

BIOLOGICAL AND BIOORGANIC Chemistry

Edited by
Corresponding Member of the NAMS of Ukraine,
Professor **Yu.I. GUBSKY**,
Professor **I.V. NIZHENKOVSKA**

IN 2 BOOKS

2

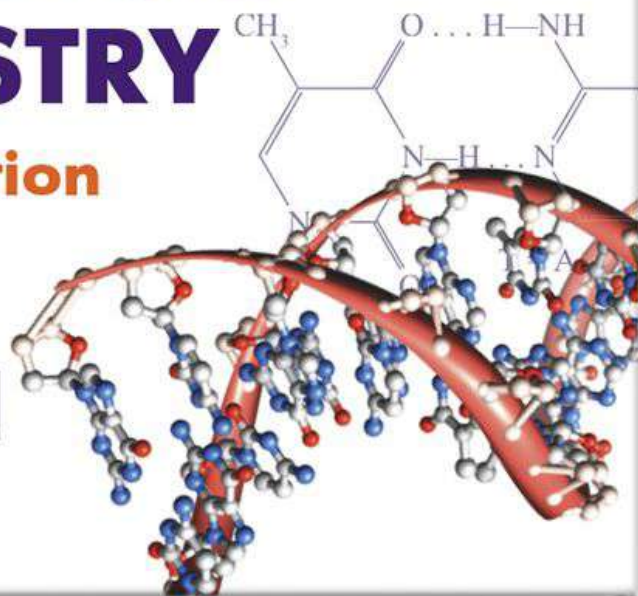
BOOK

BIOLOGICAL CHEMISTRY

Second edition

MEDICINE

WWW.MEDPUBLISH.COM.UA



BIOLOGICAL AND BIOORGANIC Chemistry

Edited by
Corresponding Member of the NAMS of Ukraine,
Professor **Yu.I. GUBSKY**,
Professor **I.V. NIZHENKOVSKA**



BIOLOGICAL CHEMISTRY

Second edition

APPROVED

by the Ministry of Education and Science of Ukraine as
a textbook for students of higher medical educational
establishments

PUBLISHED

pursuant to the Order of the Ministry of Health of Ukraine
No. 502 as of 22 June 2010 as a national textbook for
students of higher medical educational establishments

RECOMMENDED

by the Academic Council of Bogomolets National Medical
University as a textbook for students of higher medical
educational establishments

Kyiv
AUS Medicine Publishing
2021

UDC 577.1ya73
LBC 547:57(075)
B63

*Approved by the Ministry of Education and Science of Ukraine as a textbook for students
of higher medical educational establishments
(letter No. 1/11-3466, 18 March 2016)*

*Published pursuant to the Order of the Ministry of Health of Ukraine
No. 502 as of 22 June 2010 as a national textbook for students
of higher medical educational establishments*

*Recommended by the Academic Council of Bogomolets National Medical University
as a textbook for students of higher medical educational establishments
(minutes No. 4, 15 February 2013)*

Authors:

Yu.I. Gubsky, Corresponding Member of the NAMS of Ukraine, Professor; *I.V. Nizhenkovska*, Professor; *M.M. Korda*, Professor; *B.G. Borzenko*, Professor; *O.Z. Brazaluk*, Professor; *G.M. Ersteniuk*, Professor; *K.O. Efetov*, Professor; *V.I. Zhukov*, Professor; *N.V. Zaichko*, Professor; *I.O. Komarevtseva*, Professor; *M.B. Lutsyuk*, Professor; *O.O. Mardashko*, Professor; *I.F. Meshchysheh*, Professor; *K.S. Neporada*, Professor; *O.Ya. Sklyarov*, Professor; *L.M. Tarasenko*, Professor; *O.M. Torokhtin*, Professor; *T.I. Bondarchuk*, Associate Professor; *O.V. Kuznetsova*, Associate Professor; *O.V. Lozova*, Associate Professor; *A.S. Yagupova*, Associate Professor

This textbook contains a systematic presentation of the course of biological chemistry according to the educational program for students of higher medical (pharmaceutical) educational establishments. The core text of this book examines the structure of an enzyme, and the metabolic pathways of the major classes of biomolecules (proteins, amino acids, carbohydrates, lipids, nucleotides, porphyrins); structural features and properties of nucleic acids, DNA and RNA; molecular biology and genetics, biochemical foundations of the physiological functions of the human body and their neurohumoral regulation are highlighted. Considerable attention is paid to the molecular mechanisms underlying the functions of blood cells, liver, kidneys, muscles, connective tissue, immune and nervous systems. The biochemical basis of the pathogenesis of atherosclerosis, diabetes mellitus, obesity, diseases of the endocrine, immune, nervous systems and connective tissue are considered. In addition to informational material, each chapter of the textbook contains tests and tasks for self-control.

Reviewers:

L.I. Ostapchenko, Doctor of Biological Sciences, Professor, Director of the ESC "Institute of Biology and Medicine" of Taras Shevchenko National University of Kyiv;
O.G. Rezmikov, Doctor of Medical Sciences, Professor, Academician of the NAMS of Ukraine, Corresponding Member of the NAS of Ukraine, Head of the Department of Endocrinology Reproduction and Adaptation of the State Institution "V.P. Komisarenko Institute of Endocrinology and Metabolism of the NAMS of Ukraine", Kyiv;
V.O. Kalibabchuk, Doctor of Chemical Sciences, Professor, Head of the Department of Medical and General Chemistry of Bogomolets National Medical University, Kyiv

© Yu.I. Gubsky, I.V. Nizhenkovska, M.M. Korda, B.G. Borzenko,
O.Z. Brazaluk, G.M. Ersteniuk, K.O. Efetov, V.I. Zhukov, N.V. Zaichko,
I.O. Komarevtseva, M.B. Lutsyuk, O.O. Mardashko, I.F. Meshchysheh,
K.S. Neporada, O.Ya. Sklyarov, L.M. Tarasenko, O.M. Torokhtin,
T.I. Bondarchuk, O.V. Kuznetsova, O.V. Lozova, A.S. Yagupova, 2020, 2021
© AUS Medicine Publishing, design, 2021

ISBN 978-617-505-886-2

CONTENT

Introduction. History of development of biochemistry	7
Part I. GENERAL PRINCIPLES OF REGULATION OF METABOLISM	15
Chapter 1. Biomolecules and cellular structures	15
1.1. Chemical composition of living organism.....	15
1.2. Biomolecules and their functions	15
1.3. Scheme of structure of prokaryotic and eukaryotic cells.....	17
1.4. Biological membranes	18
Chapter 2. Enzymes	22
2.1. Enzymes: structure, properties and classification.....	22
2.2. Mechanism of the enzyme action	33
2.3. Kinetics of enzymatic reactions. The units of enzymatic activity	37
2.4. Regulation of enzymatic processes.....	52
2.5. Medical enzymology.....	55
2.6. Cofactors and coenzymes: chemical structure and functions	63
Chapter 3. Fundamental regularities of metabolism. Tricarboxylic acid cycle	76
3.1. Common pathways of protein, lipid, and carbohydrate metabolism	76
3.2. Oxidative decarboxylation of pyruvic acid.....	80
3.3. Tricarboxylic acid cycle or Krebs cycle	83
Chapter 4. Molecular foundations of bioenergetics	94
4.1. Pathways of the oxygen consumption in the reactions of biological oxidation.....	94
4.2. Tissue respiration	97
4.3. Chemiosmotic mechanism of ATP synthesis in mitochondria	103
4.4. Non-phosphorylative oxidation in electron transport chain as the mechanism of heat production in the mitochondria.....	109
4.5. Inhibitors and uncouplers of oxidative phosphorylation	110
Chapter 5. Hormonal regulation of metabolism	113
5.1. General characteristics of hormones	114
5.2. Classification of hormones	116
5.3. Mechanism of action of hydrophilic hormones	118
5.4. Mechanism of action of hormones that interact with the intracellular receptors.....	123
5.5. Regulation of secretion of hormones	125

CONTENT

Part II. CARBOHYDRATE, LIPID AND AMINO ACID METABOLISM.	
REGULATION OF CARBOHYDRATE, LIPID AND AMINO ACID METABOLISM	128
Chapter 6. Carbohydrate metabolism. Regulation of carbohydrate metabolism	128
6.1. Glycolysis	129
6.2. Alcohol fermentation	139
6.3. Pentose phosphate pathway of glucose metabolism	140
6.4. Metabolism of fructose	145
6.5. Metabolism of sorbitol.....	146
6.6. Metabolism of galactose	147
6.7. Gluconeogenesis	148
6.8. Metabolism of glycogen	151
6.9. Regulation of glycogenolysis and glycogenesis	157
Chapter 7. Lipid metabolism. Regulation of lipid metabolism	161
7.1. Metabolism of triacylglycerols	162
7.2. Metabolism of fatty acids	166
7.3. Metabolism of glycerol.....	177
7.4. Ketone body formation and utilization in normal and pathological conditions.....	177
7.5. Metabolism of phospholipids	182
7.6. Metabolism of cholesterol	184
7.7. Disorders of lipid metabolism	187
Chapter 8. Amino acid metabolism. Enzymopathies of amino acid metabolism	193
8.1. General pathways of amino acids transformation	193
8.2. Formation and detoxification of ammonia. Urea cycle	200
8.3. Specialized pathways of acyclic and cyclic amino acids	205
8.4. Biosynthesis of porphyrins	228
8.5. Hereditary disorder of porphyrin metabolism	232
PART III. MOLECULAR BIOLOGY. BIOCHEMISTRY	
OF INTERCELLULAR COMMUNICATIONS	235
Chapter 9. Metabolism of nucleotides	235
9.1. Biosynthesis and catabolism of purine and pyrimidine nucleotides	235
9.2. Disorders of purine and pyrimidine metabolism	249
Chapter 10. Fundamentals of molecular biology	252
10.1. Structure of deoxyribonucleic acid.....	253
10.2. Biosynthesis of deoxyribonucleic acid	256
10.3. Biosynthesis of ribonucleic acid (RNA).....	262
10.4. Ribosomal protein synthesis (translation).....	268
10.5. Antibiotics are inhibitors of template synthesis	285
10.6. Viruses and toxins are inhibitors of template synthesis in eukaryotic cells.....	288
10.7. Biochemical mechanism of antiviral effect of interferons	289

Chapter 11. Fundamentals of molecular genetics	291
11.1. Phases of eukaryotic cell cycle. Biochemical mechanism of control of cell entry into mitosis	292
11.2. Molecular mechanism of mutations	294
11.3. Genetic recombinations	297
11.4. Amplification of genes (genes of metallothionein, dihydrofolate reductase) ...	301
11.5. Genetic engineering: some basic concepts, biomedical significance	302
Chapter 12. Biochemistry of hormonal regulation	306
12.1. Hormones of hypothalamic-pituitary system.....	306
12.2. Pancreatic hormones	319
12.3. Hormones of digestive system.....	323
12.4. Hormones of thyroid gland	325
12.5. Hormonal regulation of calcium homeostasis	331
12.6. Steroid hormones of adrenal glands and gonads	336
12.7. Biological active eicosanoids.....	344
12.8. Eicosanoids in the inflammation.....	349
Part IV. FUNCTIONAL BIOCHEMISTRY	353
Chapter 13. Biochemistry of human nutrition	353
13.1. Macronutrients	354
13.2. Biochemical role of microelements	356
13.3. Digestion of nutrients in the digestive tract	360
13.4. Violations of digestion in alimentary canal	370
13.5. Vitamins	372
Chapter 14. Biochemistry of blood	385
14.1. Respiratory function of red blood cells	385
14.2. Normal and pathological forms of hemoglobin.....	389
14.3. Acid-base balance and buffer systems of blood.....	390
14.4. Non-protein components of plasma.....	394
14.5. Blood proteins.....	400
14.6. Blood plasma lipoproteins	410
14.7. Blood coagulation, anticoagulant and fibrinolytic systems	414
Chapter 15. Biochemistry of immune processes	423
15.1. Immunoglobulins: structure, biological functions.....	424
15.2. Mediators and hormones of immune system	427
15.3. Biochemical components of human complement system.....	430
15.4. Biochemical mechanisms of development of immunodeficiency	432
Chapter 16. Biochemical functions of the liver	436
16.1. Bile formation in liver.....	439
16.2. Metabolism of bile pigments in the liver	441
16.3. Pathobiochemistry of jaundice.....	445

CONTENT

16.4. Biochemical disturbances in certain liver diseases.....	449
16.5. Biotransformation of xenobiotics and endogenous toxins	453
Chapter 17. Biochemical functions of the kidneys	465
17.1. Steps of urine formation	465
17.2. Physical characteristics of urine	469
17.3. Chemical composition of urine.....	471
17.4. Role of the kidneys in acid-base balance.....	476
17.5. Features of kidney metabolism.....	477
17.6. Biochemical tests of kidney function.....	480
Chapter 18. Biochemistry of muscles	483
18.1. Structure of myofibrils.....	483
18.2. Chemical composition of muscle tissue.....	484
18.3. Biochemical features of cardiac and smooth muscles	488
18.4. Biochemical mechanisms of contraction and relaxation of muscles	488
18.5. Sources of energy for muscle contractions	491
18.6. Biochemical changes in muscle pathology	493
Chapter 19. Biochemistry of connective tissue.....	496
19.1. Structure and metabolism of collagen	496
19.2. Elastin structure	499
19.3. Structure and metabolism of proteoglycans.....	500
19.4. Structure of glycoproteins.....	504
Chapter 20. Biochemistry of nervous system	506
20.1. Chemical composition of the nervous system	506
20.2. Nervous tissue metabolism	509
20.3. Molecular basis of bioelectrical processes on the membrane of neurons.....	513
20.4. Neurotransmitters.....	517
20.5. Metabolism of neurotransmitters and neuromodulators in mental disorders ...	521
20.6. Neurochemical mechanisms of psychotropic drugs	522
Answers for tests for self-control.....	524
Index	525
References.....	542

Book 2

BIOLOGICAL CHEMISTRY

Edited by

Corresponding Member of the NAMS of Ukraine,

Professor **Yu.I. GUBSKY**,Professor **I.V. NIZHENKOVSKA****Second edition**

This textbook contains a systematic presentation of the course of biological chemistry according to the educational program for students of higher medical (pharmaceutical) educational establishments. The core text of this book examines the structure of an enzyme, and the metabolic pathways of the major classes of biomolecules (proteins, amino acids, carbohydrates, lipids, nucleotides, porphyrins); structural features and properties of nucleic acids, DNA and RNA; molecular biology and genetics, biochemical foundations of the physiological functions of the human body and their neuro humoral regulation are highlighted. Considerable attention is paid to the molecular mechanisms underlying the functions of blood cells, liver, kidneys, muscles, connective tissue, immune and nervous systems. The biochemical basis of the pathogenesis of atherosclerosis, diabetes mellitus, obesity, diseases of the endocrine, immune, nervous systems and connective tissue are considered. In addition to informational material, each chapter of the textbook contains tests and tasks for self-control.

ISBN 978-617-505-886-2



9 786175 058862

**MEDICINE**

WWW.MEDPUBLISH.COM.UA