

8. Main concepts of chemical kinetics. Simple and complex, homogeneous and heterogeneous reactions. The speed of homogeneous chemical reactions and methods of its measuring.

9. The main postulate of chemical kinetics. The order of reaction and the reaction speed constant. The Law of mass action for the speed of the reaction and its sphere of application.

10. Kinetic equations of the reactions of zero, first and second order. Period of semi-transformation. Molecularity of the reaction.

11. Theory of active collisions. Arrhenius' equation. Energy of activation. Vant-Hoff's rule. Temperature coefficient of the reaction speed for enzymatic processes.

12. Catalysis and catalysts. The theories of catalysis. The mechanism of homogeneous and heterogeneous catalysis. Enzymes as biological catalysts, peculiarities of their action.

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14. Osmose and osmotic pressure of solutions. Vant-Hoff's law.

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16. The role of osmotic phenomena in biological processes.

17. The pressure of saturated vapor of solvent above the solution. Raoul's first law.

18. Boiling and freezing temperatures of solvents. Raoul's second law. Cryoscopy. Ebullioscopy.

19. Colligative properties of electrolyte solutions. Isotonic coefficient.

20. Titration analysis, its methods and tasks.

21. Classification of titration analysis methods.

22. Requirements to the methods used in titration analysis.

23. Standard solutions. Primary standards and requirements made to them. Secondary standards.

24. The theory of weak electrolyte solutions. Main characteristics of a weak electrolyte: α, K_{ion}, pK_{ion}.

25. The theory of strong electrolyte solutions. Main characteristics of a strong electrolyte: a, f_a, I.

26. Protolytic theory of acids and bases.

27. The ion product of water. Hydrogen index pH.

28. Calculation of solution pH of weak and strong acids and bases.

29. Determination of hydrogen ion exponent.

30. Role of hydrogen ions in biological processes.

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32. Calculation of pH of acid and basic buffer solutions.

33. Mechanism of action of buffer systems.

34. Buffer capacity.

35. Basic buffer systems of the organism. Acidosis. Alkalosis.

36. Hydrocarbonate buffer system, mechanism of action.

37. Hemoglobin buffer system, mechanism of action.

38. Phosphate buffer system, mechanism of action.

39. Protein buffer system, mechanism of action.

41.Conception of disperse systems & their classification.

42.Disperse systems & their classification on the base of dispersity degree. The nature of colloid stage. Methods of preparation & purification of colloid solutions. Artificial kidney.

43.Molecular-kinetic properties of colloid systems: Brownian movement, diffusion, osmotic pressure.

44.Methods of preparation of colloid solutions & their purification from LMC impurities.

45.Mechanism of colloid particle formation. The structure of double electric layer. Micelle, nucleus, granule.

46.Kinetic & aggregative stability of soles. Factors of stability. Conception of the theory of

coagulation proposed by Deryagin-Landau & others.

47.Soles coagulation. Electrolytes influence on the soles stability. The coagulation threshold. Schulze-Hardy rule.

48. Coagulation of colloid compounds. The threshold of coagulation. Schulze-Hardy rule. Mutual soles coagulation.

49.Kinetic coagulation during the electrolytes action. Hidden slow & quick coagulation. Soles coagulation by the mixtures of electrolytes. Mutual coagulation of colloids.

50.Oxidative-reductive reactions & their role in the life processes. Equivalent of oxidizer & reducer.

51.Electrodes potentials & mechanism of their formation. Nurnst equation. Normal hydrogen electrode.

52.The mechanism of formation of oxidizing-reducing potential. Peter's equation.

53.Diffusion & membrane potentials.

10. SELF_STUDY WORK OF STUDENTS:

№	The name of the section	Content of self – study work	Number of hours	Type of checking
1	Introduction. Safety in chemical laboratory. Periodical system by D.I. Mendeleev. Electronic structure of elements and ions.	Theoretical training for practical work	1	Additional questions on the exam
2	Biogenic p - elements: chemical properties, biological role, uses in medicine.	Theoretical training for practical work	1	Additional questions on the exam
3	Biogenic s - elements: chemical properties, biological role, uses in medicine.	Theoretical training for practical work	1	Additional questions on the exam
4	Biogenic d - elements: chemical properties, biological role, uses in medicine.	Theoretical training for practical work	2	Additional questions on the exam

5	Formation of complexes in biological systems	Theoretical training for practical work	1	Additional questions on the exam
6	Methods of expression of solutions concentration. Preparation of solutions.	Theoretical training for practical work	1	Additional questions on the exam
7	Acid-base equilibrium in the organism. pH scale of biological liquids.	Theoretical training for practical work	2	Additional questions on the exam
8	Volumetric analysis. Neutralization method. Alkalimetry.	Theoretical training for practical work	2	Additional questions on the exam
9	Neutralization method. Acidimetry.	Theoretical training for practical work	1	Additional questions on the exam
10	Buffer systems: classification, mechanism of the action.	Theoretical training for practical work	2	Additional questions on the exam
11	Buffer capacity. Role of the buffer systems in biological systems.	Theoretical training for practical work	1	Additional questions on the exam
12	Colligative properties of solutions. Osmosis.	Theoretical training for practical work	1	Additional questions on the exam
13	Thermal effects of the chemical direction of the processes.	Theoretical training for practical work	1	Additional questions on the exam
14	Kinetics of biochemical reactions.	Theoretical training for practical work	1	Additional questions on the exam
15	Chemical equilibrium. Solubility equilibrium	Theoretical training for practical work	2	Additional questions on the exam
16	Potentiometric method of analysis.	Theoretical training for practical work	1	Additional questions on the exam
17	Determination of oxidation-reduction (redox) potential.	Theoretical training for practical work	2	Additional questions on the exam

18	Determination of oxidation-reduction (redox) potential.	Theoretical training for practical work	2	Additional questions on the exam
19	Absorption of biological active compounds on the layer liquid - gas.	Theoretical training for practical work	2	Additional questions on the exam
20	Absorption of biological active compounds on the layer solid compound - solution.	Theoretical training for practical work	1	Additional questions on the exam
21	Ion exchange. Chromatography.	Theoretical training for practical work	2	Additional questions on the exam
22	Preparation, purification and properties of colloidal solutions.	Theoretical training for practical work	2	Additional questions on the exam
23	Coagulation of colloidal solutions. Colloidal stability.	Theoretical training for practical work	2	Additional questions on the exam
24	Properties of biopolymers. Isoelectric point of proteins.	Theoretical training for practical work	2	Additional questions on the exam

10. EDUCATIONAL, METHODOLOGICAL AND INFORMATIONAL SUPPORT OF THE SUBJECT

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7.2. UlSU educational portal. - URL: http://edu.ulsu.ru. - Access mode: for register. users. - Text: electronic.

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