

The Foundations of Biochemistry

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1. The Size of Cells and Their Components

- (a) If you were to magnify a cell 10,000-fold (typical of the magnification achieved using an electron microscope), how big would it appear? Assume you are viewing a "typical" eukaryotic cell with a cellular diameter of 50 μm .
- (b) If this cell were a muscle cell (myocyte), how many molecules of actin could it hold? Assume the cell is spherical and no other cellular components are present; actin molecules are spherical, with a diameter of 3.6 nm. (The volume of a sphere is $4/3 \pi r^3$.)
- (c) If this were a liver cell (hepatocyte) of the same dimensions, how many mitochondria could it hold? Assume the cell is spherical; no other cellular components are present; and the mitochondria are spherical, with a diameter of 1.5 μm .
- (d) Glucose is the major energy-yielding nutrient for most cells. Assuming a cellular concentration of 1 mM (i.e., 1 millimole/L), calculate how many molecules of glucose would be present in our hypothetical (and spherical) eukaryotic cell. (Avogadro's number, the number of molecules in 1 mol of a nonionized substance, is 6.02×10^{23} .)
- (e) Hexokinase is an important enzyme in the metabolism of glucose. If the concentration of hexokinase in our eukaryotic cell is 20 mM, how many glucose molecules are present per hexokinase molecule?

Answer

- (a) The magnified cell would have a diameter of $50 \times 10^4 \mu\text{m} = 500 \times 10^3 \mu\text{m} = 500 \text{ mm}$, or 20 inches—about the diameter of a large pizza.
- (b) The radius of a globular actin molecule is $3.6 \text{ nm}/2 = 1.8 \text{ nm}$; the volume of the molecule, in cubic meters, is $(4/3)(3.14)(1.8 \times 10^{-9} \text{ m})^3 = 2.4 \times 10^{-26} \text{ m}^3$.
The number of actin molecules that could fit inside the cell is found by dividing the cell volume (radius = 25 μm) by the actin molecule volume. Cell volume = $(4/3)(3.14)(25 \times 10^{-6} \text{ m})^3 = 6.5 \times 10^{-14} \text{ m}^3$. Thus, the number of actin molecules in the hypothetical muscle cell is

$$(6.5 \times 10^{-14} \text{ m}^3) / (2.4 \times 10^{-26} \text{ m}^3) = 2.7 \times 10^{12} \text{ molecules}$$

or 2.7 trillion actin molecules.

**Significant figures:* In multiplication and division, the answer can be expressed with no more significant figures than the least precise value in the calculation. Because some of the data in these problems are derived from measured values, we must round off the calculated answer to reflect this. In this first example, the radius of the actin (1.8 nm) has two significant figures, so the answer (volume of actin = $2.4 \times 10^{-26} \text{ m}^3$) can be expressed with no more than two significant figures. It will be standard practice in these expanded answers to round off answers to the proper number of significant figures.

Solution Of Lehninger

R. Buvet, M.J. Allen, J.-P. Massué



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Guide to Lehninger's Principles to Biochemistry, 1984 *Loose-Leaf Version for Lehninger Principles of Biochemistry 7e & Study Guide and Solutions Manual for Lehninger Principles of Biochemistry 7e* David L. Nelson, Michael M. Cox, 2017 Lehninger Principles of Biochemistry is 1 bestseller for the introductory biochemistry course because it brings clarity and coherence to an often unwieldy discipline offering a thoroughly updated survey of biochemistry's enduring principles definitive discoveries and groundbreaking new advances with each edition This new Seventh Edition maintains the qualities that have distinguished the text since Albert Lehninger's original edition clear writing careful explanations of difficult concepts helpful problem solving support and insightful communication of contemporary biochemistry's core ideas new techniques and pivotal discoveries Again David Nelson and Michael Cox introduce students to an extraordinary amount of exciting new findings without an overwhelming amount of extra discussion or detail And with this edition W H Freeman and Sapling Learning have team up to provide the book's richest most completely integrated text media learning experience yet through an extraordinary new online resource SaplingPlus *Solutions Manual for An Introduction to Genetic Analysis* David Scott, 2012 Since its inception Introduction to Genetic Analysis IGA has been known for its prominent authorship including leading scientists in their field who are great educators This market best seller exposes students to the landmark experiments in genetics teaching students how to analyze experimental data and how to draw their own conclusions based on scientific thinking while teaching students how to think like geneticists Visit the preview site at www.whfreeman.com/IGA10epreview [Guide to Lehninger's Principles of Biochemistry](#) Paul Van Eikeren, 1984 *Discovering Cell Mechanisms* William Bechtel, 2006 Between 1940 and 1970 pioneers in the new field of cell biology discovered the operative parts of cells and their contributions to cell life They offered mechanistic accounts that explained cellular phenomena by identifying the relevant parts of cells the biochemical operations they performed and the way in which these parts and operations were organised to accomplish important functions Cell biology was a revolutionary science but in this book it also provides fuel for yet another revolution one that focuses on the very conception of science itself Laws have traditionally been regarded as the primary vehicle of explanation but in the emerging philosophy of science it is mechanisms that do the explanatory work Bechtel emphasises how mechanisms were discovered focusing especially on the way in which new instruments made these inquiries possible He also describes how new journals and societies provided institutional structure to this new enterprise

Bioenergetics of the Cell: Quantitative Aspects Valdur A. Saks, Renée Ventura-Clapier, Xavier Leverve, André Rossi, Michel Rigoulet, 2012-12-06 This volume continues the discussion of the problems of in vivo and in vitro The recently solved X ray structure of the mitochondrial creatine kinase and its molecular biology cellular bioenergetics the tradition we started in 1994 by publication of the focused issue of Molecular and Cellular are analyzed with respect to its molecular physiology and Biochemistry volume 133 134 and a book Cellular Bio functional coupling to the adenine nucleotide

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Study Guide and Solutions Manual for Organic Chemistry Susan McMurry, John McMurry, 1988 *Solutions Manual to Accompany Lehninger* Frederick C. Wedler, 1994

Living Systems as Energy Converters R. Buvet, M.J. Allen, J.-P. Massué, 2013-09-24 Living Systems as Energy Converters documents the proceedings of the European Conference on Living Systems as Energy Converters held in Pont a Mousson France on October 18 22 1976 This book is organized into three main topics energy in biological molecules biological membranes as energy transducers and energy in cells organisms and populations In these topics this compilation specifically discusses the energetic evolution of complex networks of reactions protein structure and the molecular evolution of biological energy conversion and structure and function of ATP synthase The calcium transport in biological membranes conversion of solar energy into energy rich phosphate compounds and energy conservation in photosynthetic electron transport of chloroplasts are also deliberated This text likewise covers the direct conversion of radiant into electrical energy using plant systems energy budgets in natural and agricultural ecosystems and recycling of excess carbon dioxide from fossil energy conversion by plants This publication is intended for biologists and physical chemists including students concerned with the study of living systems as energy converters The Organization of Cell Metabolism G. Rickey Welch, James S. Clegg, 2012-12-06

Transport Across Single Biological Membranes D.C. Tosteson, 2012-12-06 This second Volume in the series on Membrane Transport in Biology contains a group of essays on transport across single biological membranes separating the inside and outside of cells or organelles We have not attempted to include material on all types of plasma and intracellular membranes but rather have emphasized structures which have been studied relatively thoroughly Four chapters describe transport of different types of molecules and ions across the plasma membranes of mammalian red cells Two essays concern the excitable membranes of nerve and muscle cells while the remaining four chapters treat transport across several types of intracellular membranes Water makes up more than two thirds of the mass of most living cells The transport of water between the inside and outside of cells and organelles is important for the function of these structures As a result of

investigations in many laboratories over the past four decades our picture of the water permeability of the red cell membranes is rather detailed when compared to the water permeability of other biological membranes In Chapter 1 R I Macey describes this picture and also considers the permeability of red cell membranes to non electrolytes including metabolic substrates such as sugars amino acids purines and nucleosides The Ten Most Wanted Solutions in Protein Bioinformatics Anna Tramontano,2005-05-24 Utilizing high speed computational methods to extrapolate to the rest of the protein universe the knowledge accumulated on a subset of examples protein bioinformatics seeks to accomplish what was impossible before its invention namely the assignment of functions or functional hypotheses for all known proteins The Ten Most Wanted Solutions in Protein **Chemistry for the Life Sciences** Raul Sutton,2008-11-20 Presents short topics tied to numerical or conceptual ideas reinforced with worked examples and questions Retaining the user friendly style of the first edition this text is designed to eliminate the knowledge gap for those life sciences students who have not studied chemistry at an advanced level It contains new chapters on Biomedical & Pharmaceutical Sciences with Patient Care Correlations Reza Karimi,2014-01-29 Biomedical Pharmaceutical Sciences with Patient Care Correlations provides a solid foundation in the areas of science that pharmacy students most need to understand to succeed in their education and career Offering a comprehensive overview of the biomedical and pharmaceutical sciences it is an ideal primary or secondary textbook for introductory courses Students can also use this text to refresh their scientific knowledge before beginning graduate study Biomedical Pharmaceutical Sciences with Patient Care Correlations includes 16 chapters that cover subjects ranging from cell biology and medicinal chemistry to toxicology and biostatistics It also includes clinical correlations and integrated cases Practical as well as informative this essential reference relates the subject matter to the real world of pharmacy practice to assist students throughout their graduate studies and professional careers Features Provides a comprehensive introduction to the biomedical and pharmaceutical sciences curriculum Serves as an ideal text for all introductory pharmacy courses Covers the topics that are most challenging for students Relates science to the real world of pharmacy practice Includes over 525 illustrations photos and figures **Calcium in Human Biology** B.E.C. Nordin,2013-03-12 Calcium in Human Biology provides an authoritative review of current knowledge and points the way to further progress in the understanding of this essential nutrient In addition to considering the established importance of an adequate dietary source of available calcium for the formation of sound bones and teeth there is detailed discussion of the part calcium plays in a variety of aspects of human metabolism The book is written primarily for those working in the nutritional sciences and related fields It will also be of interest to clinicians nutritionists and to those interested more generally in the biological sciences as well as to those in the important sectors of the food industry which utilise or produce dairy products and other foods significant to the supply of dietary calcium Biochemistry Francis J. Chlapowski,1988 **Arsenic Toxicity: Challenges and Solutions** Nitish Kumar,2021-02-15 Arsenic As is a widely distributed element in the environment having no known useful physiological

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Solutions Manual to Accompany Lehninger, Nelson, Cox Principles of Biochemistry, Second Edition Albert L.

Lehninger, Frederick Wedler, 1993-12-01 *Chemistry and Physics of Aqueous Gas Solutions* William Alfred Adams, 1975

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