


|                                                                                  |                                                                                                                                                                                                                                                                             |                                                                                                                                           |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Федеральное государственное бюджетное образовательное учреждение высшего образования<br/>«Волгоградский государственный медицинский университет» Министерства<br/>здравоохранения Российской Федерации</p> <p><b>КАФЕДРА<br/>ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ</b></p> | <p>ОБРАЗОВАТЕЛЬНАЯ<br/>ПРОГРАММА<br/>НАПРАВЛЕНИЯ ПОДГОТОВКИ<br/>33.05.01 «ФАРМАЦИЯ»</p> <p>ДИСЦИПЛИНА<br/>«МОЛЕКУЛЯРНАЯ<br/>БИОЛОГИЯ»</p> |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|

## Study Guide

Molecular biology, pharmaceutical faculty 2th year

### Class (занятие) № 1

#### Topic:

Path 1. **Introduction to the molecular biology of the cell.** The main classes of biomolecules. Transmission of information and energy in biological systems. The concept of "omics" technologies in medicine.

Path 2. **Nucleic acids:** structure and biological functions.

#### Study questions:

1. The subject of molecular biology. The importance of molecular biology in the medical education system;
2. The main classes of biological molecules: nucleotides, amino acids, carbohydrates and lipids;
3. The concept of biopolymers: nucleic acids, proteins and polysaccharides;
4. Principles of structure and biological functions of nucleic acids;
5. Principles of structure and biological functions of proteins;
6. Definition and biological role of enzymes;
7. The main types of chemical reactions in biological systems;
8. Metabolic pathways. The concept of metabolism. Energy supply of metabolic processes. The role of macroergic compounds (bonds). Ways of using ATP (Adenosine triphosphate) energy;
9. The concept of "omics" technologies in medicine;
10. Structure and functions of nucleic acids. Primary, secondary and tertiary structure of DNA;
11. Main differences between DNA and RNA;



Федеральное государственное бюджетное образовательное учреждение высшего образования  
«Волгоградский государственный медицинский университет» Министерства  
здравоохранения Российской Федерации


**КАФЕДРА  
ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ**

ОБРАЗОВАТЕЛЬНАЯ  
ПРОГРАММА  
НАПРАВЛЕНИЯ ПОДГОТОВКИ  
33.05.01 «ФАРМАЦИЯ»

ДИСЦИПЛИНА  
«МОЛЕКУЛЯРНАЯ  
БИОЛОГИЯ»

### **Vocabulary (list of mandatory terms and concepts):**

- nucleic acids;
- proteins;
- covalent bond;
- ionic bond;
- pH value;
- dehydrogenation;
- dehydration;
- oxidation;
- redox reactions;
- metabolic pathway;
- biopolymers;
- anabolism;
- catabolism;
- hydrophobicity;
- hydrophilicity;
- amphiphilicity  
(diphilicity);
- catalyst;
- macromolecules;
- metabolism;
- macroergic bonds;
- amino acid;
- nucleotide.

|                                                                                  |                                                                                                                                                                                                                                                                             |                                                                                                                                           |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Федеральное государственное бюджетное образовательное учреждение высшего образования<br/>«Волгоградский государственный медицинский университет» Министерства<br/>здравоохранения Российской Федерации</p> <p><b>КАФЕДРА<br/>ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ</b></p> | <p>ОБРАЗОВАТЕЛЬНАЯ<br/>ПРОГРАММА<br/>НАПРАВЛЕНИЯ ПОДГОТОВКИ<br/>33.05.01 «ФАРМАЦИЯ»</p> <p>ДИСЦИПЛИНА<br/>«МОЛЕКУЛЯРНАЯ<br/>БИОЛОГИЯ»</p> |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|

## Study Guide

Molecular biology, pharmaceutical faculty 2th year

### (Занятие № 2)

#### Topic:

Path 1. **Nucleic acids:** levels of DNA compactification. Methods for studying the structure and functions of nucleic acids.

Path 2. **DNA replication and repair:** mechanisms and biomedical significance. DNA structure damage and repair mechanisms. Medicine that inhibit replication.

#### Study questions:

1. Levels of structural organization of chromatin. The role of histone and non-histone proteins in DNA compaction.
2. Methods for studying the structure and functions of nucleic acids.
3. DNA replication: basic principles of matrix biosynthesis. Consistency of replication and cell cycle.
4. Initiation of DNA replication: the scheme of the process, the main enzymes and their function.
5. Elongation and termination of DNA replication: the scheme of the process, the main enzymes and their function. Mechanisms of biosynthesis of leading and lagging DNA chains.
6. Mechanisms of DNA structure damage and their biological consequences.
7. DNA repair: the main mechanisms of DNA structure restoration. Violations of DNA repair systems and their biomedical significance.
8. Medicine that inhibit replication.

#### Vocabulary (list of mandatory terms and concepts):

- nucleoside;
- nucleic acids;
- hydrogen bonding;




Федеральное государственное бюджетное образовательное учреждение высшего образования  
«Волгоградский государственный медицинский университет» Министерства  
здравоохранения Российской Федерации

**КАФЕДРА  
ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ**

ОБРАЗОВАТЕЛЬНАЯ  
ПРОГРАММА  
НАПРАВЛЕНИЯ ПОДГОТОВКИ  
33.05.01 «ФАРМАЦИЯ»

ДИСЦИПЛИНА  
«МОЛЕКУЛЯРНАЯ  
БИОЛОГИЯ»

- biopolymers;
- Chargaff rule;
- histones;
- the nucleosome;
- euchromatin;
- heterochromatin;
- apurination;
- interphase;
- replication origin;
- replicon;
- photolyase;
- DNA insertase;
- semi - conservativeness;
- replication fork;
- fragments of Okazaki;
- ligation;
- telomerase;
- Hayflick limit.

|                                                                                  |                                                                                                                                                                                                                                                                             |                                                                                                                                           |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Федеральное государственное бюджетное образовательное учреждение высшего образования<br/>«Волгоградский государственный медицинский университет» Министерства<br/>здравоохранения Российской Федерации</p> <p><b>КАФЕДРА<br/>ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ</b></p> | <p>ОБРАЗОВАТЕЛЬНАЯ<br/>ПРОГРАММА<br/>НАПРАВЛЕНИЯ ПОДГОТОВКИ<br/>33.05.01 «ФАРМАЦИЯ»</p> <p>ДИСЦИПЛИНА<br/>«МОЛЕКУЛЯРНАЯ<br/>БИОЛОГИЯ»</p> |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|

## Study Guide

Molecular biology, pharmaceutical faculty 2th year

### (Занятие № 3)

#### Topic:


**Stages of realization of genetic information.** Structure and functions of various types of RNA. Molecular mechanisms of transcription and translation. Part 1, 2.

#### Study questions:

1. Stages of implementation of genetic information. The concept of transcription and translation
2. The main types of RNA and their functions. Types of RNA polymerases
3. RNA biosynthesis: stages of the process. Features of transcription in eukaryotes.
4. Post-transcriptional changes in RNA. Alternative splicing
5. Protein biosynthesis. The genetic code and its properties. Function and structural features of tRNA
6. Activation of amino acids
7. Ribosomes: structural features in prokaryotes and eukaryotes. Active centers of ribosomes
8. Polyribosomes.

#### Vocabulary (list of mandatory terms and concepts):

- transcription;
- ribozymes;
- RNA polymerase;
- cistron;
- transcription factors;
- exons;
- promoter;
- introns;
- terminator;
- spliceosome;
- polyadenylation;
- alternative splicing;

|                                                                                  |                                                                                                                                                                                                                                                                             |                                                                                                                                           |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Федеральное государственное бюджетное образовательное учреждение высшего образования<br/>«Волгоградский государственный медицинский университет» Министерства<br/>здравоохранения Российской Федерации</p> <p><b>КАФЕДРА<br/>ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ</b></p> | <p>ОБРАЗОВАТЕЛЬНАЯ<br/>ПРОГРАММА<br/>НАПРАВЛЕНИЯ ПОДГОТОВКИ<br/>33.05.01 «ФАРМАЦИЯ»</p> <p>ДИСЦИПЛИНА<br/>«МОЛЕКУЛЯРНАЯ<br/>БИОЛОГИЯ»</p> |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|

## Study Guide

Molecular biology, pharmaceutical faculty 2th year

(Занятие № 4)

### Topic:


**Regulation of gene expression in prokaryotes.** The theory of the "operon". Mechanisms of gene induction and repression in eukaryotes. Medicines that modulate gene expression. Part 1, 2.

### Study questions:

1. Features of gene expression in prokaryotes and eukaryotes.
2. What is positive regulation? What is negative regulation?
3. Principles of regulation of gene expression in prokaryotes. The theory of the "operon". Lactose and tryptophan operon.
4. Levels of regulation of gene expression in eukaryotes. Packaging of genetic material.
5. Euchromatin and heterochromatin. Regulation of RNA transcription and processing.
6. Regulation of translation and post-translational modifications of the protein. Mechanisms of induction and repression of gene expression.

### Vocabulary (list of mandatory terms and concepts):

- operon;
  - promoter;
  - enhancers;
  - silencers;
  - heterochromatin;
- exons;
  - introns;
  - repressor proteins
  - alternative splicing;
  - euchromatin;

|                                                                                  |                                                                                                                                                                                                                                                                             |                                                                                                                                           |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Федеральное государственное бюджетное образовательное учреждение высшего образования<br/>«Волгоградский государственный медицинский университет» Министерства<br/>здравоохранения Российской Федерации</p> <p><b>КАФЕДРА<br/>ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ</b></p> | <p>ОБРАЗОВАТЕЛЬНАЯ<br/>ПРОГРАММА<br/>НАПРАВЛЕНИЯ ПОДГОТОВКИ<br/>33.05.01 «ФАРМАЦИЯ»</p> <p>ДИСЦИПЛИНА<br/>«МОЛЕКУЛЯРНАЯ<br/>БИОЛОГИЯ»</p> |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|

## **Study Guide**

Molecular biology, pharmaceutical faculty 2th year

**(Занятие № 5)**

### **Topic:**

**Molecular genetic technologies in the development and study of medicines.**


Prospects of gene therapy in the treatment of diseases. Part 1, 2.

### **Study questions:**

1. A general idea of genetic engineering and molecular genetics.
2. The concept of genetic engineering. Goals, tasks, methods.
3. The role of genetic engineering and molecular genetics in the development of medicines.
4. Bacteria as super-producers of antibiotics.
5. Prospects of gene therapy in the treatment of diseases. Monoclonal antibodies.

### **Vocabulary (list of mandatory terms and concepts):**

- gene therapy;
- CRISPR/Cas9
- CAR-T
- Monoclonal antibodies;
- DNA Sequencing;
- PCR;

|                                                                                  |                                                                                                                                                                                                                                                                             |                                                                                                                                           |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Федеральное государственное бюджетное образовательное учреждение высшего образования<br/>«Волгоградский государственный медицинский университет» Министерства<br/>здравоохранения Российской Федерации</p> <p><b>КАФЕДРА<br/>ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ</b></p> | <p>ОБРАЗОВАТЕЛЬНАЯ<br/>ПРОГРАММА<br/>НАПРАВЛЕНИЯ ПОДГОТОВКИ<br/>33.05.01 «ФАРМАЦИЯ»</p> <p>ДИСЦИПЛИНА<br/>«МОЛЕКУЛЯРНАЯ<br/>БИОЛОГИЯ»</p> |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|

## Study Guide


Molecular biology, pharmaceutical faculty 2th year

### (Занятие № 6)


#### Concluding №1

1. The subject of molecular biology. The importance of molecular biology in the medical education system;
2. The main classes of biological molecules: nucleotides, amino acids, carbohydrates and lipids;
3. Cellular organelles (overview, structure, function)
4. Central dogma of molecular biology, prokaryotic and eukaryotic gene.
5. Principles of structure and biological functions of nucleic acids;
6. Principles of structure and biological functions of proteins;
7. Definition and biological role of enzymes;
8. Chemical composition of the cell. Types of chemical bonds. Small and large molecules in the cell.
9. Metabolic pathways. The concept of metabolism. Energy supply of metabolic processes. The role of macroergic compounds (bonds). Ways of using ATP (Adenosine triphosphate) energy;
10. The concept of "omics" technologies in medicine;
11. Structure and functions of nucleic acids. Primary, secondary and tertiary structure of DNA;
12. Main differences between DNA and RNA;
13. Levels of structural organization of chromatin. The role of histone and non-histone proteins in DNA compaction.
14. Structure of human genome (histones, nucleosomes, chromatin)
15. Methods for studying the structure and functions of nucleic acids.
16. DNA replication: basic principles of matrix biosynthesis. Consistency of replication and cell cycle.
17. Comparison of DNA replication in prokaryotes and eukaryotes
18. Initiation of DNA replication: the scheme of the process, the main enzymes and their function.
19. Elongation and termination of DNA replication: the scheme of the process, the main enzymes and their function. Mechanisms of biosynthesis of leading and lagging DNA chains.



|                                                                                  |                                                                                                                                                                                                                                                                             |                                                                                                                                           |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Федеральное государственное бюджетное образовательное учреждение высшего образования<br/>«Волгоградский государственный медицинский университет» Министерства<br/>здравоохранения Российской Федерации</p> <p><b>КАФЕДРА<br/>ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ</b></p> | <p>ОБРАЗОВАТЕЛЬНАЯ<br/>ПРОГРАММА<br/>НАПРАВЛЕНИЯ ПОДГОТОВКИ<br/>33.05.01 «ФАРМАЦИЯ»</p> <p>ДИСЦИПЛИНА<br/>«МОЛЕКУЛЯРНАЯ<br/>БИОЛОГИЯ»</p> |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|

20. Types of DNA damages and their causes.
21. DNA repair: the main mechanisms of DNA structure restoration. Violations of DNA repair systems and their biomedical significance.
22. Medicine that inhibit replication.
23. Stages of implementation of genetic information. The concept of transcription and translation
24. The main types of RNA and their functions. Types of RNA polymerases
25. RNA biosynthesis: stages of the process. Features of transcription in eukaryotes.
26. Post-transcriptional modifications in eukaryotes. Role of splicing
27. Protein biosynthesis. The genetic code and its properties. Function and structural features of tRNA
28. Ribosomes: structural features in prokaryotes and eukaryotes. Active centers of ribosomes
29. Features of gene expression in prokaryotes and eukaryotes.
30. Gene Expression. tRNAs and aminoacyl-tRNA synthetases, ribosome structure.
31. Principles of regulation of gene expression in prokaryotes. The theory of the "operon". Lactose and tryptophan operon.
32. Levels of regulation of gene expression in eukaryotes. Packaging of genetic material.
33. Euchromatin and heterochromatin. Regulation of RNA transcription and processing.
34. Regulation of translation and post-translational modifications of the protein. Mechanisms of induction and repression of gene expression.
35. The concept of genetic engineering. Goals, tasks, methods.

|                                                                                  |                                                                                                                                                                                                                                                                             |                                                                                                                                           |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Федеральное государственное бюджетное образовательное учреждение высшего образования<br/>«Волгоградский государственный медицинский университет» Министерства<br/>здравоохранения Российской Федерации</p> <p><b>КАФЕДРА<br/>ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ</b></p> | <p>ОБРАЗОВАТЕЛЬНАЯ<br/>ПРОГРАММА<br/>НАПРАВЛЕНИЯ ПОДГОТОВКИ<br/>33.05.01 «ФАРМАЦИЯ»</p> <p>ДИСЦИПЛИНА<br/>«МОЛЕКУЛЯРНАЯ<br/>БИОЛОГИЯ»</p> |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|

## Study Guide

Molecular biology, pharmaceutical faculty 2th year

(Занятие № 7)

### Topic:


**Classification and functions of proteins.** Methods of studying the structure of proteins. The use of enzymes in molecular genetic research. Part 1, 2.

### Study questions:

1. Amino acids: principles of structure, classification. The peptide bond.
2. Proteins (proteins): definition, biological functions.
3. Levels of structural organization of proteins. Primary structure.
4. The secondary structure of the protein. Types and their characteristics.
5. The tertiary structure of the protein. Globular and fibrillar proteins.
6. Chemical bonds that stabilize the structures of the protein molecule.  
Denaturation and renaturation.
7. Methods of studying the structure of proteins. Techniques for studying protein.
8. The use of enzymes in molecular genetic research.

### Vocabulary (list of mandatory terms and concepts):

- peptide;
- zymogen;
- holoprotein;
- folding;
- ligand;
- oligopeptide;
- polypeptide;
- native conformation;
- hydrogen bond;
- active site;
- allosteric center;
- hydrophobic interactions;

|                                                                                  |                                                                                                                                                                                                                                                                         |                                                                                                                                   |
|----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Федеральное государственное бюджетное образовательное учреждение высшего образования<br/>«Волгоградский государственный медицинский университет» Министерства здравоохранения Российской Федерации</p> <p><b>КАФЕДРА<br/>ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ</b></p> | <p>ОБРАЗОВАТЕЛЬНАЯ ПРОГРАММА<br/>НАПРАВЛЕНИЯ ПОДГОТОВКИ<br/>33.05.01 «ФАРМАЦИЯ»</p> <p>ДИСЦИПЛИНА<br/>«МОЛЕКУЛЯРНАЯ БИОЛОГИЯ»</p> |
|----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|

## Study Guide

Molecular biology, pharmaceutical faculty 2th year

(Занятие № 8)

### Topic:


**Post-translational modifications of the protein.** Protein folding and its disorders. Molecular mechanisms of proteinopathies. Proteins and enzymes as biomarkers.

### Study questions:

1. Import of proteins into cellular organelles: nucleus, mitochondria, EPR, Golgi apparatus, etc.
2. The role of chaperones and chaperonins. Hsp70 chaperones.
3. GroEL/GroES system structure.
4. Non-enzymatic post-translational modification.
5. Enzymatic post-translational modification with cleavage of the polypeptide chain.
6. Covalent modification of alpha-amino and alpha-carboxyl groups.
7. Methylation, hydroxylation, introduction of additional carboxyl group, phosphorylation, glycosylation, ADP-ribosylation, prenylation, sulfation, ubiquitinylation of proteins.
8. The lifetime of proteins in the cell.

### Vocabulary (list of mandatory terms and concepts):

- GroE complex;
- chaperone;
- mitochondria;
- EPR;
- translation of proteins;
- methylation;
- hydroxylation;
- ubiquitinylation;
- prions;

|                                                                                  |                                                                                                                                                                                                                                                                         |                                                                                                                                   |
|----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Федеральное государственное бюджетное образовательное учреждение высшего образования<br/>«Волгоградский государственный медицинский университет» Министерства здравоохранения Российской Федерации</p> <p><b>КАФЕДРА<br/>ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ</b></p> | <p>ОБРАЗОВАТЕЛЬНАЯ ПРОГРАММА<br/>НАПРАВЛЕНИЯ ПОДГОТОВКИ<br/>33.05.01 «ФАРМАЦИЯ»</p> <p>ДИСЦИПЛИНА<br/>«МОЛЕКУЛЯРНАЯ БИОЛОГИЯ»</p> |
|----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|

## Study Guide

Molecular biology, pharmaceutical faculty 2th year

### (Занятие № 9)


#### Topic:

**Principles of coordination of metabolic pathways.** Regulation of enzymatic activity.  
Proteins and enzymes as targets for drugs.


#### Study questions:

1. Metabolic pathways and the biological significance of their regulation.
2. Principles of regulation of enzyme activity.
3. Examples and functional role of cofactors – metal ions.
4. Examples and functional role of cofactors – vitamin derivatives.
5. Allosteric regulation of enzymatic activity.
6. Inhibitors of enzymatic activity: classification and mechanisms of action.
7. Regulation of enzyme activity by protein-protein interactions.
8. Adenylate cyclase mechanism of hormonal signal transmission. The role of cAMP.
9. Regulation of enzyme activity by covalent modification. Phosphorylation and dephosphorylation.
10. Partial proteolysis: biological significance and examples.
11. Principles of using enzymes as clinical and laboratory biomarkers.
12. Diagnostic value of isoenzymes.
13. Limitations of determining the activity of enzymes for the diagnosis of diseases.
14. Enzymes as medicines.

#### Vocabulary (list of mandatory terms and concepts):

|                                                                                  |                                                                                                                                                                                                                                                                         |                                                                                                                                   |
|----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Федеральное государственное бюджетное образовательное учреждение высшего образования<br/>«Волгоградский государственный медицинский университет» Министерства здравоохранения Российской Федерации</p> <p><b>КАФЕДРА<br/>ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ</b></p> | <p>ОБРАЗОВАТЕЛЬНАЯ ПРОГРАММА<br/>НАПРАВЛЕНИЯ ПОДГОТОВКИ<br/>33.05.01 «ФАРМАЦИЯ»</p> <p>ДИСЦИПЛИНА<br/>«МОЛЕКУЛЯРНАЯ БИОЛОГИЯ»</p> |
|----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|

- metabolic pathway,
- enzyme lability,
- efficiency of enzymes,
- catalytic specificity of enzymes,
- prosthetic groups,
- Michaelis constant,
- allosteric effectors of enzymes,
- zymogens,
- partial proteolysis,
- G-proteins,
- adenylate cyclase,
- protein kinases,
- phosphatases,
- heterotropic regulation,
- homotropic regulation,
- competitive inhibition,
- non-competitive inhibition;

|                                                                                  |                                                                                                                                                                                                                                                                         |                                                                                                                                   |
|----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Федеральное государственное бюджетное образовательное учреждение высшего образования<br/>«Волгоградский государственный медицинский университет» Министерства здравоохранения Российской Федерации</p> <p><b>КАФЕДРА<br/>ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ</b></p> | <p>ОБРАЗОВАТЕЛЬНАЯ ПРОГРАММА<br/>НАПРАВЛЕНИЯ ПОДГОТОВКИ<br/>33.05.01 «ФАРМАЦИЯ»</p> <p>ДИСЦИПЛИНА<br/>«МОЛЕКУЛЯРНАЯ БИОЛОГИЯ»</p> |
|----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|

## Study Guide

Molecular biology, pharmaceutical faculty 2th year

### (Занятие № 10)

#### Topic:


**Structure and functions of biological membranes.** Membrane proteins. Mechanisms of transport of substances through the membrane. Intercellular contacts.

#### Study questions:

1. Principles of the structure of biological membranes: formation of a lipid bilayer, mosaic model. The main components of biological membranes.
2. Functions and properties of biological membranes.
3. Classification and biological functions of membrane proteins.
4. Classification of mechanisms of transport of substances through membranes.
5. Passive transport: basic mechanisms and biological role. Osmotic pressure and its importance in maintaining cell integrity. Saline solutions.
6. Active transport: basic mechanisms and examples of transporter proteins.
7. Exocytosis and endocytosis: the main mechanisms and biological role.

#### Vocabulary (list of mandatory terms and concepts):

- lipids;
- amphiphilicity;
- osmosis;
- translocase;
- primary-active transport;
- exocytosis;
- endocytosis;
- receptor;
- secondary messenger
- adenylate cyclase;
- protein kinase;
- cAMP;
- phosphodiesterase;
- phospholipase;
- inositol triphosphate;
- calmodulin;

|                                                                                  |                                                                                                                                                                                                                                                                         |                                                                                                                                   |
|----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Федеральное государственное бюджетное образовательное учреждение высшего образования<br/>«Волгоградский государственный медицинский университет» Министерства здравоохранения Российской Федерации</p> <p><b>КАФЕДРА<br/>ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ</b></p> | <p>ОБРАЗОВАТЕЛЬНАЯ ПРОГРАММА<br/>НАПРАВЛЕНИЯ ПОДГОТОВКИ<br/>33.05.01 «ФАРМАЦИЯ»</p> <p>ДИСЦИПЛИНА<br/>«МОЛЕКУЛЯРНАЯ БИОЛОГИЯ»</p> |
|----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|

## Study Guide

Molecular biology, pharmaceutical faculty 2th year

### (Занятие № 11)

#### Topic:


**The receptor function of biological membranes.** Principles of receptor signal transmission. Metabotropic and ionotropic receptors.

#### Study questions:

1. Metabotropic and ionotropic receptors
2. The receptor function of biological membranes. Classification of receptors.
3. Principles of hormonal signal transmission.
4. Classification of G-proteins. Secondary intermediaries.
5. Adenylate cyclase signal transduction system: examples of receptors, main effects and biological role.
6. Inositol phosphate signal transduction: examples of receptors, main effects and biological role.

#### Vocabulary (list of mandatory terms and concepts):

- cAMP
- Adenylate Cyclase
- Guanylate Cyclase
- G-protein
- Phosphodiesterase
- Protein kinase
- Phosphoproteins
- Adenylate Cyclase system
- Inositol phosphate system;

|                                                                                  |                                                                                                                                                                                                                                                                             |                                                                                                                                           |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Федеральное государственное бюджетное образовательное учреждение высшего образования<br/>«Волгоградский государственный медицинский университет» Министерства<br/>здравоохранения Российской Федерации</p> <p><b>КАФЕДРА<br/>ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ</b></p> | <p>ОБРАЗОВАТЕЛЬНАЯ<br/>ПРОГРАММА<br/>НАПРАВЛЕНИЯ ПОДГОТОВКИ<br/>33.05.01 «ФАРМАЦИЯ»</p> <p>ДИСЦИПЛИНА<br/>«МОЛЕКУЛЯРНАЯ<br/>БИОЛОГИЯ»</p> |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|

## Study Guide

Molecular biology, pharmaceutical faculty 2th year

### (Занятие № 12)

#### Topic:

**Catalytic receptors.** Molecular mechanisms of signal transduction from nuclear and cytoplasmic receptors. Regulation of receptor activity.


#### Study questions:

1. A nuclear-type reception system.
2. The structure of nuclear receptors.  
Androgen/estrogen/glucocorticoid/mineralocorticoid/retinoid/thyroid hormone receptors.
3. Hormone sensitive DNA elements.
4. Mechanisms of hormonal induction of transcription and translation processes.
5. The interaction of hormones with the chromatin of target cells.
6. Activation of transcription by translocation of sAMP-dependent protein kinases from the cytoplasm into the nuclei of target cells.
7. Mechanisms of intracellular signal transduction and biological effects on the example of the insulin receptor.
8. Regulation of receptor activity.

#### Vocabulary (list of mandatory terms and concepts):

- Hormone-receptor complex
- Transcribed genes
- Promoter
- Enhancers
- Hormone-sensitive Element (HRE)
- Activator Function (AF) of the receptor
- Nuclear receptor domains (A-F);



|                                                                                  |                                                                                                                                                                                                                                                                             |                                                                                                                                           |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Федеральное государственное бюджетное образовательное учреждение высшего образования<br/>«Волгоградский государственный медицинский университет» Министерства<br/>здравоохранения Российской Федерации</p> <p><b>КАФЕДРА<br/>ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ</b></p> | <p>ОБРАЗОВАТЕЛЬНАЯ<br/>ПРОГРАММА<br/>НАПРАВЛЕНИЯ ПОДГОТОВКИ<br/>33.05.01 «ФАРМАЦИЯ»</p> <p>ДИСЦИПЛИНА<br/>«МОЛЕКУЛЯРНАЯ<br/>БИОЛОГИЯ»</p> |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|

## **Study Guide**


Molecular biology, pharmaceutical faculty 2th year

**(Занятие № 13)**


**Concluding №2**

### **Regulation of enzyme activity. Biological membranes. Receptor signal transduction**

1. Amino acids: principles of structure, classification. The peptide bond.
2. Proteins (proteins): definition, biological functions.
3. Levels of structural organization of proteins. Primary structure. The secondary structure of the protein.
4. The tertiary structure of the protein. Globular and fibrillar proteins.
5. Chemical bonds that stabilize the structures of the protein molecule. Denaturation and renaturation.
6. Methods of studying the structure of proteins. Techniques for studying protein.
7. The role of chaperones and chaperonins. Hsp70 chaperones.
8. Non-enzymatic post-translational modification.
9. Enzymatic post-translational modification with cleavage of the polypeptide chain.
10. Methylation, hydroxylation, introduction of additional carboxyl group, phosphorylation, glycosylation, ADP-ribosylation, prenylation, sulfation, ubiquitinylation of proteins.
11. Metabolic pathways and the biological significance of their regulation.
12. Principles of regulation of enzyme activity.
13. Examples and functional role of cofactors – metal ions, vitamin derivatives.
14. Allosteric regulation of enzymatic activity.
15. Inhibitors of enzymatic activity: classification and mechanisms of action.

|                                                                                  |                                                                                                                                                                                                                                                                             |                                                                                                                                           |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Федеральное государственное бюджетное образовательное учреждение высшего образования<br/>«Волгоградский государственный медицинский университет» Министерства<br/>здравоохранения Российской Федерации</p> <p><b>КАФЕДРА<br/>ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ</b></p> | <p>ОБРАЗОВАТЕЛЬНАЯ<br/>ПРОГРАММА<br/>НАПРАВЛЕНИЯ ПОДГОТОВКИ<br/>33.05.01 «ФАРМАЦИЯ»</p> <p>ДИСЦИПЛИНА<br/>«МОЛЕКУЛЯРНАЯ<br/>БИОЛОГИЯ»</p> |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|

- 16.Regulation of enzyme activity by protein-protein interactions.
- 17.Adenylate cyclase mechanism of hormonal signal transmission. The role of cAMP.
- 18.Regulation of enzyme activity by covalent modification. Phosphorylation and dephosphorylation.
- 19.Partial proteolysis: biological significance and examples.
- 20.Principles of using enzymes as clinical and laboratory biomarkers.
- 21.Enzymes as medicines.
- 22.Principles of the structure of biological membranes: formation of a lipid bilayer, mosaic model. The main components of biological membranes.
- 23.Functions and properties of biological membranes.
- 24.Classification and biological functions of membrane proteins.
- 25.Classification of mechanisms of transport of substances through membranes.
- 26.Passive transport: basic mechanisms and biological role. Osmotic pressure and its importance in maintaining cell integrity. Saline solutions.
- 27.Active transport: basic mechanisms and examples of transporter proteins.
- 28.Exocytosis and endocytosis: the main mechanisms and biological role.
- 29.Metabotropic and ionotropic receptors
- 30.The receptor function of biological membranes. Classification of receptors.
- 31.Principles of hormonal signal transmission.
- 32.Classification of G-proteins. Secondary intermediaries.
- 33.Adenylate cyclase signal transduction system: examples of receptors, main effects and biological role.
- 34.Inositol phosphate signal transduction: examples of receptors, main effects and biological role.
- 35.A nuclear-type reception system.
- 36.The structure of nuclear receptors.  
Androgen/estrogen/glucocorticoid/mineralocorticoid/retinoid/thyroid hormone receptors.

|                                                                                  |                                                                                                                                                                                                                                                                         |                                                                                                                                   |
|----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Федеральное государственное бюджетное образовательное учреждение высшего образования<br/>«Волгоградский государственный медицинский университет» Министерства здравоохранения Российской Федерации</p> <p><b>КАФЕДРА<br/>ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ</b></p> | <p>ОБРАЗОВАТЕЛЬНАЯ ПРОГРАММА<br/>НАПРАВЛЕНИЯ ПОДГОТОВКИ<br/>33.05.01 «ФАРМАЦИЯ»</p> <p>ДИСЦИПЛИНА<br/>«МОЛЕКУЛЯРНАЯ БИОЛОГИЯ»</p> |
|----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|

37. Hormone sensitive DNA elements.


38. Mechanisms of hormonal induction of transcription and translation processes.

39. The interaction of hormones with the chromatin of target cells.

40. Activation of transcription by translocation of cAMP-dependent protein kinases from the cytoplasm into the nuclei of target cells.

41. Mechanisms of intracellular signal transduction and biological effects on the example of the insulin receptor.

42. Regulation of receptor activity.

|                                                                                  |                                                                                                                                                                                                                                                                             |                                                                                                                                           |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Федеральное государственное бюджетное образовательное учреждение высшего образования<br/>«Волгоградский государственный медицинский университет» Министерства<br/>здравоохранения Российской Федерации</p> <p><b>КАФЕДРА<br/>ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ</b></p> | <p>ОБРАЗОВАТЕЛЬНАЯ<br/>ПРОГРАММА<br/>НАПРАВЛЕНИЯ ПОДГОТОВКИ<br/>33.05.01 «ФАРМАЦИЯ»</p> <p>ДИСЦИПЛИНА<br/>«МОЛЕКУЛЯРНАЯ<br/>БИОЛОГИЯ»</p> |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|

## Study Guide

Molecular biology, pharmaceutical faculty 2th year


### (Занятие № 14)

#### Topic:

**The cell cycle and its regulation.** Phases of mitosis. Proteins and enzymes in the regulation of cell proliferation. Growth factors.

#### Study questions:

1. The concept of the cell cycle. Phases of mitosis. Cytokinesis.
2. Structure and organization of the cell nucleus. The nuclear envelope. Nuclear pores.
3. Levels of DNA packing in chromosomes. Chromatin remodeling.
4. Spatial organization of chromosomes in the interphase nucleus. Metaphase chromosome. Types of chromosomal rearrangements.
5. Cyclins and cyclin-dependent kinases in the control of the cell cycle: the main complexes and mechanisms of action at different phases of the cell cycle. Dynamics of expression of cyclin proteins.
6. The main regulatory proteins of the cell cycle: protein kinases and protein phosphatases cyclin-dependent kinases, cyclin-dependent kinase inhibitor proteins, ubiquitin ligases and their activators.
7. Molecular mechanisms of regulation of the S-phase of the cell cycle. Control of chromosome replication. The role of cohesin proteins.
8. Telomeric sections of chromosomes. The role of the enzyme telomerase.
9. Molecular mechanisms of the M-phase of the cell cycle. The structure of the mitotic spindle of division. Types of microtubules. The structure of the centrosome. Mechanisms of cytokinesis in mammals.

|                                                                                  |                                                                                                                                                                                                                                                                             |                                                                                                                                           |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Федеральное государственное бюджетное образовательное учреждение высшего образования<br/>«Волгоградский государственный медицинский университет» Министерства<br/>здравоохранения Российской Федерации</p> <p><b>КАФЕДРА<br/>ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ</b></p> | <p>ОБРАЗОВАТЕЛЬНАЯ<br/>ПРОГРАММА<br/>НАПРАВЛЕНИЯ ПОДГОТОВКИ<br/>33.05.01 «ФАРМАЦИЯ»</p> <p>ДИСЦИПЛИНА<br/>«МОЛЕКУЛЯРНАЯ<br/>БИОЛОГИЯ»</p> |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|

## Study Guide

Molecular biology, pharmaceutical faculty 2th year


### (Занятие № 15)

#### Topic:

**Cell damage.** Pathobiochemical aspects of necrosis. Types of programmed cell death.  
The role of apoptosis in norm and pathology.

#### Study questions:

1. Growth factors and mitogens: classification and mechanisms of action.  
Epidermal and transforming growth factor.
2. Growth factor receptors: structure and mechanisms of signal transduction.
3. The role of pro- and anti-apoptotic proteins in the regulation of the cell cycle.  
Cell cycle arrest after DNA damage.
4. Types and mechanisms of cell damage. Necrosis and apoptosis: definitions and comparative characteristics.
5. Types of programmed cell death. Apoptosis. Biological significance.  
Morphological signs of apoptosis. Comparative characteristics of necrosis and apoptosis.
6. Biochemical mechanisms of apoptosis: triggering factors, the role of caspases, cytochrome C, and protein p53.
7. Phases of apoptosis: classification of regulatory proteins and their functions.  
Formation by apoptosis.
8. Disorders of apoptosis. The role of apoptosis in the pathogenesis of tumor and neurodegenerative diseases.

|                                                                                  |                                                                                                                                                                                                                                                                         |                                                                                                                                   |
|----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Федеральное государственное бюджетное образовательное учреждение высшего образования<br/>«Волгоградский государственный медицинский университет» Министерства здравоохранения Российской Федерации</p> <p><b>КАФЕДРА<br/>ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ</b></p> | <p>ОБРАЗОВАТЕЛЬНАЯ ПРОГРАММА<br/>НАПРАВЛЕНИЯ ПОДГОТОВКИ<br/>33.05.01 «ФАРМАЦИЯ»</p> <p>ДИСЦИПЛИНА<br/>«МОЛЕКУЛЯРНАЯ БИОЛОГИЯ»</p> |
|----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|

## Study Guide

Molecular biology, pharmaceutical faculty 2th year

### (Занятие № 16)


#### Topic:

**Molecular genetic mechanisms of tumor cell transformation and metastasis.**

Principles of development and research of antitumor drugs.

#### Study questions:

1. Carcinogenesis (oncogenesis, tumorigenesis). Molecular mechanisms of tumor cell transformation and metastasis of tumor cells.
2. Violations of DNA repair systems in the development of various diseases.
3. The biological significance of apoptosis in normal and pathological conditions.
4. Signaling pathways in the regulation of the cell cycle.
5. Protein folding and its disorders in neurodegenerative diseases.
6. Principles of the development and research of antitumor drugs.

|                                                                                  |                                                                                                                                                                                                                                                                         |                                                                                                                                   |
|----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Федеральное государственное бюджетное образовательное учреждение высшего образования<br/>«Волгоградский государственный медицинский университет» Министерства здравоохранения Российской Федерации</p> <p><b>КАФЕДРА<br/>ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ</b></p> | <p>ОБРАЗОВАТЕЛЬНАЯ ПРОГРАММА<br/>НАПРАВЛЕНИЯ ПОДГОТОВКИ<br/>33.05.01 «ФАРМАЦИЯ»</p> <p>ДИСЦИПЛИНА<br/>«МОЛЕКУЛЯРНАЯ БИОЛОГИЯ»</p> |
|----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|

## **Study Guide**

Molecular biology, pharmaceutical faculty 2th year


**(Занятие № 17)**

**Concluding №3**

**Regulation of proliferative activity of cells. Mechanisms of cell death.**


**Oncogenesis.**

1. The concept of the cell cycle. Phases of mitosis. Cytokinesis.
2. Structure and organization of the cell nucleus. The nuclear envelope. Nuclear pores.
3. Levels of DNA packing in chromosomes. Chromatin remodeling.
4. Spatial organization of chromosomes in the interphase nucleus. Metaphase chromosome. Types of chromosomal rearrangements.
5. Cyclins and cyclin-dependent kinases in the control of the cell cycle: the main complexes and mechanisms of action at different phases of the cell cycle. Dynamics of expression of cyclin proteins.
6. The main regulatory proteins of the cell cycle: protein kinases and protein phosphatases cyclin-dependent kinases, cyclin-dependent kinase inhibitor proteins, ubiquitin ligases and their activators.
7. Molecular mechanisms of regulation of the S-phase of the cell cycle. Control of chromosome replication. The role of cohesin proteins.
8. Telomeric sections of chromosomes. The role of the enzyme telomerase.
9. Molecular mechanisms of the M-phase of the cell cycle. The structure of the mitotic spindle of division. Types of microtubules. The structure of the centrosome. Mechanisms of cytokinesis in mammals.
10. Growth factors and mitogens: classification and mechanisms of action. Epidermal and transforming growth factor.

|                                                                                  |                                                                                                                                                                                                                                                                         |                                                                                                                                       |
|----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Федеральное государственное бюджетное образовательное учреждение высшего образования<br/>«Волгоградский государственный медицинский университет» Министерства здравоохранения Российской Федерации</p> <p><b>КАФЕДРА<br/>ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ</b></p> | <p>ОБРАЗОВАТЕЛЬНАЯ ПРОГРАММА<br/>НАПРАВЛЕНИЯ ПОДГОТОВКИ<br/>33.05.01 «ФАРМАЦИЯ»</p> <p>ДИСЦИПЛИНА<br/>«МОЛЕКУЛЯРНАЯ<br/>БИОЛОГИЯ»</p> |
|----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|

11. Growth factor receptors: structure and mechanisms of signal transduction.
12. The role of pro- and anti-apoptotic proteins in the regulation of the cell cycle. Cell cycle arrest after DNA damage.
13. Types and mechanisms of cell damage. Necrosis and apoptosis: definitions and comparative characteristics.
14. Types of programmed cell death. Apoptosis. Biological significance. Morphological signs of apoptosis. Comparative characteristics of necrosis and apoptosis.
15. Biochemical mechanisms of apoptosis: triggering factors, the role of caspases, cytochrome C, and protein p53.
16. Phases of apoptosis: classification of regulatory proteins and their functions. Formation by apoptosis.
17. Disorders of apoptosis. The role of apoptosis in the pathogenesis of tumor and neurodegenerative diseases.
18. Carcinogenesis (oncogenesis, tumorigenesis). Molecular mechanisms of tumor cell transformation and metastasis of tumor cells.
19. Violations of DNA repair systems in the development of various diseases.
20. The biological significance of apoptosis in normal and pathological conditions.
21. Signaling pathways in the regulation of the cell cycle.
22. Protein folding and its disorders in neurodegenerative diseases.
23. Principles of the development and research of antitumor drugs.



|                                                                                  |                                                                                                                                                                                                                                                                             |                                                                                                                                           |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Федеральное государственное бюджетное образовательное учреждение высшего образования<br/>«Волгоградский государственный медицинский университет» Министерства<br/>здравоохранения Российской Федерации</p> <p><b>КАФЕДРА<br/>ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ</b></p> | <p>ОБРАЗОВАТЕЛЬНАЯ<br/>ПРОГРАММА<br/>НАПРАВЛЕНИЯ ПОДГОТОВКИ<br/>33.05.01 «ФАРМАЦИЯ»</p> <p>ДИСЦИПЛИНА<br/>«МОЛЕКУЛЯРНАЯ<br/>БИОЛОГИЯ»</p> |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|


## Study Guide

Molecular biology, pharmaceutical faculty 2th year


### EXAM

#### List of questions for EXAM


1. The subject of molecular biology. The importance of molecular biology in the medical education system;
2. The main classes of biological molecules: nucleotides, amino acids, carbohydrates and lipids;
3. Cellular organelles (overview, structure, function)
4. Central dogma of molecular biology, prokaryotic and eukaryotic gene.
5. Principles of structure and biological functions of nucleic acids;
6. Principles of structure and biological functions of proteins;
7. Definition and biological role of enzymes;
8. Chemical composition of the cell. Types of chemical bonds. Small and large molecules in the cell.
9. The main types of chemical reactions in biological systems;
10. Metabolic pathways. The concept of metabolism. Energy supply of metabolic processes. The role of macroergic compounds (bonds). Ways of using ATP (Adenosine triphosphate) energy;
11. The concept of "omics" technologies in medicine;
12. Structure and functions of nucleic acids. Primary, secondary and tertiary structure of DNA;
13. Main differences between DNA and RNA;
14. Levels of structural organization of chromatin. The role of histone and non-histone proteins in DNA compaction.
15. Structure of human genome (histones, nucleosomes, chromatin)
16. Methods for studying the structure and functions of nucleic acids.
17. DNA replication: basic principles of matrix biosynthesis. Consistency of replication and cell cycle.
18. Comparison of DNA replication in prokaryotes and eukaryotes
19. Initiation of DNA replication: the scheme of the process, the main enzymes and their function.
20. Elongation and termination of DNA replication: the scheme of the process, the main enzymes and their function. Mechanisms of biosynthesis of leading and lagging DNA chains.

|                                                                                  |                                                                                                                                                                                                                                                                             |                                                                                                                                           |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Федеральное государственное бюджетное образовательное учреждение высшего образования<br/>«Волгоградский государственный медицинский университет» Министерства<br/>здравоохранения Российской Федерации</p> <p><b>КАФЕДРА<br/>ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ</b></p> | <p>ОБРАЗОВАТЕЛЬНАЯ<br/>ПРОГРАММА<br/>НАПРАВЛЕНИЯ ПОДГОТОВКИ<br/>33.05.01 «ФАРМАЦИЯ»</p> <p>ДИСЦИПЛИНА<br/>«МОЛЕКУЛЯРНАЯ<br/>БИОЛОГИЯ»</p> |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|


21. Types of DNA damages and their causes.
22. DNA repair: the main mechanisms of DNA structure restoration. Violations of DNA repair systems and their biomedical significance.
23. Medicine that inhibit replication.
24. Stages of implementation of genetic information. The concept of transcription and translation
25. The main types of RNA and their functions. Types of RNA polymerases
26. RNA biosynthesis: stages of the process. Features of transcription in eukaryotes.
27. Post-transcriptional modifications in eukaryotes. Role of splicing
28. Protein biosynthesis. The genetic code and its properties. Function and structural features of tRNA
29. Ribosomes: structural features in prokaryotes and eukaryotes. Active centers of ribosomes
30. Features of gene expression in prokaryotes and eukaryotes.
31. Gene Expression. tRNAs and aminoacyl-tRNA synthetases, ribosome structure.
32. Principles of regulation of gene expression in prokaryotes. The theory of the "operon". Lactose and tryptophan operon.
33. Levels of regulation of gene expression in eukaryotes. Packaging of genetic material.
34. Euchromatin and heterochromatin. Regulation of RNA transcription and processing.
35. Regulation of translation and post-translational modifications of the protein. Mechanisms of induction and repression of gene expression.
36. The concept of genetic engineering. Goals, tasks, methods.
37. Amino acids: principles of structure, classification. The peptide bond.
38. Proteins (proteins): definition, biological functions.
39. Levels of structural organization of proteins. Primary structure. The secondary structure of the protein.
40. The tertiary structure of the protein. Globular and fibrillar proteins.
41. Chemical bonds that stabilize the structures of the protein molecule. Denaturation and renaturation.
42. Methods of studying the structure of proteins. Techniques for studying protein.
43. The role of chaperones and chaperonins. Hsp70 chaperones.
44. Non-enzymatic post-translational modification.
45. Enzymatic post-translational modification with cleavage of the polypeptide chain.
46. Methylation, hydroxylation, introduction of additional carboxyl group, phosphorylation, glycosylation, ADP-ribosylation, prenylation, sulfation, ubiquitinylation of proteins.

|                                                                                  |                                                                                                                                                                                                                                                                             |                                                                                                                                           |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Федеральное государственное бюджетное образовательное учреждение высшего образования<br/>«Волгоградский государственный медицинский университет» Министерства<br/>здравоохранения Российской Федерации</p> <p><b>КАФЕДРА<br/>ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ</b></p> | <p>ОБРАЗОВАТЕЛЬНАЯ<br/>ПРОГРАММА<br/>НАПРАВЛЕНИЯ ПОДГОТОВКИ<br/>33.05.01 «ФАРМАЦИЯ»</p> <p>ДИСЦИПЛИНА<br/>«МОЛЕКУЛЯРНАЯ<br/>БИОЛОГИЯ»</p> |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|

47. Metabolic pathways and the biological significance of their regulation.
48. Principles of regulation of enzyme activity.
49. Examples and functional role of cofactors – metal ions, vitamin derivatives.
50. Allosteric regulation of enzymatic activity.
51. Inhibitors of enzymatic activity: classification and mechanisms of action.
52. Regulation of enzyme activity by protein-protein interactions.
53. Adenylate cyclase mechanism of hormonal signal transmission. The role of cAMP.
54. Regulation of enzyme activity by covalent modification. Phosphorylation and dephosphorylation.
55. Partial proteolysis: biological significance and examples.
56. Principles of using enzymes as clinical and laboratory biomarkers.
57. Enzymes as medicines.
58. Principles of the structure of biological membranes: formation of a lipid bilayer, mosaic model. The main components of biological membranes.
59. Functions and properties of biological membranes.
60. Classification and biological functions of membrane proteins.
61. Classification of mechanisms of transport of substances through membranes.
62. Passive transport: basic mechanisms and biological role. Osmotic pressure and its importance in maintaining cell integrity. Saline solutions.
63. Active transport: basic mechanisms and examples of transporter proteins.
64. Exocytosis and endocytosis: the main mechanisms and biological role.
65. Metabotropic and ionotropic receptors
66. The receptor function of biological membranes. Classification of receptors.
67. Principles of hormonal signal transmission.
68. Classification of G-proteins. Secondary intermediaries.
69. Adenylate cyclase signal transduction system: examples of receptors, main effects and biological role.
70. Inositol phosphate signal transduction: examples of receptors, main effects and biological role.
71. A nuclear-type reception system.
72. The structure of nuclear receptors.  
Androgen/estrogen/glucocorticoid/mineralocorticoid/retinoid/thyroid hormone receptors.

|                                                                                  |                                                                                                                                                                                                                                                                             |                                                                                                                                           |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Федеральное государственное бюджетное образовательное учреждение высшего образования<br/>«Волгоградский государственный медицинский университет» Министерства<br/>здравоохранения Российской Федерации</p> <p><b>КАФЕДРА<br/>ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ</b></p> | <p>ОБРАЗОВАТЕЛЬНАЯ<br/>ПРОГРАММА<br/>НАПРАВЛЕНИЯ ПОДГОТОВКИ<br/>33.05.01 «ФАРМАЦИЯ»</p> <p>ДИСЦИПЛИНА<br/>«МОЛЕКУЛЯРНАЯ<br/>БИОЛОГИЯ»</p> |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|

73. Hormone sensitive DNA elements.
74. Mechanisms of hormonal induction of transcription and translation processes.
75. The interaction of hormones with the chromatin of target cells.
76. Activation of transcription by translocation of cAMP-dependent protein kinases from the cytoplasm into the nuclei of target cells.
77. Mechanisms of intracellular signal transduction and biological effects on the example of the insulin receptor.
78. Regulation of receptor activity.
79. The concept of the cell cycle. Phases of mitosis. Cytokinesis.
80. Structure and organization of the cell nucleus. The nuclear envelope. Nuclear pores.
81. Levels of DNA packing in chromosomes. Chromatin remodeling.
82. Spatial organization of chromosomes in the interphase nucleus. Metaphase chromosome. Types of chromosomal rearrangements.
83. Cyclins and cyclin-dependent kinases in the control of the cell cycle: the main complexes and mechanisms of action at different phases of the cell cycle. Dynamics of expression of cyclin proteins.
84. The main regulatory proteins of the cell cycle: protein kinases and protein phosphatases cyclin-dependent kinases, cyclin-dependent kinase inhibitor proteins, ubiquitin ligases and their activators.
85. Molecular mechanisms of regulation of the S-phase of the cell cycle. Control of chromosome replication. The role of cohesin proteins.
86. Telomeric sections of chromosomes. The role of the enzyme telomerase.
87. Molecular mechanisms of the M-phase of the cell cycle. The structure of the mitotic spindle of division. Types of microtubules. The structure of the centrosome. Mechanisms of cytokinesis in mammals.
88. Growth factors and mitogens: classification and mechanisms of action. Epidermal and transforming growth factor.
89. Growth factor receptors: structure and mechanisms of signal transduction.
90. The role of pro- and anti-apoptotic proteins in the regulation of the cell cycle. Cell cycle arrest after DNA damage.
91. Types and mechanisms of cell damage. Necrosis and apoptosis: definitions and comparative characteristics.
92. Types of programmed cell death. Apoptosis. Biological significance. Morphological signs of apoptosis. Comparative characteristics of necrosis and apoptosis.

|                                                                                  |                                                                                                                                                                                                                                                                             |                                                                                                                                           |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Федеральное государственное бюджетное образовательное учреждение высшего образования<br/>«Волгоградский государственный медицинский университет» Министерства<br/>здравоохранения Российской Федерации</p> <p><b>КАФЕДРА<br/>ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ</b></p> | <p>ОБРАЗОВАТЕЛЬНАЯ<br/>ПРОГРАММА<br/>НАПРАВЛЕНИЯ ПОДГОТОВКИ<br/>33.05.01 «ФАРМАЦИЯ»</p> <p>ДИСЦИПЛИНА<br/>«МОЛЕКУЛЯРНАЯ<br/>БИОЛОГИЯ»</p> |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|

93. Biochemical mechanisms of apoptosis: triggering factors, the role of caspases, cytochrome C, and protein p53.
94. Phases of apoptosis: classification of regulatory proteins and their functions. Formation by apoptosis.
95. Disorders of apoptosis. The role of apoptosis in the pathogenesis of tumor and neurodegenerative diseases.
96. Carcinogenesis (oncogenesis, tumorigenesis). Molecular mechanisms of tumor cell transformation and metastasis of tumor cells.
97. Violations of DNA repair systems in the development of various diseases.
98. The biological significance of apoptosis in normal and pathological conditions.
99. Signaling pathways in the regulation of the cell cycle.
100. Protein folding and its disorders in neurodegenerative diseases.
101. Principles of the development and research of antitumor drugs.