

Документ подписан простой электронной подписью  
Информация о владельце:  
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Должность: Ректор  
Дата подписания: 09.06.2022 17:00:52  
Уникальный программный ключ:  
ca953a0120d891083f939673078ef1a989dae18a

**Federal State Autonomous Educational Institution for Higher Education**  
**PEOPLES' FRIENDSHIP UNIVERSITY OF RUSSIA**  
**Agrarian and Technological Institute**

## **WORKING COURSE SYLLABUS**

### **Physical and Colloidal Chemistry**

**Recommended by the Methodological Council for the Education Field:**

**36.05.01 Veterinary medicine**

**2022 г.**

## 1. GOALS AND OBJECTIVES OF THE DISCIPLINE

The aim of mastering the discipline "**Physical and Colloidal Chemistry**" is to reveal the relationship between physical and chemical phenomena and understanding of the essence of physical and colloid-chemical processes occurring in nature and in biological systems.

## 2. REQUIREMENTS FOR THE RESULTS OF MASTERING THE DISCIPLINE

The development of the discipline "**Physical and Colloidal Chemistry**" is aimed at creating the following competencies (parts of competencies) for students:

*Table 2.1. List of competencies formed by students during the development of the discipline (results of the development of the discipline)*

<b>Code</b>	<b>Competence</b>	<b>Indicators of competence accomplishment (within the discipline)</b>
UK -8	The ability to create and maintain safe living conditions in everyday life and in professional activities for the preservation of the natural environment, ensuring the sustainable development of society, including in the event of a threat and occurrence of emergencies and military conflicts.	UK-8.1 Analyzes the factors of harmful influence on the vital activity of elements of the habitat. (technical means, technological processes, materials, buildings and structures, natural and social phenomena);
		UK -8.2 Identifies dangerous and harmful factors within the scope of the task being performed;
		UK-8.3 Identifies and eliminates problems related to safety violations in the workplace;
		UK-8.4 Explains measures to prevent emergencies;
		UK -8.5 "Explains the rules of conduct in the event of emergencies of natural and man-made origin, as well as in the event of military conflicts;"
		UK-8.6 Provides first aid, participates in recovery activities.
GPC -4	The ability to use methods of solving problems using modern equipment in the development of new technologies in professional activity and to use modern professional methodology for conducting	GPC-4.1 Possesses the conceptual and methodological apparatus of basic natural sciences at a level sufficient for full-fledged professional activity at the modern level.
		GPC-4.2 He knows the methods of solving problems using modern equipment.

	experimental research and interpreting their results.	GPC-4.3 He is ready to use modern methodology in the development and conduct of experimental research.
		GPC-4.4 Uses modern professional methodology in interpreting research results.
PC -3	Ability to develop animal research programs using special (instrumental) and laboratory methods.	PC-3.1 He is able to develop individual animal research programs, including the use of special (instrumental) and laboratory methods to detect deviations from the physiological norm of the state of a living organism, conduct differential diagnosis of the detected pathology or control the course of the disease and the effectiveness of the prescribed treatment.
		PC-3.2 Capable of developing mass comprehensive animal research programs (medical examination programs) of animals, taking into account their type and purpose, both general and special.
PC -7	The ability to choose the necessary drugs of chemical and biological nature for the treatment of animals, taking into account their combined pharmacological effect on the body.	PC -7.1 He is able to choose medicines of chemical and biological nature necessary for the treatment of animals, guided by the principles of evidence-based medicine, taking into account their combined pharmacological effect on the body.
		PC-7.2 He is able to justify the prescription of a drug in a certain clinical case or the impossibility of using this drug in the situation under consideration.
		PC-7.3 He is able to calculate the dose, frequency and duration of the course of application of the drug to the patient, taking into account the form of release and the characteristics of the administration of the drug to the patient.
		PC-7.4 He is able to take into account drug interactions when prescribing a course of treatment to an animal already receiving medications and biologically active additives due to the presence of diseases identified earlier.
		PC-7.5 He is able to take into account economic, species and age characteristics, as well as the results of laboratory studies

		of the patient when choosing drugs for the treatment of the patient.
PC -17	Ability to organize disinfection and disinfection of livestock premises to ensure veterinary and sanitary well-being in accordance with the plan of veterinary and sanitary measures	PC-17.1 He is capable of collecting and analyzing information necessary for the organization and planning of veterinary and sanitary measures
		PC-17.2 He is able to choose the optimal equipment, consumables and medicinal and disinfecting preparations necessary and safe enough for the conduct of veterinary and sanitary measures
		PC-17.3 He is able to determine the procedure for disinfection, disinsection, deratization and other veterinary and sanitary measures, taking into account the peculiarities of animal husbandry, technical characteristics of premises and epizootic situation
		PC-17.4 He is able to monitor the results of veterinary and sanitary measures

### 3. COURSE IN HIGHER EDUCATION

The discipline "**Physical and Colloidal Chemistry**" refers to the mandatory part of block B1 of the Educational Program of Higher Education.

As part of the Educational Program of Higher Education, students also master other disciplines and /or practices that contribute to achieving the planned results of mastering the discipline "**Physical and Colloidal Chemistry**".

*Table 3.1. List of Higher Education Program components disciplines that contribute to expected learning outcomes*

Competence code	Competence	Previous Disciplines (Modules)	Subsequent Disciplines (Modules)
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UK -8	The ability to create and maintain safe living conditions in everyday life and in professional activities for the preservation of the natural environment, ensuring the sustainable development of society, including in the event of a threat and occurrence of emergencies and military conflicts.	History Inorganic and analytical chemistry Organic chemistry Biological physics	Life safety Biological chemistry Veterinary Microbiology and Mycology Virology and biotechnology Veterinary radiobiology Parasitology and invasive diseases Epizootology and infectious diseases Organization of veterinary affairs General and Veterinary Ecology Veterinary sanitation Veterinary deontology Laboratory diagnostics of infectious and invasive diseases Organization of state veterinary supervision
GPC -4	The ability to use methods of solving problems using modern equipment in the development of new technologies in professional activity and to use modern professional methodology for conducting experimental research and interpreting their results.	Inorganic and analytical chemistry Organic chemistry Biological physics Computer science	Cytology, Histology and Embryology Biological chemistry Veterinary Microbiology and Mycology Virology and biotechnology Physiology and ethology of animals Breeding with the basics of private animal husbandry Pathological physiology Veterinary radiobiology Clinical diagnostics Pathological anatomy Operative surgery with topographic anatomy Instrumental diagnostic methods Toxicology Obstetrics, gynecology and andrology Internal diseases General surgery

		<p>Private Veterinary Surgery</p> <p>Parasitology and invasive diseases</p> <p>Epizootology and infectious diseases</p> <p>Maths</p> <p>Immunology</p> <p>Veterinary sanitation</p> <p>Processing technology for livestock products</p> <p>Medicinal and poisonous plants</p> <p>Fodder plants</p> <p>The basics of intellectual work</p> <p>Personality psychology and professional self-determination</p> <p>Clinical laboratory diagnostics</p> <p>Laboratory diagnostics of infectious and invasive diseases</p> <p>Horse diseases</p> <p>Diseases of Productive Animals</p> <p>Diseases of small pets</p> <p>Болезни мелких домашних животных</p> <p>Diseases of bees and entomophages</p> <p>Fish pathology and aquaculture</p> <p>Diseases of exotic animals</p> <p>Anesthesiology, resuscitation and intensive care</p> <p>Dermatology</p> <p>Cardiology</p> <p>Endocrinology</p> <p>Nephrology</p> <p>Reconstructive surgery</p> <p>Veterinary ophthalmology</p> <p>Animal Dentistry</p>
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PC -3	Ability to develop animal research programs using special (instrumental) and laboratory methods.	Animal anatomy Organic chemistry Biological physics	Biological chemistry Veterinary Microbiology and Mycology Virology and biotechnology Physiology and ethology of animals Pathological physiology Clinical diagnostics Pathological anatomy Instrumental diagnostic methods Toxicology Obstetrics, gynecology and andrology Internal diseases General surgery Private Veterinary Surgery Parasitology and invasive diseases Epizootology and infectious diseases Immunology Veterinary deontology Clinical laboratory diagnostics Laboratory diagnostics of infectious and invasive diseases Veterinary and industrial laboratories with design basics Horse diseases Diseases of Productive Animals Diseases of small pets Болезни мелких домашних животных Diseases of bees and entomophages Fish pathology and aquaculture Diseases of exotic animals Anesthesiology, resuscitation and intensive care
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			Dermatology Cardiology Endocrinology Nephrology Reconstructive surgery Veterinary ophthalmology Animal Dentistry
PC -7	The ability to choose the necessary drugs of chemical and biological nature for the treatment of animals, taking into account their combined pharmacological effect on the body.	Inorganic and analytical chemistry Organic chemistry	Biological chemistry Veterinary Microbiology and Mycology Virology and biotechnology Pathological physiology Veterinary pharmacology Toxicology Obstetrics, gynecology and andrology Internal diseases General surgery Private Veterinary Surgery Parasitology and invasive diseases Epizootology and infectious diseases Medicinal and poisonous plants Horse diseases Diseases of Productive Animals Diseases of small pets Болезни мелких домашних животных Diseases of bees and entomophages Fish pathology and aquaculture Diseases of exotic animals Anesthesiology, resuscitation and intensive care Dermatology Cardiology Endocrinology Nephrology

			Veterinary ophthalmology Animal Dentistry
PC -17	Ability to organize disinfection and disinfection of livestock premises to ensure veterinary and sanitary well-being in accordance with the plan of veterinary and sanitary measures	Inorganic and analytical chemistry Organic chemistry	Life safety Veterinary Microbiology and Mycology Virology and biotechnology Veterinary pharmacology Veterinary sanitation Здоровье и благополучие ЖИВОТНЫХ

#### 4. COURSE WORKLOAD AND TRAINING ACTIVITIES

Course workload of the discipline "**Physical and Colloidal Chemistry**" is 2 credits.

*Table 4.1. Types of academic activities during the period of the HE program mastering for **full-time** study*

Types of academic activities		HOURS	Semesters				
			2	-	-	-	
Contact academic hours		36	36	-	-	-	
including							
Lectures		18	18	-	-	-	
Lab work		18	18			-	
Seminars (workshops/tutorials)		-	-	-	-	-	
Self-study		30	30	-	-	-	
Evaluation and assessment (exam/pass/fail grading)		6	6	-	-	-	
<b>Course workload</b>		Academic hour	<b>72</b>	<b>72</b>	-	-	-
		Credit unit	<b>2</b>	<b>2</b>	-	-	-

*Table 4.2. Types of academic activities during the period of the HE program mastering for **part-time** study*

Types of academic activities		HOURS	Semesters			
			2	-	-	-
Contact academic hours		18	18	-	-	-
including						
Lectures		-	-	-	-	-

Lab work		18	18	-	-	-
Seminars (workshops/tutorials)		-	-	-	-	-
Self-study		44	44	-	-	-
Evaluation and assessment (exam/pass/fail grading)		10	10	-	-	-
<b>Course workload</b>	Academic hour	<b>72</b>	<b>72</b>	-	-	-
	Credit unit	<b>2</b>	<b>2</b>	-	-	-

## 5. CONTENT OF THE DISCIPLINE

*Table 5.1 Content of the discipline (module) by type of academic work*

<b>Name of the discipline section</b>	<b>Content of the section (topics)</b>	<b>Types of academic activities</b>
Section 1. Phase equilibria. Properties of solutions	Topic 1.1 Types of solutions: liquid, gas, solid. Thermodynamics of solutions. Chemical potential of a solution component. Types of solutions. Heterogeneous multicomponent systems. Gibbs phase rule. Single-component heterogeneous systems. Clapeyron-Clausius equation. State diagrams of water.	Lectures, Lab work.
	Topic 1.2 Characteristics of binary systems. Number of parameters and number of phases. Equilibrium between liquid solution and vapor. Raoul's law. Deviations from Raoul's law for non-ideal liquid solutions. Liquid-vapor state diagrams for binary systems. Lever rule. Azeotropic solutions. Fractional distillation. Limited solubility of liquids. Extraction. Solubility of gases in liquids. Sechenov's law. Cryoscopy and ebullioscopy. Osmosis. Colligative properties of electrolyte solutions.	Lectures, Lab work.
	Topic 1.3 Vant-Goff isotonic coefficient.	Lectures, Lab work.
	Topic 1.4 Equilibria between solid phases and melts. Types of melting diagrams. Physical and chemical analysis.	Lectures, Lab work.

		Topic 1.5 Three-component systems. The Gibbs-Rosebohm triangle. The solubility diagram of three liquids.	Lectures, Lab work.
Section 2. Electrochemistry.	2.	Topic 2.1 Differences between the properties of electrolyte solutions and the properties of non-electrolyte solutions. Arrhenius theory of electrolytic dissociation. Ionic equilibria in solutions. Dissociation constants. Ionic derivation of water. Hydrogen index. Buffer solutions. Reasons for the stability of ionic systems. The ionic strength of solutions.	Lectures, Lab work.
		Theme 2.2 Electrical conductivity of electrolyte solutions. Specific, equivalent and molar conductivity of electrolyte solutions and their dependence on concentration. Kohlrausch's rule. Mobility of ions. Application of conductometry in analytical chemistry.	Lectures, Lab work.
		Topic 2.3 Mechanism of appearance of the potential jump at the interface. Diffusion potential.	Lectures, Lab work.
		Topic 2.4 Electrode potentials. The Nernst equation. Standard electrode potentials. Hydrogen electrode. Measurement of pH.	Lectures, Lab work.
		Topic 2.5 Galvanic elements and electromotive force. Electrochemical and concentration elements. The Nernst equation. Calculation of the standard Gibbs energy.	Lectures, Lab work.
	Section 3. Chemical kinetics. Catalysis.		Topic 3.1 Basic definitions. Simple and complex reactions. Reaction rate. Kinetic law of acting masses. Kinetic equation, molecularity and order of reaction. Kinetics of simple zero, first and second order reactions. The half-turn period. Methods for determining the order of a reaction.
		Topic 3.2 Complex reactions: reversible, parallel, serial and conjugate.	Lectures, Lab work.

	Topic 3.3 Influence of temperature on the reaction rate. Van Goff rule and Arrhenius equation. Determination of the shelf life of drugs and storage conditions.	Lectures, Lab work.
	Topic 3.4 The theory of active collisions. Reaction activation energy, methods of determination. The theory of activated complex. Peculiarities of reactions in liquid solutions. Photochemical reactions.	Lectures, Lab work.
	Topic 3.5 Catalysis. Kinetics of homogeneous catalytic reactions. Enzymatic catalysis. Michaelis-Menten equation. Inhibitors. Heterogeneous catalysis.	Lectures, Lab work.
Section 4. Surface phenomena. Adsorption. Chromatography.	Topic 4.1 Surface tension and phenomena at the interface: adsorption, adhesion, wetting. Flotation as a method of separation of dispersed phases. Lyophobic and lyophilic surfaces. Adhesion. Dupré's equation. Wetting. The Gibbs adsorption theory. Adsorption on liquid surfaces. Surface active substances (surfactants). The Duclos-Traube rule. The Szyszkowski equation.	Lectures, Lab work.
	Topic 4.2 Physical adsorption, chemisorption. Model theories of reversible adsorption on homogeneous surfaces. Henry and Langmuir adsorption isotherms. Ultimate adsorption, determination of specific surface area of sorbents. Heat of adsorption. Peculiarities of adsorption of molecules and ions from solutions on solid surfaces. Adsorption isotherm with exchange constant. The lyotropic series. Ionites.	Lectures, Lab work.
	Topic 4.3 Porous materials. Enterosorbents.	Lectures, Lab work.
	Topic 4.4 Chromatography. Types of chromatography. Qualitative and quantitative chromatographic analysis.	Lectures, Lab work.

Section 5. Colloid chemistry. Classifications, methods of production and properties of dispersed systems.	Topic 5.1 History, major tasks and directions of development of colloidal chemistry. Classification of dispersed (colloidal) systems, their importance. The role of stabilizer.	Lectures, Lab work.
	Topic 5.2 Conditions and methods of obtaining dispersions. Peptization.	Lectures, Lab work.
	Topic 5.3 Micelle structure of hydrophobic sol.	Lectures, Lab work.
	Topic 5.4 Commonality of molecular and kinetic properties of solutions and disperse systems. Diffusion and Brownian motion. Fick's, Einstein's and Einstein-Smoluchowski's equations. Osmosis and membrane processes of purification of colloidal systems (dialysis, ultrafiltration).	Lectures, Lab work.
	Topic 5.5 Kinetic stability of free-dispersed systems. Sedimentation. Analysis of dispersity of colloidal systems according to sedimentation and centrifugation. Suspensions. Hypsometric law.	Lectures, Lab work.
	Topic 5.6 Optical properties. Scattering and absorption of light in colloidal systems. Rayleigh's law. Application of Lambert-Beyer law to turbid media. Optical methods of research of dispersions (nephelometry, turbidimetry, ultramicroscopy, electron microscopy).	Lectures, Lab work.
Section 6. Electrical phenomena in dispersions. Aggregative stability. Coagulation.	Topic 6.1 Appearance of the double electric layer (DES) at the phase boundary. Lippmann equation. The structure of DES and its potentials DES (thermodynamic, adsorption and electrokinetic) and the influence of various factors on them. The isoelectric state.	Lectures, Lab work.
	Topic 6.2 Electrokinetic phenomena (electrophoresis, electro-osmosis, sedimentation and flow potentials) and their practical significance. Electrophoresis. Helmholtz-Smoluchowski equations.	Lectures, Lab work.

	Topic 6.3 Factors of kinetic and aggregative stability of disperse systems. Coagulation, electrolyte coagulation threshold (rule of significance). Deryagin-Landau-Ferwey-Overbeck /DLFO/ theory of stability of hydrophobic colloids. Potential curves. Thixotropy.	Lectures, Lab work.
	Topic 6.4 Gels of hydrophobic sols. Coagulation kinetics. Special cases of coagulation of sols with electrolytes. Structural and mechanical factor of stabilization of dispersions. Colloidal protection. Protective substances, protective numbers.	Lectures, Lab work.
Section 7. Lyophilic colloids. Solutions of high molecular weight compounds (HMS) and their properties.	Topic 7.1 General characteristics of high molecular weight compounds (HMS). Classification of high-molecular-molecular compounds. Natural and synthetic high-molecular-molecular-molecule compounds. Conformation of macromolecules.	Lectures, Lab work.
	Topic 7.2 Swelling of OMC. Thermodynamics and kinetics of swelling. Resolutions of hydrophobic polymeric materials as thermodynamically equilibrium colloidal systems. Comparison of properties of solutions of HMS and hydrophobic sols. Osmotic pressure, viscosity and optical properties of the Navy solutions. Solutions of polyelectrolytes. Polyampholytes. Protein isoelectric point and methods of its determination. Gibbs-Donnan membrane equilibrium. Disturbance of stability of polymer solutions (gelation, coacervation, desalinization, denaturation).	Lectures, Lab work.
	Topic 7.3 Gels of the Navy solutions. Properties of the gels of the Navy and gels of hydrophobic sols. Syneresis of gels. Gels.	Lectures, Lab work.

## 6. CLASSROOM INFRASTRUCTURE AND TECHNOLOGY SUPPORT REQUIREMENTS

*Table 6.1. Material and technical support of the discipline*

<i>Classroom for Academic Activity Type</i>	<i>Equipping the classroom</i>	<b>Specialized educational/laboratory equipment, software and materials for the development of the discipline (if necessary)</b>
Lecture	An auditorium for conducting lecture-type classes, equipped with a set of specialized furniture; a board (screen) and technical means of multimedia presentations.	-reagents, -instruments, -sets of reference materials, -materials for current knowledge control (tests, control tasks).
Laboratory	An auditorium for laboratory work, individual consultations, routine monitoring and interim certification, equipped with a set of specialized furniture and equipment.	-distiller, -analytical scales, -magnetic stirrers, -ionomers, -pH-meters, -Liquid thermostat, -polarimeter (saccharimeter), -meters -Conductivity meters (conductivity meters), EMF-measurers, -photometers, -gasometers, -chromatographs, -nephelometers, -Viscosimeters
Self-studies	An auditorium for independent work of students (can be used for seminars and consultations), equipped with a set of specialized furniture and computers with access to an electronic information and educational environment.	

## 7. RECOMMENDED SOURCES FOR COURSE STUDIES

### *Main reading:*

1. Belyaev A.P. Physical and colloidal chemistry : textbook / A.P. Belyaev, V.I. Kuchuk ; edited by A.P. Belyaev. - 3-th edition, revised. and supplement. - Moscow : GEOTAR-Media, 2021. - 816 c. - ISBN 978-5-9704-5690-3.
2. Mikhalenko Irina Ivanovna. Practical work in physical chemistry : a textbook for full-time students of Pharmacy, studying in the discipline of physical and colloid chemistry. Kinetics of chemical reactions. Catalysis. Section / I.I. Mikhalenko. - Moscow : PFUR, 2020. - 78 c. : ill. - ISBN 978-5-209-09653-5

### *Additional Reading:*

1. A.G. Stromberg, D.P. Semchenko Physical Chemistry. M: Vysshaya shkola. 2001.
2. Emanuel N.M., Knorre D.G. Course of Chemical Kinetics. Textbook. M: High School. 1984. 463 c.
3. Filippov Yu.I., Popovich M.P. Physical Chemistry. Moscow State University. 1980. 399 c.
4. Glazov V.M., Fundamentals of Physical Chemistry. Textbook. M. Vysshaya shkola.1981. 465c.
5. Atkins P. Physical Chemistry: In 2 vols. Moscow: Mir, 1980. T.1, 2.
6. Laboratory work and tasks in colloid chemistry. Edited by Yu.G. Frolov. M.1986.215s.

*Resources of the Internet information and telecommunication network:*

1. Electronic library system of RUDN and third-party Electronic library systems to which university students have access on the basis of concluded contracts:

- Electronic library system of RUDN - ELS RUDN <http://lib.rudn.ru/MegaPro/Web>
- ELS "University Library online" <http://www.biblioclub.ru>
- ELS Yurayt <http://www.biblio-online.ru>
- ELS "Student Consultant" [www.studentlibrary.ru](http://www.studentlibrary.ru)
- ELS "Lan" <http://eZlanbook.com/>
- ELS "Trinity Bridge" <http://www.trmost.com/>

2. Databases and search engines:

- electronic fund of legal and regulatory and technical documentation <http://docs.cntd.ru/>
- search engine Yandex <https://www.yandex.ru/>
- search engine Google <https://www.google.ru/>
- abstract database SCOPUS <http://www.elsevierscience.ru/products/scopus/>

Educational and methodological materials for independent work of students during the development of the discipline/ module\*:

1. A course of lectures on the discipline "**Physical and Colloidal Chemistry**".
2. Laboratory workshop on the discipline "**Physical and Colloidal Chemistry**".

\* - All educational and methodological materials for independent work of students are placed in accordance with the current procedure on the discipline page in the **Telecommunication educational and Information System!**

## 8. MID-TERM ASSESSMENT

Evaluation materials and a point-rating system\* for assessing the level of competence formation (part of competencies) based on the results of mastering the discipline "**Physical and Colloidal Chemistry**" are presented in the Appendix to this Work Program of the discipline.

\* - Assessment Materials and a Point Rating System are formed based on the requirements of the relevant local regulatory act of the RUDN.

### DEVELOPER:

Associate Professor, Department of Physical and  
Colloid Chemistry

Position, Basic curriculum

Signature

Markova E.B.

Full name.

Associate Professor, Department of Physical and  
Colloid Chemistry

Position, Basic curriculum

Signature

Shishko T.F.

Full name.

**HEAD OF THE DEPARTMENT:**

Department of Physical and Colloid Chemistry

Name Basic Curriculum

Signature

Cherednichenko A.G.

Full name.

**HEAD OF THE HIGHER EDUCATION PROGRAM:**

Director of the Department of Veterinary Medicine

Position, Basic curriculum

Signature

Vatnikov Yu.A.

Full name