Министерство здравоохранения Республики Беларусь

УЧРЕЖДЕНИЕ ОБРАЗОВАНИЯ
«ГРОДНЕНСКИЙ ГОСУДАРСТВЕННЫЙ МЕДИЦИНСКИЙ УНИВЕРСИТЕТ»

Кафедра биологической химии

BIOCHEMISTRY

Guidelines for the medical faculty for international students (in English)

Part I.

БИОЛОГИЧЕСКАЯ ХИМИЯ

Методические рекомендации
для студентов факультета иностранных учащихся
(на английском языке)

Часть I.

Гродно
ГрГМУ
2020

CLASS № 1

<u>THEME</u>: INTRODUCTION INTO BIOCHEMISTRY

THEORETICAL PART

1. History of biochemistry.
2. Major objectives, branches and research trends of biochemistry.
3. Objects and methods of biochemistry.
4. Role of biochemistry in medical education.

LITERATURE FOR TRAINING:

1. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 28th ed. – New York [etc]: McGraw-Hill, Medical, 2009. – P. 1-5.
2. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 29th ed. – New York [etc]: McGraw-Hill, Medical, 2012. – P. 1-5.
3. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 30th ed. – New York [etc]: McGraw-Hill, Medical, 2015. – P. 1-5..
4. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 31th ed. – New York [etc]: McGraw-Hill, Medical, 2018. – P. 1-5..
5. Biochemistry: manual for the medical faculty for international students (in English) / Н.Э. Петушок, А.А. Масловская, М.Н. Курбат. – Гродно: ГрГМУ, 2014. – P. 7-10.
6. Lecture notes.

LABORATORY WORK

Laboratory work № 1. Work with pipettes.

Laboratory work № 2. Colorimetry. work with photoelectrocolorimeter

Questions to laboratory work

1. Biochemical laboratory safety rules
2. Pipettes, types, rules for working with them
3. Colorimetry, principle of the method. Construction of a photoelectrocolorimeter. Device operation rules.
4. Ways for calculating of substance concentration in colorimetry.

CLASS № 2

<u>THEME</u>: PROPERTIES AND FUNCTIONS OF PROTEINS

THEORETICAL PART

1. History of protein studies.
2. Proteins as the major components of the body. Functions of proteins. Protein content in the tissues.
3. Structure of amino acids. Classification. Shape of proteins. Molecular mass of protein
4. Physicochemical properties of proteins. Precipitation reactions of proteins.
5. Methods for separation and purification of protein: ultracentrifugation, electrophoresis, chromatography, dialysis.
6. Colour reactions of amino acids and proteins, practical use.
7. Methods for the quantitative measurement of proteins in a solution. Total serum protein.

LITERATURE FOR TRAINING:

1. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 28th ed. – New York [etc]: McGraw-Hill, Medical, 2009. – P. 14-24.
2. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 29th ed. – New York [etc]: McGraw-Hill, Medical, 2012. – P. 17-29.
3. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 30th ed. – New York [etc]: McGraw-Hill, Medical, 2015. – P. 15-25.
4. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 31th ed. – New York [etc]: McGraw-Hill, Medical, 2018. – P. 14-21.
5. Biochemistry: manual for the medical faculty for international students (in English) / Н.Э. Петушок, А.А. Масловская, М.Н. Курбат. – Гродно: ГрГМУ, 2014. – P. 11-15.
6. Lecture notes.

LABORATORY WORK

Laboratory work 1. Colour reactions of amino acids and proteins
Laboratory work 2. Quantitative determination of total protein in blood serum.

CLASS № 3

<u>THEME</u>: STRUCTURES OF PROTEINS

THEORETICAL PART

1. Primary structure of proteins. Determination of primary structure. Properties of the peptide bond.
2. Secondary structure of proteins. Supersecondary structure.
3. Tertiary structure of proteins. Types of stabilizing bonds.
4. Relation between tertiary structure and function of proteins. Denaturation of proteins, factors, practical use.
5. Quaternary structure of proteins.

LITERATURE FOR TRAINING:

1. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 28th ed. – New York [etc]: McGraw-Hill, Medical, 2009. – P. 25-40.
2. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 29th ed. – New York [etc]: McGraw-Hill, Medical, 2012. – P. 25-47.
3. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 30th ed. – New York [etc]: McGraw-Hill, Medical, 2015. – P. 25-48.
4. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 31th ed. – New York [etc]: McGraw-Hill, Medical, 2018. – P. 23-44.
5. Biochemistry: manual for the medical faculty for international students (in English) / Н.Э. Петушок, А.А. Масловская, М.Н. Курбат. – Гродно: ГрГМУ, 2014. – P. 15-17.
6. Lecture notes.

LABORATORY WORK

Laboratory work 1. Denaturation of protein by nitric acid.

Laboratory work 2. Separation of albumins and globulins of egg white by salting-out.

CLASS № 4

<u>THEME</u>: DIVERSITY AND CLASSIFICATION OF PROTEINS

THEORETICAL PART

1. Biologically important peptides; classification, representatives, biological functions. Glutathione.
2. Dynamic state of native proteins. Complementarity. Ligands and function of proteins.
3. A variety of proteins and their functions. Quantitative determination of protein for functional properties. Protein medicines (hormones, enzymes, etc.).
4. Changes of proteins in ontogenesis and disease.
5. Simple proteins; representatives, characteristics, biological functions.
6. Conjugated proteins: representatives, characteristics, biological functions.

LITERATURE FOR TRAINING:

1. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 28th ed. – New York [etc]: McGraw-Hill, Medical, 2009. – P. 43-50.
2. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 29th ed. – New York [etc]: McGraw-Hill, Medical, 2012. – P. 48-56.
3. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 30th ed. – New York [etc]: McGraw-Hill, Medical, 2015. – P. 44-48, 51-59.
4. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 31th ed. – New York [etc]: McGraw-Hill, Medical, 2018. – P. 41-44, 47-55.
5. Biochemistry: manual for the medical faculty for international students (in English) / Н.Э. Петушок, А.А. Масловская, М.Н. Курбат. – Гродно: ГрГМУ, 2014. – P. 17-19.
6. Lecture notes.

LABORATORY WORK

Laboratory work № 1 Acidic hydrolysis of proteins.

Laboratory work № 2 Quantitative determination of total protein in blood serum.

CLASS № 5

<u>THEME</u>: ENZYMES: PROPERTIES AND MECHANISM OF ACTION

THEORETICAL PART

1. History of enzymes study.
2. Properties of enzymes. Active and allosteric centers in enzymes.
3. Simple and conjugated enzymes. Cofactors of enzymes. Co-enzymatic functions of vitamins.
4. Mechanism of enzyme catalysis.
5. Specificity of enzymes.
6. Classification and nomenclature of enzymes.
7. Isoenzymes.
8. Units of enzyme activity.

LITERATURE FOR TRAINING:

1. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 28th ed. – New York [etc]: McGraw-Hill, Medical, 2009. – P. 51-56.
2. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 29th ed. – New York [etc]: McGraw-Hill, Medical, 2012. – P. 57-65.
3. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 30th ed. – New York [etc]: McGraw-Hill, Medical, 2015. – P. 60-68.
4. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 31th ed. – New York [etc]: McGraw-Hill, Medical, 2018. – P. 56-63.
5. Biochemistry: manual for the medical faculty for international students (in English) / Н.Э. Петушок, А.А. Масловская, М.Н. Курбат. – Гродно: ГрГМУ, 2014. – P. 20-27.
6. Lecture notes.

LABORATORY WORK

Laboratory work № 1. Effect of temperature on amylase activity.

Laboratory work № 2. Effect of activator and inhibitor on amylase activity.

Laboratory work № 3. Determination of amylase activity in blood serum.

CLASS № 6

<u>THEME</u>: KINETICS OF ENZYMATIC REACTIONS

THEORETICAL PART

1. Enzyme kinetics (Michaelis-Menten and Lineweaver-Burk equations).
2. Factors affecting enzymatic reaction rate (temperature, pH, substrate and enzyme concentration).
3. Regulation of enzyme activity:
   3.1. Activation and inhibition of enzymes
   3.2. Allosteric regulation. Covalent modification of the structure of enzymes (phosphorylation - dephosphorylation, limited proteolysis).
4. Drugs as the inhibitors of enzymes.

LITERATURE FOR TRAINING:

1. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 28th ed. – New York [etc]: McGraw-Hill, Medical, 2009. – P. 62-83.
2. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 29th ed. – New York [etc]: McGraw-Hill, Medical, 2012. – P. 70-83.
3. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 30th ed. – New York [etc]: McGraw-Hill, Medical, 2015. – P. 73-86.
4. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 31th ed. – New York [etc]: McGraw-Hill, Medical, 2018. – P. 68-81, 84-91.
5. Biochemistry: manual for the medical faculty for international students (in English) / Н.Э. Петушок, А.А. Масловская, М.Н. Курбат. – Гродно: ГрГМУ, 2014. – P. 28-33, 36-37.
6. Lecture notes.

LABORATORY WORK

Kinetics of lipase-catalyzed hydrolysis of triacylglycerols

CLASS № 7

<u>THEME</u>: APPLIED ASPECTS OF ENZYMOLOGY

THEORETICAL PART

1. Tissue-specific enzymes.
2. Serum enzymes used in clinical diagnosis. Origin of serum enzymes.
3. Enzymes in genetic diseases.
4. Practical applications of enzymes in medicine. Immobilized enzymes.

LITERATURE FOR TRAINING:

1. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 28th ed. – New York [etc]: McGraw-Hill, Medical, 2009. – P. 56-61.
2. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 29th ed. – New York [etc]: McGraw-Hill, Medical, 2012. – P. 63-69.
3. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 30th ed. – New York [etc]: McGraw-Hill, Medical, 2015. – P. 68-70.
4. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 31th ed. – New York [etc]: McGraw-Hill, Medical, 2018. – P. 63-65.
5. Biochemistry: manual for the medical faculty for international students (in English) / Н.Э. Петушок, А.А. Масловская, М.Н. Курбат. – Гродно: ГрГМУ, 2014. – P. 33-37.
6. Maslovskaya, A.A. Test Assignments for the Faculty of Foreign Students (in English Language) / A.A. Maslovskaya, V.V.Lelevich. – Grodno, GrSMU, 2010.
7. Lecture notes.

MCQ «Proteins. Enzymes»
Students' individual work «Proteins, enzymes»

C L A S S № 8

MINI-EXAM «PROTEINS & ENZYMES»

1. History of protein study.
2. Proteins as the major components of the body. A variety of proteins and their functions.
3. Structure of amino acids. Classification. Shape of proteins. Molecular mass of proteins, methods of determination.
4. Physicochemical properties of proteins. Precipitation reactions of proteins.
5. Methods for separation and purification of protein: ultracentrifugation, electrophoresis, chromatography, dialysis.
6. Colour reactions of amino acids and proteins.
7. Methods for the quantitative measurement of proteins in a solution. Total serum protein.
8. Primary structure of proteins. Determination of primary structure. Peptide bond formation.
9. Secondary structure of proteins. Supersecondary structure.
10. Tertiary structure of proteins. Types of stabilizing bonds.
11. Relation between tertiary structure and function of proteins. Denaturation of proteins, factors, practical use.
12. Quaternary structure of proteins.
13. Factors responsible for the stability of proteins in solution. Salting out.
14. Biologically important peptides; classification, representatives, biological functions. Glutathion.
15. Dynamic state of native proteins. Complementarity. Ligands and function of proteins. Quantitative determination of protein for functional properties.
16. Protein medicines (hormones, enzymes, etc.).
17. Changes of proteins in ontogenesis and disease.
18. Simple proteins; representatives, characteristics, biological functions.
19. Conjugated proteins; representatives, characteristics, biological functions.
20. History of enzymes study.
21. Properties of enzymes. Active and allosteric centers in enzymes.

22. Simple and conjugated enzymes. Cofactors of enzymes. Co-enzymatic functions of vitamins.
23. Mechanism of enzyme catalysis.
24. Specificity of enzymes.
25. Classification and nomenclature of enzymes.
26. Isoenzymes.
27. Definition of enzyme activity. Units of enzyme activity.
28. Enzyme kinetics (Michaelis-Menten and Lineweaver-Burk equations).
29. Factors affecting enzymatic reaction rate (temperature, pH, substrate and enzyme concentration).
30. Regulation of enzyme activity.
31. Activation and inhibition of enzymes.
32. Drugs as the inhibitors of enzymes.
33. Tissue-specific enzymes.
34. Serum enzymes used in clinical diagnosis. Origin of serum enzymes.
35. Enzymes in genetic diseases.
36. Practical applications of enzymes in medicine. Immobilized enzymes.

CLASS № 9

<u>THEME</u>: GENERAL PATHWAYS OF AMINO ACID METABOLISM

THEORETICAL PART

1. Dynamic state of body proteins. Nitrogen balance.
2. Sources of amino acids in the body and ways of their use.
3. Digestion of proteins in the gastrointestinal tract. Absorption of amino acids.
4. Intestinal putrefaction of proteins (conversion of amino acids by intestinal bacteria).
5. General pathways of amino acid metabolism.
6. Transamination of amino acids, enzymes, biological role. Coenzyme function of vitamin B_6. Mechanism of transamination. Aminotransferases, their tissue specificity and diagnostic significance.
7. Types of deamination of amino acids. Oxidative deamination and reductive amination. Biological role.
8. Transdeamination. Biological role.

LITERATURE FOR TRAINING:

1. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 28th ed. – New York [etc]: McGraw-Hill, Medical, 2009. – P. 234-236, 239-242, 462, 465.
2. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 29th ed. – New York [etc]: McGraw-Hill, Medical, 2012. – P. 265-270, 519-521.
3. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 30th ed. – New York [etc]: McGraw-Hill, Medical, 2015. – P. 282-283, 287-292, 539-541, 543-544.
4. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 31th ed. – New York [etc]: McGraw-Hill, Medical, 2018. – P. 263-264, 269-274, 519-523, 525.
5. Biochemistry: manual for the medical faculty for international students (in English) / Н.Э. Петушок, А.А. Масловская, М.Н. Курбат. – Гродно: ГрГМУ, 2014. – P. 183-199.
6. Lecture notes.

LABORATORY WORK

Determination of alanine aminotransferase activity in the blood serum

CLASS № 10

<u>THEME</u>: DETOXIFICATION OF AMMONIA. METABOLISM OF CERTAIN AMINO ACIDS

THEORETICAL PART

1. Decarboxylation of amino acids. Types of decarboxylation, biological role. Biogenic amines: synthesis, their functions. Oxidation of biogenic amines.
2. Ways for the formation and detoxification of ammonia.
3. Intracellular detoxification of ammonia: reductive amination, synthesis of glutamine and asparagine. Role of glutaminase in the maintenance of acid-base balance in the body.
4. Biosynthesis of urea. Disorders of the urea synthesis and excretion.
5. Catabolism of amino acids in the organism. Glucogenic and ketogenic amino acids.
6. Metabolism of methionine: formation of S-adenosylmethionine, its role in transmethylation reactions. Synthesis of creatine. Lipotropic effect of methionine.
7. Metabolism of phenylalanine and tyrosine. Disorders of phenylalanine and tyrosine metabolism (phenylketonuria, alkaptonuria, albinism).

LITERATURE FOR TRAINING:

1. Harper’s Illustrated Biochemistry / Robert K. Murray [et. al.]. – 28th ed. – New York [etc]: McGraw-Hill, Medical, 2009. – P. 146, 243-247, 248,254, 257-258, 268-269, 435-436.
2. Harper’s Illustrated Biochemistry / Robert K. Murray [et. al.]. – 29th ed. – New York [etc]: McGraw-Hill, Medical, 2012. – P. 271-290, 303, 304.
3. Harper’s Illustrated Biochemistry / Robert K. Murray [et. al.]. – 30th ed. – New York [etc]: McGraw-Hill, Medical, 2015. – P. 291-296, 299, 304-306, 315-316.
4. Harper’s Illustrated Biochemistry / Robert K. Murray [et. al.]. – 31th ed. – New York [etc]: McGraw-Hill, Medical, 2018. – P. 264-265, 273-278, 286-288, 290.
5. Biochemistry: manual for the medical faculty for international students (in English) / Н.Э. Петушок, А.А. Масловская, М.Н. Курбат. – Гродно: ГрГМУ, 2014. – P. 200-218.
6. Lecture notes.

LABORATORY WORK

Determination of urea in the blood serum (enzymatic kinetic method)

Students' individual work «Metabolism of amino acids»

CLASS № 11

<u>THEME:</u> STRUCTURE OF NUCLEOTIDES AND NUCLEIC ACIDS

THEORETICAL PART

1. History of nucleic acids study.
2. Chemical composition of nucleic acids. Differences between DNA and RNA.
3. DNA: composition, structure, cell localization, biological role.
4. RNA: types, composition, structures, cell localization, biological role.
5. Nucleoproteins: structure of ribosomes of eucaryotes and chromatin.
6. Biosynthesis of purine nucleotides: synthesis of phosphoribosylamine, origin of atoms in the purine ring.
7. Inosinic acid as a precursor for synthesis of adenylic and guanylic acids. Regulation of biosynthesis of purine nucleotides.

LITERATURE FOR TRAINING:

1. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 28th ed. – New York [etc]: McGraw-Hill, Medical, 2009. – P. 285-291, 292-295, 302-311, 312-317.
2. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 29th ed. – New York [etc]: McGraw-Hill, Medical, 2012. – P. 323-342, 343-359, 741-743.
3. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 30th ed. – New York [etc]: McGraw-Hill, Medical, 2015. – P. 340-342, 347-348, 359-377.
4. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 31th ed. – New York [etc]: McGraw-Hill, Medical, 2018. – P. 320-322, 325, 327-331, 338-355.
5. Biochemistry: manual for the medical faculty for international students (in English) / Н.Э. Петушок, А.А. Масловская, М.Н. Курбат. – Гродно: ГрГМУ, 2014. – P. 38-44, 219-222.
6. Lecture notes.

LABORATORY WORK

Hydrolysis of nucleoproteins. Reactions on nucleoproteins components in hydrolysate:

a. Biuret reaction on peptides.
b. Silver test on purine bases.
c. Trommer test on ribose and deoxyribose.
d. Molibdenium test on phosphoric acid.

CLASS № 12

<u>THEME:</u> METABOLISM OF NUCLEOTIDES AND NUCLEIC ACIDS

THEOREICAL PART

1. Biosynthesis of pyrimidine nucleotides. Regulation of biosynthesis of pyrimidine nucleotides.
2. Synthesis of deoxyribonucleotides. Synthesis of thymidylic acid.
3. Digestion of nucleic acids in the gastrointestinal tract. Degradation of nucleic acids in tissues. Re-utilization of nucleosides and nitrogenous bases for synthesis of nucleotides.
4. Degradation of purine and pyrimidine nucleotides.
5. Disorders of metabolism of nucleotides: xanthinuria, orotaciduria, gout.
6. Biosynthesis of DNA in eukaryotic cells: substrates, enzymes, scheme.

LITERATURE FOR TRAINING:

1. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 28th ed. – New York [etc]: McGraw-Hill, Medical, 2009. – P. 295-301, 311, 322-330.
2. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 29th ed. – New York [etc]: McGraw-Hill, Medical, 2012. – P. 323-342, 365-394, 741-743.
3. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 30th ed. – New York [etc]: McGraw-Hill, Medical, 2015. – P. 352-357, 381-389.
4. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 31th ed. – New York [etc]: McGraw-Hill, Medical, 2018. – P. 332-337, 361-369.
5. Biochemistry: manual for the medical faculty for international students (in English) / Н.Э. Петушок, А.А. Масловская, М.Н. Курбат. – Гродно: ГрГМУ, 2014. – P. 45-47, 219-231.
6. Lecture notes.

LABORATORY WORK

Determination of uric acid concentration in the blood serum.

CLASS № 13

THEME: BIOSYNTHESIS OF NUCLEIC ACIDS AND PROTEIN

THEORETICAL PART

1. Biosynthesis of RNA in eukaryotic cells: substrates, enzymes, steps, scheme.
2. RNA processing.
3. Reverse transcription: scheme, biological role.
4. The genetic code: its characteristic features.
5. Stages of protein synthesis. Activation of amino acids.
6. Eukaryotic translation: initiation, elongation, termination.
7. Posttranslational processing of proteins.
8. Regulation of gene expression.

LITERATURE FOR TRAINING:

1. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 28th ed. – New York [etc]: McGraw-Hill, Medical, 2009. – P.335-351, 353-368, 369-387.
2. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 29th ed. – New York [etc]: McGraw-Hill, Medical, 2012. – P.395-410, 411-432, 434-446.
3. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 30th ed. – New York [etc]: McGraw-Hill, Medical, 2015. – P. 394-411, 413-426.
4. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 31th ed. – New York [etc]: McGraw-Hill, Medical, 2018. – P. 374-392, 393-406, 428-450.
5. Biochemistry: manual for the medical faculty for international students (in English) / Н.Э. Петушок, А.А. Масловская, М.Н. Курбат. – Гродно: ГрГМУ, 2014. – P.48-69.
6. Lecture notes.

MCQ «Metabolism of nucleotides and nucleic acids».

Students' individual work «Proteins, enzymes».

CLASS № 14

<u>THEME:</u> PRINCIPLES OF MOLECULAR BIOLOGY

THEORETICAL PART

1. Antibiotics as inhibitors of protein synthesis.
2. Enzymes and techniques used in molecular biology.
3. The blot-analysis of DNA and RNA. Methods for protein identifying: Western blot analysis.
4. Polymerase chain reaction: stages and practical applications.
5. Restriction fragment length polymorphism. DNA fingerprint.
6. Sequencing of nucleic acids.
7. Genetic engineering, recombinant DNA technology.

LITERATURE FOR TRAINING:

1. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 28th ed. – New York [etc]: McGraw-Hill, Medical, 2009. – P. 367-368, 388-405.
2. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 29th ed. – New York [etc]: McGraw-Hill, Medical, 2012. – P.395-410, 411-432, 434-446.
3. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 30th ed. – New York [etc]: McGraw-Hill, Medical, 2015. – P. 426-427, 451-467.
4. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 31th ed. – New York [etc]: McGraw-Hill, Medical, 2018. – P. 432-449, 406-407.
5. Biochemistry: manual for the medical faculty for international students (in English) / Н.Э. Петушок, А.А. Масловская, М.Н. Курбат. – Гродно: ГрГМУ, 2014. – P.54-69.
6. Lecture notes.

Watching training videos.

Students' individual work "Principles of molecular biology

CLASS № 15

MINI-EXAM «METABOLISM OF NUCLEIC ACIDS AND NUCLEOTIDES. PRINCIPLES OF MOLECULAR BIOLOGY»

1. History of nucleic acids study.
2. Chemical composition of nucleic acids. Differences between DNA and RNA.
3. DNA: composition, structure, cell localization, biological role.
4. RNA: types, composition, structures, cell localization, biological role.
5. Nucleoproteins: structure of ribosomes of eucaryotes and chromatin.
6. Biosynthesis of purine nucleotides: synthesis of phosphoribosyl amine, origin of atoms in the purine ring.
7. Inosinic acid as a precursor for synthesis of adenylic and guanylic acids. Regulation of biosynthesis of purine nucleotides.
8. Biosynthesis of pyrimidine nucleotides. Regulation of biosynthesis of pyrimidine nucleotides.
9. Synthesis of deoxyribonucleotides. Synthesis of thymidylic acid.
10. Digestion of nucleic acids in the gastrointestinal tract. Degradation of nucleic acids in tissues. Re-utilization of nucleosides and nitrogenous bases for synthesis of nucleotides.
11. Degradation of purine and pyrimidine nucleotides.
12. Disorders of metabolism of nucleotides: xanthinuria, orotaciduria, gout.
13. Biosynthesis of DNA in eukaryotic cells: substrates, enzymes, scheme.
14. Biosynthesis of RNA in eukaryotic cells: substrates, enzymes, steps, scheme.
15. RNA processing.
16. Reverse transcription: scheme, biological role.
17. The genetic code: its characteristic features.
18. Stages of protein synthesis. Activation of amino acids.
19. Eukaryotic translation: initiation, elongation, termination.
20. Posttranslational processing of proteins.
21. Regulation of gene expression.
22. Antibiotics as inhibitors of protein synthesis.
23. Enzymes and techniques used in molecular biology.

24. The blot-analysis of DNA and RNA. Methods for protein identifying: Western blot analysis.
25. Polymerase chain reaction: stages and practical applications.
26. Restriction fragment length polymorphism. DNA fingerprint.
27. Sequencing of nucleic acids.
28. Genetic engineering, recombinant DNA technology.

CLASS № 16

<u>THEME:</u> BASICS OF BIOENERGETICS

THEORETICAL PART

1. Bioenergetics of the cell.
2. High-energy compounds: structure, biological role (ATP and other nucleoside triphosphates, 1,3-bisphosphoglycerate, phosphoenolpyruvate, creatine phosphate, acetyl CoA, succinyl CoA).
3. Electron transport chain (ETC), its structural organization and functioning. Electron transport chain complexes.
4. NAD^+($NADP^+$)-dependent dehydrogenases, structure of coenzyme, biological role.
5. FAD(FMN)-dependent dehydrogenases, structure of coenzyme, biological role.
6. Coenzyme Q, structure, biological role.
7. Cytochromes, structure, biological role.

LITERATURE FOR TRAINING:

1. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 28th ed. – New York [etc]: McGraw-Hill, Medical, 2009. – P. 92-97, 99-100, 103-106.
2. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 29th ed. – New York [etc]: McGraw-Hill, Medical, 2012. – P. 109-114, 121-131.
3. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 30th ed. – New York [etc]: McGraw-Hill, Medical, 2015. – P. 113-117, 119-122, 126-132.
4. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 31th ed. – New York [etc]: McGraw-Hill, Medical, 2018. – P. 105-109, 111-121.
5. Biochemistry: manual for the medical faculty for international students (in English) / Н.Э. Петушок, А.А. Масловская, М.Н. Курбат. – Гродно: ГрГМУ, 2014. – P. 79-84.
6. Lecture notes.

LABORATORY WORK

Quantitative determination of high-energy compounds in the muscular tissue.

CLASS № 17

<u>THEME:</u> THE CENTRAL PATHWAY OF METABOLISM. BIOCHEMISTRY OF MEMBRANES

THEORETICAL PART

1. ATP: structure, biological role; the ways of its formation (oxidative and substrate-level phosphorylation) and use.
2. Oxidative phosphorylation, mechanisms. The chemiosmotic theory of oxidative phosphorylation. The P/O ratio.
3. Regulation of ETC. Activators and inhibitors of the electron transport chain. Uncoupling agents.
4. The citric acid cycle: reactions, regulation and biological role.
5. Relation of the citric acid cycle with the electron transport chain, energy yield of the citric acid cycle.
6. Chemical composition and structure of biological membranes. Lipids and proteins of biological membranes.
7. General properties and functions of biological membranes.
8. Types of transport mechanisms across membranes.

LITERATURE FOR TRAINING:

1. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 28th ed. – New York [etc]: McGraw-Hill, Medical, 2009. – P. 94-95, 106-112, 143-148, 406-424.
2. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 29th ed. – New York [etc]: McGraw-Hill, Medical, 2012. – P. 115-120, 147-150, 163-169, 664-665.
3. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 30th ed. – New York [etc]: McGraw-Hill, Medical, 2015. – P. 115-118, 132-134, 161-167, 477-495.
4. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 31th ed. – New York [etc]: McGraw-Hill, Medical, 2018. – P. 108-110, 121-125, 150-155, 459-477.
5. Biochemistry: manual for the medical faculty for international students (in English) / Н.Э. Петушок, А.А. Масловская, М.Н. Курбат. – Гродно: ГрГМУ, 2014. – P. 74-78, 84-89.
6. Lecture notes.

LABORATORY WORK

Laboratory work № 1. Detection of the succinate dehydrogenase activity
Laboratory work № 2. Detection of the cytochrome oxidase activity
Students' individual work "Energy metabolism"

CLASS № 18

<u>THEME:</u> OXIDATIVE PROCESSES IN THE CELL. INTRODUCTION INTO METABOLISM

THEORETICAL PART

1. General characteristics of oxidation processes. Oxidase and peroxidase types of oxidation: schemes, enzymes, biological role.
2. Dioxygenase and monooxygenase types of oxidation: schemes, enzymes, biological role. Microsomal oxidation: scheme, cytochrome P_{450}, biological role.
3. Reactive oxygen species: their tissue-damaging effects.
4. Antioxidant systems, role of enzymes and non-enzymatic antioxidants.
5. Metabolism and metabolic pathways. Interrelations between anabolism and catabolism.
6. Experimental study of metabolism, the use of radioisotope tracers.
7. The specific and common pathways of catabolism.

LITERATURE FOR TRAINING:

1. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 28th ed. – New York [etc]: McGraw-Hill, Medical, 2009. – P. 98-102, 131-134, 596-597.
2. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 29th ed. – New York [etc]: McGraw-Hill, Medical, 2012. – P. 115-120, 151-154.
3. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 30th ed. – New York [etc]: McGraw-Hill, Medical, 2015. – P. 120-125, 139-141.
4. Harper's Illustrated Biochemistry / Robert K. Murray [et. al.]. – 31th ed. – New York [etc]: McGraw-Hill, Medical, 2018. – P. 111-116, 129-131.
5. Biochemistry: manual for the medical faculty for international students (in English) / Н.Э. Петушок, А.А. Масловская, М.Н. Курбат. – Гродно: ГрГМУ, 2014. – P. 70-78, 90-95.
6. Lecture notes.

CREDIT SESSION