AIMS Biophysics

http://www.aimspress.com/journal/biophysics

AIMS Biophysics, 7(2): 119–120.
DOI: 10.3934/biophy.2020009
Received: 21 April 2020
Accepted: 22 April 2020
Published: 24 April 2020

Editorial

Interdisciplinary experimental approaches for the investigation of complex systems of biophysical interest

S. Magazù* and M.T. Caccamo*

Department of Department of Mathematical and Computer Sciences Physical Sciences and Earth Sciences, University of Messina, Italy

* **Correspondence:** Email: smagazu@unime.it, mcaccamo@unime.it.

It is well known that, as a rule, biophysics deals with the study of both biological systems and biological processes by using physics-based methods.

More specifically, on one hand, it is generally assumed that physics provides fundamental theories for understanding the behaviors of biomolecular systems. For example, statistical mechanics allows the understanding of the average behavior of biological systems, quantum mechanics allows the comprehension of electron transfer processes within biological matrices, linear response theory allows the modelization of system biologic response, and thermodynamics of irreversible systems allows to deal with open systems capable to interact with external environments. Here the main difficulty is to match the deep simplicity of physics with the overwhelming complexity of biological systems.

On the other hand, many of the powerful methods and approaches for investigating systems of biological interest make reference to physics-based experimental techniques. Many, meaningful examples can be found within the last century physics and biological research activities, such as X-rays, discovered by Wilhelm Röntgen (Nobel Prize in Physics in 1901), and X-ray diffraction by crystals, discovered by Max von Laue (Nobel Prize in Physics in 1914), which made possible to fully characterize the structures of proteins by Max Perutz and John Kendrew (Nobel Prize in Chemistry in 1962), the DNA structure by Francis Crick, James Watson, and Maurice Wilkins (1962 Nobel Prize in Physiology or Medicine), the structures of photosynthetic reaction centers (Nobel Prize in Chemistry in 1988), of ion channels (Nobel Prize in Chemistry in 2003), of RNA polymerase II (2006 Nobel Prize in Chemistry), and of ribosome (2009 Nobel Prize in Chemistry). Other relevant examples are furnished by nuclear magnetic resonance (Nobel Prizes in Physics in 1943, 1944, and 1962; Nobel Prizes in Chemistry; and 2003 Nobel Prize in Physiology or Medicine), atomic force microscopy (1986 Nobel Prize in Physics in 1991 and 2002), electron microscopy (Nobel Prize in Physics in 1986), and optical tweezers (Nobel Prize in Physics in 1997).

Finally, many employed computational techniques, which have their roots in physics, such as molecular dynamics simulation, are largely employed for modeling biomolecular systems.

Therefore, while on the speculative and theoretical point of view, the basic assumption is that biological processes can be understood starting from the study of the constituent molecules and of their interactions, on the experimental point of view the constant increase of the instrumental spatial and time resolution allows better and better to characterize the structural and dynamical system properties and hence to connect the behaviour of complex biological systems to that of the component single-molecules. One clear trend of such deep interdisciplinary interaction is that biology is becoming more and more quantitative. On this ground, one expects that, tackling the present, open, challenging, biological problems, requires a closer integration of biology and physics in formulating new concepts and theories, in inventing new experimental techniques and in improving the exiting ones.

Nowadays, biophysics applies the theories of physics and chemistry and the approaches of mathematics and computer modeling to biological systems, to understand the structure, dynamics, interactions, and ultimately the function of biological systems.

In this framework, the main aim of this Special Issue is to investigate complex systems of biophysical interest by means of different and interdisciplinary experimental approaches, highlighting the synergy between theories, simulations and experiments, so answering to the question why the study of complex systems of biophysical interest is becoming more and more prominent. As a rule, a complex system is supposed to present a collective behaviour, out of the interaction of their constitutive parts. It means that the whole system is more than the sum of its parts. The field is inherently interdisciplinary, drawing from physics, chemistry, biology, mathematics, computer science and many other fields. Each field has their own techniques, tools, definitions, terminology, methods as well as particular ways of asking and answering questions. In some cases, these fields are aligned, in other cases there can be contradictions and misunderstandings.

From the experimental point of view, the characterization of the different molecular processes involved in the dynamics of some complex systems of biophysical interest can be successfully investigated by means of different techniques, such as Photon Correlation Spectroscopy, Fourier Transform Infrared Spectroscopy, Raman Spectroscopy, Brillouin Scattering, Neutron Scattering, Synchrotron Radiation, Differential Scanning Calorimetry, Nuclear Magnetic Resonance, ultrasonic and thermodynamic techniques and others.

Another goal of the special issue is to present some of the most recent interdisciplinary findings on complex systems of biophysical interest, such as proteins, enzymes, antioxidants, micelles, microemulsions and aqueous solutions, furnishing a representative overview of the molecular mechanisms involved in many biological processes.