TABLE OF CONTENTS

Part 1. Introduction. Plastic Is Everywhere 21

Part 2. Properties of Micro- and Nanoplastics as a Factor of Their Activity 24
Mechanisms of Plastic Degradation 25
Increase in Specific Surface Area and the Role of Surface Processes 27
Formation of Surface Charge and Behavior in Aquatic Environment 28
Electrostatic Mechanisms of Microplastics' Interaction with Soil Systems 31
Linking Electrokinetic Properties to Biological Interactions 32
Reaccumulation of Electrostatic Charge by Micro- and Nanoplastics 36

Part 3. The Impact of Micro- and Nanoplastics on the Universal Mechanisms of Natural Systems 38
Forests 39
Animals 47
Insects 51
Birds 56
Marine Life 60

Part 4. Micro- and Nanoplastics as a Factor of Cellular Dysfunction: Mechanisms and Biological Consequences 62
Electrophysiological Foundation of the Human Body and Its Vulnerability to Micro- and Nanoplastics 63
Mechanisms of MNP Internalization and the Role of Surface Charge 65
Disruption of Electrical Stability and Neuronal Membrane Potential 68
Impact on Ion Channels 71
Disruption of Neurotransmitter Transmission 72
Induction of Oxidative Stress and Inflammation 74
Mitochondrial Dysfunction and Energy Deficit 76
Structural Protein Degradation Induced by Nanoplastics 82

Part 5. Micro- and Nanoplastics as a Potential Neurobiological Risk Factor 90
Bioaccumulation and Penetration into the CNS 91
Neuroinflammation and Neurodegeneration 96
Potential Clinical and Epidemiological Implications 100

Part 6. Systemic Impact of Micro- and Nanoplastics on the Human Body Through the Destabilization of the Gut–Brain Axis and Disruption of Intestinal Barrier Functions 102
Impairment of Physical Integrity and Selective Permeability of the Intestinal Barrier .. 103
Role of Surface Charge and Formation of the "Protein Corona" 104
Immune Activation and the Chronicity of Inflammation 105
Clinical Evidence from Inflammatory Bowel Disease 106
Destabilization of Microbiota as a Key Regulator 106
Systemic Effects of Dysbiosis: Impact on the Central Nervous System 108

Part 7. Micro- and Nanoplastics as a Factor in Systemic Destabilization of Immune Defense and Amplification of Infectious Risks 110
Immunotoxicity of Micro- and Nanoplastics 111
MNPs and Damage to Lymphoid Organs 113
Electrostatic Properties of MNPs and Increased Pathogenicity of Microorganisms .. 115
The Role of Microplastics in the Spread of Viral and Bacterial Pathogens 116
Protein Corona and Immune Recognition of MNPs 117
Microplastics as a Factor of Increasing Antibiotic Resistance 118
Sorption properties of microplastics and accumulation of pollutants 119
External electron transfer as a mechanism of bacterial metabolic activation 119

Part 8. Inhalation Exposure to Micro- and Nanoplastics: Risks to the Respiratory System 121
Scale of Impact and Physical Penetration Capability 123
Accumulation in Tissues and the Mechanism of Cell Damage 123
Cellular and Intracellular Toxicity 126
Disruption of Local Homeostasis and Respiratory Tract Dysbiosis 128
Experimental and Clinical Evidence Base 129
Carcinogenic Potential of Micro- and Nanoplastics 132

Part 9. The Systemic Impact of Micro- and Nanoplastics on the Musculoskeletal System: From Cellular Toxicity to the Global Disease Burden 134
Identification of MNPs in Human Bone and Skeletal Muscle 136
Mechanisms of Spinal Degeneration 138
A New Paradigm for Bone Loss: Osteocytic Osteolysis 139
The Impact of MNPs on Bone Metabolism and Structure 139
The Specifics of Nanotoxicity 141
Skeletal Muscle Degradation and Mitochondrial Dysfunction 142
Clinical Picture: Osteoarthritis and Epidemiological Evidence 142
Degenerative Bone Diseases: Challenges for Society and Healthcare 143

Part 10. The Impact of Micro- and Nanoplastics on Human Reproductive Health 145
Damage to Male Reproductive Cells and Impairment of Spermatogenesis 146
Hormonal Imbalance and Its Consequences 151
Neurogenic Mechanisms of Erectile Dysfunction 151
Epidemiology of Erectile Dysfunction: Current Trends 152
Impact of MNPs on the Female Reproductive System 152

Part 11. The Impact of Micro- and Nanoplastics on Prenatal and Postnatal Development 156
Penetration of Micro- and Nanoplastics Through the Placental Barrier 157
Mechanisms of Placental Toxicity: Cellular and Molecular Effects 159
Preterm Birth and the Global Burden of Perinatal Pathology 163
Impact on Embryonic Tissues and Organogenesis 163
Rising Prevalence of Congenital Anomalies 170
Postnatal Exposure to MNPs 175
Endocrine, Immune, and Epigenetic Effects 176
Vulnerability of the Developing Brain 177
Sudden Infant Death Syndrome 178

Part 12. Micro- and Nanoplastics as a Potential Risk Factor for Cardiovascular Diseases 182
Mitochondrial Dysfunction as a Mechanism of Cardiac Damage 183
Microplastics in Atherosclerotic Plaques and the Risk of Vascular Events 185
Disruption of Vascular Homeostasis and Endothelial Dysfunction 185
Impact on Blood Cells and Thrombogenesis Processes 186
Micro- and Nanoplastics as a Potential Risk Factor for Sudden Cardiac Death 189

Part 13. Micro- and Nanoplastics as a Risk Factor for Oncogenesis: From Cellular Mechanisms to Global Epidemiology 195
Global Dynamics and Prognosis of Oncological Morbidity 196
Epidemiological Shift: The Phenomenon of Early-Onset Oncogenesis 197
Cellular Mechanisms: Oxidative Stress and DNA Damage 200
Mitochondrial Dysfunction as a Mechanism of the Oncogenic Impact of Nanoplastics 204
Micro- and Nanoplastics as a Potential Factor in Tumor Metastasis 206
The Problem of Resistance to Therapy 207

Part 14. Micro- and Nanoplastics as a Factor in Accelerated Biological Aging 209
Population Manifestations of Accelerated Biological Aging 210
Biological Aging: What Occurs at the Cellular Level 211
Activation of Key Biological Aging Mechanisms by Micro- and Nanoplastics 213

Part 15. The Influence of MNPs on Climate Processes 214
The Role of Oceans in the Climate System 215
The Impact of Micro- and Nanoplastics on Oceanic Processes 215
Mechanisms of MNPs on the Aqueous Environment 218
The Mediterranean Sea as a Model of MNP Concentration Influence on the Marine Thermal Regime 220
Global Distribution of MNPs 221
The Influence of Micro- and Nanoplastics on Ocean Acidification 223
Influence of Micro- and Nanoplastics on the Atmosphere 225
Energy Balance and the Climate Crisis 226

Part 16. The Illusory Nature of Existing Technological Solutions to Global Plastic Pollution 228
Limitations of Mechanical Cleanup: Scale and Time 229
Ecological Risks of Ecosystem Intervention 230
Risks of Traditional Landfilling and Waste Migration 231
The Disposal Problem and Pollution Transfer to the Atmosphere 231
Thermal Degradation as a Source of Micropollution 234
The Recycling Paradox 235
Micro- and Nanoplastics: Irreversibility of Pollution and Biological Integration 237

Part 17. From the Illusion of "Purification" to Strategies for MNP Neutralization 240

Part 18. Discussion on the Risks of Micro- and Nanoplastics to Living Organisms 245

Part 19. Research Perspective: Can Subsurface Electrical Organization of Nanoplastics Contribute to Their Behavior? 253

Part 20. Conclusion 260

References 262