UKRAINIAN MINISTRY OF HEALTH OF UKRAINE
NATIONAL PHARMACEUTICAL UNIVERSITY
DEPARTMENT OF PHYSICS

BIOPHYSICS, PHYSICAL METHODS OF ANALYSIS

WORKING SYLLABUS
of academic course

qualification _____**Master of Pharmacy**_____
(name of higher education level)

field of study _____**22 Public Health**_____
(code and the name of the field of knowledge)

speciality _____**226 Pharmacy for foreign students**_____
(code and specialty)

educational program _____**Pharmacy**_____
(name of educational program)

specialization _____
(name of specialization)

2016 year

Working syllabus on course **Biophysics, Physical methods of analysis** of speciality **226 Pharmacy** of educational program **Pharmacy** for 1st year students.

Developer: prof._Storozhenko I.P., head of physics department
teacher Barannyk M.O.

Working syllabus reviewed and approved at the physics department meeting

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Protocol № ___, «____»_____2016

Head of department _____ prof.___Storozhenko I.P.

(signature) (surname and initials)

Working syllabus approved at the meeting of specialized methodical committee

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Protocol № ___, «____»_____2016

Head of specialized committee _____ prof. Yarnykh T.G.

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1. Description of course

"Biophysics, physical methods of analysis" studies the physical and chemical processes that occur in biological systems, using physical and mathematical methods. The object of study of biophysics are separate molecules (molecular biophysics), cells (cell biophysics), and organs, tissues, systems and interaction with an environment. To study the biological systems biophysics is using different physical methods of analysis.

The subject of studying discipline "Biophysics, physical methods of analysis" is the knowledge of physical processes occurring in biological environments, impact of external factors on living organisms and physical methods of analysis that used in medicine and pharmacy. According to the curriculum "Biophysics, physical methods of analysis" is one of the basic general educational disciplines that form the theoretical basis for training highly qualified specialists for pharmacy. The study of this discipline forms the student's basic understanding of the properties and the most general form of matter motion, the most important physical laws underlying mechanical, thermal, electrical, magnetic, spectral, polarization and other physical methods of study of the drugs properties.

Interdisciplinary connections. "Biophysics, physical methods of analysis" as an academic discipline integrates with the following disciplines as higher mathematics, inorganic chemistry, biology, physiology, human anatomy, etc.; lays the foundations for studying by students biochemistry, pathophysiology, clinical laboratory diagnostics, clinical pharmacology and clinical pharmacy, analytical chemistry, pharmaceutical chemistry, physical and colloid chemistry and others.

The information volume of academic discipline. To studying the discipline assigned 150 hours (5 ECTS).

2. The purpose and tasks of academic discipline

The purpose of teaching of academic discipline "Biophysics, physical methods of analysis" is the deepening and improvement of knowledge, skills and practical understanding of biophysical processes in living organisms; physical methods of diagnosis and investigation of biological systems; the impact of physical factors on the human body, as well as consideration of a number of questions that are necessary for future pharmacists in the study of pharmaceutical sciences at the undergraduate courses and in their careers.

The main **tasks** of the course "Biophysics, physical methods of analysis" is

- mastering of students of the basic principles and theoretical positions of biophysics;
- explaining of the relationship of physical and biological aspects of living systems;
- studying biological problems associated with physical and physicochemical mechanisms of interactions that underlie biological processes;
- investigation of transformation mechanisms of energy in biological systems, electronic-conformational interactions in biomacromolecules, regulation and self-organization of complex biological systems.
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Achieving these goals will enable to students-pharmacists to master by physical, biophysical and mathematical knowledge and skills that necessary to prepare pharmacists as well as to explore other disciplines in higher medical and pharmaceutical educational establishments.

3. Competencies and planned results of learning

Discipline "Biophysics, physical methods of analysis" provides acquisition of ***competences*** by education applicants:

- *Integrated:*
  - the ability to solve typical and complex specialized tasks and practical problems in professional pharmaceutical activities using regulations, theories and methods of fundamental, chemical, technology, medical, pharmacological, social and economic sciences;
  - integrate knowledge and handle complexity, formulate opinion with incomplete or limited information;
  - clearly and unambiguously convey their conclusions and knowledge to professional and non professional audience, reasonably justify it.
- *General:*
  - the ability to apply knowledge in practical situations;
  - the ability to abstract thinking, analysis and synthesis;
  - the ability to learn and be trained in modern;
  - adaptability and actions in the new situation;
  - the ability to assess and provide the quality of performed work;
  - the ability to conduct research at an appropriate level.
- *Special (professional, substantive):*
  - ability to develop methods for quality control of medicinal products, pharmaceutical substances, medicinal plant materials and auxiliary substances using physical methods of control;
  - ability to identify drugs and its metabolites in biological fluids and tissues, to conduct research of the chemical composition of new pharmaceutical substances;
  - ability to ensure proper storage of medicines and medical devices in accordance with their physicochemical properties and rules of Good storage practices (GSP) in health facilities;
  - ability to ensure rational use of prescription and non-prescription medicines according to physicochemical and pharmacological characteristics.

Following the completion of educational discipline applicant should

know:

- physical basis and biophysical mechanisms of the action of external factors on systems of the human body;
- theoretical foundations of physical methods of drugs research of, principles of structure and work of appropriate equipment;
- the possibility and scope learned methods;
- general physical and biophysical laws that underlie human life;

be able:

- apply the physics methods in studies of biological objects;
- work with measuring equipment that is used in biology, medicine and pharmacy;
- apply mathematical methods in the analysis of research results;

have:

- physical methods of analysis and to know physical basis of the following methods: visible, ultraviolet and infrared spectroscopy; Raman spectroscopy; Mass spectroscopy; Spectroscopy of nuclear magnetic resonance; X-ray analysis; thermal analysis; chromatography; polarimetry; refractometry; microscopic analysis; colorimetry.

4. Structure of the course

Names of content modules and subjects	Number of hours					
	full time mode					
	Total	including				
		L	S	PT	LW	SW
1	*2*	*3*	*4*	*5*	*6*	*7*
Content module 1. Fundamentals of General Biophysics						
Topic 1. Mechanical oscillations and waves. Biophysics of muscle contraction.	13	2	1	6	-	4
Topic 2. Molecular Physics. Thermodynamics.	14	2	1	6	-	5
Topic 3. Thermodynamics of biological processes. Molecular Biophysics.	13	2	1	6	-	4
Topic 4. Biophysics of vision. Biophysics of hearing.	13	2	1	6	-	4
Topic 5. Nuclear physics and quantum mechanics.	14	2	1	6	-	5
Topic 6. Transport of substances through biological membranes.	13	2	1	6	-	4
Total in 1st content module	80	12	6	36	-	26
Content module 2. Fundamentals of Applied Biophysics						
Topic 7. Hydrostatics and hydrodynamics. Biophysics of the blood system.	14	2	1	6	-	5
Topic 8. Electromagnetism. Biophysics of nerve impulses.	15	2	2	6	-	5
Topic 9. The action of physical factors on biological objects. Own physical fields of human.	14	2	1	6	-	5
Topic 10. Mathematical Biophysics.	13	2	1	6	-	4
Topic 11. Physical methods of analysis.	14	2	1	6	-	5
Total in 2nd content module	70	10	6	30	-	24
Final module control						
Total hours	150	22	12	66	-	50

5. The content of the syllabus of the academic course

Content module 1. Fundamentals of General Biophysics

Topic 1. Mechanical oscillations and waves. Biophysics of muscle contraction.

Mechanical oscillation and waves. The muscle fibre structure. Muscle tension. The power and speed of muscle contraction.

Topic 2. Molecular Physics. Thermodynamics.

Principles of the molecular-kinetic theory of ideal gases. Basic concepts of thermodynamics. The first law of thermodynamics. The second law of thermodynamics. Thermodynamic potentials. Real gases. Phase transitions. Transport phenomena.

Topic 3. Thermodynamics of biological processes. Molecular Biophysics.

Features of biological objects as thermodynamic systems. The first law of thermodynamics in chemistry and biology. The second law of thermodynamics for opened systems. Change in standard free energy. Chemical and electrochemical potentials. The rate of increase of entropy and the dissipative function. Conjugated processes. Concepts of linear non-equilibrium thermodynamics. Onsager's equation. Criteria for reaching and stability of stationary states.

Types of interactions in macromolecules. The structure of water and hydrophobic interactions. The structure and properties of biopolymers. The structure of proteins. Transitions "spiral-ball". Enzyme catalysis. Biophysics of nucleic acids.

Topic 4. Biophysics of vision. Biophysics of hearing.

Optics. Thermal radiation. The optical system of the human eye. The molecular mechanism of vision. Sounds waves. Intensity of sounds. Intensity level. Doppler Effect. Biophysical function of the ear.

Topic 5. Nuclear physics and quantum mechanics.

The Bohr's theory of the atomic structure. Nuclear reactions. Radioactivity. The Planck's formula. Photo effect. Corpuscular properties of light. Wave properties of particles. The Heisenberg uncertainly principle. The wave function. The Schrödinger's equation. Quantum numbers. The Pauli exclusion principle. X-rays. Interaction of the ionizing radiation with matter.

Topic 6. Transport of substances through biological membranes.

The structure of biological membranes. Phase transitions in membranes. Passive transport of neutral particles. Passive transport of ions. The Nernst equation. The Donnan equilibrium. Ion transport through channels. Passive transport of substances with carriers. Induced ion transport. Active transport. The secondary active transport.

Content module 2. Fundamentals of Applied Biophysics

Topic 7. Hydrostatics and hydrodynamics. Biophysics of the blood system.

Hydrostatics and hydrodynamics. Surface phenomena. Rheological and hemodynamic characteristics of blood. The erythrocyte sedimentation rate. The Frank's model. The pulse wave. Mass transfer in the capillary network.

Topic 8. Electromagnetism. Biophysics of nerve impulses.

Electrostatics. Conductors in an electric field. Energy of the electric field. Dielectrics in the electric field. Direct electric current. Magnetostatics. Magnetic properties of bodies. Electromagnetic induction. Alternating current. Electromagnetic oscillations. Maxwell's equations. Electromagnetic waves. The resting membrane potential. The action potential. Electric stimulation of membranes. Excitation propagation along a nerve fibre. The rate of the nerve impulse propagation.

Topic 9. The action of physical factors on biological objects. Own physical fields of human.

The effect of the electric current on living organisms. The mechanism of the biological action of electromagnetic waves of the radio-frequency range. Electronic transitions in atoms and molecules. The effect of the optical range on biological objects. The effect of the ultraviolet radiation on biological molecules. The target theory. The optical radiation in medicine. Doses of the ionizing radiation. The effect of the ionizing radiation on a living organism. Quantitative evaluation of radio damage. Modification of radiobiological effects. Electric and magnetic fields of human. Physical principles of electrocardiography. Thermal radiation. Bioluminescence.

Topic 10. Mathematical Biophysics.

The "predator-prey" model. Analysis of the "predator-prey" model. Features of modelling of pharmacokinetic processes. The one-compartment pharmacokinetic model. The subcompartment pharmacokinetic model. The model of continuous introduction of a medicine.

Topic 11. Physical methods of analysis.

Spectral analysis. Visible spectroscopy. Ultraviolet spectroscopy. Infrared spectroscopy. Raman Spectroscopy. Spectroscopy of nuclear magnetic resonance. Mass spectroscopy. X-ray. Microscopic analysis. Polarimetry. Thermal analysis. Refractometry. Chromatography.

Final module control

6. Topics of lectures

№	Topics	Number of hours
		Full time mode
1	Mechanical oscillations and waves. Biophysics of muscle contraction.	2
2	Molecular Physics. Thermodynamics.	2
3	Thermodynamics of biological processes. Molecular Biophysics.	2
4	Biophysics of vision. Biophysics of hearing.	2
5	Nuclear physics and quantum mechanics.	2
6	Transport of substances through biological membranes.	2
7	Hydrostatics and hydrodynamics. Biophysics of the blood system.	2
8	Electromagnetism. Biophysics of nerve impulses.	2
9	The action of physical factors on biological objects. Own physical fields of human.	2
10	Mathematical Biophysics.	2
11	Physical methods of analysis.	2
	Total hours	**22**

Plans of lectures

Topic 1. Mechanical oscillations and waves. Biophysics of muscle contraction.

Plan:

1.1. Mechanical oscillation and waves.

1.2. The muscle fibre structure. Muscle tension. The power and speed of muscle contraction.

Topic 2. Molecular Physics. Thermodynamics.

Plan:

2.1. Principles of the molecular-kinetic theory of ideal gases. Basic concepts of thermodynamics. The first law of thermodynamics. The second law of thermodynamics.

2.2. Thermodynamic potentials. Real gases.

2.3. Phase transitions. Transport phenomena.

Topic 3. Thermodynamics of biological processes. Molecular Biophysics.

Plan:

3.1. Features of biological objects as thermodynamic systems. The first law of thermodynamics in chemistry and biology. The second law of thermodynamics for opened systems.

3.2. Change in standard free energy. Chemical and electrochemical potentials. The rate of increase of entropy and the dissipative function.

3.3. Conjugated processes. Concepts of linear non-equilibrium thermodynamics. Onsager's equation. Criteria for reaching and stability of stationary states.

Topic 4. Biophysics of vision. Biophysics of hearing.

Plan:

4.1. Optics. Thermal radiation.

4.2. The optical system of the human eye. The molecular mechanism of vision.

4.3. Sounds waves. Intensity of sounds. Intensity level.

4.4. Doppler Effect. Biophysical function of the ear.

Topic 5. Nuclear physics and quantum mechanics.

Plan:
5.1. The Bohr's theory of the atomic structure. Nuclear reactions. Radioactivity. The Planck's formula. Photo effect. Corpuscular properties of light.
5.2. Wave properties of particles. The Heisenberg uncertainly principle. The wave function. The Schrödinger's equation. Quantum numbers. The Pauli exclusion Principle.
5.3. X-rays. Interaction of the ionizing radiation with matter.
Topic 6. Transport of substances through biological membranes.
Plan:
6.1. The structure of biological membranes. Phase transitions in membranes.
6.2. Passive transport of neutral particles. Passive transport of ions. The Nernst equation. The Donnan equilibrium.
6.3. Ion transport through channels. Passive transport of substances with carriers. Induced ion transport.
6.4. Active transport. The secondary active transport.
Topic 7. Hydrostatics and hydrodynamics. Biophysics of the blood system.
Plan:
7.1. Hydrostatics and hydrodynamics. Surface phenomena.
7.2. Rheological and hemodynamic characteristics of blood. The erythrocyte sedimentation rate.
7.3. The Frank's model. The pulse wave. Mass transfer in the capillary network.
Topic 8. Electromagnetism. Biophysics of nerve impulses.
Plan:
8.1. Electrostatics. Conductors in an electric field. Energy of the electric field. Dielectrics in the electric field. Direct electric current.
8.2. Magnetostatics. Magnetic properties of bodies. Electromagnetic induction.
8.3. Alternating current. Electromagnetic oscillations. Maxwell's equations. Electromagnetic waves.
8.4. The resting membrane potential. The action potential. Electric stimulation of membranes. Excitation propagation along a nerve fibre. The rate of the nerve impulse propagation.
Topic 9. The action of physical factors on biological objects. Own physical fields of human.
Plan:
9.1. The effect of the electric current on living organisms. The mechanism of the biological action of electromagnetic waves of the radio-frequency range. Electronic transitions in atoms and molecules. The effect of the optical range on biological objects. The effect of the ultraviolet radiation on biological molecules.
9.2. The target theory. The optical radiation in medicine. Doses of the ionizing radiation. The effect of the ionizing radiation on a living organism. Quantitative evaluation of radio damage. Modification of radiobiological effects.
9.3. Electric and magnetic fields of human. Physical principles of electrocardiography. Thermal radiation. Bioluminescence.
Topic 10. Mathematical Biophysics.
Plan:
10.1. The "predator-prey" model. Analysis of the "predator-prey" model.
10.2. Features of modelling of pharmacokinetic processes. The one-compartment pharmacokinetic model. The subcompartment pharmacokinetic model. The model of continuous introduction of a medicine.

Topic 11. Physical methods of analysis.
Plan:
11.1. Spectral analysis. Visible spectroscopy. Ultraviolet spectroscopy. Infrared spectroscopy. Raman Spectroscopy. Spectroscopy of nuclear magnetic resonance. Mass spectroscopy.
11.2. X-ray. Microscopic analysis. Polarimetry. Thermal analysis. Refractometry. Chromatography.

7. Topics of seminars

№	Topics	Number of hours
		Full time mode
1	Mechanical oscillations and waves. Biophysics of muscle contraction.	1
2	Molecular Physics. Thermodynamics.	1

3	Thermodynamics of biological processes. Molecular Biophysics.	1
4	Biophysics of vision. Biophysics of hearing.	1
5	Nuclear physics and quantum mechanics.	1
6	Transport of substances through biological membranes.	1
7	Hydrostatics and hydrodynamics. Biophysics of the blood system.	1
8	Electromagnetism. Biophysics of nerve impulses.	2
9	The action of physical factors on biological objects. Own physical fields of human.	1
10	Mathematical Biophysics.	1
11	Physical methods of analysis.	1
	Total hours	**12**

Plans of seminars

Topic 1. Mechanical oscillations and waves. Biophysics of muscle contraction.
The purpose of class: Studying of mechanical oscillations and waves parameters. Introduction to the theory of muscle contraction.
Plan:
1.1. Parameters of mechanical oscillations and waves.
1.2. The structure of the muscle fiber. Characteristics of muscles work. The power and speed of muscle contraction.
1.3. Physical methods of analysis: colorimetry.
Topic 2. Molecular Physics. Thermodynamics.
The purpose of class: Master the basic provisions of the molecular-kinetic theory.
Plan:
2.1. Inquire historical background of the formation of molecular-kinetic theory.
2.2. The process of energy conversion and directions of thermodynamic processes.
2.3. Maxwell and Boltzmann distributions.
2.4. Physical methods of analysis: polarimetry.
Topic 3. Thermodynamics of biological processes. Molecular Biophysics.
The purpose of class: Assimilation of basic provisions of the thermodynamics of biological processes.
Plan:
3.1. Examples of isolated, closed and open thermodynamic systems.
3.2. Classical (equilibrium) thermodynamics and thermodynamics of irreversible processes (nonequilibrium).
3.3. Molecular biophysics.
3.4. Physical methods of analysis: thermal analysis.
Topic 4. Biophysics of vision. Biophysics of hearing.
The purpose of class: Studying of the optical system of the human eye. Studying of the biophysical mechanism of hearing.
Plan:
4.1. The molecular mechanism of vision.
4.2. Biophysical function of the ear.
4.3. Physical methods of analysis: Raman Spectroscopy.
Topic 5. Nuclear physics and quantum mechanics.
The purpose of class: Studying the basics of quantum mechanics as the foundation for the study of quantum chemistry and quantum biophysics.
Plan:
5.1. Examples of nuclear reactions. Radioactivity.
5.2. Wave properties of particles. Wave function.
5.3. The interaction of radiation with matter.
5.4. Physical methods of analysis: mass spectroscopy.
Topic 6. Transport of substances through biological membranes.
The purpose of class: Master the basic process types of transport of drugs through biological membranes.

Plan:
6.1. The ability of substances to overcome the membrane barrier cell - a key to the effectiveness of most drugs.
6.2. Regulations of linear nonequilibrium thermodynamics.
6.3. Onsager's equation.
6.4. Physical methods of analysis: Refractometry.
Topic 7. Hydrostatics and hydrodynamics. Biophysics of the blood system.
The purpose of class: Studying of the rheological and hemodynamic properties of blood.
Plan:
7.1. Studying the basics of hydrostatics.
7.2. Surface phenomena on the border of three environments.
7.3. Frank's model.
7.4. Physical methods of analysis: Chromatography.
Topic 8. Electromagnetism. Biophysics of nerve impulses.
The purpose of class: Studying the basic laws of electrodynamics. Nerve impulse.
Plan:
8.1. Conductors and dielectrics in an electric field.
8.2. The magnetic properties of bodies.
8.3. Electromagnetic waves.
8.4. Physical methods of analysis: visible and ultraviolet spectroscopy.
Topic 9. The action of physical factors on biological objects. Own physical fields of human.
The purpose of class: Studying the interaction of electromagnetic radiation - natural and artificial electromagnetic background on biological organisms.
Plan:
9.1. The mechanism of biological effects of electromagnetic waves.
9.2. Effects of ultraviolet radiation on biological molecules.
9.3. The interaction of radiation with matter.
9.4. Physical methods of analysis: Spectroscopy of nuclear magnetic resonance.
Topic 10. Mathematical Biophysics.
The purpose of class: Learn how to use mathematical methods in pharmacy, biology and medicine.
Plan:
10.1. History of construction of Voltaire's mathematical model.
10.2. The model of interaction types.
10.3. Examples of pharmacokinetic models.
10.4. Physical methods of analysis: microscopic analysis.
Topic 11. Physical methods of analysis.
The purpose of class: Physical methods of analysis.
Plan:
1.1. Consideration of own physical fields of biological organisms.
1.2. Electric field of human.
1.3. Magnetic field of human.

8. Topics of practical training

№	Topics	Number of hours
		Full time mode
1	Mechanical oscillations and waves. Biophysics of muscle contraction.	6
2	Molecular Physics. Thermodynamics.	6
3	Thermodynamics of biological processes. Molecular Biophysics.	6
4	Biophysics of vision. Biophysics of hearing.	6
5	Nuclear physics and quantum mechanics.	6
6	Transport of substances through biological membranes.	6
7	Hydrostatics and hydrodynamics. Biophysics of the blood system.	6
8	Electromagnetism. Biophysics of nerve impulses.	6
9	The action of physical factors on biological objects. Own physical fields of human.	6
10	Mathematical Biophysics.	6
11	Physical methods of analysis.	6
	Total hours	**66**

Plans of practical training

Topic 1. Mechanical oscillations and waves. Biophysics of muscle contraction.

The purpose of class: To learn concepts related with the structure of of muscle fibers and the characteristics of its work.

Plan:

1.1. Mechanical oscillations. Elastic waves.

1.2. The structure of myofibrils.

1.3. The structure of the myosin.

1.4. The structure of striated muscle. Hill's equation.

1.4. The structure of the muscle fiber. Tension of muscle. The power and speed of muscle contraction.

Topic 2. Molecular Physics. Thermodynamics.

The purpose of class: Obtain the practical skills of using the laws of molecular physics and thermodynamics in studying chemical and biological sciences.

Plan:

2.1. Basics of molecular-kinetic theory of gases. Basic concepts of thermodynamics. The first law of thermodynamics. The second law of thermodynamics.

2.2. Thermodynamic potentials.

2.3. Ideal and real gases.

2.4. Phase transitions. Transport Phenomena.

2.5. The average energy of the molecules.

2.6. Maxwell's distribution.

2.7. Boltzmann's distribution.

2.8. Mendeleev-Clapeyron equation.

2.9. Entropy.

Topic 3. Thermodynamics of biological processes. Molecular Biophysics.

The purpose of class: Master the basic provisions of the thermodynamics of biological processes and explore physical structure of biologically important molecules.

Plan:

3.1. Features of biological objects as thermodynamic systems. The first law of thermodynamics in chemistry and biology. The second law of thermodynamics for open systems.

3.2. Changing the standard free energy. Chemical and electrochemical potentials. The rate of increase of entropy and dissipative function.

3.3. Conjugated processes. Regulations of linear nonequilibrium thermodynamics. Onsager's equation. Criteria of achievement and stability of steady states.

3.4. Hess's law - the first law of thermodynamics for chemical processes.

3.5. Clausius criterion - the criterion of the evolution of classical thermodynamics.

3.6. Helmholtz's and Gibbs's thermodynamic potentials. Prigogine's theorem. Model of shimmering clusters. Sterioizomiry. L and D isomers. Tsis- and trans conformation.

Topic 4. Biophysics of vision. Biophysics of hearing.

The purpose of class: To acquire knowledge about the physical structure of the eye and understand the basic physical properties of sound.

Plan:

4.1. The course of rays in the eye of man.

4.2. Absolute threshold of the eye.

4.3. Light absorption and photo conversion in the organs of vision.

4.4. Wave properties. Physical properties of sound.

4.4. Intensity level

4.5. Doppler Effect.

Topic 5. Nuclear physics and quantum mechanics.

The purpose of class: To master the basic provisions of atomic physics and quantum mechanics and learn how to use this knowledge to create new dosage forms.

Plan:

5.1. The Bohr's theory of atomic structure. Nuclear reactions. Radioactivity. Planck's formula. Photoelectric effect. Particle properties of light.

5.2. Wave properties of particles. Ratio of uncertainties. Wave function. Schrödinger's equation. Quantum numbers. Pauli's principle.

5.3. X-ray radiation. The interaction of radiation with matter.

5.4. Bohr's postulates. Atomic spectra. Isotopes. Balmer's formula. Photoelectric effect.

5.5. The de Broglie's wavelength. Heisenberg's ratio.

Topic 6. Transport of substances through biological membranes.

The purpose of class: Form the basic information about the types of transport and the ability of substances to overcome the membranes barrier.

Plan:

6.1. The structure of the membrane. Artificial membrane structures. Phase transitions in membranes.

6.2. Passive transport of neutral particles. Passive transport of ions. Nernst equation. Donnan equilibrium.

6.3. Ion transport through channels. Passive transport of substances using carriers. Induced ion transport. Active transportation. Secondary-active transport.

6.4. Fick's equation for passive transport.

6.5. The coefficient of permeability of the membrane. Teorel's equation. Nernst-Planck's equation. Goldman's equation. Nernst's equation.

Topic 7. Hydrostatics and hydrodynamics. Biophysics of the blood system.

The purpose of class: To master the basic provisions of hydrostatics and hydrodynamics and circulation laws.

Plan:

7.1. The structure of liquids. Hydrostatics and hydrodynamics. Surface phenomena.

7.2. Rheological and hemodynamic properties of blood. Erythrocyte sedimentation rate. Frank's model. Pulse wave. Transfer of substances in the capillary network.

7.3. Frenkel's theory. Pascal's law. The theorem of the continuity of the jet. Bernoulli's equation. Reynolds number. Capillary phenomena. Zhyuren's law. Hematocrit. Pulse wave.

Topic 8. Electromagnetism. Biophysics of nerve impulses.

The purpose of class: Obtain knowledge on the basics of electromagnetism that will understand interact of living organisms with electromagnetic fields.

Plan:

8.1. Electrostatics. Conductors in the electric field. The energy of the electric field. Dielectrics in an electric field. Direct electric current.

8.2. Magnetostatics. The magnetic properties of bodies. Electromagnetic induction.

8.3. Alternating current. Electromagnetic fluctuations. Maxwell's equations. Electromagnetic waves.

8.4. The rest potential. The action potential. Irritation of the membrane by electric shock. The distribution of excitation along nerve fibers. The speed of nerve impulses. Goldman-Hodgkin-Katz's equation.

8.5. The principle of superposition of electric fields. Gauss's law for the electric field.

8.6. Polarization of dielectrics. Ohm's law in differential form.

Topic 9. The action of physical factors on biological objects. Own physical fields of human.
The purpose of class: To form knowledge about the possible effects of electromagnetic radiation on the human body.
Plan:
9.1. Effects of electric current on a living organism. The mechanism of biological effects of electromagnetic waves of of radiofrequency range. Electronic transitions in atoms and molecules. The action of radiation of optical range on biological objects. Effects of ultraviolet radiation on biological molecules.
9.2. Theory of target. Optical radiation in medicine. The doses of ionizing radiation. The action of ionizing radiation on the body. Quantitative evaluation of radiodamage. Modification of the radio-biological effects.
9.3. Electric and magnetic fields of human. Physical principles of electrocardiography. Thermal radiation. Bioluminescence.
9.4. Artificial electromagnetic fields. Photo biological effect of electromagnetic radiation on humans.
9.5. Biological effects of ultraviolet radiation. Photo damage of DNA. Compton effect. X-ray radiation.
Topic 10. Mathematical Biophysics.
The purpose of class: To form the general concepts of mathematical modeling in biophysics.
Plan:
10.1. The model "predator-prey". Analysis of the model "predator-prey".
10.2. Phase portrait of the model "predator-prey".
10.3. Types of singular points.
10.4. Features of pharmacokinetic modeling processes. One-compartment pharmacokinetic model. Pharmacokinetic model with sub camera. Multicompartment pharmacokinetic model. The model of continuous introduction of a medicine.
10.5. Constant of elimination.
Topic 11. Physical methods of analysis.
The purpose of class: To view the common methods of analysis of drugs.
Plan:
11.1. Spectral analysis. Spectroscopy in the visible and ultraviolet region. Infrared spectroscopy. Raman Spectroscopy. Spectroscopy of nuclear magnetic resonance. Mass spectroscopy.
11.2. X-ray analysis. Microscopic analysis. Polarimetry. Thermal analysis. Refractometry. Chromatography.
11.3. Physical basis of methods of analysis. Technology of spectral analysis.

9. Topics of laboratory workshop

Laboratory workshop is not provided by the working curriculum.

10. Solitary work

№ з/п	Topics	Number of hours
		Full time mode
1	Mechanical oscillations and waves. Biophysics of muscle contraction.	4
2	Molecular Physics. Thermodynamics.	5
3	Thermodynamics of biological processes. Molecular Biophysics.	4
4	Biophysics of vision. Biophysics of hearing.	4
5	Nuclear physics and quantum mechanics.	5
6	Transport of substances through biological membranes.	4
7	Hydrostatics and hydrodynamics. Biophysics of the blood system.	5
8	Electromagnetism. Biophysics of nerve impulses.	5
9	The action of physical factors on biological objects. Own physical fields of human.	5
10	Mathematical Biophysics.	4
11	Physical methods of analysis.	5
	Total hours	**50**

Tasks for solitary work

Content module 1.

1. Tasks for determining of the maximum speed of muscle contraction, the work that carried by muscle, muscle heat, general muscle power.

2. Tasks for finding of internal energy, enthalpy, Gibbs potential, Helmholtz potential, entropy.

3. Tasks for calculation of osmotic electric work, changes of electrochemical potentials in the transport of ions through the cell membrane, the efficiency of coupling processes, changes of thermodynamic potential in the cell.

4. Tasks for calculation of the optical power of glasses and other optical devices, intensity levels of sounds.

5. Tasks for finding of radioactive decay constant, mass defect and binding energy, the limits of the Balmer's series of the hydrogen atom, the absorption coefficient of X-ray ionization, de Broglie wavelength.

6. Tasks for the calculation of the work of sodium-potassium pump, distribution coefficients of substance, diffusion coefficient, Gibbs free energy, the potential difference on the membrane, ion concentration inside and outside the cell.

Content module 2.

7. Tasks for the calculation of speed of blood flow in different parts of the circulatory system, hydraulic resistance of peripheral part of the circulatory system, erythrocyte sedimentation rate, pulse wave propagation velocity .

8. Tasks for the determining the resting potential, action potential, temperature, constant length of cell nerve fibers, the speed of nerve impulses.

9. Tasks for calculating of the characteristics that associated with the absorption of X-ray by different tissues of the human body, the depth of penetration of electromagnetic radiation in tissues, energy of quantum radiation in different ranges of electromagnetic waves.

10. Tasks for calculating of elimination constants, half-time period of drug, initial concentration, maximum concentration of drug in the body.

11. Tasks for building a block and diagram of the device used in physical methods of analysis.

11. Individual tasks

Content module 1.

1. Tasks for the calculation of work and power of human muscles.

2 Tasks for building the particle distribution functions by Maxwell's energies and Boltzmann distribution functions in the gravitational field.

3. Tasks for the calculations of thermodynamic potentials during phase transitions.

4. Tasks for building a course of rays in the eye of the person at different types of aberrations.

5. Tasks for the calculations of frequencies and wavelength of spectral lines for hydrogen atom.

6. Tasks for the calculation flow of ions Na^+, K^+, Cl^- through cell membranes.

Content module 2.

7. Tasks for the calculating the characteristics of the circulatory system of human.

8. Tasks for calculation of the speed of nerve impulses in different fibers.

9. Tasks for using of physical factors, including electromagnetic radiation in medicine and pharmacy.

10. Drafting of differential equations, corresponding to different pharmacokinetic models.

11. Tasks for analyzing and comparing the advantages and disadvantages of various methods of substance analysis.

12. Methods, techniques and technologies of teaching

During the teaching of course "Biophysics, physical methods of analysis" using the following

- *methods of teaching:*
  - verbal methods (lectures, discussions);
  - visual methods (illustration, demonstration, frontal experiment);
  - practices (solving of professional content);
  - independent work of students with comprehension and learning;
  - using an educational computer programs in the discipline;
  - the use of project method for interdisciplinary integration;
- *techniques of teaching:*
  - according to the teaching methods of discipline;
- *technologies of teaching:*
  - interactive (video lectures, lectures using interactive boards and presentations);
  - games (games, exercises, discussions game, game situation, role and business educational games);
  - audiovisual (using audio graphical information);
  - problem teaching.

12. Methods of control

Current control based on control of theoretical knowledge and skills.
Forms of current control:
- Oral examination (frontal, individual, combined);
- Practical test of existing professional skills;
- Test control (open and closed tests).

Independent student work is evaluated at workshops and is part of the final grade of the student.

13. The form of the final control of the success of training *(grade)*

Final module control is estimated at maximum 40 points for a successful theoretical training and on mastering of practical skills and is considered passed if the student scored at least 24 points.

14. The scheme of calculation and distribution of points

Current testing and independent work											**Final control**	**Total**
Content module 1						**Content module 2**						
T1	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**T10**	**T11**		
5	5	5	5	5	5	6	6	6	6	6	**40**	**100**
30						30						
60												

14. Methodical providing

1. Syllabus of the course.
2. Tutorial.
3. Manual.
4. Set of multimedia presentations of lectures.
5. Supporting set of lectures.
6. Methodical recommendations for teacher.
7. Methodical materials for independent students work.
8. Guidance for practical training for students.
9. Test and control tasks for practical classes.
10. Questions and tasks for the final control.

15. Recommended literature

Basic

1. Vladimir Timanyuk, Elena Zhivotova, Igor Storozhenko. Biophysics: Textbook for students of higher schools / Kh.: NUPh, Golden Pages, 2011.- 576p.
2. Vladimir Timaniuk, Marina Kaydash, Ella Romodanova. Physical methods of analysis / Manual for students of higher schools/– Kharkiv: NUPh: Golden Pages, 2012. – 192 p.
3. Philip Nelson. Biological Physics. – W. H. Freeman, 1st Edition, 2007. – 600 p.

Support

1. Eduard Lychkovsky. Physical methods of analysis and metrology: tutorial / Eduard Lychkovsky, Zoryana Fedorovych. – Lviv, 2012. – 107 p.
2. Daniel Goldfarb. Biophysics DeMYSTiFied. – McGraw-Hill Professional, 1st Edition, 2010. – 400 p.

16. Information resources, including the Internet

1. Center for distance learning technologies of NPhaU. Access mode: http://nuph.edu.ua/centr-distancijjnih-tehnologijj-navcha/.
2. http://meduniv.lviv.ua/index.php?option=com_content&view=article&id=145&Itemid=183&lang=uk
3. http://gen.lib.rus.EC/
4. http://window.edu.ru
5. http://elib.fksu.ru/index.php/book
6. http://ebookee.com
7. www.vargin.mephi.ru