Учреждение образования
«Гродненский государственный медицинский университет»

УТВЕРЖДАЮ
Ректор учреждения образования
«Гродненский государственный
медицинский университет»,
профессор
_____ В.А.Снежицкий
«27» июня 2013 г.
Регистрационный № УД-84/р.

ОБЩАЯ ХИМИЯ

**Учебная программа учреждения высшего образования
по учебной дисциплине для специальности
1-79 01 01 Лечебное дело**

Факультет: лечебный
Кафедра общей и биоорганической химии

Курс 1
Семестр 1

Лекции: 36 Экзамен I семестр

Лабораторные занятия: 54

Всего аудиторных часов
по дисциплине: 90

Всего часов
по учебной дисциплине: 192

Форма получения
высшего образования: дневная

Составили: В.В. Болтромеюк, кандидат химических наук, доцент
А.К. Волкович

2013 г.

Учебная программа составлена на основе учебной программы по дисциплине «Общая химия» для специальности 1-79 01 01 «Лечебное дело», утвержденной учреждением образования «Минский государственный медицинский университет» 31.05.2013 г., регистрационный №УД L -47/баз.

Рассмотрена и рекомендована к утверждению на заседании кафедры общей и биоорганической химии учреждения образования «Гродненский государственный медицинский университет»

07 июня 2013 г.

Протокол № 11

Заведующий кафедрой
_____ В.В. Болтромеюк

Одобрена и рекомендована к утверждению Центральным научно-методическим советом учреждения образования «Гродненский государственный медицинский университет»
«26» июня 2013 г.
протокол № 9

Председатель ЦНМС,
первый проректор
_____ В.В. Воробьёв

The studying program is prepared on the base of General Chemistry studying program in Minsk State Medical University for the speciality **1-79 01 01** — "**General Medicine**", approved 31.05.2013, registration number УД L -47/баз.

Discussed and recommended for approval at the meeting of General and Bioorganic Chemistry Department

30 August 2013

Protocol № _1_

Head of the department, PhD, docent
_____ V.V. Boltromeyuk

Approved and recommended for approval by the Central Scientific and Methodological Council of Grodno State Medical University

«___»_____2013

Chairman of the Council
_____ V.V. Vorobiov

EXPLANATORY NOTE

General Chemistry combines selected chapters of Inorganic, Physical, Colloidal, and Analytical Chemistry. It examines physical and chemical bases of conditions, ways and mechanisms of realization of vital processes in health and pathological states on the molecular level.

The goals and objectives of the discipline

Goal: The formation of student's chemical competence level needed to understand the physicochemical principles of somatic cells life processes in human body; to bring scientific generalizations and modern methods of research work in biomedical and health problems solving.

Objectives:

- to form the modern concept of chemical thermodynamics and kinetics, which are the main theoretical bases for Bioenergetics and Enzymology;
- to study the basics of the modern theory of solutions, which is a scientific basis for the intracellular electrolytes balance research, acid-base balance, diffusion and osmosis phenomena, physico-chemistry of normal and pathophysiological processes in homo- & heterogeneous systems of human body;
- to study the basic fundamentals of electrochemistry as bio-electrochemistry base and electrochemical research methods in biology and medicine;
- to study the physico-chemical bases of surface phenomena, disperse systems and high molecular compounds solutions, which help to understand the structure of biological membranes, the essence of lymph-, hemosorption & other enterosorbtion processes;

Communications with other disciplines

General chemistry stays in close relationship with Biophysics, Pharmacology, Molecular biology, Physiology and forms the important part of educational process in medical schools for the preparation of highly qualified specialist, able to formulate and solve problems staying on the borders of natural sciences.

Requirements for the preparation of a student after the discipline study.

a) Student must know:

- basic concepts and laws of chemistry important for the explanation of vital processes;
- most important physical and chemical methods of body and environment chemical substances structure, properties & content research.

b) Student must be able:

- to prepare water solutions of specified composition;
- to measure the pH of biological fluids and to determine their buffer capacity;
- to use thermodynamic calculations for energy characteristics of biochemical processes;
-

c) Student must get:

- the methods of simple chemical experiments performance;
- the methods of bibliographic search by the issue, to navigate in the information stream, find necessary facts, background information.

For the study of "General Chemistry" by the specialty 1-79 01 01 "General Medicine" 192 hours are devoted. Of these 90 hours — classes, including 36 hours of lectures & 54 hours for laboratory practicals

CONTENT OF EDUCATIONAL MATERIAL

1. Introduction to the discipline of "General Chemistry"

1.1. Subject and tasks of chemistry.

Place of chemistry among other natural sciences. Chemical disciplines in medical education. Communications of General Chemistry with the major disciplines of Medical and Biological educational profiles. The role of General Chemistry in the formation of professional skills of students of higher medical education institutions.

2. Fundamentals of chemical thermodynamics

Subject and objectives of chemical thermodynamics. Classification of thermodynamic systems and processes. Homogeneous and heterogeneous systems. Isolated, closed and opened systems. Processes: isochoric, isobaric, isothermal, adiabatic. The concept of phase. Internal energy, enthalpy. Isobaric and isochoric heat effects. The first beginning (law) of thermodynamics. Hess's law and its corollaries.

Thermochemical calculations and their uses for energy characteristics of biochemical processes. Spontaneous and non-spontaneous processes . Statistical and thermodynamic interpretations of entropy. Standard entropy. The second beginning (law) of thermodynamics and its application to biological systems. Gibbs energy . Reversible and irreversible thermodynamic processes. Criteria of directions flow for the spontaneous thermodynamic processes. Thermodynamics of chemical equilibrium.

3. Chemistry of solutions

3.1. Introduction. The concept of chemical equivalent

Equipment of chemical laboratory, design and structure of work. Safety precautions of laboratory work. Rules of laboratory journal reference. The concept of chemical equivalent. Equivalence factor. Molar mass of equivalent. Chemical quantity of substances equivalents. Molar concentration of chemical equivalent. Preparation of solutions of definite concentrations by the dilution of a concentrated solution.

3.2. Theoretical bases of titration analysis

An essence of titration analysis. The law of equivalents. Methods of work solutions preparation. Titration methods: direct, reverse, substitution method. Methods of equivalence point determination in titrimetry. Introduction in the work with laboratory measuring glass equipment, used in titrimetry and acquisition of skills in work with it.

3.3. Acid-base titration

The essence of acid-base titration method. Acid-base indicators. Principles of acid-base indicators selection. Titration curves. Identification of equivalent molar

concentration and the titer of hydrochloric acid solution by the standard sodium hydroxide solution.

3.4. Theoretical bases of oxidimetry

Redox reactions. The equivalent of oxidizer and reluctant. The usage of electronic balance method in the equilibration of redox reactions. Direction of spontaneous redox reactions. The usage, nature and classification of oxidimetry methods.

3.5. Permanganatometric titration

The essence and objectives of permanganatometric titration. Work solutions used in permanganatometry. Determination of equivalence point. Finding of molar equivalent concentrations and titer of $KMnO_4$ solution by the work solution of oxalic acid.

3.6. Chemistry of solutions. Ways of expression of the solutions concentration

Role of solutions in life processes. Water as a solvent. Solubility of low molecular compounds in liquids. Factors affecting the solubility. Henry's; Dalton's; Sechenov's laws. Ways of expression of the solutions composition and concentration.

3.7. Colligative properties of solutions

Colligative properties of non-electrolytes diluted solutions. Raoult's law. Osmosis and osmotic pressure. Van't Hoff's law. Colligative properties of electrolytes diluted solutions. Isotonic coefficient. Role of osmosis and osmotic pressure in biochemical systems. Hypo-, hyper-, isotonic solutions. Lysis, plasmolysis and hemolysis. Izoosmizm.

3.8. Acid-base theory

Protolytic theory of acids and bases. The strength of acids and bases. Dissociation of water. The ionic product of water. The pH as a quantitative measure of active acidity. Acid-base indicators.

3.9. Buffer systems

Buffer systems, their classification. The mechanism of buffer systems action. Henderson-Hasselbalch equation. Buffer capacity and factors determining it. Buffer systems of human organism. The concept of acid-base equilibrium of blood. Acidosis and alkalosis.

4. Elements of Chemical Kinetics

4.1. Fundamentals of Chemical Kinetics

Subject of chemical kinetics. Chemical kinetics as the basis for the study of rates and mechanisms of biochemical processes. Rates of homogeneous chemical reactions and methods of measurement. The law of mass action for the reaction rate. A constancy of reaction rate. Dependence of reaction rate on temperature. Temperature

coefficient of reaction rate and its specificities for biochemical processes. Energy of activation. Theory of active collisions. The concept of transition state theory.

4.2. Kinetic classification of chemical reactions. catalysis

Molecularity of chemical reactions. The order of chemical reaction. Kinetic equations of the 1-st, 2-nd and zero order reactions. Determination of the order of chemical reaction. One-step (simple) and multistage (complex) reactions. The concept of complex reactions kinetics: Successive, Parallel, Conjugated, Reversible & Chain reactions. Homogeneous and heterogeneous catalysis. The mechanism of acid-base catalysis. Enzymes as biological catalysts.

5 . Electrochemistry

5.1. Conductivity of solutions of electrolytes. Theory of electrical potentials appearance

Body fluids and tissues as second order electroconductors. Specific and molar electric conductivity, their variation with concentration of the solution . Limiting molar electroconductivity . Absolute speed and mobility of ions . Kohlrausch law . Conductometric measurement of dissociation degree and dissociation constancy of a weak electrolyte.

Electroconductivity of biological fluids and tissues in healthy and pathological states. Metal electrodes, the mechanism of electrode potentials occurrence. Chemical and concentration galvanic elements (cells). Redox, diffusion and membrane potentials. A calculation of electrode potentials by the Nernst or Nernst-Peters equation. Standard state electrode potentials.

5.2. Measurement of electrode potentials. Potentiometry

Practical measurement of electrode potentials. Reference (hydrogen, silver chloride) and measuring electrodes (standard state electrode potentials). Hydrogen scale of standard electrode potentials. Ion-selective electrodes: glass electrode. Potentiometric measurement of the concentration of ions in solutions. Potentiometric titration, its essence and usage in quantitative analysis and biomedical research.

6. Surface phenomena

6.1. Interfacial adsorption on the “liquid-gas” and “liquid-liquid” borders of partition

Surface phenomena and their importance in biology and medicine. Surface energy and surface tension. Surfactants and surface-inactive substances. Surface activity. Duclos-Traube’s rule. Adsorption on the liquid-gas and liquid-liquid borders of partition. Gibbs equation. The orientation of molecules in the surface layer and the structure of biological membranes.

6.2. Interfacial adsorption on the “gas-solid” and “solid-liquid” borders of partition. Chromatography

Interfacial adsorption on the “gas-solid” and “solid-liquid” (solution) borders of partition. Monomolecular and multilayer adsorption. Adsorption of strong electrolytes: elective, ion exchange. Ionites and their usage in medicine. Chromatography, its essence and application in biology and medicine. Classification of chromatographic methods by the aggregate states of phases and by the dominant feature of separation process.

7. Disperse Systems

7.1. Physico-chemical properties of disperse systems

Disperse systems classification by the dispersion degree. The nature of colloidal state. Methods of colloidal solutions preparation and purification. Dialysis, electrodialysis, ultrafiltration, gel filtration. Artificial kidney. Molecular-kinetic properties of colloidal systems: Brownian motion, diffusion, osmotic pressure. The mechanism of electric charge appearance on the colloidal particles. The structure of double electric layer. Micelle, nucleus, granule. The zeta potential of colloidal particles . Electrokinetic phenomena. Electrophoresis, electroosmosis and their practical usage in medicine.

7.2. Stability of colloidal dispersions

Kinetic and aggregate stability of sols. Coagulation. The concept of the coagulation theory by Derjaguin-Landau-Verwey-Overbeek. The effects of electrolytes on the stability of sols. Coagulation threshold. Schulze-Hardy rule. Alternation of coagulation zones. Coagulation of sols by the mixtures of electrolytes. Mutual coagulation of sols. Kinetics of sols coagulation. Slow hidden and fast visible coagulations.

7.3. High molecular compounds (biopolymers) solutions

High molecular compounds (HMC); classification, methods of preparation. The structure and geometry of macromolecules, types of bonding. Internal rotation of units in the macromolecules. Flexibility of macromolecules chains. Swelling and dissolution of biopolymers. The mechanism of swelling. The influence of various factors on the magnitude of swelling. Osmotic pressure of biopolymers solutions. Polyelectrolytes. Isoelectric point. Biopolymers solutions “salting out”. Coacervation and its role in biological systems.

8. Structure of atoms and chemical bonding

8.1. Quantum-mechanical theory of atomic structure

Basic concepts of quantum mechanics. Quantum mechanical model of the atom. Atomic orbital. Characteristics of energy state of an electron by the system of quantum numbers. Pauli’s principle. The principle of energy minimum. Main and excited state of an atom. Periodic law and Periodic System by D.I. Mendeleev in the light of the quantum theory of atomic structure. S-, p-, d-, f-elements. The notion of the ionization energy, electron affinity, electronegativity.

8.2. Chemical bonding and molecular structure

The method of valence bonds. The mechanism of covalent bond formation. Valency; maximal valency. The concept of atomic orbitals hybridization. A spatial geometry of molecules. Polarity and polarizability of bonding. Molecular orbitals method. Hydrogen bonding. A role of hydrogen bonding in the processes of associates formation; dissolution; in biological processes.

8.3. Complex compounds

Werner's theory of coordination compounds. The central atom, ligands, coordination number of the central complex forming atom (ion). Denticity of ligands. Classification of complex compounds. Intracomplex compounds. Chelates. The concept of metalloenzymes; the structure of active sites. Character of bonding in complex ions according to the valented bonds method. Dissociation of complex compounds: stability and instability constants. Application of complex compounds in medicine.

INFORMATION METHODOLOGICAL PART

LITERATURE

Main materials:

1. Болтромеюк, В.В. Общая химия. В.В.Болтромеюк. – Минск: Выш.шк., 2012. – 624с.
2. Введение в химию биогенных элементов и химический анализ. / Под редакцией Е.В. Барковского. Мн.: Вышэйшая школа. 1997. – 176 с.
3. Евстратова, К.И. Физическая и коллоидная химия. К.И. Евстратова, Н.А.Купина, Н.А., Е.Е. Малахова. – М.: Высшая школа, 1990.– 479 с.
4. Зеленин, К.Н. Общая и биоорганическая химия. К.Н. Зеленин. – С. – Пб.: Элби-СПб, 2003.– 711 с.
5. Общая химия. / Под редакцией Ю.А. Ершова.– М: Высшая школа, 2002.– 560 с.

Extra materials:

1. Мушкамбаров, Н.Н. Физическая коллоидная химия». Н.Н. Мушкамбаров. – М.: Высшая школа, 2001.– 226 с.
2. Суворов, А.В. Общая химия. А.В. Суворов, А.Б. Никольский. – С-Пб.: Специальная литература, 1994.– 312 с.
3. Сумм, Б.Д. Основы коллоидной химии. Б.Д. Сумм. – М.: Академия, 2006.– 189 с.
4. Ленский, А.С. Введение в бионеорганическую и биофизическую химию. А.С. Ленский. – М.: Высшая школа, 1989.– 256 с.

EDUCATIONAL-METHODICAL CARD

Nuimber of chapter, topic, practical	The name of chapter, topic, practical; list of studied questions	Number of classroom hours				Literature	forms of knowledge control
		lectures	practical (seminar) classes	laboratory classes	controlled self study of the student		
1	2	3	4	5	6	7	8
1.	**Introduction to the discipline of "General Chemistry"**	**1,3**		**2,5**	**0,7**		
1.1.	Subject and tasks of chemistry.	1,3		2,5	0,7	[1], [2]	Exam
2.	**Chemical thermodynamics and bioenergetics**	**1,3**			**2,7**		
2.1.	Fundamentals of chemical thermodynamics	1,3			2,7	[1], [2], [3]	Test control
3.	**Chemistry of solutions**	**5,2**		**22,5**	2,8		
3.1.	The concept of chemical equivalent			2,5		[1], [2], [3]	Test control, oral survey
3.2.	Theoretical bases of titration analysis			2,5		[1], [2]	Test control, oral survey
3.3.	Acid-base titration			2,5		[1], [2]	Test control, oral survey
3.4.	Theoretical bases of oxidimetry			2,5		[1], [2], [4]	Test control, oral survey
3.5.	Permanganatometric titration			2,5		[1], [2], [4]	Test control, oral survey
3.6.	Chemistry of solutions. Ways of expression of solutions concentration	1,3		2,5	0,7	[1], [2]	Test control, oral survey
3.7.	Colligative properties of solutions	1,3		2,5	0,7	[1], [3], [4]	Test control, oral survey

3.8.	Acid-base theory	1,3		2,5	0,7	[1], [3]	Test control, oral survey
3.9.	Buffer systems	1,3		2,5	0,7	[1], [3], [4]	Test control, oral survey
4.	**Elements of Chemical Kinetics**	**2,6**		**5**	**1,4**		
4.1.	Fundamentals of Chemical Kinetics	1,3		2,5	0,7	[1], [3], [5]	Test control, oral survey
4.2.	Kinetic classification of chemical reactions. catalysis	1,3		2,5	0,7	[1], [5]	Test control, oral survey
5.	**Electrochemistry**	**2,6**		**5**	**1,4**		
5.1.	Electroconductivity of solutions of electrolytes. Theory of electrical potentials appearance	1,3		2,5	0,7	[1], [3], [5]	Test control, oral survey
5.2.	Measurement of electrode potentials. Potentiometry	1,3		2,5	0,7	[1], [3], [4]	Test control, oral survey
6.	**Phisico-chemistry of surface phenomena**	**2,6**		**5**	**1,4**		
6.1.	Interfacial adsorption on the “liquid-gas” and “liquid-liquid” borders of partition	1,3		2,5	0,7	[1], [3], [5]	Test control, oral survey
6.2.	Interfacial adsorption on the “gas-solid” and “solid-liquid” borders of partition. Chromatography	1,3		2,5	0,7	[1], [3], [4]	Test control, oral survey
7.	**Phisico-chemistry of disperse systems**	**3,9**		**7,5**	**2,1**		
7.1.	Physico-chemical properties of disperse systems	1,3		2,5	0,7	[1], [3], [4]	Test control, oral survey
7.2.	Stability of colloidal dispersions	1,3		2,5	0,7	[1], [3], [5]	Test control, oral survey
7.3.	High molecular compounds (biopolymers) solutions	1,3		2,5	0,7	[1], [5]	Test control, oral survey
8.	**Structure of atoms and chemical bonding**	**3,9**		**2,5**	**4,1**		
8.1.	Quantum-mechanical theory of atomic structure	1,3			2,7	[1], [3], [4]	Test control
8.2.	Chemical bonding and molecular structure	1.3			0,7	[1], [3], [4]	Test control
8.3.	Complex compounds	1,3		2,5	0,7	[1], [5]	Test control, oral survey
	Quantity of academic hours	**23,4**		**50**	**16,6**		

Total	**90**

PROTOCOL
of General Chemistry training program harmonization
with the other disciplines of specialty 1-79 01 “General Medicine”

Name of the discipline, which study is associated with the discipline of the curriculum	Department, providing a study of this discipline	Proposals of department for changes in the content of the training program.	Decision made by the department, responsible for the development of training program.
Biophysics. Bioelectric potentials	Department of Medical and Biological Physics	The Department agreed with the content of the curriculum	Agreement protocol approved by the department meeting from 29 of June 2013 Protocol № 12