



BIOLOGICAL CHEMISTRY



БИОЛОГИЧЕСКАЯ ХИМИЯ

BIOLOGICAL CHEMISTRY

Допущено

Министерством образования Республики Беларусь
в качестве учебного пособия для иностранных студентов
учреждений высшего образования по специальностям
«Лечебное дело», «Стоматология», «Фармация»



МИНСК «НОВОЕ ЗНАНИЕ» 2025

УДК 577.1(075.8)
ББК 28.072(2Англ)я73
Б63

А в т о р ы :

проф. А.Д. Таганович; доц. А.В. Колб; доц. Н.Н. Ковганко; доц. Ж.А. Рутковская;
доц. Т.В. Рябцева; доц. А.Г. Кадушкин; доц. Е.А. Девина; доц. Е.А. Хотыко;
ст. преподаватель Д.И. Мурашко

Р е ц е н з е н т ы :

кафедра общей и клинической биохимии с курсом ФПК и ПК Витебского
государственного ордена Дружбы народов медицинского университета;
д-р мед. наук, проф., зав. кафедрой биологической химии Гродненского госу-
дарственного медицинского университета В.В. Лелевич;
канд. филол. наук, доц. кафедры современных технологий перевода Минского
государственного лингвистического университета Т.И. Голикова

При оформлении обложки использованы материалы shutterstock.com по лицензии.

Б63 **Биологическая химия** = Biological chemistry : учеб. пособие /
А.Д. Таганович, А.В. Колб, Н.Н. Ковганко [и др.]. — Минск : Новое
знание, 2025. — 356 с. : ил.
ISBN 978-985-24-0777-9.

Содержит схемы, рисунки, пояснительный текст к лекциям по основным
программным разделам курса биологической химии для студентов медицин-
ского факультета иностранных учащихся, обучающихся на английском языке
по специальностям «Лечебное дело» и «Стоматология». Предназначено для
облегчения конспектирования лекций и улучшения усвоения материала.
Рекомендуется для подготовки к лекциям, практическим занятиям и экза-
мену по биологической химии.

Для иностранных студентов 1–2-го курсов, обучающихся на английском
языке.

УДК 577.1(075.8)
ББК 28.072(2Англ)я73

ISBN 978-985-24-0777-9

© Оформление. ООО «Новое знание», 2025

TABLE OF CONTENTS

Preface	10
1. Proteins: structure and functions	14
1.1. Biological functions of proteins	14
1.2. Amino acids	16
Properties of amino acids	19
1.3. Peptides	20
1.4. Structural organization and properties of proteins	21
1.5. Protein classification	27
1.6. Separation and purification of proteins	28
Dialysis	29
Gel filtration (gel chromatography)	30
Ammonium sulfate precipitation (salting out)	31
Polyacrylamide gel electrophoresis (PAGE)	32
Western blot	33
1.7. Clinical aspects	34
Application of amino acids in drug therapy	34
Application of peptides as drugs	34
Diseases of protein folding	35
Medical implications of protein denaturation	35
Medical implications of Western blot	35
2. Enzymes	36
2.1. History of enzymes	36
2.2. General enzyme properties	37
2.3. Enzyme nomenclature and classification	39
2.4. Coenzymes	41

2.5. Enzyme kinetics.....	43
2.6. Regulation of enzyme-catalyzed reactions.....	45
2.7. Isoenzymes.....	51
2.8. Medical aspects of enzymology.....	52
3. Introduction to metabolism and bioenergetics	55
3.1. Adenylate system	58
3.2. Oxidative phosphorylation and tissue respiration.....	60
3.3. Mechanism of tissue respiration	62
The tissue respiration and oxidative phosphorylation disorders	67
3.4. Photophosphorylation. Photosynthesis	68
3.5. The central metabolic pathways.....	75
3.6. Oxidative decarboxylation of pyruvate.....	75
Regulation of the process	76
Impaired pyruvate oxidation.....	77
3.7. Citric acid cycle	77
3.8. Pathways of O ₂ utilization by cells.....	79
4. Carbohydrate metabolism	80
4.1. Structure and functions of major carbohydrates	80
Classification of carbohydrates.....	80
4.2. Digestion and absorption of carbohydrates	83
Absorption of carbohydrates	84
4.3. Metabolism of glycogen	85
Glycogen biosynthesis (glycogenesis)	85
Regulation of glycogen synthesis	86
Glycogen breakdown (glycogenolysis).....	87
Regulation of glycogen breakdown.....	87
4.4. Glycolysis.....	89
Regulation of glycolysis.....	93
Biological role of glycolysis.....	93
4.5. Glucose oxidation under aerobic conditions	94
Transfer of the cytosolic NADH · H ⁺ to the mitochondrion.....	95
4.6. Gluconeogenesis.....	96
4.7. Pentose phosphate pathway	99
4.8. Uronic acid pathway	101
4.9. Ethanol metabolism.....	102

Table of contents

4.10. Glucose reduction pathway (sorbitol pathway).....	102
4.11. Regulation of blood glucose level.....	103
4.12. Clinical aspects of carbohydrate metabolism disorders.....	103
5. Lipid metabolism	106
5.1. Molecular structure and properties of lipids.....	107
5.2. Digestion of lipids	110
5.3. Lipid transport in the blood.....	114
5.4. Lipid storage and mobilization in the adipose tissue	116
5.5. β -Oxidation of fatty acids	118
5.6. Fatty acid biosynthesis	122
5.7. Eicosanoids.....	125
5.8. Cholesterol biosynthesis	126
5.9. Ketone bodies.....	127
5.10. Clinical aspects	130
6. Protein and amino acid metabolism	133
6.1. Nitrogen balance	133
6.2. Protein digestion.....	136
6.3. Amino acid pool	140
6.4. General reactions of amino acid metabolism	142
Transamination.....	142
Deamination.....	143
Amino acid decarboxylation.....	145
6.5. Amino acid synthesis.....	147
6.6. Ammonia detoxification.....	148
6.7. Hyperammonemia.....	151
6.8. Non-protein blood nitrogen.....	152
6.9. Clinical aspects	152
7. Hemostasis	155
7.1. Hemostatic system proteins	155
7.2. Coagulation hemostasis system.....	159
7.3. The role of vitamin K in coagulation process.....	163
7.4. Prevention of blood clotting in blood vessels.....	165
7.5. Fibrinolysis.....	167
7.6. Pathological blood clotting.....	172
7.7. Laboratory assessment of hemostasis	173

8. Chemistry of nucleic acids	175
8.1. DNA structure	177
8.2. RNA structure.....	181
8.3. Nucleoprotein metabolism.....	182
8.4. Nucleotide biosynthesis.....	185
8.5. <i>De novo</i> synthesis of purine nucleotides	186
8.6. <i>De novo</i> synthesis of pyrimidine nucleotides.....	189
8.7. Formation of deoxyribonucleotides.....	191
8.8. Biosynthesis of DNA, RNA and proteins.....	192
Biosynthesis of DNA	192
Biosynthesis of RNA.....	195
Protein biosynthesis	198
8.9. Regulation of protein synthesis in the cell	201
8.10. Inhibitors of protein biosynthesis	203
8.11. Polymerase chain reaction (PCR)	203
9. Hormones	205
9.1. Synthesis of hormones, transport in blood, catabolism.	
Major features of the hormone action.....	206
9.2. Classification of hormones according to the mechanism	
of action	207
9.3. Mechanism of signal transduction through the 7-TMS	
receptors	208
9.4. Mechanism of signal transduction through the 1-TMS	
receptors	211
Receptors possessing catalytic activity.....	212
1-TMS receptors associated with cytosolic tyrosine kinases	214
9.5. Mechanism of signal transduction through the intracellular	
receptors	215
9.6. Hypothalamic hormones	217
9.7. Hormones of the adenohypophysis.....	218
9.8. Iodine containing thyroid hormones.....	219
9.9. Pancreatic hormones	220
9.10. Steroid hormones	226
10. Liver biochemistry	227
10.1. Biological role of the liver	227
10.2. Liver function tests.....	235

11. Metabolism integration	238
11.1. Principal components of metabolism integration.....	238
11.2. Major features of metabolism in the liver in the well fed state.....	245
11.3. Extrahepatic tissue metabolism peculiarities in the well fed state.....	247
11.4. Metabolism in fasting.....	248
11.5. Organ specialization of metabolism in fasting.....	249
11.6. Interorgan metabolism after 12-hour fast	250
11.7. Interorgan metabolism after a 3-day fast.....	251
11.8. Interorgan metabolism after 3 weeks of starvation.....	252
12. Blood biochemistry	254
12.1. Major blood functions.....	254
12.2. Chemical composition of blood plasma.....	255
12.3. Metabolism of red blood cells.....	255
12.4. Blood respiratory function.....	258
12.5. Blood plasma proteins.....	267
12.6. Blood serum enzymes.....	274
13. Nutrition biochemistry. Vitamins and other essential nutritive factors.	
Protein-energy malnutrition	275
13.1. Essential nutritive factors.....	275
13.2. Vitamins	279
Water-soluble vitamins	279
Vitamin B ₁ (thiamin, antineuritic vitamin).....	279
Vitamin B ₂ (riboflavin).....	280
Pantothenic acid	280
Nicotinic acid (niacin, PP — “pellagra preventive”)	281
Vitamin B ₆ (pyridoxine, pyridoxal, pyridoxamine, antidermatitic vitamin)	281
Folic acid (folate, B _c , B ₉)	282
Vitamin B ₁₂ (cobalamine, antianemic vitamin)	282
Biotin (vitamin H, antiseborrheic vitamin).....	284
Vitamin C (ascorbic acid, antiscorbutic vitamin)	285
Fat-soluble vitamins.....	285
Vitamin A (retinol, antixerophthalmic, growth vitamin).....	285
Vitamin E (tocopherol, fertility vitamin).....	287

Vitamin D (calciferol, antirachitic vitamin).....	288
Vitamin K (naphthoquinones, antihemorrhagic vitamin)	290
13.3. Vitamin-like substances	292
13.4. Protein-energy malnutrition.....	293
14. Nutrition biochemistry. Water and mineral metabolism	295
<hr/>	
14.1. Body water.....	295
14.2. Water-salt balance regulation.....	297
14.3. Antidiuretic hormone (ADH)	298
14.4. Renin-angiotensin-aldosterone system (RAAS).....	298
14.5. Minerals.....	299
Macroelements	300
Sodium	300
Potassium	300
Chlorine.....	301
Regulation of electrolyte and water balance.....	301
Natriuretic peptides.....	304
Calcium.....	304
Phosphorus	305
Calcium and phosphate regulation.....	305
Magnesium.....	307
Sulfur.....	308
Microelements	308
Iron.....	308
Copper.....	310
Zinc	311
Selenium	311
Iodine.....	312
Cobalt.....	312
15. Urine biochemistry	313
<hr/>	
15.1. Physical and chemical characteristics of urine.....	314
15.2. Urine chemical composition under normal conditions	316
Organic components	316
Inorganic components	317
15.3. Pathologic components of urine	317
15.4. Clinical aspects	319
Collection and handling of a urine specimen for analysis.....	319

Table of contents

“Three tube test” for hematuria	320
Orthostatic proteinuria	320
Quantification of proteinuria	321
16. Biochemistry of connective tissues	322
16.1. Cell types	322
16.2. Extracellular matrix	324
16.3. Proteoglycans	325
16.4. Mucoproteins	334
16.5. Glycoproteins	334
16.6. Degradation of protein-carbohydrate complexes	335
16.7. Collagens	335
16.8. Elastin	339
16.9. Adhesive proteins	341
17. Biochemistry of teeth and oral fluid	344
17.1. Teeth	344
17.2. Oral fluid	347
17.3. Enamel surface formations	350
17.4. Fluorine and its biological role	353
References	355