

CONTENTS

Contributors	xiii
Preface	xv

PART I. PHYSICOCHEMICAL PROPERTIES OF AQUEOUS PHASE SYSTEMS AND PARTITIONING BEHAVIOR OF BIOMATERIALS

Compositions and Phase Diagrams for Aqueous Systems Based on Proteins and Polysaccharides

Vladimir Tolstoguzov

I. Introduction: Limited Compatibility of Macromolecular Compounds	3
II. Phase Diagrams	7
III. Factors Affecting Phase Behavior of Biopolymer Mixtures	14
IV. Features of the Composition-Property Relationships in Mixed Biopolymer Systems	22
V. Concluding Remarks	26
References	27

Partitioning and Concentrating Biomaterials in Aqueous Phase Systems

Göte Johansson and Harry Walter

I. Introduction	33
II. Aqueous Phase Systems	35
III. Partitioning of Biomaterials	41
IV. Concentration of Proteins	55
V. Concluding Remarks	56
References	57

Effects of Specific Binding Reactions on the Partitioning Behavior of Biomaterials

Gerhard Kopperschläger

I.	Introduction	61
II.	Theoretical Considerations of Affinity Partitioning	63
III.	Selection of Ligands and Mode of Coupling	67
IV.	Affinity Partitioning of Proteins	71
V.	Partitioning of Genetically Engineered Proteins	77
VI.	Factors Influencing Affinity Partitioning of Proteins	77
VII.	Affinity Partitioning of Cell Membranes and Cells	82
VIII.	Affinity Partitioning of Nucleic Acids	87
IX.	Concluding Remarks	88
	References	91

Properties of Interfaces and Transport across Them

Heriberto Cabezas

I.	Introduction	99
II.	Interfaces	100
III.	Properties of Interfaces and Phases	111
IV.	Equilibrium Partitioning across Interfaces	119
V.	Transport across Interfaces	124
VI.	The Time Scale for Phase Formation	131
VII.	Summary	132
	References	134

Compartmentalization of Enzymes and Distribution of Products in Aqueous Two-Phase Systems

Folke Tjerneld and Hans-Olof Johansson

I.	Introduction	137
II.	Thermodynamic Forces for Partitioning of Proteins and Solutes between Two Aqueous Polymer Phases	139
III.	Enzyme Reactions in Aqueous Phase Systems	144
IV.	Concluding Remarks	150
	References	151

PART II. PHYSICOCHEMICAL PROPERTIES OF CYTOPLASM

Macromolecular Crowding and Its Consequences

H.-O. Johansson, D. E. Brooks, and C. A. Haynes

I. Introduction: Phase Separation in Macromolecular Solutions	155
II. Macromolecular Crowding	158
III. Flory-Huggins Theory	159
IV. The Potential for Liquid-Liquid Phase Separation in the Cytosol: A Flory-Huggins Model	161
V. Conclusion	169
References	169

Lens Cytoplasmic Phase Separation

John I. Clark and Judy M. Clark

I. Introduction	171
II. Development of Transparency	172
III. Phase Separation and Lens Cytoplasmic Proteins	173
IV. Phase Diagrams for Lens Cytoplasmic Proteins	175
V. Effects of Composition on the Phase Diagram	176
VI. Endogenous Mechanisms for Regulation of Phase Separation	180
VII. Phase Separation and Cellular Structures	182
VIII. Concluding Remarks	184
References	184

Cytoarchitecture and Physical Properties of Cytoplasm: Volume, Viscosity, Diffusion, Intracellular Surface Area

Katherine Luby-Phelps

I. Introduction	189
II. Examining the Assumptions	190
III. Physical Properties of Cytoplasm (Measured)	198
IV. Concluding Remarks	214
References	215

Intracellular Compartmentation of Organelles and Gradients of Low Molecular Weight Species

Tak Yee Aw

I.	Introduction	223
II.	Compartmentation of Mitochondria within Mammalian Cells	225
III.	Intracellular Gradients of O ₂	228
IV.	Intracellular Gradients of Metabolites and Substrates	235
V.	Regional Compartmentation of Ions in Aqueous Cytoplasm in Mammalian Cells	243
VI.	Concluding Remarks	248
	References	249

Macromolecular Compartmentation and Channeling

Judit Ovádi and Paul A. Srere

I.	Introduction	255
II.	Enzyme Interactions	257
III.	Metabolic Channeling	268
IV.	Cross-Linking Processes	273
V.	One Future Direction	275
	References	276

The State of Water in Biological Systems

Keith D. Garlid

I.	Introduction	281
II.	Osmotic Behavior of Polar Solutes—Introduction to the Osmotic Intercept	283
III.	Mitochondria—The Experimental Model	285
IV.	Osmotic Equilibria in Mitochondria	286
V.	Nonelectrolyte Distributions in Mitochondria	290
VI.	Solute Distribution as a Function of Matrix Volume	292
VII.	Discussion	295
VIII.	Concluding Remarks	300
	References	301

Mechanisms for Cytoplasmic Organization: An Overview

Len Pagliaro

I.	Introduction	303
II.	Cytoplasm as a Biochemical Environment: Compartmentation Is a Fundamental Characteristic	304

III.	Mechanisms, Models, and Dynamics for Establishing and Maintaining Cytoplasmic Organization	307
IV.	Concluding Remarks	314
	References	315

PART III. CYTOPLASM AND PHASE SEPARATION

Can Cytoplasm Exist without Undergoing Phase Separation?

D. E. Brooks

I.	Introduction	321
II.	Cytoplasm of the Lens of the Eye	322
III.	Role of Bound Water	323
IV.	Role of Insoluble Structures	325
V.	Phase and Interface Volumes	325
VI.	Experimental Approaches to Detecting Phases in Cytoplasm	326
VII.	Conclusions	329
	References	329

Consequences of Phase Separation in Cytoplasm

Harry Walter

I.	Introduction: General Thesis	331
II.	Visualizing Phase Separation in Cytoplasm	332
III.	Visualizing Biomaterials in Phase-Separated Cytoplasm	335
IV.	Aspects of Cytoplasmic Organization	340
V.	Concluding Remarks	341
	References	343
	Index	345