FACULTY OF PHARMACY

STUDY PROGRAM 0916.1 PHARMACY

CHAIR OF GENERAL CHEMISTRY

APPROVED
at the meeting of the Commission for Quality Assurance and Evaluation of the Curriculum faculty of Pharmacy
Minutes No. 2 of 09.11.2021
Chairman, PhD, associate professor
Uncu Livia _____

APPROVED
at the Council meeting of the Faculty of Pharmacy
Minutes No. 3 of 16.12.2021
Dean of Faculty, PhD, associate professor
Ciobanu Nicolae _____

APPROVED
approved at the meeting of the chair of
General chemistry
Minutes No. 3 of 10.09.2021
Head of chair, PhD, associate professor
Cheptanaru Constantin _____

SYLLABUS

DISCIPLINE **PHARMACEUTICAL DISPERSE SYSTEMS**

Integrated studies

Type of course: **Compulsory**

Syllabus was elaborated by:

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I. INTRODUCTION

General presentation of the discipline: the place and the role of the discipline in the formation of the specific competences of the professional / specialty training program

The curriculum of the discipline of Pharmaceutical disperse systems at Pharmacist Qualification is a pedagogical normative document and a didactic tool for the efficient organization of the educational process, elaborated on the basis of the Framework Program for Pharmaceutical Higher Education in the Republic of Moldova, based on the Charter of the State University of Medicine and Pharmacy ,,Nicolae Testemitanu", Regulation for organizing studies in higher education based on the National Credit Studies System, no. 1/8 of 06.04.2017, Regulation of evaluation and academic performance in the State University of Medicine and Pharmacy, Nicolae Testemitanu, nr. 5/4 of October 12, 2016, in coordination with the curriculum of pharmaceutical disciplines (pharmaceutical chemistry, pharmaceutical biochemistry, drug technology, pharmacology and clinical pharmacy).

Pharmaceutical disperse systems is the branch of chemistry that studies the disperse systems and surface physicochemical phenomena. The goal of the discipline is to study the systems and properties that classical chemistry could not study, although these properties and systems are often the most important for pharmaceutical science.

The extremely important and extensive field of disperse systems requires knowledge and notions of this discipline with chemical, biological and pharmaceutical profile. The discipline Pharmaceutical disperse systems is the fundamental of the complete understanding of different physicochemical processes, both theoretically and practically.

Aim of the curriculum in professional training

The discipline of Pharmaceutical disperse systems is a fundamental discipline for the formation of future pharmacists, the acquired knowledge being necessary for understanding the physicochemical mechanisms present in the process of preparation and analysis of pharmaceutical forms. The course has the purpose of forming the theoretical knowledge in the field of disperse systems, the accumulation of practical skills and their application to the study of pharmaceutical chemistry and drugs technology. The acquired knowledge allows the future ability to measure and control the physicochemical properties of drugs.

Languages of the course: Romanian, Russian, English;

Beneficiaries: the students of the II year, faculty of Pharmacy, Pharmacy specialty.

II. MANAGEMENT OF THE DISCIPLINE

Code of discipline		**F.04.O.043**	
Name of the discipline		Pharmaceutical disperse systems	
Persons in charge of the discipline		PhD, associate professor, **Budu Grigore** lecturer **Jora Elena** lecturer **Mirzac Viorica**	
Year	**II**	Semester/Semesters	**IV**
Total number of hours, including:			**120**
Lectures	**15**	Practical/laboratory hours	**45**
Seminars	**-**	Self-training	**60**
Clinical internship			
Form of assessment	**E**	Number of credits	**4**

III. TRAINING AIMS WITHIN THE DISCIPLINE

At the end of the discipline study the student will be able to:

- ***at the level of knowledge and understanding:***

• determine the object of study of the discipline;
• know the theoretical principals of the physical and physicochemical processes that take place in formation of disperse systems;
• know the most important factors that influence the processes of formation of disperse solutions and their role in pharmaceutical practice;
• know the properties of disperse systems and their relation to the particles size;
• gain knowledge about surface phenomena occurring at the interfaces;

- ***at the application level:***

• create the necessary conditions for obtaining disperse systems;
• coagulate disperse systems by various methods;
• interpret the results obtained in laboratory works;
• qualitative revealing of the influence of adsorbate, adsorbent and solvent nature on adsorption from solutions;
• apply chromatographic methods to the production and analysis of drugs;
• evaluate the quality of dispersed systems and propose ways to increase their stability;
• solve situational problems, processing multilaterally and critically the acquired information;
• be competent to apply the cause-effect principle.

at the integration level:

• apply the knowledge and methodology in the field of colloidal chemistry in studying the following; disciplines: analytical chemistry, pharmaceutical chemistry and pharmaceutical technology;
• appreciate the importance of Pharmaceutical disperse systems in the context of pharmacy;
• define the interrelationship between Pharmaceutical disperse systems and other fundamental disciplines;
• understand the principles of the new achievements of pharmaceutical disciplines;
• implement the knowledge gained in the research activity;
• be competent to use critically and with confidence the scientific information obtained using the new information and communication technologies;
• use multimedia technology to receive, evaluate, store, produce, present and exchange information, and communicate and participate in networks via Internet;
• apply the learning and researching abilities to the management of the professional path.

IV. TERMS AND CONDITIONS

From Student of the second year is required:
• knowledge of the language of instruction;
• high school knowledge level of sciences (chemistry, physics, mathematics, biology);
• digital abilities (use of the Internet, document processing, electronic tables and presentations, use of graphics programs);
• ability to communicate and team work;
• qualities - tolerance, compassion, autonomy.

V. THEMES AND ESTIMATE ALLOCATION OF HOURS

Lectures, practical hours/ laboratory hours/seminars and self-training

No. d/o	THEME	Number of hours		
		Lectures	Practical hours	Self-training
1.	The subject of Pharmaceutical disperse systems and its importance in pharmacy. The nature, classification and general properties of dispersed systems. The methods of preparation and purification of dispersed systems.	1	3	2
2.	The kinetic and optical properties of disperse systems.	1	3	4
3.	Surface phenomena. Adsorption at the liquid-gas, solid-liquid and solid-gas interfaces.	1	3	4
4.	The thermodynamics of surface phenomena. The adsorption from non-electrolyte and electrolyte solutions.	1	3	4
5.	Chromatography and its application in pharmaceutical practice. Test-paper N 1.	1	3	6
6.	Electrokinetic phenomena in colloidal systems. Analysis of electrical phenomena and their use in the study of disperse systems.	1	3	4
7.	Micellar solutions. Stability and coagulation of Lyophobic disperse systems.	1	3	4
8.	Suspensions, emulsions and their application in pharmacy.	1	3	3
9.	Aerosols, powders and their application in the pharmacy.	1	3	3
10.	Association colloids (Lyophilic Colloids). Test-paper N 2.	1	3	6
11.	Macromolecular Compounds (MMC) and their interaction with solvents.	1	3	4
12.	Viscosity and osmotic pressure of MMC solutions.	1	3	4
13.	Stability of MMC solutions. Donnan equilibrium.	1	3	4
14.	Gels. Diffusion in gels. Test-paper N 3.	1	3	6
15.	Disperse systems in nature. Ecological problems.	1	3	2
Total		**17**	**45**	**60**

VI. REFERENCE OBJECTIVES OF CONTENT UNITS

Objectives	Content units
Chapter 1. Disperse systems. Kinetic-molecular and optical properties of disperse systems. Surface tension and superficial free energy.	
• to define the terms: dispersed system, dispersed phase, medium of dispersion, dispersion degree, specific surface, osmosis, concentration gradient, rate of diffusion, surface tension; • to know the classifications, names of dispersed systems; • to know the methods of obtaining and purification of the dispersed systems; • to apply the knowledge of sedimentation analysis in determining of the particles' size of the dispersed phase; • to demonstrate the relationship between the optical properties and molecular weight, the particles' size of the dispersion phase, and to use the optical methods for studying of the properties of colloidal solutions • to know the methods of determination of the superficial tension and the superficial activity.	The problems and the methods of discipline Pharmaceutical disperse systems. Dispersed Systems. Classification of dispersed systems according to different criteria. Methods of preparation and purification of disperse systems. Kinetic-molecular and optical properties of disperse systems and their use in pharmaceutical practice. Thermodynamics of surface phenomena. Surface tension and surface free energy (Gibbs energy). Methods of determination of superficial tension. The orientation of molecules at the interface layer.
Chapter 2. Surface phenomena. Sorption processes at the interface. Chromatography. Application of chromatography to the production and analysis of drugs. Direct and indirect electrokinetic phenomena. Coagulation of disperse systems.	
• to define the notions: sorption, adsorption, chemisorption, desorption, capillary condensation, adsorption isotherm, cohesion and adhesion, hydrophilic coefficient, partition coefficients, ionization, electrophoresis, electroosmosis, flow and sedimentation potentials, coagulation threshold, additivity, mutual coagulation; • to draw the adsorption isotherm and to calculate the length of the molecule and the surface occupied in the saturated adsorption layer; • to be familiar with the classification and properties of solid sorbents and their use in the pharmacy, the function principle of ion exchange resins and their role in various fields; • to explain the coagulation process and the action of electrolytes on sols, the mutual coagulation of lyophobic sols and to know the methods of stabilizing the sols; • to integrate knowledge about sorption, chromatographic analysis methods, electrokinetic phenomena, coagulation and to use them in	Surface phenomena. Adsorption at the liquid-gas interface. The factors influencing the adsorption process of gases and dissolved substances. Determination of the adsorption at the solid-liquid and solid-gas interfaces. Gibbs's relationship. Monomolecular adsorption. Langmuir's adsorption equation. Adsorption of the electrolytes. Chromatography. Applying chromatography to the production and analysis of drugs. Structure and electrical charge of colloidal particles. Direct and indirect electrokinetic phenomena. Electrophoresis and its use. Coagulation with electrolytes. The phenomenon of additivity, antagonism and synergism. Mutual coagulation. Stability of lyophilic sols.

Objectives	Content units
pharmaceutical technology, pharmaceutical chemistry, toxicology chemistry;	
C**hapter 3.** Coarse dispersed systems. Association colloids. Macromolecular compounds (MMC). Methods of preparation, classification and properties of MMC and their solutions. Donnan membrane equilibrium.	
• to define the notions: aerosol, powder, suspension, emulsion, foams, pastes, flotation, coalescence, association colloids, critical micelle concentration, solubilization, direct and indirect micelles, MMC, velocity, swelling of polymers, viscosity, nonionic and polyelectrolyte polymers, membrane equilibrium, isoelectric point and isoelectric state of polyampholytes, coacervation, thixotropy, syneresis; • to know the types of coarse dispersed systems, methods of obtaining and stabilizing them, application of dispersed coarse systems in pharmacy and medicine, superficial active substances and their classification, association colloids, classification of MMC according to different criteria; • to explain the structure of the micelles of the association colloids, depending on the concentration of the solution, to understand the mechanism of swelling and dissolving of macromolecular compounds and the influence of various factors on the degree of swelling, the principle of the membrane equilibrium and what conclusions can be drawn from Donnan's equation; • to demonstrate the relationship between the viscosity of MMC solution, the osmotic pressure and their molecular weight; • to apply theoretical knowledge in obtaining and stabilizing the emulsions, the methods for determining of the superficial tension to determine the critical micelle concentration, to draw diagrams of swelling degree and velocity dependence on time; • to integrate the theoretical knowledge about coarse dispersed systems, colloids of association in the research of dispersion, emulsification, solubilization processes.	Aerosols and their properties Application of aerosols in pharmaceutical practice. Powders and their properties (compaction, granulation and spraying). Powder application. Suspension's properties. Preparation. The stability factors of suspension. Foam. Pastes. Applying in the pharmacy. Properties of emulsions. Emulsifiers and mechanism of action. Stability of emulsions. Association colloids (soaps, detergents, tannins, dyes agents). Classification of surfactant colloids. The critical micelle concentration and the methods for its determining. Macromolecular Compounds (MMC). Methods of preparation and classification of MMC. The mechanical properties of MMC. Swelling and dissolution of macromolecular compounds. The viscosity of MMC and methods of its measuring. Osmotic pressure of neutral polymer solutions. Stability factors of solutions of macromolecular compounds. Membrane equilibrium. Donnan's equation.

VII. PROFESSIONAL (SPECIFIC (SC)) AND TRANSVERSAL (TC) COMPETENCES AND STUDY OUTCOMES

- **Professional (specific) (SC) competences**
  - PC1. Knowledge of the theoretical principals and the notions of Pharmaceutical disperse systems necessary for the understanding of chemical and biochemical processes and the acquisition of specific knowledge in order to deepen the physical chemical methods used in the analysis of the drugs.
  - PC2. The ability to use appropriately and in the context of specialized terminology in study of disperse systems.
  - PC3. The ability to explain and interpret the theoretical and practical contents of the discipline in an interdisciplinary approach to other fundamental and specialized biomedical subjects: organic chemistry, analytical chemistry, physical chemical analysis methods, pharmaceutical chemistry, drugs technology.
  - PC4. Developing skills to use laboratory methodologies and specific techniques in study of disperse systems. Acquiring the experience and skills of laboratory equipment, analysis and standardization of medicines, rigorous application of methods of analysis and interpretation of results, in compliance with occupational safety and health standards.
- **Transversal competences (TC)**
  - TC1. Using notions in new contexts, promoting logical thinking, developing teamwork skills.
  - TC2. Using theoretical notions in problems solving, recognizing a problem when it comes out and providing solutions that are responsible for solving.
  - TC3. Optimal and creative use of own potential in scientific activities, acquiring the necessary notions in professional development
  - TC4. Awareness of the need for individual study as a basis for personal autonomy and professional development. Professional development.
- **Study outcomes**
  - to know the methods of preparation and purification of dispersed systems;
  - to build up the sedimentation curves and to determine the particles' size of the dispersed phase and its relative content in the powders
  - be able to determine the surface tension by the Rebinder method and apply the calculations of the STA molecule surface;
  - to separate by chromatography the mixture of substances (thin layer, chromatographic paper and column);
  - to obtain stable emulsions, determine their type, and to reverse phase of emulsions;
  - be able to determine the critical micelle concentration for colloidal solutions of STA (surfactants).
  - be able to determine the molecular weight of polymers by the viscozimetric methods, to determine the isoelectric point of the proteins.
  - be able to implement the knowledge gained in the research activity;
  - be competent to use critically and with confidence the scientific information obtained using the new information and communication technologies.

VIII. STUDENT'S SELF-TRAINING

No.	Expected product	Implementation strategies	Assessment criteria	Implementation terms
1.	Working with sources of information.	Read the lecture or course material on the subject carefully. Read the questions on the subject, which require a reflection on the subject. Get acquainted with the list of additional information sources on the topic. Select the source of additional information for that subject. Read the text entirely, carefully and write the essential content. Write generalizations and conclusions regarding the importance of the subject.	Ability to extract the essentials; interpretative skills.	During the semester
2.	Working with the problem book.	Problem solving on the subject of laboratory work.	Volume and accuracy of solved problems.	During the semester
3.	Essay	Analysis of relevant sources on the topic of the paper. Analysis, systematization and synthesis of information on the proposed subject. Compilation of the report in accordance with the requirements in force and presentation to the chair.	The quality of systematization and analysis of the informational material obtained through its own activity. Concordance of the information with the proposed subject.	During the semester

IX. METHODOLOGICAL SUGGESTIONS FOR TEACHING-LEARNING-ASSESSMENT

- ***Teaching and learning methods used***

The discipline of Pharmaceutical disperse systems is taught in the classical way: with lectures and practical works. Lectures will be read by course holders. In practical work, students will study the most important experiences, completing the workbook at the end with explanations of general applicability and specific field of research of the medicine.

Methods of teaching-learning: Traditional: didactic exposure, didactic conversation, demonstration, work with manual, exercise; Modern: problem-solving, scheduled training, case study, discovery learning.

The experiment allows intensive student engagement and a particularly active participation in the instructive-educative process and the formation of intuitive practical skills for students. The experiment is the fundamental way of teaching disperse systems, being considered a "pillar" for supporting active methods. The observation develops the spirit of observation, investigation, the ability to understand the essence of objects and phenomena, the processing and interpretation of experimental data, the interest in knowledge. Diagram analysis - Selection of required information. Recognition based on knowledge and information selected structures indicated in the drawing, drawing. The didactic discovery is done through different teaching methods: directed observation; independent observation; learning by experience - experiences; case study; problem solving; individual study, etc. Diagram design - Element selection. Wording of an appropriate title and legend of the symbols used. Classification - Determination of classification criteria. Distribution of structures / processes by groups according to established criteria. Individual study - study of bibliography, solving exercises and problems.

- ***Applied teaching strategies / technologies*** *(specific to the discipline)*

In order to be successful in learning discipline Pharmaceutical disperse systems, the student should actively work both in the courses and in the laboratory, as well as in their own right, and the teacher to use the didactic technologies specific to the discipline. The most important methods in teaching colloidal chemistry are brainstorming, multi-voting, and round table discussions. "Brainstorming" is a technique of stimulating individual creativity by organizing free discussions on a given theme based on free-of-charge ideas for solving a problem. "Multi-voting"; used to select the most important or most popular items in a list to narrow down the list to a few high priority items. "The round table"; "Case Study"; are also used efficiently in course Pharmaceutical disperse systems classes where it is necessary to confirm many ideas by performing certain experiences.

- ***Methods of assessment*** *(including the method of final mark calculation)*

Current: frontal and / or individual control by applying docimological tests, solving problems / exercises, analyzing laboratory work as well as totalization works.

Final*:* exam (semester IV). The final exam is a computer-based testing. The final exam mark is calculated by the computer testing mark and the average mark for the semester. The final average mark for the semester is based on total points earned for quizzes and student self-training. The students with the average annual score below grade 5 are not admitted to exam, as well as students who have not process absences from the practical work. Exam subjects and the list of theoretical questions are approved at the meeting and are brought to the attention of the students at least one month before the session.

Method of mark rounding at different assessment stages

Intermediate marks scale (annual average, marks from the examination stages)	National Assessment System	ECTS Equivalent
1,00-3,00	**2**	**F**
3,01-4,99	**4**	**FX**
5,00	**5**	**E**
5,01-5,50	**5,5**	
5,51-6,0	**6**	
6,01-6,50	**6,5**	**D**
6,51-7,00	**7**	
7,01-7,50	**7,5**	**C**
7,51-8,00	**8**	
8,01-8,50	**8,5**	**B**
8,51-8,00	**9**	
9,01-9,50	**9,5**	**A**
9,51-10,0	**10**	

The average annual mark and the marks of all stages of final examination (computer assisted, oral) - are expressed in numbers according to the mark scale (according to the table), and the final mark obtained is expressed in number with two decimals, which is transferred to student's record-book.

Absence on examination without good reason is recorded as "absent" and is equivalent to 0 (zero). The student has the right to have two re-examinations.

X. RECOMMENDED LITERATURE:

A. Compulsory:

1. DUNCAN J Shaw, 2003, Introduction to colloid and surface chemistry, 4th Edition, Butterworth-Heinemann, Oxford
2. Handbook of applied surface and colloid chemistry Volume 1 – 2, Edited by Krister Holmberg, Chalmers University of Technology, Goteborg, Sweden, JOHN WILEY & SONS, LTD, 2002.
3. V. SARBU, E. JORA, V. MIRZAC: Colloidal chemistry study guide, manuscript in preparation, accessible in electronic version.

B. Additional

1. Steven S. ZUMDAHL. Chemistry. Lexington, Massachusetts, Toronto.
2. Francis Marion MILLER. Chemistry, Structure and dynamics. McGraw-Hill book company, USA.