

PATHOPHYSIOLOGY

TEXTBOOK

Edited by
N.V. Krishtal,
V.A. Mikhnev

Third edition

MEDICINE

WWW.MEDPUBLISH.COM.UA

UDC 616-092(075.8)

LBC 52.5ya73

P20

П 20

*Approved by the Ministry of Education and Science of Ukraine
as a textbook for students of higher medical educational establishments
(letter No. 1.4/18-G-1816 dated 24 October 2017)*

*Issued under the Order of the Ministry of Health of Ukraine
No. 502 dated 22 June 2010 as a national textbook
for students of higher medical educational establishments*

Authors:

N.V. Krishtal, V.A. Mikhnev, N.N. Zayko, Y.V. Byts, G.M. Butenko, O.G. Reznikov, L.Ya. Danylova, I.I. Pototska, V.O. Horban, N.K. Simeonova, O.I. Sukmanskyi, L.P. Zayarna, V.Ye. Dosenko, A.I. Gozhenko, V.O. Kostenko, A.V. Kubyshkin, V.F. Myslytskyi, L.O. Popova, S.V. Ziablitsev

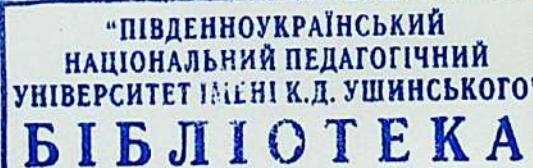
Reviewers:

O.A. Moybenko — Academician of the National Academy of Sciences of Ukraine, Doctor of Medical Sciences, Professor;

Ya.M. Kolesnyk — Honored Worker of Sciences and Engineering of Ukraine, Doctor of Medical Sciences, Professor of the Department of Pathological Physiology of Zaporizhzhia State Medical University;

M.S. Reheda — Honored Worker of Education of Ukraine, Doctor of Medical Sciences, Professor, Head of the Department of Pathological Physiology of Danylo Halytsky Lviv National Medical University

544213



P20 **Pathophysiology** : textbook / N.V. Krishtal, V.A. Mikhnev, N.N. Zayko et al. ; edited by N.V. Krishtal, V.A. Mikhnev. — 3rd edition. — Kyiv : AUS Medicine Publishing, 2019. — 656 p. + 4 p. colour insert.

ISBN 978-617-505-759-9

The textbook is prepared by a team of staff at higher educational establishments and academic research institutions of Ukraine, who are recognized experts in various aspects of pathophysiology that gives reason this basic textbook to be national. It is recommended for English-speaking students of higher medical educational establishments. The textbook can be useful for teachers and physicians of all specialties.

UDC 616-092(075.8)

LBC 52.5ya73

Б-ка ПНПУ ім. К.Д.Ушинського



544213

ISBN 978-617-505-759-9

© N.V. Krishtal, V.A. Mikhnev, N.N. Zayko, Y.V. Byts, G.M. Butenko, O.G. Reznikov, L.Ya. Danylova, I.I. Pototska, V.O. Horban, N.K. Simeonova, O.I. Sukmanskyi, L.P. Zayarna, V.Ye. Dosenko, A.I. Gozhenko, V.O. Kostenko, A.V. Kubyshkin, V.F. Myslytskyi, L.O. Popova, S.V. Ziablitsev, 2017, 2019

© AUS Medicine Publishing, design, 2019

Contents

Abbreviations	11
Preface	14
Introduction (MD, PhD, DSc, Professor Nikolay N. Zayko).....	15
The Subject and Tasks of Pathological Physiology	15
Relationship Between Pathological Physiology and Other Medical Sciences, Its Importance for Clinical Disciplines.....	15
Experiment as the Basic Method of Pathological Physiology	16
Historical Sketch of the Development of Pathological Physiology (MD, PhD, DSc, Professor Valentin F. Myslitskiy; MD, PhD, DSc, Professor Sergey V. Ziablitsev).....	18
 Part One GENERAL NOSOLOGY	
Chapter I. GENERAL THEORY OF DISEASES (MD, PhD, DSc, Professor Nikolay N. Zayko).....	23
Health	23
Disease	24
Principles of Diseases Classification	25
Pathological Reaction, Pathological Process, Pathological Condition	26
Typical Pathological Processes	27
Main Periods (Stages) of Disease Development	27
Chapter II. ETIOLOGY AND PATHOGENESIS (MD, PhD, DSc, Professor Nikolay N. Zayko).....	31
Etiology	31
Conditions of the Disease Occurrence	33
Pathogenesis	34
The Cause-and-Effect Relationship	35
General and Local	36
Structure and Function	36
Nonspecific and Specific	36
Adaptation and Compensation	37
Reactivity and its Role in Pathology (MD, PhD, DSc, Professor Liudmila Ya. Danilova) ...	38
Types of Resistance. Relations with Reactivity	39
Chapter III. PATHOGENIC EFFECT OF ENVIRONMENTAL FACTORS ON THE ORGANISM (MD, PhD, Associate Professor Natalia K. Simeonova)	41
Mechanical Trauma	41
Thermal Trauma	41
Barotrauma	45
Radiation Injury	46
Etiology	46
Pathogenesis	47

PATHOPHYSIOLOGY

Acute Radiation Disease.....	53
Chronic Radiation Disease	54
Electrotrauma	55
Pathogenic Effect of Space Flight Factors.....	56
Chapter IV. THE ROLE OF HEREDITY, CONSTITUTION AND AGE IN PATHOLOGY (MD, PhD, Associate Professor <i>Natalia K. Simeonova</i>)	57
Genetically Determined Diseases	57
Classification	57
Etiology	58
Pathogenesis	59
Molecular Genetic (Hereditary) Diseases.....	60
Chromosomal Diseases.....	65
Hereditary Predisposition	66
Genetic Examination of a Patient	66
Principles of Prevention and Treatment of Hereditary Diseases.....	69
Role of The Constitution in Pathology.....	70
Pathological Physiology of Fetal Development (MD, PhD, DSc, Professor <i>Larisa A. Popova</i>).....	73
Ageing (MD, PhD, DSc, Professor <i>Gennadiy M. Butenko</i>)	74
Changes in the Body during Aging	77
Ageing and Diseases	82
Causes and Mechanisms of Ageing.....	83
The Ways of Influence on Ageing	84

Part Two

GENERAL PATHOPHYSIOLOGY OF CELLS. TYPICAL METABOLIC DISORDERS

Chapter V. PATHOPHYSIOLOGY OF CELL (MD, PhD, DSc, Professor <i>Gennadiy M. Butenko</i>).....	86
Disturbances of Cells Functions	86
Disorders of Metabolic Processes and Environment Interaction	87
Disturbance of Cell Energy Supply	88
Disturbances of Genetic Information Storage and Transfer	89
Intracellular Synthesis Disorders	91
Dissimilation Interruption	92
Cell Damage and Death	93
Chapter VI. PATHOLOGY OF ENERGY BALANCE (MD, PhD, DSc, Professor <i>Liudmila Ya. Danilova</i>; MD, PhD, DSc, Professor <i>Nikolay V. Krishtal</i>)	95
Chapter VII. PATHOPHYSIOLOGY OF CARBOHYDRATE METABOLISM (MD, PhD, DSc, Professor <i>Liudmila Ya. Danilova</i>; MD, PhD, DSc, Professor <i>Nikolay V. Krishtal</i>)	98
Carbohydrate Metabolism and its Regulation	98
Pathology of the Carbohydrate Metabolism.....	100
Chapter VIII. PATHOPHYSIOLOGY OF LIPID METABOLISM (MD, PhD, DSc, Professor <i>Nikolay V. Krishtal</i>; MD, PhD, DSc, Professor <i>Liudmila Ya. Danilova</i>)	105
Malabsorption of Lipids.....	105
Disorders of Lipid Transport and Deposition	105

Lipid Infiltration and Lipid Dystrophy	107
Disorder of Intermediate Lipid Metabolism	107
Disorders of Lipid Metabolism in The Adipose Tissue	108
Obesity	109
Weight Loss	114
Lipidoses	115
Chapter IX. PATHOPHYSIOLOGY OF PROTEIN METABOLISM (MD, PhD, DSc,	
Professor <i>Larisa A. Popova</i> ; MD, PhD, DSc, Professor <i>Victor Ye. Dosenko</i>)	116
Disorders of Amino Acid Metabolism	116
Hereditary Disorders of Metabolism of Certain Amino Acids	117
Disorders of Final Stages of Protein Metabolism	119
Disorders of Proteins of the Blood	120
Disorders of the Nucleic Acids Metabolism	120
Chapter X. PATOPHYSIOLOGY OF ACID-BASE HOMEOSTASIS	
(MD, PhD, DSc, Professor <i>Nikolay V. Krishtal</i>)	122
Etiology, Pathogenesis and Forms of Acid-Base Imbalance	124
The Relationship between ABH and Mineral Exchange	124
Etiology and Classification of Non-Respiratory Acid-Base Imbalance	126
Pathological Effects of Acid-Base Imbalance on the Body	127
Mechanisms of Compensation of Acid-Base Imbalance	128
Chapter XI. PATOPHYSIOLOGY OF WATER-ELECTROLYTE BALANCE	
(MD, PhD, DSc, Professor <i>Nikolay V. Krishtal</i> ; MD, PhD, DSc, Professor <i>Oleg I. Sukmanskiy</i>)	132
Types, Causes, and Consequences of Water-Electrolyte Imbalance	136
Electrolyte Imbalance	142
The Exchange of Sodium and Its Imbalance	142
The Exchange of Potassium and Its Imbalance	143
The Exchange of Magnesium and Its Imbalance	144
The Exchange of Chlorine and Its Imbalance	145
The Exchange of Calcium and Its Imbalance	146
The Exchange of Phosphorus and Its Imbalance	148
The Osteoporosis	149
Chapter XII. PATHOPHYSIOLOGY OF MICROELEMENTS METABOLISM	
(MD, PhD, DSc, Professor <i>Nikolay V. Krishtal</i>)	151
Iron Exchange and Imbalance	152
Copper Exchange and Imbalance	156
Zinc Exchange and Imbalance	159
Manganese Exchange And Imbalance	161
Chromium Exchange and Imbalance	162
Vanadium Exchange and Imbalance	163
Molybdenum Exchange and Imbalance	165
Selenium Exchange and Imbalance	165
Iodine Exchange And Imbalance	169
Fluoride Exchange and Imbalance	171
Chapter XIII. PATHOPHYSIOLOGY OF VITAMINS METABOLISM	
(MD, PhD, DSc, Professor <i>Nikolay V. Krishtal</i>)	173
Classification and General Characteristics of Vitamins in the Human Body	173

PATOPHYSIOLOGY

Sources of Vitamins and Their Metabolism in the Body	177
Main Causes of Vitamin Deficiency Development	179
Deficiency of Antineurotic Vitamin B ₁	181
Deficiency of Riboflavin.....	182
Deficiency of Antipellagric Vitamin PP.....	182
Deficiency of Antidermatitic Vitamin B ₆	183
Deficiency of Folic Acid	184
Deficiency of Antianemic Vitamin B ₁₂	185
Deficiency of Antiscorbutic Vitamin C.....	186
Deficiency of Biotin	187
Deficiency of Rutin	188
Deficiency of Antixerophthalmic Vitamin A	188
Deficiency of Antirachitic Vitamin D.....	188
Deficiency of Vitamin E.....	190
Deficiency of Vitamin F.....	191
Deficiency of Antihemorrhagic Vitamin K.....	192
Hypervitaminoses.....	192

Part Three

TYPICAL PATHOLOGICAL PROCESSES

Chapter XIV. PATHOPHYSIOLOGY OF PERIPHERAL BLOOD CIRCULATION

(MD, PhD, DSc, Professor <i>Yuriy V. Byts</i> ; MD, PhD, DSc, Professor <i>Anatoliy V. Kubyshkin</i>)	194
Arterial Hyperemia	196
Venous Hyperemia.....	201
Ischemia	202
Stasis	206
Thrombosis	206
Embolism.....	209

Chapter XV. MICROCIRCULATORY DISORDERS (MD, PhD, DSc,

Professor <i>Yuriy V. Byts</i> ; MD, PhD, DSc, Professor <i>Anatoliy V. Kubyshkin</i>)	213
Intravascular Mechanisms of Microcirculatory Disorders.....	214
Extravascular Mechanisms of Microcirculatory Disorders	217

Chapter XVI. INFLAMMATION (MD, PhD, DSc, Professor *Nikolay V. Krishtal*)

Experimental Models of Inflammation	219
Etiology of Inflammation.....	220
Pathogenesis of Inflammation.....	220
Alteration.....	221
The Inflammatory Cells and Mediators	225
The Influence of Inflammatory Mediators on the Organism.....	233
Vascular Reactions in Inflammation.....	234
Exudation	236
Emigration of the White Blood Cells	237
Phagocytosis	242
Proliferation and Regeneration.....	244
Classification.....	249

Chapter XVII. PATHOPHYSIOLOGY OF THE IMMUNITY (MD, PhD, DSc, Professor Vladislav A. Horban; MD, PhD, DSc, Professor Nikolay V. Krishtal)	251
The Main Functions and Structure of the Immune System	251
Genesis and Function of T- and B-Lymphocytes	253
Experimental Models of Hypofunction of the Immune System	257
Immune Deficiency Diseases.....	257
Immune-Suppressive Diseases	263
Disorders of the Systems that Functionally Associated with the Immune System.....	264
Chapter XVIII. ALLERGY (MD, PhD, DSc, Professor Vladislav A. Horban)	267
Etiology.....	267
Classification of Allergens.....	267
Pathogenesis.....	269
Immunological Stage of Allergic Reactions and Their Classification	269
The Pathochemical Stage of Allergic Reactions	274
Pathophysiological Stage of Allergic Reactions	276
Mechanisms of Formation of Allergic Reactions.....	277
Autoallergic Diseases	279
False Allergy (Paraallergy, Heteroallergy).....	281
Prevention of the Allergy. Desensibilization	282
Chapter XIX. FEVER (MD, PhD, DSc, Professor Nikolay N. Zayko)	283
Etiology.....	283
Pathogenesis. The Role of the Thermoregulatory Centers in the Fever Development	284
Stages of the Fever	288
Types of Temperature Curves	289
Difference between Fever and Hyperthermia	291
Effect of Fever on Body Organs and Systems.....	292
Significance of Fever for Organism	293
Chapter XX. TUMORS (NEOPLASMS) (MD, PhD, DSc, Professor Vladislav A. Horban)	295
Experimental Models of Neoplasia.....	295
Features of the Neoplastic Tissue	296
Malignancy of Tumors.....	298
Etiology of Tumor	299
Pathogenesis of Tumor	302
The Tumor Effect on the Organism.....	309
The Role of the Organism in the Neoplastic Process	310
Chapter XXI. STARVATION (MD, PhD, DSc, Professor Liudmila Ya. Danilova)	313
The Complete Starvation	313
Incomplete Starvation.....	318
Partial Starvation	319
Chapter XXII. HYPOXIA (MD, PhD, Associate Professor Natalia K. Simeonova)	321
Etiology.....	321
Pathogenesis.....	322
Compensatory and Adaptive Reactions	322
Immediate Compensatory Reactions	323
Delayed Compensatory Reactions	324

PATHOPHYSIOLOGY

Adaptation	326
Pathological Changes During the Hypoxia	326

Part Four PATHOPHYSIOLOGY OF ORGANS AND SYSTEMS

Chapter XXIII. PATHOPHYSIOLOGY OF THE BLOOD SYSTEM

(MD, PhD, Associate Professor <i>Irina I. Pototskaya</i>)	329
Total Blood Volume Disorders	329
Hemorrhage	331
Pathology of the Erythrocytes	332
Erythrocytosis	334
Anemia	335
The Posthemorrhagic Anemia	336
Hemolytic Anemia	337
The Dyserythropoietic Anemia	341
Pathological Changes of the Leukocytes	347
Disorders of the Leukopoiesis	347
Quantitative Changes of the Leukocytes in the Blood	347
The Qualitative Changes of the Leukocytes in the Blood	351
Hemoblastosis, Leukemia	354
Pathology of the Hemostasis	358
Hemorrhagic Syndromes	359
Thrombotic Syndromes	363

Chapter XXIV. PATHOPHYSIOLOGY OF CARDIOVASCULAR DISORDERS

CAUSED BY HEART DYSFUNCTION

(MD, PhD, DSc, Professor <i>Gennadiy M. Butenko</i>)	367
Heart Failure	368
Heart Failure Associated with Volume Overload. Mechanisms of Compensation	369
Heart Failure due to Myocardium Damage	377
Cardiac Rhythm Disorders	383

Chapter XXV. PATHOPHYSIOLOGY OF CARDIOVASCULAR DISORDERS

CAUSED BY VESSELS DYSFUNCTION (MD, PhD, DSc,

Professor <i>Yuriy V. Byts</i> ; MD, PhD, DSc, Professor <i>Nikolay V. Krishtal</i>)	390
Pathological Changes in the Vessels of the Compensatory Type. Atherosclerosis	392
Experimental Models of the Atherosclerosis	393
Etiology	393
Pathogenesis	399
Pathophysiology of Vessels of the Resistance (Muscle) Type	403
Arterial Hypertension	403
Experimental models of the hypertension	404
Etiology	406
Pathogenesis	407
Pulmonary Hypertension	414
Arterial Hypotension	415

Chapter XXVI. PATHOPHYSIOLOGY OF EXTREME STATES

(MD, PhD, Associate Professor <i>Larisa P. Zayarnaya</i>)	417
Shock	417

Etiology	417
Pathogenesis	418
Specific Features of the Shock Development	428
Collapse	435
Chapter XXVII. PATHOPHYSIOLOGY OF THE RESPIRATION	
(MD, PhD, DSc, Professor <i>Vladimir A. Mikhnev</i>)	440
Disorders of the Alveolar Ventilation.....	440
Disregulative Ventilative Respiratory Insufficiency.....	441
Obstructive Ventilative Insufficiency	446
Restrictive Ventilative Insufficiency.....	448
Disorders of the Respiration in the Pulmonary Obstructive and Restrictive Processes.....	451
Diffusive Insufficiency of the Lungs	451
Decrease of the Total Blood Flow in the Lungs.....	454
Breaking of the Total and Local Ventilation-Perfusion Ratio in the Lungs	454
Impact of the Respiratory Failure on the Body	456
Disorders of Non-Respiratory Functions of the Lungs.....	459
Chapter XXVIII. PATHOPHYSIOLOGY OF THE DIGESTIVE SYSTEM	
(MD, PhD, DSc, Professor <i>Oleg I. Sukmanskiy</i> ; MD, PhD, DSc, Professor <i>Vitaliy A. Kostenko</i>)	461
Appetite Disorder.....	461
Digestive Disorders in the Oral Cavity	463
The Chewing Disorder	463
Dental Caries.....	463
Periodontal Pathology	465
Disorders of Salivation	466
Disorders of Swallowing and Esophageal Motility	468
Digestive Disorders in the Stomach.....	469
Disorders of the Stomach Secretion	469
Disorders of the Stomach Motility	471
Peptic Ulcer	475
Intestinal Digestive Disorders	478
Digestive Disorders Connected with Impairment of the Bile and Pancreatic Juice Secretion.....	478
Pancreatitis	479
Disorders of the Parietal Digestion.....	481
Disorder of Intestinal Absorption. Malabsorption Syndrome	483
Intestinal Motility Disorders.....	484
Intestinal Obstruction	485
Intestinal Dysbiosis. Intestinal Auto intoxication.....	486
Disorders of Hormone Synthesis in the Digestive System	487
Chapter XXIX. PATHOPHYSIOLOGY OF THE LIVER	
(MD, PhD, Associate Professor <i>Irina I. Pototskaya</i>)	490
General Characteristics of Pathological Processes in the Liver	490
Hepatic Insufficiency.....	491
Disorders of the Metabolism in Liver.....	493
Hepatic Protective Dysfunctions	496
Hepatic Coma	497

PATOPHYSIOLOGY

Disorders of the Cholopoiesis and Cholekinesis.....	499
Disorders of the Hemodynamics at Diseases of Liver.....	506
Chapter XXX. PATHOPHYSIOLOGY OF THE KIDNEYS (MD, PhD, DSc, Professor Nikolay V. Krishtal; MD, PhD, DSc, Professor Anatoliy I. Gozhenko).....	508
Disorders of the Renal Functions and Processes.....	508
Disorders of Glomerular Filtration.....	509
Disorders of Tubular Reabsorption and Secretion.....	511
Pathogenesis of the Renal Syndromes	515
Nephrotic Syndrome	517
Acute Renal Failure.....	518
Chronic Renal Failure.....	520
Tubulointerstitial Syndrome	521
Etiology and Pathogenesis of the Main Renal Diseases.....	522
Glomerulonephritis.....	522
Pyelonephritis	525
Chapter XXXI. PATHOPHYSIOLOGY OF THE ENDOCRINE SYSTEM (MD, PhD, DSc, Professor Aleksandr G. Reznikov).....	527
Hormones and Their Role in the Body	527
Etiology and Pathogenesis of Endocrine Disorders	530
Dysfunction of the Hypothalamic-Pituitary System	538
Dysfunctions of the Pituitary.....	538
Neuroendocrine Diseases	541
Disorders of Other Endocrine Organs	542
Dysfunctions of the Thyroid Gland.....	542
Dysfunctions of the Parathyroid Glands.....	546
Dysfunctions of the Adrenal Glands.....	547
Dysfunctions of the Sex Glands	550
The Endocrine Dysfunction of the Thymus	552
Dysfunctions of the Pineal Body (Epiphysis)	552
Stress and General Adaptation Syndrome	553
Diabetes Mellitus (MD, PhD, DSc, Professor Nikolay V. Krishtal)	554
Type 1 Diabetes Mellitus.....	557
Type 2 Diabetes Mellitus.....	562
Chapter XXXII. PATHOPHYSIOLOGY OF THE NERVOUS SYSTEM (MD, PhD, DSc, Professor Vladimir A. Mikhnev)	566
Etiology and Pathogenesis of the Nervous System Disorders	566
Dysfunctions of the Nervous System	569
Dysfunctions of the Nerve Cells and Conductors.....	569
Dysfunctions of the Synapses	571
Disorders of the Sensitivity.....	573
Pain	575
Disorders of the Motor Functions of the Nervous System	580
The Nervous Trophicity and Dystrophic Process	586
Dysfunctions of the Autonomic Nervous System	589
Experimental Models of Emotional Reactions and their Disorders	591
Coma (MD, PhD, Associate Professor Larisa P. Zayarnaya).....	595
References.....	603
Index.....	638
