MINISTRY OF HEALTH OF THE REPUBLIC OF BELARUS
EDUCATIONAL INSTITUTION
BELARUSIAN STATE MEDICAL UNIVERSITY

APPROVED
by First Vice-Rector, Professor
_____ I.N.Moroz
03.06.2019
Reg. # UD-6.590/1920/edu.

INDUSTRIAL TECHNOLOGY OF DRUGS

Curriculum of higher educational institution in the educational discipline for the specialty:

1-79 01 08 «Pharmacy»

Minsk BSMU 2019

Curriculum is based on the educational program «Industrial Technology of Drugs», approved 01.12.2016, registration # TD-L.590/1617/edu.

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RECOMMENDED FOR APPROVAL:

by the Department of Pharmaceutical Technology of Educational Institution «Belarusian State Medical University»
(protocol # 9 of 10.04.2019);

by the Methodological Commission of pharmaceutical disciplines of the Educational Institution «Belarusian State Medical University»
(protocol # 9 of 23.05.2019)

EXPLANATORY NOTE

«Industrial Technology of Drugs» is an educational discipline containing systematic scientific knowledge about research, properties, production, analysis, storage and sale of drugs.

The aim of teaching and learning of the discipline «Industrial Technology of Drugs» is the formation of students' knowledge and skills of drugs production and development in various drug forms, as well as the organization of ready-made drugs production at pharmaceutical enterprises.

The tasks of studying the discipline are to develop students` academic, personal-social and professional competences, based on the ability to self-search educational and information resources, as well as acquire and understand the knowledge about:

– theoretical foundations of technological processes of drugs production and the professional activities of the pharmacist-technologist at pharmaceutical enterprises;

– methods of drug forms production and their standardization at pharmaceutical enterprises;

– principles of improvement of the industrial technology and development of new production methods of periodic, prolonged and directed action drugs;

– methodology of the development of regulatory documentation for drugs production.

Teaching and successful learning of the discipline «Industrial Technology of Drugs» is carried out on the basis of knowledge and skills acquired by the student in the following academic disciplines:

Fundamentals of Medical Statistics. Mathematical analysis. Elements of probability theory. Statistics, design of experiments.

General and Inorganic Chemistry. Solutions, theory of solutions, solubility of solids, liquids and gases. Complexation, production of inorganic substances. Chemical reactions.

Organic Chemistry. The structure of organic compounds. Chemical reactions of organic compounds. The synthesis of organic compounds.

Physical and Colloid Chemistry. Thermodynamics of phase equilibria (Gibbs rule, extraction). Thermodynamics of chemical equilibrium (law of mass action, equilibrium constant). Thermodynamics of dilute solutions (the laws of Vant-Hoff and Raoult), isotonic solutions. High-molecular substances, surface-active materials, colloidal solutions, suspensions, emulsions.

Biological Physics. Mechanics of solids and plastic bodies. Molecular physics (molecular-kinetic theory). Physical optics, electricity and magnetism, ultrasound. Thermal radiation.

Pharmaceutical Latin. Latin spelling and terminology.

Pharmacognosy. The nomenclature of medicinal plants and medical plant raw materials. Biologically active substances of plants. Drugs from medical plant raw materials.

Pharmaceutical Hygiene. Hygiene of pharmaceutical enterprises and workplace hygiene on pharmaceutical enterprises.

Organization and Economics of Pharmacy. Standardization of pharmaceutical activity.

Pharmaceutical Chemistry. The relationship between the chemical structure, action, storage conditions of drugs. The main methods of drugs standardization.

Pharmacology. Introducing drugs into the human body. The absorption, metabolism and elimination of drugs. The pharmacokinetics of drugs. Drugs classification according to pharmacotherapeutic groups.

As a result of studying the discipline «Industrial Technology of Drugs» the student should

know:

– terminology of drugs industrial technology;

– state regulation of drugs production in pharmaceutical enterprises, rules of GMP, GLP, GCP, GVP;

– requirements of Good Manufacturing Practice for the organization of drugs industrial production;

– requirements for pharmaceutical substance quality for drugs industrial production;

– classification and administration of excipients used in drugs production;

– characteristics of processes and equipment used in drugs industrial technology;

– features of drugs production of prolonged and directed action;

be able to:

– use Pharmacopoeia, Pharmacopoeia articles of the manufacturer, technical regulations and other regulatory documents to find the necessary information on the composition, production, storage of drugs;

– develop technological documentation for ready-made drugs;

– make technological schemes of drugs production and describe the technological processes of their production;

master:

– technologies of production and standardization of solid, liquid, soft and gaseous dosage forms in industrial conditions;

– the basics of validation of technological equipment and technological processes.

The structure of the curriculum in the educational discipline «Industrial Technology of Drugs» consists of three parts: «Introduction to the Discipline», «Processes and Equipment of Pharmaceutical Technology» and «Industrial Technology of Drugs».

Total number of hours for the study of the discipline is 324 academic hours. Classroom hours according to the types of studies: lectures - 66 hours, laboratory (practical) studies - 118 hours, student independent work (out-of-classes self-study) - 140 hours.

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

Final assessment – state examination.

Form of higher education – full-time.

ALLOCATION OF ACADEMIC TIME ACCORDING TO SEMESTERS OF STUDY

Code, name of the specialty	semester	Number of academic hours					Form of current assessment
		total	in-class	including		out-of-class self-studies	
				lectures	laboratory studies		
1-79 01 08 «Pharmacy»	7	144	98	34	64	46	Credit
	8	180	86	32	54	94	Exam
Total hours		**324**	**184**	**66**	**118**	**140**	

THEMATIC PLAN

Section (topic) name	Number of class hours	
	lectures	practical
1. Introduction to the discipline «Industrial Technology of Drugs»	4	**8**
1.1. The development of industrial drugs production in the Republic of Belarus. General principles of the organization of drugs production at pharmaceutical enterprises	2	4
1.2. Rules of GMP, GLP, GCP, GVP. Normative and technical documentation of drugs production	2	4
2. Processes and equipment of pharmaceutical technology	**12**	**24**
2.1.The main processes of industrial technology, their role in the drugs production. General concepts of machines and devices	2	4
2.2. Mechanical processes and equipment	2	4
2.3. Hydromechanical processes and equipment. Basics of hydraulics	4	8
2.4. Heat processes and equipment	2	4
2.5. Mass-exchanging processes and equipment	2	4
3. Industrial technology of drugs	**50**	**86**
3.1. Industrial technology of solid drug forms. Powders and herbal teas production	2	4
3.2. Industrial production of granules and dragee. Study of physico-chemical and technological properties of powders and granulates	2	4
3.3. Tablets (characteristics and classification). Theoretical bases of tableting. Characteristics of tablet machines	2	4
3.4. Excipients used in the tablets production. Technological schemes of tablets production	2	4
3.5. Tests for tablets	–	4
3.6. Tablets coating. Production of molded, multi-layer and matrix tablets	2	4
3.7. Industrial production of capsules. Microencapsulation of drugs	2	4
3.8. Drafting of regulatory documentation for the tablets production	–	4
3.9. Industrial production of semi-solid drugs	2	3
3.10. Industrial production of suppositories and medical pencils	2	3
3.11. Industrial production of patches and mustard plasters	2	
3.12. Industrial production of liquid drugs for internal and	2	3

Section (topic) name	Number of class hours	
	lectures	practical
external use		
3.13. Production of drugs for parenteral use and organization of their industrial production	2	3
3.14. Production and preparation ampoules for filling. Technological production scheme of solutions in ampoules	2	3
3.15. Mechanization and automation of ampoule production. Quality assessment of injectable solutions in ampoules	–	
3.16. Features of industrial technology of solutions for injections in ampoules, infusions, sterile suspensions and emulsions. Impact assessment of technological factors on the quality of solutions for injection	2	3
3.17. Industrial production of medical solutions. Production of emulsions and suspensions	2	3
3.18. Dilution and strengthening of medical solutions in their industrial production	–	
3.19. Industrial production of syrups, essential oils, aromatic waters	2	3
3.20. Basic regularities of the extraction of capillary-porous raw materials with cellular structure. Characteristics of galenic drugs	2	3
3.21. Industrial production of tinctures	2	3
3.22. Production of 1:1 and 1:2 liquid extracts	2	3
3.23. Industrial production of soft and dry extracts, extracts-concentrates	2	3
3.24. Industrial production of oil extracts and biogenic stimulants	2	3
3.25. Industrial production of neogalenicals drugs	2	3
3.26. Industrial production of drugs from animal raw materials	2	3
3.27. Industrial production of aerosols	2	3
3.28. Industrial production of eye drugs	2	3
3.29. Prolonged and directed action drugs	2	3
3.30. Drafting of regulatory documentation for the production of injection and extraction drugs	–	
Total hours	**66**	**118**

CONTENT OF THE EDUCATIONAL MATERIAL

1. Introduction to the discipline «Industrial Technology of Drugs»

1.1. The development of industrial drugs production in the Republic of Belarus. General principles of the organization of drugs production at pharmaceutical enterprises

Aim and objectives of «Industrial Technology of Drugs» as an educational discipline. The main terms used in the industrial technology of drugs.

Development of industrial production of drugs in the Republic of Belarus. Expansion of the drugs nomenclature of industrial production. State program «Import substitution of drugs».

Differentiation and specialization of pharmaceutical enterprises. Structure of pharmaceutical enterprises. Manufactory principle of the organization of drugs production.

A set of measures for quality assurance, preparation of production, employees, premises, equipment, materials, documentation, rules of production and quality control of drugs.

Technological process and its components: stages and operations. Periodic, continuous and combined technological process. Types of technological processes. General concepts of the technological process: series, raw materials, ingredients, semi-ready-made product, ready-made product, by-product, waste products and industrial waste.

Material and energy balance. Technical and economic balance. Technological yield, loss, consumption coefficient and consumption norms.

1.2. Rules of GMP, GLP, GCP, GVP. Normative and technical documentation of drugs production

The system of requirements for the production and quality control of drugs – Good manufacturing practice (GMP). Main sections of GMP: introduction, terminology, staff, buildings and premises, equipment, production process, functions of quality control department (QA), registration and reporting. Standards, structure and scope of Good Practices: Good Laboratory Practice (GLP), Good Clinical Practice (GCP), Good Pharmacovigilance Practice (GVP).

The system of air preparation at pharmaceutical enterprises organized by GMP. Particle pollution levels for different zones in the «equipped» and «operated» state. Air filtration at pharmaceutical enterprises. Basic requirements for «clean» rooms and control of air parameters in the production of sterile drugs.

The concept of installations for producing water for injection. Water treatment system at pharmaceutical enterprises.

Modern technologies of production and storage of water for injection at pharmaceutical enterprises.

Legislative acts of regulation of quality and conditions of drugs production in the Republic of Belarus. Technological regulations, Pharmacopoeia, manufacturer's pharmacopoeia monograph. Regulation of production and quality of pharmaceutical substances, excipients and dosage forms. Pharmacopoeia: European, international,

USA, UK and other indicators and quality standards of pharmaceutical substances and drugs.

Production regulations as the basic technological document. Types of regulations: laboratory, pilot, start-up, industrial and standard industrial. The content of the regulations: characteristics of the final production; chemical scheme of production; technological scheme of production; apparatus scheme of production and specification of equipment; characteristics of raw materials and semi-products; presentation of the process; material balance; processing and disposal of waste products; production control; safety, fire safety and industrial sanitation; environmental protection; list of production instructions; technical and economic standards; information materials.

2. Processes and Equipment of Pharmaceutical Technology

2.1. The main processes of industrial technology, their role in the drugs production. General concepts of machines and devices

Characteristics of the main processes of industrial technology: mechanical, Hydromechanical, heat and mass-exchanging processes. The role and relationship of technological processes in the production of drugs.

General concepts of machines and devices. The machine as the unity of the engine, transmission and executive mechanisms. Characteristics of engines, receiving transmission and executive mechanisms. Characteristics of the apparatuses, reactors. Control and measuring instruments and devices.

2.2. Mechanical processes and equipment

General characteristics of mechanical processes.

Grinding. The degree of grinding, its dependence on the strength, hardness, elasticity and brittleness of the material. Theoretical basis of grinding. Surface and volume theory of grinding. The unified Rebinder grinding theory. The grinding methods: crushing, breaking, bump, attrition, etc. Grinding machines (mills), the principle and mode of operation. Dismembrators, disintegrators, excelsior mills, hammer mills, ball mills, vibratory mills, jet mills. The basic rule of grinding. Features of grinding plant materials. The purpose and use of the grinding process in the industrial technology.

Cryogrinding, its influence on the quality of the grinding material. Grinding in liquid and viscous environment.

Classification of solid materials. Basics of air and hydraulic classification of grinding material. Mechanical classification (sifting). Sieve and sieve analysis. Materials and types of grids (wire-mesh, stamped, grate). Standards and numbering of sieves. The device and the principle of operation of mechanized sieves: swinging, rotating, vibration. Safety of sifting.

Mixing in the industrial production of drugs. Mixers of solid, liquid and paste materials. Types, devices and principles of mixers operation: drum, screw, circulation, centrifugal, gravity, fluidized bed mixers.

Characteristics of mixers used in tablet production: drum, worm-blade, belt, centrifugal, SPM-200.

2.3. Hydromechanical processes and equipment. Basics of hydraulics

General characteristics of hydrodynamic processes. Basics of hydraulics. The concept of real and ideal liquids. Hydrostatics and hydrodynamics of liquids.

Laminar and turbulent motion of liquids. Hydrodynamic boundary layer. Film flow of liquids. The flow of liquids through fixed granular layers and porous membranes.

Hydrodynamics of fluidized (fluidized bed) granular layers. The use of fluidization in the pharmaceutical technology and their characteristics. Basic properties of fluidized bed.

Design of mixers and their characteristics. Pneumatic mixing with compressed gas, air, jet steam, bubbling, circulation mixing.

Gravitational and pulsation mixing. The use of rotary pulsation apparatus for dissolution process intensification.

Theoretical basis and use of ultrasound for dispersion and mixing of medical solutions. Electrostrictive and magnetostrictive generators of ultrasound, their characteristics and device.

Separation of heterogeneous systems.

Separation of liquid and solid phases by settling. Siphon devices for separation of solid and liquid phases.

Separation by gravity. Settling and sedimentation. The rate of settling. Factors affecting on the rate of settling. Settling equipment of periodic and semi-continuous action.

Separation of solid and liquid phases under the influence of the difference of pressure. Filtration, filtration methods, filtration equation. Types of filters: nutch and druk-filters, filter presses, cartridge, drum and disc filters. Filters for cleaning gases from mechanical impurities. Characteristics of filter materials.

Separation of solid and liquid phases in the field of centrifugal forces. Centrifugation, separation factor, filtering and settling centrifuges, centrifuges of periodic and continuous action, super centrifuges. Characteristics of separators.

2.4. Heat processes and equipment

General characteristics of heat processes. Energy in production processes. Heat processes in pharmaceutical technology. Heat transfer mechanisms: heat conductivity, convection, radiation of heat, joint heat transfer.

Heating agents and methods of heating. Water vapor as the main heat transfer agent. Wet, dry, saturated and superheated steam. Heat content of water vapor, communication and reduction of water vapor. Heating by indirect steam and jet steam. The consumption of steam when heated. Direction of the movement of heat carriers (direct flow, counter flow, cross current, mixed current) and its influence on the heat transfer intensity.

Heat exchangers and their classification. Characteristics of heat exchangers: surface, mixing, regenerative and internal heat (coil, shell and tube, double pipe, ribbed, steam jackets, scrubbers, refrigerators, boilers, heaters, etc.).

Cooling agents, cooling methods, condensation and their mechanisms. Characteristics of condensers: surface and mixing (direct current and countercurrent).

Cooling and freezing, cryoprocesses, condensation in industrial technology.

2.5. Mass-exchanging processes and equipment

General characteristics of mass-exchanging processes. Classification, place and role of mass-exchanging processes in industrial technology.

Evaporation, evaporation methods: under vacuum, atmospheric pressure and high pressure. Device of evaporator installations: evaporator apparatus, receivers, vacuum pumps, refrigerators, hot wells. Characteristics of single-effect and multiple-effect evaporator systems: ball, tube, film. Evaporation with secondary steam thermocompression.

Side effects during evaporation: encrustation, temperature depression, hydrostatic effect, drop entrainment, foamability and ways to eliminate them.

Drying in the industrial production of drugs. Forms of moisture and material connection. Statics and kinetics of drying. Drying methods: contact and convective drying. Properties of air as a drying agent: temperature, absolute and relative humidity, moisture content and heat content. Contact dryers: vacuum drying cabinets, vacuum drum dryers. Convective dryers: spray, disc and jet spray dryers. Freeze (lyophilized) drying. Air dryers: chamber, drum, fluidized bed dryers. Freeze and spray dryers.

Acoustic drying in fluidized and spouted layers.

3. Industrial technology of drugs

3.1. Industrial technology of solid drug forms. Powders and herbal teas production

Production of powder mixtures. Factors affecting the homogeneity of mixtures in the process of production, transportation and storage of powders.

Characteristics of powders for external and oral use: «effervescent» powders, nasal powders, powders for the preparation of oral solutions, suspensions, syrups.

Technological and apparatus schemes of powders production in the pharmaceutical enterprises. Dosing, prepacking and packaging of powders in the industrial production. Shelf-life and storage conditions of powders. Tests for powders: content uniformity, uniformity of dosage units, uniformity of mass, uniformity of doses mass in multi-dose containers, etc. Improving the technology of powders. The nomenclature of powders of the industrial production.

Packaging, labeling, storage of powders.

Characteristics of herbal teas industrial production. Technological scheme of herbal teas production in industrial conditions. Nomenclature and private herbal teas technology: antiasthmatic herbal tea, herbal tea in briquettes etc. Testing for herbal teas: powder fineness, uniformity of dosage units, uniformity of not presented in dose units, quantitation of biologically active substances.

Packaging, labeling, storage of herbal teas.

3.2. Industrial production of granules and dragee. Study of physical-chemical and technological properties of powders and granulates

Characteristics and classification of granules: «effervescent» granules, film-coated, modified-release and enteric-coated granules. Testing for granules: the uniformity of dosage units, content uniformity, uniformity of mass, uniformity of mass of unit dose released from the multidose container.

Characteristics of technological and physical-chemical properties of powders and granulates: flowability, compressibility, granulometric composition, bulk density and tapped density, relative density, etc.

Pharmaceutical and technological tests (flowability, bulk density and tapped density, powder flow, powder fineness), methods and the equipment for their determination.

Methods of granulation in the production of tablet masses: wet and granulation by pressing or rolling. Classification and characterization of wet granulation: punching and structural.

Structural granulation with pan-coating, fluidised bed, spray drying, wet granulation.

Comparative characteristics of granulation methods.

Granulators and drum pulpers used for granulation: granulator model 3027, dry granulator, dryer-granulator with fluidized bed DG-30, DG-60, DG-100, etc.

Drying of granulate. Dryers with fluidized bed DP-30, DP-60, DP-100, etc.

Technological scheme of granules production. The nomenclature of industrial granules production.

Packaging, labeling, storage of granules.

Characteristics of dragee. The dragee production by means of building up in the coating pans. Tests for dragee: content uniformity, uniformity of mass, disintegration, dissolution. The nomenclature of industrial dragee production.

Packaging, labeling, storage of dragee.

3.3. Tablets (characteristics and classification). Theoretical bases of tableting. Characteristics of tablet machines

Characteristics, types and nomenclature of tablets for oral, external, sublingual, implantation and parenteral use. Uncoated and coated tablets, «effervescent» tablets, soluble, dispersible, enteric-coated and modified-release tablets, freeze-dried tablets.

Theoretical bases of tableting: mechanical, capillary theory, fusion under pressure. The forces manifestation of cohesion and adhesion when pressed.

Characteristics and principle of operation of crank and rotary tablet machines. The main elements of tablet machines: matrix and punches. Feeders of tablet machines: frame, stirrer, vacuum, vibration. Tablet machines of double pressing.

3.4. Excipients used in the tablets production. Technological schemes of tablets production

Excipients used in the tablets production (diluents, disintegrants, glidants, binders, antifriction substances, colorants, corrigents, prolongators), their characteristics and nomenclature.

Excipients effect on the therapeutic efficacy of active substances in tablets.

Technological schemes of tablets production: direct compression and granulation in the tablets production. The stages and operations characteristics of the technological process of tablets production.

Spheronization of granules in the tablet mass production. The quality assessment of the granules: granulometric composition, moisture content, flowability, compressibility.

Lubrication granules with antifriction substances.

Packaging, labeling, storage of tablets. Equipment for tablets packaging.

3.5. Tests for tablets

Test for tablets: the uniformity of dosage units, content uniformity, uniformity of mass, dissolution and disintegration tests, talc and aerosil content. Friability of uncoated tablets and resistance to crushing of tablets. Test «Dissolution» for solid dosage forms. Instruments and methods for the «Dissolution» test: basket apparatus, paddle apparatus, reciprocating cylinder, flow-through cell. The technique of the test «Dissolution» for solid dosage forms with conventional, prolonged and retard release, the results interpretation.

Characteristics of the test «Disintegration of tablets», instruments and methods of the test, the results interpretation for different types of tablets.

3.6. Tablets coating. Production of molded, multi-layer and matrix tablets

Tablets coating, aim and methods of coating. The range and characteristics of excipients for tablets coating: sugar, sugar syrup, magnesium carbonate, colorants, glossing agents, film coating agents, plasticizers. The coating technology (sugar-coating): waterproofing and sealing, subcoating, smoothing, polishing.

Characteristics and classification of tablets film coatings, the range of film coating agents. Methods for applying film coatings on tablets. Technology of pressed coatings. Granulate production for pressed coatings.

Molded tablets production. Production of freeze-dried tablets.

Characteristic of multi-layer tablets, prolonged action tablets and retard tablets.

3.7. Industrial production of capsules. Microencapsulation of drugs

Capsules, characteristics, classification. The hard and soft capsules, enteric-coated and modified-release capsules, wafer capsules.

Technological scheme of gelatin capsules production. Preparation of gelatin mass, forming capsules by dipping, pressing and dropping method. Filling capsules with content. Equipment for the capsules production and filling. Tests for capsules: the uniformity of dosage units, content uniformity, uniformity of mass, dissolution, disintegration for hard and soft capsules.

Packaging, labeling, storage of capsules.

Microcapsules, microgranules and microdragee, their characteristics. Microencapsulation of pharmaceutical substances. Methods of microcapsulation: physical, physico-chemical, chemical. Characteristics of excipients for microencapsulation. Dosage forms from microcapsules (tablets, capsules, ointments, suspensions, suppositories, spansules). The assessment of microcapsules quality.

3.8. Drafting of regulatory documentation for the tablets production

General characteristic and basis of drafting of regulatory documents in the tablets manufacture. Technical code of practice TCP 030-2017 (02040). Production of drugs. Good Manufacturing Practice. Technological regulations of production, the order of development, types and structure of technological regulations. Drafting of technological regulations for the tablets production.

3.9. Industrial production of semi-solid drugs

Semi-solid drugs, characteristics, classification. Ointments, creams, gels, pastes, poultices, liniments, their characteristics. Tests for soft drugs: the uniformity of dosage units, sterility.

Classification of ointments. Hydrophobic, hydrophilic and water-emulsion ointments. Characteristics and classification of ointment bases. The assessment of ointments quality: structural and mechanical properties of ointments (rheology).

Lipophilic and hydrophilic creams. Characteristics of lipophilic and hydrophilic gels. The nomenclature of gelling agents. Characteristics of pastes and poultices.

Features of ointments and pastes production in pharmaceutical enterprises. Technological schemes of ointments production. Technological equipment for the ointments production and packaging. The nomenclature of ointments of industrial production.

Pastes in industrial production: zinc, salicylic-zinc, boric-zinc-naphthalene, etc.

Packing, labeling, storage of ointments, pastes.

3.10. Industrial production of suppositories and medical pencils

Drugs for rectal use, characteristics, classification. Suppositories, rectal capsules, foams, tampons. Rectal solutions, suspensions, emulsions. Powders and tablets for preparation of rectal solutions and suspensions. Semi-solid drugs for rectal use.

Drugs for vaginal use, characteristics, classification. Pessaries, vaginal tablets and capsules, foams, tampons, solutions, emulsions and suspensions. Tablets for vaginal solutions and suspensions preparation. Semi-solid drugs for vaginal use.

Tests for rectal and vaginal drugs: the uniformity of dosage units, content uniformity, uniformity of mass, dissolution.

Characteristics of suppositories industrial production. Characteristics of the suppository bases. Technological equipment for suppositories production and packaging. Development prospects of rectal and vaginal dosage forms production: the line expansion of excipients, mechanization and automation of production and packaging.

Medical pencils, characteristics. Types of medical pencils. Ways of medical pencils manufacture: pouring, pressing, dipping. Private technology of medical pencils: silver nitrate pencil, menthol pencil, hemostatic pencil, etc.

Packing, labeling, storage of suppositories and medical pencils.

3.11. Industrial production of patches and mustard plasters

Definition, characteristics, classification of medical and skin patches. Patches testing for sterility and dissolution. The range of excipients for patches production. Equipment for patches masses producing, pasting and drying patches (reactor, USPL-1 installation, chamber-loop dryer, etc.). The nomenclature of patches: band-aid, pepper-plaster, corn-plaster. Liquid patches: cleolum, collodium, etc. Patches-aerosols.

Mustard plasters production.

Packaging, labeling, storage of patches.

Characteristics of hydrogel plates. Production of hydrogel plates. Hydrogel plates tests for sterility, dissolution.

Packing, labeling, storage of hydrogel plates.

3.12. Industrial production of liquid drugs for internal and external use

Characteristics and classification of liquid drugs for internal (oral) and external use. Solutions, emulsions, suspensions, drops for internal use, their characteristics. Powders and granules for preparation of solutions, emulsions, suspensions for internal use.

Sterility tests for liquid drugs for external use.

Powders for preparation of drops for internal use. Solutions, suspensions, emulsions for external use. Shampoo and foams for skin.

Tests for liquid drugs for internal use: the uniformity of dosage units, content uniformity, uniformity of mass, uniformity of dose and dosing drops for internal use, uniformity of doses mass in multi-dose containers.

Packaging, labeling, storage of liquid drugs for internal and external use.

3.13. Production of drugs for parenteral use and organization of their industrial production

Drugs for parenteral use, their characteristics and classification.

Characteristics of injectable drugs. Infusions, characteristics and classification. Concentrates for injection and infusion drugs preparation. Powders for injection and infusion drugs preparation. Gels for injections, implants and drapes, their characteristics.

Medicine testing for parenteral use: the uniformity of dosage units, content uniformity, uniformity of mass, bacterial endotoxins – pyrogenicity.

Characteristics and effects of bacterial endotoxins-pyrogenes on the human body. Sources of pyrogenic substances in sterile and aseptically prepared dosage forms. Biological tests for injectable drugs: pyrogenicity, abnormal toxicity, bacterial endotoxins.

Glass and polymer containers for sterile drugs, requirements and glass classes. Quality control of glass containers. Tests for hydrolytic and thermal stability, holding power of closures and container closure integrity.

Production of sterile products at pharmaceutical enterprises.

Non-aqueous and mixed solvents for injection solutions: fatty oils, ethyloleate, benzyl benzoate, ethyl alcohol, macrogols, glycerin, propylene glycol, etc.

Pharmaceutical substances and excipients for injectable drugs, purity requirements, decontamination, depyrogenation and sterilization.

3.14. Production and preparation ampoules for filling. Technological production scheme of solutions in ampoules

Ampoule production: preparation of the glass tubes, calibration, washing. Manufacture of ampoules on the semi-automatic machines, fritting. Ampoules preparation for filling. Ampoules broaching, internal and external washing of ampoules. Vacuum, syringe and vapor condensation internal washing of ampoules. Drying and sterilization of ampoules.

Ampoules, vials, syringes, carpules, cartridges, their characteristics, production and preparation for their filling.

Methods of filling ampoules with solutions: vacuum, syringe and vapor condensation method. Ampoules sealing. Semi-automatic sealing of ampoules. Ampoules sealing with gas protection.

Sterilization of injection solutions. Pharmacopoeia methods of sterilization: thermal, chemical, radiation, sterilization by filtration.

The characteristic of the sterilization equipment. Operating instruction with under pressure equipment. Preparation and sterilization in steam sterilizers. Dry-heat sterilizer. Regimes of thermal sterilization depending on objects properties and their quantity. Sterility assurance level. Safety precautions for different sterilization methods.

Labeling of solutions in ampoules.

3.15. Mechanization and automation of ampoule production. Quality assessment of injectable solutions in ampoules

The quality assessment of solutions for injection in ampoules: clarity, coloration, volume, sterility, toxicity, bacterial endotoxins-pyrogenes, particulate contamination test. Mechanization and automation of ampoule production.

Packaging, labeling, storage of solutions for injection in ampoules.

3.16. Features of industrial technology of solutions for injections in ampoules, infusions, sterile suspensions and emulsions. Assessment of the impact of technological factors on the quality of solutions for injections

Stabilization of injection solutions of weak bases and strong acids salts; strong bases and weak acids salts; readily oxidizable substances.

Ways of stabilization of injection solutions. The range of stabilizers: acids, alkalies, antioxidants, anticatalysers, etc. Using of gas protection in the injection solutions production. Characteristics and nomenclature of preservatives.

Industrial production features of injection solutions of glucose, novocaine, caffeine-sodium benzoate, calcium chloride, magnesium sulfate, calcium gluconate, ascorbic acid, etc. Oil solutions of camphor, hormones and their analogues.

Industrial production features of injection solutions at pharmaceutical enterprises. Types of infusion solutions: plasma-substituting, water-salt balance regulators, for parenteral nutrition, oxygen carriers and multifunctional. Requirements of isotonicity, isohydricity, isoionicity and viscosity to infusion solutions. Industrial production of salt, plasma-substituting and detoxication solutions. The nomenclature of infusion solutions of industrial production.

Industrial production features of injection solutions of thermolabile drugs.

Sterile suspensions and emulsions of industrial production. Suspensions of insulin, corticosteroids, etc., their production. Production of emulsions for parenteral nutrition, using of ultrasonic installations in their production. Industrial production of powders for sterile solutions: features of technology and lyophilization of powders. Packaging of powders into vials and ampoules. Development prospects of sterile dosage forms production. Ways to improve the shelf life of drugs for parenteral use.

Physical, chemical, biological processes occurring in drugs for injection. Stability of drugs. Factors affecting drugs stability. Methods of stabilization of drugs: physical and chemical. The basic principle of drugs stabilization. Shelf life of ready-made drugs.

3.17. Industrial production of medical solutions. Production of emulsions and suspensions

Medical solutions, characteristics, classification of solutions depending on the solvent nature, concentration and preparation method (by chemical interaction or dissolution): aqueous solutions, alcohol, oil, glycerin solutions. Requirements for medical solutions.

Production of solutions for internal and external use in various ways at pharmaceutical enterprises.

Dissolution as a diffusion-kinetic process.

Intensification of the dissolution process. Temperature and hydrodynamic conditions in medical solutions production.

Technological schemes of solutions production for internal and external use. General and specific rules of aqueous and non-aqueous solutions production.

Stages of dissolution. Factors affecting the dissolution process: grinding, temperature change, mixing.

Indicators of substances solubility in different solvents and designation of solubility in Pharmacopoeia of the Republic of Belarus.

Using mechanical mixing in medical solutions production.

Nomenclature of medical solutions and prospects for its expansion. Standardization and storage of medical solutions. Production of medical solutions: basic acetic aluminum salt, basic acetic lead, alcohol and aqueous solutions of iodine, iodinol, iodonate, methylene blue alcohol solution, brilliant green, etc.

The quality assessment of solutions for external and internal use.

Packaging, labeling, storage of medical solutions.

Methods for manufacture suspensions and emulsions at pharmaceutical enterprises: mechanical mixing, colloidal mixing, dispersion by ultrasound.

Characteristics of equipment for suspensions and emulsions industrial production: rotary pulsation apparatus, colloidal mills, dispersants, homogenizers.

Technological scheme of emulsions and suspensions industrial production. The components dispersion. Modern range of emulsions and suspensions of industrial production.

Packing, labeling, storage of emulsions and suspensions.

3.18. Dilution and strengthening of medical solutions in their industrial production

Methods of expressing the solutions concentration. Density of solutions. Determination of density using the hydrometer and pycnometer: using formulas of dilution and strengthening for salts, acids and alkalis solutions. Methods for determining the concentration of alcohol and features of alcoholic solutions dilution or strengthening at pharmaceutical enterprises. Dilution of ethyl alcohol. Alcoholometric tables, rules for using alcoholometric tables.

3.19. Industrial production of syrups, essential oils, aromatic waters

Syrups, characteristics, classification: flavoring and medical. The place of syrups in drug therapy. Using new excipients sorbitol, fructose, synthetic sweetening agents for syrups production with high biological availability. Technological schemes of syrups production at pharmaceutical enterprises. The quality assessment of syrups.

Nomenclature: sugar syrup, syrup with aloe and iron, sweatweed syrup, rose hips syrup, etc.

Powders and granules for syrups preparation, tests: the uniformity of dosage units, content uniformity, uniformity of mass.

Packaging, labeling, storage of syrups.

Essential oils, characteristics. Production of essential oils. General tests for essential oils: relative density ratio, refractive index, optical rotation, fatty oils and mineral oils in essential oils. Additional tests for essential oils: solidification temperature; acid number; peroxide number; foreign esters; residue after evaporation; water; solubility in alcohol.

Aromatic water, characteristics, classification. Technological scheme of aromatic water-solutions and distilled aromatic waters production. Equipment for production of distilled aromatic waters. Aromatic water-solutions: dill, mint. Distilled aromatic waters: coriander alcohol water, bitter-almond water and its concentrate. The quality assessment of aromatic waters.

Packaging, labeling, storage of aromatic waters.

3.20. Basic extraction regularities of capillary-porous raw materials with cellular structure. Characteristics of galenical drugs

Extraction of plant, animal, microbiological raw materials and tissue culture in the «solid – liquid» system as one of the types of mass-exchanging processes.

Technological characteristic of phases: the content of active, extractives and moisture in raw materials; the quality of the raw materials, the rate and amount of swelling the raw material, the absorbability of the raw material extracting agents, density, bulk density and bulk weight of the raw material, the porosity of the raw material, crude herbal drug granulation, the particle surface of the raw material, the coefficient of washing out, internal diffusion, swelling and absorption.

Characteristics of extractants. Requirements for extractants: solubility, selectivity, polarity, viscosity, surface tension, medium reaction. Classification and modern range of extractants: water, ethyl alcohol, chloroform, ether, acetone, etc. Using liquefied gases in the production of extractive drugs.

Features of extraction of capillary-porous materials with cellular structure, stages of extraction: the penetration of the extractant to the raw material, dissolution and desorption, the internal molecular diffusion, external convection and molecular diffusion. The diffusion equation (the first and the second Fick's equation and the convective diffusion). Coefficients of internal, molecular and convective diffusion. Diffusion losses, the calculations of diffusion losses. Factors affecting the reduction of losses on the diffusion (absorption of raw material of the extractant, the division of the extractant and raw materials in parts).

Kinetics of mass transfer in the extraction of liquefied gases. The influence of certain factors on the process of extraction of liquefied gases, hardware implementation of the process.

Extraction methods of animal and plant raw materials: static and dynamic, periodic and continuous, equilibrium and non-equilibrium. Maceration, remaceration, percolation, repercolation, rapid repercolation, continuous extraction, circulation.

Equipment for extraction of animal and plant raw materials: maceration tanks, commuted and uncommunicated battery extractors (percolators), continuous extractors, rotary pulsation apparatus.

Ways of intensification of the extraction process: changes in hydrodynamic conditions, powdering and deformation of raw materials in the extractant, the impact of ultrasound, electromagnetic field, electro-impulse discharges, surfactants, etc.

Extraction in the «liquid – liquid» system. Characteristics of the solvents, the distribution coefficient.

Main methods of extraction separation: single and multiple extraction. Continuous counter-current extraction.

Extractors, classification, structure and working principle of the spray, rotary-disc, pulsation, centrifugal and mixer-settler extractors.

Brief characteristics of plant raw materials and sources of its production. Features of the plant cells structure. Characteristics of biologically active substances of herbal raw materials. Stages of production development of drugs from plant raw materials and their classification. Characteristic of total (native) or galenic and total cleared (neogalenical) drugs. Drugs from individual substances extracted from plants and complex. Technical and economic features of drugs production from plant raw materials. Pharmacopoeia of the Republic of Belarus, Good Manufacturing Practice (GMP) in the production of drugs from plant raw materials.

3.21. Industrial production of tinctures

Tinctures, characteristics, classification. Technological scheme of tinctures production. Methods for extracts production: maceration and its modifications, fourfold maceration, turboextraction, percolation. Obtaining tinctures by dissolving soft and dry extracts.

Purification from ballast substances.

Tests for tinctures: relative density ratio, ethanol content, methanol and 2-propanol, dry residue, heavy metals, quantification. Determination of alcohol concentration in tinctures.

Private technology of tinctures production: setwell, hawthorn, St. John's wort, belladonna, ginseng, lily-of-the-valley, motherwort, eucalyptus, etc. Production of difficult tinctures: peppermint, strophanthus. Production of complex tinctures.

Packing, labeling, storage of tinctures.

Recuperation of alcohol from waste raw material by displacement of water and distillation with water vapor, equipment, rectification.

3.22. Production of 1:1 and 1:2 liquid extracts

Extracts, classification by consistency and applied extractant.

Liquid extracts, characteristics. Technological scheme of liquid extracts production. Methods for extracts production: percolation, repercolation with a complete and uncompleted cycle. Purification from ballast substances.

Tests for liquid extracts: relative density ratio, ethanol content, methanol and 2-propanol, dry residue, heavy metals, quantification.

Nomenclature of liquid extracts (hawthorn, rhodiola, thyme, eleutherococcus, magnolia, passion-flower, etc.).

Packaging, labeling, storage of liquid extracts.

3.23 Industrial production of soft and dry extracts, extracts-concentrates

Soft and dry extracts, characteristics, classification. Technological scheme of soft and dry extracts production. Methods for producing extracts in the production of soft and dry extracts: bismaceration, percolation, repercolation, counter-current extraction, circulation extraction. Purification of aqueous and alcohol extracts from ballast substances. Evaporation and drying of extracts.

Tests for soft and dry extracts: dry residue; solvents; heavy metals; water, loss on drying; quantification.

Nomenclature of soft extracts: belladonna, licorice, setwell, etc.

Nomenclature of dry extracts: belladonna, nux vomica, licorice, hollyhock, etc.

Packing, labeling, storage of soft and dry extracts.

Liquid (1:2) and dry extracts-concentrates for preparation of aqueous extracts. Technological schemes of liquid and dry extracts-concentrates production. The nomenclature of 1:2 liquid extracts-concentrates (setwell) and dry extracts-concentrates (adonis, hollyhock, thermopsis). Tests for liquid and dry concentrate extracts: relative density ratio; ethanol content; methanol and 2-propanol; dry residue; heavy metals; water, loss on drying; quantification.

Packaging, labeling, storage of liquid and dry extracts-concentrates.

3.24. Industrial production of oil extracts and biogenic stimulants

Characteristics of oil extracts and methods of their production. Henbane's oil, St. John's wort oil, rosehips oil, sea buckthorn's oil. Tests for oil extracts: quantitative content of biologically active substances.

Drugs from fresh herbal plant materials.

Not condensed and condensed saps, tinctures and extracts from fresh herbal plant materials, features of their production. Obtaining saps and extraction drugs from fresh herbal plant materials. Tests for saps: quantitative definition. Nomenclature of saps: plantains sap, wormseed sap, kalanchoe sap, etc. Tinctures from fresh herbal materials.

Biogenic stimulators, their chemical structure, properties and production conditions. Drugs from plant and animal raw materials, production and standardization. Production of aloe extract.

Packaging, labeling, storage of oil extracts and biogenic stimulants.

3.25. Industrial production of neogalenicals drugs

Neogalenical drugs. Brief historical background of the creation of the most purified medicinal products from plant raw materials. Technological scheme of neogalenical drugs production. Methods for obtaining the primary extract in the production of neogalenical drugs, characteristics of the extractants. The ways of maximum extraction purification from the ballast and related substances: fractional precipitation, change of solvent, solvent extraction, chromatography etc. Private technology of neogalenical drugs. Production of adonizid.

Classification and production technology of drugs of individual substances of herbal plant materials: digitoxin, celanid, digoxin, ergometrine oleate.

Tests for neogalenical drugs: quantitative determination of biologically active substances.

Packaging, labeling, storage of neogalenical drugs.

3.26. Industrial production of drugs from animal raw materials

Drugs from animal raw materials, characteristics and brief historical background of the creation. Drugs classification from animal raw materials on medical use, the nature of the active substances and methods of production. Features of using animal raw materials in the production of drugs. Technological scheme of drugs production from dried and fat-free animal organs for internal and injectable use.

Hormonal drugs from the thyroid gland (thyroidin), pituitary gland (adrenocorticotropic hormone – ACTH), pancreas (insulin).

Enzyme drugs. Tests: quantitative content.

Packaging, labeling, storage of drugs from animal raw materials.

3.27. Industrial production of aerosols

Characteristics of the inhalation route of drugs administration. Drugs for inhalation, their characteristics and classification. Liquid drugs for inhalation: drugs that are transferred into a vapor state; liquid drugs to spray; metered-dose drugs for inhalations under pressure. Tests for inhalation drugs: uniformity of the released dose, particle size, number of doses in the inhaler.

Powders for inhalations, their tests: particle size, number of doses in a multi-dose inhaler.

Characteristics of under pressure drugs. Characteristics and classification of aerosols. The requirements for under pressure drugs: the size of the particles, dose received with one click on the proportioning valve etc.

Excipients using in the aerosols production: propellants, solvents, solubilizers, surfactants, film formers, etc.

Technological scheme of aerosols production. Characteristics of aerosol cans, valve spray systems. Methods of filling aerosol cans. The range of aerosols: ingalipt, kameton, levovinizol etc. The quality assessment of aerosol cans. Safety in the production, transportation and storage of aerosol packages. Environmental problems of aerosol production.

Packaging, labeling, storage of aerosols.

3.28. Industrial production of eye drugs

Characteristics of eye drugs: eye drops, inserts, eyewashes. Requirements of stability, absence of extraneous mechanical impurities, pH value, comfort to eye drops and eyewashes.

Industrial production of eye drops. Stages and operations of the technological process of eye drops production.

Stabilization and preservation of eye drops, characteristics of preservatives. Using buffer solvents in the production of eye drops. Prolongation of the action of eye drops with methylcellulose, polyvinyl alcohol, polyacrylamide, etc.

Calculation of isotonicity for eye drops. Sterilization of eye drops. Tests for eye drops: the size of the particles. Packaging, its effect on the stability and sterility of eye drops. Nomenclature, labeling, storage of eye drops.

Eye soft drugs. Requirements for eye ointments and basics for eye ointments. Sterility, stability of eye ointments. Technological scheme of production of eye ointments in aseptic conditions. Standardization of eye ointments: particle size,

homogeneity, structural and rheological properties, viscosity, pH, etc. Tests for eye ointments: particle size. Nomenclature of eye ointment industrial production.

Packaging, labeling, storage of eye ointments.

Characteristics of eye inserts, film formers in the manufacture of ophthalmic inserts. Technological scheme of production of eye inserts. Tests for eye inserts: the uniformity of dosage units, content uniformity. Nomenclature of eye inserts.

Packaging, labeling, storage of eye inserts.

Powders for eye drops and eyewashes preparation, their characteristics and tests: the uniformity of dosage units, content uniformity, uniformity of mass.

3.29. Prolonged and directed action drugs

Prolonged and directed action drugs.

Classification of drugs by time of action and the nature of the distribution of active substances in the human body. Drugs of short-term periodic action and, as a rule, system distribution (drugs of the first generation). Prolonged action drugs and the system of distribution (drugs of the second generation). Long-term and directed action drugs (third-generation drugs).

Methods of prolongation of the action of drugs: reducing the rate of excretion from the body, slowing biotransformation, inhibition and duration of absorption. Immobilization of drugs on inorganic and organic vehicles. Methods of drugs immobilization: physical (adsorption, inclusion in the gel, microcapsulation), physical and chemical (formation of inclusion compounds, solid dispersions) and chemical (covalent binding of drugs with the polymer vehicle, crosslinking of drug molecules with the polymer using bifunctional reagents, etc.).

Therapeutic systems: matrix (biodegradable and non-biodegradable), membrane, osmotic, targeted delivery systems of active substances.

Transdermal therapeutic systems (TTS). Classification of TTS by technological and pharmacokinetic principle.

Directed action drugs. Ringsdorf model and its components: polymer vehicle, solubilizer, medicine, vector (targeting device). Modern nomenclature of delivery systems: monoclonal antibodies, glycoproteins, erythrocytes.

Liposomes, characteristics, classification. Single-layer and multi-layer liposomes. Thermosensitive and pH-sensitive liposomes. Excipients for liposomes production. Natural phospholipids. Methods of liposomes production. Obtaining liposomes by ultrasound. Inclusion of drugs in liposomes. Directed transport of liposomes.

Erythrocytes as vehicles of drugs. Methods of drugs administration into red blood cells.

Directed drugs administration by magnetic field. Ferrites, ferromagnetic fluids, magnetically controlled liposomes, microcapsules, red blood cells, their characteristics.

3.30. Drafting of regulatory documentation for the production of injection and extraction drugs

Technological schemes of injectable dosage forms production. Technological process description of injectable dosage forms production. Drafting of material balance taking into account losses at different stages and operations of injectable

dosage forms production. Technical code of practice TCP 030-2017 (02040). Good Manufacturing Practice. Technological production regulations, the order of development of sterile products production.

General characteristics and principles of normative and technological documentation for extractive drugs production. Technical code of practice TCP 030-2017 (02040). Good Manufacturing Practice. Technological production regulations, the order of development of extractive drugs production.

COURSE WORK IN DISCIPLINE «INDUSTRIAL TECHNOLOGY OF DRUGS»

The main objective of the course work is to create more profound knowledge on the chosen topic concerning drugs production in industrial conditions, the preparation of technological schemes of the production process, quality control of intermediate products and the ready-made products.

While working, the student should acquire the following practical skills in solving technological and technical issues: to select information in accordance with the theme plan; to analyze technologies of drugs production in accordance with GMP requirements; to make technological schemes of drugs production; to summarize information material on the topic with offers for implementation in practical pharmacy.

The task to perform the course work students receive at the Department of Pharmaceutical Technology at their teacher. In some cases, the Department can offer the student to do research work on the scientific topic of the department.

The work is carried out under the guidance of a teacher. If students have complex themes, teachers from other departments can be their consultants. Recommended plan can be specified or modified in the process of implementation, but it should reflect all the issues concerning the research of the topic. All the changes should be coordinated with the teacher.

The paper should contain no more than 30 pages, including visual materials, conclusions and list of literature (appendix are not included in the total volume of paper).

The course work defense is carried out at the department within the established time.

EDUCATIONAL DISCIPLINE CURRICULAR CHART

Section, topic No	Section (topic) name	number of hours		self-studies	Form of control
		lectures	practical		
	7 semester				
1.	**Introduction to the discipline «Industrial Technology of Drugs»**	**4**	**8**	**4**	
1.1	The development of industrial production of drugs in the Republic of Belarus. General principles of the organization of drugs production at pharmaceutical enterprises	2	4	1	Test, written classroom practical exercises, interview, report publications
1.2	Rules of GMP, GLP, GCP, GVP. Normative and technical documentation of drugs production	2	4	3	Test, written classroom practical exercises, interview, tasks solution
2.	**Processes and equipment of pharmaceutical technology**	**12**	**24**	**14**	
2.1	The main processes of industrial technology, their role in the drugs production. General concepts of machines and devices	2	4	3	Test, written classroom practical exercises, interview
2.2	Heat processes and equipment	2	4	3	Test, written classroom practical exercises, interview
2.3	Mechanical processes and equipment	2	4	2	Test, written classroom practical exercises, interview

2.4	Hydromechanical processes and equipment. Basics of hydraulics	4	8	3	Test, written classroom practical exercises, interview
2.5	Mass-exchanging processes and equipment	2	4	3	Test, written classroom practical exercises, interview, **control questioning,** evaluation based on module rating system
3.	**Industrial technology of drugs**	**50**	**86**	**122**	
3.1	Industrial technology of solid drug forms. Powders and herbal teas production	2	4	2	Test, written classroom practical exercises, interview, case based evaluation (case tasks solution)
3.2	Industrial production of granules and dragee. Study of physical-chemical and technological properties of powders and granulates	2	4	2	Test, written classroom practical exercises, interview, case based evaluation (case tasks solution)
3.3	Tablets (characteristics and classification). Theoretical bases of tableting. Characteristics of tablet machines	2	4	4	Test, written classroom practical exercises, interview, case studies
3.4	Excipients used in the tablets production. Technological schemes of tablets production	2	4	4	Test, written classroom practical exercises, interview, case studies
3.5	Tests for tablets	-	4	4	Test, written classroom practical exercises, interview, case studies
3.6	Tablets coating. Production of molded, multi-layer and matrix tablets	2	4	4	Test, written classroom practical exercises, interview, case based evaluation (case tasks solution)
3.7	Industrial production of capsules. Microencapsulation of drugs	2	4	4	Test, written classroom practical exercises, interview,

					case studies
3.8	Drafting of regulatory documentation for the tablets production	-	4	4	Test, written classroom practical exercises, interview, evaluation based on modular rating system, **credit**
3.9	Industrial production of semi-solid drugs	2	-	-	
3.10	Industrial production of suppositories and medical pencils	2	-	-	
3.11	Industrial production of patches and mustard plasters	2	-	-	
	8 semester				
3.9	Industrial production of semi-solid drugs	-	3	5	Test, written classroom practical exercises, interview, case studies
3.10	Industrial production of suppositories and medical pencils	-	3	5	Test, written classroom practical exercises, interview, case studies, accounts of laboratory work with oral defense
3.11	Industrial production of patches and mustard plasters	-		4	Test, written classroom practical exercises, case studies, **control questioning**, interview
3.12	Industrial production of liquid drugs for internal and external use	2	3	4	Test, written classroom practical exercises, interview, case studies, accounts of laboratory work with oral defense
3.13	Production of drugs for parenteral use and organization of their industrial production	2	3	5	Test, written classroom practical exercises, interview, case studies, accounts of laboratory work with oral defense

3.14	Production and preparation of ampoules for filling. Technological scheme of the production of solutions in ampoules	2	3	10	Test, written classroom practical exercises, interview, case studies, electronic tests
3.15	Mechanization and automation of ampoule production. Quality assessment of solutions for injections in ampoules	-			
3.16	Features of industrial technology of solutions for injections in ampoules, infusions, sterile suspensions and emulsions. Assessment of the impact of technological factors on the quality of solutions for injection	2	3	4	Test, written classroom practical exercises, interview, case studies, accounts of laboratory work with oral defense
3.17	Industrial production of medical solutions. Production of emulsions and suspensions	2	3	5	Test, written classroom practical exercises, interview, case studies, accounts of laboratory work with oral defense
3.18	Dilution and strengthening of medical solutions in their industrial production	-			
3.19	Industrial production of syrups, essential oils, aromatic waters	2	3	4	Test, written classroom practical exercises, interview, case studies
3.20	Basic extraction regularities of capillary-porous raw materials with cellular structure. Characteristics of galenic drugs	2	3	5	Test, written classroom practical exercises, interview, case based evaluation (case tasks solution)
3.21	Industrial production of tinctures	2	3	4	Test, written classroom practical exercises, interview, case studies
3.22	Production of 1:1 and 1:2 liquid extracts	2	3	4	Test, written classroom practical exercises, interview, case studies, accounts of laboratory work with oral defense

3.23	Industrial production of soft and dry extracts, extract-concentrates	2	3	4	Test, written classroom practical exercises, interview, case based evaluation (case tasks solution)
3.24	Industrial production of oil extracts and biogenic stimulants	2	3	4	Test, written classroom practical exercises, interview, case studies
3.25	Industrial production of neogalenic drugs	2	3	4	Test, written classroom practical exercises, interview, case studies
3.26	Industrial production of drugs from animal raw materials	2	3	5	Test, written classroom practical exercises, case based evaluation (case tasks solution), **control questioning**, interview
3.27	Industrial production of aerosols	2	3	4	Test, written classroom practical exercises, interview, case studies, electronic tests, accounts of laboratory work with oral defense
3.28	Industrial production of eye drugs	2	3	4	Test, written classroom practical exercises, interview, case studies
3.29	Prolonged and directed action drugs	2	3	10	Test, written classroom practical exercises, interview, case studies; **examination**
3.30	Drafting of regulatory documentation for the production of injection and extraction drugs	-			
	Total hours	**66**	**118**	**140**	

INFORMATION AND INSTRUCTIONAL UNIT

LITERATURE

Basic:

1. Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems / Loyd Allen, Howar Ansee / LWW; Tenth, North American edition. – 2013. – 832 p.
2. Industrial drug technology (eng) / Yu.V.Yudina, Yu.V.Shmyrova, S.V.Stepanenko and etc./, Kharkiv NUPh «Original», 2012. – 255 p.
3. The Theory and Practice of Pharmaceutical Technology. University Textbook /Attila Dévay / University of Pécs Institute of Pharm. Tech. and Biopharm. – 2013. – 526 p.
4. Pharmaceutical Manufacturing Handbook : Production and processes / Shayne Cox Gad / John Wiley & Sons, Inc. – 2010. – 1386 p.
5. European Medicine Agency. Guidelines for Good Manufacturing Practice for Medicinal Products for Human and Veterinary Use. Public Health. EudraLex - Volume 4 – 2018.

Additional:

6. Pharmaceutical Process Engineering / Anthony J. Hickey David Ganderton / Informa Healthcare USA, Inc. – 2010. – 238 p.
7. Encyclopedia of Pharmaceutical Science and Technology. 4th Edition / James Swarbrick / CRC Press. – 2013. – 4296 p.
8. European Medicine Agency. Guideline on the quality of water for pharmaceutical use, 2018
9. European Medicine Agency. Guideline on the sterilisation of the medicinal product, active substance, excipient and primary container, 2019
10. European Medicine Agency. Guideline on Good Pharmacovigilance Practices (GVP), 2017
11. European Medicine Agency. Guideline on process validation for finished products, 2016
12. Guidelines on packaging for pharmaceutical products, Annex 9 (WHO Technical Report Series, No. 902)
13. ICH. Harmonised Tripartite Guideline. Quality Risk Management Q10, 2009
14. Stability testing of active pharmaceutical ingredients and finished pharmaceutical products. Forty-third report. Annex 2 (WHO Technical Report Series, No.953).
15. International Council on Harmonisation. ICH Q1A (R2): Stability testing of new drug substances and products
16. International Council on Harmonisation. ICH Q2 (R1): Validation of analytical procedures: text and methodology
17. International Council on Harmonisation. ICH Q3B: Impurities in drug products
18. International Council on Harmonisation. ICH Q7: Good Manufacturing Practice: Guide for active pharmaceutical ingredients

19. International Council on Harmonisation. ICH Q8: Pharmaceutical development, 2009
20. Guidelines on good manufacturing practices: validation. In: Quality assurance of pharmaceuticals. WHO guidelines, good practices, related regulatory guidance and GXP training materials, Geneva, World Health Organization, 2016
21. WHO good manufacturing practices: main principles for pharmaceutical products. In: WHO guidelines, good practices, related regulatory guidance and GXP training materials, Geneva, World Health Organization, 2016

LIST OF AVAILABLE DIAGNOSTIC TOOLS

The following forms are used for competences assessment:

1. Oral form:
- interviews.
2. Written form:
- tests;
- control questioning;
- written classroom practical exercises;
- article/report publications;
- evaluation based on module-rating system;
- case based evaluation (case tasks solution);
- tasks solution;
- case studies.
3. Oral-written form:
- accounts of laboratory work with oral defense;
- credit;
- examination.
4. Technical form:
- electronic tests.

LIST OF PRACTICAL SKILLS

In the process of studying the discipline, students should acquire the following practical skills:

- use Pharmacopoeia, Pharmacopoeia articles of the manufacturer, technical regulations and other regulatory documents;
- develop technological documentation for ready-made drugs;
- make technological schemes of drugs production;
- develop different drug forms;
- carry out quality control of different drug forms;
- carry out biopharmaceuticals research in drug forms development.

LIST OF LECTURES

7 semester

1. Introduction to the discipline «Industrial Technology of Drugs».
2. The development of industrial production of drugs in the Republic of Belarus. General principles of the organization of drugs production at pharmaceutical enterprises.
3. Rules of GMP, GLP, GCP, GVP. Normative and technical documentation of drugs production.
4. Processes and equipment of pharmaceutical technology. The main processes of industrial technology, their role in the drugs production. General concepts of machines and devices.
5. Mechanical processes and equipment.
6. Hydromechanical processes and equipment. Basics of hydraulics.
7. Heat processes and equipment.
8. Mass-exchanging processes and equipment.
9. Industrial technology of drugs. Industrial technology of solid drug forms. Powders and herbal teas production.
10. Industrial production of granules and dragee. Study of physico-chemical and technological properties of powders and granulates.
11. Tablets (characteristics and classification). Theoretical bases of tableting. Characteristics of tablet machines.
12. Excipients used in the tablets production. Technological schemes of tablets production.
13. Tablets coating. Production of molded, multi-layer and matrix tablets.
14. Industrial production of capsules. Microencapsulation of drugs.
15. Industrial production of semi-solid drugs.
16. Industrial production of suppositories and medical pencils.
17. Industrial production of patches and mustard plasters.

8 semester

1. Industrial production of medical solutions. Production of emulsions and suspensions. Industrial production of liquid drugs for internal and external use.
2. Industrial production of syrups, essential oils, aromatic waters.
3. Basic extraction regularities of capillary-porous raw materials with cellular structure. Characteristics of galenic drugs.
4. Industrial production of tinctures.
5. Production of 1:1 and 1:2 liquid extracts.
6. Industrial production of soft and dry extracts, extract-concentrates.
7. Industrial production of oil extracts and biogenic stimulants.
8. Industrial production of neogalenicals drugs.
9. Industrial production of drugs from animal raw materials.
10. Production of drugs for parenteral use and organization of their industrial production.

11. Production and preparation ampoules for filling. Technological scheme of the production of solutions in ampoules.
12. Sterilization in industrial technology of drugs
13. Features of industrial technology of solutions for injections in ampoules, infusions, sterile suspensions and emulsions. Assessment of the impact of technological factors on the quality of solutions for injection.
14. Production of freeze-dried drugs.
15. Industrial production of aerosols.
16. Industrial production of eye drugs.

LIST OF LABORATORY (PRACTICAL) STUDIES

7 semester

1. Introduction to the discipline «Industrial Technology of Drugs». The development of industrial production of drugs in the Republic of Belarus. General principles of the organization of drugs production at pharmaceutical enterprises.
2. Rules of GMP, GLP, GCP, GVP. Normative and technical documentation of drugs production. Processes and equipment of pharmaceutical technology. The main processes of industrial technology, their role in the drugs production. General concepts of machines and devices.
3. Mechanical processes and equipment.
4. Hydromechanical processes and equipment. Basics of hydraulics.
5. Hydromechanical processes and equipment.
6. Heat processes and equipment.
7. Mass-exchanging processes and equipment.
8. Colloquium #1 on the topics #1-8.
9. Industrial technology of drugs. Industrial technology of solid drug forms. Powders and herbal teas production.
10. Industrial production of granules and dragee. Study of physical-chemical and technological properties of powders and granulates.
11. Tablets (characteristics and classification). Theoretical bases of tableting. Characteristics of tablet machines.
12. Excipients used in the tablets production. Technological schemes of tablets production. Drafting of regulatory documentation for the tablets production.
13. Tablets coating. Production of molded, multi-layer and matrix tablets.
14. Industrial production of capsules. Microencapsulation of drugs.
15. Colloquium #2 on the topics #10-15.
16. Credit.

8 semester

1. Industrial production of semi-solid drugs.
2. Industrial production of suppositories and medical pencils. Industrial production of patches and mustard plasters.
3. Industrial production of liquid drugs for internal and external use.

4. Industrial production of medical solutions. Production of emulsions and suspensions. Dilution and strengthening of medical solutions in their industrial production.
5. Industrial production of syrups, essential oils, aromatic waters.
6. Colloquium #3 on the topics #1-5
7. Basic extraction regularities of capillary-porous raw materials with cellular structure. Characteristics of galenical drugs.
8. Industrial production of tinctures.
9. Production of 1:1 and 1:2 liquid extracts.
10. Industrial production of soft and dry extracts, extract-concentrates. Industrial production of oil extracts and biogenic stimulants.
11. Industrial production of neogalenic drugs.
12. Industrial production of drugs from animal raw materials.
13. Production of drugs for parenteral use and organization of their industrial production.
14. Production and preparation of ampoules for filling. Technological scheme of the production of solutions in ampoules. Mechanization and automation of ampoule production. Quality assessment of solutions for injections in ampoules.
15. Features of industrial technology of solutions for injections in ampoules, infusions, sterile suspensions and emulsions. Assessment of the impact of technological factors on the quality of solutions for injection.
16. Industrial production of aerosols.
17. Industrial production of eye drugs.
18. Colloquium #4 on the topics #7-17.

PROTOCOL OF THE CURRICULUM APPROVAL BY OTHER DEPARTMENTS

Title of the discipline requiring approval	Department	Amendments to the curriculum of the academic discipline	Decision of the department, which designed the curriculum (date, protocol #)
1. Standardization of drugs	Pharmaceutical chemistry	No offers	Protocol #9 of 10.04.2019

COMPILERS/AUTHORS:

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