

**MEDICAL UNIVERSITY – PLOVDIV**  
**FACULTY OF PHARMACY**

**SYLLABUS**  
**IN**  
**BIOLOGY**

**Approved by the Department Council on 16 February 2024**

**Confirmed by the Faculty Council - Protocol № 3/27.03.2024**

## Biology

### Syllabus

Discipline	Final exam/ semester	According to the Faculty of Pharmacy curriculum of MU-Plovdiv Academic hours				ECTS	Academic hours in semester			
		Aauiditori	Lectures	Practices	Non-auditoriu		I semester		II semester	
							L	P	L	P
Biology	I	60	30	30	70	4.3	2	2	-	-

**DISCIPLINE:**

Biology

**TYPE OF DISCIPLINE ACCORDING TO THE UNIFORM STATE REQUIREMENTS:**

Mandatory

**LEVEL OF QUALIFICATION:**

Master degree /M/

**FORMS OF TRAINING:**

Lecture courses, practical courses, seminars

**YEAR OF TRAINING:**

I<sup>ST</sup>

**DURATION OF TRAINING:**

I semester

**ACADEMIC HOURS:**

30 hours of lectures, 30 hours of practical courses

**TECHNICAL EQUIPMENT APPLIED IN THE TRAINING:**

Microscopes, permanent and temporary microscopic preparations, cell cultures, audiovisual equipment, tools and technical devices for illustration and performance of molecular, cellular, and immunological methods, laboratory protocols, test books.

**FORMS OF EVALUATION:**

Ongoing evaluation – weekly tests, oral examinations, combined written exam test.

Final evaluation – combined written test.

**EVALUATION CRITERIA:**

The final grade is based on the mark from the final combined test exam.

**ASPECTS OF EVALUATION CRITERIA:**

Participation in seminars

**SEMESTER EXAM:**

Yes /written examination/

**STATE EXAM:**

No

**LECTURER:**

Full Professor and Associate Professor

**DEPARTMENT:**

Medical Biology

**ANNOTATION**

The discipline Biology allows students to acquire knowledge and skills in the following basic biological concepts:

- Molecular bases of life – biological macromolecules
- Transfer of genetic information
- Genetic code
- Organization of the genetic material in the cell
- Karyotype

- Heredity and variability
- Genetic engineering
- Biology of the cell
- Reproduction
- Immunological homeostasis

## **BASIC AIMS OF THE DISCIPLINE**

The aim of the course is to develop:

1. The understanding that living systems, including humans, have hierarchically ordered levels of organization with their own specificity and rules that determine biological features and functions.
2. The notion that humans, as a product of biological evolution, are ecologically connected to the development of nature and of the biosphere as a whole.
3. The ability to apply biological rules as scientific theory and methodology in the field of Pharmacy.
4. Practical skills and knowledge of basic biological techniques with medical and pharmaceutical application.

## **EXPECTED RESULTS**

1. *Theoretical knowledge* – mastering and analysis of:
  - hierarchical levels and structural organization of the human organism (molecular, cellular and systemic)
  - genetic structures and processes of transfer of genetic and epigenetic information
  - mechanisms of immunological homeostasis
  - human ontogenesis
2. *Practical skills*
  - preparation of temporary and permanent microscopic slides
  - light microscopy
  - karyotyping
  - basic immunological reactions
  - blood typing
  - basic Molecular Biology methods
  - basic Cell Biology methods

## LECTURES

1<sup>st</sup> year students in Pharmacy

### **LECTURE №1 – 2 hours. Organization of genetic material in the eukaryotic cell. Structure of chromosomes.**

Submicroscopic structure of chromosomes – levels of organization of chromatin. Microscopic structure of chromosomes: a) types; b) eu- and heterochromatin. Sex chromatin.

### **LECTURE №2 – 2 hours. Karyotype. Pathological karyotype. Genes and chromosomal mutations.**

Normal human karyotype, types of chromosomes, karyotyping. Abnormal karyotype - autosomal and gonosomal anomalies. Gene and chromosomal mutations.

### **LECTURE №3 – 2 hours. Cell division. Mitosis.**

Individual development of the cells. Cell cycle. Mitosis – phases and mechanisms. Cytokinesis. Regulation of the cell cycle.

### **LECTURE №4– 2 hours. Meiosis. Gametogenesis. Fertilization.**

Cytological foundations of sexual reproduction (meiosis): a) mechanism; b) significance of meiosis. Gametogenesis: a) oogenesis; b) spermatogenesis. Origin of germ cells. Fertilization: a) types; b) fertilization in mammals and humans – mechanism.

### **LECTURE №5 – 2 hours. Nucleic acids. DNA replication.**

Nucleic acid structure. DNA: a) helicoidal model; b) conformation; c) DNA functions. RNA – types, structure and functions. Required elements for DNA replication. Replication of linear and circular DNA molecules.

### **LECTURE №6 – 2 hours. Transcription. Translation. Genetic code.**

Transcription- characteristics, required elements for Transcription. Transcription in prokaryotes and eukaryotes. Translation – definition, required elements. Mechanism of translation. Post-translational modifications of proteins. Regulation of translation. Characteristics of the genetic code.

**LECTURE № 7 – 2 hours. Apoptosis. Tumor Biology.**

Programmed cell death – characteristics and types, mechanism, genetic control. Biological characteristics of tumor cells. Genetic control of tumorigenesis.

**LECTURE №8 - 2 hours. Gene and cell engineering. Gene therapy.**

Methods of gene, cellular, organisms and population level. Methods for the isolation and synthesis of genes. Obtaining of recombinant DNA. Methods for introducing genes into somatic cells. Vectors. Control of gene expression. Gene therapy. Achievements and perspectives of genetic engineering.

**LECTURE №9 – 2 hours. Immunological homeostasis. Innate immunity.**

Immunological homeostasis – essence. Innate and acquired immunity - mechanisms and characteristics.

**LECTURER №10 – 2 hours. Antigens. Characterization and classification of antigens. Alloantigenic systems in humans. The AB0 (H) system. Rhesus system.**

Antigens – characteristics. Natural antigens – classification. Types of antigenic specificity. Human Alloantigen Systems - ABO (H) and Rhesus. Origin and biological significance of alloantigens.

**LECTURER №11 – 2 hours. Immune system. Immunocompetent cells.**

Functions and features of the immune system. Central and peripheral organs. Cells of the immune response: a) types, characteristics, functions; b) stages in the differentiation of immunocompetent cells.

**LECTURE №12 – 2 hours. Antibodies – classification, structure functions.**

Antibodies: a) classification; b) structure and properties; c) mechanism of action. Basic classes of antibodies. Antibody functions.

**LECTURE №13 – 2 hours. Major histocompatibility complex. Transplantation immunology.**

Antigens of tissue compatibility. Genes form the MHC complex. Types transplantation. Immune response in graft rejection.

**LECTURE №14 – 2 hours. Antigenic recognition, processing and presentation. Cellular interactions.**

Antigenic recognition, processing and presentation. Mediators of the immune response. Cytokines and cytokine network. Cellular interactions in the immune response.

**LECTURE №15 – 2 hours. Hypersensitivity reactions.**

Hypersensitivity reactions – classification, mechanisms, basic characteristics.

**PRACTICES**

**PRACTICAL №1 - 2 hours. Microscope.**

Introduction. Microscopy with a dry and an oil immersion objective system. Microscopic observation of blood smears from frog and human. Micropipettes – types. Adjust the volumes of the variable micropipettes. Laboratory algorithm.

**PRACTICAL №2 - 4 hours. Nucleic acids. DNA replication.**

Structure of DNA and RNA. Chargaff rules. Factors and mechanism of replication. Basic steps and protocols for genomic DNA isolation. Spectrophotometric measurement of DNA and RNA. PCR. Steps and required reagents for PCR.

**PRACTICAL №3 - 4 hours. Gene and chromosomal (structural and numerical) mutations.**

Mechanism and classification of chromosomal mutations. Genomic mutations. Medical significance of trisomies and monosomies. Analysis of different pathological karyograms. Agarose gel electrophoresis for analysis of PCR products. Interpretation of results.

**PRACTICAL №4 - 4 hours. Transfer of genetic information. Genetic code.**

Transcription units in eukaryotes and prokaryotes. Mechanism and stages of transcription. RNA processing and splicing. Post-transcriptional modifications. Mechanism and stages of translation. Genetic code. Protocol for isolation of total protein from tissue samples. Spectrophotometric measurement of protein concentration. Electrophoresis for protein separation. Interpretation of results.

**PRACTICAL №5 - 4 hours. Organization of genetic material in a eukaryotic cell. Karyotype. Cell cycle and reproduction. Fertilization.**

Microscopic and submicroscopic structure of eukaryotic chromosomes. Euchromatin and heterochromatin. X-chromosome inactivation. Normal human karyotype. Phases of the cell cycle. Main characteristics of sexual reproduction. Stages of meiosis. Differences between mitosis and meiosis. Mechanism and stages of fertilization. Preparation of microscopic slides and staining of spermatozoa of different biological species. Observation of microscopic slides of mammalian ovary and testis. Flow cytometric determination of mitotic index. Interpretation of results. Observation of cell division in cell cultures.

**PRACTICAL №6 - 4 hours. Apoptosis. Tumor biology. Pharmacogenomics.**

Types of cell death. Characteristics of apoptosis and necrosis, of normal and tumor cell. Mechanisms of tumor growth. Oncogenes and proto-oncogenes. Observation of morphological changes in apoptosis in cell cultures. qPCR. Interpretation of results. Clinical cases.

**PRACTICAL №7 - 4 hours. Innate and adaptive immunity. Blood group antigens. Immunoglobulins. Immunological methods - part I.**

Characteristics of innate and adaptive immunity. Characteristics and classification of antigens. Blood group system ABO (H). Types of immune cells. Blood groups and Rh-factor examination. Structure, functions and classes of antibodies. Precipitation reaction. Types of ELISA methods for determining antigens and antibodies. Interpretation of results.

**PRACTICAL №8 - 4 hours. Major histocompatibility complex. Tumor immunology. Hypersensitivity reactions. Immunological methods – Part II.**

Structure and function of the MHC-system. Tumor-associated and tumor-specific antigens. Hypersensitivity reactions. Western blot, immunoelectrophoresis. Flow cytometry. Immunohistochemical detection of proteins on paraffin sections of tumor tissue.

## **BIBLIOGRAPHY**

1. Gevezova M., Draganova M., Kazakova M., Mehterov N., Minchev D., Sarafian V., Sbirkov S. Practical book - Medical biology for first year pharmacy students. Medical Universiti - Plovdiv, 2022. ISBN:978-619-237-060-2.
2. Bios instant notes. Molecular Biology by A. McLennan, A. Bates, P. Turner, M. White. 2013,

4th edition, Garland Science, Taylor & Francis Group.

3. Basic Immunology: Functions and Disorders of the Immune System by A. K. Abbas, A. H. Lichtman, Shiv Pillai. 2012, 4th edition, Elsevier.
4. Human Biology by Starr C. and McMillan B. 2014, 10th edition, BOOKS/COLE.
5. Feodorova Y., M. Kazakova, V. Alexandrov, N. Mehterov, V. Sarafian. Ed. V. Sarafian. Tests in Medical Biology. ISBN: 978-619-7085-88-4, 2017.
6. Sarafian V., M. Kazakova, M. Draganova, N. Mehterov. Practical Book. Medical Biology for first year students. Plovdiv, ISBN: 978-619-237-016-9, 2020.

## **CONSPECTUS**

### **MOLECULAR AND CELL BIOLOGY**

1. Nucleic acids. DNA – localization and structure. The double helix model. Chargaff's rules. DNA conformations.
2. Nucleic acids. Linear and circular DNA. DNA functions. Mitochondrial DNA – characteristics, functions.
3. Nucleic acids. RNA – structure and types, functions. Differences between RNA and DNA.
4. Replication of DNA. Necessary elements and mechanism. Replication of linear DNA molecules. Fidelity of replication
5. Replication of circular DNA molecules. Differences between prokaryotic and eukaryotic replication
6. Transcription. Necessary elements, stages and mechanism. Reverse transcription.
7. Transcription in prokaryotes and in eukaryotes – comparison. Processing of mRNA.
8. Translation. Necessary elements, stages and mechanism.
9. Transfer of genetic information. The Central dogma. The genetic code – characteristics.
10. Molecular diagnostics – DNA analysis: DNA electrophoresis, PCR, qPCR, DNA sequencing.
11. Mutation – characteristics and types. Gene rearrangements and point mutations.
12. Genetic engineering – pre and post – zytotic selection, *in vitro* fertilization.
13. Genetic engineering – cellular hybridization, fusion of embryos (hymeras), animal cloning.
14. Molecular engineering. Recombinant DNA technologies, vector systems, transfer of foreign genes into somatic cells. Gene therapy – vectors, principles

15. Submicroscopic structure of chromosomes. Chromatin.
16. Microscopic structure of chromosomes. Types of chromosomes. The normal human karyotype.
17. Structural chromosomal mutations – deletions, duplications, inversions, translocations.
18. Numerical chromosomal mutations – aneuploidy and polyploidy.
19. Epigenetic control of gene expression. X-chromosome inactivation.
20. The eukaryotic cell cycle. Mitosis. Stages of mitosis. Cell cycle regulation – cyclins and Cdk.
21. Apoptosis. Characteristics. Genetic control, mechanisms, detection.
22. Biology and genetics of cancer. Tumor-suppressor genes and oncogenes.
23. Meiosis – mechanism and stages. Differences between mitosis and meiosis.
24. Gametogenesis. Spermatogenesis. Oogenesis.
25. Fertilization.

## **IMMUNOLOGY**

26. Innate and adaptive immunity. Characteristics of the immune response. Innate immunity-mechanisms.
27. Adaptive immunity. Fate of the antigen.
28. The immune system. Central and peripheral lymphoid organs.
29. Antigens – characteristics, types. Haptens.
30. Human alloantigens. Blood group antigens ABO (H), Se and Rhesus.
31. Cells and molecules of the immune system. B-cells, T-cells. Characteristics and functions.
32. APC, NK-cells. Characteristics and functions.
33. Kinetics of the immune response. Humoral and cellular immunity. Primary and secondary immune response.
34. The Complement system – characteristics and functions.
35. Antibodies – structure and function.
36. Immunoglobulin classes and characteristics.
37. MHC – complex. Structure and function. MHC restriction.
38. Hypersensitivity reactions – general characteristics and types.