FACULTY OF PHARMACY

STUDY PROGRAM 0916.1 PHARMACY

CHAIR OF DRUG TECHNOLOGY

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, Doctor of pharmacy, Associate Professor
Uncu Livia_____

APPROVED
at the Council meeting of the Faculty of Pharmacy
Minutes No.3 of 16.12.2021
Dean of Faculty, Doctor of pharmacy, Associate Professor
Nicolae Ciobanu _____

APPROVED
approved at the meeting of the chair Drug Technology
Minutes No.1 of 25.08.2021
Head of chair, Doctor of pharmacy, Associate Professor
Nicolae Ciobanu _____

SYLLABUS

DISCIPLINE: **BIOPHARMACY AND PHARMACEUTICAL NANOTECHNOLOGIES**

Integrated studies/Cycle I, Bachelor's degree

Course type: **Compulsory**

Curriculum developed by the team of authors:

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Cristina Ciobanu - Doctor of pharmacy, Associate Professor

Chisinau, 2021

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

The need and usefulness of the discipline of ***Biopharmacy and Pharmaceutical Nanotechnology*** for student-pharmacists is due to the fact that today pharmacist must have, in addition to extensive knowledge of pharmaceutical technology, knowledge about the evolution of the drug after its administration in the body. The emergence and development of new forms and modern pharmaceutical systems imposes requirements on pharmacists in terms of knowledge of the bioavailability and bioequivalence of drugs to ensure a maximum therapeutic effect with minimal side effects. As a solution, to the new requirements for the training of professional skills of the future pharmacist, the discipline of Biopharmacy and Pharmaceutical Nanotechnologies is proposed, which is a basic discipline, the study of which at university will allow the future pharmacist to learn the principles of preformulation and formulation of new and advanced drugs, as well as the formation of concepts about the influence of biopharmaceutical factors on the pharmacokinetic parameters of the drug, the development of critical thinking in addressing the issues of biopharmaceutical and pharmacokinetic evaluation of drugs in accordance with current professional requirements.

- Mission of the curriculum (aim) in professional training

To provide students with knowledge on the influence of drug at stages of preformulation and formulation, on the bioavailability of pharmaceutical forms and pharmacokinetic parameters. Training in the skills of biopharmaceutical and pharmacokinetic evaluation of medicines, as well as the development of skills in understanding the principles of release of medicinal substances in pharmaceutical forms and systems with modified release, controlled and transport to the target. Introduction to pharmaceutical nanotechnologies as an extension of existing science at the nano level using new modern technologies.

- Language (s) of instruction: Romanian, English.

I. Beneficiaries: students of the 5th year, faculty of Pharmacy.

II. MANAGEMENT OF THE DISCIPLINE

Code of discipline		S.09.O.070	
Name of the discipline		Biopharmacy and Pharmaceutical Nanotechnology	
Person(s) in charge of the discipline		Dr., Assoc. Prof., Cristina Ciobanu Dr. habil., Univ. Prof., Eugen Diug	
Year	V	Semester/Semesters	9

Total number of hours, including:			
Lectures	26/2	Practical/laboratory hours	39/3
Seminars	-	Self-training	55
Form of assessment	E	Number of credits	4

III. TRAINING AIMS WITHIN THE DISCIPLINE

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

• at the level of knowledge and understanding:

- To know the objectives and content of the discipline Biopharmacy and Pharmaceutical Nanotechnologies;
- To know the object of study of the course;
- To define the concepts of biopharmaceutical evaluation of pharmaceutical forms and systems;
- To identify the influence of different pharmaceutical factors on the bioavailability of medicinal substances;
- To know the main physico-chemical and technological parameters of medicinal substances, auxiliary substances and adjuvants, which determine the quality of the pharmaceutical product in biopharmaceutical aspect;
- To know the advanced applications in pharmacy using nanotechnologies and nanomaterials.
- To know the types of nanoparticles and to understand the biological role of polymeric nanoparticles.

• at application level:

- To apply theoretical knowledge in order to optimize the bioavailability of drugs by identifying the particularities of biopharmaceutical factors;
- To compare new principles of preformulation and formulation of pharmaceutical forms and systems according to biopharmaceutical requirements;
- To evaluate the physico-chemical properties of medicinal substances, auxiliary substances and packaging material in biopharmaceutical aspect;
- To apply in practice the experience and biopharmaceutical principles at various stages of the evolution in the preformulation and formulation of medicines;
- To apply new methods of biopharmaceutical evaluation of pharmaceutical forms and systems;
- Apply knowledge of pharmaceutical nanotechnologies to the biological evaluation of nanoparticles as vehicles for target transport.
- Compare the applications of nanoparticles to modified-release of drugs.
- To apply new nanotechnologies in order to obtain nanoparticles for the transport of drug molecules to the target (vectorized).

• at the integration level:

- Possess abilities to develop the composition of a medicinal product in order to increase the bioavailability of the active substance;
- To identify biopharmaceutical factors and their influence on the bioavailability of active substances in pharmaceutical forms;
- To be aware of the principles of quantitative and qualitative selection of new auxiliaries and adjuvants needed in the formulation of medicines;
- To present knowledge and skills in order to optimize the composition of pharmaceutical forms from

a biopharmaceutical point of view;
- To accumulate basic notions regarding the structure of nanoparticulate systems;
- To identify new nanomaterials in order to formulate nanoparticles.
- To identify new routes of administration of vectorized nanoparticles.

VI. PROVISIONAL TERMS AND CONDITIONS

In order to master the discipline, thorough knowledge in the field of biochemistry, pharmacology, physiology, analytical chemistry, pharmaceutical chemistry, pharmacotherapy, pharmaceutical technology obtained in previous years of study is required.

V. THEMES AND ESTIMATEAL LOCATION OF HOURS

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

Nr.	THEME	Number of hours		
		Lectures	Practical hours	Self-training
I.	Biopharmacy **The role of biopharmacy in drug design.** Development of a drug. Drug preformulation and formulation. CADD. 3D printing. Classification of drug generations.	**1**	-	5
II.	**Elements of classical pharmacokinetics.** Notions of body compartment and pharmacokinetic models. Kinetic processes. Compartmental pharmacokinetic models and pharmacokinetic parameters. Factors influencing pharmacokinetic parameters.	**3**	-	6
1.	Description of the "*in vitro*" pharmacokinetic model for evaluating the pharmacokinetic parameters of the drug. Preparation of the calibration graph for the determination of sodium salicylate.	-	3	-
2.	Evaluation of pharmacokinetic parameters of sodium salicylate using the "*in vitro*" pharmacokinetic model. **Pharmacokinetics of single dose. Fast intravenous administration.**	-	3	-
3.	Evaluation of pharmacokinetic parameters of sodium salicylate using the "*in vitro*" pharmacokinetic model. **Pharmacokinetics of single dose. Extravascular administration.**	-	3	-
4.	Evaluation of pharmacokinetic parameters of sodium salicylate using the *"in vitro"* pharmacokinetic model. **Pharmacokinetics of repeated doses. Intravenous administration.**	-	3	-
5.	Evaluation of pharmacokinetic parameters of sodium salicylate using the "*in vitro*" pharmacokinetic model. **Intravenous infusion.**	-	3	-
III.	**Biopharmaceutical factors influencing the bioavailability of medicinal substances.** Biopharmaceutical factors. Ionization of medicinal substances. Biopharmaceutical drug classification system. The biopharmaceutical aspect of pharmaceutical forms. Formulation factors influencing drug bioavailability.	**4**	-	9
6.	Influence of formulation factors on Biopharmaceutical Parameters. ***Tablets with standard content of lubricant.***	-	3	-

Nr.	THEME	Number of hours		
		Lectures	Practical hours	Self-training
7.	Influence of formulation factors on Biopharmaceutical Parameters. ***Tablets with high content of lubricant.***	-	3	-
IV.	**Evolution of the drug substance in the stages of absorption, distribution, metabolism and elimination.** Absorption of drugs in the gastrointestinal tract; parenteral absorption: through the skin; intravaginal, intrauterine, intraocular, intranasal. Biotransformation and drug disposal.	**2**	-	6
V.	**Bioavailability of pharmaceutical forms.** Bioavailability of enteral, parenteral, respiratory and topical drugs. Objectives of a bioavailability study. Bioequivalence of drugs.	**2**	-	3
8.	Pharmaceutical availability of medicinal substances from solid forms.	-	3	-
9.	Pharmaceutical availability of medicinal substances from semi-solid forms.	-	3	-
VI.	**PHARMACEUTICAL NANOTECHNOLOGIES** **Modified release pharmaceutical forms and systems.** Classification. Benefits. Rapid-release dosage forms in the oral cavity. Preparation procedures. Patented technologies used in the manufacture of tablets.	**2**	-	4
VII.	**Prolonged and sustained release pharmaceutical forms:** zero order release, binary release, bi-phase release, positioned release, accelerated release, circadian release, delayed release. Technological methods and polymers used to achieve prolonged release.	**2**	-	4
10.	Evaluation of biopharmaceutical parameters of sodium salicylate in different formulations. ***Fast release dosage form.***	-	3	-
11.	Evaluation of biopharmaceutical parameters of sodium salicylate in different formulations. ***Prolonged release pharmaceutical form.***	-	3	-
VIII	**Pharmacokinetics of controlled release pharmaceutical systems.** Pre-scheduled pharmaceutical systems. Therapeutic systems with release activation. Self-adjusting or feedback systems. Ionophore systems.	**2**	-	4
IX.	**Vectorized or target transport systems**. Targets of drug therapy at the target. Vector requirements. Classification of drug shipments. Nanoparticles - vehicles for drugs. Targeted release systems based on colloidal drug carriers. Microparticles (microspheres, microcapsules)	**2**	-	5
X.	**Nanoparticles (technologies, uses).** dendrimers, carbon nanotubes, silicate mesoporous nanoparticles, quantum dots, metallic nanoparticles, solid lipid nanoparticles, polymeric micelles, liposomes.	**4**	-	6
XI.	**Monoclonal antibodies - as drug vectors.** Historical data on the discovery and development of monoclonal antibodies. Advantages and disadvantages of preparations based on monoclonal antibodies. Classification of monoclonal antibodies. Production of monoclonal antibodies	**2**	-	3
12.	Solving experimental and clinical pharmacokinetic problems	-	6	-

Nr.	THEME	Number of hours		
		Lectures	Practical hours	Self-training
Total		**26**	**39**	**55**

VI. PRACTICAL WORKS PURCHASED AT THE END OF THE COURSE

The essential practical tasks are:

- To explain the peculiarities of the functioning of the in vitro monocompartmental pharmacokinetic model.
- Construct the calibration chart of the standard analytical substance.
- To master the distinct methodology of single and repeated doses by interpreting the data and performing the calculations of the pharmacokinetic parameters.
- Carry out zero-dose drug administration and interpret the results by assessing the steady-state concentration.
- Determine *in vitro* the availability for solid and semi-solid pharmaceutical forms.
- To use the factors of difference and similarity in the analysis of dissolution profiles in various assortments of drugs.
- To know and apply calculation formulas to solve situation problems.
- To apply Windows, Microsoft Excel programs in interpreting data and building pharmacokinetic charts.
- To analyze biopharmaceutical the active substances based on their properties, excipients, applied technologies, form and route of administration.

VII. REFERENCE OBJECTIVES OF CONTENT UNITS

Objectives	Content units
Theme 1. The role of biopharmacy in drug design.	
• To define the purpose and objectives of biopharmacy as a science. • To know the importance of drug technology and biopharmacy in the preformulation and formulation stages. • To know the basic stages of drug design and their characteristics, including modern approaches based on computer design (CADD). • To know the principles of the rules of the 3 and 5 filters. • To know the role of biopharmacy in 3D printing of medicines. • To have knowledge of the criteria for classifying drug generations.	Defining biopharmacy as a science. Stages of drug development. Preformulation and drug formulation. The rule of 3 and 5 filters. Computer Aided Drug Design. 3D printing. Generations of drugs.
Theme 2. Elements of classical pharmacokinetics.	

Objectives	Content units
• To define the notions of compartment of the organism • To know the distinct particularities of the pharmacokinetic models. • To demonstrate the ability to analyze the kinetic processes depending on the kinetic course of the drug according to physiology and pathology of the involved organ. • To define the pharmacokinetic parameters. • To apply the acquired knowledge, with the application of calculation methods, in the analysis of case studies.	Notions of body compartment. Pharmacokinetic models. Kinetic processes. Classification. Pharmacokinetic parameters and factors influencing the pharmacokinetic parameters.
Theme 3. Biopharmaceutical factors influencing the bioavailability of medicinal substances.	
• To know the biopharmaceutical factors at the preformulation stage and in the technological practice. • To evaluate the physico-chemical parameters of medicinal substances using the knowledge gained in related disciplines. • To define the notions of acidity, basicity constant, ionic product of water, logarithm with changed sign of acidity and basicity constants. • To know the methodology for calculating the percentage of non-ionized molecules depending on the constant of acidity and basicity of the pharmaceutical substances and pH. • Demonstrate Lipinski score assessment skills. • Know *in vivo* and *in vitro* methods for determining the intestinal permeability of drugs. • To know the critical factors for the formulation of tablets, capsules, suppositories, etc. • To have the capacity to differentiate medicinal preparations based on the biopharmaceutical classification system of medicinal products.	Classification and exposure of the influence of pharmaceutical factors on the bioavailability of medicines. Ionization constant of medicinal substances. Influence of pH at the site of absorption on drug ionization. Calculation of the percentage of non-ionized molecules. Methods for determining the intestinal permeability of drugs. The rule of C.A. Lipinski. Biopharmaceutical Classification System for Drugs.
Theme 4. Evolution of the drug substance in the stages of absorption, distribution, metabolism and elimination.	
• Have knowledge of the classification of routes of drug administration. • To know the main stages of release, absorption, distribution, metabolism, elimination and biological response of drugs. • To know the particularities of the administration and absorption of enteral, parenteral and external drugs. • To evaluate comparatively the absorption at	Classification of types of transport through biological membranes. Enteral absorption. Parenteral absorption. Absorption through the skin and mucous membranes. Biotransformation and drug disposal.

Objectives	Content units
different levels of the gastrointestinal tract. • To integrate the advantages and disadvantages of the routes of administration of medicines in terms of the biopharmaceutical and pharmacokinetic properties of medicines • To know the stages of biotransformation and elimination of drugs.	
Theme 5. Bioavailability of pharmaceutical forms.	
• To know the principles of release of active substances from pharmaceutical formulations. • To define the notions of bioavailability and chemical, pharmaceutical, pharmacological and bioequivalence equivalence. • Possess knowledge of methods for determining *in vivo* bioavailability and *in vitro* availability. • Evaluation of the bioavailability of topical preparations. • To know the characteristics and classification principles of *in vitro* dissolution rate determination tests. • Integrate knowledge of techniques for determining differences in difference and similarity and the constant dissolution of drugs.	Disposal of drugs. Methods for determining bioavailability. Bioequivalence of drugs.
Theme 6. Modified release pharmaceutical forms and systems.	
• Know the principles of classification of modified-release pharmaceutical systems (fast, prolonged, repeated, sustained, etc.). • Define orodispersible tablets as a fast-release pharmaceutical system. • Know the peculiarities of orodispersible tablets compared to regular tablets. • To know the advantages and disadvantages of orodispersible tablets compared to other pharmaceutical forms. • Describe the manufacturing process of orodispersible tablets (lyophilization, modeling, sublimation, spray drying, direct compression) • Describe the patented technologies for the production of orodispersible tablets (Zydis, OraSolv, DuraSolv, Flash Dose, Wowtab, Flashtab, OraQuik, Quik-DisTM, Nanocrystal).	Classification of modified-release pharmaceutical systems. Characteristic of orodispersible tablets. Particularities. Advantages and disadvantages. Procedures for the manufacture of orodispersible tablets. Patented technologies for the production of orodispersible tablets.
Theme 7. Prolonged and sustained release dosage forms.	
• To know the principles of release of medicinal substances from pharmaceutical systems with prolonged and sustained action.	Principles of release of long-acting and sustained-release drugs from pharmaceutical systems: zero-release;

Objectives	Content units
• Demonstrate skills in formulating dispensing pharmaceutical systems: zero order; binary; biphasic (fast-slow; slow-fast); positioned; accelerated; delayed; multiple-pulsatile. • Describe the technological methods and polymers used to achieve prolonged release.	binary release; biphasic release (fast-slow; slow-fast); positioned release; accelerated release; delayed release; multiple-pulsatile release. Technological methods and polymers used to achieve prolonged release.
Theme 8. Controlled release pharmaceutical systems.	
• To know the structure of controlled release pharmaceutical systems and their classification. • Describe the polymers used for controlled release systems: hydrophilic, hydrophobic, biodegradable. • Apply knowledge to optimize the formulation of controlled release systems. • To know the structure of transdermal therapeutic systems and their range authorized in the Republic of Moldova. • Demonstrate skills in developing technologies for the manufacture of controlled release pharmaceutical systems: physically activated systems; osmotic systems; chemically activated systems; floating intra-gastric systems; biomucoadhesive systems; self-adjusting release or feedback systems.	Structure of controlled release pharmaceutical systems. Classification. Polymers used for controlled release systems. Pre-programmed systems. Transdermal therapeutic systems. Classification. Characteristic. Physically activated systems. Osmotic systems. Chemically activated systems. Floating intra-gastric systems. Biomucoadhesive systems. Self-adjusting or feedback systems.
Theme 9. Vectorized pharmaceutical or target transport systems	
• To know the objectives of drug therapy at the target and the advantages of vectorized systems. • Know the classification and requirements of the target drug carriers. • To know the structure and methods of obtaining microparticles as first generation target carriers. • Demonstrate skills in developing microcapsule and microsphere manufacturing technologies.	The advantages of vectorized systems. The goals of drug therapy at the target. Requirements for carriers (vectors). Classification of target drug carriers. First generation carriers: Microparticles as drug carriers. Microcapsules. Microspheres. Preparation methods.
Theme 10. Nanoparticles. Technologies. Uses.	
• Know the structure and methods of obtaining nanoparticles as second generation target carriers. • Know the skills of developing technologies for obtaining dendrimers, carbon nanotubes, silicate mesoporous nanoparticles, quantum dots, metal nanoparticles, solid lipid nanoparticles, polymeric micelles, liposomes.	Second generation carriers: Nanoparticles - vehicles for drugs: dendrimers, carbon nanotubes, silicate mesoporous nanoparticles, quantum dots, metal nanoparticles, solid lipid nanoparticles, polymeric micelles, liposomes.
Theme 11. Monoclonal antibodies - as drug vectors	
• To know the function and mechanisms of action of monoclonal antibodies as third-generation	Third generation of carriers: Monoclonal antibodies. The function. Mechanisms of action. Targets for

Objectives	Content units
target transporters. • Know the methods of obtaining monoclonal antibodies and drugs formulated on the basis of monoclonal antibodies.	action. Obtaining monoclonal antibodies. Drugs based on monoclonal antibodies.

VIII. PROFESSIONAL (SPECIFIC (SC)) AND TRANSVERSAL (TC) COMPETENCES AND STUDY FINALITIES

✓ Professional (specific) (SC) competences

- ***PC1***: Knowledge of the theoretical bases of the disciplines included in the faculty curriculum, of the general principles in the elaboration, analysis and registration of pharmaceutical and parapharmaceutical products; knowledge of the general principles of organization and functioning of pharmaceutical institutions with different legal forms of activity; knowledge of the legislative framework in the field of pharmacy; knowledge of the rights and obligations of the pharmacist.
- ***PC2:*** performing various practical tasks related to the preparation, analysis and standardization of drugs of synthetic origin and phytopreparations; knowledge of the medicine in terms of its action, indications, contraindications, side effects, administration and interactions; implementation of patient counseling and pharmaceutical care in practice.
- ***PC3:*** designing the practical activity in the pharmaceutical system according to the diversity of professional roles; use and adaptation of theoretical knowledge in the field of pharmacy to the situations of practical activity; streamlining professional activity by introducing innovative elements in the field of pharmaceuticals; application of the requirements of the normative acts in the field of pharmacy in the practical activity; possession of the computer as a working tool in the theoretical and practical pharmaceutical activity; establishing the correlation between the components of the pharmaceutical activity process and the population health care system; continuous efficiency of the pharmaceutical activity by introducing innovations and implementing inventions in the field.
- ***PC4:*** diagnosing the particularities and organizational culture of the institution in the pharmaceutical system, where the specialist works; design and coordination of the pharmaceutical activity in various institutions: open state or private pharmacies; hospital pharmacies; pharmaceutical warehouses; medicine factories, laboratories for quality control and certification of medicines, etc .; active involvement of the specialist in the process of accomplishing the mission of the pharmaceutical institution; demonstrating the ability to make decisions aimed at improving the pharmaceutical system.
- ***PC5:*** determining the criteria for evaluating the effectiveness of the pharmaceutical system and personal activity according to the real conditions and in a concrete social context; determining the ways of directing the pharmaceutical activity based on the evaluation results; identifying research problems in the field of pharmacy; knowledge of the methodology of scientific research in the practical activity of pharmacist or head of the pharmaceutical unit.
- ***PC6:*** adopting messages to various socio-cultural backgrounds, including by communicating in several foreign languages; use of problem-solving skills in the pharmaceutical activity through collaboration with doctors; promoting the principles of tolerance and compassion towards patients; use of information technology (and computer) in the pharmaceutical business.

✓ Transversal competences (TC)

- ***TC1:*** Promoting logical reasoning, practical applicability, evaluation and self-evaluation in

decision making; observance of the norms of ethics and pharmaceutical deontology when preparing, analyzing, transporting and dispensing medicines to the population and medical institutions.

- ***TC2:*** Identifying the training needs according to the evolution of the pharmaceutical system; determining the priorities in the continuous professional training of the pharmacist; appreciation of the changes that have taken place in the pharmaceutical system as a condition of its functionality.
- ***TC3:*** Carrying out activities and exercising the specific roles of teamwork. Promoting the spirit of initiative, dialogue, cooperation, positive attitude and respect for others, empathy, altruism and continuous improvement of one's activity.

✓ Study finalities

- To identify the main physico-chemical and technological parameters of medicinal substances, auxiliary substances and adjuvants, which determine the quality of the pharmaceutical product in biopharmaceutical aspect;
- To know the main pharmacokinetic parameters and their importance in order to optimize pharmacotherapy;
- To describe the pharmacokinetic models and to calculate the main pharmacokinetic parameters;
- To argue the principles of selection of the physicochemical properties of medicinal substances, auxiliary substances and packaging material in biopharmaceutical aspect;
- To compare practical experience and biopharmaceutical principles at various stages of evolution in preformulation and drug formulation;
- To interpret the quality norms of medicines in biopharmaceutical aspect;
- To organize biopharmaceutical research in the development of generic drugs under the conditions of the pharmaceutical industry;
- To develop the composition of a medicine in order to increase the bioavailability of the active substance;
- To formulate new prescriptions of drugs with the use of different auxiliary substances and the biopharmaceutical evaluation of their selection;
- To argue from a biopharmaceutical point of view the quantities of auxiliary substances and adjuvants in drug formulations;
- To evaluate the influence of biopharmaceutical factors on the bioavailability of active substances in pharmaceutical forms.

IX. STUDENT'S SELF-TRAINING

No.	Expected product	Implementation strategies	Assessment criteria	Implementation terms
1.	Working with books and Internet scientific data	Systematic work in the library and media library. Explore current electronic sources on the topic under discussion	1. The quality of judgments formed, logical thinking, flexibility. 2. The quality of the systematization of the informational material obtained through own	During the semester

			activity.	
2.	Report	Analysis of relevant sources on the topic of the paper. Analysis, systematization and synthesis of information on the proposed topic. Preparation of the report in accordance with the requirements in force and its presentation at the department.	1. The quality of the systematization and analysis of the informational material obtained through own activity. 2. The concordance of the information with the proposed topic	During the semester
3.	Case study analysis	Choice and description of the case study Analysis of the causes of the problems appeared in the case study. Prognosis of the investigated case. Deduction of the expected outcome of the case.	1. Analysis, synthesis, generalization of data obtained through own investigation. 2. Formation of a knowledge algorithm based on the conclusions obtained.	During the semester

X. METHODOLOGICAL SUGGESTIONS FOR TEACHING-LEARNING-ASSESSMENT

➢ *Teaching and learning methods used*

Course, practical works, individual work, presentation of the course work. The discipline Biopharmacy and Pharmaceutical Nanotechnologies is taught in a classic way: lectures, laboratory works, individual work. The course is held in the ninth semester by the course holder.

Students can access the lectures in PDF format on the department's website (https://teo.usmf.md/ro). Each student receives from the library the compendium of Biopharmacy and Pharmacokinetics (authors: prof. Univ. Diug Eugen, associate professor Guranda Diana, associate professor Ciobanu Cristina) and the methodological guide (authors: Ciobanu Cristina, associate professor; Guranda Diana, associate professor) which is returned at the end of the course. A concrete support in understanding the biopharmacy is carried out by xperimental laboratory works. The activity of the students in this sense offers them an efficient basis for a better presentation of the concepts exposed to the courses as well as the possibility to apply the theoretical knowledge in practical situations.

Due to the fact that there is a real difficulty in conducting a pharmacokinetic study on experimental animals or volunteers in the practical training of student-pharmacists, the use of different *in vitro* (virtual) pharmacokinetic models is often used. These models make it possible to simulate the processes of dissolution, absorption, distribution and elimination of the drug substance.

The *in vitro* open monocompartmental pharmacokinetic model was taken as the basic model for laboratory experiments. The model has been adapted in terms of existing equipment and the way it works to make it useful for students in the Biopharmacy and Pharmacokinetics laboratory.

The model serves to determine the pharmacokinetic parameters, helps to understand their significance or to evaluate the biopharmaceutical properties of drugs. For a better mastery of the material, a number of experimental and clinical pharmacokinetics as well as biopharmaceutical problems have been proposed, which suggest areas of practical application, in the preparation of drug administration schemes in clinical situations, as well as in the formulation of biopharmaceutical principles.

Various technical means are used in the training process: Erweka DT-6 dissolution apparatus (pharmacopoeial test method); SF-42 spectrophotometer; photocolorimeter; reactive. At the end of the practical classes each student presents the work done, in the form of graphs and calculations of pharmacokinetic parameters with the respective conclusions.

Individual work includes virtual training with CDs and biopharmacy and pharmacokinetic films (20 hours), coursework, according to the individual distribution of a drug substance for each student, from the list of drugs registered in the Republic of Moldova (15 hours) according to a logarithm and deepening knowledge by studying additional literature (20 hours).

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

The chair is equipped with 13 computers (PC Workstation PC 1330 Navigator and 12 PC Mini Nettop Seli 3Q chours and BENQ monitor). Computers are connected to the Internet via Wireless N (Router WR941ND).

The concept of using virtual programs provides:

1. Use of CDs and movies in the library (see the virtual training section of the program - 45 positions);
2. Access to specialized sites:
   - ♦ www.drugbank.ca/
   - ♦ www.pipte.org/
   - ♦ www.pharmaceutical-technology.com/
   - ♦ www.iptonline.com/
   - ♦ www.pharmatech.com/
   - ♦ www.pharmatechglobal.net/
   - ♦ www.in-pharmatechnologist.com/
   - ♦ www.informahealthcare.com/
   - ♦ www.fip.org/formulation_Design_and_Pharm..;
   - ♦ www.youtube.com/

   and other.
3. Online High School
   - ♦ www.aiuhs.org/
   - ♦ www.studentloan.com/
4. Distance Learning Online
   - ♦ www.ftu.edu/
   - ♦ www.atl.ualberta.ca/
   - ♦ www.helix.net/

and other.

Suggestions for individual activity

Individual work in learning process includes the study of additional material for each subject from basic and additional bibliographic sources, from the databases available through the communication networks and the library of the department.

Virtual training (CD information, video)

No.	The name of the CD, the movie	Pages, slides, minutess
	CD	
1	Shargel Leon, Wu-Pong Susanna, B.C. Yu Andrew APPLIED Biopharmaceutics & Pharmacokinetics, 5-th Edition, 2007,CD	599 p **(10 hours)**
2	Collins Charles C., In Vitro Dissolution of Ointments, Creams and Transdermals, Palm Beach Atlantic University, Florida USA, CD	328 slides **(3 hours)**
	Total	**13 hours**
	Video materials	
	Biofarmacy - general aspects, drug absorption	
3	From Idea to Medicine – Drug Development at Roche	15,39 minutes
4	Robots Speed the Pace of Modern Drug Discovery (Novartis)	3,03 minutes
5	Drug Discovery and Development Process	7,21 minutes
6	Introduction to Bioavalaibility	4,49 minutes
7	Route of Administration	11,05 minutes
8	Study of the Biopharmacy in Rectale Route	22,35 minutes
9	Oral Drug Absorbtion	1,28 minutes
10	Drug Absorption an Overview – I	17,13 minutes
11	Drug Absorption Overview – II	16,44 minutes
12	Drug Absorption Bioavailability, First Pass Metabolism	50,32 minutes
	Total	**149 minutes**
	Bioavailability. Dissolution test	
13	Bioavailability – dosage forms	5,58 minutes
14	Bioavailability – and the Gut Wall	8,41 minutes
15	Bioavailability – Fraction absorbed	3,23 minutes
16	Bioavailability- The Liver	5,17 minutes
17	Electrolab Dissolution Tester with Disso	4,37 minutes
18	Improving the Solubility - Bioavailability of Poorly Soluble Drugs	12,08 minutes
19	iDisso with Dosage Forms	3,09 minutes
20	Dissolution Test Calculation Form	5,23 minutes
	Total	**47 minutes**
	Pharmacokinetics	

No.	The name of the CD, the movie	Pages, slides, minutess
21	Introduction to Pharmacokinetics	10,51 minutes
22	Pharmacokinetics What the Body Does to a Drug	4,27 minutes
23	What is Pharmacokinetics ADME	16,29 minutes
24	Volume of Distribution	23,51 minutes
25	Clearance Concepts	6,01 minutes
26	Trapezoidal Roule in Excel	8,45 minutes
27	Drug Clearance – Pharmacokinetics	10,35 minutes
28	Drug Distribution – an Overview	16,21 minutes
29	Drug Half-life – an Overview	11,43 minutes
30	Drug Metabolism	2,57 minutes
31	First Order Elimination Rate constant and Half-life	8,14 minutes
32	First Pass Effect	2,05 minutes
33	Pharmacokinetics ant Pharmacodynamics	29,34 minutes
34	Excel Graph with Target Lines and AUC	41,10 minutes
35	How to Calculate AUC	8,53 minutes
	Total	**199 minutes**
	Modern pharmaceutical technologies and formulations	
36	Polymeric Drug Delivery Systems	9,10 minutes
37	NHL Mod (Rituxan, Rituximab)	4,24 minutes
38	Liposome – A Technology Marvel Module *2*	2,16 minutes
39	Liposome – Basics I (Encapsula Nano Sciens)	6,16 minutes
40	Liposome - Basics II (Encapsula Nano Sciens)	6,22 minutes
41	Nanoparticle Drug Delivery in Cancer Theraapy	2,42 minutes
42	Nanotechnology for Target Cancer Therapy	2,42 minutes
43	Xatral	1,43 minutes
44	3 Phase Tablet	2,07 minutes
45	Controlled Drugs Delivery Technology SODAS	1,15 minutes
	Total	**37 minutes**
	Total	**(432 minutes) 7 hours**
	TOTAL	**20 hours**

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

Current: The discipline of Biopharmacy and Pharmaceutical Nanotechnology during a semester (13 weeks) includes 2 totalizations. Totalizations are based on tests and solving pharmacokinetic problems. The ninth semester ends with an exam. Frequency during the semester and notes from completions and coursework are included online in the SIMU program. The average grade is calculated automatically by the SIMU program. Students with an annual grade point average of less than 5, as well as students who have not recovered their absences from laboratory work, are not admitted to the promotion exam.

Final: The promotion exam (summative assessment) is a complex one, consisting of the test-grid test, and the oral test. The test-grid test consists of 50 tests. 60 minds are reserved for this test. The test

is assessed with marks from 0 to 10. For the oral test each student receives a ticket containing 2 questions. The student has 30 minds to prepare. The test is assessed with marks from 0 to 10.

The final grade consists of 3 components: average annual grade (coefficient 0.5); grid test (coef. 0.2), oral interview (coef.0.3). The final weighted grade is calculated based on the positive grades (≥5) automatically according to the SIMU program. The annual average grade and the marks of the final examination stages will be expressed in numbers according to the grading scale indicated in the table. The final grade obtained will be expressed in two decimal places, which will be entered in the notebook.

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**
8,51-9,00	**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, test, 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 in the failed exam.

IV. RECOMMENDED LITERATURE:

A. Compulsory :

1. CIOBANU, Cristina, GURANDA, Diana. Biopharmacy and pharmakokinetics. Indicație metodică pentru studenții anului 5 a facultății de Farmacie a USMF Nicolae Testemițanu, grupa engleză. Chișinau: Europres, 2019. 52 p. CZU: 615.015(076) C51. (english)
2. DIUG, E., GURANDA, D., CIOBANU, C. *Biofarmacie şi farmacocinetică. Compendiu.,* ed. II-a, editura, Chișinău: Medicina. Tipografia "Print-Caro",. 2019, 204 p. (romanian)
3. LEUCUŢA S. *Biofarmacie şi farmacocinetică*, ed. Dacia, Cluj Napoca, 2002, 304 p. (romanian)
4. LEUCUŢA S. *Medicamente cu cedare modificată*. Cluj-Napoca, 2011, 383 p. (romanian)
5. SHARGEL, Leon, YU, Andrew. Applied Biopharmaceutics & Pharmacokinetics. 7th. Edition, 2016, Mc Graww-Hil Education. USA., 910 p. (english)

B. Additional

1. ACHIM MARCELA *Micro- şi nanoparticule utilizate în terapia la țintă.* Editura Medicală Universitară „Iuliu Haţieganu", Cluj-Napoca, 2010, 201 p. (romanian)
2. LEUCUŢA S.E, TOMIŢA I. *Planuri experimentale şi optimizarea formulării medicamentelor*, Ed. Risoprint, 2011, 296 p. (romanian)
3. LEUCUŢA S.E. *Medicamente vectorizate*. Ed. Medicală, Bucureşti, 1996, 293 p. (romanian)
4. MARKI A., SERES A., SZTOJKOV-IVANOV A. Biopharmacy practice. Szeged, 2015. (english)
5. MIRCIOIU CONSTANTIN şi a.. *Elemente de biofarmacie şi farmacocinetică, Vol.2, Evaluări comparative şi corelări.* Editura Universitară „Carol Davila", Bucureşti, 2008, 136 p. (romanian)
6. POPA MARCEL, UGLEA CONSTANTIN. *Polimeric Nanomedicines*. Bentham Science Publishers, 2013, 790 p. (romanian)
7. POPOVICI A., BAN I., TEKES. ET. *Bazele teoretice ale Tehnologiei farmaceutice, Capitolul 3. Evaluarea biofarmaceutică a formelor farmaceutice,* Ed. „Mirton" Timişoara, 1998, p. 132 – 219. (romanian)
8. POPOVICI IULIANA, LUPULEASA DUMITRU. *Tehnologie farmaceutică (tratat),* vol.2.–Ed. 2-a. Editura. Polirom– Iaşi, 2017, 1071 p. (romanian)
9. POPOVICI IULIANA, LUPULEASA DUMITRU. *Tehnologie farmaceutică (tratat),* vol.3.– Ed. 2-a. Editura. Polirom– Iaşi, 2017, 847 p. (romanian)
10. POPOVICI IULIANA, LUPULEASA DUMITRU. *Tehnologie farmaceutică (tratat),* vol.1.– Ed. 4-a. Ed. Polirom– Iaşi, 2017, 720 p. (romanian)
11. ROBERT E. Notari. Biopharmaceutics and clinical pharmacokinetics. Published by CBS Publishers & Distributors Pvt. Ltd, 4th New edition 2010. (english)