MORAN • SCRIMGEOUR

BIOCHEMISTRY RESOURCE BOOK

- Problems for each chapter
- Step-by-step solutions to all problems
- Dictionary of biochemical terms
- Summaries of all chapters
- Reviews of key molecular structures
- Reviews of major metabolic pathways
- Common abbreviations
- Tables of essential data
- Stereo viewer

BIOCHEMISTRY RESOURCE BOOK

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BIOCHEMISTRY RESOURCE BOOK

Preface

This *Biochemistry Resource Book* is designed to serve as a study guide to accompany Moran·Scrimgeour *Biochemistry* and as a source of useful data that students can use long after completing the course. The book consists of several parts. The study guide portion is arranged by chapters that correspond to chapters in Moran·Scrimgeour *Biochemistry*. Next is an appendix of useful biochemical information for general reference. Following that is a list of common abbreviations. Finally, there is a dictionary of biochemical terms, including complete definitions for over 800 terms. A stereo viewer comes with each copy of the *Resource Book* and can be used for viewing the stereo images that appear in Moran·Scrimgeour *Biochemistry*. An alphabetical listing of the contents of all figures and tables in the *Resource Book* (beginning on page xi) allows easy access to information.

Each chapter in the *Resource Book* includes a summary of the corresponding chapter in Moran·Scrimgeour *Biochemistry* and a selection of figures and tables that warrant careful study. The figures include important molecular structures, major metabolic pathways, and summary figures of various kinds. Summary tables and tables of important data are included for easy reference. The problems for each chapter are thought-provoking, a test not of memorization skills but of the student's ability to apply principles. For each problem, a complete, step-by-step solution is provided, including illustrations when appropriate.

The appendix contains 12 tables of scientific data, with emphasis on material most useful for students of biochemistry. Following the appendix is a list of common biochemical abbreviations.

The dictionary of biochemistry contains over 930 cross-referenced entries and over 800 precise definitions. This material can be used to test mastery of particular terms or can be consulted whenever an unfamiliar term is encountered.

We intend this *Resource Book* to be valuable not only as a supplement to Moran·Scrimgeour *Biochemistry* but also as a reference work and review manual that will become a permanent part of the student's library.

Charlotte W. Pratt
Principal Editor
February 1994

Tables and Figures Listed by Topic

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Cells

Summary

The unit of life is the cell. Cells are surrounded by a plasma membrane consisting of lipids and protein molecules. Chemical traffic between the cell interior and exterior is strictly controlled by selective transport across the plasma membrane. Cells are of two types, eukaryotic or prokaryotic. Eukaryotic cells contain internal membranous structures termed organelles that divide the cell interior into compartments, and they possess a cytoskeleton consisting of fibers formed from protein subunits. Prokaryotic cells are generally much smaller than eukaryotic cells, and they do not possess internal compartments.

Bacteria are prokaryotes. Most bacteria possess a cell wall surrounding the plasma membrane. If the cell wall is surrounded by an outer membrane, the bacteria are Gram-negative; prokaryotic cells that do not possess an outer membrane surrounding their cell wall are Gram-positive. Much of the biochemical diversity of nature is found in the prokaryotic realm, reflecting adaptation to an enormous range of different environments.

The organelles of eukaryotic cells have specialized functions. The nucleus, surrounded by a double membrane, contains the genetic material. The endoplasmic reticulum is an extensive membrane system continuous with the outer membrane of the nucleus. The rough endoplasmic reticulum is studded with membrane-bound ribosomes. Synthesis of proteins to be exported or proteins that will remain embedded in membranes is one of the principal metabolic activities of the rough endoplasmic reticulum. Ribosomes are absent in regions called smooth endoplasmic reticulum, where much of the lipid synthesis of the cell occurs.

Material newly synthesized in the endoplasmic reticulum is packaged in vesicles that merge with the Golgi apparatus, where modification and sorting of materials occurs. Vesicles then bud off on the far side of the Golgi and carry sorted material to specific cellular destinations.

Lysosomes and peroxisomes contain enzymes that catalyze potentially destructive reactions. Sequestration of these enzymes in lysosomes and peroxisomes protects the cell.

Mitochondria and chloroplasts are organelles involved in energy metabolism. Mitochondria are the centers of oxidative respiration and are the main sites of ATP formation. Chloroplasts are large organelles specialized for the conversion of light energy into chemical energy by the process of photosynthesis. Both organelles almost certainly arose endosymbiotically.

Eukaryotic cells contain elaborate networks of fibrous proteins collectively termed the cytoskeleton. The principal components of the cytoskeleton are actin filaments, microtubules, and intermediate filaments. Actin filaments and microtubules contribute to cell structure and are capable of directed motion. The role of intermediate filaments appears to be primarily structural.

Viruses are genetic parasites. They do not carry out independent metabolism, but depend on the metabolic capacities of host cells to reproduce themselves.

Study Information

Table 2·1 Comparison of prokaryotes and eukaryotes

	Prokaryotes	Eukaryotes
Organisms	Eubacteria, archaebacteria	Animals, plants, fungi, protists
Organization	Unicellular, some colonial	Unicellular, multicellular
Cell size (diameter)	~1–10 μm	~10–100 μm
Membranous organelles	No	Yes
Cytoskeleton	No	Yes
Peptidoglycan cell walls	Yes	No
Endo- and exocytosis	No	Yes
Chromosomes		
Number	1	>1
Location	Nucleoid	Nucleus
Topology	Circular	Linear
Chromosome segregation	Mechanism uncertain	Mitotic spindle

[Adapted from Neidhardt, F. C., Ingraham, J. L., and Schaecter, M. (1990). *Physiology of the Bacterial Cell: A Molecular Approach* (Sunderland, Massachusetts: Sinauer Associates), p. 4, and Stanier, R. Y., Ingraham, J. L., Wheelis, M. L., and Painter, P. R. (1986). *The Microbial World*, 5th ed. (Englewood Cliffs, New Jersey: Prentice Hall), p. 74.]

Problems

1. List three major criteria that distinguish bacterial cells from animal cells.
2. Match the organelles with their principal function.

Organelle:	**Function:**
Nucleus	(a) Photosynthesis
Mitochondrion	(b) Synthesis of phospholipids; synthesis of membrane and secretory proteins
Endoplasmic reticulum	(c) Intracellular digestion
Golgi apparatus	(d) Contains genetic material
Lysosome	(e) Aerobic energy metabolism
Chloroplast	(f) Modification and sorting of protein products

Solutions

1. (a) Bacterial cells are prokaryotic; animal cells are eukaryotic.
(b) Bacterial cells are generally much smaller than animal cells.
(c) Bacterial cells reproduce at a much faster rate than animal cells.
(d) Bacterial cells have cells walls; animal cells do not.

2.

Nucleus	(d) Contains genetic material
Mitochondrion	(e) Aerobic energy metabolism
Endoplasmic reticulum	(b) Synthesis of phospholipids; synthesis of membrane and secretory proteins
Golgi apparatus	(f) Modification and sorting of protein products
Lysosome	(c) Intracellular digestion
Chloroplast	(a) Photosynthesis

3

Water

Summary

Water is a nonlinear molecule whose H—O—H bond angle is 104.5°. Because oxygen is more electronegative than hydrogen, an uneven distribution of charge occurs within each O—H bond of the water molecule (that is, each O—H bond is polar). The polarity of the covalent bonds of the water molecule and the geometry of the molecule are such that the molecule has a positive end and a negative end and thus has a permanent dipole.

A water molecule forms four hydrogen bonds in ice and up to four hydrogen bonds in liquid water. In biological systems, intermolecular hydrogen bonds form between water molecules and many types of biomolecules. Some biomolecules also form intramolecular hydrogen bonds.

Ionic substances, such as sodium chloride, and highly polar nonionic compounds, such as short-chain alcohols and glucose, readily dissolve in water and are said to be hydrophilic. Ionic and polar molecules are surrounded by water molecules that form a solvation sphere. Nonpolar substances, such as hydrocarbons, are essentially insoluble in water and are called hydrophobic. The phenomenon of exclusion of nonpolar substances by water is called the hydrophobic effect. Detergents are amphipathic, meaning they have both hydrophobic and hydrophilic groups. These compounds may form monolayers on the surface of aqueous solutions and micelles when dispersed in aqueous media. Chaotropes enhance the solubility of nonpolar compounds in water.

The major noncovalent interactions in cells are electrostatic attractions, hydrogen bonds, van der Waals forces, and hydrophobic interactions. These weak forces stabilize the structures of proteins, nucleic acids, and membranes.

Although water is nucleophilic and present in large amounts, cells use several strategies to prevent degradative hydrolytic reactions and to allow condensation reactions. Unwanted hydrolysis of biopolymers is prevented by storing some hydrolases in inactive forms or sequestering them in organelles. Cells use the chemical potential energy of ATP to overcome the unfavorable equilibria of biosynthetic reactions. Furthermore, water is often excluded from the active sites of enzymes, where biosynthetic reactions are catalyzed.