MINISTRY OF EDUCATION AND SCIENCE OF RUSSIAN FEDERATION
PENZA STATE UNIVERSITY
MEDICAL INSTITUTE

APPROVED
HEAD OF THE INSTITUTE
_____ MITROSHIN A.N.
«7» 03 2016 г.

THE PROGRAM OF ACADEMIC DISCIPLINE

C 1.1.11 CHEMISTRY

Program/Specialty 31.05.01 - General Medicine

Graduate's qualification (degree) General Practitioner

Mode of study Full-time

Penza – 2016

1. Subject mastering goals

Main goals of mastering of studying the discipline "Chemistry" is to equip the future specialist with knowledge and skills in the field of knowledge about modern achievements in chemistry, to teach students to use the acquired knowledge in the future specialty.

The task of the discipline is to familiarize students with the basic theories of the structure of matter, the chemical activity of substances.

When studying this discipline, the following competences are formed:

- employ knowledge in general science and its branches for solving professional tasks (GPC-7);

• know how to use drugs medicines and their combinations in in solving professional problems (GPC-8).

2. Subject's place in the structure of the MPEP's (main professional educational program of higher education)

Discipline "Chemistry" in the curriculum is in the basic part of the cycle C.1.

Chemistry is based on knowledge gained in the course of studying the school course in chemistry, mathematics and physics courses.

Competencies acquired during the study of chemistry prepare the student for mastering the disciplines of biochemistry C 1.1.13, pharmacology C 1.1.20, ecology C 1.1.34 and others.

3. Student competences developed as a result of subject (module) mastering

Studying of the subject is intended to developelements of the following competences according to FSESHE in the given field:

Competence codes	Title of of the competence	Structural elements of competence (having mastered the subject students should have knowledge, skills, working abilities)
GPC -7	employ knowledge in general science and its branches for solving professional tasks	Knowledge: the main provisions of chemical science, the rules of work and safety in chemical laboratories with reagents, instruments; Chemical and biological essence of the processes occurring in a living organism at the molecular level; Skills: to solve practical problems of chemistry in the sphere of professional activity; To use educational, scientific, popular scientific literature, the Internet for professional activities; Use laboratory equipment; Work with magnifying techniques in the study of chemistry; Working abilities: chemical methods for assessing technical indicators in relation to

		objects of professional activity.
GPC -8	know how to use drugs medicines and their combinations in in solving professional problems	Knowledge: the basic chemical properties of substances, the chemical-biological essence of the processes occurring in the living organism at the molecular level with the administration of drugs; Skills: to solve practical problems of chemistry in the sphere of professional activity; Working abilities: chemical methods for assessing technical indicators in relation to objects of professional activity.

4.1. Structure of the discipline (module)

General workload of the subject totals is 3 credit units, 17 lectures, 51 practice classes and 40 hours Out-of-class work (total 108 hours).

№	Subject's (module's) sections and topics	Semester	Semester's weeks	Types of learning, including students' out-of-class work and workload (in hours)									Current progress monitoring types *(by semester's weeks)*							
				Class work				Out-of-class work												
				Total	Lecture	Practice	Laboratory work	Total	Preparing for class work	Papers, essays etc.	Course work (project)	Preparing for exams	Interview	Spoken test	Test marking	Check work marking	Paper marking	Marking of essays and other creative	Course work	other
1.	Topic 1.1. Introduction. The main types of reactions occurring in the body. Elements of chemical thermodynamics.	1	**1**		2		2		1,5				1							
2.	Topic 1.2. Chemical equilibrium.	1	**2**				2		1,5											
3.	c 1.3. Elements of chemical kinetics.	1	**2**				2		1,0				2							
4.	Topic 2.1. Methods of expressing the concentrations of substances in solutions, methods of preparing solutions of a given concentration. The doctrine of solutions.	1	**3**		2		2		1,5											
5.	Topic 2.2. Colligative properties of solutions (diffusion, osmosis, osmolality, osmolarity). Equilibria in solutions. Hydrolysis of salts. Buffer systems. Solubility product.	1	**4**				2		1,5				4							

6.	Topic 2.3. Oxidation-reduction equilibria. Electrochemistry.	1	**4**				2		1,0				4	4						
7.	Topic 3.1. Chemistry of disperse systems.	1	**5**		2		2		1				5							
8.	Topic 3.2. Physico-chemical properties of solutions of biopolymers.	1	**6**				2		1											
9.	Topic 3.3. The role of colloidal surfactants in the assimilation and transport of low-polar substances in a living organism.	1	**6**				2		1				6							
10.	Topic 3.4.Elektrolitny balance of the human body.	1	7		2		2		1				7							
11.	Topic 4.1. Human chemical elements: s-elements and their compounds	1	**8**				2		1				8							
12.	Topic 4.2. d-elements and their connections and p elements and their connections.	1	**8**				2		1				8	8						
13.	Topic 5.1. Electronic effects, conjugation, aromatic.	1	**9**		2		2		1				9							
14.	Theme 5.2. Classification of reactions in organic chemistry	1	**10**				2		1											
15.	Theme 5.3. Types of isomerism in organic chemistry. The main types of reactions.	1	**10**				2		1				10							
16.	Topic 5.4. Carbohydrates.	1	**11**		2		2		1,5				11							
17.	Theme 5.5. Mono- and disaccharides. Tautomeric transformations. Chemical	1	**12**				2		1,5				12							

	properties, reaction mechanisms.																		
18.	Theme 5.6. Polysaccharides. Structure and properties. Homopolysaccharides and heteropolysaccharides.	1	**12**				2		1				12	12					
19.	Topic 6.1. Lipids. Saponifiable and unsaponifiable lipids.	1	**13**		2		2		1,0				13						
20.	Topic 6.2. Phospholipids, glycolipids, sphingolipids.	1	**14**				2		1,5				14						
21.	Topic 6.3. Terpenes and steroids.	1	**14**				2		1,5				14						
22.	Topic 6.4. Amino acids. Classification. Physical and chemical properties.	1	**15**		2		2		3				15						
23.	Topic 7.1. Heterocyclic compounds.	1	**16**		2		2		1,5				16						
24.	Topic 7.2. Nucleosides, nucleotides, polynucleotides.	1	**17**				3		1,5				17						
25.	Topic 7.3. Nucleic acids. Structure.	1	**17**				2		1				17	17					
	Course work (project)																		
	Preparing for examination											8							
	General workload, in hours				17		51		32			8	Interim attestation						
													Type				Semester		
													Test				*1*		
													Exam						

4.2. Contents of the discipline (module)

(The title of the sections, the disciplines and their content)

Topic 1.1. Introduction Chemistry and Medicine. Subject, tasks and methods of chemistry. Chemical disciplines in the system of medical education.

The structure of the atom (independently). Quantum-mechanical model of the atom. Characteristics of the energy state of an electron by a system of quantum numbers. The ground and excited state of the atom.

Periodic law and the periodic system of DI Mendeleev in the light of the quantum-mechanical theory of the structure of atoms; s-, p-, f-blocks of elements.

Chemical bond and intermolecular interaction (independently). The main types of chemical bonds. The mechanism of covalent bond formation. Length, energy and polarity of the bond. The structure of molecules as a consequence of the nature of the electronic structure of atoms. Saturation and directionality of covalent bond. Structure of molecules. Hybridization. Multiple connections. Method of molecular orbitals. Ionic bonding. Conditions for the formation of ionic bonds. The nature of intermolecular interaction. Non-directivity and unsaturation of the ionic bond. Donor-acceptor mechanism of covalent bond formation. Hydrogen bond. Intermolecular interaction. Crystalline and amorphous and vitreous state of matter.

The main types of reactions occurring in the body. Classification of substances of a living organism by their biological role. Classification of reactions, based on the nature of the transferred particles.

Protolytic reactions. Basic provisions of the protolytic theory of acids and bases: molecular and ionic acids and bases, conjugated protolytic vapor, ampholytes. Hydrogen pH.

Oxidation-reduction reactions. Redox systems of the first and second type. Types of redox reactions: intermolecular, intramolecular, disproportionation.

Ligand exchange reactions. Basic concepts of Werner's coordination theory. Spatial structure of complex compounds. Classes of complex compounds: intracomplex, macrocyclic, multi-nuclear.

Reactions of atomic-molecular exchange. Reactions of radical, electrophilic and nucleophilic substitution.

Reactions of association-dissociation and aggregation. Reaction of addition, precipitation.

Elements of chemical thermodynamics. Power engineering of chemical processes. Standard enthalpy of formation of chemical compounds. The law of Hess and the consequences of it. Basics of thermochemical calculations. The concept of entropy. Gibbs energy as a measure of chemical affinity. Direction of spontaneous flow of chemical processes.

Topic 1.2. Chemical equilibrium. Chemical equilibrium. The equilibrium constant. The principle of Le Chatelier, its significance for man. Exergonic and endergonic processes in the body. . The concept of homeostasis and the standard state of the body.

Topic 1.3. Elements of chemical kinetics. The rate of homogeneous and heterogeneous chemical reactions. Factors affecting the reaction rate. Law of the acting masses. The theory of active molecules. Energy and sources of activation. Catalysis. Mechanism of action of enzymes. The Michaelis-Menten equation.

Topic 2.1. Solutions. Classification and general properties of solutions. Ways of expression of concentration. Solubility. Dependence of solubility on the nature of the solvent and solute, temperature and pressure. Solutions of non-electrolytes. The laws of Henry, Dalton and Sechenov and their biological significance. Diffusion in solutions and the role of diffusion in biological systems. Cryoscopy and ebullioscopy. Osmosis. The distribution of the substance between two immiscible liquids.

Topic 2.2. Solutions of electrolytes. Theory of electrolytic dissociation. Weak electrolytes. The constant of electrolytic dissociation. The law of dilution Ostwald. Strong electrolytes. Interion interactions. Activity and activity ratio. Isotonic coefficient. Ionic strength of solutions.

Modern ideas about acids and bases. Ionic product of water. The hydrogen index. Equilibrium in solutions of sparingly soluble salts. Solubility product. Salt effect.

Hydrolysis of salts. Constant and degree of hydrolysis. Forms of hydrolysis: simple, stenchened, full.

Buffer systems (hydrocarbonate and phosphate systems), classification and their role in the human body. The Henderson-Hasselbach equation.

Electrolytes in the human body. Electrochemistry. Electrical conductivity of solutions of electrolytes. Conductometry. Electrical conductivity of tissues and biological fluids.

Topic 2.3. Oxidation-reduction and electrochemical processes. Step-oxidation. Nature of oxidation-reduction processes. Simple and complex substances as oxidants and reducing agents. The main types of oxidation-reduction reactions. Oxidation-reduction equivalent.

The concept of the electrode potential. Diffusion and membrane potentials. Hydrogen electrode. Classification of electrodes. Potentiometry. Ionometry and its application in medicine. Standard electrode potentials of metals and other oxidation-reduction systems. Direction of oxidation-reduction reactions. Dependence of the electrode potential on concentration and temperature. The Nernst equation. Theory of galvanic cells.

Complex connections. The structure of complex compounds. Chemical bonding in complexes. The method of valence bonds and the theory of the crystal field. Nomenclature of complex connections. Stability of complex compounds in aqueous solutions. The most important types of complex compounds (aqua, amino, acido, hydroxo complexes, chelates). Heteronuclear and poly-ligand complex compounds.

Complexes in medicine. Chelation therapy. Complexes as medicines.

Topic 3.1. Physical chemistry of surface phenomena. Surface energy and surface tension. Adsorption on the interface of phases. Adsorption isotherms. Ion exchange. Chromatography. The significance of the phenomenon of adsorption for living organisms.

Topic 3.2. Physico-chemical properties of solutions of biopolymers. Basic concepts of polymer chemistry. Spatial structure of high-molecular compounds. Solutions of high-molecular compounds and their properties (swelling and viscosity).

Topic 3.3. Chemistry of disperse systems. Methods for the preparation and purification of colloidal solutions. The structure of colloidal particles. Molecular-kinetic and electrotrokinetic properties of colloidal solutions. Coagulation. Colloidal solutions of surfactants. Polyampholytes, isoelectric point of polyampholytes. Colligative properties of IUD solutions. Selected methods of analysis (independently). Representations of the application in phototherapy and biology of photocolorimetry and other methods of analysis.

Topic 4.1. Chemical elements of the biosphere. The prevalence of chemical elements in nature. Macro and trace elements in the environment and in the human body. Arrangement of elements in the human body. Biological role of chemical elements in the human body. Regularities in the distribution of nutrient elements according to the periodic system of elements Mendeleyev's. The concept of the biogeneity of chemical elements. Biosphere, the cycle of biogenic elements. Clarks of elements. Concentration of biogenic elements by living systems. Classification of biogenic elements by their functional role: organogenes, elements of the electrolyte background, microelements. The concept of impurity elements (accumulating and non-accumulating). The main sources of intake of impurity elements in the human body. Chemical aspects of the environment.

Man and the biosphere. Technical progress and the environment. The relationship between endemic diseases and the characteristics of the environment.

Topic 4.2. s-elements and their connections. General characteristics of s-elements. Chemistry of elements of the s-block. Electronic structures of atoms and cations. Comparison of the properties of the ions of the elements of the IA and II groups (complexation, precipitation). The biological role of sodium, potassium, calcium, magnesium. Chemical similarity and biological antagonism (sodium-potassium, magnesium-calcium).

General characteristics; Brief information about the history of discovery of elements and their prevalence in nature. Changes in the groups of the radii of atoms and ions, the ionization potential. Comparison of the properties of simple substances IA and IIA groups. Reactions of sodium and potassium with oxygen. Properties of the most important beryllium compounds. Amphotericity of

beryllium compounds. Reactions of complexation of compounds of Group IIA elements, peculiarities of complexation of compounds of Group IA elements. Qualitative reactions to ions of lithium, sodium, potassium, beryllium, magnesium, calcium, strontium and barium. Use of flame staining reactions for the detection of IA and IIA cations. Medicobiological value of sodium, potassium, calcium. Compounds of lithium, sodium, potassium, magnesium and calcium as medicines. Toxicity of beryllium and barium. Hydrogen and its compounds. Hydrogen cation. Water. Radiolysis of water.

Topic 4.3.d-elements and their connections. General characteristics of d-elements. The biological role of d-elements. Chemistry of d-block elements. Electronic structures of atoms and cations. The most important biogenic elements of the d-block are: an island of biometals, chromium-copper, molybdenum. Oxidation-reduction properties: regularities of stability of oxidation degrees, instability of some oxidation states due to reaction of compounds with water (cobalt +3, chromium +2); Disproportionation of intermediate oxidation states (manganese 3+, 6+). Stability in the conditions of the body degree of oxidation. Formation of complex compounds with organic ligands; Hydroxokompleksy; Aminocomplexes; Formation of insoluble compounds: hydroxides, phosphates, carbonates, oxalates.

The biological role of manganese and its compounds. The biological role of elements of the family of iron and platinum. Iron-containing complexes. Hemoglobin and myoglobin. Cyto-chromium. Catalase and peroxidase. Non-heme iron-containing proteins. Iron-sulfur-containing proteins. Application of d-elements in medicine.

p-elements and their compounds. General characteristics of p-elements. Biological role of the p-elements of III, IV, V, VI and VII groups and their compounds.

Electronic structures of atoms and ions. Regularities in the manifestation of stable degrees of oxidation. Features of complexation reactions. Protolytic properties of p-block compounds. Inorganic compounds of carbon: cyanides, thiocyanates, carbon monoxide (II). Nitrogen: azide ion; oxonitride nitrogen (V), nitrous acid and nitrite. Phosphorus: polyphosphates. Oxygen: properties of ozone; singlet oxygen. Protolytic and redox-amphoteric properties of hydrogen peroxide. Sulfur: sodium thiosulfate. Chlorine: oxygen-containing compounds of chlorine. Chloride-calcium hypochlorite. The use of p-elements in medicine.

Topic 5.1. The mutual influence of atoms in organic molecules. Polarization and polarizability of bonds. Influence of inductive and mesomeric effects on the reactivity of substances. Electrodonor and electric acceptor substituents.

Acidity and basicity of organic compounds. Acidity and basicity according to Bronsted. Acids and Bronsted bases. Factors affecting the strength of acids and Bronsted bases. Acids and Lewis bases.

Topic 5.2. Types of organic reactions. Classification of organic reactions and reagents. The nature of bond rupture in the substrate and reagent. Radical, electrophilic and nucleophilic reagents and reactions (examples). Symbols of organic reactions.

Theme 5.3. Types of isomerism in organic chemistry. Structural isomerism and stereoisomerism (configurational and conformational).

Chiral molecules. Dynamic isomerism is tautomerism. Enantiomers with one chirality center. Stereoisomerism of lactic acid. Stereochemical series. Relative and absolute configurations. Fisher's projection formulas. Enantiomers and diastereomers in molecules with two or more centers of chirality. Racemates and mesoforms. Stereoisomerism of malic and tartaric acids.

Topic 5.4. Carbohydrates. Classification. The structure of aldohexoses. Types of isomerism in the series of monosaccharides. Stereoisomerism. Cyclic forms of monosaccharides in the Fisher and Heuwes designs, and -anomers. Cyclo-oxo-tautomerism. Aminosugar, deoxisugar. Tautomeric forms of glucose, ribose, deoxyribose, mannose, arabinose, lyxose, fructose, galactose. Chemical properties: mutarotation, formation of glycosides, ethers and esters. Oxidation and reduction reactions. Mutual conversions in an alkaline medium. Dehydration in an acidic medium.

Topic 5.5. Disaccharides. Restoring and non-reducing disaccharides. The difference in properties. The formation of open forms of maltose, lactose, cellobiose. Sugar-for. The structure of the molecule. Hydrolysis of sucrose.

Topic 5.6. Polysaccharides. Starch and fiber. Structure. Fractions of starch. Hydrolysis. Fiber Esters.

Alkanes. (Independently) sp3 - hybridization. The nature of σ - bond. Homogological series of methane. Radical substitution at the saturated carbon atom: halogenation and oxidation. Factors affecting the stability of radicals. Regioselective processes.

Alkenes. (Independently) sp2 - hybridization. The nature of the double bond. Chemical properties of alkenes. Electrophilic attachment to a double bond. The Markovnikov rule.

Conjugated systems with an open circuit (independently). 1,3-dienes. Reactions 1,2 and 1,4 of the addition. The stepwise mechanism of these reactions.

Conjugate systems with a closed conjugation system (independently). Benzene. Structure. Aroma. Hückel rule. The mechanism of reactions of electrophilic substitution in the aromatic series. Reactions of nitration, halogenation, sulfonation, alkylation and acylation by Friedel-Crafts. Effect of substituents on the reactivity of the benzene series. The orienting effect of the substituents of the first and second kind. Benzene derivatives as medicines: paraaminophenol and its derivatives, PABA, anesthesin and novocaine; sulfonamides: sulfadimethoxin and norsulfazole.

Halogen derivatives (independently). Methods for obtaining the properties of monohalogen derivatives of fatty series. Their interaction with ammonia, hydrocyanic acid, water, alcohol, aqueous alkali and thiols as examples of substitution and addition reactions. The mechanism of these reactions. Formation of esters. Dehydrohalogenation reaction.

Alcohols, phenols, thiols, ethers, sulphides (independently). Nomenclature. Monohydric alcohols. Synthetic methods and properties: for-compound and nucleophilic substitution reactions. Polyhydric alcohols: ethylene glycol and glycerol. Getting and properties. Phenols, thiols, ethers, sulphides are their chemical properties and the field of application in medicine.

Aldehydes and ketones (independently). Methods for the synthesis of aldehydes and ketones. The cost of the carbonyl group. Homological series of aldehydes. Nomenclature. The mechanism of re-actions of nucleophilic addition via the carbonyl group. Addition of water, alcohols HC. Substitution of □-hydrogen for halogen. Aldole and croton condensation of aldehydes. Addition-cleavage reactions. The addition of amines and their derivatives. The foundations of Schiff. Polymerization. Oxidation and reduction reactions of aldehydes. Dysmutation of formaldehyde. The reaction of Cannizzaro.

Carboxylic acids (independently). Methods of synthesis. The structure of the carboxyl group. Dissociation of acids. Preparation and properties of functional derivatives of acids. Mechanism of nucleophilic substitution reactions. Dibasic acids. Nomenclature. Production. Decarboxylation ability.

Amines (independently). Medico-biological significance. Nomenclature. Methods of synthesis. Properties: basicity of fatty amines, alkylation and acylation reactions, action of nitrous acid. Interaction with carbonyl compounds. The foundations of Schiff. Amines of an aromatic series. Aniline. Acetanilide.

Aminoalcohols (independently). Aminoethanol. Receiving. Acetylcholine. Catecholamine. Their biological significance.

Hydroxy- and oxo-acids (independently). Hydroxy acids. Methods of synthesis. Reactions of hydroxyl and carboxyl groups. Specific reactions of hydroxy acids. Individual representatives: glycolic, silicic and tartaric acids. Stereochemistry.

Oxoacids. Methods for the synthesis of pyruvic acid. Decarboxylation reaction. Some representatives: pyruvic, oxaloacetic, acetoacetic acid kits. Keto-enol tautomerism of acetoacetic ether.

Topic 6.1. Lipids. Classification of lipids. Fats as a mixture of triacylglycerides. Liquid and solid fats. Structure. Higher saturated and unsaturated acids, which are part of liquid and solid fats. Their stereoisomerism. General scheme of synthesis. Properties: saponification, hydrogenation, oxidation.

Topic 6.2. Glycerophospholipids. Phosphatidic acid. Phosphatidylcolamine. Phosphatidylserine. Phosphatidylcholine. Hydrolysis of cephalin.

Topic 6.3. Terpenes and steroids.

Topic 6.3. Amino acids. The structure of amino acids that make up proteins. Classification. Stereoisomerism. Three-letter designations, irreplaceable □-amino acids. Methods of obtaining α, β γ - amino acids. Chemical properties: amphotericity, isoelectric point, reactions of the carboxyl group: formation of salts, esters, halogen-dioxide-rides, decarboxylation.

Amino group reactions: acylation, deamination, transamination, interaction with aldehyde, with dinitrofluorobenzene. Formation of peptides. Qualitative reactions. Specific reactions α, β ,γ - amino acids.

Urea. Preparation of carbon dioxide and ammonia. Properties: formation of salts, biuret, action of nitrous acid. Acylation of urea - the formation of ureides and barbituric acid. Barbiturates. Their use in medicine. Guanidine.

Topic 7.1. Heterocyclic compounds. Five-membered heterocyclic compounds with one heteroatom: furan, thiophene, pyrol. The general method of synthesis. Properties: aromaticity, electrophilic substitution, hydrogenation. Cross transitions. Indole. Derivatives of indole are tryptophan. Ways of metabolism of tryptophan.

Six-membered heterocyclic compounds with one and two heteroatoms. Pyridine. Properties: nucleophilic properties of the nitrogen atom, hydrogenation of pyridine, oxidation of homologues, nicotinic and isonicotinic acids. Their derivatives, used in medicine: vitamin PP, nicotinamide, cordiamine, tubazid.

Group of pyrimidine. Uracil, thymine, cytosine, barbituric acid, lactam-lacticum

Purine and its derivatives: hypoxanthine, xanthine, uric acid.

Tautomerism. Adenine and guanine. Their transformation into hypoxanthine and xanthine. Methylated-xanthines - theophylline, toebromine, caffeine.

Topic 7.2. Nucleosides, nucleotides, polynucleotides.

Topic 7.3. Nucleic acids. Structure. Properties of NA.

5. Educational technologies

1. Reading lectures using a multimedia projector and tablet, handouts in the form of diagrams and drawings, control of students' independent work in the form of a colloquium on a lecture course, doing home control work.
2. Conducting laboratory works, organizing discussion of experimental results and protecting laboratory work in the form of seminars and colloquia, developing skills in working with technological, diagnostic, measuring and research equipment.
3. Independent work of the student.

6. Educationaland methodological support of students' out-of-class work. Assessment means for current progress monitoring, interim attestation of subject mastering results

6.1. Plan for Individual work of students

№ week	Topic	Out-of-classwork type	Task	Recommended literature	Amount of hours
1-2	Introduction. The main types of reactions occurring in the body. Elements of chemical thermodynamics. Chemical equilibrium. Elements of chemical kinetics.	Preparation for the class work.	To study the theoretical material on the topic of the lesson. Answer questions for self-monitoring in guidelines Fill in the workbook on the topic of classes	General chemistry. Methodical instructions to laboratory practice. / I.G.Kolchugina, G.E.Vanina T.K. Semchenko and others. RIO PSU, 2015. – 190 p. General chemistry. Practicum. / I.G.Kolchugina, G.E.Vanina T.K. Semchenko and others. RIO PSU,	3

				2015. – 108 p.	
3-4	Methods of expressing the concentrations of substances in solutions, methods of preparing solutions of a given concentration. The doctrine of solutions. Colligative properties of solutions (diffusion, osmosis, osmolality, osmolarity). Equilibria in solutions. Hydrolysis of salts. Buffer systems. Solubility product. Oxidation-reduction equilibria. Electrochemistry. Corrosion of metals.	Preparation for the class work.	To study the theoretical material on the topic of the lesson. Answer questions for self-monitoring in guidelines Fill in the workbook on the topic of classes	General chemistry. Methodical instructions to laboratory practice. / I.G.Kolchugina, G.E.Vanina T.K. Semchenko and others. RIO PSU, 2015. – 190 p. General chemistry. Practicum. / I.G.Kolchugina, G.E.Vanina T.K. Semchenko and others. RIO PSU, 2015. – 108 p.	3
5-6	Chemistry of disperse systems. Physico-chemical properties of solutions of biopolymers. The role of colloidal surfactants in the assimilation and transport of low-polar substances in a living organism.	Preparation for the class work.	To study the theoretical material on the topic of the lesson. Answer questions for self-monitoring in guidelines Fill in the workbook on the topic of classes	General chemistry. Methodical instructions to laboratory practice. / I.G.Kolchugina, G.E.Vanina T.K. Semchenko and others. RIO PSU, 2015. – 190 p. General chemistry. Practicum. / I.G.Kolchugina, G.E.Vanina T.K. Semchenko and others. RIO PSU, 2015. – 108 p.	2
7-8	Electrolyte balance of the human body. Human chemical elements: s-elements and their compounds, d-elements and their compounds and p-elements and their compounds.	Preparation for the class work.	To study the theoretical material on the topic of the lesson. Answer questions for self-monitoring in guidelines Fill in the workbook on the topic of classes	General chemistry. Methodical instructions to laboratory practice. / I.G.Kolchugina, G.E.Vanina T.K. Semchenko and others. RIO PSU, 2015. – 190 p. General chemistry. Practicum. / I.G.Kolchugina, G.E.Vanina T.K. Semchenko and others. RIO PSU, 2015. – 108 p.	2
9-10	Electronic effects, conjugation, aromatic. Classification of reactions in organic chemistry, the main types of reactions and reagents.	Preparation for the class work.	To study the theoretical material on the topic of the lesson. Answer questions for self-monitoring in guidelines	Bioorganic chemistry. Methodical instructions to laboratory practice./	3

			Fill in the workbook on the topic of classes	G.E.Vanina, I.G.Kolchugina, T.K. Semchenko Penza, publishing house PSU, 2015. – 208p.	
11-12	Carbohydrates. Mono- and disaccharides. Tautomeric transformations. Chemical properties, reaction mechanisms. Polysaccharides. Structure and properties. Homopolysaccharides and heteropolysaccharides.	Preparation for the class work.	To study the theoretical material on the topic of the lesson. Answer questions for self-monitoring in guidelines Fill in the workbook on the topic of classes	Bioorganic chemistry. Methodical instructions to laboratory practice./ G.E.Vanina, I.G.Kolchugina, T.K. Semchenko Penza, publishing house PSU, 2015. – 208p.	2
13-14	Lipids. Saponifiable and unsaponifiable lipids. Phospholipids, glycolipids, sphingolipids. Terpenes and steroids.	Preparation for the class work.	To study the theoretical material on the topic of the lesson. Answer questions for self-monitoring in guidelines Fill in the workbook on the topic of classes	Bioorganic chemistry. Methodical instructions to laboratory practice./ G.E.Vanina, I.G.Kolchugina, T.K. Semchenko Penza, publishing house PSU, 2015. – 208p.	3
15-16	Amino acids. Classification. Physical and chemical properties. Qualitative reactions.	Preparation for the class work.	To study the theoretical material on the topic of the lesson. Answer questions for self-monitoring in guidelines Fill in the workbook on the topic of classes	Bioorganic chemistry. Methodical instructions to laboratory practice./ G.E.Vanina, I.G.Kolchugina, T.K. Semchenko Penza, publishing house PSU, 2015. – 208p.	3
17	Nucleic acids. Structure. Nucleosides, nucleotides, polynucleotides.	Preparation for the class work.	To study the theoretical material on the topic of the lesson. Answer questions for	Bioorganic chemistry. Methodical instructions to	3

	Properties of Nucleic acids.		self-monitoring in guidelines Fill in the workbook on the topic of classes	laboratory practice./ G.E.Vanina, I.G.Kolchugina, T.K. Semchenko Penza, publishing house PSU, 2015. – 208p.	

6.2. Instruction alguide lines on students' out-of-class work organization

Preparation for classroom classes by students is held at home or in the library.

1. General chemistry. Methodical instructions to laboratory practice. / I.G.Kolchugina, G.E.Vanina T.K. Semchenko and others. RIO PSU, 2015. – 190 p.
2. General chemistry. Practicum. / I.G.Kolchugina, G.E.Vanina T.K. Semchenko and others. RIO PSU, 2015. – 108 p.
3. Bioorganic chemistry. Methodical instructions to laboratory practice./ G.E.Vanina, I.G.Kolchugina, T.K. Semchenko Penza, publishing house PSU, 2015. – 208p.

When conducting an individual work, the student must answer questions for self-preparation and perform tasks.

6.3. Materials to carry out current monitoring and interim attestation of students' knowledge

Control of mastering competences

№	Type of control	Controlled topics (sections)	Competences, the components of which are controlled
1	Interviewing	Section 1-5	GPC-7, GPC-8
2	Colloquium 1	Section 1-5	GPC-7, GPC-8
3	Interviewing	Section 6-7	GPC-7, GPC-8
4	Colloquium 2	Section 6-7	GPC-7, GPC-8
5	Interviewing	Section 8-9.1	GPC-7, GPC-8
6	Colloquium 3	Section 8-9.1	GPC-7, GPC-8
7	Interviewing	Section 9.2-10	GPC-7, GPC-8
8	Colloquium 4	Section 9.2-10	GPC-7, GPC-8

Questions for the 1st Colloquium (3 weeks)

1. Classification of reactions, based on the nature of the transferred particles. Protolytic reactions. Oxidation-reduction reactions (intermolecular, intramolecular, disproportionation). Ligand exchange reactions. Reactions of atomic-molecular exchange. Reactions of radical, electrophilic and nucleophilic substitution. Reactions of association-dissociation and aggregation. Reaction of addition, precipitation.

2. The subject and methods of chemical thermodynamics. Interrelation between the processes of metabolism and energy in the body. Chemical thermodynamics as a theoretical basis of bioenergetics.
3. Basic concepts of thermodynamics. Internal energy. Work and heat are two forms of energy transfer. Types of thermodynamic systems and processes.
4. The first law of thermodynamics. Enthalpy. Standard enthalpy of formation, standard enthalpy of combustion.
5. Hess's Law. Thermochemical processes. Application of the first law of thermodynamics to biosystems.
6. The second law of thermodynamics. Reversible and irreversible in the thermodynamic sense of the process. Entropy.
7. Gibbs energy. Forecasting the direction of spontaneous processes in isolated and closed systems. The standard Gibbs energy of formation, the standard Gibbs energy of biological oxidation
8. Thermodynamic equilibrium conditions. The role of enthalpy and entropy factors ..
9. The principle of energy coupling. Examples of exergonic and endergonic processes occurring in the body. The concept of homeostasis and the stationary state of a living organism.
10. Chemical equilibrium. Reversible and irreversible in the direction of the reaction. The constant of chemical equilibrium. Equations of the isotherm and chemical reaction isobar. Forecasting the bias of chemical equilibrium.
11. The subject and basic concepts of chemical kinetics. Chemical kinetics as a basis for studying the velocities and mechanisms of biochemical processes. The reaction rate, the average reaction rate in the interval, the true speed.
12. Classification of reactions used in kinetics: homogeneous, heterogeneous reactions; Reactions simple and complex (parallel, sequential, conjugate, chain, oscillatory).
13. Molecularity of the elementary act of reaction. Kinetic equations. The order of the reaction. Period of half-transformation.
14. Dependence of the reaction rate on concentration. Kinetic equations of the first, second and zero order reactions.
15. Dependence of the reaction rate on temperature. Temperature coefficient of reaction speed and its features for biochemical processes.
16. The concept of the theory of active collisions. Activation energy; Arrhenius equation. The role of the steric factor. The concept of the theory of the transition state.
17. Catalysis. Homogeneous and heterogeneous catalysis. Features of catalytic activity of enzymes. The Michaelis-Menten equation and its analysis.
18. The role of water and solutions in life. Physicochemical properties of water, which determine its unique role as the sole bio-solvent. Autoprotolysis of water. The constant of autoprotolysis of water. Hydrogen pH.
19. Dependence of solubility of substances in water on the ratio of hydrophilic and hydrophobic properties; The influence of external conditions on the solubility. Thermodynamics of dissolution. The concept of an ideal solution.
20. Colligative properties of dilute solutions of electrolytes. Raoult's law and its consequences: a decrease in the freezing point of the solution, an increase in the boiling point of the solution, and osmosis.
21. Osmotic pressure: the Van't Hoff law.
22. Elements of the theory of solutions of electrolytes. Strong and weak electrolytes. The ionization constants of a weak electrolyte. Law of breeding Ostwald. Protolithic equilibria and processes. The constant of acidity and basicity. Ampholytes. Isoelectric point.
23. General provisions of the theory of strong electrolytes. Ionic strength of the solution. Activity and coefficient of ion activity. Electrolytes in the body.
24. Osmotic properties of solutions of electrolytes. Osmolality and osmolarity of biological fluids.
25. Hypo-, hyper- and isotonic solutions. Isotonic coefficient. Concepts of isosmia (electrolyte homeostasis). The role of osmosis in biological systems. Plasmolysis and cytolysis.

26. Buffer action is the main mechanism of protolytic homeostasis of the body. The mechanism of action of buffer systems, their quantitative characteristics. Protein buffer system of blood. The concept of the acid-base state of the body.
27. Hydrolysis. The role of hydrolysis reactions in biochemical processes, hydrolysis of ATP.
28. Heterogeneous equilibria and processes. Solubility constant. Conditions for the formation and dissolution of precipitation. Reactions underlying the formation of inorganic matter bone tissue calcium hydroxide phosphate. The phenomenon of isomorphism: replacement of hydroxide ions in calcium hydroxide phosphate by fluoride ions, calcium ions on strontium ions.
29. Redox-equilibrium and processes. The mechanism of appearance of electrode and redox potentials. The Nernst-Peters equations.
30. Comparative strength of oxidants and reducing agents. Forecasting the direction of redox processes based on the redox potentials. Toxic effect of oxidants (nitrates, nitrites, nitrogen oxides). The use of redox reactions for detoxification.
31. Electrochemistry. Corrosion of metals.

Option ticket to 1 colloquium

1. Calculate the volume of a solution of sulfuric acid 95% (density 1.96 g / ml) is necessary for the preparation of 1 liter of a 0.5 mol / l solution.
2. Write the half reaction equations for this redox reaction. Indicate the substance of the oxidizing agent, the reducing agent. Write down the electronic formula of the oxidizing agent and the reducing agent taking into account the degree of oxidation.

$$FeSO_4 + KClO_3 + H_2SO_4 \rightarrow Fe_2(SO_4)_3 + KCl + H_2O$$

4. Calculate the equilibrium constant of the reaction:
NH3 (g) + HCl (g) = NH_4Cl (s) at 298 K.
5. Write the kinetic equation of the reaction:
$FeCl_3$ + 3KNCS ⇆ Fe (NCS) $_3$ + 3KCl
Knowing that it has the first order of concentration of both reactants. Calculate the value of the rate constant if $\tau_{1/2}$ = 90 min at 25 ° C.
6. Calculate the mass concentration of lead ions (in grams per liter) in a saturated solution of lead (II) chloride.
7. The freezing point of some biological fluids is less than the freezing point of water by the following number of degrees: saliva - 0.2-0.4; Blood serum - 0.55; Urine 1.3-2.3. Calculate the molality of these fluids and the osmotic pressure of the serum at 37^0C.
8. Calculate the concentration of hydrogen ions in a buffer solution containing 0.01 mole / liter acetic acid and 0.1 mole / l sodium acetate.

<u>Questions for the 2nd Colloquium (Week 7)</u>

1. Classification of substances of a living organism by their biological role. The concept of the biogeneity of chemical elements. Biosphere, the cycle of biogenic elements. Concentration of biogenic elements by living systems. Classification of biogenic elements by their functional role: organogenes, elements of the electrolyte background, microelements.
2. The concept of impurity elements (accumulating and non-accumulating). The main sources of intake of impurity elements in the human body. Chemical aspects of the environment.
3. Adsorption equilibria and processes on the moving boundaries of the phase separation. Surface Gibbs energy and surface tension.
4. Adsorption. Surface-active and surface-active substances. Change in surface activity in homologous series. Adsorption isotherm. Orientation of molecules in the surface layer and the structure of biomembranes.
5. Adsorption equilibria at fixed boundaries of phase separation. Physical adsorption and chemisorption. Adsorption of gases on solids. Adsorption from solutions. The Langmuir equation. Dependence of adsorption on various factors. The importance of adsorption processes for life.

Physico-chemical basis of adsorption therapy, hemosorption, application of ion exchangers in medicine.
6. Classification of disperse systems. Classification of disperse systems by degree of dispersion; On the aggregate state of phases. The nature of the colloidal state. Reception and properties of disperse systems. Preparation of suspensions, emulsions, colloidal solutions.
7. Molecular-kinetic properties of colloid-disperse systems: Brownian motion, diffusion, osmotic pressure, sedimentation equilibrium. Optical properties: light scattering.
8. Electrokinetic properties: electrophoresis and electroosmosis; Flow potential and sedimentation potential. The structure of a double electrical layer. Electrokinetic potential and its dependence on various factors.
9. Stability of disperse systems. Sedimentation and aggregative stability of lysozols. Factors affecting the stability of lysozols. Coagulation. Coagulation threshold and its definition. The Schulze-Gardi rule. Colloidal protection and peptization.
10. Colloidal surfactants. Biologically important colloidal surfactants (soaps, detergents, bile acids). Micelle formation in surfactant solutions. Determination of the critical concentration of micelle formation. Liposomes.
11. Properties of IUD solutions. Features of dissolution of IUDs as a consequence of their structure. Form of macromolecules. Mechanism of swelling and dissolution of the IUS. Dependence of swelling on various factors.
12. Viscosity of blood and other biological fluids. Osmotic pressure of solutions of biopolymers. Oncotic pressure of plasma and blood serum.
13. Polyelectrolytes. Isoelectric point and methods of its determination. Membrane equilibrium Donnan.
14. Stability of solutions of biopolymers. Salting out biopolymers from solution. Coacervation and its role in biological systems. Gelation of IUD solutions. Properties jelly: syneresis and thixotropy.
15. Ion-selective electrodes based on solid membranes; Their use to measure the concentration of hydrogen ions (glass electrode), potassium, calcium, sodium in biological fluids.
16. Chromatography. Classification of chromatographic methods by the dominant mechanism of separation of substances. Application of thin-layer, paper, gas-liquid, high-performance liquid, molecular sieve chromatography in biomedical research.

Option ticket to the 2nd colloquium.

1. 20 ml of a solution of potassium chloride of unknown concentration reacts with 23.33 ml of a 0.02 n solution of silver nitrate. Determine the normality of the solution of potassium chloride.
2. Write the dissociation equation for the salts K_3 [Fe (CN) $_6$] and NH_4FeSO_4 in the aqueous solution. An alkali solution was added to each of them. In which case precipitate of iron (III) hydroxide precipitates? What is the difference between complex salts and double salts?
3. Adsorption of 2.8 g of oxygen with activated carbon releases 1.36 kJ of heat. Calculate the heat of adsorption of oxygen on the coal.
4. To obtain the silver chloride sol, 15 ml of potassium chloride solution with a concentration of 0.025 mol / l were mixed with 85 ml of silver nitrate solution with a concentration of 0.005 mol / l. Write the formula of the micelle and determine to which electrode the particles will move during electrophoresis.

Questions for the 3rd Colloquium (11th week)

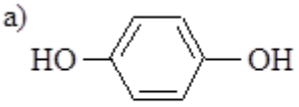
1. Classification of organic compounds.
2. Basic rules of the systematic nomenclature of organic compounds. Substitutive, radically functional nomenclature, the notion of rational nomenclature. Trivial names.
3. Physicochemical methods of isolation and investigation of organic compounds.
4. Extraction, crystallization, distillation, sublimation, drying, determination of physico-chemical constants.
5. Chromatography, its types. Electrophoresis. Polarimetry.

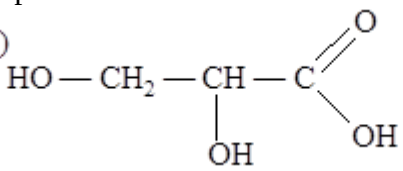
6. Spectral methods of analysis: infrared (IR), ultraviolet (UV), NMR spectroscopy, mass spectrometry.
7. The theory of the structure of organic compounds AM Butlerova.
8. Spatial structure of organic compounds. Stereochemical formulas.
9. Energy characteristic of conformational states; Blocked, hindered, oblique conformations.
10. Conformations (chair, bath) of cyclic compounds. Axial and equatorial connections.
11. Stereoisomerism of molecules with one chiral center (enantiomeria). The concept of "optical activity".
12. Fisher projection formulas. D- and L-system of stereochemical nomenclature. Rules of the R, S-nomenclature.
13. Stereoisomerism of molecules with two or more centers of chirality: enantiomeria and diastereomerium. Mesoforms. The racemates.
14. Stereoisomerism in a series of compounds with a double bond (* -diastereo-meria). Cis and trans isomers.
15. Polarization of bonds. Electronic effects inductive and mesomeric.
16. Electron-donor and electron-withdrawing substituents.
17. Conjugation (, and p, - conjugation). Conjugate systems with an open chain. Aroma. Hückel's aromaticity criterion.
18. Classification of organic reactions (substitution, addition, elimination, rearrangement, oxidation-reduction).
19. Mechanisms of reactions radical, ionic (electrophilic, nucleophilic).
20. Electronic and spatial structure of radicals, carbanions, carbocation, and their relative stability.
21. Mechanism of the reaction of free radical substitution. Halogenation, nitration, sulfonation of alkanes.
22. Mechanism of reaction of electrophilic addition of alkenes.
23. The influence of static and dynamic factors on regioselectivity of reactions. The Markovnikov rule.
24. Peculiarities of electrophilic addition to open conjugate systems: hydration of , -unsaturated carboxylic acids.
25. Aroma: aromatic criteria, Hückel's rule.
26. Aromatic benzoids (benzene, naphthalene, anthracene, phenanthrene).
27. Aromatic heterocyclic compounds (furan, thiophene, pyrrole, imidazole, pyridine, pyrimidine, purine).
28. The mechanism of reactions of electrophilic substitution of aromatic compounds. The structure of and -complexes.
29. Effect of substituents in the aromatic nucleus and heteroatoms in heterocyclic compounds on the reactivity in electrophilic substitution reactions. The orienting effect of substituents and heteroatoms.
30. Reactions of nucleophilic substitution of halogen derivatives, alcohols.
31. The influence of electronic and spatial factors on the reactivity of compounds in nucleophilic substitution reactions.
32. Alkylation reactions of alcohols, phenols, thiols, ammonia and amines. Role of acid catalysis in the nucleophilic substitution of the hydroxyl group.
33. Elimination reactions (dehydrohalogenation, dehydration).
34. Electronic structure of carbonyl compounds aldehydes, ketones.
35. Mechanism of reactions of nucleophilic addition and nucleophilic condensation of aldehydes, ketones.
36. Reactions of carbonyl compounds with water, alcohols, thiols, primary amines.
37. Reaction of aldol addition. Basic catalysis. Aldolnoe splitting as a reaction inverse aldolnom connection.

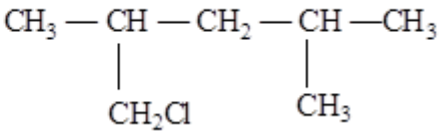
38. Oxidation-reduction properties of carbonyl compounds.
39. The structure of the carboxyl group. Dissociation of carboxylic acids.
40. The mechanism of nucleophilic substitution of carboxylic acids.
41. Acylation reactions - the formation of anhydrides, esters, thioesters, amides.
42. Reactions of hydrolysis of anhydrides, esters, thioesters, amides.
43. Acidity and basicity of organic compounds; The Bronsted theory. Conjugated acids and bases.
44. Acidic properties of alcohols, thiols, carboxylic acids, amines.
45. Basic properties of neutral molecules containing a heteroatom with an unshared pair of electrons (alcohols, ethers, carbonyl compounds, amines) and anions (hydroxide, alkoxide, enolate ions, acylate ions).
46. General regularities of the change in acid and basic properties as a function of the electronic effects of substituents.

Option ticket to the 3d colloquium.

Name the connections for the replacement nomenclature:

а) 

б) 

в) 

2. Write the structural formulas of the compounds:
a) 2,4-dimethylhexane b) 2-methylpentene-2 c) methoxymethane
3. Label the distribution of electron density in the molecule of cinnamic acid
C_6H_5─CH == CH─COOH. Determine the presence or absence of a conjugate system, specify the sign and the type of electronic effects.
4. Draw Newman's projections of the conformation of 2-aminoethanol-1.
5. Write the structural formula of the organic substance of the composition C_5H_{12}, if it is known that during its chlorination the predominantly tertiary chloro- derivative is obtained. Explain why substitution most easily occurs in a tertiary carbon atom.
6. Carry out the nitration of chlorobenzene. Consider the reaction mechanism. Name the main product of the reaction.
7. Write the equations of reactions, with which you can carry out the following transformations, indicate the conditions for the reactions: ethane → bromoethane → butane → acetic acid → chloroacetic acid.
8. Compare the reactivity of toluene and benzene in the chlorination reaction.
9. Write the equation of acid hydrolysis of ethyl methanoate. Consider the reaction mechanism. Write the D, L-isomers of serine (2-amino-3-hydroxypropanoic acid) using Fisher's projection formulas. Label the R, S-system for the configuration of the chiral center of connections.

Questions for the 4th Colloquium (17th week)

1. Classification of carbohydrates.
2. Stereoisomerism of monosaccharides. Cyclo-oxo-tautomerism.
3. Formation of O- and N-glycosides. Hydrolysis of glycosides.
4. Oxidation of monosaccharides. Reducing properties of aldoses. Reduction of monosaccharides.
5. Oligosaccharides. Structure, cyclo-oxo tautomerism. Reductive properties of disaccharides.
6. Polysaccharides: starch (amylose, amylopectin), glycogen, dextran, cellulose.
7. Classification of lipids.
8. Structure of triacylglycerols, higher fatty acids, which are part of lipids.
9. Properties of triacylglycerols: hydrolysis, hydrogenation, saponification, oxidation.
10. Glycerophospholipids. Phosphatidic acid. Phosphatidylcolamine, phosphatidylserines, phosphatidylcholines. Hydrolysis of cephalin.

11. Nomenclature, classification of amino acids.
12. Stereoisomerism of amino acids. Acid-base properties, bipolar structure of amino acids.
13. Chemical properties of α-amino acids. Reactions of esterification, acylation, alkylation, imine formation.
14. Reactions of deamination, decarboxylation, hydroxylation.
15. Peptides. The structure of the peptide group. Hydrolysis of peptides.
16. Determination of the amino acid sequence of peptides. Reactions of N- and C-terminal amino acids.
17. Chemical composition of nucleic acids. Pyrimidine (uracil, thymine, cytosine) and purine (adenine, guanine) bases.
18. Aromatic properties of nitrogenous bases. Lactam-lactimium tautomerism. Deamination reactions.
19. Structure of nucleosides, nucleotides. Hydrolysis of nucleosides and nucleotides.
20. Primary structure of nucleic acids. Phosphodiester bond.
21. Complementarity of nucleic bases. Hydrogen bonds in complementary pairs of nucleic bases.
22. Ribonucleic and deoxyribonucleic acids.

Option ticket to the 4 colloquium.

1. Write the equations of interaction of diethyl ketone with methylamine. Explain the reaction mechanism.
2. Determine the structure of the substance, if during its hydrolysis in an acidic environment formed oleic, palmitic, phosphoric acids, glycerin and serine. Write the equation of hydrolysis, name all the substances.
3. Write down possible disaccharides, which are formed from pyranose forms of glucose. Which one has the trivial name D- maltose?
4. Draw tautomeric forms of guanine, the structural formula of guanidine-5'-monophosphate, indicate ester and macroergic bonds.
5. What products are formed during the hydrolysis of the peptide **tirogliparpheneley** with the participation of **chymotrypsin,** which hydrolyses peptide bonds on aromatic amino acids? Write the equation of the reaction.

Note: questions for conducting colloquiums can be used to carry out laboratory protection.

Option ticket to the examination.

Федеральное государственное бюджетное образовательное учреждение высшего образования «Пензенский государственный университет»

Program/Specialty 31.05.03- Dentestry

Graduate's qualification (degree) GP-dentist

Mode of study Full-time

Chemistry

1. A solution is prepared by dissolving 22.4 g of $MgCl_2$ in 200 g of water. Taking the density of pure water to be 1.00 g/ml and the density of the resulting solution to be 1.089 g/ml, calculate the mole fraction, molarity, mass % of $MgCl_2$ in this solution. (4 balls)
2. To calculate change of an enthalpy (ΔH), entropy (ΔS), Gibbs's energy (ΔG) reactions under standard conditions. On the basis of value of Gibbs's energy (ΔG) define, whether probably course of this reaction is spontaneous. (4 balls)
3. Write the equilibrium expression for the reaction. To write down expression for the rate of reaction(4 balls)

$$4HCl_{(g)} + O_{2(g)} = H_2O_{(aq)} + 2Cl_{2(g)}$$

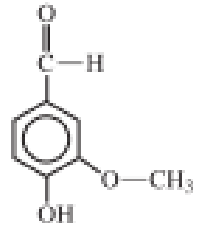
4. The buffer system consisting from KH_2PO_4 (salt) and K_2HPO_4 (acid), is prepared at a ratio of salts 16:1 in moles. To define pH this solution.

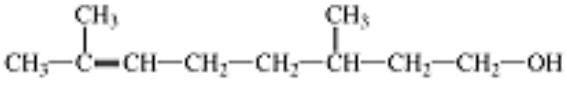
($pK_a = 7.2$) (4 balls)

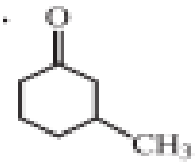
Work out the half-reaction. Place coefficients in the equations of reactions. Specify, what substance is an oxidizing agent, what – a reducing agent. (4 balls)

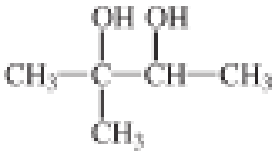
$$K_2Cr_2O_7 + KI + H_2SO_4 \rightarrow Cr_2(SO_4)_3 + I_2 + K_2SO_4 + H_2O$$

5. Give the IUPAC name for each of the following compounds (4 balls):









6. Write isomers for alcohol with common formula $C_5H_{12}O$ (4 balls).
7. What is the major product in the reaction of propene with each of the following reagents? Name this reactions and products (4 balls).

a) HBr ; b) H_2 /Pd ;

c) [O] $KMnO_4$ (H_2O) ;

8. Give the reaction for esterification of ethanoic acid and ethanol (4 balls).
9. Write formulas of tripeptides: Val-Phe-Leu. (4balls).
10. Give the scheme of oxidation of D-glucose and D-galactose by the action of mild (Br_2) and strong (HNO_3) oxidizing agents. (4 balls).

List of practical works

1. Rules of work and safety in the chemical laboratory. Classes of inorganic compounds. Thermochemistry.
2. Chemical kinetics. Chemical equilibrium.
3. Calculation and preparation of solutions with%, m, Me, M, Concentration titer.
4. Colligative properties of solutions.
5. Solutions of electrolytes. Solubility product, pH.
6. Oxidation-reduction reactions. Directivity of oxidation-reduction reactions. Corrosion of metals.
7. Buffer solutions. Hydrolysis.
8. Chemical bonding. Complex connections.
9. Adsorption.
10. Colloidal systems. IUD solutions.
11. Classification and nomenclature of organic compounds.
12. Conformations of open and closed chains.
13. Configuration isomers.
14. Conjugation and aromaticity. Electronic effects of substituents.
15. Properties of hydrocarbons.
16. Properties of alcohols and phenols.
17. Properties of carbonyl compounds.
18. Properties of carboxylic acids and their functional derivatives.
19. Properties of amines. Acidity and basicity of organic compounds.
20. Mono- and disaccharides.
21. Polysaccharides.
22. Lipids.
23. Amino acids.
24. Nucleic acids.
25. The final lesson

Estimated activities in the implementation of practical and test work

Week number	Name of laboratory work or practical occupation	balls
1.	Classes of inorganic compounds. Calculation of solutions of different concentrations.	3
2.	Thermochemistry. Chemical kinetics. The speed of chemical reactions. Types of reactions (oscillatory, sequential, etc.). Chemical equilibrium.	3
3.	Colloquium No. 1.	5
4.	Colligative properties of solutions. Solutions of electrolytes. Solubility product, pH. Buffer solutions. Hydrolysis.	3
	Complex connections. (Independently)	
5.	Adsorption.	3
6.	Colloidal systems.	3
7.	Oxidation-reduction reactions. Methods of compiling the OB equations, OB potential.	3

8.	Colloquium No. 2 (at home).	5
9.	Classification and nomenclature of organic compounds	3
10.	Structural and conformational isomerism of organic compounds. Optical and geometric isomerism of organic compounds	3
	Mutual influence of atoms. Electronic effects. Conjugation and aromaticity. (Independently)	
11.	Colloquium No. 3.	5
12.	Mechanisms of hydrocarbon reactions. Properties of hydrocarbons.	3
13.	Mechanisms of reactions of oxygen-containing organic compounds. Properties of aldehydes, alcohols, phenols, carboxylic acids and ethers and esters.	3
	Acidity and basicity of organic compounds. (Independently)	
14.	Carbohydrates.	3
15.	Structure and properties of amino acids, peptides, proteins	3
16.	Structure and properties of lipids. Structure and properties of nucleic acids	3
17.	Colloquium No.4.	6

Total for the current control: 60 balls.
Total for the examination: 40 balls. Total for discipline: 100 balls

7. Educational, methodological and informationalmeans provided for subject (module)

a) basic literature

№	**literature**	Number	
		In the library	At the department
1	Chemistry. Lectures. / G.E.Vanina, I.G.Kolchugina, T.K. Semchenko. RIO PSU, 2015. – 150 p.	50	5
2			

b) additional literature

№	**literature**	Number	
		In the library	At the department
1	General chemistry. Methodical instructions to laboratory practice. / I.G.Kolchugina, G.E.Vanina T.K. Semchenko and others. RIO PSU, 2015. – 190 p.	20	150
2	General chemistry. Practicum. / I.G.Kolchugina, G.E.Vanina T.K. Semchenko and others. RIO PSU, 2015. – 108 p.	20	170

3	Bioorganic chemistry. Methodical instructions to laboratory practice./ G.E.Vanina, I.G.Kolchugina, T.K. Semchenko Penza, publishing house PSU, 2015. – 208p.	50	170
5			
6			
5			
7			
8			

c) Software and Online resources:

1. Fundamentals of bioorganic *chemistry* = Основы биоорганической химии [Электронный ресурс] : учебник / Zurabyan S.E. - M. : ГЭОТАР-Медиа, 2015. http://www.studentlibrary.ru/book/ISBN9785970421406.html
2. Chemistry. https://he.palgrave.com/companion/Lewis-And-Evans-Chemistry-4th-Edition/
3. General chemistry. Ebbing Gammon. Ninth edition. college.hmcopic/ebbing9e

8. Material and technical means provided for subject (module)

№	Name of the discipline (Module), a practitioner in accordance with the curriculum	The name of special Premises and premises For independent work	he equipment of special premises and premises For independent work
1.	Chemistry	Auditorium 8-401, 8th building of the PSU, 54 m^2	Multimedia projector - 1 pc. Laptop - 1 pc. Tables - 26 pcs. Wall-mounted screen - 1 pc. Educational board - 1 pc. Visual aids (posters).
		Auditorium 8-405, 8th building of the PSU, 36.6 m^2	Multimedia projector - 1 pc. Laptop - 1 pc. Laboratory tables - 6 pcs. Cabinet for dishes and chemicals - 4 pcs. Wall-mounted screen - 1 pc. Educational board - 1 pc. Cupboard for kitchenware and chemicals. Reakt.-4pcs Visual aids (posters). Exhaust hood - 1 pc.
		Auditorium 8-406, 8th building of the PSU, 36.6 m^2	Multimedia projector - 1 pc. Laptop - 1 pc. Laboratory tables - 6 pcs. Cabinet for dishes and chemicals - 4 pcs. Wall-mounted screen - 1 pc. Educational board - 1 pc. Cupboard for kitchenware and chemicals. Reakt.-5 pcs. Visual aids (posters). Exhaust hood - 1 pc.
2.		Auditorium 8-404, 8th building of the PSU, 36.0m^2	Multimedia projector - 1 pc. Laptop - 1 pc. Tables lab - 4 pcs. Tables - 4 pcs. Educational board - 1 pc. Cupboard for kitchenware and chemicals. Reakt.-4pcs. Extractor-1 Visual aids (posters).

The program of the discipline CHEMISTRY is prepared in accordance with the requirements of the Federal state standard of higher professional education and the recommendations of the educational program in the area **31.05.01** - General Medicine

The developer of the program:
Author: Prof. Y.P. Perelygin

Ass. Prof. I.G. Kolchugina

The Program is approved by the Department of Chemistry

Protocol № 7 «9» 03 2016.

Department chair _____ Perelygin Y.P

The program is coordinated with the Head of the Medical Faculty
Prof. Moiseeva I.Ya. «05» «03» 20 .

Program is approved by the methodical commission of the Medical institute.

Protocol № 7 «05» 03 2016

Chairman of the methodical commission of the Medical institute
_____ Kalmin O.V.
(signature)

Information on reconfirmation of the program for the next academic year and registration of changes

The academic year	Chair decision (protocol N°., date, signature of the department chair)	Changes made	Sheet numbers (pages)		
			exchanged	new	annulled
2017-18	№1 from 12.09.2017	Added in paragraph 5 is the description of the application of educational technologies to students with limited health and disability opportunities.	10	10	
2018-2019	V from 1.09.2018	No change			