Preface

Biophysics represents perhaps one of the best examples of interdisciplinary research areas, where concepts and methods from disciplines such as physics, biology, biochemistry, colloid chemistry, and physiology are integrated. It is by no means a new field of study and has actually been around, initially as quantitative physiology and partly as colloid science, for over a hundred years. For a long time, biophysics has been taught and practiced as a research discipline mostly in medical schools and life sciences departments, and excellent biophysics textbooks have been published that are targeted at a biologically literate audience.

With a few exceptions, it is only relatively recently that biophysics has started to be recognized as a physical science and integrated into physics departments' curricula, sometimes under the new name of biological physics. In this period of crystallization and possible redefinition of biophysics, there still exists some uncertainty as to what biophysics might actually represent. A particular tendency among physicists is to associate biophysics research with the development of powerful new techniques that should eventually be used not by physicists to study physical processes in living matter, but by biologists in their biological investigations. There is value in that judgment, and excellent books have been published that introduce the interested reader to the use of physical principles for the development of new methods of investigation in life sciences. The tremendous progress registered in the development of photonics tools could serve as an excellent example in this regard. However, that is definitely not the whole story! Although the authors of this book have received their undergraduate and graduate education in Physics, and have gained a deep appreciation of the power of classical physical concepts as applied to other sciences, they believe that biophysics is not "merely" applied physics. There is also a component to biophysics that may well qualify as fundamental physics. We will illustrate this idea by drawing a parallel to astrophysics. It is perhaps widely understood that astrophysics is not fully equivalent to, let us say, classical mechanics applied to the study of the motion of planets, neither can it be reduced to the development of optical instruments for observation of such motions of planets, which are, admittedly, all indispensable tools in astrophysics research. Take for instance the existence of the microwave background, the black holes, the still puzzling rotational curves of galaxies which seem to suggest the existence of dark matter, or the even more puzzling accelerated expansion of the universe, which may imply the existence of exotic forms of dark energy: these phenomena can all qualify as fundamentally new physics or at least they did at the time of their discovery. Returning to biophysics, it ought to be said that, while previously unforeseen extensions of the classical physics (such as thermodynamics, electrodynamics and quantum mechanics) can go a long way into explaining the intricate behavior of biological systems, interesting new physics can be expected to be discovered, for example in the study of biological networks, or in the study of (protein) dynamics at mesoscale.

In our opinion, the new biophysicist should start his or her biophysics education with a background in physics and mathematics. According to our experience, it is favorable to graft biological ideas and concepts onto a physical and mathematical backbone that is constructed and consolidated early in one's career. We would like to stress out that much of the well-known physics has been fruitfully applied to the field of biology over decades by extraordinarily qualified quantitative physiologists and physical chemists. The physicist becoming a biophysicist should be willing to forge new directions of exploration into the physical reality and be ready to learn relevant biology and biochemistry terminology, much the same way that an astrophysicist employs the language of astronomy besides employing physical concepts and tools.

The present book aims to introduce the graduate physics students and also the interested physicists at any stage in their postdoctoral career to topics in "classical" biophysics and also to some up-to-date topics in current biophysics. In keeping with the widely accepted practice in other sub-fields of physics, we try to present the material in a quantitative, mathematical way, and assume familiarity with most of the known physical laws and concepts. The advanced undergraduate physics student and the life scientists interested in biophysics are also invited to join in, by building on their knowledge of basic physics. For the benefit of our readers that might need to refresh their knowledge of life sciences, essential notions of biochemistry and biology are introduced, as necessary, throughout the book, and especially in much of chapter 2. Life scientists may choose to skip those sections altogether, and delve directly into the quantitative biophysics sections.

The authors combined have over five decades of teaching and research experience in biophysics, and the selection of the topics covered in this book is based on what appeared to them as more commonly studied topics in biophysics. However, given the vastness of the biophysics research, originating in the diversity of the living matter, no single book would be expected to do justice to all the interesting topics in biophysics. Therefore, any attempt to group a wide variety of biophysics subjects into a single book is inevitably biased by the authors' background and expertise. This textbook should be regarded merely as a starting point for the study of biophysics, which may be furthered by consulting the references provided, as well as the readers' own selection of biophysics literature.

The way towards biophysics research may be long and not always easy. However, we invite you, our reader, to take on this road without any hesitation, and to share with us the continual feeling of wonder and surprise at the amazing degree of coherence and beauty of the living matter organization and operation.

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