

MINISTRY OF HEALTH OF THE REPUBLIC OF BELARUS
Educational Institution
«BELARUSIAN STATE MEDICAL UNIVERSITY»



APPROVED

by Rector of the Educational
Institution «Belarusian State
Medical University»



 S.P. Rubnikov

26.06.2025

Reg. # UD-0912-01-26/5.26/edu.

PHARMACEUTICAL CHEMISTRY

**Curriculum of the educational institution
in the academic discipline for the specialty**

7-07-0912-01 «Pharmacy»

The curriculum is based on the educational program «Pharmaceutical Chemistry», approved 26.06.2025 registration # УД-0912-01-26/2526/уч., on the education plan in the specialty 7-07-0912-01 «Pharmacy» approved 16.04.2025, registration # 7-07-0912-01/2425/mf.

COMPILERS:

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RECOMMENDED FOR APPROVAL:

Department of Pharmaceutical Chemistry with a course for advanced training and retraining of the Educational Institution «Belarusian State Medical University» (protocol № 11 of 25.04.2025);

By the Scientific and Methodological Council of the Educational Institution «Belarusian State Medical University» (protocol № 10 of 26.06.2025)

EXPLANATORY NOTE

«Pharmaceutical Chemistry» is an academic discipline of the «Pharmaceutical Chemistry and Pharmacognosy» module, containing systematized scientific knowledge about the chemical structure of medicines, their classification, molecular basis of their action mechanism, link between chemical structure and pharmacological action and methods of quality control and production of medicines.

The aim of the academic discipline «Pharmaceutical Chemistry» is the formation of specialized competencies for the selection and use of appropriate methods and technologies in quality monitoring of medicines, assessing stability of medicines during storage, predicting physical-chemical, chemical-analytical and pharmacological properties of medicines on the base of their structure.

The objectives of the academic discipline «Pharmaceutical Chemistry» are to form students' scientific knowledge about classification of medicines; the most important principles of creating original medicines; patterns in links between chemical structure and pharmacological activity of medicines; factors affecting the stability of medicines; methods and techniques of pharmaceutical analysis; principles of detection of medicines and their metabolites in biological fluids; skills and abilities required for forecasting physical-chemical, chemical-analytical and pharmacological properties of medicines, based on their structure and the implementation of quality control of pharmaceutical substances and medicines, interpretation and documentation of the results of the analyzes performed.

The knowledges, abilities and skills acquired during the study of the academic discipline «Pharmaceutical Chemistry» are necessary for the successful mastery of the following academic disciplines: «Pharmacognosy», «Toxicological Chemistry», «Pharmaceutical Ecology», «Pharmaceutical Care», «Modern Methods of Analysis and Standardization of Medicines», modules «Pharmacology and Pharmacotherapy», «Pharmaceutical Technology».

A student who has mastered educational material of an academic discipline «Pharmaceutical Chemistry» should have the following specialized competencies:

choose and use appropriate methods and technologies when conducting quality control of medicines and medicinal plant raw materials, evaluate the obtained results; prognosticate the physicochemical properties, quality control methods and pharmacological properties of medicinal substances based on its structure.

As a result of studying the academic discipline «Pharmaceutical Chemistry», the student should

know:

terminology of pharmaceutical chemistry, its goals, objectives and areas of research;
principles of medicines classification;
chemical structure of medicines;
sources and methods of medicines preparation, main stages and principles of original medicines creation;
types of regulatory documentation regulating quality of medicines;
factors and processes affecting stability of medicines, requirements for their storage conditions;

methods and techniques of pharmaceutical analysis;
 influence of chemical structure of medicines on the pharmacological action;
 chemical basis of the interaction of medicines with their targets;
 principles for detection of medicines and their metabolites in biological fluids;

be able to:

identify pharmaceutical substances, excipients and medicines;
 determine physical constants and quality indicators of pharmaceutical substances and excipients;

perform quantitative analysis of pharmaceutical substances and medicines; carry out statistical processing of experimental data;

carry out quality control of industrially manufactured and pharmaceutical medicines;

master:

experimental skills in assessing quality of pharmaceutical substances, excipients and medicines of industrial manufacture and pharmaceutical production;

skills in interpreting results of drug analysis;

methodology for predicting physical-chemical, chemical-analytical and pharmacological properties of medicinal substances based on their chemical structure.

Total number of hours for the study of the discipline is 533 academic hours, of which 349 classroom hours and 204 hours of student independent work. Classroom hours according to the types of studies: lectures – 81 hours (including 18 hours of supervised student independent work (SSIW)), laboratory classes –268 hours.

Intermediate assessment is carried out according to the syllabus of the specialty in the form of a credit (5, 7 semester) and examination (6, 8 semester).

Form of higher education – full-time.

ALLOCATION OF ACADEMIC TIME ACCORDING TO SEMESTERS OF STUDY

Code, name of specialty	Semester	Total number of academic hours	Number of classroom hours				Out-of-class self-studies	Form of intermediate assessment
			Number of classroom hours	including				
				class lectures	SSIW	laboratory classes		
7-07-0912-01 «Pharmacy»	5	115	86	15	3	68	29	Credit
	6	120	86	15	3	68	34	Examination
	7	120	89	15	6	68	31	Credit
	8	198	88	18	6	64	110	Examination
Total number		553	349	63	18	268	204	

THEMATIC PLAN

Name of section (topic)	Number of classroom hours	
	lectures (including SSIW)	laboratory classes
1. General issues of pharmaceutical chemistry	4,5	12
1.1. Introduction to the academic discipline «Pharmaceutical Chemistry». Methods and sources of obtaining medicines	1,5	4
1.2. Ensuring the quality of pharmaceutical substances and medicines. General characteristics of pharmaceutical analysis. Pharmacopoeial analysis	1,5	4
1.3. Stability, shelf life and modern approaches to degradation, neutralization and disposal of medicines	1,5	4
2. Pharmaceutical analysis	12	48
2.1. Reagents used in pharmacopoeial analysis. Properties of pharmaceutical substances	1,5	4
2.2. Titrimetric methods used in pharmaceutical analysis. Gravimetry	-	4
2.3. Spectrometric and thermal methods used in pharmaceutical analysis	1,5	4
2.4. Chromatographic and biological methods used in pharmaceutical analysis	1,5	8
2.5. Methods for identification of inorganic cations and anions used in pharmacopoeial analysis	-	4
2.6. Methods for identification of organic ions and functional groups used in pharmacopoeial analysis. Instrumental identification methods	1,5	4
2.7. Pharmacopoeial testing of pharmaceutical substances	1,5	4
2.8. Pharmacopoeial testing of pharmaceutical substances and electrochemical methods used in pharmaceutical analysis	1,5	4
2.9. Impurities in pharmaceutical substances	1,5	8
2.10. Statistical processing of chemical experiment results, validation of methods and principle of choosing a quantitative determination method. Pharmacopoeial water quality control	1,5	4
3. Pharmacopoeial quality control of the medicines main groups classified by chemical structure	19,5	76
3.1. Pharmacopoeial analysis of pharmaceutical substances of inorganic nature: s-elements	1,5	8
3.2. Pharmacopoeial analysis of pharmaceutical substances of inorganic nature: p-elements	1,5	8
3.3. Pharmacopoeial analysis of pharmaceutical substances of inorganic nature: d-elements	1,5	4

Name of section (topic)	Number of classroom hours	
	lectures (including SSIW)	laboratory classes
3.4. Pharmacopoeial quality control of pharmaceutical substances of aliphatic nature: alkanes, alcohols, ethers, aldehydes, sulfoxides	1,5	4
3.5. Pharmacopoeial quality control of pharmaceutical substances of aliphatic nature: carbohydrates, terpenoids	-	4
3.6. Pharmacopoeial quality control of pharmaceutical substances of aliphatic nature: carboxylic acids, amino acids	1,5	8
3.7. Pharmacopoeial quality control of pharmaceutical substance of aromatic nature: phenols, aromatic acids	1,5	4
3.8. Pharmacopoeial quality control of pharmaceutical substances of aromatic nature: phenylalkylamines, sulfanilic acid	1,5	4
3.9. Pharmacopoeial quality control of pharmaceutical substances of heterocyclic nature: furan, nitrofuran and nitroimidazole derivatives	1,5	4
3.10. Pharmacopoeial quality control of pharmaceutical substances of heterocyclic nature: derivatives of furan, benzopyran, pyrazole, benzimidazole, pyridine	1,5	4
3.11. Pharmacopoeial quality control of pharmaceutical substances of heterocyclic nature: derivatives of isoquinoline, purine, pteridine, isoalloxazine, pyrimidothiazole, corrin	1,5	4
3.12. Pharmacopoeial quality control and pharmaceutical chemistry of terpenoids and chromone derivatives, secoderivatives of ergosterol and naphthoquinone, related to fat-soluble vitamins and their derivatives	1,5	4
3.13. Pharmacopoeial quality control and pharmaceutical chemistry of aromatic amino acid derivatives related to medicinal products for local anesthesia	1,5	8
3.14. Quality control of pharmaceutically manufactured (extemporaneous medicines) and industrially produced medicines	1,5	8
4. Pharmaceutical chemistry of the main pharmacotherapeutic groups of medicines	45	132
4.1. Determination of medicines and their metabolites in biological objects	-	4
4.2. Modern methodology of original medicines creation	-	
4.3. Pharmaceutical chemistry of medicines for anesthesia and sleeping pills	1,5	4
4.4. Pharmaceutical chemistry of anticonvulsant and antiparkinsonian medicines	1,5	4
4.5. Pharmaceutical chemistry of neuroleptics and anxiolytics	1,5	4

Name of section (topic)	Number of classroom hours	
	lectures (including SSIW)	laboratory classes
4.6. Pharmaceutical chemistry of antidepressants, psychostimulants and nootropic medicines	1,5	4
4.7. Pharmaceutical chemistry of narcotic analgesics, opioid receptor agonists and antagonists	1,5	8
4.8. Pharmaceutical chemistry of non-steroidal anti-inflammatory medicines (NSAIDs), prostaglandins and their derivatives	1,5	4
4.9. Pharmaceutical chemistry of cholinergic medicines and muscle relaxants	1,5	4
4.10. Pharmaceutical chemistry of adrenergic medicines (adrenergic agonists and sympathomimetics)	1,5	4
4.11. Pharmaceutical chemistry of adrenergic medicines (adrenergic receptor antagonists and sympatholytics)	1,5	4
4.12. Pharmaceutical chemistry of H ₁ -histamine receptor antagonists, mast cell membrane stabilizers and leukotriene receptor antagonists	1,5	4
4.13. Pharmaceutical chemistry of histamine H ₂ receptor antagonists, proton pump inhibitors and serotonergic medicines	1,5	8
4.14. Pharmaceutical chemistry of phosphodiesterase inhibitors, antitussive, expectorant and mucolytic medicines	1,5	4
4.15. Pharmaceutical chemistry of medicines for treatment of heart diseases and antiarrhythmic medicines	1,5	8
4.16. Pharmaceutical chemistry of calcium channel blockers and angiotensin-converting enzyme inhibitors	1,5	4
4.17. Pharmaceutical chemistry of angiotensin receptor antagonists and diuretics	1,5	4
4.18. Pharmaceutical chemistry of lipid-lowering medicines and medicines affecting the blood system	1,5	4
4.19. Pharmaceutical chemistry of medicines for the treatment of thyroid diseases and oral hypoglycemic medicines	1,5	4
4.20. Pharmaceutical chemistry of corticosteroids	3	4
4.21. Pharmaceutical chemistry of gestagens, androgens and estrogens	1,5	8
4.22. General characteristics of antibiotics. Pharmaceutical chemistry of beta-lactam antibiotics	3	4
4.23. Pharmaceutical chemistry of the antibiotics main groups	1,5	4
4.24. Pharmaceutical chemistry of synthetic antibacterial and anthelmintic medicines	1,5	4
4.25. Pharmaceutical chemistry of antiviral and antifungal medicines	1,5	4

Name of section (topic)	Number of classroom hours	
	lectures (including SSIW)	laboratory classes
4.26. Pharmaceutical chemistry of antitubercular and antimalarial medicines	3	4
4.27. Pharmaceutical chemistry of antitumor, antigout and immunosuppressive medicines	3	8
4.28. Pharmaceutical chemistry of contrast and radiopharmaceutical medicines, sorbents	1,5	8
Total hours	81	268

CONTENT OF THE EDUCATIONAL DISCIPLINE

1. General issues of pharmaceutical chemistry

1.1. Introduction to the academic discipline «Pharmaceutical Chemistry». Methods and sources of obtaining medicines

Main sections of pharmaceutical chemistry, areas of research and connections with other sciences. Basic terms used in pharmaceutical chemistry.

Rules for the selection and procedure for assigning names of medicinal products. International nonproprietary names (INN) of pharmaceutical substances. National nonproprietary names of pharmaceutical substances. Trade names of medicines. Synonyms of medicines. Analogues.

Classifications of medicinal substances used in pharmaceutical chemistry: classification of medicinal substances depending on the chemical structure, anatomical-therapeutic-chemical classification (ATC), nosological, pharmacotherapeutic classification, etc.

Main stages in the history of pharmaceutical chemistry. Development of pharmaceutical chemistry on the territory of the modern Republic of Belarus. Modern problems and prospects for the development of pharmaceutical chemistry.

Modern approaches in production of pharmaceutical substances. The main methods and sources of obtaining medicines. Use of natural substances as medicines. Plants, fungi, animals, microorganisms, minerals, etc. as sources of medicines. Isolation of medicinal substances from natural sources. Segregation of biologically active compounds from food, toxic and other mushrooms. Preparation of medicinal substances by chemical modification of natural compounds and full chemical synthesis. Basic chemical transformations underlying total chemical synthesis. Reactants for synthesis. Application of biotechnological methods, including microorganism's usage and genetic engineering for medicinal substances preparation. Metabolomics and proteomics in the production of modern medicines. *Ex homine* medicines.

1.2. Ensuring the quality of pharmaceutical substances and medicines. General characteristics of pharmaceutical analysis. Pharmacopoeial analysis

Modern requirements for medicines: safety, effectiveness, quality. Legal acts regulating the quality control of medicines in the Republic of Belarus. System for

ensuring the quality of medicines at all stages of circulation. Good Practice Standards: Good Research Practice (GRP), Good Laboratory Practice (GLP), Good Clinical Practice (GCP), Good Manufacturing Practice (GMP), Good Pharmacy Practice (GPP), Good Storage Practice (GSP), Good Distribution Practice (GDP), good pharmacovigilance practice (GVP), etc. The structure of the quality control system for medicines in the Republic of Belarus. The problem of counterfeit medicines. Prerequisites and methods against drugs counterfeiting.

Documentation regulating the quality of pharmaceutical substances and medicines. State Pharmacopoeia of the Republic of Belarus (SPh RB), regulatory documents on the quality of pharmaceutical substances and medicinal products. Regional (European Pharmacopoeia, Pharmacopoeia of the Eurasian Economic Union) and national pharmacopoeia (British Pharmacopoeia, US Pharmacopoeia, State Pharmacopoeia of the Russian Federation, State Pharmacopoeia of the Republic of Kazakhstan, State Pharmacopoeia of Ukraine, etc.), International Pharmacopoeia of the World Health Organization.

Difference between medicines and biologically active food additives, medical devices and other pharmaceutical products. Principles of quality control of synthetic and biotechnological medicines: similarities and differences. The concept of diagnostic test systems, approaches to their development and quality control.

Pharmaceutical analysis as an integral part of pharmaceutical chemistry and a section of applied analytical chemistry. Features and types of pharmaceutical analysis. Main groups of analytical chemistry methods used in pharmaceutical analysis.

Basic principles of pharmacopoeial analysis. Unification and standardization of similar tests. Pharmacopoeial monographs. Pharmacopoeial terminology.

1.3. Stability, shelf life and modern approaches to degradation, neutralization and disposal of medicines

Basic terms describing the methodology for assessing stability and shelf life of medicines. Environmental factors (physical, chemical, microbiological) affecting the stability of medicines. Types of chemical reactions leading to changes in the structure and properties of medicines: oxidation, hydrolysis, polymerization, isomerization, etc. Kinetic patterns of medicines decomposition. Methods for increasing the stability of medicines. Stabilizers, preservatives, antioxidants, etc.

Methodology for assessing stability and determining shelf life of pharmaceutical substances and medicines. Long-term, accelerated and stress stability tests. Photostability studies. Predicting shelf life of medicines. Calculation of shelf life of medicines according to the package marking.

Influence of packaging on the stability of medicinal products. Requirements for storage containers and storage conditions for certain groups of pharmaceutical substances and medicinal products. Good storage practices. General and specific principles of medicines storage.

Concept of degradation, neutralization and disposal of medicines. Modern methods of drug neutralization. Chemical disposal method as an option for pharmacophore degradation. Chemical reactions used to degrade medicines. Examples of reagents used for the degradation of cytostatic and antimicrobial medicines. Methods for monitoring the completeness of medicines chemical degradation.

2. Pharmaceutical analysis

2.1. Reagents used in pharmacopoeial analysis. Properties of pharmaceutical substances

Section «Reagents» of the SPh RB. Preparation of reagent solutions, standard and buffer solutions. Titrated solutions (standard solutions) used for titrimetric analysis. Standard substances for titrated solutions. Features of preparation and determination of titer (standardization). Correction factors. Indicators. Features of the indicators used in pharmacopoeial analysis solutions preparation. Expiration dates and labeling of reagents.

Physical properties of pharmaceutical substances: aggregation state, appearance, color, hygroscopicity, crystalline properties, polymorphism. Solubility of pharmaceutical substances. Conventional terms denoting solubility. Acid-base properties of pharmaceutical substances.

2.2. Titrimetric methods used in pharmaceutical analysis. Gravimetry

Chemical methods of analysis. Gravimetric method of analysis. Titrimetric methods of analysis. Acid-base titration in aqueous, aqueous-organic and non-aqueous media. Determination of nitrogen in organic compounds. Methods of redox titration (iodometry, chloriodometry, iodometry, nitrimetry (determination of amine nitrogen in compounds with a primary aromatic amino group), permanganatometry, cerimetry, dichromatometry). Complexometric titration methods (complexometry). Pharmacopoeial conditions for complexometric titration. Precipitation titration methods (argentometry). Titrants, analytes, determination of titration end point, features and application in pharmaceutical analysis.

2.3. Spectrometric and thermal methods used in pharmaceutical analysis

Spectrometric methods of analysis. Absorption methods (atomic absorption spectrometry, molecular absorption spectrometry in the ultraviolet and visible regions, spectrometry in the infrared region, nuclear magnetic resonance spectrometry). Emission spectrometric methods of analysis (atomic emission spectrometry, fluorimetry, X-ray fluorescence spectrometry). Spectrometric methods based on the scattering of electromagnetic radiation (Raman spectrometry, giant Raman spectrometry, nephelometry, turbidimetry). Refractometry. Chiroptical methods of analysis (polarimetry, circular dichroism spectrometry). Principle of the method, equipment used and application in pharmaceutical analysis.

Thermal methods of analysis (thermogravimetry, differential thermal analysis, differential scanning calorimetry).

2.4. Chromatographic and biological methods used in pharmaceutical analysis

Chromatographic separation methods. Gas chromatography. Liquid chromatography (thin layer and paper chromatography, high performance liquid chromatography (liquid chromatography), size exclusion chromatography, ion exchange chromatography). Supercritical fluid chromatography.

Electrophoresis. Capillary electrophoresis.

Mass spectrometry. Combination of mass spectrometry with chromatographic methods. Principle of the method, equipment (materials) used and application in pharmaceutical analysis.

Biological methods of analysis. Microbiological determination of antibiotic activity (diffusion method, turbidimetry method). Protein-binding analysis methods (immunochemical and receptor).

2.5. Methods for identification of inorganic cations and anions used in pharmacopoeial analysis

General characteristics of identification methods used in pharmacopoeial analysis (identification). First and second identification.

Chemical identification methods. General pharmacopoeial monograph of the SPh RB «Identification reaction of ions and functional groups». Specific identification reactions. Identification of inorganic cations and anions.

2.6. Methods for identification of organic ions and functional groups used in pharmacopoeial analysis. Instrumental identification methods

General pharmacopoeial monograph of the SPh RB «Identification reaction of ions and functional groups». Specific identification reactions. Identification of organic ions and functional groups.

Application of instrumental methods in identification. Spectrometric identification methods. Chromatographic identification methods. Identification methods based on determination of physical constants.

2.7. Pharmacopoeial testing of pharmaceutical substances

Determination of melting point, solidification point, drip point, distillation temperature limits and boiling point. Determination of density of liquid and solid substances. Determination of liquids viscosity. Determination of specific rotation and refractive index.

2.8. Pharmacopoeial testing of pharmaceutical substances and electrochemical methods used in pharmaceutical analysis

Determination of color, transparency and degree of liquids turbidity. Determination of volatile substances and water quantities (distillation method, semi-micromethod, micromethod), weight loss during drying, total ash and sulfate ash. Potentiometric pH determination.

Electrochemical methods of analysis. Conductometry, potentiometry (ionometry and potentiometric titration), voltammetry and amperometric titration.

2.9. Impurities in pharmaceutical substances

The concept of impurities in pharmaceutical substances. Terminology used for impurities. Nature and character of impurities. Classification of impurities. General and specific methods for impurities detection. Pharmacopoeial monograph of the SPh RB «Tests for the maximum content of impurities». Examples of impurities formed at different stages of pharmaceutical substances and medicines circulation. Impurities formed during synthesis, storage and production. Examples of impurities. Determination of associated impurities. Standardization of impurity content. Genotoxic impurities and methods for their determination. Examples of genotoxic impurities.

Identification of residual solvents and control of their quantity. Determination of pharmaceutical substances and medicines microbiological purity.

2.10. Statistical processing of chemical experiment results, validation of methods and principles of choosing a quantitative determination method. Pharmacopoeial water quality control

Pharmacopoeial requirements for statistical processing and validation. Statistical processing of chemical experiment results. Validation of analytical methods used in pharmaceutical analysis. Basic validation characteristics of methods and tests.

Prerequisites for choosing a method for the quantitative determination of a drug depending on its chemical structure and object of analysis. Features of the pharmaceutical substances, dosage forms and impurities analysis. Application of titrimetric, spectrometric, chromatographic and other methods for quantitative analysis. Calculation of substance content based on the analytical signal value.

Types of water in the SPh RB. Pharmacopoeial water quality control. Highly purified water, water for injection («in bulk» and sterile), purified water («in bulk» and in containers). Production and storage features of various types of water. Electrical conductivity. Determination of water specific electrical conductivity. Determination of total organic carbon content in water for pharmaceutical use. Microbiological criteria for test results of water various types.

3. Pharmacopoeial quality control of the medicines main groups classified by chemical structure

3.1. Pharmacopoeial analysis of pharmaceutical substances of inorganic nature: s-elements

Preparation methods, structural formula, properties, quality control, chemical basis of pharmacological action and storage conditions of s-elements derivatives: barium sulfate, magnesium oxide light and heavy, magnesium hydroxide, magnesium sulfate heptahydrate, anhydrous calcium chloride, hexahydrate and dihydrate.

Organic and inorganic salts of magnesium (pidolate, lactate, stearate, gluconate, aspartate, acetate, light and heavy carbonate, sulfate, chloride, citrate, etc.) and calcium (pantothenate, levofolate, ascorbate, glycerophosphate, carbonate, lactate, stearate, folate, chloride, etc.). Chelated forms of magnesium. Influence of anion nature on bioavailability of cation.

Organic and inorganic salts of potassium (acetate, hydroaspartate hemihydrate, sorbate, citrate, lactate, carbonate, stearate, folinate, etc.) and sodium (acetate, lactate, citrate, etc.), their role in water-salt metabolism.

3.2. Pharmacopoeial analysis of pharmaceutical substances of inorganic nature: p-elements

Preparation methods, structural formula, properties, quality control, chemical basis of pharmacological action and storage conditions of p-elements derivatives: solutions of hydrogen peroxide, iodine, povidone-iodine, sodium and potassium chlorides, sodium and potassium bromides, sodium and potassium iodides, heavy bismuth nitrate, sodium bicarbonate, sodium thiosulfate, boric acid, sodium tetraborate, hydrated aluminum oxide, hydrated aluminum phosphate, aluminum chloride, sulfur for external use. Organic bismuth salts (subgallate, subsalicylate).

3.3. Pharmacopoeial analysis of pharmaceutical substances of inorganic nature: d-elements

Preparation methods, structural formula, properties, quality control, chemical basis of pharmacological action and storage conditions of d-elements derivatives: zinc oxide, zinc sulfate hexa- and heptahydrate, zinc undecylenate, zinc gluconate, zinc acexamate, iron sulfate heptahydrate and dried, iron chloride hexahydrate, iron fumarate, iron gluconate, copper sulfate pentahydrate and anhydrous, potassium permanganate, silver proteinate, etc. Organic and inorganic salts of zinc, copper and iron. Influence of anion nature on bioavailability of cation. Effect of chemical form and additives on bioavailability of iron. Organic (colloidal) and inorganic (soluble) forms of silver.

3.4. Pharmacopoeial quality control of pharmaceutical substances of aliphatic nature: alkanes, alcohols, ethers, aldehydes, sulfoxides

Preparation methods, structural formula, properties, quality control, chemical basis of pharmacological action and storage conditions of alkanes, alcohols, ethers, aldehydes, sulfoxides derivatives: petrolatum, ethyl alcohol 96%, 95%, 90%, 80%, 70%, 60%, 40%, glycerin, glycerin 85%, isopropyl alcohol, anesthetic ether, ether, formaldehyde 35% solution, chloral hydrate, dimethyl sulfoxide, macrogol. The chemical nature of excipients in soft dosage forms (vaseline oil, petrolatum, ceresin, paraffin, macrogol, etc.).

3.5. Pharmacopoeial quality control of pharmaceutical substances of aliphatic nature: carbohydrates, terpenoids

Preparation methods, structural formula, properties, quality control, chemical basis of pharmacological action and storage conditions of carbohydrates, terpenoids derivatives: glucose monohydrate and anhydrous, lactose monohydrate and anhydrous, sucrose, lactulose, sodium saccharin, levomenthol, racemic menthol, D-camphor, racemic camphor, turpentine oil, etc.

3.6. Pharmacopoeial quality control of pharmaceutical substances of aliphatic nature: carboxylic acids, amino acids

Preparation methods, structural formula, properties, quality control, chemical basis of pharmacological action and storage conditions of carboxylic acids, amino acids derivatives: magnesium, calcium, potassium, manganese, iron and zinc gluconate, glacial acetic acid, lactic acid, S-lactic acid, aminocaproic acid, glycine, glutamic acid, DL-methionine, cysteine hydrochloride.

3.7. Pharmacopoeial quality control of pharmaceutical substances of aromatic nature: phenols, aromatic acids

Preparation methods, structural formula, properties, quality control, chemical basis of pharmacological action and storage conditions of phenols and aromatic acids derivatives: phenol, resorcinol, benzyl benzoate, benzalkonium chloride, paracetamol, benzoic acid, sodium benzoate, salicylic acid, sodium salicylate, choline salicylate, etc.

3.8. Pharmacopoeial quality control of pharmaceutical substances of aromatic nature: phenylalkylamines, sulfanilic acid

Preparation methods, structural formula, properties, quality control, chemical basis of pharmacological action and storage conditions of phenylalkylamines and sulfanilic acid derivatives: chloramphenicol and its esters (palmitate, etc.),

sulfanilamide, sodium sulfacetamide, sulfomethoxazole, silver sulfadiazine, sulfasalazine. Sulfonamides and trimethoprim, their combinations (co-trimoxazole).

3.9. Pharmacopoeial quality control of pharmaceutical substances of heterocyclic nature: furan, nitrofuran and nitroimidazole derivatives

Preparation methods, structural formula, properties, quality control, chemical basis of pharmacological action and storage conditions of furan, nitrofuran and nitroimidazole derivatives: ascorbic acid, sodium ascorbate, nitrofural, nitrofurantoin, furazolidone, nifuratel, nifuroxazide; metronidazole and its benzoate, tinidazole, ornidazole.

3.10. Pharmacopoeial quality control of pharmaceutical substances of heterocyclic nature: derivatives of benzopyran, pyrazole, benzimidazole, pyridine

Preparation methods, structural formula, properties, quality control, chemical basis of pharmacological action and storage conditions of benzopyran, pyrazole, benzimidazole, pyridine derivatives: bioflavonoids and their derivatives (rutoside trihydrate, troxerutin), metamizole sodium monohydrate, phenazone, bendazole hydrochloride (dibazole), nicotinic acid, nicotinamide, xanthinol nicotinate, nicketamide, pyridoxine hydrochloride. Characteristics and classification of vitamins, water-soluble vitamins.

3.11. Pharmacopoeial quality control of pharmaceutical substances of heterocyclic nature: derivatives of isoquinoline, purine, pteridine, isoalloxazine, pyrimidothiazole, corrin

Preparation methods, structural formula, properties, quality control, chemical basis of pharmacological action and storage conditions of isoquinoline, purine, pteridine, isoalloxazine, pyrimidothiazole, corrine derivatives: papaverine hydrochloride, drotaverine hydrochloride, caffeine and its monohydrate, theophylline and its monohydrate, aminophylline (theophylline-ethylenediamine, theophylline-ethylenediamine hydrate and for injection), theobromine, pentoxifylline, folic acid, riboflavin, riboflavin sodium phosphate, thiamine salts and esters (benfotiamine, cocarboxylase, nitrate, hydrochloride), cyanocobalamin.

3.12. Pharmacopoeial quality control and pharmaceutical chemistry of terpenoids and chromone derivatives, secoderivatives of ergosterol and naphthoquinone, related to fat-soluble vitamins and their derivatives

Characteristics and classification of fat-soluble vitamins. Preparation methods, structural formula, properties, quality control, chemical basis of pharmacological action and storage conditions of fat-soluble vitamins: retinol and its esters (acetate, palmitate, etc.), retinoids (tretinoin, isotretinoin, adapalene, etc.), ergocalciferol, cholecalciferol, α -tocopherol, α -tocopheryl acetate and hydrosuccinate, RRR- α -tocopheryl acetate, menadione, phytomenadione, menadione sodium bisulfite. The concept of vitamin-like substances.

3.13. Pharmacopoeial quality control and pharmaceutical chemistry of aromatic amino acid derivatives related to medicinal products for local anesthesia

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding with the target, quality control and representatives of medicines for local anesthesia: benzocaine, procaine hydrochloride, tetracaine hydrochloride, lidocaine hydrochloride

monohydrate, bupivacaine hydrochloride, articaine hydrochloride, oxybuprocaine hydrochloride, proximetacaine hydrochloride. Local anesthetics as derivatives of aromatic amino acids. Local irritants: capsaicin, etc.

3.14. Quality control of pharmaceutically manufactured (extemporaneous medicines) and industrially produced medicines

Features of pharmaceutically manufactured medicines (extemporaneous medicines) quality control. Legal acts regulating the quality control of pharmaceutical medicines. In-pharmacy quality control of medicinal products and its types. Monographs of the SPh RB «Express analysis of extemporaneous medicines» Differences between express analysis and pharmacopoeial quality control. Express analysis methods. Quality control of powders, solutions, ointments, suppositories and other pharmaceutical dosage forms. Assessment of extemporaneous medicines quality.

Sampling and sample preparation in the analysis of various dosage forms. Criteria for selecting methods of identification and quantification of industrially produced medicines. Pharmaco-technological tests. Approaches to quality control of various dosage forms of industrial production. Features of multicomponent medicines analysis. Quality control of excipients in dosage forms (preservatives, etc.). Methods used in the analysis of industrially produced dosage forms.

4. Pharmaceutical chemistry of the main pharmacotherapeutic groups of medicines

4.1. Determination of medicines and their metabolites in biological objects

Features of biopharmaceutical analysis. Objects and main stages of biopharmaceutical analysis. The complexity of sample preparation for the analysis of biological objects. Separation and concentration methods used in biopharmaceutical analysis. Application of chromatographic, spectrometric, protein-binding and other methods for the determination of medicines and their metabolites in biological objects.

Pharmacokinetics studies of medicines. Main pharmacokinetic parameters of medicines: bioavailability, volume of distribution, clearance, elimination rate constant, half-life, etc. Link between the main pharmacokinetic parameters and structure of medicines and their physicochemical properties (lipophilicity, acidity/basicity, etc.). The main mechanisms of drug absorption depending on their chemical structure.

Metabolism of medicines. The main phases of drug metabolism: non-synthetic (oxidation, reduction and hydrolysis reactions) and synthetic (conjugation reactions). Changes in lipophilicity, pharmacological activity and toxicity of medicines during metabolism. Chemical reactions of first-pass metabolism.

Bioequivalence studies of generic medicines. Concept of therapeutic, pharmaceutical and biological equivalence of medicines. Main stages of bioequivalence studies of generic medicines. Features of the analytical stage of bioequivalence studies.

Relationship between concentration of a drug in biological fluids and its effect. Pharmacokinetic curve. Therapeutic drug monitoring.

4.2. Modern methodology of original medicines creation

The main stages of creating an original medicinal product. Development of a new pharmacologically active chemical compound chemical structure. Concept of a leader connection and the requirements for it. The main strategies for searching of lead

compound: random discoveries, study of natural compounds, study of biochemical processes in the body, study of medicines side effects, «classical» screening, combinatorial synthesis and «total» screening, computer modeling, molecular docking. Modern approaches in search for a leader compound (peptidomimetics, creation of clones (me-too), gene technologies, ex homine, etc.). Lead compound optimization: QSAR (quantitative correlation of activity with structure or property descriptors), bioisosterism. Work in graphic editors such as ChemDraw. Computer programs used for molecular docking and drug design (DokingServer, AUTODOC, TEST, PASS, etc.). Neural networks and artificial intelligence in drug development. Quantum mechanical molecules calculations. Schrödinger platform. Methods of improving pharmacokinetic and pharmaceutical properties of medicines. Promedicines, dual medicines and soft medicines. Stereochemical aspects of medicines action. New dosage forms. Targeted delivery of active ingredients. Medicines for gene and cell therapy. Concept of personalized medicines. 3D printing technologies.

4.3. Pharmaceutical chemistry of medicines for anesthesia and sleeping pills

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of medicines for anesthesia: nitrous oxide, halothane, isoflurane, sevoflurane, propofol, ketamine hydrochloride, esketamine hydrochloride, sodium thiopental, sodium hydroxybutyrate and hypnotics: nitrazepam, midazolam, zopiclone, zolpidem tartrate, doxylamine hydrosuccinate, melatonin.

4.4. Pharmaceutical chemistry of anticonvulsant and antiparkinsonian medicines

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of anticonvulsants: sodium phenobarbital and its promedicines (benzobarbital, primidone), phenytoin, valproic acid and sodium valproate, clonazepam, carbamazepine, gabapentin, pregabalin, lamotrigine, levetiracetam, topiramate and antiparkinsonian medicines: levodopa, carbidopa, entacapone, amantadine hydrochloride, bromocriptine mesylate, pramipexole dihydrochloride monohydrate, trihexyphenidyl hydrochloride. Medicines used for Alzheimer's disease: memantine hydrochloride. Agents to suppress lactation: cabergoline.

4.5. Pharmaceutical chemistry of neuroleptics and anxiolytics

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of antipsychotics: chlorpromazine hydrochloride, trifluoperazine dihydrochloride, fluphenazine decanoate, fluphenazine enanthate, fluphenazine dihydrochloride, flupenthixol dihydrochloride, zuclopenthixol decanoate, haloperidol, haloperidol decanoate, droperidol, clozapine, quetiapine fumarate, olanzapine, chlorprothixene hydrochloride, sulpiride, amisulpride, risperidone, aripiprazole, cariprazine hydrochloride; prokinetics - dopamine receptor antagonists (metoclopramide hydrochloride monohydrate, domperidone, itopride hydrochloride) and anxiolytics: chlordiazepoxide, diazepam,

oxazepam, tofisopam, alprazolam, buspirone hydrochloride, fabomotizole dihydrochloride.

4.6. Pharmaceutical chemistry of antidepressants, psychostimulants and nootropic medicines

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of antidepressants: amitriptyline hydrochloride, clomipramine, venlafaxine hydrochloride, duloxetine hydrochloride, maprotiline hydrochloride, paroxetine hydrochloride, sertraline hydrochloride, fluvoxamine maleate, fluoxetine hydrochloride, citalopram hydrochloride, escitalopram, escitalopram oxalate, vortioxetine hydrobromide, mirtazapine, vortioxetine; psychostimulants: mebicar and nootropic medicines: piracetam, γ -aminobutyric acid (aminalone) and its derivatives (phenibut, hopantenic acid), citicoline sodium, ethylmethylhydroxypyridine succinate. The concept of antioxidants and antihypoxants (thioctic acid).

4.7. Pharmaceutical chemistry of narcotic analgesics, opioid receptor agonists and antagonists

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of narcotic analgesics: morphine hydrochloride (sulfate), hydromorphone hydrochloride, oxycodone hydrochloride, buprenorphine hydrochloride, butorphanol tartrate, tramadol hydrochloride, methadone hydrochloride; opioid receptor antagonists: naloxone hydrochloride dihydrate and peripheral opioid receptor agonists: loperamide hydrochloride, trimebutine maleate.

4.8. Pharmaceutical chemistry of non-steroidal anti-inflammatory medicines (NSAIDs), prostaglandins and their derivatives

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of NSAIDs: acetylsalicylic acid, mesalazine, diclofenac sodium, aceclofenac, etodolac, indomethacin, ketorolac trometamine, nepafenac, ibuprofen, flurbiprofen, ketoprofen, dexketoprofen trometamol, naproxen, nimesulide, oxicams (piroxicam, meloxicam, lornoxicam, tenoxicam), coxibs (celecoxib, etoricoxib) and topical NSAIDs (benzydamine hydrochloride).

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of prostaglandins and their derivatives: alprostadil, misoprostol, dinoprost, dinoprost trometamol, latanoprost, travoprost, tafluprost.

4.9. Pharmaceutical chemistry of cholinergic medicines and muscle relaxants

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding

(impact) with the target, quality control and representatives of M-cholinergic receptor agonists and acetylcholinesterase inhibitors: pilocarpine hydrochloride, neostigmine methyl sulfate, pyridostigmine bromide, donepezil hydrochloride, ipidacrine hydrochloride monohydrate; M-cholinergic receptor antagonists: atropine sulfate, ipratropium bromide, tiotropium bromide monohydrate, tropicamide, oxybutynin hydrochloride, otilonium bromide, solifenacin succinate, dimenhydrinate; ganglion blockers and muscle relaxants: hexamethonium benzene sulfate, suxamethonium chloride, atracurium besylate, rocuronium bromide.

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of M, N-cholinomimetics: choline alfoscerate and muscle relaxants: tolperisone hydrochloride, baclofen, thiocolchicoside monohydrate, mebeverine hydrochloride, alverine citrate.

4.10. Pharmaceutical chemistry of adrenergic medicines (adrenergic agonists and sympathomimetics)

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of adrenoreceptor agonists and sympathomimetics: epinephrine hydrotartrate (adrenaline hydrotartrate), phenylephrine hydrochloride, naphazoline nitrate, tetraizoline hydrochloride, xylometazoline hydrochloride, oxymetazoline hydrochloride, clonidine hydrochloride, tizanidine hydrochloride, brimonidine tartrate and imidazoline receptor agonist (moxonidine), methyl dopa, dopamine hydrochloride, dobutamine hydrochloride, salbutamol sulfate, salmeterol xinafoate, fenoterol hydrobromide, formoterol fumarate dihydrate, olodaterol hydrochloride, mirabegron, ephedrine hydrochloride

4.11. Pharmaceutical chemistry of adrenergic medicines (adrenergic receptor antagonists and sympatholytics)

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of adrenoreceptor antagonists and sympatholytics: prazosin hydrochloride, tamsulosin hydrochloride, doxazosin mesylate, terazosin hydrochloride dihydrate, silodosin, derivatives of ergoalkaloids (dihydroergocristine mesylate, nicergoline), propranolol hydrochloride, sotalol hydrochloride, timolol maleate, atenolol, metoprolol tartrate, bisoprolol fumarate, betaxolol hydrochloride, nebivolol hydrochloride, carvedilol, reserpine.

4.12. Pharmaceutical chemistry of H₁-histamine receptor antagonists, mast cell membrane stabilizers and leukotriene receptor antagonists

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of mast cell membrane stabilizers: sodium cromoglycate; H₁ receptor antagonists: diphenhydramine hydrochloride, clemastine fumarate, chlorpyramine hydrochloride, mebhydroline, promethazine hydrochloride, cetirizine dihydrochloride, levocetirizine dihydrochloride, pheniramine maleate, chlorphenamine maleate, ketotifen hydrofumarate, loratadine, desloratadine, olapatadine hydrochloride, ebastine,

azelastine hydrochloride, bilastine, dimethindene maleate, hifenadine hydrochloride, sehifenadine hydrochloride; H₁-agonists and H₃-histamine receptor antagonists: betahistine dihydrochloride, betahistine mesylate; histamine mimetics: histamine dihydrochloride and leukotriene receptor antagonists: montelukast sodium.

4.13. Pharmaceutical chemistry of histamine H₂ receptor antagonists, proton pump inhibitors and serotonergic medicines

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of H₂-histamine receptor antagonists: ranitidine hydrochloride, famotidine and proton pump inhibitors: omeprazole magnesium, esomeprazole magnesium di- and trihydrate, lansoprazole, pantoprazole sodium sesquihydrate, rabeprazole sodium.

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of triptans (sumatriptan succinate, zolmitriptan, rizatriptan benzoate, etc.), setrons (odnansetron hydrochloride dihydrate, tropisetron hydrochloride, granisetron hydrochloride, etc.), ergot alkaloids and their derivatives (methylergometrine maleate, ergotamine tartrate).

4.14. Pharmaceutical chemistry of phosphodiesterase inhibitors, antitussive, expectorant and mucolytic medicines

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of phosphodiesterase inhibitors: cilostazol, dipyridamole, vinpocetine, sildenafil citrate, tadalafil.

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of antitussive medicines: codeine monohydrate and its phosphate hemihydrate, dextromethorphan hydrobromide, butamirate citrate, prenoxidiazine hydrochloride, glaucine hydrobromide; expectorant and mucolytic medicines: guaifenesin, bromhexine hydrochloride, ambroxol hydrochloride, acetylcysteine, carbocysteine.

4.15. Pharmaceutical chemistry of medicines for treatment of heart diseases and antiarrhythmic medicines

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (effect) with the target, quality control and representatives of cardiac glycosides: digoxin, strophanthin-G; nitrates: glyceryl trinitrate, isosorbide mononitrate and dinitrate and other medicines for the treatment of heart diseases: trimetazidine dihydrochloride, ivabradine hydrochloride, molsidomine, meldonium dihydrate.

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of antiarrhythmic medicines: procainamide hydrochloride, propafenone hydrochloride, etacizine hydrochloride, amiodarone hydrochloride.

4.16. Pharmaceutical chemistry of calcium channel blockers and angiotensin-converting enzyme inhibitors

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of calcium channel blockers: nifedipine, amlodipine besylate, nimodipine, lercanidipine hydrochloride, verapamil hydrochloride, diltiazem hydrochloride, cinnarizine.

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of angiotensin-converting enzyme inhibitors: captopril, enalapril maleate, lisinopril dihydrate, perindopril tert-butylamine, ramipril.

4.17. Pharmaceutical chemistry of angiotensin receptor antagonists and diuretics

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of angiotensin receptor antagonists: losartan potassium, valsartan, neprilysin inhibitor (sacubitril), candesartan cilexetil, telmisartan, irbesartan, olmesartan medoxomil, azilsartan medoxomil.

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of diuretics: furosemide, torasemide, indapamide, chlorthalidone, hydrochlorothiazide, spironolactone, eplerenone, acetazolamide and antiglaucoma medicines: brinzolamide, dorzolamide hydrochloride.

4.18. Pharmaceutical chemistry of lipid-lowering medicines and medicines affecting the blood system

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of statins: atorvastatin calcium trihydrate, rosuvastatin calcium, pitavastatin calcium and other lipid-lowering medicines: orlistat, fibrates (fenofibrate), ezetimibe.

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of anticoagulants, antiplatelet agents: warfarin sodium, phenindione, clopidogrel hydrosulfate, hydrochloride, besilate, ticagrelor, apixaban, rivaroxaban and hemostatic agents: tranexamic acid, etamsylate, etc.

4.19. Pharmaceutical chemistry of medicines for the treatment of thyroid diseases and oral hypoglycemic medicines

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of medicines with the activity of thyroid hormones: levothyroxine sodium, liothyronine sodium and antithyroid medicines: propylthiouracil, thiamazole.

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of oral hypoglycemic medicines: glibenclamide, gliquidone, gliclazide, glipizide, metformin hydrochloride, repaglinide, sitagliptin phosphate monohydrate, vildagliptin, linagliptin, empagliflozin, dapagliflozin propanediol monohydrate.

4.20. Pharmaceutical chemistry of corticosteroids

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of mineralocorticoids: deoxycortone acetate, fludrocortisone acetate and glucocorticoids of systemic, topical and local action: hydrocortisone, hydrocortisone acetate, hydrocortisone hydrosuccinate, prednisolone, prednisolone acetate, prednisolone sodium phosphate, prednisolone pivalate, methylprednisolone, methylprednisolone acetate, methylprednisolone hydrosuccinate, betamethasone, betamethasone valerate, betamethasone dipropionate, betamethasone acetate, betamethasone sodium phosphate, dexamethasone, dexamethasone sodium phosphate, dexamethasone acetate, dexamethasone isonicotinate, triamcinolone, triamcinolone acetonide, triamcinolone hexacetonide, fluocinolone acetonide, beclomethasone dipropionate, clobetasol propionate, fluticasone furoate, fluticasone propionate, mometasone furoate, budesonide, enoxolone.

4.21. Pharmaceutical chemistry of gestagens androgens and estrogens

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of gestagens and progestins: progesterone, medroxyprogesterone acetate, dydrogesterone, norethisterone, norethisterone acetate, levonorgestrel, linestrenol, dienogest, gestodene, desogestrel, drospirenone, norgestrel acetate, chlormadinone acetate and progesterone antagonists: mifepristone, ulipristal acetate.

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of androgens and anabolic steroids: testosterone, testosterone decanoate, testosterone enanthate, methyltestosterone, methandienone, nandrolone decanoate. Steroid and non-steroidal anabolic agents.

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of estrogens: estrone, estradiol hemihydrate, estradiol valerate, estradiol benzoate, estriol, ethinyl estradiol, non-steroidal synthetic analogues of estrogens.

4.22. General characteristics of antibiotics. Pharmaceutical chemistry of beta-lactam antibiotics

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (effect) with the target, quality control and representatives of penicillins (penams).

Natural penicillins: benzylpenicillin salts (benzathine, potassium, sodium, procaine); phenoxymethylpenicillin, benzathine phenoxymethylpenicillin, potassium phenoxymethylpenicillin. Semi-synthetic penicillins: oxacillin sodium monohydrate, ampicillin, ampicillin trihydrate and ampicillin sodium, amoxicillin trihydrate, piperacillin, piperacillin sodium.

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of cephalosporins (cephema): cefazolin sodium, cephalexin monohydrate, cefoperazone sodium, cefotaxime sodium, cefuroxime sodium, cefuroxime axetil, ceftriaxone sodium, ceftazidime pentahydrate, cefpodoxime proxetil, cefdinir, cefprozil monohydrate, cefepime dihydrochloride monohydrate.

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of monobactams: aztreonam; beta-lactamase inhibitors: sulbactam sodium, tazobactam sodium, potassium clavulanate and carbapenems: imipenem monohydrate, meropenem trihydrate, doripenem monohydrate, dehydropeptidase inhibitor (cilastatin).

4.23. Pharmaceutical chemistry of the antibiotics main groups

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of aminoglycosides: streptomycin sulfate, gentamicin sulfate, tobramycin, amikacin sulfate, neomycin sulfate, framycetin sulfate; macrolides, azalides: erythromycin and its esters (estolate, ethyl succinate, lactobionate, stearate), clarithromycin, azithromycin, spiramycin, josamycin propionate; lincosamides: lincomycin hydrochloride, clindamycin hydrochloride and phosphate; tetracyclines: tetracycline, doxycycline hyclate and antibiotics of other groups: glycopeptides (vancomycin hydrochloride), bacitracin.

4.24. Pharmaceutical chemistry of synthetic antibacterial and anthelmintic medicines

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of fluoroquinolones: ciprofloxacin hydrochloride, pefloxacin mesylate, norfloxacin, ofloxacin, levofloxacin, lomefloxacin hydrochloride, moxifloxacin hydrochloride ; 8-hydroxyquinoline derivatives: nitroxoline, chloroquinaldol; oxazolidinones: linezolid and topical antiseptic medicines (benzoxonium chloride, gramicidin C, cetylpyridinium chloride, biclotymol, chlorhexidine diacetate and digluconate, etc.). New mechanisms of antibacterial medicines action.

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of anthelmintic medicines: albendazole, mebendazole, piperazine adipate, pyrantel embonate, levamisole hydrochloride.

4.25. Pharmaceutical chemistry of antiviral and antifungal medicines

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of antiviral medicines: antiherpetic medicines - guanine derivatives (acyclovir, ganciclovir, penciclovir and their promedicines), butaminophen, inosine pranobex, antiretroviral medicines - zidovudine, lamivudine, tenofovir disoproxil fumarate, nevirapine, ritonavir, saquinavir mesylate, anti-influenza medicines - oseltamivir phosphate, rimantadine hydrochloride, umifenovir hydrochloride and extended-spectrum antiviral medicines - ribavirin.

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of antifungal medicines: clotrimazole, miconazole nitrate, butoconazole nitrate, sertaconazole nitrate, isoconazole nitrate, bifonazole, ketoconazole, fluconazole, voriconazole, itraconazole, terbinafine hydrochloride, amorolfine, ciclopirox, micafungin sodium, griseofulvin, polyene antibiotics.

4.26. Pharmaceutical chemistry of antitubercular and antimalarial medicines

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of antitubercular medicines: isoniazid, prothionamide, pyrazinamide, ethambutol hydrochloride, rifampicin, sodium aminosalicylate dihydrate, bedaquiline fumarate, pretomanid. Combinations of antitubercular medicines. New targets for antitubercular medicines action.

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of antimalarial medicines: quinine salts, chloroquine phosphate and sulfate, hydroxychloroquine sulfate, mefloquine hydrochloride, primaquine diphosphate, pyrimethamine, proguanil hydrochloride, artemisinin and its derivatives. Combinations of antimalarial medicines.

4.27. Pharmaceutical chemistry of antitumor, antigout and immunosuppressive medicines

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of antitumor medicines. Alkylating antitumor medicines: melphalan, cyclophosphamide, temozolomide, bendamustine, platinum complexes (cisplatin, carboplatin, oxaliplatin). Antimetabolites: fluorouracil and its promedicines (tegafur, capecitabine hydrochloride), methotrexate, fludarabine phosphate, mercaptopurine. Medicines obtained by modifying the structure of mercaptopurine. Protein kinase inhibitors: imatinib mesylate, nilotinib hydrochloride monohydrate, sunitinib maleate, etc. Natural compounds and their derivatives, antitumor antibiotics: taxanes (paclitaxel, docetaxel trihydrate), vinblastine sulfate, irinotecan hydrochloride trihydrate,

etoposide, doxorubicin hydrochloride, epirubicin hydrochloride, bleomycin sulfate. Hormone antagonists: flutamide, cyproterone acetate, tamoxifen citrate, fulvestrant, anastrozole, letrozole, finasteride, dutasteride. Other anticancer medicines: bortezomib, brentuximab vedotin. New targets for antitumor medicines action.

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of antigout medicines: allopurinol, febuxostat and immunosuppressants: azathioprine, cyclosporine, mycophenolate mofetil.

4.28. Pharmaceutical chemistry of contrast and radiopharmaceutical medicines, sorbents

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of contrast medicines. Iodine-containing radiopaque medicines: amidotrizoic acid and its salts, iohexol. Magnetic resonance contrast medicines: gadopentetate dimeglumine, gadodiamide hydrate. Contrast medicines for ultrasound examination: galactose.

Characteristics, classification, chemical structure, properties, relationship between structure and action, chemical basis of the mechanism of action and binding (impact) with the target, quality control and representatives of radiopharmaceuticals. Diagnostic radiopharmaceuticals (compounds of ^{99m}Tc , etc.). Therapeutic radiopharmaceuticals (compounds of ^{89}Sr , ^{131}I , ^{32}P , etc.).

Sorbents as medicines. Chemical nature of carbon (activated carbon) and non-carbon (diosmectite, etc.) sorbents. Determination of sorption characteristics.

COURSEWORK REQUIREMENTS

The purpose of writing coursework is to deepen and expand theoretical knowledge and practical skills; mastering techniques of working with scientific literature, logically consistent presentation and material structuring; ability to draw conclusions and document the results in the form of coursework text, presentation and oral defense, as well as mastering the skills of public defense by answering questions and arguing one's point of view.

The volume of course work does not exceed 30-40 pages. The work must be holistic and complete. It is recommended to use computer programs for drag design, reference books of medicinal substances physical and chemical constants, etc., when writing a course work. The structure of the work, as a rule, includes: title page, table of contents, list of abbreviations and symbols, introduction (where the purpose and objectives of the course work are formulated, its relevance is substantiated), the main part, which may contain structural parts and reveals the essence of the course work, a conclusion with specific conclusions, a list of references and applications. 40 hours are allotted to complete the course work.

EDUCATIONAL DISCIPLINE «PHARMACEUTICAL CHEMISTRY» CURRICULAR CHART

Section, topic #	Title of section, topic	Number of class hours		Supervised student independent work	Literature	Practical skill	Forms of control	
		lectures	laboratory				of practical skill	of current / intermediate certification
5th semester								
	Lectures	15	-	3				
1.	General issues of pharmaceutical chemistry	4,5	-	-				
1.1.	Introduction to the academic discipline «Pharmaceutical Chemistry». Methods and sources of obtaining medicines	1,5	-	-	1, 4			
1.2.	Ensuring the quality of pharmaceutical substances and medicines. General characteristics of pharmaceutical analysis. Pharmacopoeial analysis	1,5	-	-	1, 4			
1.3.	Stability, shelf life and modern approaches to degradation, neutralization and disposal of medicines	1,5	-	-	1, 4			
2.	Pharmaceutical analysis	9	-	3	-			
2.1.	Reagents used in pharmacopoeial analysis. Properties of pharmaceutical substances	1,5	-	-	1, 4			
2.3.	Spectrometric and thermal methods used in pharmaceutical analysis	-	-	1,5	1, 4			Electronic test, control work, survey
2.4.	Chromatographic and biological methods used in pharmaceutical analysis	-	-	1,5	1, 4			Electronic test, control work, survey

2.6.	Methods for identifying organic ions and functional groups used in pharmacopoeial analysis. Instrumental identification methods	1,5	-	-	1, 4			
2.7.	Pharmacopoeial tests of pharmaceutical substances	1,5	-	-	1, 4			
2.8.	Pharmacopoeial tests of pharmaceutical substances and electrochemical methods used in pharmaceutical analysis	1,5	-	-	1, 4			
2.9.	Impurities in pharmaceutical substances	1,5	-	-	1, 4			
2.10.	Statistical processing of chemical experiment results, validation of methods and the principle of choosing a quantitative determination method. Pharmacopoeial water quality control	1,5	-	-	1, 4			
3.	Pharmacopoeial quality control of the medicines main groups classified by chemical structure	1,5			-			
3.1.	Pharmacopoeial analysis of pharmaceutical substances of inorganic nature: s-elements	1,5	-	-	1, 4			
	Laboratory lessons	-	68	-	-			
1.	General issues of pharmaceutical chemistry		12					
1.1.	Introduction to the academic discipline «Pharmaceutical Chemistry». Methods and sources of obtaining medicines	-	4	-	1-4			Survey, electronic test
1.2.	Ensuring the quality of pharmaceutical substances and medicines. General characteristics of pharmaceutical analysis. Pharmacopoeial analysis	-	4	-	1-4			Survey, electronic test
1.3.	Stability, shelf life and modern approaches to degradation, neutralization and disposal of medicines	-	4	-	1-4			Survey, electronic test
2.	Pharmaceutical analysis		48					
2.1.	Reagents used in pharmacopoeial analysis. Properties of pharmaceutical substances. L.w. «Preparation of reagent solutions for pharmacopoeial analysis. Quality control of a	-	4	-	1-4	Preparation of reagent solutions: ammonium chloride solution, potassium dichromate solution, potassium ferricyanide solution,	Lab report,	Survey, electronic test

	pharmaceutical substance according to the section «Description»					potassium <i>permanganate</i> solution, potassium <i>thiocyanate</i> solution. Quality control of pharmaceutical substances sodium chloride, corn starch, potassium permanganate, glycine, iodine, riboflavin, sulfonamide, etc. according to the section «Description»		
2.2.	Titrimetric methods used in pharmaceutical analysis. Gravimetry. L.w. «Quality control of potassium iodide and benzoic acids according to the indicator «Quantitative determination», sodium benzoate according to the section «Weight loss on drying»	-	4	-	1-4	Alkalimetric titration of benzoic acid Determination of weight loss during drying of sodium benzoate. Calculation of titrimetric determination results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation	Lab report,	Survey, electronic test
2.3.	Spectrometric and thermal methods used in pharmaceutical analysis. L.w. «Spectrophotometric determination of chloramphenicol in capsules, metformin hydrochloride in tablets and quality control of magnesium sulfate solution according to the section «Quantitative determination»	-	4	-	1-4	Spectrophotometric determination of chloramphenicol in capsules, metformin hydrochloride tablets. Refractometric determination of magnesium sulfate 5% solution. Calculation of spectrophotometric, polarimetric and refractometric determination results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation	Lab report,	Survey, electronic test
2.4.	Chromatographic and biological methods used in pharmaceutical analysis. L.w. «Quality control of rutoside trihydrate according to the section «Identification»: TLC, HPLC of rutascorbine (ascorutin)»	-	4	-	1-4	Identification of rutoside trihydrate using thin layer chromatography. HPLC analysis of routine	Lab report,	Survey, electronic test

	Final lesson on the topics «General issues of pharmaceutical chemistry and methods used in pharmaceutical analysis»	-	4	-	1-4			Colloquium*
2.5.	Methods for identifying inorganic cations and anions used in pharmacopoeial analysis. L.w. «Pharmacopoeial identification of inorganic cations and anions using chemical reactions»	-	4	-	1-4	Identification of inorganic cations and anions using chemical reactions	Lab report,	Survey, electronic test
2.6.	Methods for identifying organic ions and functional groups used in pharmacopoeial analysis. Instrumental identification methods. L.w. «Pharmacopoeial identification of organic ions and functional groups using chemical reactions and organic substances using instrumental methods»	-	4	-	1-4	Identification of organic cations and anions using chemical reactions. Spectrophotometric determination of atenolol. Polarimetric determination of levomenthol. Calculation of spectrophotometric and polarimetric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation	Lab report,	Survey, electronic test
2.7.	Pharmacopoeial tests of pharmaceutical substances. L.w. «Determination of the melting point of salicylic acid. Determination of the relative density of sulfuric acid. Determination of chondroitin solution for injections dynamic viscosity by means of the capillary viscometry method. Quality control of ethyl alcohol 96% according to the «Test» section: determination of relative density»	-	4	-	1-4	Determination of salicylic acid melting point. Determination of sulfuric acid and ethyl alcohol 96% relative density. Determination of chondroitin sulfate solution for injection viscosity by means of capillary viscometry	Lab report,	Survey, electronic test
2.8.	Pharmacopoeial tests of pharmaceutical substances and electrochemical methods used in pharmaceutical analysis.	-	4	-	1-4	Determination of transparency and degree of turbidity of glycine, hydrated aluminum oxide, etc solutions.	Lab report,	Survey, electronic test

	L.w. «Determination of turbidity degree, transparency and color of solutions. Quality control of disodium edetate according to the section «Tests»: pH					Determination of the color of sodium benzoate, resorcinol, drotaverine hydrochloride, sodium sulfacetamide, etc. solutions. Determination of disodium edetate solution pH		
2.9.	Impurities in pharmaceutical substances. L.w. «Tests for maximum impurity content»	-	4	-	1-4	Tests for the maximum impurities content in pharmaceutical substances sodium bicarbonate, sodium chloride	Lab report,	Survey, electronic test
	Final lesson «Methods of pharmacopoeial analysis»	-	4	-	1-4			Colloquium*, control work
2.10.	Statistical processing of chemical experiment results, validation of methods and the principle of choosing a quantitative determination method. Pharmacopoeial water quality control. L.w. «Pharmacopoeial quality control of purified water in containers»	-	4	-	1-4	Statistical processing of quantification results. Tests for the maximum impurities content in purified water. Determination of purified water electrical conductivity. Determination of purified water acidity or alkalinity	Lab report,	Survey, electronic test
3.	Pharmacopoeial quality control of the medicines main groups classified by chemical structure	-	8	-				
3.1.	Pharmacopoeial analysis of pharmaceutical substances of inorganic nature: s-elements. L.w. «Quality control of pharmaceutical substances magnesium sulfate heptahydrate and calcium chloride dihydrate»	-	4	-	1-4	Identification of magnesium sulfate heptahydrate, calcium chloride dihydrate using chemical reactions. Complexometric titration of magnesium sulfate heptahydrate. Determination of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by storage conditions.	Lab report, situational problems solving, express survey	Survey, electronic test

						Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation		
	Final lesson «General approaches to pharmacopoeial analysis»	-	4	-	1-4	Alkalimetric titration of benzoic acid. Spectrophotometric determination of chloramphenicol in capsules. Refractometric determination of magnesium sulfate 5% solution. Determination of the melting point of salicylic acid. Calculation of the results of spectrophotometric, polarimetric and refractometric determination, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation	Lab report*	Credit
	Total hours	15	68	3				
6th semester								
	Lectures	15	-	3				
3.	Pharmacopoeial quality control of the medicines main groups classified by chemical structure	15	-	3	-			
3.2.	Pharmacopoeial analysis of pharmaceutical substances of inorganic nature: p-elements	-	-	1,5	1, 4			Electronic test, control work
3.3.	Pharmacopoeial analysis of pharmaceutical substances of inorganic nature: d-elements	1,5	-	-	1, 4			

3.4.	Pharmacopoeial quality control of pharmaceutical substances of aliphatic nature: alkanes, alcohols, ethers, aldehydes, sulfoxides	1,5	-	-	1, 4			
3.6.	Pharmacopoeial quality control of pharmaceutical substances of aliphatic nature: carboxylic acids, amino acids	1,5	-	-	1, 4			
3.7.	Pharmacopoeial quality control of pharmaceutical substances of aromatic nature: phenols, aromatic acids	1,5	-	-	1, 4			
3.8.	Pharmacopoeial quality control of pharmaceutical substances of aromatic nature: phenylalkylamines, sulfanilic acid	1,5	-	-	1, 4			
3.9.	Pharmacopoeial quality control of pharmaceutical substances of heterocyclic nature: derivatives of furan, nitrofur and nitroimidazole	1,5	-	-	1, 4			
3.10.	Pharmacopoeial quality control of pharmaceutical substances of heterocyclic nature: derivatives of benzopyran, pyrazole, benzimidazole, pyridine	1,5	-	-	1, 4			
3.11.	Pharmacopoeial quality control of pharmaceutical substances of heterocyclic nature: derivatives of isoquinoline, purine, pteridine, isoalloxazine, pyrimidothiazole, corrin	1,5	-	-	1, 4			
3.12.	Pharmacopoeial quality control and pharmaceutical chemistry of derivatives of terpenoids, chromone, seco derivatives of ergosterol and naphthoquinone, related to fat-soluble vitamins and their derivatives	1,5	-	-	1, 4			
3.13.	Pharmacopoeial quality control and pharmaceutical chemistry of aromatic amino acid derivatives related to medicinal products for local anesthesia	1,5	-	-	1, 4			

3.14.	Quality control of pharmaceutically manufactured (extemporaneous medicines) and industrially produced medicines	-	-	1,5	1, 4			Electronic test, control work
	Laboratory lessons							
3.	Pharmacopoeial quality control of the medicines main groups classified by chemical structure	-	68	-	-			
3.2.	Pharmacopoeial analysis of pharmaceutical substances of inorganic nature: p-elements: solutions of hydrogen peroxide, iodine, povidone-iodine, sodium and potassium chlorides, sodium and potassium bromides, sodium and potassium iodides. L.w. «Quality control of pharmaceutical substances potassium chloride, bromide and iodide»	-	4	-	1-4	Identification of potassium chloride, potassium iodide, potassium bromide using chemical reactions. Argentometric titration of potassium chloride, potassium iodide. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by storage conditions. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation	Lab report, situational problems solving, express survey	Survey, electronic test
	Pharmacopoeial analysis of pharmaceutical substances of inorganic nature: p-elements: basic heavy bismuth nitrate, sodium bicarbonate, sodium thiosulfate, boric acid, sodium tetraborate, hydrated aluminum oxide, hydrated aluminum phosphate, aluminum chloride, sulfur for external use.	-	4	-	1-4	Alkalimetric titration of boric acid. Identification of sodium bicarbonate using chemical reactions. Acidimetric titration of sodium bicarbonate. Identification of medicines by structural formulas, assigning them to	Lab report, situational problems solving, express survey	Survey, electronic test

	L.w. «Quantitative determination of the pharmaceutical substance boric acid and sodium bicarbonate»					certain pharmacotherapeutic and chemical groups by storage conditions. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation		
3.3.	Pharmacopoeial analysis of pharmaceutical substances of inorganic nature: d-elements. L.w. «Quality control of pharmaceutical substances copper sulfate pentahydrate and zinc sulfate heptahydrate»	-	4	-	1-4	Identification of copper sulfate pentahydrate, zinc sulfate heptahydrate using chemical reactions. Iodometric titration of copper sulfate pentahydrate. Complexometric titration of zinc sulfate heptahydrate. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by storage conditions. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation	Lab report, situational problems solving, express survey	Survey, electronic test
3.4.	Pharmacopoeial quality control of pharmaceutical substances of aliphatic nature: alkanes, alcohols, ethers, aldehydes, sulfoxides.	-	4	-	1-4	Determination of ethyl alcohol 96% relative density. Refractometric determination of glycerol, dimethyl sulfoxide.	Lab report, situational problems	Survey, electronic test

	L.w. «Determination of ethyl alcohol content. Quality control of glycerin, ethyl alcohol, isopropyl alcohol and dimethyl sulfoxide»					Identification of glycerin and ethyl alcohol using chemical reactions. Determination of isopropyl alcohol transparency and turbidity. Determination of isopropyl alcohol color. Spectrophotometric determination of isopropyl alcohol, dimethyl sulfoxide. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by storage conditions. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation	solving, express survey	
3.5.	Pharmacopoeial quality control of pharmaceutical substances of aliphatic nature: carbohydrates, terpenoids. L.w. «Quality control of pharmaceutical substances glucose monohydrate and 5% glucose solution from pharmaceutical manufactures»	-	4	-	1-4	Polarimetric determination of glucose monohydrate. Identification of glucose monohydrate using chemical reactions. Determination of glucose monohydrate solution electrical conductivity. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by storage conditions.	Lab report, situational problems solving, express survey	Survey, electronic test

					Express analysis of pharmaceutical preparations (extemporaneous dosage forms), calculation of results, assessment of compliance with the standards of permissible deviations and a conclusion on the satisfactory preparation of the dosage form. Refractometric determination of glucose in a 5% solution		
3.6.	Pharmacopoeial quality control of pharmaceutical substances of aliphatic nature: carboxylic acids, amino acids. L.w. «Quality control of pharmaceutical substances glacial acetic acid, cysteine hydrochloride, D,L-methionine and glycine»	-	4	-	1-4 Quality control of the pharmaceutical substance glacial acetic acid according to the section «Description». Determination of glacial acetic acid transparency and degree of turbidity. Determination of glacial acetic acid color. Test for the maximum impurities content in glacial acetic acid. Alkalimetric titration of glacial acetic acid. Polarimetric determination of cysteine hydrochloride monohydrate, D, L-methionine. Iodometric titration of cysteine hydrochloride monohydrate. Identification of D, L-methionine using thin layer chromatography Determination of glycine solution pH. Identification of medicines by structural formulas, assigning them to	Lab report, situational problems solving, express survey	Survey, electronic test

						certain pharmacotherapeutic and chemical groups by storage conditions. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation		
	Final lesson «Pharmacopoeial analysis of pharmaceutical substances of inorganic and aliphatic nature»	-	4	-	1-4			Colloquium*
3.7.	Pharmacopoeial quality control of pharmaceutical substances of aromatic nature: phenols, aromatic acids. L.w. «Quality control of salicylic acid, sodium benzoate, phenol and resorcinol»	-	4	-	1-4	Determination of salicylic acid and resorcinol the melting points. Alkalimetric titration of salicylic acid. Quality control of the pharmaceutical substance sodium benzoate according to the section «Description». Identification of sodium benzoate, phenol, resorcinol using chemical reactions. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by storage conditions. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation	Lab report, situational problems solving, express survey	Survey, electronic test

3.8.	Pharmacopoeial quality control of pharmaceutical substances of aromatic nature: phenylalkylamines, sulfanilic acid. L.w. «Quality control of the pharmaceutical substance sulfonamide, sulfomethoxazole, trimethoprim and chloramphenicol»	-	4	-	1-4	Determination of sulfanilamide, sulfamethoxazole and trimethoprim the melting points. Nitritometric titration of sulfonamide. Spectrophotometric determination of trimethoprim. Identification of chloramphenicol by means of thin layer chromatography. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by storage conditions. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation	Lab report, situational problems solving, express survey	Survey, electronic test
3.9.	Pharmacopoeial quality control of pharmaceutical substances of heterocyclic nature: derivatives of furan, nitrofuran and nitroimidazole. L.w. «Quality control of pharmaceutical substance ascorbic acid, nitrofural and metronidazole tablets»	-	4	-	1-4	Spectrophotometric determination of ascorbic acid, nitrofural (identification and quantitation), metronidazole tablets. Determination of ascorbic acid solution pH. Identification of ascorbic acid, nitrofural using chemical reactions. Polarimetric determination of ascorbic acid.	Lab report, situational problems solving, express survey	Survey, electronic test

						Iodometric determination of ascorbic acid. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by storage conditions. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation		
3.10.	Pharmacopoeial quality control of pharmaceutical substances of heterocyclic nature: derivatives of benzopyran, pyrazole, benzimidazole, pyridine. L.w. «Quality control of pharmaceutical substances nicotinic acid and troxerutin»	-	4	-	1-4	Determination of nicotinic acid melting point. Alkalimetric titration of nicotinic acid. Identification of troxerutin using chemical reactions. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by storage conditions. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation	Lab report, situational problems solving, express survey	Survey, electronic test
3.11.	Pharmacopoeial quality control of pharmaceutical substances of heterocyclic	-	4	-	1-4	Acidimetric titration of theophylline-ethylenediamine.	Lab report, situational	Survey, electronic test

	nature: derivatives of isoquinoline, purine, pteridine, isoalloxazine, pyrimidothiazole, corrin. L.w. «Quality control of the pharmaceutical substance theophylline-ethylenediamine, folic acid; drotaverine hydrochloride, solution for injection of caffeine sodium benzoate, cyanocobalamin tablets»					Determination of caffeine melting point. Polarimetric determination of folic acid. Identification of drotaverine hydrochloride, caffeine sodium benzoate using chemical reactions. Spectrophotometric determination of cyanocobalamin tablets. Quality control of industrially manufactured medicines (tablets, capsules, solutions, etc.). Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by storage conditions. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation	problems solving, express survey	
3.12.	Pharmacopoeial quality control and pharmaceutical chemistry of derivatives of terpenoids, chromone, seco derivatives of ergosterol and naphthoquinone, related to fat-soluble vitamins and their derivatives L.w. «Quality control of alpha-tocopheryl acetate, menadione sodium bisulfite»	-	4	-	1-4	Quality control of the pharmaceutical substance alpha-tocopheryl acetate according to section «Description». Spectrophotometric determination of menadione sodium bisulfite solution for injection.	Lab report, situational problems solving, express survey	Survey, electronic test

						Quality control of industrially manufactured medicines (tablets, capsules, solutions, etc.). Identification of menadione sodium bisulfite using chemical reactions. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by storage conditions. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation		
3.13.	Pharmacopoeial quality control and pharmaceutical chemistry of aromatic amino acid derivatives related to medicines for local anesthesia. L.w. «Quality control of the pharmaceutical substance procaine hydrochloride»	-	4	-	1-4	Determination of procaine hydrochloride melting point. Identification of procaine hydrochloride using chemical reactions. Determination of procaine hydrochloride solution pH. Nitritometric determination of procaine hydrochloride. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by storage conditions. Calculation of spectrophotometric, titrimetric, polarimetric and	Lab report, situational problems solving, express survey	Survey, electronic test

						refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation		
	Final lesson «Pharmacopoeial analysis of pharmaceutical substances of aromatic and heterocyclic nature, vitamins, medicines for local anesthesia»	-	4	-	1-4			Colloquium*, control work
3.14.	Quality control of pharmaceutically prepared medicines (extemporaneous medicines) and industrially manufactured medicines. L.w. «Express analysis of pharmaceutical dosage forms using titrimetric and refractometric methods»	-	4	-	1-4	Express analysis of pharmaceutical preparations (extemporaneous dosage forms), calculation of results, assessment of compliance with the standards of permissible deviations and a conclusion on the satisfactory preparation of the dosage form. Quality control of industrially manufactured medicines (tablets, capsules, solutions, etc.)	Lab report, situational problems solving, express survey	Survey, electronic test
	Final lesson «Pharmacopoeial analysis of pharmaceutical substances»	-	4	-	1-4	Acidimetric titration of sodium bicarbonate. Alkalimetric titration of salicylic acid. Alkalimetric titration of benzoic acid. Alkalimetric titration of nicotinic acid. Complexometric titration of zinc sulfate heptahydrate. Determination of nicotinic acid melting point. Determination of salicylic acid melting point. Determination of procaine hydrochloride melting point. Polarimetric determination of ascorbic acid. Polarimetric determination of folic acid. Spectrophotometric determination of nitrofur (authenticity).	Lab report*	

						Spectrophotometric determination of nitrofurantoin (quantitative determination). Spectrophotometric determination of chloramphenicol in capsules. Determination of procaine hydrochloride solution pH. Refractometric determination of glucose 5% solution. Refractometric determination of magnesium sulfate 5% solution. Determination of sodium edetate solution pH. Identification of medicinal products by structural formulas, their assignment to specific pharmacotherapeutic and chemical groups with indication of storage conditions. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determination results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation		
	Total hours	15	68	3				Examination

7th semester

	Lectures							
4.	Pharmaceutical chemistry of the main pharmacotherapeutic groups of medicines	15	-	6	-			
4.3.	Pharmaceutical chemistry of medicines for anesthesia and sleeping pills	1,5	-	-	1, 4			
4.4.	Pharmaceutical chemistry of anticonvulsant and antiparkinsonian medicines	-	-	1,5	1, 4			Electronic test, control work
4.5.	Pharmaceutical chemistry of neuroleptics and anxiolytics	1,5	-	-	1, 4			
4.6.	Pharmaceutical chemistry of antidepressants, psychostimulants and nootropic medicines	-	-	1,5	1, 4			Electronic test, control work
4.7.	Pharmaceutical chemistry of narcotic analgesics, opioid receptor agonists and antagonists	1,5	-	-	1, 4			

4.8.	Pharmaceutical chemistry of non-steroidal anti-inflammatory medicines (NSAIDs), prostaglandins and their derivatives	1,5	-	-	1, 4			
4.9.	Pharmaceutical chemistry of cholinergic medicines and muscle relaxants	-	-	1,5	1, 4			Electronic test, control work
4.10.	Pharmaceutical chemistry of adrenergic medicines (adrenergic agonists and sympathomimetics, adrenergic receptor antagonists and sympatholytics)	1,5	-	-	1, 4			
4.11.	Pharmaceutical chemistry of adrenergic medicines (adrenergic agonists and sympathomimetics, adrenergic receptor antagonists and sympatholytics)	-	-	1,5	1, 4			Electronic test, control work
4.12.	Pharmaceutical chemistry of H ₁ -histamine receptor antagonists, mast cell membrane stabilizers and leukotriene receptor antagonists	1,5	-	-	1, 4			
4.13.	Pharmaceutical chemistry of histamine H ₂ receptor antagonists, proton pump inhibitors and serotonergic medicines	1,5	-	-	1, 4			
4.14.	Pharmaceutical chemistry of phosphodiesterase inhibitors, antitussive, expectorant and mucolytic medicines	1,5	-	-	1, 4			
4.15.	Pharmaceutical chemistry of medicines for the treatment of heart diseases and antiarrhythmic medicines	-	-	-	1, 4			
4.16.	Pharmaceutical chemistry of calcium channel blockers and angiotensin converting enzyme inhibitors	1,5	-	-	1, 4			
	Laboratory lessons							
4.	Pharmaceutical chemistry of the main pharmacotherapeutic groups of medicines	-	68	-				
4.1.	Determination of medicines and their metabolites in biological objects	-	4	-	1-4	Computer modeling of the interaction of a drug with a target, use of molecular docking and drag design to predict the	Lab report, situational problems	Survey, electronic test

4.2.	Modern methodology of original medicines creation					relationship between the chemical structure of a drug and its pharmacological (toxic) effect	solving, express survey	
4.3.	Pharmaceutical chemistry of medicines for anesthesia and sleeping pills. L.w. «Quality control of sodium thiopental»	-	4	-	1-4	Identification of sodium thiopental using qualitative reactions. Acidimetric titration of sodium thiopental. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by targets of action. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation	Lab report, situational problems solving, express survey	Survey, electronic test
4.4.	Pharmaceutical chemistry of anticonvulsant and antiparkinsonian medicines. L.w. «Quality control of amantadine hydrochloride and bromocriptine mesylate according to the section «Identification». Qualitative reactions to levodopa»	-	4	-	1-4	Identification of amantadine hydrochloride, bromocriptine mesylate, levodopa using qualitative reactions. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by targets of action. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation	Lab report, situational problems solving, express survey	Survey, electronic test

4.5.	Pharmaceutical chemistry of neuroleptics and anxiolytics. L.w. «Quality control of haloperidol, sulpiride and metoclopramide hydrochloride according to the section «Identification»	-	4	-	1-4	Identification of haloperidol, sulpiride and metoclopramide hydrochloride using qualitative reactions. Identification of metoclopramide hydrochloride using thin layer chromatography. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by targets of action. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation	Lab report, situational problems solving, express survey	Survey, electronic test
4.6.	Pharmaceutical chemistry of antidepressants, psychostimulants and nootropic medicines. L.w. «Quality control of amitriptyline hydrochloride»	-	4	-	1-4	Identification of amitriptyline hydrochloride using qualitative reactions. Determination of amitriptyline hydrochloride solutions transparency, color, acidity and alkalinity. Alkalimetric titration of amitriptyline hydrochloride. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by targets of action. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results,	Lab report, situational problems solving, express survey	Survey, electronic test

						their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation		
4.7.	Pharmaceutical chemistry of narcotic analgesics, agonists and antagonists of opioid receptors. L.w. «Quality control of loperamide hydrochloride. Qualitative reactions to substances of opioid structure»	-	4	-	1-4	Spectrophotometric determination of loperamide hydrochloride. Alkalimetric titration of loperamide hydrochloride. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by targets of action. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation	Lab report, situational problems solving, express survey	Survey, electronic test
	Final lesson «Creation, pharmacokinetics and pharmacodynamics, as well as pharmaceutical chemistry of medicines affecting the nervous system»	-	4	-	1-4			Colloquium*
4.8.	Pharmaceutical chemistry of non-steroidal anti-inflammatory medicines (NSAIDs), prostaglandins and their derivatives. L.w. «Quality control of ibuprofen according to the section «Identification». Quantitative determination of ibuprofen in tablets (capsules)»	-	4	-	1-4	Polarimetric determination of ibuprofen. Spectrophotometric determination of ibuprofen in tablets (capsules). Quality control of industrially manufactured medicines (tablets, capsules, solutions, etc.). Identification of medicines by structural formulas, assigning them to	Lab report, situational problems solving, express survey	Survey, electronic test

						certain pharmacotherapeutic and chemical groups by targets of action. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation		
4.9.	Pharmaceutical chemistry of cholinergic medicines and muscle relaxants. L.w. «Quality control of pyridostigmine bromide according to the section «Identification».	-	4	-	1-4	Identification of pyridostigmine hydrobromide using qualitative reactions. Spectrophotometric determination of pyridostigmine hydrobromide. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by targets of action. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation	Lab report, situational problems solving, express survey	Survey, electronic test
4.10.	Pharmaceutical chemistry of adrenergic medicines (adrenergic agonists and sympathomimetics) L.w. «Quality control of phenylephrine hydrochloride; naphazoline hydrochloride and xylometazoline hydrochloride according to the section «Identification».	-	4	-	1-4	Identification of phenylephrine hydrochloride using qualitative reactions. Polarimetric determination of phenylephrine hydrochloride.	Lab report, situational problems solving, express survey	Survey, electronic test

						Spectrophotometric determination of phenylephrine hydrochloride. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by targets of action. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation		
4.11.	Pharmaceutical chemistry of adrenergic medicines (adrenergic receptor antagonists and sympatholytics). L.w. Quality control of atenolol according to the section «Identification» and quantitative determination of timolol maleate in eye drops»	-	4	-	1-4	Determination of atenolol melting point. Identification of atenolol by means of thin layer chromatography. Polarimetric determination of atenolol. Spectrophotometric determination of timolol maleate in eye drops. Quality control of industrially manufactured medicines (tablets, capsules, solutions, etc.). Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by targets of action. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results,	Lab report, situational problems solving, express survey	Survey, electronic test

						their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation		
4.12.	Pharmaceutical chemistry of H ₁ -histamine receptor antagonists, mast cell membrane stabilizers and leukotriene receptor antagonists. L.w. «Quality control of diphenhydramine hydrochloride»	-	4	-	1-4	Quality control of diphenhydramine hydrochloride according to section «Description». Determination of diphenhydramine hydrochloride solutions transparency and color. Alkalimetric titration of diphenhydramine hydrochloride. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by targets of action. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation	Lab report, situational problems solving, express survey	Survey, electronic test
4.13.	Pharmaceutical chemistry of H ₂ -histamine receptor antagonists, proton pump inhibitors and serotonergic medicines. L.w. «Quality control of ondansetron hydrochloride according to the section «Identification» and quantitative determination of omeprazole in capsules»	-	4	-	1-4	Spectrophotometric determination of ondansetron hydrochloride, omeprazole capsules. Quality control of industrially manufactured medicines (tablets, capsules, solutions, etc.). Statistical processing of quantitative determination results.	Lab report, situational problems solving, express survey	Survey, electronic test

						Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by targets of action. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation		
	Final lesson on the topics «Pharmaceutical chemistry of medicines affecting specific receptors, NSAIDs, prostaglandins, proton pump inhibitors»	-	4	-	1-4			Colloquium*, control work
4.14.	Pharmaceutical chemistry of phosphodiesterase inhibitors, antitussive, expectorant and mucolytic medicines. L.w. «Quality control of acetylcysteine, ambroxol hydrochloride, dextromethorphan hydrobromide»	-	4	-	1-4	Identification of acetylcysteine using qualitative reactions. Determination of acetylcysteine solution and ambroxol hydrochloride pH. Iodometric titration of acetylcysteine. Polarimetric determination of dextromethorphan hydrobromide. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by targets of action. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal	Lab report, situational problems solving, express survey	Survey, electronic test

						product with the requirements of regulatory documentation		
4.15.	Pharmaceutical chemistry of medicines for the treatment of heart diseases and antiarrhythmic medicines. L.w. Quantitative determination of amiodarone in tablets and identification of trimetazidine in tablets»	-	4	-	1-4	Spectrophotometric determination of amiodarone hydrochloride, trimetazidine hydrochloride. Quality control of industrially manufactured medicines (tablets, capsules, solutions, etc.). Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by targets of action. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation	Lab report, situational problems solving, express survey	Survey, electronic test
	Final lesson «Pharmaceutical chemistry of medicines affecting the nervous system, specific receptors, NSAIDs, prostaglandins, proton pump inhibitors, phosphodiesterase inhibitors, antitussives, expectorants and mucolytics, medicines for the treatment of heart disease and antiarrhythmic medicines»	-	4	-	1-4	Spectrophotometric determination of ibuprofen, omeprazole in capsules, loperamide hydrochloride, timolol maleate in eye drops. Identification of metoclopramide hydrochloride and levodopa using qualitative reactions. Polarimetric determination of dextromethorphan, ibuprofen. Acidimetric titration of sodium thiopental. Determination of the melting point of atenolol. Alkalimetric titration of amitriptyline hydrochloride.	Lab report*	Credit

						Determination of the pH of an acetylcysteine solution. Calculation of the results of spectrophotometric, titrimetric, polarimetric determination, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation. Identification of medicinal products by structural formulas, their assignment to specific pharmacotherapeutic and chemical groups with indication of targets of action		
	Total hours	15	68	6				

8th semester

	Lectures	18	-	6				
4.	Pharmaceutical chemistry of the main pharmacotherapeutic groups of medicines	18	-	6	-			
4.17.	Pharmaceutical chemistry of angiotensin receptor antagonists and diuretics	1,5	-	-	1, 4			
4.18.	Pharmaceutical chemistry of lipid-lowering medicines and medicines affecting the blood system	1,5	-	-	1, 4			
4.19.	Pharmaceutical chemistry of medicines for the treatment of thyroid diseases and oral hypoglycemic medicines	1,5	-	-	1, 4			
4.20.	Pharmaceutical chemistry of corticosteroids	1,5	-	1,5	1, 4			Electronic test, control work
4.21.	Pharmaceutical chemistry of gestagens, androgens and estrogens	1,5	-	-	1, 4			
4.22.	General characteristics of antibiotics. Pharmaceutical chemistry of beta-lactam antibiotics	1,5	-	1,5	1, 4			Electronic test, control work

4.23.	Pharmaceutical chemistry of antibiotics main groups	1,5	-	-	1, 4			
4.24.	Pharmaceutical chemistry of synthetic antibacterial and anthelmintic medicines	1,5	-	-	1, 4			
4.25.	Pharmaceutical chemistry of antiviral and antifungal medicines	1,5	-	-	1, 4			
4.26.	Pharmaceutical chemistry of antitubercular and antimalarial medicines	1,5	-	1,5	1, 4			Electronic test, control work
4.27.	Pharmaceutical chemistry of antitumor, antigout and immunosuppressive medicines	1,5	-	1,5	1, 4			Electronic test, control work
4.28.	Pharmaceutical chemistry of contrast and radiopharmaceutical medicines, sorbents	1,5		-	1, 4			
	Laboratory lessons	-	64	-				
4.	Pharmaceutical chemistry of the main pharmacotherapeutic groups of medicines	-	64	-	-			
4.16.	Pharmaceutical chemistry of calcium channel blockers and angiotensin-converting enzyme inhibitors. L.w. «Quality control of amlodipine besylate, cinnarizine, verapamil hydrochloride»	-	4	-	1-4	Spectrophotometric determination of amlodipine besylate. Quality control of amlodipine besil according to section «Description». Polarimetric determination of amlodipine besylate. Alkalimetric titration of verapamil hydrochloride. Determination of cinnarizine melting point. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by targets of action. Calculation of spectrophotometric, titrimetric, polarimetric and	Lab report, situational problems solving, express survey	Survey, electronic test

						refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation		
4.17.	Pharmaceutical chemistry of angiotensin receptor antagonists and diuretics. L.w. «Quality control of captopril according to the indicator «Quantitative determination»	-	4	-	1-4	Iodometric titration of captopril. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by targets of action. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation	Lab report, situational problems solving, express survey	Survey, electronic test
4.18.	Pharmaceutical chemistry of lipid-lowering medicines and medicines affecting the blood system. L.w. «Quality control of furosemide and hydrochlorothiazide»	-	4	-	1-4	Spectrophotometric determination of furosemide in solution for injection, in tablets; hydrochlorothiazide. Quality control of industrially manufactured medicines (tablets, capsules, solutions, etc.). Identification of hydrochlorothiazide using qualitative reactions and thin layer chromatography. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by targets of action. Calculation of spectrophotometric,	Lab report, situational problems solving, express survey	Survey, electronic test

						titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation		
4.19.	Pharmaceutical chemistry of medicines for the treatment of thyroid diseases and oral hypoglycemic medicines. L.w. «Quality control of metformin hydrochloride and levothyroxine»	-	4	-	1-4	Spectrophotometric determination of metformin hydrochloride in tablets. Quality control of industrially manufactured medicines (tablets, capsules, solutions, etc.). Identification of metformin hydrochloride by means of thin layer chromatography. Identification of levothyroxine sodium using qualitative reactions. Determination of gliquidone melting point. Statistical processing of quantitative determination results. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by targets of action. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation	Lab report, situational problems solving, express survey	Survey, electronic test

4.20.	Pharmaceutical chemistry of corticosteroids. L.w.»Quality control of prednisolone, hydrocortisone acetate and triamcinolone acetonide»	-	4	-	1-4	Identification of prednisolone and triamcinolone acetonide by means of thin layer chromatography. Spectrophotometric determination of prednisolone. Polarimetric determination of prednisolone and triamcinolone acetonide. Quality control of triamcinolone acetonide according to section «Description». Statistical processing of quantitative determination results. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by targets of action. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation	Lab report, situational problems solving, express survey	Survey, electronic test
4.21.	Pharmaceutical chemistry of gestagens, androgens and estrogens. L.w. «Quality control of ethinyl estradiol and drospirenone»	-	4	-	1-4	Identification of ethinyl estradiol by means of thin layer chromatography. Determination of drospirenone melting point.	Lab report, situational problems solving, express survey	Survey, electronic test

						Quality control of drospirenone according to section «Description». Polarimetric determination of drospirenone. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by targets of action. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation		
	Final lesson «Pharmaceutical chemistry of medicines» affecting cardiovascular and respiratory systems, metabolism and blood, hormones»	-	4	-	1-4			Colloquium*
4.22.	General characteristics of antibiotics. Pharmaceutical chemistry of beta-lactam antibiotics. L.w. «Quantitative determination of ceftriaxone sodium»	-	4	-	1-4	Spectrophotometric determination of sodium ceftriaxone. HPLC analysis of sodium ceftriaxone. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by targets of action. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal	Lab report, situational problems solving, express survey	Survey, electronic test

						product with the requirements of regulatory documentation		
4.23.	Pharmaceutical chemistry of antibiotics main groups. L.w. «Quality control of streptomycin sulfate and doxycycline hyclate»	-	4	-	1-4	Quality control of streptomycin sulfate and doxycycline hyclate according to section «Description». Identification of streptomycin sulfate, doxycycline hyclate using qualitative reactions. Spectrophotometric determination of streptomycin sulfate. Determination of doxycycline hyclate solution pH. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by targets of action. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation	Lab report, situational problems solving, express survey	Survey, electronic test
4.24.	Pharmaceutical chemistry of synthetic antibacterial and anthelmintic medicines. L.w. «Quantitative determination of ciprofloxacin and nitroxoline in tablets»	-	4	-	1-4	Spectrophotometric determination of ciprofloxacin and nitroxoline in tablets. Quality control of industrially manufactured medicines (tablets, capsules, solutions, etc.). Identification of medicines by structural formulas, assigning them to	Lab report, situational problems solving, express survey	Survey, electronic test

						certain pharmacotherapeutic and chemical groups by targets of action. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation		
4.25.	Pharmaceutical chemistry of antiviral and antifungal medicines. L.w. «Quality control of umifenovir hydrochloride and nystatin»	-	4	-	1-4	Spectrophotometric determination of umifenovir hydrochloride. Identification of nystatin using qualitative reactions. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by targets of action. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation	Lab report, situational problems solving, express survey	Survey, electronic test
4.26.	Pharmaceutical chemistry of antitubercular and antimalarial medicines. L.w. «Quality control of rifampicin and prothionamide»	-	4	-	1-4	Quality control of rifampicin according to section «Description». Spectrophotometric determination of rifampicin, prothionamide. Identification of rifampicin, prothionamide using qualitative reactions.	Lab report, situational problems solving, express survey	Survey, electronic test

						Determination of rifampicin solution pH. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by targets of action. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation		
4.27.	Pharmaceutical chemistry of antitumor, antigout and immunosuppressive medicines. L.w. «Quality control of febuxostat according to the section «Identification».	-	4	-	1-4	Spectrophotometric determination of febuxostat. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by targets of action. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation	Lab report, situational problems solving, express survey	Survey, electronic test
	Final lesson «Pharmaceutical chemistry of chemotherapeutic medicines»	-	4	-	1-4			Colloquium*, control work
4.28.	Pharmaceutical chemistry of contrast and radiopharmaceutical medicines, sorbents	-	4	-	1-4	Statistical processing of quantitative determination results. Identification of medicines by structural formulas, assigning them to	Lab report, situational problems	Survey, electronic test

						certain pharmacotherapeutic and chemical groups by targets of action. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation	solving, express survey	
	Final lesson «Pharmaceutical chemistry of the main pharmacotherapeutic groups of medicines»	-	4	-	1-4	Acidimetric titration of sodium thiopental. Alkalimetric titration of amitriptyline hydrochloride. Iodometric titration of captopril. Determination of atenolol melting point. Determination of isoniazid melting point. Determination of cinnarizine melting point. Polarimetric determination of ibuprofen. Polarimetric determination of dextromethorphan. Spectrophotometric determination of loperamide hydrochloride. Spectrophotometric determination of ibuprofen. Spectrophotometric determination of timolol maleate eye drops. Spectrophotometric determination of sodium ceftriaxone. Spectrophotometric determination of metformin. Spectrophotometric determination of omeprazole in capsules. Determination of acetylcysteine solution pH. Determination of doxycycline hyclate solution pH.	Lab report*	

						Identification of metoclopramide hydrochloride and levodopa using qualitative reactions. Identification of medicinal products by structural formulas, their assignment to specific pharmacotherapeutic and chemical groups with indication of targets of action. Calculation of spectrophotometric, titrimetric and polarimetric determination results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation. Statistical processing of quantitative determination results		
	Total	18	64	6				
	Total hours for the academic discipline	63	268	18				Examination

*This is a mandatory form of current certification

INFORMATION AND INSTRUCTIONAL UNIT

LITERATURE

Basic:

1. Pharmaceutical chemistry: textbook / I. M. Sechenov First P-Moscow State Medical University; ed. G. V. Ramenskaya. – Moscow: Geotar-Media, 2023. – 376 p.

Additional:

2. Pharmaceutical chemistry. Analysis of the Medicinal Substances according to Functional Groups: study guide. / O.O. Tsurkan. – Kyiv: AUS Medicine Publishing, 2018. – 152 p.

3. Pharmaceutical analysis: The study guide for students of higher schools / ed. by V. A. Georgiyants. – Kharkiv: NUPh Golden Pages, 2018. – 494 p.

Electronic courseware for the educational discipline «Pharmaceutical Chemistry»:

4. <https://etest.bsmu.by/course/view.php?id=1596>;
<https://etest.bsmu.by/course/view.php?id=183>.

METHODOLOGICAL RECOMMENDATIONS FOR ORGANIZING AND PERFORMANCE INDEPENDENT WORK OF STUDENTS IN THE ACADEMIC DISCIPLINE

Time allocated for independent work can be used by students for:
preparation for lectures and laboratory classes;
preparation for colloquiums, credit and exam;
problem solving;
performing research and creative tasks;
preparation of reports;
compiling reviews of scientific literature on a given topic;
compiling a thematic selection of literary sources and Internet sources;
preparation of tests by students for the organization of mutual knowledge assessment.

METHODOLOGICAL RECOMMENDATIONS FOR THE ORGANIZATION AND PERFORMANCE OF SUPERVISED STUDENT INDEPENDENT WORK IN THE ACADEMIC DISCIPLINE

APPROXIMATE LIST OF TASKS FOR SUPERVISED STUDENT INDEPENDENT WORK:

preparation of tests for the organization of mutual assessment.
preparation of thematic reports, papers, presentations;
design of information and demonstration materials (stands, posters, graphs, tables, newspapers, etc.);
production of models, laboratory and teaching aids.

SUPERVISED STUDENT INDEPENDENT WORK FORMS OF CONTROL:

colloquium
electronic test;
control work;
survey.

LIST OF AVAILABLE DIAGNOSTIC TOOLS

The following forms of current certification are used to diagnose competencies:

- express-interview in laboratory class;
- survey;
- express survey;
- control work;
- electronic test;
- colloquium;
- situational problems solving;
- laboratory work report.

LIST OF AVAILABLE TEACHING METHODS

Traditional method;
 active (interactive) methods:
 Problem-based learning PBL (Problem-Based Learning);
 Research-based learning RBL (Research-Based Learning).

LIST OF PRACTICAL SKILLS

Name of practical skill	Form of practical skills control
1. Identification of ascorbic acid, bendazole hydrochloride, glycerol, glucose monohydrate, drotaverine hydrochloride, potassium (sodium) chloride, potassium (sodium) iodide, potassium (sodium) bromide, calcium chloride dihydrate, caffeine sodium benzoate, magnesium sulfate heptahydrate, copper sulfate pentahydrate, menadione sodium bisulfite, sodium benzoate, sodium bicarbonate, nitrofurazone, procaine hydrochloride, resorcinol, ethyl alcohol, troxerutin, phenol, zinc sulfate heptahydrate using chemical reactions	Lab report, situational problems solving
2. Identification of D, L-methionine, rutoside trihydrate, chloramphenicol using thin layer chromatography	Lab report, situational problems solving
3. Acidimetric titration of sodium bicarbonate, theophylline-ethylenediamine	Lab report
4. Alkalimetric titration of benzoic acid, boric acid, nicotinic acid, salicylic acid, glacial acetic acid	Lab report
5. Iodometric titration of ascorbic acid, acetylcysteine, glucose, copper sulfate pentahydrate, cysteine hydrochloride monohydrate, ascorbic acid	Lab report
6. Iodometric determination of potassium iodide	Lab report

Name of practical skill	Form of practical skills control
7. Nitritometric titration of procaine hydrochloride, sulfonamide	Lab report
8. Complexometric titration of magnesium sulfate heptahydrate, zinc sulfate heptahydrate	Lab report, situational problems solving
9. Argentometric titration of potassium (sodium) chloride, potassium (sodium) iodide	Lab report, situational problems solving
10. Determination of the melting point of caffeine, nicotinic acid, procaine hydrochloride, resorcinol, salicylic acid, sulfanilamide, caffeine, sulfamethoxazole, trimethoprim	Lab report, situational problems solving
11. Polarimetric determination of ascorbic acid, levomenthol, glucose monohydrate, cysteine hydrochloride, D,L-methionine, folic acid	Lab report, situational problems solving
12. Refractometric determination of glycerol, dimethyl sulfoxide, solutions of magnesium sulfate, glucose	Lab report, situational problems solving
13. Spectrophotometric determination of ascorbic acid, atenolol, dimethyl sulfoxide, isopropyl alcohol, metronidazole, menadione sodium bisulfite, metformin hydrochloride, nitrofural (identification and quantification), trimethoprim, cloramphenicol, cyanocobalamin	Lab report, situational problems solving
14. Determination of pH of solutions of ascorbic acid, disodium edetate, glycine, procaine hydrochloride, ascorbic acid	Lab report, situational problems solving
15. Determination of the relative density of sulfuric acid, ethyl alcohol 96%	Lab report, situational problems solving
16. Preparation of reagent solutions: ammonium chloride solution R, potassium dichromate solution R, potassium ferricyanide solution R, potassium permanganate solution R, potassium thiocyanate solution R	Lab report
17. Quality control of pharmaceutical substances sodium chloride, corn starch, potassium permanganate, glycine, iodine, riboflavin, sulfonamide, alpha-tocopheryl acetate according to the section «Description»	Lab report, situational problems solving
18. Determination of the viscosity of chondroitin sulfate solution for injection by means of capillary viscometry	Lab report, situational problems solving

Name of practical skill	Form of practical skills control
19. Determination of transparency and turbidity of isopropyl alcohol, glacial acetic acid, solutions of glycine, hydrated aluminum oxide	Lab report, situational problems solving
20. Definition of chromaticity of isopropyl alcohol, glacial acetic acid, solutions of sodium benzoate, resorcinol, drotaverine hydrochloride, sodium sulfacetamide	Lab report, situational problems solving
21. Tests for the maximum impurities content in purified water, glacial acetic acid, pharmaceutical substances sodium bicarbonate and sodium chloride	Lab report, situational problems solving
22. Determination of electrical conductivity of purified water and glucose monohydrate solution	Lab report, situational problems solving
23. Determination of weight loss during drying of sodium benzoate	Lab report, situational problems solving
24. Identification of inorganic and organic cations and anions using qualitative reactions	Lab report
25. Determination of acidity or alkalinity of purified water and pharmaceutical substances	Lab report, situational problems solving
26. HPLC analysis of ascorutin (rutascorbine), ceftriaxone sodium	Lab report, situational problems solving
27. Express analysis of pharmaceutical preparations (extemporaneous dosage forms), calculation of results, assessment of compliance with the standards of permissible deviations and a conclusion on the satisfactory preparation of the dosage form	Lab report, situational problems solving
28. Calculation of spectrophotometric, titrimetric, polarimetric and refractometric determinations results, their interpretation and conclusion on the compliance of the medicinal product with the requirements of regulatory documentation	Situational problems solving
29. Quality control of industrially manufactured medicines (tablets, capsules, solutions, etc.)	Lab report, situational problems solving
30. Identification of amantadine hydrochloride, amitriptyline hydrochloride, acetylcysteine, haloperidol, hydrochlorothiazide, diphenhydramine hydrochloride, doxycycline hyclate, bromocriptine mesylate, levodopa, levothyroxine sodium, metoclopramide hydrochloride, nystatin, prothionamide, pyridostigmine bromide, rifampicin, streptomycin sulfate, sulpiride, sodium	Lab report, situational problems solving

Name of practical skill	Form of practical skills control
thiopental, phenylephrine hydrochloride using qualitative reactions	
31. Identification of atenolol, hydrochlorothiazide, metoclopramide hydrochloride, metformin hydrochloride, levothyroxine, prednisolone, triamcinolone acetonide, ethinyl estradiol using thin layer chromatography	Lab report, situational problems solving
32. Acidimetric titration of sodium thiopental	Lab report
33. Alkalimetric titration of amitriptyline hydrochloride, verapamil hydrochloride, diphenhydramine hydrochloride, loperamide hydrochloride	Lab report
34. Iodometric titration of acetylcysteine, captopril	Lab report
35. Identification of xylometazoline hydrochloride by fluorescence	Lab report, situational problems solving
36. Determination of atenolol, drospirenone, cinnarizine, gliquidone melting point	Lab report, situational problems solving
37. Polarimetric determination of amlodipine besylate, atenolol, drospirenone, dextromethorphan hydrobromide, ibuprofen, prednisolone, triamcinolone acetonide, phenylephrine hydrochloride	Lab report, situational problems solving
38. Spectrophotometric determination of amiodarone hydrochloride, amlodipine besylate, atenolol, hydrochlorothiazide, ibuprofen, loperamide hydrochloride, metformin hydrochloride, nitroxoline, omeprazole, ondasetron hydrochloride, prednisolone, pyridostigmine bromide, rifampicin, streptomycin sulfate, millol maleate, trimetazidine hydrochloride, phenylephrine hydrochloride, umifenovir hydrochloride, febuxostat, furosemide, prothionamide, ceftriaxone sodium, ciprofloxacin	Lab report, situational problems solving
39. Determination of the pH of a solution of acetylcysteine, ambroxol hydrochloride, doxycycline hyclate, rifampicin	Lab report, situational problems solving
40. Quality control of pharmaceutical substances amlodipine besylate, diphenhydramine hydrochloride, doxycycline drospirenone hyclate, rifampicin, streptomycin sulfate, triamcinolone acetonide according to the section «Identification»	Lab report, situational problems solving
41. Identification of medicines by structural formulas, assigning them to certain	Express survey, situational problems solving

Name of practical skill	Form of practical skills control
pharmacotherapeutic and chemical groups by target of action	
42. Identification of medicines by structural formulas, assigning them to certain pharmacotherapeutic and chemical groups by storage conditions	Express survey, situational problems solving
43. Statistical processing of quantitative determination results	Situational problems solving
44. Computer modeling of the interaction of a drug with a target, the use of molecular docking and drug design to predict the relationship between the chemical structure of a drug and its pharmacological (toxic) effect	Course work

LIST OF EQUIPMENT USED

1. Sets of chemical glassware for identification of substances.
2. Sets of chemical glassware, incl. measuring, for titration.
3. Sets of laboratory glassware.
4. Spectrophotometer.
5. Refractometer.
6. Polarimeter.
7. Set for performing thin layer chromatography.
8. Gas chromatograph.
9. Ion meter (pH meter).
10. Water and sand baths.
11. Drying cabinet.
12. Centrifuge.
13. Aquadistiller.
14. Deionizer.
15. Conductivity meter.
16. Thermometer.
17. Analytical and precision balances.
18. Shaker mixers.
19. Multimedia projector, TV.
20. Computer.
21. Melting point determination device.
22. Viscometer.
23. Device with black and white background.
24. Pantone colors.
25. Chromatographic chambers and plastics, spray chambers, UV irradiator for thin layer chromatograms.
26. Ultrasonic bath.
27. Vacuum filtration unit.

**PROTOCOL OF THE CURRICULUM APPROVAL
BY OTHER DEPARTMENTS**

Title of the discipline requiring approval	Department	Amendments to the curriculum in the academic discipline	Decision of the department, which designed the curriculum (date, protocol #
1. Pharmacology	Pharmacology	Adjustments in medicines under study list	Protocol # 11 of 25.04.2025
2. Pharmacy Technology of Drugs	Pharmaceutical Technology with a course for advanced training and retraining	Adjustments in pharmaceutical substances under study list	Protocol # 11 of 25.04.2025
3. Pharmacognosy	Pharmacy Organization with a course for advanced training and retraining	Adjustments in list of studied identification methods and quantitative analysis' of biologically active substances	Protocol # 11 of 25.04.2025

COMPILED BY:

Head of the Pharmaceutical Chemistry Department with a course for advanced training and retraining of the Educational Institution «Belarusian State Medical University», Ph.D., Associate Professor

R.I. Lukashou

Associate Professor of the Pharmaceutical Chemistry Department with a course for advanced training and retraining of the Educational Institution «Belarusian State Medical University», Ph.D.

S.G. Khaminets

Curriculum content, composition and the accompanying documents comply with the established requirements.

Head of the Office of Educational Activities of the Educational Institution «Belarusian State Medical University»

24.06.2025

I.L. Kotovich

Methodologist of the Educational and Methodological Department of the Office of Educational Activities of the Educational Institution «Belarusian State Medical University»

24.06.2025

S.V. Zaturanova