

Contents

1	The Structure and Function of Living Organisms	1
1.1	General Physiochemical Properties of Biological Structures	2
1.1.1	Small-Molecule Structures and Polymers	2
1.1.2	The Biological Purpose of Cellular and Organism Structures	3
1.1.3	Supporting Structures	5
1.1.4	Structures Associated with Biological Functions	15
1.1.5	Energy and Information Storage Structures	23
1.2	Self-Organization	25
1.3	H. Hypothesis	27
1.3.1	H.1. Protein Folding Simulation Hypothesis—Late Stage Intermediate—Role of Water	27
	References	30
2	Energy in Biology—Demand and Use	33
2.1	General Principles of Thermodynamics	33
2.2	Biological Energy Sources—Synthesis of Water	37
2.3	ATP Synthesis	43
2.4	Photosynthesis	46
2.5	Direct and Indirect Exploitation of Energy Sources	48
2.6	Energy Conversion Efficiency in Biological Processes	57
2.7	Entropic Effects	58
2.8	Energy Requirements of Organisms	60
	References	62
3	Information—its Role and Meaning in Organisms	65
3.1	Information as a Quantitative Concept	66
3.2	Reliability of Information Sources	71
3.2.1	Steady-state Genetics	72
3.2.2	Replication and its Reliability	74
3.2.3	Gene Expression and its Fidelity	79
3.2.4	Epigenetics	83

3.2.5	Development Genetics (Embryogenesis and Regeneration)—the Principles of Cell Differentiation	84
3.2.6	The Genetics of Evolution	93
3.3	Types of Information Conveyed by DNA	99
3.4	Information Entropy and Mechanisms Assisting Selection	104
3.5	Indirect Storage of Genetic Information	106
3.5.1	Self-organization as a Means of Exploiting Information Associated with the Natural Direction of Spontaneous Processes	107
3.6	The Role of Information in Interpreting Pathological Events	114
3.7	H. HYPOTHESIS	114
3.7.1	H.3. Protein Folding Simulation Hypothesis—Early Stage Intermediate	114
	References	121
4	Regulation in Biological Systems	125
4.1	The Cell and the Organism	126
4.2	The Principle and Mechanism of Automatic Intracellular Regulation	127
4.2.1	Cellular Receptors	128
4.2.2	Cellular Effectors	131
4.3	Regulatory Coupling Between Cells and Organisms—Hierarchical Properties of Regulation	134
4.4	Regulatory Mechanisms on the Organism Level	136
4.4.1	Signal Encoding	137
4.4.2	Signal Amplification	139
4.4.3	Cascade Amplifier	139
4.4.4	Positive feedback loop	143
4.4.5	Signal Attenuation	144
4.4.6	Signal Inactivation	146
4.4.7	Discrimination	149
4.4.8	Coordinating Signals on the Organism Level	150
4.4.9	Extracellular Process Control	151
4.4.10	Cell Population Control	153
4.5	Development Control	154
4.6	Basic Principles of Regulation in Biology	156
4.7	Regulation Levels	158
4.8	H. Hypothesis	159
4.8.1	H.4. Proteome Construction Hypothesis	159
	References	163
5	Interrelationship In Organized Biological Systems	167
5.1	The Need of Mutual Relations in Biological Systems	167
5.2	Cooperation and Coordination	168
5.3	The Characteristics of Process Coordination in Individual Cells and Organisms	174

5.4	Mutual Relation Between Cells and the Organism—Activation Activation and Inhibition of Enzymes (Rapid Effects)	176
5.5	Mutual Support Between Cells and the Organism—Interdependence Related to Gene Expression (Slow Effects)	182
5.5.1	The Structural Underpinnings of Interrelationship	185
5.5.2	The Role of Common Metabolite in Complex Process Coordination	188
5.5.3	Signal Effectiveness and the Structuring of Mutual Relations in Metabolism	189
5.5.4	Interrelationship in Times of Crisis—Safety Valves	191
5.6	Specialization of Cells Interrelationship	192
5.7	H. Hypothesis	193
5.7.1	H.5. The Criteria of Life	193
	References	198
	Index	201

Systems Biology

Functional Strategies of Living Organisms

Konieczny, L.; Roterman-Konieczna, I.; Spólnik, P.

2014, XIII, 204 p. 157 illus., 91 illus. in color., Hardcover

ISBN: 978-3-319-01335-0