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, Ph.D, associate prof.
Livia Uncu _____

APPROVED
at the Council meeting of the Faculty of Pharmacy
Minutes No. 3 of 16.12.2021
Dean of Faculty Ph.D, associate prof.
Nicolae Ciobanu _____

APPROVED
at the meeting of the chair General Chemistry
Minutes No. 3 of 10.09.2021
Head of chair. Ph.D in chem., associate prof.
Constantin Cheptanaru _____

SYLLABUS

DISCIPLINE **ORGANIC CHEMISTRY**

Integrated studies

Type of course: **Compulsory discipline**

Syllabus was elaborated by:

Cheptanaru Constantin, PhD, associate professor.

Chisinau, 2021

I. PRELIMINARIES

- **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 curriculum in *Organic Chemistry* at pharmacist qualification is a normative pedagogical 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", Organization rules of studies in higher education based on the National Credit Studies System, no. 1/8 of 06.04.2017, Organization rules for evaluation and academic performance in State University of Medicine and Pharmacy "Nicolae Testemitanu", no. 5/4 of 12.10.2016, coordinated with the curriculum of pharmaceutical subjects (pharmaceutical chemistry, pharmaceutical biochemistry, drug technology, pharmacology and clinical pharmacy). Organic chemistry is a fundamental discipline, the study of which at the stage of higher pharmaceutical education is intended for students of the pharmacy faculty and is based on the study of the majority of disciplines (pharmaceutical chemistry, toxicology chemistry, pharmaceutical biochemistry, drug technology, pharmacognosis, pharmacology, etc.).

The study of organic chemistry is organized by implementing different methods used to separate and identify organic compounds, to establish their molecular structure, and to present the great diversity of natural organic and synthetic compounds synthesized on classes, establishing relationships between molecular structure and properties.

Mission of the curriculum (aim) in professional training

The course of organic chemistry aims to form the concepts of chemical structure - functions - reactivity based on the approach of notions of chemical bonding, hybridization, geometry of molecules, electron displacements by field effect, inductive and conjugation effect, etc. At the same time, the aim is to form systemic knowledge, at a contemporary scientific level, their use in structural analysis, in explaining chemical behavior, explaining the mechanisms of reaction given the chemical behavior of substances. Accumulation of specific skills in organic chemistry in the assimilation of specialized notions, in explaining the physical, chemical, and biological properties of medicinal substances and other components of a drug. Creating skills for the correct use of laboratory methods and techniques specific to pharmaceutical disciplines: synthesis methods, separation methods, purification methods, physico-chemical analysis methods.

- **Languages of the course:** romanian, russian, english.

- **Beneficiaries:** students of the 2nd year, faculty of Pharmacy, Pharmacy specialty.

II. MANAGEMENT OF THE DISCIPLINE

Code of discipline		**F.03.O.024** **F.03.O.032**	
Name of the discipline		**Organic Chemistry**	
Person(s) in charge of the discipline		Ph.D in chem., assistant prof. **Constantin Cheptănaru**	
Year	**II**	Semester/Semesters	**III** and **IV**
Total number of hours, including:			**270**
Lectures	**45**	Practical/laboratory hours	**90**
Seminars	**-**	Self-training	**135**
Form of assessment	**E and E**	Number of credits	**9**

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:***
  - to know the basis of organic compounds structure, the electronic structure of carbon atom and organogenetic elements, the electronic structure of chemical bonds interconnecting with the mutual influence of the atoms in the molecule, the electronic effects of the substitutes, conjugation and aromaticity, acidity and basicity of organic compounds, the general mechanisms of chemical reactions.
  - to know the main classes of organic homofunctional compounds, structure, nomenclature, the obtaining methods, general and specific properties, the reaction mechanisms.
  - to know the structure, the composition, and the main properties of heterofunctional organic compounds - traditional specialty of pharmacy.
  - to know the peculiarities of structure, reactivity and the significance of heterocyclic compounds with nitrogen, oxygen and sulfur.
  - to understand the structure and the main properties of biologically active heterofunctional organic compound - participants in the metabolic processes (hydroxy-, amino-, and oxo- acids, nucleosides, nucleotides and biopolymers - peptides and proteins, polysaccharides, nucleic acids).
  - to know the structure, properties and importance of plant and animal organic compounds - simple and complex lipids, terpenoids, steroids, alkaloids and their synthetic analogues.
  - to know the informational possibilities of physico-chemical methods of analysis (IR spectroscopy, UV-Vis, NMR, MS) and the identification of organic compounds.

- to understand the main procedures of organic chemistry laboratory (purification, elimination, extraction, recrystallization, melting temperature determination, simple and fractional distillation in vacuum and with vapor), the accident prevention in the chemical laboratory.

- ***at the application level:***
  - to determine the class and group of organic compounds according to the classification rules. The structural formulas according to systematic nomenclature.
  - to represent graphically the structural, stereochemical and conformational formulas of organic compounds, types of stereoisomers.
  - to determine the acidic and basic sites and to appreciate and compare the acidity of organic compounds.
  - to determine and describe the mechanisms of organic reactions to forecast the direction and outcome organic transformations.
  - to apply the qualitative analysis identification reactions of organic combinations.
  - to carry out the synthesis of a given organic compound from the documentation till the obtaining of a pure compound and it characteristic.

- ***at the integration level:***
  - to appreciate the importance of organic chemistry in content of integration with profile disciplines (pharmaceutical chemistry, toxicological chemistry, drugs technology, pharmacology etc.).
  - to know the identification reactions of different pharmaceutical organic compounds classes;
  - to be able to perform the synthesis of organic molecules that are used frequently in pharmaceutical practice;
  - to explain the pharmacological properties of the organic molecules depending on their chemical structure.

IV. PROVISIONAL TERMS AND CONDITIONS

Curriculum - general and inorganic chemistry, analytical chemistry, physical chemistry.
Competences - for the good acquisition of the university course of organic chemistry, the students must have the capacity to understand, to learn and to apply practically the theoretical notions.
Students must have the ability to make correlations between the notions taught, between the course and the practical works, as well as interdisciplinary. Thorough knowledge in Chemistry is required, obtained in pre-university institutions: electronic structure of bioelements, theory of structure of organic compounds, structural isomerism, types of chemical bonds in organic compounds, nomenclature bases and classification of organic compounds.

Student of the second year should possess:

- knowledge of the language of instruction;
- digital competences (use of the Internet, document processing, electronic tables and presentations, use of graphic programs);
- ability to communicate and work in team;
- 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.	Introduction. Chemical bonds and reciprocal influence of atoms in organic molecules. Types of chemical bonds in organic compounds. The inductive effect. Conjugated systems. Aromaticity. The mesomeric effect. Electron donor ED and withdrawn EW substituents.	2	3	5
2.	The spatial structure of organic compounds. The configuration. The stereochemical formulas. Stereoisomerism and enantiomerism. The absolute and relative configuration. D, L and R, S series. Racemic mixture. Diastereomeria. Conformations. The energetic characteristics of open and cyclic chain conformations.	2	3	5
3.	Acidity and basicity of organic compounds. The Bronsted theory. Types of acids and organic bases. Factors that influence the acidity and basicity. Classification of reagents and organic reactions. The general mechanisms of radical, electrophile and nucleophile reactions.	2	3	5
4.	The reactivity of unsaturated hydrocarbons. Alkenes, π-diastereomerism. The mechanism of electrophile addition (A_E – reactions): the addition of halides, halogenated acids, hydration reaction. The Markovnikov`s rule. Oxidation reactions. Dependencies of oxidation products and the reaction conditions. Polymerization reactions. Synthetic and natural rubbers. Alkynes. Reactionary ability. Qualitative reactions of alkenes and alkynes.	2	3	5
5.	The reactivity of monocyclic arenes. Aromaticity. Electrophile substitution reactions, S_E mechanism. Halogenation, nitration, sulphonation, alkylation and acylation of arenes. The substitution rules at benzene ring. I-st and II-nd order functional groups. The coordinating and non-coordinating orientation.	2	3	5
6.	The reactivity of condensed arenes. The naphthalene group. Obtaining. Electrophile substitution reactions. Substitution orientation in naphthalene ring. Oxidation and reduction. Anthracene, phenanthrene and their reactivity. The polynuclear condensate arenes.	2	3	5
7.	Halogenated derivatives of hydrocarbons. Mono and bimolecular nucleophile substitution reactions. The alkylhalydes in the organic chemistry synthesis. The elimination reactions. The alkenhalydes, alyl- and vinyl. Halogenoarenes.	2	3	5
8.	The reactivity of hydroxyl derivatives of hydrocarbons and their sulfur analogues. Nucleophilic substitution and elimination reactions. Alcohols and thiols oxidation. Applying these reactions for aldehydes, ketones, carboxylic acids synthesis and for primary, secondary and tertiary alcohols identification.	2	3	5

No. d/o	THEME	Number of hours		
		Lectures	Practical hours	Self-training
9.	The reactivity of ethers and thioethers. Nomenclature. Reactive capacity. The most important representatives. Phenols, structural particularities and chemical reactivity. Extending the synthesis possibilities by carboxylation, hydroxylation and formylation reactions. Mono- and dihydroxy phenol oxidation. Qualitative reactions of phenols.	2	3	5
10.	Carbonyl compounds. Synthesis methods. Structure and reactivity of carbonyl group. Nucleophilic addition reactions, A_N mechanism. Role of acid catalysis. The addition of Grignard reagent. The polymerization reactions.	2	3	5
11.	The reactivity of aldehydes and ketones. The addition-elimination reactions. Reactions with CH acid site. Aldolic and crotonic condensation. The haloformic reaction. Oxidation and reduction.	2	3	5
12.	The reactivity of carboxyl compounds. Classification of carboxylic acids. The structure of carboxyl group and carboxyl anion. Nucleophilic substitution reactions, mechanism. The role of catalyst. Use of nucleophilic substitution reactions to obtain functional derivatives - halogen anhydrides, anhydrides, esters, amides, hydrazides.	2	3	5
13.	Saturated and unsaturated dicarboxylic acids. Their chemical reactivity. CH acidity of ethylacetate and malonic esters. The condensation reaction of ethylacetate and malonic ester synthesis.	2	3	5
14.	Reactive capacity of amines. Classification. Preparation methods. Basic and nucleophilic properties. Reactions of amines with nitric acid. The influence of the aminogroup on the benzene cycle. S_E reactions (halogenation, nitration, sulfonation).	2	3	5
15.	The reactivity of diazocombinations. The diazotation reactions. The structure of diazonium salts. Diazotation agents. The diazonium salts reactions with nitrogen elimination. The reactions of azocombination. The azo colorants (methyl orange, congo red) and their proprieties. The colour theory.	2	3	5
16.	Heterofunctional carboxylic acids. Halogenacids, hydroxyacids, aminoacids and oxoacids. Preparation. Heterofunctional properties. Specific reactions. Keto-enol tautomerism. Synthesis with acetylacetic ester. Phenolic acids. Salicylic acid. Preparation. Chemical peculiarities. Functional derivatives as medicinal preparations.	1	3	4
17.	α-Aminoacids, peptides and proteins. Protein aminoacids. Structure, classification, nomenclature. Chemical properties of α - amino acids as heterofunctional compounds. Reactions of α - amino acids of biological importance: transamination, deamination, hydroxylation and decarboxylation. Peptides. Establishing the primary structure. Determination of amino acid sequence by Edman's method	1	3	4

No. d/o	THEME	Number of hours		
		Lectures	Practical hours	Self-training
	(phenylisothiocyanate). Peptide chemical synthesis strategy.			
18.	Monosaccharides. The classification, stereoisomerism and cyclo-oxo tautomerism. The Haworth formulas. The conformations. The chemical reactivity capability. The qualitative chemical reactions. The most important representatives. The vitamin C.	1	3	4
19.	Oligo- and polysaccharides. Disaccharides. Classification. The structure of non-reducing (sucrose) and reducing disaccharides (maltose, lactose, cellobiose). Nomenclature, cyclo-oxo-tautomerism, properties. Polysaccharides. Starch (amylose, amylopectin). Structure and properties. Glycogen. Dextran. Cellulose, structure and derivatives. Notion of heteropolysaccharides.	1	3	4
20.	Pentaatomic heterocycles with a single heteroatom. Structure, nomenclature, aromatic character. Acid-base properties. Furan, pyrrole, thiophene. Acidophobic properties. Electrophilic substitution reactions. Substitution orientation. Furfural, furacillin. Porphine, hemoglobin. The corynic cycle. Indole group.	1	3	4
21.	Pentaatomic heterocycles with two heteroatoms. Pyrazole, imidazole, oxazole, thiazole. Tautomerism of pyrazole and imidazole. Training of associates. Acid-base properties, S_E reactions. Pyrazolone-5 and its derivatives: antipyrine, amidopyrine, analgesic, butadione. Their synthesis. Thiazolidine. Notions about the structure of penicillins.	1	3	4
22.	Hexaatomic heterocycles. Pyridine, quinoline and pyran groups. Reactivity and importance of their derivatives in medicine and pharmacy. Pyrimidine, pyrazine, piperizine. Pyrimidine derivatives: barbituric acid, barbital, phenobarbital, vitamin B1. Oxazine, phenoxazine.	1	3	4
23.	Condensed heterocycles. Purina. Hypoxanthine. Xantina. Methylated xanthines: theophylline, theobromine, caffeine. Uric acid, acid and neutral urates. Murexidic reaction. Pteridine group. Folic acid, rioboflavin.	1	3	4
24.	Alkaloids. Chemical classification. Basic properties. Qualitative reactions. Pyridine and piperidine group alkaloids: nicotine, coniine, anabazine. Alkaloids of the quinoline group: quinine. Alkaloids of the isoquinoline group and isoquinolinphenrene: papaverine, morphine, codeine. Tropanoid alkaloids: atropine, cocaine. Indole group alkaloids: reserpine, lysergic acid and its amide.	1	3	4
25.	Nucleic acids. Nuclear bases. Nucleoside. Nucleotide. Structure, nomenclature, attitude to hydrolysis. RNA, DNA. Primary structure. Notions about the secondary structure. Nucleoside mono- and nucleoside polyphosphates. Nucleotide coenzymes: ATP, NAD^+, $NADP^+$, FAD. Their structure and importance. The role of nucleic acids in protein biosynthesis	1	3	4

No. d/o	THEME	Number of hours		
		Lectures	Practical hours	Self-training
26.	Hydrolyzable lipids (neutral). Natural fats as a mixture of triacylglycerides. Higher fatty acids that are part of lipids. Their structure, nomenclature and conformation. Reactive capacity of lipids (acidic and basic hydrolysis, hydrogenation, addition and oxidation reactions) used to assess the quality of fats. Heavens and wines, their importance in pharmaceuticals.	1	3	4
27.	Complex lipids. Phosphatidic acids. Phospholipids: phosphoacylglycerins (phosphatidylcolamine – kephalins, phosphatidylcholine – lecithins). The sphingolipids: sphingomyelin and glycolipids (cerebroside and ganglioside). The structure, hydrolysis and biological importance. The biological oxidation. The notion of prostaglandins.	1	3	4
28.	Non-hydrolyzable lipids. The structural particularities of terpenoids, carotenoids as a isoprenoid derivatives. Terpenoid. Classification. Isoprene rule. Monoterpenoids - biologically active substances and medicinal preparations (essential oils, pinene, limonene, menthol, camphor, etc.). Diterpenoids: vitamin A, retinal. Triterpenoid: squalene; Tetraterpenoids: carotene.	1	3	4
29.	Steroids. The structure of sterane. The nomenclature, stereoisomeria, 5α and 5β representatives. The main groups of steroids: sterines, biliary acid, sexual androgen and estrogen hormones, aglicons of cardiotonic glycosides, corticosteroids – main representatives and their characteristic.	1	3	4
30.	The evaluation lecture. The chemical reactivity of the principal classes of organic compounds as a base for elaboration of synthesis methods and analysis of drugs molecules, prognosis of their metabolism in the organism.	1	3	4
Total		**45**	**90**	**135**

VI. REFERENCE OBJECTIVES OF CONTENT UNITS

Objectives	Content units
Chapter 1. The basis of organic compounds structure	
• To define the main notions of the important class of organic compounds, conjugation and aromatic state, electronic effects of substituents, acidity and basicity of organic compounds. • To know classification and nomenclature of organic compounds, reciprocal influence of atoms in molecules, acid and base properties of organic compounds, stereoisomerism and its importance. • To demonstrate electronic effects of substituents. • To apply nomenclature rules, factors that acidity and basicity are depends of, notions of stereoisomerism and importance in the medicine field. • To integrate the knowledge gained in the field with the needs of other disciplines in the field of drug chemistry.	Classification and nomenclature of organic compounds. Systematic nomenclature rules. Reciprocal influence of atoms in organic molecules, conjugation and aromaticity as factors of stability. Electronic effects of substituents. Electron donor ED and withdrawn EW substituents. The spatial structure and stereoisomerism of organic compounds. The absolute and relative configuration. Stereoisomeric relations-activity of natural compounds and chiral drugs. Acid and base properties of organic compounds. Acidity and basicity of medications.
Chapter 2. The reactivity of unsaturated hydrocarbons, aromatic compounds and homofunctional compounds that contain halogen, hydroxy- groups.	
• To define the laws on the reactive capacity of unsaturated and aromatic hydrocarbons and hydroxyl compounds. • to know and to explain the reactivity of unsaturated and aromatic hydrocarbons, hydroxyl compounds. • to demonstrate the mechanisms of electrophilic addition and substitution reactions, monomolecular and bimolecular nucleophilic substitution. • to apply the rules of electrophile addition, electrophile substitution particularities and nucleophilic substitution. • to integrate the knowledge gained in the field with the needs of other disciplines in the field of drugs chemistry.	The reactive capacity of unsaturated compounds and the peculiarities of the reactivity of conjugated systems. Peculiarities of the reactive capacity of monocyclic arenas and arenas with condensed rings. The influence of substituents on the reactivity of arenas. Reactive capacity of homofunctional organic compounds containing halogen, hydroxyl groups. Mechanisms of nucleophilic substitution and elimination reactions, and the influence of electronic and steric factors. Forecast of chemical reactivity and use in drug synthesis of organic substances.
Chapter 3. The reactivity of carbonyl and carboxyl compounds, amines and diazocompounds.	
• To define the laws concerning the reactive capacity of carbonyl and carboxylic compounds, amines and	Methods of production and reactivity of carbonyl compounds. Mechanism of nucleophilic addition.

Objectives	Content units
diazoderivatives. • to know and to interpret the reactive capacity of carbonyl and carboxylic compounds, amines and diazoderivatives. • to demonstrate the mechanisms of nucleophilic addition and nucleophilic substitution reactions. • to apply the laws of nucleophile addition to carbonyl compounds and nucleophilic substitution. • to integrate the knowledge gained in the field with the needs of other disciplines in the field of pharmaceutical chemistry.	Reactive capacity of carboxylic compounds and the nucleophilic substitution mechanism of carboxylic acids and their functional derivatives. Aliphatic and aromatic amines. Particularities of chemical reactivity. Diazotization of aromatic amines and production of azo- and diazoderivatives. Their importance in chemistry and dye technology, as well as in pharmaceutical analysis
Chapter 4. Heterofunctional carboxylic acids and carbohydrates	
• To define the notions of hydroxyacid, oxoacid, aminoacid, proteinogenic amino acid, monosaccharides, di- and polysaccharides. • to know the specificities of the chemical reactivity of the hydroxy-, oxo- and amino acid heterofunctional compounds, polyhydroxyaldehydes and polyhydroxyketones (monosaccharides, di- and polysaccharides). • to demonstrate the analytical reactions for the identification of hydroxy, oxo- and amino acids, monosaccharides, di- and polysaccharides). • to apply the knowledge about the reactivity of the heterofunctional compounds to explain the peculiarities of the chemical behavior of these compounds. • to integrate the knowledge gained in the field with the needs of other disciplines in the field of drug chemistry.	Hydroxiacids, obtaining, spreading in nature and specific reactions depending on the mutual position of the functional groups in the molecule. Oxoacids, their production and their transformations in metabolic reactions. α-Aminoacid proteins, classification, nomenclature and main reactions used in peptide synthesis. Specific reactions to identify α-amino acids and peptides. Monosaccharides, classification, nomenclature, stereoisomerism and chemical transformations characteristic of polyhydroxicarbonyl compounds. Di- and polysaccharides as representatives of natural biopolymers and their biological role.
Chapter 5. Five-membered, six-membered and fused rings heterocycles.	
• To define the aromaticity of penta-atomic and hexa-atomic heterocycles with one, two or more heteroatoms. • to know the most important representatives of penta-atomic and hexa-atomic heterocycles with one, two or more heteroatoms. The structure and biological importance of the more important hydroxy- and amino-derivatives. • to demonstrate the reactive capacity of super-aromatic and electron-insufficient heterocycles π. • to apply the knowledge about the reactivity of the heterocycles to explain the properties of the biological importance of hydroxy- and amino-	Aromatic heterocyclic combinations: generalities, nomenclature. Penta-atomic heterobicycles with one and two heteroatoms. Heterocycles of six atoms with nitrogen and oxygen atoms. Pyridine group, pyran group, quinoline and isoquinoline group. Heterocycles with condensed rings. Purine group and pteridine group. Amino- and more important oxo-derivatives. Natural products of vegetable nature -

Objectives	Content units
derivatives. • to integrate the knowledge gained in the field with the needs of other disciplines in the field of drug chemistry.	alkaloids. Classification, nomenclature and biological importance.
Chapter 6. Nucleic acids, hydrolysable and non- hydrolysable lipids	
• to define the notions of nucleosides, nucleotides, nucleic acids, hydrolysable and non-hydrolysable lipids, terpenoids, steroids. • to know nucleic bases, the structure of nucleosides and nucleotides, the structure of triacylglycerols and phospholipids, the isoprenic rule and the classification of terpenoids and steroids. • to demonstrate the principle of the chemical structure of polynucleotide chains, complementary bases, triacylglycerols, phospholipids, terpenoids and steroids. • to apply the accumulated knowledge to the composition and structure of nucleosides and nucleotides, triacylglycerols and phospholipids, terpenoids and steroids to explain chemical and biochemical transformations. • to integrate the knowledge gained in the field with the needs of other disciplines in the field of drug chemistry.	Nucleic bases, nucleosides, nucleotides, nucleic acids. Nucleoside mono- and nucleoside polyphosphates. Nucleotide coenzymes: ATP, NAD^+, $NADP^+$, FAD. Their structure and importance. Hydrolysable lipids - triacylglycerols, composition, structure and reactive capacity, used to assess the quality of fats. Non-hydrolysable lipids Particularities of the terpene and carotenoid structure as isoprenic derivatives. Terpenoids. Classification. Isoprenic rule. Monoterpenoids - biologically active substances and medicinal preparations. Steroids. The structure of the steran. Main groups of steroids: Sterins, bile acids, androgenic sex hormones, estrogen sex hormones, cardiotonic glycosides aglycons, corticosteroids, their main representatives and their characteristic.

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

✓ Professional (specific) (SC) competences

- PC1. Knowledge of the theoretical bases of the disciplines included in the curriculum of the faculty, general principles in the design, formulation, preparation and conditioning of pharmaceutical and para-pharmaceutical products.
- PC2. Performing various practical exercises related to the preparation, analysis and standardization of synthetic and phytopreparate drugs, physico-chemical analysis methods.
- PC3. Design and coordination of pharmaceutical activity in various institutions: laboratories for quality control and certification of medicines, toxicology laboratories, drug factories etc; demonstrating the ability to make decisions to improve the pharmaceutical system.
- PC4. Adoption of messages in various socio-cultural environments, including through multi-language communication, use of problem-solving capabilities through interdisciplinary correlation with other fundamental and specialized subjects: analytical chemistry, pharmaceutical chemistry, pharmacognosis, biochemistry, etc., the development of the bibliographic documentation and the synthesis of the obtained information.

✓ Transversal competences (TC)

- TC1. Obtaining moral markers, forming professional and civic attitudes, allowing students to be honest, honest, nonconflicted, cooperative, available to help people interested in community development; to know and apply ethical principles related to medical-pharmaceutical practice; recognize a problem when it comes out and provide solutions that are responsible for solving it.
- TC2. Acquiring practical skills and acquiring some useful working methods both for the future pharmacist activity and in other laboratories. Familiarizing the student with the specifics of teamwork, relationship and communication skills.
- TC3. To have openness to lifelong learning; to become aware of the need for individual study as a basis for personal autonomy and professional development; to capitalize optimally and creatively on their own potential in collective activities; to use information and communication technology.

✓ Study outcomes

- To know and understand the notions of general organic chemistry necessary for the study of classes of organic compounds.
- Acquiring, understanding and using notions related to the classification, structure, name, acquisition and physico-chemical behavior of the main classes of organic compounds.
- Ability to use theoretical notions in structural analysis, explaining chemical behavior, explaining reaction mechanisms and predicting chemical behavior of substances.
- Understanding the importance of organic chemistry in acquiring specialized notions in explaining the physical, chemical and biological properties of drug substances and other components of a drug.
- The importance of knowing physical and chemical properties for understanding and predicting the stability of pharmaceuticals.
- Knowledge of the theoretical and practical notions needed for the synthesis, separation, purification and analysis of compounds in the main classes of organic compounds.
- Ability to use working techniques for the synthesis and analysis of organic substances.
- Ability to use the notions learned in organic chemistry laboratories in the synthesis and characterization of organic substances.

VIII. STUDENT'S SELF-TRAINING

No.	Expected product	Implementation strategies	Assessment criteria	Implementation terms
1.	Working with information sources	Read lecture or course material in the subject carefully. Read questions on the subject, which require a reflection on the subject. To get acquainted with the list of additional information sources on the topic. Select the source of additional information for that theme. Reading the text entirely, carefully and writing the essential content. Wording of generalizations and conclusions regarding the importance of the theme / subject	Ability to extract the essentials; interpretative skills;	During the semester
2.	Working with the laboratory workbook and problems.	Reporting of laboratory work. Solving problems related to laboratory work.	Volume and accuracy of solved problems.	During the semester
3.	Report	Analysis of relevant sources on the topic of the paper. Analysis, systematization and synthesis of information on the proposed theme. 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 theme.	During the semester

IX. METHODOLOGICAL SUGGESTIONS FOR TEACHING-LEARNING-ASSESSMENT

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

The discipline of organic chemistry is taught in classical ways: lectures, practical and laboratory works. At the lectures, the theoretical course will be read by the course holders. In practical and laboratory work, students will broaden, deepen and verify their theoretical knowledge, will have easy-to-understand principles and methods for qualitative and quantitative organic analysis, and will pay attention to the laboratory work. The Chair reserves the right to spend some practical work in an interactive manner.

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

To succeed in Organic Chemistry success, the student should work actively both in the laboratory and in the laboratory, and the teacher should use the didactic technologies specific to the discipline. The most important methods in teaching organic chemistry are the problem, *experiment and brainstorming.*

Brainstorming is a technique of group creativity designed to generate a large number of ideas to solve a problem.

Problems called and teaching through problem solving or, more specifically, teaching through productive problem solving. A didactic method consisting in putting in the minds of the students some deliberately created difficulties in overcoming which, by their own effort, the student learns something new.

The laboratory experiment is a method of acquiring knowledge and training skills and skills of intellectual and practical work, it allows an intensive activity of the student and a particularly active participation in the educational process, it has a pronounced applicative character with weight particular in the formation of practical skills**.**

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

Current: frontal and / or individual control by applying tests, solving problems / exercises, analyzing case studies as well as totalization works

Final*:* exam (semester III), exam (semester IV).

The examin the discipline of Organic Chemistry is combined, consisting of the test-grid test and the oral test. The final mark of the exam will consist of the annual average mark, the grid test and the oral test.

Students with an annual average below grade 5, as well as students who have not recovered their absences from the practical work are not admitted to the exam. The average grade is calculated from the grades from three totalization papers and the individual work.

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, 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.

X. RECOMMENDED LITERATURE:

A. Compulsory:

1. ZURABYAN S.E. *Fundamentals of bioorganic chemistry*. GEOTAR-Media publishing group, 2017.
2. CHEPTĂNARU C. *Chimie organică.* Ch. "Print Caro", 2019.
3. STEVEN S. ZUMDAHL. *Chemistry.* Lexington, Massachusetts, Toronto, 1986.
4. FRANCIS MARION MILLER. *Chemistry, Structure and dynamics.* McGraw-Hill book company, USA., 1984.
5. TIUKAVKINA N.; BAUKOV I.; RUCIKIN V. *Chimia bioorganică.* Ch.: "Lumina", 1992.
6. VALENTIN ZAHARIA. *Chimie organică,* Cluj-Napoca, 2016.

B. Additional

1. NENIŢESCU C. D. *Chimie organică.* B.: "Regia Autonomă Monitorul Oficial", 2015.
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