

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.

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Michael Brown



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Guide to Lehninger's Principles to Biochemistry, 1984 **Guide to Lehninger's Principles of Biochemistry** Paul Van Eikeren, 1984 **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 *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 **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 translocase as energetics role of coupled creatine kinases edited by V Saks well as its participation together with the adenylate kinase and R Ventura Clapier and published by Kluwer Publishers system in intracellular energy transfer The results of the Dordrecht Boston In the present volume use of quantitative studies of creatine kinase deficient transgenic mice are methods of studies of organized metabolic systems such as summarized and analyzed by using mathematical models of mathematical modeling and Metabolic Control Analysis for the compartmentalized energy transfer thus combining two investigation of the problems of bioenergetics of the cell is powerful new methods of the research All these results described together with presentation of new experimental together with the physiological and NMR data on the cardiac results The following central problems of the cellular bio metabolic and mitochondrial responses to work load changes energetics are the focus of the discussions the mechanisms concord to the concept of metabolic networks of energy of regulation of oxidative phosphorylation in the cells in vivo transfer and feedback regulation

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

Study

Guide and Solutions Manual for Organic Chemistry Susan McMurry, John McMurry, 1988

Chemical Evolution: Structure and Model of the First Cell Cyril Ponnampereuma, Julian Chela-Flores, 1995-07-31 This interdisciplinary book consists of the proceedings of the Alexander Ivanovich Oparin 100th Anniversary Conference The Third Trieste Conference on Chemical Evolution which took place at the International Centre for Theoretical Physics from 29 August till 2 September 1994 A general overview of Oparin's life and work is followed by a review of Alfonso Herrera another pioneer in the studies of the origin of life The subject matter is organized in ten sections corresponding to various aspects of our current understanding of the subject that was initiated by Oparin These subjects were covered by fifty three speakers There were sixty seven participants from a wide geographical distribution twenty seven countries were represented We have included

the invited lecture of Professor Igor Kulaev who was unable to be present at the conference for reasons beyond his control. The conference was generously supported by the International Centre for Theoretical Physics, the Commission of the European Communities, the International Centre for Genetic Engineering and Biotechnology, the International Centre for Science and High Technology, and UNESCO. Cyril Ponnampereuma, University of Maryland, U.S.A., Julian Chela Flores, ICTP, Italy, and IDEA, Venezuela.

xi FOREWORD As this volume was going to press, we learnt of the untimely death of Cyril Ponnampereuma who died of cardiac arrest on December 20, 1994.

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.

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 Provides a comprehensive introduction to the biomedical and pharmaceutical sciences curriculum.
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 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.

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 Bioinformatics

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 *Wandering in the Gardens of the Mind* John Prebble, Bruce Weber, 2003-02-27 Peter Mitchell winner of the 1978 Nobel Prize for chemistry for his chemiosmotic theory was a highly original scientist who revolutionized our understanding of cellular metabolism and bioenergetics This is the only full biography of Mitchell and it should be of considerable interest to biophysicists biochemists and physicians and researchers focusing on metabolism as well as historians of medicine and biology Standard Methods of Clinical Chemistry David Seligson, 2013-10-22 Volume 3 presents a wide variety of approaches to analytical procedures in clinical chemistry This 20 chapter volume discusses the principles

Journal of the Chemical Society ,1952 **Cells and Tissues** Gerald Oster, Arthur W. Pollister, 2013-09-03 Physical Techniques in Biological Research Volume III Cells and Tissues focuses on physical techniques applied to the study of cells determining the morphology chemical characteristics and functions of the cellular organelles This book discusses the microtomy and postdrying treatment of tissues phase contrast and interference microscopy in cytology and fluorescence microscopy The electron microscopy of microorganisms ultrastructure of layered lipoprotein structures and techniques for the mass isolation of cellular components are also elaborated This publication likewise covers the microphotometry with visible light ultraviolet absorption techniques and stereoscopic techniques in X ray microscopy Other topics include the birefringence and dichroism of cells and tissues autoradiography at the cellular level and manometric techniques for single cells This volume is a good source for biologists and specialists concerned with the study of cells and tissues *Practical Biochemistry* Pamela Jha, 2024-08-12 Practical Biochemistry provides both foundational knowledge and advanced insights into biochemistry including the basic compounds and laboratory methods The book is designed for students and academic professionals seeking a comprehensive understanding of the practical aspects of the subject The book is systematically divided into five sections each dedicated to a specific category of macromolecules and related biochemical techniques 1 Carbohydrates 2 Proteins 3 Nucleic acids 4 Lipids 5 Supplementary Techniques and Safety Data Sheet SDS Each chapter within these sections is structured to provide a thorough understanding of the aim principles procedures and practical applications of biochemical techniques Key features Comprehensive Information meticulously organized and structured chapters provide a thorough and methodical approach to learning Additional Learning Tools Did You Know segments and Viva Voice questions enrich the learning experience by offering interesting facts and stimulating critical thinking Practical Focus Step by step guides aid readers in understanding and applying the techniques in the lab Safety and Accuracy teaches how to conduct safe and accurate experiments with precautions Accessible Language simple and lucid language helps beginners to understand complex biochemical concepts Residue Reviews / Rückstands-Berichte Francis A. Gunther, 2012-12-06 That residues of pesticide and other foreign chemicals in food stuffs are of concern to everyone everywhere is amply attested by the reception accorded previous volumes of Residue Reviews and by the gratifying enthusiasm sincerity and efforts shown by all the individuals from whom manuscripts have been solicited Despite much

propaganda to the contrary there can never be any serious question that pest control chemicals and food additive chemicals are essential to adequate food production manufacture marketing and storage yet without continuing surveillance and intelligent control some of those that persist in our foodstuffs could at times conceivably endanger the public health Ensuring safety in use of these many chemicals is a dynamic challenge for established ones are continually being displaced by newly developed ones more acceptable to food technologists pharmacologists toxicologists and changing pest control requirements in progressive food producing economies These matters are of genuine concern to increasing numbers of governmental agencies and legislative bodies around the world for some of these chemicals have resulted in a few mishaps from improper use Adequate safety in use evaluations of any of these chemicals persisting into our foodstuffs are not simple matters and they incorporate the considered judgments of many individuals highly trained in a variety of complex biological chemical food technological medical pharmacological and toxicological disciplines It is hoped that Residue Reviews will continue to serve as an integrating factor both in focusing

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