
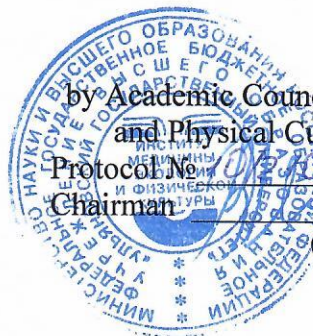


Министерство науки и высшего образования РФ ФГБОУ ВО «Ульяновский государственный университет»	Форма	
Ф-рабочая программа по дисциплине		



APPROVED

by Academic Council of Institute of Medicine, Ecology
and Physical Culture of Ulyanovsk State University
Protocol No. 07 from « 19 » 07 2019.
Chairman /V.I. Midlenko/

(signature)

WORKING PROGRAM

Subject:	<u>Biological</u> <u>Chemistry</u>
Department:	<u>General and Biological</u> <u>Chemistry</u>

Speciality: 31.05.01 "General Medicine"
(код специальности (направления), полное наименование)

Qualification – specialist, term of training-6 years, form of training-full-time.

The date of implementation of the program:
« _____ » _____ 2019 г.

Information about the developers:

Name	Department	Academic degree, academic title
Edward Sh. Yenikejev	General and Biological Chemistry	Cand.Biol.Sci., Assistant professor

Head of department	
<u>Shroll Shy</u>	<u>[Signature]</u>
(Name)	(Signature)
« <u>10</u> » <u>07</u>	<u>2019</u> г.



1. Aims and objectives of the discipline.

The purpose of mastering the discipline "Biological chemistry" is the formation of systemic knowledge of the chemical composition and molecular processes of the human body as the characteristics of its normal and pathological state. It is necessary for the study of subsequent disciplines and in the professional activities of future medics. The main objective of the discipline is to form a biochemical approach in assessing the parameters of all body systems in normal and pathological conditions, as well as their interaction with the environment.

2. Place of discipline in main professional education program.

The discipline "Biological Chemistry" refers to the basic part of main professional education program of speciality.

3. Requirements for the results of the development of the discipline.

The process of studying the discipline is aimed at the formation of the following competencies:

- readiness to use basic physico-chemical, mathematical and other natural-scientific concepts and methods in solving professional problems (ОПК-7);
- ability to assess morphofunctional, physiological States and pathological processes in the human body in solving professional problems (ОПК-9).

By the end of the course, students should be able to:

- assess the course of biochemical processes in living systems, relying on theoretical propositions
- scientifically substantiate the observed phenomena
- carry out biochemical studies to address the question about the normal or pathological state of metabolism
- present experimental data in graphs and tables
- solve common practical problems
- confidently navigate the information flow (use reference data and bibliography on a particular problem)

know:

- basic concepts, laws and modern scientific theories of biological chemistry
- concepts of the structure and functions of biologically active substances in living systems
- metabolism at the level of catabolism of the main substrates and biosynthesis of compounds necessary for the body
- the features of biochemical processes in the body, the principles of regulation of metabolism in living systems

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- methods of biochemical analysis in biology and medicine

possess:

- skills of safe work in biochemical laboratory
- skills of analysis of metabolic processes and establishment of the structure of biomolecules

Volume of the discipline is 6 credit units (216 hours.)

1. Volume of the discipline.

1.1. Volume of the discipline and types of educational work:

Type of educational work	Number of hours (form of training-full-time)		
	Total	By semester	
		2	3
Classroom lessons:	126	63	63
Lectures	36	18	18
Practical works	90	36	54
Self - study	54	36	18
Type of certification (exam)			36
Total volume of the discipline	216	90	126


1.2. Distribution of hours by topics and types of educational work:

Form of training-full-time

Title of sections and topics	Total	Types of educational work			
		Classroom lessons			Self - study
		Lectures	Classes	Practical work	
Section 1. Static biochemistry					
1. Proteins (part 1).	5	1	1	1	2
2. Proteins (part 2).	5	1	1	1	2
3. Enzymes (part 1).	6	1	2	1	2
4. Enzymes (part 2).	6	1	2	1	2
5. Structure and functions of nucleic acids (part 1).	4	1	1		2
6. Structure and functions of nucleic acids (part 2).	5	1	1	1	2
7. Replication of	7	2	2	1	2



DNA.					
8. Transcription of DNA.	6	2	2		2
9. Translation: protein biosynthesis.	7	2	2	1	2
10. Mutations and DNA repair system.	5	1	1	1	2
11. Structure and functions of biological membrane.	5	1	1	1	2
12. Membrane transport.	3	1			2
13. Respiration chain and ATP synthesis.	4	2			2
Section 2. Dynamic biochemistry.					
1. Introduction to metabolism.	5	1	1	1	2
2. Metabolism of carbohydrates (part 1).	5	1	1	1	2
3. Metabolism of carbohydrates (part 2).	6	1	2	1	2
4. Lipid metabolism.	7	2	2	1	2
5. Metabolism of proteins.	6	2	1	1	2
6. Metabolism of nucleotides (part 1).	6	1	2	1	2
7. Metabolism of nucleotides (part 2).	6	1	2	1	2
Section 3. Functional biochemistry.					
1. Hormones.	6	2	1	1	2
2. Hormonal regulation of metabolism of proteins, carbohydrates and fats.	6	1	2	1	2

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3. Endocrine regulation of calcium and phosphate homeostasis.	7	2	2	1	2
4. Thyroid hormones, prostaglandins and steroid hormones.	6	1	2	1	2
5. Biochemistry of blood and liver.	7	2	2	1	2
6. Biochemistry of muscle and nervous system.	7	2	2	1	2
7. Biochemistry of extracellular matrix.	7	2	2	1	2
Total	180	36	58	32	54

2. The content of the discipline.

1. Proteins: molecular structure, functions.

Biomedical significance of amino acids and peptides. Classification and nomenclature of peptides. Biomedical significance of proteins. Classification of proteins. The orders of protein structure. Forces stabilizing protein structures: weak and strong bonds. Properties of proteins. Isoelectric point of protein. Methods of protein separation. Protein functions in the body.

2. Enzymes – general properties, kinetics.

Biomedical importance of enzymes. Classification and nomenclature of enzymes. Coenzymes and prosthetic groups. Biochemical catalysis. The concept of transition state. Specificity of enzymes. Isoenzymes: properties and clinical significance. Functional and nonfunctional plasma enzymes. The rate of enzymatic reaction. The kinetics of enzymatic catalysis. Active site and allosteric site: structure and significance. Inhibition of enzymatic reaction: competitive and noncompetitive inhibitors. Enzyme poisons.

3. Enzymes – mechanism of action, regulation of activities.



Significance of metal ions in substrate binding and in catalysis. Metalloenzymes and metal-activated enzymes. Regulation of enzyme quantity. Compartmentation of enzymes. Constitutive and induced enzymes. Allosteric effectors. Feedback inhibition and feedback regulation. Covalent modifications of enzymatic activity.

4. Nucleic acids and protein biosynthesis.

Structure, function and replication of informational macromolecules. Significance of phosphorylated nucleosides. Metabolism of purine and pyrimidine nucleotides. Organization and replication of DNA. Classes of RNA. Synthesis, processing and modification of RNA. Features of the genetic code. Genetic mutations and their consequences. Protein biosynthesis: initiation, elongation and termination. Posttranslational modifications.

5. Biologic oxidation. The citric acid cycle. The respiratory chain.

Biomedical importance of the energy production and storage in the cell. Reactions of the citric acid cycle. Regulation and energy balance of the citric acid cycle. Characterization of oxidoreductases. Free radical reactions. Reactive oxygen species. The respiratory chain members. Inhibitors of the respiratory chain. Uncouplers. Oxidative phosphorylation.

6. Overview of glucose metabolism.

Absorptive and postabsorptive state. Transport of glucose to the cell. Insulin-dependent and insulin-independent tissues. Role of the liver, adipose tissue, erythrocytes, muscle and kidney in glucose metabolism. Hyperglycemia, hypoglycemia and glucosuria. Biochemical symptoms of diabetes mellitus.

7. Metabolism of glucose.

Synthesis of glucose: gluconeogenesis. Gluconeogenic substrates. The Cori cycle. The alanine-glucose cycle. Metabolic and hormonal regulation of gluconeogenesis. Control of blood glucose in well-fed state and in starvation. Glucose oxidation: glycolysis. Metabolic and hormonal regulation of glycolysis. Significance of glycolysis in aerobic and anaerobic conditions. Decarboxylation of pyruvate and its regulation.

8. Carbohydrates of physiologic significance. Metabolism of glycogen.

Classification of dietary carbohydrates. Glucose as the most important



monosaccharide. Digestion of dietary saccharides. Absorption of monosaccharides.

Synthesis of glycogen: glycogenesis. Degradation of glycogen: glycogenolysis.

9. The pentose phosphate pathway. Other pathways of hexose metabolism.

Physiologic significance of the pentose phosphate pathway. Reactions of the pentose phosphate pathway and their regulation. NADPH generation in the pentose phosphate pathway. The uronic acid pathway and its significance. Metabolism of fructose. Metabolism of galactose.

10. Lipids of physiologic significance. Lipid digestion and absorption.

Classification of lipids. Dietary lipids and their physiologic significance. Lipid digestion. Pancreatic lipase and other lipases. Emulsification and formation of mixed micelles. Role of bile salts in lipid digestion and absorption. Monoacylglycerol pathway.

11. Lipid transport and storage. Lipoproteins.

Classification and structure of lipoproteins. Metabolism of chylomicrons and VLDLs. Role of the liver and the adipose tissue in lipoprotein metabolism. Intravascular and intracellular lipolysis. Hepatic conversion of glucose to lipids. Down-regulation of LDL-receptor. Reverse cholesterol transport.

12. Metabolism of fatty acids.

Synthesis of fatty acids: lipogenesis. Regulation of lipogenesis. Oxidation of fatty acids: β -oxidation and its regulation. Ketogenesis. Ketonemia and ketonuria. Ketoacidosis.

13. Overview of fatty acid metabolism.

Role of the adipose tissue in lipid metabolism. The synthesis of triacylglycerols and its regulation. Metabolism of fatty acids in the well-fed state and in starvation.

Metabolism of acylglycerols and phospholipids.

14. Metabolism of cholesterol and bile acids.

Dietary sources of cholesterol. Regulation of cholesterol absorption. Biosynthesis of cholesterol and its regulation. Role of the liver in cholesterol metabolism. Catabolism of cholesterol. Primary and secondary bile acids. Enterohepatic circulation of bile acids.



15. Dietary proteins. Protein digestion and absorption.

Biological value of protein. Nitrogen balance. Digestion of dietary proteins. Production and secretion of HCl. Proteolytic enzymes: endopeptidases and exopeptidases. Zymogens – mechanism of activation. Absorption of amino acids.

16. Catabolism of the carbon skeletons of amino acids.

Biochemical pathways of catabolism of particular amino acids. Conversion of amino acids to substrates of carbohydrate and lipid metabolism. Metabolic disorders of amino acid catabolism.

17. Catabolism of amino acid nitrogen.

Deaminations, deamidations and transaminations. Formation of ammonia in the body: reactions and tissue localization. Cellular mechanisms of ammonia detoxification. The urea cycle. Metabolic disorders of the urea cycle. The alanine-glucose cycle.

18. Biosynthesis of the nutritionally nonessential amino acids. Conversion of amino acids to specialized products.

Nutritionally essential and nonessential amino acids. Biomedical importance of nonessential amino acids. Biosynthetic pathways of nonessential amino acids. Specialized products of amino acid metabolism.

19. Hormonal regulation of carbohydrate, protein and lipid metabolism. Insulin and glucagon.

Insulin: molecular structure, synthesis, secretion and biodegradation. Metabolic and hormonal regulation of insulin secretion. Glucagon: structure, synthesis and secretion. Physiologic activity of insulin and glucagon.

20. Acid – base balance.

Buffers of physiologic significance. Partial pressure of carbon dioxide. Respiratory regulation of acid-base balance. Renal regulation of acid-base balance. Recovery of filtered bicarbonate. Generation of new bicarbonate. Ammoniogenesis in the kidney. Quantitation of acid excretion. Plasma potassium concentration. Acid-base disturbances.

21. Steroid hormones.

Cholesterol as a precursor of steroid hormones. Classification of steroid hormones. Synthesis of steroid hormones in adrenal cortex and in gonads. Metabolic activity of steroid hormones.



22. Plasma proteins. Immunoglobulins.

Biomedical importance of plasma proteins. Classification and functions of plasma proteins. Specific and nonspecific transporters. Oncotic pressure in physiology and pathology. Acute phase proteins. Immunoglobulins: classification, structure, properties and functions.

23. Porphyrins and bile pigments. Metabolism of iron.

Biosynthesis of porphyrins. Hemoproteins. Synthesis of heme. Degradation of heme –bilirubin. Hepatic and intestinal metabolism of bilirubin. Stercobilinogen and urobilinogen. Hyperbilirubinemias. Dietary sources of iron. Iron absorption and its transport in plasma. Transferrin, ferritin and total iron binding capacity.

24. Biochemistry of the liver.

Central role of the liver in protein, carbohydrate and lipid metabolism. Hepatic detoxifications. Metabolism of xenobiotics in the liver.

25. The vitamins.

Classification of vitamins. Water-soluble and lipid-soluble vitamins. Metabolism of vitamins. Metabolic disorders caused by vitamin deficiency. Toxic effects of vitamins.

3. Themes and questions for preparing to classes.

PROTEINS.

1. Amino acids as monomers of proteins.
2. Peptide bond: formation and features.
3. Proteins as biologically active molecules: functions and classification.
4. Primary structure of proteins.
5. Secondary structure of proteins (types and stabilizing factors).
6. Tertiary structure of proteins: principle of formation and stabilizing factors.
7. Quaternary structure of proteins.
8. Denaturation and renaturation of proteins.
9. Methods of isolation, separation and purification of proteins.



ENZYMES.

1. Classification of enzymes.
2. Principles of action of enzymes.
3. Coenzymes and cofactors.
4. Specificity of enzymes.
5. The influence of temperature and pH on enzyme activity.
6. The influence of substrate concentration on the rate of enzymic reaction.
Michaelis – Menten equation.
7. Nonspecific inhibition of enzyme activity.
8. Specific inhibition: competitive, uncompetitive and noncompetitive.
9. Allosteric enzymes: mechanism of action.

STRUCTURE AND FUNCTIONS OF NUCLEIC ACIDS.

1. Components and classification of nucleic acids.
2. Primary structure of nucleic acids.
3. Secondary structure of DNA.
4. Tertiary and quaternary structure of DNA.
5. Secondary and tertiary structure of RNA.
6. Denaturation and renativation of nucleic acids.
7. Hybridization of nucleic acids.

REPLICATION OF DNA.

1. General principles of replication.
2. Enzymes of replication.
3. Initiation of replication.
4. Elongation of replication.
5. Termination of replication.
6. Replication of plasmid DNA and genetic information of viruses.

TRANSCRIPTION OF DNA.

1. General principles of transcription (enzymes, matrix, substrates).
2. Initiation of transcription.
3. Elongation of transcription.
4. Termination of transcription.
5. Post – transcriptional modification.



TRANSLATION (PROTEIN SYNTHESIS).

1. Genetic code and its features.
2. Initiation of translation.
3. Elongation of translation.
4. Termination of translation.
5. Post – translational modification.

OPERON STRUCTURE.

1. General structure of operon.
2. Structure and functions of promoter.
3. Structure and functions of operator.
4. Negative inducible and negative repressible operons.
5. Positive inducible and positive repressible operons.

MUTATIONS & DNA REPAIR SYSTEM.

1. Classification of mutations.
2. Mutagenic factors.
3. Enzymes of DNA repair system.
4. Mechanisms of DNA repair.
5. Spontaneous mutations.

STRUCTURE & FUNCTIONS OF CELL MEMBRANE.

1. Components of cell membrane.
2. Functions of cell membrane.
3. Model of elementary membrane.
4. Model of globular subunits.
5. Model of Sanger and Nicolson.
6. Features of cell membranes.

MEMBRANE TRANSPORT.

1. Classification of membrane transport processes.
2. Passive transport: kinds of transporters, kinds of transport systems.
3. Active transport.
4. Endocytosis and exocytosis.



RESPIRATION CHAIN AND SYNTHESIS OF ATP.

1. Methods of obtaining and storing energy in cells.
2. Energy transporters.
3. Methods of synthesis of ATP.
4. Respiration chain and its components.
5. Coupling of respiration and synthesis of ATP: Mitchell hypothesis.
6. Uncoupling of respiration and synthesis of ATP.

METABOLISM OF CARBOHYDRATES. PART 1.

1. Digestion and absorption of carbohydrates in gastrointestinal tract.
2. Mechanisms of blood glucose uptake, kinds of porters (GLUT1, GLUT2, etc).
3. Pathways of glucose metabolism in cells.
4. Glycolysis: the sequence of reactions, enzymes, regulation.
5. Energy balance of glycolysis in aerobic and anaerobic conditions.

METABOLISM OF CARBOHYDRATES. PART 2.


2. Gluconeogenesis: reactions, enzymes, regulation, significance.
3. Metabolism of glycogen: glycogenesis and glycogenolysis.
4. Pentose phosphate pathway: metabolic reactions, metabolic significance.
5. Disorders of carbohydrates metabolism (diabetes, glycogen storage diseases, etc.).

TRICARBOXILIC ACID CYCLE.

1. Oxydative decarboxylation of pyruvate. Pyruvate dehydrogenase complex, reactions, coenzymes.
2. Tricarboxylic acid cycle: reactions, regulation.
3. Energetics of TCA cycle.
4. Anaplerotic pathways of TCA cycle.

METABOLISM OF PROTEINS.

1. Digestion of proteins and absorption of amino acids in gastrointestinal tract.
2. General principles of catabolism of amino acids in cells.
3. Urea cycle in liver cells: reactions, enzymes, significance.

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4. General principles of biosynthesis of amino acids.
5. Disorders of metabolism of proteins and amino acids: disturbances of utilization, absorption and renal reabsorption.

LIPID METABOLISM.

1. Digestion and absorption of lipids in gastrointestinal tract. Lipoproteins.
2. B-oxidation of fatty acids (saturated and unsaturated, with an even and odd numbers of carbon atoms).
3. Synthesis of ketone bodies in liver.
4. Biosynthesis of fatty acids: enzyme complex, sequence of reactions.
5. Disorders of lipid metabolism: hypo- and hyperlipoproteinemia, atherosclerosis.

METABOLISM OF NUCLEOTIDES. PART 1.

1. Digestion and absorption of nucleotides in gastrointestinal tract.
2. Catabolism of purine nucleotides.
3. Catabolism of pyrimidine nucleotides.

METABOLISM OF NUCLEOTIDES. PART 2.

1. Biosynthesis of purine nucleotides.
2. Biosynthesis of pyrimidine nucleotides.
3. Disorders of metabolism of nucleotides.

HORMONES.

1. Classification of hormones.
2. Action of hormones with intracellular receptors.
3. Action of hormones with membrane receptors via adenylyl cyclase system.
4. Action of hormones with membrane receptors via guanylyl cyclase system.
5. Action of hormones via phosphatidylinositol system.
6. Calcium as a mediator of hormone action.

HORMONAL REGULATION OF METABOLISM OF PROTEINS, CARBOHYDRATES AND FATS.



1. Mechanism of action of insulin.
2. Hormonal regulation of metabolism of carbohydrates.
3. Hormonal regulation of metabolism of proteins and amino acids.
4. Hormonal regulation of β -oxidation and biosynthesis of fatty acids.

5. Hormonal regulation of water-salt balance

6. General principles of osmoregulation. Salt balance and water balance.
7. The role of kidneys in regulation of water-salt balance in the human body.
8. The renin – angiotensin – aldosterone system of long – term regulation of blood pressure and extracellular volume in the body.
9. Disturbances of water – salt balance. Urinary tract stone disease.

ENDOCRINE REGULATION OF CALCIUM AND PHOSPHATE HOMEOSTASIS.


1. Homeostatic pathways of calcium and phosphorus.
2. Hormonal and nonhormonal mechanisms of regulation of plasma calcium and phosphate concentrations.
3. Disturbances of homeostasis of calcium and phosphate in the human body.

THYROID HORMONES, PROSTAGLANDINS AND STEROID HORMONES.

1. Biosynthesis, secretion and transport of thyroid hormones.
2. Mechanism of action and biochemical effects of thyroid hormones.
3. Hypo- and hyperfunction of thyroid gland.
4. Synthesis and regulation of synthesis of prostaglandins.
5. Biosynthesis and function of steroids and steroid hormones.

BIOCHEMISTRY OF BLOOD AND LIVER.

1. Functions of blood. Components of normal blood.
2. Plasma proteins and its functions.
3. Blood clotting.
4. Metabolism of iron in human body.

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5. Disorders of blood clotting.
6. Steps of detoxication: chemical modification and conjugation.
7. Microsomal oxidation of xenobiotics: the role of cytochrome P₄₅₀.

BIOCHEMISTRY OF MUSCLE AND NERVOUS TISSUE.

1. Muscle structure. General characteristics of muscle proteins.
2. Energy sources and molecular event in muscle contraction.
3. Structure and biochemical features of a Neurone.
4. Action potential.
5. Transmission of Nerve Impulse for one neuron to other.
6. Transmission of an Impulse from the nerves to a skeletal muscle.
7. Disorders of metabolism of the nerve tissue.

BIOCHEMISTRY OF EXTRACELLULAR MATRIX.

1. Collagen: structure, types and functions.
2. Structure and functions of elastin.
3. Glycoproteins, proteoglycans, glycosaminoglycans.
4. Deceases of connective tissue.

4. Recommended literature

4.1. Basic manual

1. Harper's Illustrated Biochemistry, 29ed. Robert K. Murray, David A Bender, Kathleen M. Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil. McGraw Hill, 2012. ISBN 97800717657763.

4.2. Additional literature

1. Denise R. Ferrier PhD. Biochemistry (Lippincott Illustrated Reviews Series), 6th edition. LWW, 2013.
2. John Baynes Ph.D., Marek H. Dominiczak. Medical Biochemistry, 4th edition (Medical Biochemistry). Saunders, 2014.

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3. Sankhavaram R. Panini. Medical Biochemistry – An Illustrated Review. Thieme, 2013.
4. Lieberman M. et al. Marks' Basic Medical Biochemistry. A Clinical Approach (4th ed.). Lippincott Williams & Wilkins, 2012.
5. Boyer, Rodney F. Biochemistry laboratory : modern theory and techniques. 2nd ed. 2012, 2006. Pearson Education, Inc. Pearson Prentice Hall, Pearson Education, Inc. Upper Saddle River, New Jersey 07458. ISBN-10: 0-13-604302-X, ISBN-13: 978-0-13-604302-7.
6. Voet D., Voet J. Biochemistry. 4th ed. John Wiley & Sons, 2011. ISBN 13 978-0470-57095-1, ISBN 13 978-0470-91745-9.
7. Biochemistry, 7th Edition. Mary K. Campbell, Shawn O. Farrell © 2012, 2009 Brooks/Cole, Cengage Learning ISBN-13: 978-0-8400-6858-3 ISBN-10: 0-8400-6858-1.

5. Questions to the exam of biochemistry.

1. Amino acids as monomers of proteins.
2. Peptide bond: formation and features.
3. Proteins as biologically active molecules: functions and classification.
4. Primary structure of proteins.
5. Secondary structure of proteins (types and stabilizing factors).
6. Tertiary structure of proteins: principle of formation and stabilizing factors.
7. Quaternary structure of proteins.
8. Denaturation and renaturation of proteins.
9. Methods of isolation, separation and purification of proteins.
10. Classification of enzymes.
11. Principles of action of enzymes.
12. Coenzymes and cofactors.



13. Specificity of enzymes.
14. The influence of temperature and pH on enzyme activity.
15. The influence of substrate concentration on the rate of enzymic reaction.
Michaelis – Menten equation.
16. Nonspecific inhibition of enzyme activity.
17. Specific inhibition: competitive, uncompetitive and noncompetitive.
18. Allosteric enzymes: mechanism of action.
19. Components and classification of nucleic acids.
20. Primary structure of nucleic acids.
21. Secondary structure of DNA.
22. Tertiary and quaternary structure of DNA.
23. Secondary and tertiary structure of RNA.
24. Denaturation and renativation of nucleic acids.
25. Hybridization of nucleic acids.
26. General principles of replication.
27. Enzymes of replication.
28. Initiation of replication.
29. Elongation of replication.
30. Termination of replication.
31. Replication of plasmid DNA and genetic information of viruses.
32. General principles of transcription (enzymes, matrix, substrates).
33. Initiation of transcription.
34. Elongation of transcription.
35. Termination of transcription.
36. Post – transcriptional modification.
37. Genetic code and its features.
38. Initiation of transcription.
39. Elongation of translation.




40. Termination of translation.
41. Post – translational modification.
42. General structure of operon.
43. Structure and functions of promoter.
44. Structure and function of operator.
45. Negative inducible and negative repressible operons.
46. Positive inducible and positive repressible operons.
47. Classification of mutations.
48. Mutagenic factors.
49. Enzymes of DNA repair system.
50. Mechanisms of DNA repair.
51. Spontaneous mutations.
52. Components of cell membrane.
53. Functions of cell membrane.
54. Model of elementary membrane.
55. Model of globular subunits.
56. Model of Sanger and Nicolson.
57. Features of cell membranes.
58. Classification of membrane transport processes.
59. Passive transport: kinds of transporters, kinds of transport systems.
60. Active transport.
61. Endocytosis and exocytosis.
62. Methods of obtaining and storing energy in cells.
63. Energy transporters.
64. Methods of synthesis of ATP.
65. Respiration chain and its components.
66. Coupling of respiration and synthesis of ATP: Mitchell hypothesis.
67. Uncoupling of respiration and synthesis of ATP.



68. Digestion and absorption of carbohydrates in gastrointestinal tract.
69. Mechanisms of blood glucose uptake, kinds of porters (GLUT1, GLUT2, etc).
70. Pathways of glucose metabolism in cells.
71. Glycolysis: the sequence of reactions, enzymes, regulation.
72. Energy balance of glycolysis in aerobic and anaerobic conditions.
73. Gluconeogenesis: reactions, enzymes, regulation, significance.
74. Metabolism of glycogen: glycogenesis and glycogenolysis.
75. Pentose phosphate pathway: metabolic reactions, metabolic significance.
76. Disorders of carbohydrates metabolism (diabetes, glycogen storage diseases, etc.).
77. Oxydative decarboxylation of pyruvate. Pyruvate dehydrogenase complex, reactions, coenzymes.
78. Tricarboxylic acid cycle: reactions, regulation.
79. Energetics of TCA cycle.
80. Anaplerotic pathways of TCA cycle.
81. Digestion of proteins and absorption of amino acids in gastrointestinal tract.
82. General principles of catabolism of amino acids in cells.
83. Urea cycle in liver cells: reactions, enzymes, significance.
84. General principles of biosynthesis of amino acids.
85. Disorders of metabolism of proteins and amino acids: disturbances of utilization, absorption and renal reabsorption.
86. Digestion and absorption of lipids in gastrointestinal tract. Lipoproteins.
87. β – oxidation of fatty acids (saturated and unsaturated, with an even and odd numbers of carbon atoms).
88. Synthesis of ketone bodies in liver.
89. Biosynthesis of fatty acids: enzyme complex, sequence of reactions.



90. Disorders of lipid metabolism: hypo- and hyperlipoproteinemia, atherosclerosis.
91. Digestion and absorption of nucleotides in gastrointestinal tract.
92. Catabolism of purine nucleotides.
93. Catabolism of pyrimidine nucleotides.
94. Biosynthesis of purine nucleotides.
95. Biosynthesis of pyrimidine nucleotides.
96. Disorders of metabolism of nucleotides.
97. Classification of hormones.
98. Action of hormones with intracellular receptors.
99. Action of hormones with membrane receptors via adenylyl cyclase system.
100. Action of hormones with membrane receptors via guanylyl cyclase system.
101. Action of hormones via phosphatidylinositol system.
102. Calcium as a mediator of hormone action.
103. Mechanism of action of insulin.
104. Hormonal regulation of metabolism of carbohydrates.
105. Hormonal regulation of metabolism of proteins and amino acids.
106. Hormonal regulation of β – oxidation and biosynthesis of fatty acids.
107. General principles of osmoregulation. Salt balance and water balance.
108. The role of kidneys in regulation of water – salt balance in the human body.
109. The renin – angiotensin – aldosterone system of long – term regulation of blood pressure and extracellular volume in the body.
110. Disturbances of water – salt balance. Urinary tract stone disease.
111. Homeostatic pathways of calcium and phosphorus.


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112. Hormonal and nonhormonal mechanisms of regulation of plasma calcium and phosphate concentrations.
113. Disturbances of homeostasis of calcium and phosphate in the human body.
114. Biosynthesis, secretion and transport of thyroid hormones.
115. Mechanism of action and biochemical effects of thyroid hormones.
116. Hypo – and hyperfunction of thyroid gland.
117. Synthesis and regulation of synthesis of prostaglandins.
118. Biosynthesis and function of steroids and steroid hormones.
119. Functions of blood. Components of normal blood.
120. Plasma proteins and its functions.
121. Blood clotting.
122. Metabolism of iron in human body.
123. Disorders of blood clotting.
124. Steps of detoxication: chemical modification and conjugation.
125. Microsomal oxidation of xenobiotics: the role of cytochrome P450.
126. Muscle structure. General characteristics of muscle proteins.
127. Energy sources and molecular event in muscle contraction.
128. Structure and biochemical features of a Neurone.
129. Action potential.
130. Transmission of Nerve Impulse for one neuron to other.
131. Transmission of an Impulse from the nerves to a skeletal muscle.
132. Disorders of metabolism of the nerve tissue.
133. Collagen: structure, types and functions.
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135. Glycoproteins, proteoglycans, glycosaminoglycans.
136. Diseases of connective tissue.

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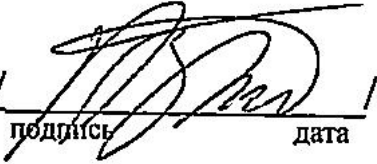
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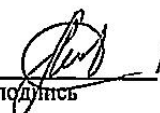

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