

BASIC BIOPHYSICS

— *For Biologist* —

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Foreword

It is a matter of immense pleasure for me to introduce the book “Basic Biophysics for Biologists” to readers in all developing countries including India. At this stage of interdisciplinary thinking, and effort like the present one is laudable, deserving gall encouragement. The book seeks to unravel relations between two great fundamental disciplines namely Physics and Biology.

Biophysics is a fascinating subject dealing with the role of physical forces in stabilising the levels of organizations in the living world and in the functioning of the various organelles and organs. The utility of various methodologies in physics in the problem solving in Biological Sciences is an important aspect of Biophysics. Therefore, the first half of the book is devoted to explaining of the nature, function and configurations of the biological molecules and biomembranes, while the second half summarises the various analytical methods like spectrophotometry and chromatography in a nutshell. It is a heartening development that this interdisciplinary subject is now receiving wider acceptance and coverage in the curricula of all the major Indian Universities. Thus, this book will be a welcome addition to the library of a biologist for whom a thorough understanding of various structural and functional aspects of an organism is absolutely essential.

I am confident that this book will help gradual updating of teaching of Biophysics in Indian Universities. It is a matter of happiness for me to write a foreword for a book, which is first of its kind

produced in India as a result of hard work on part of one of my staff members.

I wish the book and its author all success.

Prof. R. C. Patel

28th Sept. 1988

Preface

The heavy armour employed by a physicist in problem-solving often frightens a biologist who ventures to adopt physical principles in solving biochemical and clinical problems. This resulted in an exceptionally small number of biologists entering into the arena of biophysical problem solving. Since physics is based primarily upon a handful of concepts such as dimension, mass, force and energy; an attempt is made here to expose the simple principles underlying the complicated processes, giving a minimal mathematical treatment. A great catalogue of formulae, equations and physical laws is avoided and emphasis is placed on the usage of physical methods in model building and solution of problems. The powerful analytical techniques developed in recent years provide many ways to sidetrack the arduous procedures inherent in the problem solving of physics and chemistry and to arrive at the answer in a few simple steps.

The object of this book is to provide a working knowledge on the relationships between physical properties, chemical constitution and biological function. A fairly good knowledge of such relationships will help us to predict the chemical nature of a substance from its physical properties, with great accuracy and vice versa. An analysis of the data on physical and chemical nature of a compound will provide a great deal of insight into the behaviour of these substances in a biological system.

I greatly enjoyed preparing this book. Although the teaching of Biophysics at the graduate level for years sharpened my understanding of the subject, the additional reading and the fruitful discussions with the students on the ideas I “rediscovered” widened the horizons of my perception. Actually it was during these discussions, a better way of looking at an old problem dawned on me and I learned to simplify a difficult concept without getting entangled in the heavy machinery of physics.

The book is divided into four chapters, each chapter dealing with a specific aspect of living organisms. The first chapter is devoted to the structure and

behavior of matter. The electronic structure of atom is only outlined, but bonds and their formation are detailed. Special attention has been given to hydrogen bonds and apolar bonds, the to great forces stabilising the biological world. Van der Waal's forces, which contribute to the stability of molecules partially, also are dealt with in detail. The energy changes taking place in a system as well as the redox potential of various systems are discussed in brief. The chapter concludes with a note on the inclusion complexes.

The mode of molecular organisation in living matter is covered in the second chapter. Though the structure of membranes is matter of debate, the components of membranes and their properties are evaluated. Transport being a major function of the membrane, various mechanisms of membrane transport are presented. The conformations of macromolecules and the forces behind their complex and precise structures are reviewed in detail.

Third chapter embodies the spectroscopy. The changes induced by the electromagnetic radiation and the applications of these principles in the structure elucidation of organic compounds are covered here. Chiroptical methods and their importance in biological researches are appreciated. A brief account of radioactivity and its applications (especially Mossbauer spectroscopy) is given. The discussion on X-ray and laser is precisely written.

Separation methods form the last chapter. More than half of this chapter is devoted for various methods of chromatography. The common forms of chromatography are mentioned briefly while special attention has been given to latest techniques such as GLC, HPLC HPTLC, affinity chromatography etc. The role of electrophoresis, diffusion sedimentation and viscosity in the analysis of macromolecules, also is evaluated.

An appendix, given at the end, includes the Greek alphabet; separate listing of the elements (with their symbols, atomic numbers and masses), symbols, abbreviations, Newton's laws of motion and laws of thermodynamics.

I am indebted to my graduate students for their direct and indirect role in the preparation of this treatise. I wish to acknowledge the support rendered by my research students. I would like to thank Prof. R.C. Patel, Honorable Vice Chancellor of the M.S. University of Baroda for kindly consenting to go through the script and agreeing to write a 'foreword' to this book. The patience and care taken by Mr. S.G. Sumant in preparing the manuscript in time is gratefully acknowledged. Finally I thank Agrobios (India) for expeditiously processing this book through the press.

A word to my readers: The book is not an original piece of work. I owe heavily to many excellent treatises on different topics, most of which are mentioned in the bibliography. My attempts is no put them in unambiguous words and to find out certain correlations which are not yet explored. I would appreciate hearing from you biologists and biophysicists, suggestions and criticisms aimed at improving the scope and acceptability of this book.

M. Daniel

COMPONENTS AND CONSTITUTION OF MATTER

The works of the Lord are great, sought out of all of them that have pleasure therein.

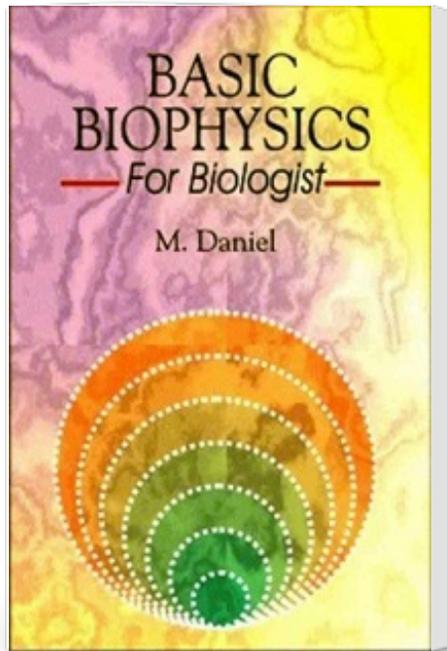
Psalms 111:2

INTRODUCTION

A study on the organization and behavior of matter would begin with a quantum mechanical model of the atoms and their components. There are various forces which stabilise the atoms and molecules and a know how of these forces along with a proper understanding on the motion and energy of the particles, provide information of the orientation of atoms and molecules in matter. The energy content of matter is inseparably linked with the forces operative within. Since the total energy of the universe is constant, the energy transaction taking place are studied by isolating a special part of the universe, a 'system', The system interacts with "system", The system interacts with "the surroundings" the rest of the universe. The energy changes taking place in bulk matter are predicted by thermodynamics.

In this chapter, the electronic structure of atom and the various forces operating within atoms, molecules and bulk matter are described. Though the nature of energy changes in biological systems is explained, a discussion on the fundamental laws of thermodynamics is avoided. However, these laws along with the Newton's laws of motion are presented in the Appendix. A brief account of the inclusion complexes also is included in the text.

Basic Biophysics for Biologist



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