



INTERNATIONAL EUROPEAN UNIVERSITY
EDUCATIONAL AND RESEARCH INSTITUTE
"EUROPEAN MEDICAL SCHOOL"

**Department of Fundamental, Medical and Preventive
Disciplines**

APPROVED by
The Scientific and Methodical Council of the
University, protocol dd. August 29, 2023 No. 7
Deputy Chair of SMC *O. Lisnichuk* - O. LISNICHUK

WORKING PROGRAM OF THE ACADEMIC DISCIPLINE:
MEDICAL AND BIOLOGICAL PHYSICS. MEDICAL
INFORMATICS

to train students of the second (Master's) level
(full-time mode of study)

Knowledge area 22 "Health care"

Specialty 222 "Medicine"

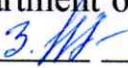
Educational program: Medicine

Discipline status: Compulsory

Kyiv – 2023

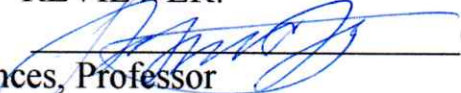
The working program of the **Medical and biological physics. Medical informatics** academic disciplines is based on the Medicine educational and professional program for the second (Master) level of the 222 Medicine specialty approved by the University Academic Council on May 30, 2023, protocol №4.

PROGRAM DEVELOPER:

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The working program of the academic disciplines is reviewed and approved by the Department of Fundamental, Medical and Preventive Disciplines, protocol No. 1 dd. August 25, 2023.

Head of the Department of Fundamental, Medical and Preventive Disciplines, PhD in biology, Associate Professor  Victoria KOVALENKO

The program is reviewed and approved by the Academic Council of the European Medical School, protocol No. 1 dd. August 29, 2023.

Chair of the Academic Council
of the European Medical School
Ph.D in Medicine,
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 Yevhenii SIMONETS

INTRODUCTION

Program study educational disciplines " Medical and biological physics. Medical informatics » composed in accordance to Standard higher education of Ukraine (further – Standard) undergraduate training of specialists of the second (master's) level of higher education in the field of knowledge 22 "Protection health" by specialty 222 "Medicine" educational qualifications "Master of medicine", professional qualification "Doctor".

Description educational disciplines (Abstract)

Educational discipline " Medical and biological physics. Medical informatics » is a fundamental medical biological discipline what is studying objects alive nature and organism a person in particular, based on physical phenomena and processes that determine their vital activity, and lie down in basis diagnostic, medical and preventive methods of medicine In accordance, educational discipline " Medical and biological physics. Medical informatics » is taught to students of higher medical educational institutions acquiring knowledge, skills and competencies in industry protection health by specialty "Medicine" educational qualifications the second (master's) equal higher education Educational discipline consists with three basic sections, and exactly: basics mathematical modeling living systems and mathematical processing of medical and biological data; basics of biological physics; basics medical physics First section disciplines is studying elements mathematical analysis (differential and integral calculus), theories differential equations, theories probabilities and mathematical statistics in their practical application to description phenomenon alive nature and processing medical biological information. The second section of the discipline (biological physics) studies the phenomena and laws of physical and physico-chemical nature at the molecular and cellular level levels of organization of living systems. The third section of the discipline (medical physics) studies: separate systems and functions body human going out with physical processes and phenomenon what causes them; the influence of physical environmental factors on the body a person; physical principles on which the methods and technical means of medicine are based diagnostics, treatment and disease prevention.

Educational discipline is taught by carrying out lectures and practical (seminar, laboratory) classes and independent work students

Informative description educational disciplines

Name indicators	Field of knowledge, direction training, educational qualifying level	Characteristics of the educational disciplines
		daytime form teaching
Number loans – 5	Branch of knowledge 22 "HEALTH PROTECTION"	Normative
	Direction preparation "Medicine"	
Content modules - 5	Specialty: 222 "Medicine"	Year of training:
General number hours – 150		1st
		1st semester
		Lectures
weekly load: Auditoriums - 5 hours	Educational qualification level: "Master of Medicine" qualifications professional "doctor"	16 hours
		Practical
		64 hours
		Independent work
		70 hours
		type of control
		Difzalik

Subject of study of the educational discipline " Medical and biological physics. Medical informatics" are physical phenomena processes and patterns, what determine life activity objects alive nature and organism in particular, at all levels of their organization and are the basis diagnostic, therapeutic and preventive methods of medicine

Interdisciplinary connections : As a fundamental medical and biological discipline, " Medical and biological physics. Medical informatics » u relationship object, subject, methods, means study and results teaching is located in tight connection with by others fundamental medical and biological disciplines, namely: with medical biology, physiology, medical chemistry, biochemistry, anatomy, histology, hygiene, ecology, medical informatics, medical statistics, as well as a number of clinical disciplines directions, such as pharmacology, anesthesiology, radiation medicine, radiology, ophthalmology, otolaryngology, traumatology, urgent medicine, medicine disasters and others. Discipline in its practical application has an important bioethical dimension.

1. GOAL AND EDUCATIONAL TASKS DISCIPLINES

1.1. the purpose teaching educational disciplines " Medical and biological physics. Medical informatics » is formation at subject students and professional competencies on basis systemic and integrative approach to the study and practical application of general scientific, fundamental physical and biophysical laws and regularities, what lie down in basis life activities living objects nature and the human body in particular.

1.2. The main ones tasks study disciplines " Medical and biological physics. Medical informatics » is:

- formation of a holistic system of physical and biophysical knowledge in students, which allows to understand the phenomena and regularities of life activities of objects of living nature and the organism human and exactly:

knowledge of biophysical mechanisms of the functioning of systems and organs of the human body in norms and pathologies, the ability to use them in practice;

knowledge of the mechanisms of influence of physical factors of the environment on the body a person on micro and macro-levels of living organization;

of knowledge physical principles, what lie down in basis diagnostic, medical and preventive methods of medicine;

of knowledge physical and technical princes work medical equipment diagnostic, medical and

medical and preventive purpose;

knowledge of methods of mathematical modeling and statistical processing of medical and biological information;

- formation systems of knowledge in students about essence information and medical information, computer science and informative processes in medicine; - formation ability and skill to solve typical and complex specialized tasks, practical problems in professional activity in industry protection health, what relate to application personal computer and work with programs general appointment;

- formation of a system of knowledge and skills for conducting research and/or implementation innovations in medicine from using modern approaches which characterized by complexity and uncertainty requirements from using settlement and analytical methods;

- provide information about modern information technologies in general and in medicine; to study principles storage, search, processing and analysis medical and biological information by with the help of computer technologies that and is an integral part of professional competence of a future specialist in the field of health care, as well as the basis for study of professionally oriented natural and clinical disciplines at higher medical schools educational institutions of Ukraine.

Achievement specified goals and implementation relevant to goals tasks will allow students – doctors master knowledge and skills in region informative technologies, what are used in medicine, which necessary for direct formation of a doctor and researcher - a professional in his field, as well as for study other academic theoretical and clinical disciplines in higher medical schools institutions

Competences and the results teaching, formation whose helps discipline.

According to with requirements standard educational discipline "Medical and biological physics" provides acquisition **of competencies by students:**

integral:

- The ability to integrate knowledge and solve complex specialized problems in broad ones and multidisciplinary contexts professional activity doctor, solve practical problems in new or unfamiliar environments in the presence of incomplete or limited information, taking into account the aspects of social and ethical responsibility in industry Health Care.

- general and professional:

General competence (GC)	
GC 1.	Ability to abstract thinking, analysis and synthesis.
GC 2.	Ability to learn and master modern knowledge.
GC 3.	Ability to apply knowledge in practical situations.
GC 4.	Knowledge and understanding of the subject area and understanding of professional activity
GC 5.	Ability to adapt and act in a new situation
GC 6.	Ability to make informed decisions
GC 7.	Ability to work in a team
GC 8.	Ability to interpersonal interaction
GC 10.	Ability to use information and communication technologies
GC 11.	Ability to search, process and analyze information from
GC 12	Determination and persistence in relation to assigned tasks and assumed responsibilities
Professional competences (PC)	
PC 2	Ability to determine the necessary list of laboratory and instrumental studies and evaluate their results
PC 10	Ability to perform medical manipulations.
PC 17	The ability to assess the impact of the environment, socio-economic and biological determinants on the state of health of an individual, family, population.
PC 24	Adherence to ethical principles when working with patients and laboratory animals
PC 25	Adherence to professional and academic integrity, to be responsible for the reliability of the obtained scientific results

Program learning outcomes (PLO)	
PLO 1.	Have thorough knowledge of the structure of professional activity. Be able to carry out professional activities that require updating and integration of knowledge. To be responsible for professional development, the ability for further professional training with a high level of autonomy
PLO 2	Understanding and knowledge of basic and clinical biomedical sciences, on level sufficient for solving professional tasks in the field of health care
PLO 21	Search for the necessary information in professional literature and databases data from other sources, analyze, evaluate and apply this information
PLO 22	Apply modern digital technologies, specialized software provision, statistical methods of data analysis for solving complex health care problems.

Integrative final program learning result, the formation of which is facilitated by the educational discipline " Medical and biological physics. Medical informatics" is the ability to solve typical and complex specialized tasks and practical problems in professional activities in industry protection health, by modeling problematic situations on basis systematic analysis of a complex of factors and conditions of a defined and undefined nature, including with their analytical evaluation, and exactly:

- formation in students holistic systems physical and biophysical knowledge, what allows you to understand the phenomena and regularities of life activities of objects of living nature and body a person;
- knowledge of the biophysical mechanisms of the functioning of systems and organs of the human body c norms and pathologies, the ability to apply them in practice;
- knowledge of biophysical mechanisms of influence of physical environmental factors on organism of a person, the ability to evaluate their importance;
- knowledge physical principles, what lie down in basis diagnostic, medical and preventive methods of medicine;
- knowledge of the physical and technical principles of medical diagnostic equipment, medical and medical and preventive purpose;
- the ability to apply biophysical knowledge in practice, the ability to determine biophysical factors and mechanisms functioning bodies and systems body in norms and pathologies;
- possession methods mathematical modeling and statistical processing medicalbiological information;
- knowledge modern approaches in use software means different appointmentand the ability to independently update and integrate acquired knowledge;
- knowledge principles proof medicine, skill their practical application;
- knowledge of the mechanisms of influence of physical factors of the environment on the body human ability to assessment their importance from using modernsoftware software;
- knowledge physical principles, what lie down in basis diagnostic, medical and preventive methods of medicine;
- to be able to classify types and methods of medical information processing; know and understandprinciples coding medical information; be able draw up list and describe methods, which ones unprocessed data they can to be processed to important information; know principles of biomedical coding information
- knowledge of the physical and technical principles of medical diagnostic equipment, medical and medical and preventive purposes;
- knowledge modern methods mathematical modeling and statistical processing medical and biological information and their skills use on practice;
- skill independently master software means different appointment and update and integrate acquired knowledge;
- skill evaluate role new ones information and communication technologies in industry protection health with prospects for the development of computer techniques

2. INFORMATIVE AMOUNT EDUCATIONAL DISCIPLINES

On study educational disciplines "Medical and biological physics. Medical informatics" is assigned 150hours, 5 ECTS credits. Including:

classrooms hours - 80 of them lectures - 16 hours;

practical classes - 64 hours;

independent work students – 70 hours

MODULE 1. MEDICAL AND BIOLOGICAL PHYSICS

INFORMATIVE MODULE 1.

MATHEMATICAL FUNDAMENTALS OF MEDICAL AND BIOLOGICAL DATA AND FUNDAMENTALS OF BIOLOGICAL PHYSICS

Topic 1 Basics theories probabilities and mathematical statistics

Functional and statistical communication between phenomena Concept random events Probability random events independent, dependent, compatible and incompatible random events Theorems addition and multiplication probabilities Conditional probability Theorem bayes, her epidemiological and clinical content.

Accidental size. Statistical totality. General totality and sample. Discrete and continuous random values Concept mathematical hope, dispersion and mean square deviation. The concept of the distribution of a random variable. Variational ranks Polygon and histogram of frequencies. Mean value, mode and median, sample variance and sample mean square deviation. Binomial distribution. Poisson distribution. Normal law distribution, him physical, biological and clinical content. Distributed Maxwell and Boltzmann. Estimation of the parameters of the general population by its sample. Trustworthy interval and trust probability Distribution student. Correlative communication between random values. Regression equation.

Topic 2. Foundations of biorheology. Foundations bioacoustics. Biophysics of hearing

Types of deformations. Mechanical stress and relative deformation. Elasticity and plasticity. Law The sound Fluidity (flow) and viscosity. Chart tension-compression. Strength limit. Mechanical properties and structural and functional organization of tissues body Elastic properties of collagen and elastin fibers. Diagram of deformations individual fabrics body Elastic properties bones and vessels Empirical models viscoelasticity. Rheological properties biological liquids relative and absolute viscosity. Blood viscosity. Factors determining blood viscosity. Hematocrit. Clinical methods definition viscosity of blood Definition coefficient viscosity by help capillary viscometer. Hess viscometer. Determination of the viscosity coefficient on the basis formulas Stokes. Rotational method.

Foundations bioacoustics. Biophysics of hearing

Spread waves in elastic environment Sound. Speed sound Acoustic effect Doppler. Intensity sound Audio resistance (acoustic impedance). Audio pressure. Interaction of sound waves with biological tissues. Reflection, absorption and scattering sound waves Coefficients absorption and transmission Dependence coefficient absorption from sound frequency. Properties of ultrasound. Ultrasonic diagnostic methods. Therapeutic and surgical application ultrasound Infrasound Objective and subjective sound characteristics. Intensity level. Volume, pitch, timbre. Hearing threshold and him nature. Connection between irritation and feeling Law Weber-Fechner. general principles functioning sensory systems body Dependence threshold audibility from frequency sound Audiometry. Diagnostics of hearing

Topic 3 . Physical foundations hemodynamics.

Movement ideal liquid Linear and voluminous speed currents Equation continuity currents Static and dynamic pressure. Bernoulli's law. Real liquids. Movement of a viscous liquid. Power viscous friction. Formula Stokes. Newtonian and non-Newtonian liquid Laminar and turbulent currents Numeric Reynolds. Law Hagen-Poiseuille. Hydrodynamic (hemodynamic) resistance. Hydromechanical model of blood circulation. Pumping function of the heart. Shock (systolic) and minute blood volume. Frank-Starling law. Blood pressure. Systolic and diastolic pressure. Pulse and average arterial pressure. Central venous pressure. Hemodynamic resistance. Total peripheral resistance. Work and power of the heart. Movement resistance blood speed blood flow and

distribution blood pressure in departments vascular channels Calculation of hemodynamic parameters. Methods of determining blood pressure and speed of blood Palpatory and auscultatory methods. Tony Korotkova. Dynamics pressure and blood vessel filling. Pulse waves. Influence of blood viscosity on hemodynamic indicators. Dependence of blood viscosity on the nature of blood flow. Biophysical factors of aneurysm development and blockage vessels

Topic 4 . Biophysics membrane processes.

Structure and physical properties of biological membranes. Transport of substances through biological membranes Selective permeability biological membranes Passive transport. Diffusion uncharged particles. Osmosis. Osmotic pressure. Diffusion of charged particles. Equation Nernst-Planck. Active transport. Sodium - potassium pump. Ionni channels

Membrane potentials. Potential actions

Electrochemical balance. Balanced concentration potential Nernst. Equation Goldman-Hodgkin-Katz. Modeling permeability biological membranes Calculation equilibrium concentration potentials for potassium, sodium and chlorine ions. Modeling transmembrane differences potentials on basis equation Goldman-Hodgkin-Katz. Study of the effect of ion permeability of membranes on the formation of the transmembrane difference potentials. Electrical excitability of cells. Action potential and its phase. Depolarization and repolarization Refractoriness. Mechanism generation potential actions Ligand- and potential dependent ionic channels Threshold activation Exciting and braking postsynaptic potentials. Generation and spread of potential actions in a neuron. Neurotransmission.

INFORMATIVE MODULE 2 . FOUNDATIONS MEDICAL PHYSICS

Topic 5. Fundamentals of biological electrodynamics. Electrographic methods of diagnosis.

The main ones characteristics electromagnetic fields (EMF) in vacuum and in substances Theory Maxwell. Electromagnetic waves and their properties Energy electromagnetic waves. Energy density . The Poynting Condition vector. Scale of electromagnetic waves. Electric and magnetic activity fabrics and bodies body Physical foundations electrography and magnetography. Electric activity myocardium and her physical modeling. Model current dipole Basic provisions of Einthoven's theory. Electric axis and integral electric vector hearts Triangle Einthoven. Standard withdrawal. Electrocardiogram. Formation electrocardiograms. Informativeness of electrocardiographic diagnostics. Disadvantages of the theory Einthoven and its improvement. Vector cardiography.

Topic 6. Physical foundations rheography.

Passage variable electric current by biological fabrics Resistance biological alternating current fabrics. Impedance Impedance dispersion. Biophysical modeling of dispersion impedance. Research dispersion impedance fabrics and him clinical value. Physical foundations rheography. Dependence impedance fabrics and bodies from blood filling Record rheograms and their informativeness. Calculation of hemodynamic parameters based on rheogram data. Diagnostic significance rheography. Physical and technical principles of work rheograph.

Topic 7. Physical basics and methods physiotherapy.

Interaction of EMF with biological tissues. Physical, physico-chemical and physiological effects thatarise under the action of EMF on the human body. Therapeutic methods based on the action of constant and impulse electric current Galvanization. Electrophoresis. Electrosleep. Darsonvalization. Effect of a constant electric field on biological tissues. Franklinization. Heat effect currents conductivity and bias. Diathermy, electrotomy and electrocoagulation. UHF – therapy. Action magnetic fields on organism a person induction currents Inductotherapy. Magnetotherapy.

INFORMATIVE MODULE 3 . FOUNDATIONS MEDICAL OPTICS AND RADIATION DIAGNOSTICS

Topic 8. Fundamentals of biological optics. Optical methods of studying biological objects.

Electromagnetic nature light Speed light Indicator refraction. Dispersion. Decomposition white light in spectrum. light perception Elements photometry. Lightflow. The power of light.

Luminosity Brightness. Light. Measurement of illumination. Luminosity. Laws geometric optics
Ideal centered optical system. Optical eye system Biophysical foundations of vision. Optical
devices. Optical microscopy. Characteristics microscope Magnification, separate ability and
distinction. Phenomenon refraction Refractometry. Phenomenon polarization. Law Malus.
Optically active environment Law bio Polarimetry. Interaction light with substance variance,
absorption and scattering light Absorption and transmission coefficients. Bouguer's law.
Absorption of light by solutions. Law Bouguer-Lambert-Bere. Optical density solution
Concentration colorimetry Scattering light in dispersed environments Effect Tyndall Molecular
scattering light Law Relay. Nephelometry.

Topic 9. Physical foundations of radiology and radiation medicine. Radiation safety.
Quantum theory light Formula Lath. The main ones position quantum mechanics Warm
radiation. The laws of radiation of an absolutely black body. Physical foundations thermography.
Infrared radiation. Ultraviolet radiation. Action infrared and ultraviolet radiation on the
body. Induced radiation. Ionizing radiation. Kinds ionizing radiation. Radioactivity. Kinds
radioactive decay Alpha- and beta- decay. Rules bias. Basic law radioactive decay Period half-life
Activity. Units activity Radiocarbon dating. Interaction radioactive radiation with substance
Dosimetry ionizing radiation. Expository dose. Power expositional doses Absorbed dose. Power
absorbed doses Methods dosimetry. Dosimeters. Interaction ionizing radiation with biological
fabrics relative biological radiation efficiency. Biological equivalent dose. Equivalent dose
strength. Radiobiological effects. Radiation damage. Protection against ionizing radiation.
Principles radiation security Biophysical foundations radial therapy

**Topic 10. Basics of radiation diagnostics. X-ray computed tomography, magnetic resonance
tomography, positron emission tomography and other types.**

Lasers. Application lasers in medicine Röntgenivske radiation. Radiography. Computed
tomography. Positron emission tomography (PET). Resonant methods quantum mechanics
Electronic paramagnetic resonance (EPR). Nuclear magnetic resonance (NMR). Magnetic
resonance tomography (MRI).

MODULE 2. MEDICAL INFORMATICS SUBSTANTIAL MODULE 4 . BASICS OF INFORMATION TECHNOLOGIES IN THE INDUSTRY GUARDS HEALTH

Topic 1. Basic concept disciplines "Medical Computer Science".

Basic concept disciplines "Medical Computer Science".

The history of the formation of medical informatics and the prospects of its development in the
context experience informatization society. Transfer information Network technologies. Computer
data: types data, processing and management of data arrays.

Topic 2. Coding and classification medical data.

Concept classification.. Concept props, classifiers. Hierarchical system classification. Faceted
system classification. Descriptive system classification Classification coding. Bar coding.
International classification systems in medicine

Topic 3. Analysis biosignals. Visualization medical and biological data

Biosignals: registration, conversion and classification of signals. Acquisition and analysis
biosignals. Digital methods of biosignal processing.

Topic 4. Processing and analysis medical images.

Types medical images and their characteristics. Methods receiving medical images. Digital
processing of medical images. Software for processing and analysis images.

Topic 5. Foundations statistical analysis medical and biological data

Modern technologies analysis data Sorting medical and biological data Work with filters.
Random variables. Laws of distribution of random variables. Statistical analysis data Elements of
selective theories.

Topic 6. Audit statistical hypothesis Correlative analysis.

Planning experiment Formulation hypothesis Statistical criteria. Rating statistical parameters and
audit hypothesis Correlative analysis.

Topic 7. Foundations telemedicine

Subject and basic concepts of telemedicine. History of telemedicine. Organizational chart

connection of the access node and medical institutions. Organizational chart communication regional access node and regional medical institution. Scheme of organization of access node communication and control center. Structural diagram of the Telemedicine Network of the Regional Center. Typical kits telemedicine equipment. Telemedicine technologies in work centers ultrasonic diagnostics radio modem line connection Prospects application telemedical technologies. Centers rehabilitation

Topic 8. Application of telecommunication technologies in medicine. "Telemedicine chain of the regional center".

Consulting telemedicine complexes, operational telemedicine hardware and software complexes, mobile telemedical complexes and systems, preventive maintenance people, service remote subjects. Scheme organizations connection node access and control center. Structural diagram of the Telemedicine Network of the Oblast center". Typical sets of telemedicine equipment.

CONTENT MODULE 5. METHODOLOGY PROCESSING AND ANALYSIS MEDICAL INFORMATION

Topic 9. Network systems diagnostics.

Rules for using the diagnostic system. Comparison of online systems diagnostics. Diagnos.ru - system. Diagnostics diseases Algorithmization and mathematical simulation of telemedical procedures, consultations, provision of emergency care.

Topic 10. Formal logic in solutions tasks diagnostics, treatment and prevention diseases Deterministic logic, logic phase interval, informational and probabilistic logic, diagnostic algorithm, informational and probabilistic logic

Topic 11. Methods support adoption solutions Strategies receiving medical of knowledge Definition of the expert system and its main functions, classification and application experts systems in medicine; knowledge base for expert systems

Topic 12. Means of forecasting. Clinical decision support systems. Definition and architecture systems knowledge, procedural knowledge, declarative knowledge, expert systems in medicine, Artificial Intelligence.

Topic 13. Modeling systems support adoption solutions

Formal model medical expert systems, conceptual model medical expert systems, tree solutions systems support medical solutions structure systems supporting the adoption of medical treatment solutions

Topic 14. Types of information systems in industry protection health.

Main aspects of informatization of medical activity, general technological scheme diagnostically - medical process, stages creation and the main ones characteristics MIS, classification of medical information systems, medical information systems basic equal.

Topic 15. Medical information systems of the medical and preventive level institution Public health and health care.

MISS consultative centers, screening systems, features organizations information environment of a medical and preventive institution, MIS territorial and state level, Information support of MIS. Hospitals informative systems: clinical using and technical realization, history development, functions, architecture, application, examples.

3. STRUCTURE EDUCATIONAL DISCIPLINES

Names of meaningful modules and topics	Number hours					
	daytime form					
	evening	in ago number of				
		l.	p.	lab	ind.	with. p.
1	2	3	4	5	6	7
Module 1. "Medical and biological physics"						
Content module 1. Mathematical foundations of medical and biological data and foundations of biological physics.						
Topic 1. Basics of probability and mathematical theory statistics		2	4			3
Topic 2. Foundations of biorheology. Foundations bioacoustics. Biophysics of hearing Physical foundations of ultrasound diagnostics.		2	4			3
Topic 3. Physical foundations hemodynamics.		1	3			3
Topic 4. Biophysics membrane processes. Membrane potentials. Potential actions		1	3			3
Topic 5. Control work on content module 1 "Fundamentals of statistical analysis of medical and biological data and fundamentals of biological physics".			2			
Together by content module 1		6	16			12
Contentful module 2. Basics medical physics						
Topic 6. Electrographic diagnostic methods.		2	2			3
Topic 7. Study of frequency dependence impedance of biological tissues and its application in medical research.		2	2			3
Topic 8. Physical foundations and methods physiotherapy.		2	2			3
Topic 9. Control work on content module 2 "Fundamentals of medical physics".			2			
Together according to content module 2		6	8			9
Contentful module 3. Basics medical optics and radiation diagnostics.						
Topic 10. Fundamentals of biological optics. Optical methods research biological objects.		1	3			3
Topic 11. Physical basics of radiology and radiation of medicine Radiation security.		1	3			3
Topic 12. Basics of radiation diagnostics. X-ray computed tomography, magnetic resonance tomography, positron emission tomography and other types.		2	2			3
Topic 13. Final control of module 1.			2			
Together according to content module 3		4	10			
Total hours for studying module 1 "Medical and biological physics"		16	34			9
Module 2. "Medical informatics"						
Contentful module 4. Basics information technologies in protection industry health.						
Topic 1. Basic concepts of the discipline "Medical Computer Science"			2			2
Topic 2. Coding and classification medical data			2			

						2
Topic 3. Analysis of biosignals. Visualization of medicalbiological data			2			3
Topic 4. Processing and analysis medical images.			2			3
Topic 5. Fundamentals of statistical analysis of medicalbiological data			2			3
Topic 6. Verification of statistical hypotheses. Correlative analysis.			2			3
Topic 7. Foundations telemedicine			2			3
Topic 8. Application telecommunications technologies in medicine. "Telemedicine network Regional center".			2			3
Together according to content module 4			16			22
Contentful section 5. Methodology processing and medical analysis information						
Topic 9. Network systems diagnostics.			2			3
Topic 10. Formal logic in solutions tasks diagnostics, treatment and prevention diseases			2			3
Topic 11. Decision support methods. Strategies obtaining medical knowledge.			2			3
Topic 12. Means of forecasting. Clinical systems support decision-making.			2			3
Topic 13. Modeling of the support system adoption solutions			2			3
Topic 14. Types of information systems in the industryprotection health.			2			3
Topic 15. Final control of module 2.			2			
Together according to content module 5			14			18
Total hours to study module 2 " Medical informatics "			30			
That's all hours		16	64			70

4. THEMES LECTURES

No s/p	Name topics	Number hours
1	Foundations statistical analysis medical and biological data	2
2	Foundations bioacoustics. Biophysics of hearing Foundations of biorheology. Physical foundations of ultrasound diagnostics.	2
3	Physical foundations hemodynamics.	1
4	Biophysics membrane processes. Membrane potentials. Potential actions	1
5	Electrographic diagnostic methods.	2
6	Study of frequency dependence impedance of biological tissues and its application in medical research.	2
7	Physical foundations and methods physiotherapy.	2
8	Fundamentals of biological optics. Optical methods research biological objects.	1
9	Physical basics of radiology and radiation of medicine Radiation security.	1
10	Basics of radiation diagnostics. X-ray computed tomography, magnetic resonance tomography, positron emission tomography and other types.	2
	Together	16

5. THEMES PRACTICAL JOIN

N o s/p	Name topics	Number hours
Module 1. "Medical and biological physics"		
1	Basics of probability and mathematical theory statistics	4
2	Foundations bioacoustics. Biophysics of hearing Foundations of biorheology. Physical foundations of ultrasound diagnostics.	4
3	Physical foundations hemodynamics.	3
4	Biophysics membrane processes. Membrane potentials. Potential actions	3
5	Control work on content module 1 "Fundamentals of statistical analysis of medical and biological data and fundamentals of biological physics".	2
6	Electrographic diagnostic methods.	2
7	Study of frequency dependence impedance of biological tissues and its application in medical research.	2
8	Physical foundations and methods physiotherapy.	2
9	Control work for content module 2 "Fundamentals of medical physics".	2
10	Fundamentals of biological optics. Optical methods research biological objects.	3
11	Physical basics of radiology and radiation of medicine Radiation security.	3
12	Basics of radiation diagnostics. X-ray computed tomography, magnetic resonance tomography, positron emission tomography and other types.	2
13	Final control of module 1.	2

Module 2. "Medical informatics"		
1	Basic concepts of the discipline "MedicalComputer Science"	2
2	Coding and classification medicaldata	2
3	Analysis of biosignals. Visualization of medicalbiological data	2
4	Processing and analysis medical images.	2
5	Basics of statistical analysis of medicalbiological data	2
6	Testing of statistical hypotheses. Correlative analysis.	2
7	Foundations telemedicine	2
8	Application telecommunication technologies in medicine. "Telemedicine networkRegional center".	2
9	Network systems diagnostics.	2
10	Formal logic in solutions tasks diagnostics, treatment and prevention diseases	2
11	Decision support methods. Strategies obtaining medical knowledge.	2
12	Means of forecasting. Clinical systems support decision-making.	2
13	Support system modeling adoption solutions	2
14	Types of information systems in the industry protection health.	2
15	Final control of module 2.	2
	Together	64

6. INDEPENDENT WORK

N o s/p	Name topics	Number hours
Module 1. "Medical and biological physics"		
1	Application methods theories probabilities in medicine	3
2	Biophysical modeling processes muscular abbreviation.	3
3	Structure and functions biological membranes. Potential actions: generation and dissemination. Neurotransmission.	3
4	Ultrasonic methods diagnostics.	3
5	Viscosity blood: methods measurement and clinical value.	3
6	Electrographic methods diagnostics.	3
7	Impedance biological fabrics Dispersion impedance. Rheography and her clinical value.	3
8	Methods physiotherapy. Physiotherapy apparatus.	3
9	Eye as optical system.	3
10	Biological ionizing action radiation. Radiation methods diagnostics.	3
Module 2. "Medical informatics"		
1	Basic concept disciplines "Medical Computer Science"	2
2	Coding and classification medical data	2
3	Visualization medical and biological data	3
4	Processing and analysis medical images.	3
5	Foundations statistical analysis medical and biological data	3
6	Audit statistical hypothesis Correlative analysis.	3
7	Basics of telemedicine.	3
8	Application telecommunications technologies in medicine	3
9	Model telemedicine consultations	3
10	Principles of solving the problems of diagnostics, treatment and prevention diseases	3
11	Methods support adoption solutions	3
12	Clinical systems support adoption solutions	3
13	Modeling systems support adoption solutions	3
14	Types informative systems in industry protection health.	3
15	Medical information systems of the treatment level preventive institution	3
Together		70

7. INDIVIDUAL TASKS - not provided

8. TASK FOR INDEPENDENT WORK

Module 1. "Medical and biological physics"

Task for independent work have on goals in depth study students of the initial material provided by this program, as well as the assimilation of related subjects program topics important for understanding the educational material of the discipline as a whole. Independent work students is component formation integral, general and special (professional) competencies, and exactly: skills using informative and communication technologies; ability to search, process and analyze information from different sources; ability to learn and master modern knowledge Task for independent work of students are formed in accordance with the topics of the program and provide preparation to assimilation current topics and disclosure connection between separate topics Form control independent work students is orally poll

and/or testing on the current classroom lesson.

Module 2. "Medical informatics"

The task for independent work involves mastering the methodology of conducting a scientific search for information using Internet resources within the proposed topics, as well as processing and presenting the search results using general and special purpose programs.

A component of independent work is the preparation of a portfolio - an ordered collection of materials selected in accordance with the given topic, which students must prepare.

The purpose of the task is to acquaint students with the basics of modern computer information technologies, trends in their development, teach the principles of data search using Internet resources, and master the methods of data processing and presentation using general and special purpose programs.

A component of the project method is a portfolio - an ordered collection of materials selected in accordance with the set goal, which students must prepare.

The task involves the student performing the following actions: determining the relevance of the topic, formulating the purpose of the work and tasks; selection of data sources according to requirements; collection of data necessary for the disclosure of the selected topic; systematization and structuring of collected data; processing of collected data; obtaining and interpreting results; formulation of conclusions in accordance with the obtained results; registration of the electronic version of the results; creating a presentation and public defense.

9. METHODS TEACHING

Mastery discipline "Medical and biological physics. Medical informatics" is realized on basis explanatory and illustrative, reproductive, problematic heuristic, research and interactive teaching methods. **Explanatory and illustrative** method is used in process teaching lecture material, under time seminary and practical classes **Reproductive** method are used in the process of assimilation of methods of mathematical analysis and statistical processing by students data, and also under time laboratory works, what provides following rules carrying out operations and serves to acquire the skill of following instructions, and thus - acquisition of relevant subject and professional competence necessary in the process implementation of treatment protocols and clinical research. **problematic, research and heuristic** methods are used in the process of independent and individual work of students and provide creative solutions to problematic tasks and application of the project approach. These methods serve to form general and substantive competencies such as ability to analysis and synthesis of knowledge and received information, its analytical processing; skills in using information and communication technologies; modeling clinical situations, evaluations relevance medical measures. Representation of the specified teaching methods takes place in the process carrying out seminary classes **Interactive** methods serve acquisition students communication competencies, skills dialogical thinking and are used in process carrying out practical classes, individual work student with the teacher, a also in the process of remote teaching.

10. METHODS CONTROL

Methods performance control development by students of the program of the discipline "Medical and biological physics. Medical informatics" are: oral survey; written (computer) test; written control work; audit acquired professional competencies by by the results implementation individual practical tasks, in ago number of laboratory works, and which are used for current control and final control day off control success teaching. Current CONTROL success teaching is carried out on to everyone practical (seminar, laboratory) occupation and is evaluated by 4-point scale.

11. FORM CONCLUSION CONTROL GOOD LUCK TEACHING

Final CONTROL of knowledge disciplines "Medical and biological physics. Medical informatics" is carried out in the form of differentiated assessment of the study of all topics planned by the dataprogram Differentiated assessment in the discipline is conducted in written

form control work by individual options, every with whose contains 3 theoretical questions and one task.

12. CALCULATION SCHEME AND DISTRIBUTION OF POINTS AWARDED STUDENTS

current progress students is evaluated by 4th ballroom scale on to everyone practical (seminar, laboratory) class.

The grade for the discipline is defined as the sum of the final score for the current performance (Table 1) and the ball by final CONTROL in form differentiated offset, and is expressed by 200 - ballroom scale (Table 2).

Recalculation of the average grade for the current academic performance in a multi-point scale for discipline ending with an exam or by differential calculation

Table 1

4-point scale	200-ball scale	4-point scale	200-ball scale	4-point scale	200-ball scale
5	120	4.29	103	3.58	86
4.96	119	4.25	102	3.54	85
4.92	118	4.21	101	3.50	84
4.87	117	4.17	100	3.46	83
4.83	116	4.12	99	3.42	82
4.79	115	4.08	98	3.37	81
4.75	114	4.04	97	3.33	80
4.71	113	4.00	96	3.29	79
4.67	112	3.96	95	3.25	78
4.62	111	3.92	94	3.21	77
4.58	110	3.87	93	3.17	76
4.54	109	3.83	92	3.12	75
4.50	108	3.79	91	3.08	74
4.46	107	3.75	90	3.04	73
4.42	106	3.71	89	3	72
4.37	105	3.67	88	Less 3	Not enough
4.33	104	3.62	87		

Rating by differentiated test is exhibited by 4-oh ballroom scale and converted into an 80-point scale according to the following: "5" - 80 points, "4" - 64 points, "3" - 48 points, "2" - 0 points. The maximum number of points that can be obtained by a student of education under the time for completing the final control is 80. The final control is considered enrolled, if the student

obtained at least 60% of the maximum number of points by final CONTROL. Minimal number points which better education should score for the final control is 48. The initial success rate is evaluated in points 200 ballroom scales ECTS and by national scale assessment ("perfectly", "fine", "satisfactorily", "not satisfactorily") in the next compliance (Tab. No. 2):

Table 2.

Total points for all types educational activity	Rating ECTS	By national scale		Definition
		4th grade scale	Test	
180 - 200	A	5 (excellent)	counted	Excellent performance only with insignificant quantity errors
160 - 179	B	4 (fine)		Above average level with by several mistakes
150 - 159	C			IN general correct work with a certain amount errors
130 - 149	D	3 (satisfactorily)		Not bad, but significant quantity shortcomings
120 - 129	E			Performance is satisfactory minimal criteria.
50 - 119	Fx	2 (unsatisfactorily)	not counted	Possible repeated drafting.
0 - 49	F			Necessary second course with educational disciplines

Assessment of individual tasks is carried out within a 12-point scale from 4 to 12 points and is added to the sum of points for current success on a 120-point scale at output evaluations for discipline

Correlation between by the results assessment current educational activity and final knowledge control - 60% and 40%.

13. METHODOLOGICAL SOFTWARE

Methodological software educational disciplines "Medical and biological physics. Medical informatics" consist of:

1. working educational program disciplines;
2. Plans lectures, practical classes and independent work students;
3. Theses lectures with disciplines;
4. Methodological recommendations to practical classes for students;
5. Methodological materials, what provide independent work students;
6. Test and control task to practical classes;
7. List questions and tasks for current, intermediate and final control of knowledge from the discipline.

**Question final control of knowledge from the discipline
"Medical and biological physics. Medical informatics":**

Module 1. "Medical and biological physics"

1. Harmonious oscillator. Equation harmonic fluctuations
2. Non-attenuating and forced fluctuation. Resonance. Self-oscillation.
3. Attenuating fluctuation. Differential equation fading oscillations, hirmsolution. Coefficient attenuation, decrement and logarithmic decrement.
4. Mechanical waves. Equation waves.
5. Classification of phenomena. Probability of random phenomena, theorem of addition probabilities
6. Theorem multiplication probabilities for independent random phenomenon conditional probability theorem multiplication of probabilities for addicts a random phenomenon.
7. Distribution random phenomenon mathematical expectation, variance, average quadratic deviation.
8. The main ones laws distribution random values (normal law, distribution Poisson, binomial distribution and others).
9. Superficial tension Coefficient superficial tension and methods him definition. Gas embolism.
10. Modern ideas about the structure and functions of biological membranes. Squirrels in biological membranes, their role.
11. Types of transport of substances through the biological membrane. Diffusion. Osmosis. Osmotic pressure.
12. Biophysical mechanism of generation of membrane potentials of a living cell. Potential calmness Equation Nernst. Equation Goldman-Hodgkin-Katz.
13. Potential actions Mechanism generation and dissemination nervous impulse
14. Biophysical models muscular abbreviation.
15. Acoustics. Physical characteristics of sound. Objective and subjective characteristics of hearing Weber-Fechner law.
16. Scale intensity and scale volume sound, units Threshold audibility and painful threshold. Audiometry. Audiogram.
17. Ultrasound. The main ones properties and features spread ultrasound and infrasound Effect of ultrasound on biological fabrics and human organs.
18. Deformations, their species Elasticity and plasticity. Law The sound Module Boy. Coefficient Poisson.
19. Mechanical properties biological fabrics Elasticity. Fluidity. Chart stretching - compression of the material.
20. Biophysical models elasticity biological fabrics
21. Internal friction. Viscosity. Formula Newton for internal friction. Newtonian and non-Newtonian fluids. Blood viscosity.
22. Stationary current. Equation continuity currents Linear and voluminous speed currents The main thing equations of fluid dynamics.
23. Laminar and turbulent currents Numeric Reynolds. Equation Bernoulli. Current viscous liquids Formula Poiseuille. Hydraulic resistance.
24. Electromagnetic field and him characteristics. Scale electromagnetic waves
25. Electric field and its characteristics. Passive electrical characteristics biological tissues. Conductivity of biological tissues. Ohm's law in differential form Electrophoresis.
26. Electrical characteristics of biological tissues. Ohm's law in differential form Conductance biological fabrics Capacitive properties Equivalent electric fabric pattern.
27. Biophysical foundations electrography. Concept about equivalent electric generator. Einthoven's concept of the genesis of the ECG (integral electric vector hearts, potential dipole, lead system).
28. Heart, as current electric dipole (current dipole and him characteristics, dipole potential hearts).
29. Electric circle variable current, what contains active, capacitive and inductive

- resistance. Concept of vector diagram Impedance
30. Impedance biological fabrics Dispersion impedance. Physical foundations rheography.
 31. Magnetic field and him characteristics. Law Bio-Savar-Laplace. Magnetic properties substances Physical foundations of magnetobiology.
 32. Theory electromagnetic waves Maxwell (currents bias, speed dissemination electromagnetic waves).
 33. Physical processes in biological objects under action electromagnetic fields (polarization, conduction currents, displacement and inductive).
 34. Physical foundations therapeutic methods (galvanization, franklinization, diathermy, inductothermy, darsonvalization, UHF- and microwave therapy, microwave resonant therapy). Heat and specific action.
 35. Polarization light Methods obtaining polarized light Double refraction Prism Never Malus' law.
 36. Optically active substances. Angle of rotation of the plane of polarization. Law of Bio. Concentration polarimetry.
 37. Absorption of light. Bouguer's law. Absorption of light by solutions. Bouguer's law-Lambert-Ber. Concentration colorimetry
 38. Scattering light in dispersed environments Molecular scattering light Law Relay. Nephelometry.
 39. The main ones idea quantum Mechanics: wave properties microparticles, formula where broil, wave function and her physical content, correlation uncertainty Heisenberg. The concept of electron microscope.
 40. Quantumly mechanical model atom hydrogen Equation Schrodinger. Quantum numbers Energy levels. Pauli principle.
 41. Radiation and absorption light atoms and molecules Spectra radiation and absorption. Spectrophotometry.
 42. Thermal radiation of bodies, its characteristics. Absolutely black and gray bodies Law Kirchhoff. Warm radiation bodies a person Concept about thermography
 43. Law radiation absolutely black bodies: law radiation Lath, Stefan-Boltzmann law, displacement law Vina
 44. Photo effect and him application. Internal and external photo effects Photoelectric devices in medicine.
 45. Luminescence: species the main ones patterns, properties Law Stokes. Application luminescence in medicine.
 46. Induced radiation. Equilibrium and inverse population of energy levels Lasers, principle actions and application in medicine.
 47. Resonant methods quantum mechanics, their application in medicine Electronic paramagnetic and nuclear magnetic resonances
 48. Röntgenivske radiation, spectrum and characteristics, application in medicine Interaction x-ray radiation with substance Law weakening X-ray radiation.
 49. Radioactivity. Kinds radioactivity. Basic law radioactive decay Period half-life Activity, units activity
 50. Ionizing radiation and its types. The interaction of the ionizer radiation with substance Protection from actions ionizing radiation.
 51. Biophysical bases of the interaction of ionizing radiation with biological ones fabrics
 52. Dosimetry. Exposure and absorbed doses. Biological effect of radiation, biological equivalent dose. Power doses Units dose and capacities dose

14. RECOMMENDED LITERATURE

Module 1. "Medical and biological physics"

The main one

1. Medical and biological physics. Part AND / [V.I. Fedev, O.I. Olar, O. Yu. Mykytyuk and others]. Educational manual for students higher medical educational institutions - Chernivtsi: Publishing house BSMU, 2016. - 205 with. (Recommended DU "Central methodological cabinet for higher medical education of the Ministry of Health of Ukraine" letter No. 23-01-9/225 from 05.03.2016, protocol No. 1 dated March 24, 2016).
2. Medical and biological physics. Part II / [V.I. Fediv, O. I. Olar, O. Yu. Mykytyuk, V.F. Boyechko]. Educational manual for students higher medical educational institutions - Chernivtsi: Publishing house BSMU, 2017. - 235 with. (recommended DU "Central methodological cabinet for higher medical education of the Ministry of Health of Ukraine", letter No. 23-01-9/261 dated 08.06.2017, protocol No. 2 dated June 2, 2017)
3. Medical and biological physics. Educational a guide for higher medical students educational institutions / V.I. Fediv, O. I. Olar, V.V. Kulchynsky, G.Yu. Rudko Study guide for students of higher medical educational institutions - Chernivtsi, Bukovynskyi state medical university, 2017.-342 with. - Language english (recommended by the State University "Central methodical cabinet for higher medical education of the Ministry of Health of Ukraine", letter No. 23-01-9/258 dated June 8, 2017, protocol No. 2 from 02.06.2017)
4. Medical and Biological Physics. MODULE 1. Mathematical processing of medical and biological data. Basic of regularities of biomechanics and electricity and their use for diagnosis and treatment. Educational-methodical textbook / ed. by VI Fediv // Chernivtsi, Higher State Educational Establishment of Ukraine "Bukovinian State Medical University", 2019. - 146 pp.
5. Medical and Biological Physics. MODULE 2. Basic concepts and laws of electromagnetism, optics, quantum and nuclear physics. Educational-methodical textbook / ed. by VI Fediv // Chernivtsi, Bukovinian State Medical University, 2020. - 151 pp.
6. V.L. Winter Biophysics. Collection tasks K.: Higher school, 2001.
7. Ya. Lopushanskyi. A collection of problems and questions in medical and biological physics. Lviv, Scientific society named after Taras Shevchenko, 2006.

Auxiliary

1. Medical and biological physics: textbook for study higher honey. (Pharm.) education institution. /by ed. Prof. AT. V. Chalogo. - Kind. 2nd - Vinnitsa : Nova Book, 2017— 528 with.
2. Medical and Biological Physics. / edited by prof. AV Chalyi. – 2nd ed. – Vinnytsia, Nova Knyha, 2013. - 480 p.
3. Biophysics/ P.G. Kostyuk (ed.), V. L. Zima, I.S. Magura, Miroshnychenko M.S., Fur coat M.F. – K.: VOC "Kyivskyi university", 2008.
4. Building and principles work medical equipment: manual / V.D. grandfather and others –TDMU – 2016. – 268 p.

Module 2. "Medical informatics"

The main one

1. Medical informatics in modules: practicum / I.E. Bulak, L.P. Voytenko, M.R. Mruga and others; by ed. I.E. Bulak. - K.: Medicine, 2012. - 208 p.
2. Handbook of Medical Informatics. Editors: JH van Bommel, M.A Musen. – <http://www.mieur.nl/mihandbook>; <http://www.mihandbook.stanford.edu>
3. Mark A. Musen B. Handbook of Medical Informatics // Electronic resource <ftp://46.101.84.92/pdf12/handbook-of-medical-informatics.pdf>
4. Edward H., Shortliffe J., Cimino J. Biomedical Informatics, 2014 // Electronic resource <http://www.rhc.ac.ir/Files/Download/pdf/nursingbooks/Biomedical%20Informatics%20Computer%20Applications%20in%20Health%20Care%20and%20Biomedicine-2014%20-%20CD.pdf>
5. Medical Informatics: Computer Applications in Health Care and Biomedicine, 2011 // Electronic resource <https://books.google.com.ua/books?id=WYvaBwAAQBAJ&pg=PA321&lpg=PA321&dq=book++medical+informatics&source=bl&ots=VjPvStLtk&sig=b39YVoBltS31QsJkUf4bnA>

Auxiliary

1. Informatics in tables and diagrams: PC and its components, Windows operating system, Internet, the main ones and auxiliary devices, systemic and applied softwaresoftware, modeling and programming / [Belousova L. AND., Olefirenko N. IN.]. — Kharkiv: Torsing plus, 2014. — 111 with.
2. Lopoch S.N., Chubenko A.V., Babych P.N. Statistical methods in medical and biological research using the EXCEL. - K.: Morion, 2001. - 408 p.
3. Informational systems and technologies: Education manual for study higher education close/ S.G. Karpenko, V.V. Popov, Yu.A. Tarnavskiy, G.A. Shportyuk. - K.: MAUP, 2004. - 192 with.
4. Paul J. Perry. Secrets of the World Wide Web. "Dialectics". Kyiv. 1996. 576p. 5. Medytsynskaya computer science: textbook / I.E. I would Yu.E. Pole, V.P. Martsenyuk, I.I. Haimzon. - K.: VSY "Medicine", 2012. - 424 p.
6. Medical Informatics=Medical Computer Science: textbook / I.E. I would Yu.E. Pole, V.P. Martsenyuk, I.Y. Haimzon. - K.: VSY "Medicine", 2012. – 368 p.
7. Informational technologies in psychology and medicine: textbook / I.E. I would I.I. Haimzon. - K.: VSV "Medicine", 2011. - 216 p.
8. Computer Science in tables and schemes: PC and him ingredients, operating room system windows,Internet, main and auxiliary devices, system and applied software support, modeling and programming / [Bilousova L. I., Olefirenko N. V.]. — Kharkiv: Torsing plus, 2014. — 111 p.
9. Basics of informatics. Microsoft Office 2013 (Word, PowerPoint in practice): training. manual / M. M. Drin, N. V. Romanenko; Ministry of Education and Science of Ukraine, Chernivtsi. national Univ named after Yu. Fedkovicha. — Chernivtsi: Cherniv. national University, 2014. — 75 p.
10. Informatics and informative technologies: practicum for org. work students on practice and laboratory classes / Yu. Yu. Squirrel, IN. AT. Laver, Yu. IN. Andrashko, I.M. Lyakh; Ministry of Education and Science of Ukraine, State Higher Secondary School "Uzhhor". national Univ., Ft information of technologies, Kaf. of computer science and physics and mathematics discipline — Uzhhorod: Outdoor layer, 2015.
11. Computer Science : practicum with information technologies / I. M. Glynskyi — Ternopil: Understudy and help., 2014. — 302 p.
12. Mintzer O.P. Computer Science and protection health / O.P. Mintzer // Medical Computer Science and engineering – 2010. – No. 2. – P.8 -21
13. Computer modeling in pharmacy: Education manual for honey. university IV r.a. Recommended Ministry of Health / Bulak I.E. and others — K., 2016. — 208 p.

15. INFORMATION RESOURCES

Informational resources educational disciplines "Medical and biological physics. Medical Computer Science" is:

- Ministry education and science of Ukraine <http://www.mon.gov.ua/>
- National library of Ukraine named after V.I. Vernadskyi <http://www.nbuv.gov.ua/>
- Internet resource with higher mathematicians, medical and biological physics
- <https://support.office.com/uk-ua/> (For reference and educational materials package Microsoftoffice)
- www.uacm.kharkov.ua (Ukrainian association "Computer Medicine")
- www.mednavigator.net (Medical search system)
- www.rmj.ru (Internet versions periodic publications)
- www.medinfo.com.ua (Medical search system of Ukraine)
- www.medico.ru (Medical search system)
- www.medinf.nmu.ua (Informative resource educational and methodical materials with disciplines "European standard computer literacy").

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