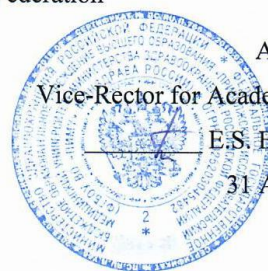


Federal State Budgetary Educational Institution of Higher Education  
"Privolzhsky Research Medical University"  
Ministry of Health of the Russian Federation



APPROVED

Vice-Rector for Academic Affairs

E.S. Bogomolova

31 August 2021

## WORKING PROGRAM

Name of the academic discipline: **THERMODYNAMICS OF CHEMICAL EQUILIBRIUM OF VARIOUS SYSTEMS**

Specialty: **33.05.01 PHARMACY**

Qualification: **PHARMACIST**

Department: **GENERAL CHEMISTRY**

Mode of study: **FULL-TIME**

Labor intensity of the academic discipline: **72 academic hours**

Nizhny Novgorod,  
2021

The working program has been developed in accordance with the Federal State Educational Standard for the specialty 33.05.01 PHARMACY approved Order of the Ministry of Science and Higher Education of the Russian Federation No. 219 of March 27, 2018.

**Developers of the working program:**

Kondrashina O.V., Ph.D., Associate Professor

2.Gordetsov A.S., Doctor of Chemistry, Professor, Head of the Department of General Chemistry.

The program was reviewed and approved at the department meeting (protocol No.1, 26.08.2021)

Head of the Department of General Chemistry,  
Doctor of Chemistry, Professor Gordetsov A.S.

 /Gordetsov A.S./

August 26, 2021

AGREED

Deputy Head of EMA ph.d. of biology \_\_\_\_\_ Lovtsova L.V.

  
(signature)

August 26, 2021

## 1. The purpose and objectives of mastering the academic discipline :

### *THERMODYNAMICS OF CHEMICAL EQUILIBRIUM OF VARIOUS SYSTEMS*

1.1. The purpose of mastering the discipline in the formation the following competencies:

UK-1: The ability to carry out a critical analysis of problem situations based on a systematic approach, to develop an action strategy

GPC-1: the ability to use basic biological, physico-chemical, chemical, mathematical methods for the development, research and examination of medicines, the manufacture of medicines.

1.2. Tasks of the discipline

1.2.1. Readiness to use basic physico-chemical, mathematical and other natural science concepts and methods of solving professional problems;

1.2.2. Readiness to solve standard tasks of professional activity using information, bibliographic resources;

1.2.3. Biomedical and pharmaceutical technology, information and communication technologies and taking into account the basic requirements of information security.

1.3. Requirements to the deliverables of mastering the discipline

As a result of completing the discipline, the student should

#### **Know:**

physico-chemical bases of surface phenomena and dispersed phenomena; the influence of various factors on the destruction of medicinal substances; the possibility of using surface phenomena for the preparation of dosage forms;

fundamentals of phase and physical states of polymers, the possibility of their changes for use in medicine, pharmacy; basic properties of high-molecular substances; factors affecting solidification, swelling, thixotropy, syneresis, coacervation, viscosity, periodic reactions in the mechanism of preparation of dosage forms.

#### **Be able to:**

independently work with educational and reference literature on physical and colloidal chemistry;

to use the basic techniques and methods of physico-chemical measurements; to work with the main types of devices used in physical and colloidal chemistry; to calculate the thermodynamic functions of the state of the system, thermal effects of chemical processes; to calculate equilibrium constants, equilibrium concentrations of reagents, equilibrium yield of reaction products, the degree of transformation of starting substances; to shift equilibria in solutions;

to assemble the simplest installations for laboratory research;

tabulate experimental data, graphically represent them, interpolate, extrapolate to find the desired values; measure physico-chemical parameters of solutions;

to carry out elementary statistical processing of experimental data in physico-chemical experiments; to process, analyze and summarize the results of physico-chemical observations and measurements; to apply the knowledge gained in the study of analytical, pharmaceutical chemistry, pharmacognosy, pharmacology, toxicology, drug technology.

#### **Possess:**

methods of statistical processing of experimental results of physico-chemical studies;

the methodology for estimating the errors of physico-chemical measurements;

methods of colorimetry, polarimetry, potentiometry, spectrophotometry, refractometry, cryometry, chromatography;

skills of interpretation of calculated values of thermodynamic functions in order to predict the possibility and direction of chemical processes; technique of conducting basic physico-chemical

experiments; technique of experimental determination of pH of solutions using indicators and instruments;

physico-chemical methods of analysis of substances forming true solutions and dispersed systems; preparation skills, quality assessment, ways to increase the stability of dispersed systems; skills of conducting scientific research to establish the relationship of physico-chemical properties and pharmacological activity.

## 2. Position of the academic discipline in the structure of the General Educational Program of Higher Education (GEP HE) of the organization.

1. 2.1. The discipline *THERMODYNAMICS OF CHEMICAL EQUILIBRIUM OF VARIOUS SYSTEMS* refers to the part formed by the participants of educational relations of Block 1 of GEP HE.

The discipline is taught in 3 semester 2 year of study.

2.2. The following knowledge, skills and abilities formed by previous academic disciplines are required for mastering the discipline:

1. General and inorganic chemistry
2. Physics
3. Mathematics

2.3. Mastering the discipline is required for forming the following knowledge, skills and abilities for subsequent academic disciplines:

1. Biochemistry
2. Toxicological chemistry
3. Pharmaceutical chemistry
4. Pharmacognosy

## 3. Deliverables of mastering the academic discipline and metrics of competence acquisition

The process of studying the discipline is aimed at the formation of the following universal (UC), general professional (GPC):

№ п/п	Competence code	The content of the competence (or its part)	Code and name of the competence acquisition metric		
			know	be able to	possess
1.	UC-1	the ability to carry out a critical analysis of problem situations based on a systematic approach, to develop an action strategy	How to put into practice the methods of humanitarian, natural sciences, biomedical and clinical sciences in various types of professional and social activities	Analyze socially significant problems and processes	The methods of humanitarian natural sciences, biomedical and clinical sciences
2.	GPC-1	the ability to use basic biological, physico-chemical, chemical, mathematical	How to apply the basic methods, means and obtaining	Work with scientific literature analyze information, conduct	Ability and willingness to participate in the

		methods for the development, research and examination of medicines, the manufacture of medicines	storage, processing of scientific and professional information; receive information from various sources, including using modern computer tools, network technologies, databases and knowledge	searches, turn what is read into tool for solving professional problems Use the rules for constructing chemical formulas, graphs, tables using appropriate computer programs, including for creating computer presentations.	formulation of scientific problems and their experimental implementation  Computer programs for constructing chemical and stereochemical formulas of organic compounds and other types of illustrative material.
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**4. Sections of the academic discipline and competencies that are formed when mastering them**

№ п/п	Competence code	Section name of the discipline	The content of the section in teaching units
1.	UC-1 GPC-1	Thermodynamic properties of the surface layer	Thermodynamics of the surface layer. Gibbs surface energy and surface tension. Methods for determining surface tension. The wetting edge angle. Dependence of surface tension on temperature. The relationship of surface Gibbs energy and surface enthalpy. Wetting enthalpy and hydrophilicity coefficient.
2.	UC-1 GPC-1	Thermodynamics of adsorption processes	2.1 Thermodynamics of multicomponent systems taking into account surface energy. Adsorption at the interface of phases. Surfactants and surfactants. Isotherm of surface tension. The Shishkovsky equation. Surface activity. The Duclos-Traube rule. 2.2. Molecular mechanisms of adsorption. Orientation of molecules in the surface layer. Determination of the area occupied by a surfactant molecule in a saturated adsorption layer and the maximum length of the surfactant molecule. 2.3. Thermodynamic analysis of adsorption. Excessive Gibbs adsorption. Gibbs adsorption isotherm equation. Measurement of adsorption at the solid–gas and solid–liquid interfaces. Factors affecting the adsorption of gases and solutes. Monomolecular adsorption, Langmuir and Freundlich adsorption isotherm equation. Polymolecular adsorption. Capillary condensation,

		absorption, chemisorption. 2.4. Adsorption of electrolytes. Non-specific (equivalent) ion adsorption. Selective ion adsorption. The Paneta Faience rule. Ion exchange adsorption. Ionites and their classification. Exchange capacity. The use of ionites in pharmacy. 2.5. Chromatography (M.S. Color). Classification
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## 5. Volume of the academic discipline and types of academic work

Type of educational work	Labor intensity		Labor intensity (AH) in semesters
	volume in credit units (CU)	volume in academic hours (AH)	
Classroom work, including	<b>1.22</b>	<b>44</b>	44
Lectures (L)	0.28	10	10
Laboratory practicum (LP)*			
Practicals (P)	0.94	34	34
Seminars (S)	-	-	
Student's individual work (SIW) exam	0.78	28	28
<b>TOTAL LABOR INTENSITY</b>	<b>2</b>	<b>72</b>	<b>72</b>

## 6. Content of the academic discipline

### 6.1. Sections of the discipline and types of academic work:

№	№ semester	Name of the section of the academic discipline	Types of academic work* (in AH)					Evaluation tools
			L	LP	P	S	SIW	
1	3	Thermodynamic properties of the surface layer	4		12		10	Multiply choice tests, tests or colloquia, survey, exam
2	3	Thermodynamics of adsorption processes	6		22		18	Multiply choice tests, tests or colloquia, laboratory works, survey, exam

		TOTAL			34		28	
			10					

\* - L – lectures; LP – laboratory practicum; P – practicals; S – seminars; SIW – student's individual work.

## 6.2. Thematic schedule of educational work types:

### 6.2.1 Thematic schedule of lectures

№	Name of lecture topics	Volume in AH
		semester 3
1.	Thermodynamics of chemical equilibrium. Types of chemical equilibrium. Thermodynamics of multicomponent systems taking into account surface energy.	2
2.	Thermodynamics of the surface layer. Thermodynamic analysis of adsorption.	2
3.	Capillary condensation. Adsorption of electrolytes.	2
4.	Thermodynamics of micelle formation. KKM. Solubilization.	2
5.	Thermodynamics of IUD solutions.	2

### 6.2.2. The thematic plan of laboratory practicums

№	Name of Practicals	Volume in AH
		Semester 3
1.	Surface phenomena. Surface tension	3.4
2.	Surface activity.	3.4
3.	Wetting. The effect of surfactants on wetting. Cohesion and adhesion.	3.4
4.	Control work No. 1 "Thermodynamic properties of the surface layer"	3.4
5.	Types of adsorption. The fundamental Gibbs adsorption equation	3.4
6.	Study of adsorption at the liquid–gas interface. Study of adsorption at the liquid–solid phase interface.	3.4
7.	Polymolecular adsorption	3.4
8.	Adsorption of gases	3.4
9.	Adsorption of electrolytes. Chromatography	3.4
10.	Control work No. 2 "Adsorption"	3.4

**6.2.3. Thematic plan of practicals:** not provided for.

**6.2.4. Thematic plan of seminars:** not provided for.

### 6.2.5. Types and topics of student's individual work (SIW)

№	Types and topics of SIW	Volume in AH
		Semester 3
1.	work with lecture material, which provides for the study of lecture notes and educational literature, work with electronic literature	8
2.	completing homework for the lesson	10
3.	preparation for the control work	4
4.	preparing for testing online	3
5.	work with Internet resources, including for the preparation of the report	3
TOTAL (total -28 AH)		

### 6.2.6. Student's research work:

№	Student's research work:	Semester
1.	Features of the curved phase interface.	3
2.	Thermodynamic foundations of adhesion.	
3.	Using the Henry, Freundlich and Langmuir equations to describe adsorption.	
4.	Application of chromatography in pharmacy.	
5.	Methods for determining surface tension.	

### 7. Types of assessment formats for ongoing monitoring and mid-term assessment

№	Semester No.	Types of control	Name of section of academic discipline	Competence codes		
					types	number of test questions
1.	3	Current monitoring	Thermodynamic properties of the surface layer	1, 2, 3- Current testing. Testing practical skills. test or colloquium	3	12
2.	3	Current monitoring	Adsorption	1 - Current testing. Oral individual survey. 2 - Current testing. Test work or colloquium. 3 - Current testing.	4	12



				Oral individual survey.		
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## 8. Educational, methodological and informational support for mastering the academic discipline (printed, electronic publications, the Internet and other network resources)

### 8.1. Key literature references

№	Name according to bibliographic requirement	Number of copies	
		at the department	at the department
1.	Zurabyan S.E. Fundamentals of bioorganic chemistry: Textbook for medical students. - Moscow 2003, 2006.: GEOTAR-MED, -320c.	-	50
2.	Ebbing, D. D. General Chemistry / D. D. Ebbing, S. D. Gammon. – 11th ed. – Australia : Cengage Learning, 2019. – 864 p. : il. – ISBN 978-1-3055-8034-3.	-	50

### 8.2. Further reading

№	Name according to bibliographic requirements	Number of copies	
		at the department	in the library
	Kharitonov Yu.Ya. Physical chemistry. Textbook. – M.: GEOTAR-Media, 2009. – p. 608	2	2
	Tasks in physical chemistry: textbook / V.V.Eremin, S.I.Kargov, I.A.Uspenskaya, N.E.Kuzmenko, V.V.Lunin. – M.: Exam, 2003. – p.320	1	1
	Zimon A.D. Physical chemistry. – M.: Agar, 2003. – p.320	2	1

### 8.3. Electronic educational resources for teaching academic subjects

#### 8.3.1. Internal Electronic Library System of the University (IELSU)

№	Name of the electronic resource	Brief description (content)	Access conditions	Number of users
	Internal Electronic Library System (EBS)	The works of the academic staff of the Academy: textbooks and manuals, monographs, collections of scientific papers, scientific articles, dissertations, abstracts of dissertations, patents.	from any computer located on the Internet, using an individual login and password	Not limited

#### 8.3.2. Electronic educational resources acquired by the University

№	Name of the electronic resource	Brief description (content)	Access conditions	Number of users
1.	International scientometric database "Web of Science Core Collection"	Web of Science covers materials on natural, technical, social, and humanitarian sciences;	Access is free from PIM computers [Electronic	Access is free from PIMU computers

		<i>takes into account the mutual citation of publications developed and provided by Thomson Reuters; has built-in capabilities for searching, analyzing, and managing bibliographic information.</i>	<i>resource] – Access to the resource at: <a href="http://apps.webofknowledge.com">http://apps.webofknowledge.com</a></i>	
2.	Electronic database "Student Consultant"	Educational literature + additional materials (audio, video, interactive materials, test tasks) for higher medical and pharmaceutical education. Publications are structured by specialties and disciplines in accordance with the current Federal State Educational Standard of Higher Education.	from any computer located on the Internet, using an individual login and password [Electronic resource] – Access mode: <a href="http://www.studmedlib.ru/">http://www.studmedlib.ru/</a>	General PIMU subscription

### 8.3.3 Open access resources

<i>№</i>	<i>Name of the electronic resource</i>	<i>Brief description (content)</i>	<i>Access conditions</i>
1.	Federal Electronic Medical Library (FEMB)	Includes electronic analogues of printed publications and original electronic publications that have no analogues recorded on other media (dissertations, abstracts, books, journals, etc.). [Electronic resource] – Access mode: <a href="http://femb.pfm/">http://femb.pfm/</a>	from any computer located on the Internet
2.	Scientific Electronic Library eLIBRARY.RU	The largest Russian information portal in the field of science, technology, medicine and education, containing abstracts and full texts of scientific articles and publications. [Electronic resource] – Access mode: <a href="https://elibrary.ru/">https://elibrary.ru/</a>	from any computer located on the Internet

## 9. Material and technical support for mastering an academic discipline

### 9.1. List of premises for classroom activities for the discipline

1. *Lecture hall equipped with multimedia equipment and microphone.*
2. *Offices for laboratory workshops.*

9.2. List of equipment for classroom activities for the discipline

1. Multimedia complex (computer and projection equipment)
2. Information stands.
3. Tables and reference books.
4. Slides and multimedia presentations of lectures.
5. Chemical tableware (burettes, pipettes, flasks, glasses, refrigerators, chemical reagents).
6. Chemical reagents.
7. Fume hood.
8. Alcohol lamps.
9. Electric stoves.
10. Analytical scales.
11. Water bath.
12. Tripods for test tubes.
13. Tripods with reagents.
14. Magnetic stirrers.

**9.3. A set of licensed and freely distributed software, including domestic production**

<b>Item no.</b>	<b>Software</b>	<b>number of licenses</b>	<b>Type of software</b>	<b>Manufacturer</b>	<b>Number in the unified register of Russian software</b>	<b>Contract No. and date</b>
1	Wtware	100	Thin Client Operating System	Kovalev Andrey Alexandrovich	1960	2471/05-18 from 28.05.2018
2	MyOffice is Standard. A corporate user license for educational organizations, with no expiration date, with the right to receive updates for 1 year.	220	Office Application	LLC "NEW CLOUD TECHNOLOGIES"	283	without limitation, with the right to receive updates for 1 year.
3	LibreOffice		Office Application	The Document Foundation	Freely distributed software	
4	Windows 10 Education	700	Operating systems	Microsoft	Azure Dev Tools for Teaching Subscription	
5	Yandex.		Browser	«Yandex»	3722	

	Browser					
6	Subscription to MS Office Pro for 170 PCs for FGBOU VO "PIMU" of the Ministry of Health of Russia	170	Office Application	Microsoft		23618/HN10 030 LLC "Softline Trade" from 04.12.2020

**10. List of changes to the working program (to be filled out by the template)**

Federal State Budgetary Educational Institution of Higher Education  
"Privolzhsky Research Medical University"  
Ministry of Health of the Russian Federation  
(FSBEI HE "PRMU" of the Ministry of Health of Russia)

Department of  
*General Chemistry*

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**CHANGE REGISTRATION SHEET**

working program for the academic discipline  
***NAME OF THE ACADEMIC DISCIPLINE***

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Field of study / specialty / scientific specialty: \_\_\_\_\_

(code,

name)

Training profile: \_\_\_\_\_

(name) - for master's degree programs

Mode of study: \_\_\_\_\_

*full-time/mixed attendance mode/extramural*

Position	Number and name of the program section	Contents of the changes made	Effective date of the changes	Contributor's signature
1				

Approved at the department meeting

Protocol No. \_\_\_\_\_ of \_\_\_\_\_ 20\_\_