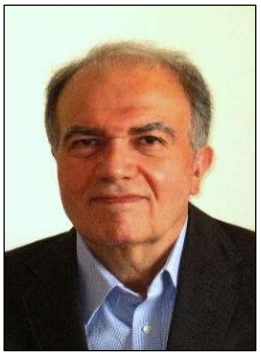
BIOPHYSICS RESEARCH AND NOBEL PRIZES

Niku Mohebalizadeh &
Ali A. Moosavi-Movahedi FIAS



Ali A. Moosavi-Movahedi *Niku Mohebalizadeh*

Abstract:
Biophysics is an interdisciplinary science that take a deep and multifaceted look at biological and natural phenomena and paleontology. The root of biophysics lies in the basic sciences and fundamental sciences, which deals with the molecular, cellular, organ and systemic discovery of biological and natural phenomena. This science is equipped with accurate tools and data science tools in the form of computing and artificial intelligence, which examines the past and present phenomena and has a very clear eye on the future of science research. Therefore, the achievements of biophysics have received valuable Nobel prizes in the field of Chemistry (23 cases), Physics (1 case), Physiology or Medicine (11 cases) in the last sixty years. A large part of the diagnostic tools in science and medicine have included the Nobel Prize, which has been in the field of biophysical research.

Keywords: Biophysics, Nobel Prizes, Accurate measurement tools, Deep science, Disease early recognition

Introduction:
Biophysics as an interdisciplinary science uses the theories and methods of physics and other basic sciences to study biological phenomena at the molecular, cellular, tissue, and organ scales. Today, research achievements in the field of biophysics are very important for expanding the boundaries of knowledge. Biophysics is linked to a wide range of disciplines, including; Biochemistry, molecular biology, physical chemistry, physiology, nanotechnology, bioengineering, computational biology, biomechanics, evolutionary biology and systems biology, artificial intelligence, physics, chemistry, mathematics, and other disciplines can be mentioned. Due to the importance of the achievements in the last sixty years, many prizes, including the Nobel Prize, have been awarded in this field of science. The Nobel Prize is awarded to outstanding research that breaks new ground in science. Biophysics research has been associated with Nobel Prizes in Chemistry, Physics, Physiology or Medicine, which are briefly described below:

1-Simply one click: Simple answers are best. Nobel Prize 2022 in Chemistry to Caroline R. Bertozzi, Morten Meldahl and Kay Barry Sharpless were awarded for the development of click chemistry and biological orthogonal chemistry. Sharpless and Meldal conducted research in the field of click chemistry. Bertozzi connected click reactions to the world of biological sciences and used it for bio-orthogonal reactions.

2-Capturing life in atomic detail: An image is the key to understanding. Scientific advances are often based on the successful visualization of objects invisible to the human eye. Jacques Dubochet, Joachim Frank and Richard Henderson received the 2017 Nobel Prize in Chemistry for developing an effective method for producing three-dimensional images of life molecules (cryo-electron microscopy).

3-Development of the world's smallest machines: Miniaturization of technology could lead to a scientific revolution. The 2016 Nobel Prize in Chemistry was jointly awarded to Jean-Pierre Sauvage, Sir James Fraser Stoddart and Bernard L. Feringa for the design and synthesis of molecular machines thousands of times thinner than a human hair. Molecular machines will be used in the development of sensors and energy storage system.

4-A great honor for small bodies: For a long time, light microscopy was held back by one supposed limitation: that it could never achieve resolution better than half the wavelength of light. The 2014 Nobel Prize in Chemistry was awarded to Eric Betzig, Stefan W. Hell, and

William E. Moerner was awarded for the development of super-resolved fluorescence microscopy. The pioneering work of these researchers has brought the optical microscope into the nano dimension.

5-How to represent the world in the brain? How does the brain create a map of the space around us? And how do we navigate our way through a complex set?
John O'Keefe, May Britt Moser and Edward I. Moser received the 2014 Nobel Prize in Physiology or Medicine for the discovery of nerve cells in the brain that enable the sense of location and orientation.

6-Computer models reflecting real life: Today, the computer is as important a tool for chemists as the test tube. The 2013 Nobel Prize in Chemistry was awarded to Martin Karplus, Michael Levitt and Arieh Warshel for the development of multiscale models (based on classical physics and quantum physics) for complex chemical systems.

7-How, where and when are vesicles transported? A major transport system in cells
The 2013 Nobel Prize in Physiology or Medicine was awarded to James E. Rothman, Randy W. Schekman and Thomas C. Sudhof was awarded due to the discovery of molecular mechanisms regulating the transport of vesicles in eukaryotic T cells.

8-Smart receivers: The body is a regulated system of interactions between billions of cells. Each cell has tiny receptors that enable it to sense its environment, so it can adapt to new situations. The Nobel Prize 2012 in Chemistry was awarded to Robert J. Lefkowitz and Brian Kobilka for the study of G protein-coupled receptors.

9- The mystery of pseudo-crystals: Previously, chemists interpreted the order in crystals as a periodic and repeating pattern. The 2011 Nobel Prize in Chemistry was awarded to Dan Schechtman for the discovery of pseudo crystals. Interatomic distances in a quasi-crystal are related to the Fibonacci sequence. The Fibonacci sequence is also regular even though it never repeats itself because it follows a mathematical law. The order in quasi-crystals is not the same as when it is a periodic crystal.

10- Chemical bases of life: The story begins with hot springs and the sea. Microorganisms from these environments were used to isolate strong ribosomes. The goal was the crystallization of ribosomes. The 2009 Nobel Prize in Chemistry was jointly awarded to Venkatraman Ramakrishnan, Thomas A. Steitz and Ada E. Yonath, was awarded for studying the structure and function of the ribosome. Accurate knowledge of the binding site of antibiotics to the ribosome helps scientists to design and produce new and more efficient drugs.

11-Immortality: How chromosomes can be completely copied during cell division and how they are protected from destruction. The 2009 Nobel Prize in Physiology or Medicine was awarded to Elizabeth H. Blackburn, Carol W. Greider and Jack W. Szostak was awarded for discovering how chromosomes are protected by telomeres and telomerase enzyme.

12-Jellyfish green light: Green fluorescent protein is a guiding star for tools in the life sciences. The 2008 Nobel Prize in Chemistry was awarded to Martin Chalfie, Roger y. Tsien and Osamu Shimomura for the discovery and development of green fluorescent protein (a green substance in jellyfish as a tool to visualize specific cellular actions).

13- DNA voice: They are sandwiched between genes and the molecular machinery that allows the silent information wrapped in DNA to speak. They in turn work to select, transmit, read and decode the DNA code, producing the components needed for life. Transcription, the copying of a strand of DNA to produce a strand of RNA, is a central operation in biology. The 2006 Nobel Prize in Chemistry was awarded to Roger D. Kornberg was awarded for his studies in the field of molecular basis of eukaryotic transcription.

14- Montage for life: Primary self-replication requires the concentration of molecular components, either on a surface or in a volume. In a sea of water and ions, the phospholipid bilayer performs an effective self-assembly and separates the organized activity from the surrounding environment and extracts energy from the environment. How does a cell allow one type of ion to pass through a lipid and exclude others? And how does deionized water

penetrate? The Nobel Prize in Chemistry in 2003 was awarded to Peter Agre for the discovery of cell membrane channels and the other half to Roderick Mackinnon for the structural and mechanical studies of ion channels.

15-Magnetic miracle: MRI imaging of human internal organs with precise and non-invasive methods is very important for diagnosis, treatment and medical follow-up. The 2003 Nobel Prize in Physiology or Medicine was awarded to Paul Lauterbur and Peter Mansfield for their discovery of magnetic resonance imaging. Paul C. Lauterbur discovered the possibility of creating a two-dimensional image by introducing a gradient to a magnetic field, and Sir Peter Mansfield developed the use of gradients in a magnetic field.

16-Revolutionary methods for biological molecules: all living things; Bacteria, plants and animals contain the same types of large molecules, macromolecules, which are responsible for life. The 2002 Nobel Prize in Chemistry is divided into two fields: mass spectrometry (MS) and nuclear magnetic resonance (NMR). John B. Fenn and Koichi Tanaka for mass spectrometry and Kurt Wuthrich for nuclear magnetic resonance have helped in various ways in the further development of these methods to accept biological macromolecules.

17-Genetic regulation: In parallel with the new generation of cells, cell death is a natural process to maintain the appropriate number of cells in the tissue. The 2002 Nobel Prize in Physiology or Medicine was awarded to Sydney Brenner, H. Robert Horvitz, and John E. Sulston was awarded for their discovery of genetic regulation of organ development and programmed cell death. In fact, this group was able to identify key genes regulating the growth of organs and programmed death in a nematode as an experimental model, and they have shown that the relevant genes exist in higher species, including humans.

18-Mind control: signal transmission in the nervous system;
The 2000 Nobel Prize in Physiology or Medicine was jointly awarded to Arvid Carlsson, Paul Greengard, and Eric R. Kandel for their discovery of a type of signal transmission in the nervous system between nerve cells called slow synaptic transmission. Carlson's work led to the discovery of dopamine as a neurotransmitter in the brain that is important for the ability to control movements. Paul Greengard was a pioneer in receptor-mediated phosphorylation and dephosphorylating of brain proteins, and Kendall was searching for ways to modify the efficiency of synapses.

19-Slow motion: The Nobel Prize in Chemistry in 1999 was awarded to Ahmad Hassan Zewail for his studies on the transition states of chemical reactions using femto-spectroscopy (10-15) seconds. To show that with a fast laser it is possible to observe how the atoms of a molecule move during a chemical reaction. Zewail technique can be described as the fastest camera in the world.

20-Energetic compound catalysis: Life requires energy. How do living organisms obtain and use energy? Half of the 1997 Nobel Prize in Chemistry went to Paul D. Boyer and John E. Walker was split, to clarify the mechanism underlying the synthesis of adenosine triphosphate and the other half to Jens C. Skou was awarded for the first discovery of sodium and potassium ion transfer enzyme and ATPase enzyme.

21-Atomic trap: At room temperature, the atoms and molecules that make up air are moving in different directions at a speed of about 4,000 kilometers per hour. The 1997 Nobel Prize in Physics was awarded to Steven Chu, Claude Cohen-Tannoudji and William D. Phillips was awarded for developing methods to cool and trap atoms with laser light. They cool gases down to about microkelvin temperatures and develop flotation of the cooled atoms in a variety of atomic traps.

22-Signal converter: G protein-coupled receptors represent the largest family of plasma membrane-bound receptor proteins involved in many cellular and physiological functions. The 1994 Nobel Prize in Physiology or Medicine was awarded to Alferd G. Gilman and Martin Rodbell for the discovery of G proteins and the role of these proteins in signal transmission in the plasma membrane of eukaryotes.

23-PCR and site-directed mutagenesis: The 1993 Nobel Prize in Chemistry for contributions to the development of DNA-based chemical methods was awarded to Kary B. Mullis for his discovery of the polymerase chain reaction that enabled methods such as DNA fingerprinting (PCR) and half to Michael Smith for contributions His foundation was given in the creation of oligonucleotide-based mutagenesis, its location and development for protein studies.

24-Magnetic Music: When matter is placed in a magnetic field, some atomic nuclei, such as the nucleus of a hydrogen atom called a proton, behave like microscopic compass needles. The 1991 Nobel Prize in Chemistry was awarded to Richard R. Ernst for his contributions to the development of high-resolution nuclear magnetic resonance spectroscopy methodology. Ernst took NMR to new dimensions, where it eventually became the most powerful tool in chemical analysis.

25-Life begins with a change in membrane potential. When the sperm merges with the egg cell at the moment of fertilization, the ion channels are activated. The 1991 Nobel Prize in Physiology or Medicine was awarded to Erwin Neher and Bert Sakmann for their discovery of the function of single ion channels in cells. They developed the patch-clamp technique. This technique is unique in that it records how a channel molecule changes its shape and thereby controls the current in a time interval of a few millionths of a second.

26-Hidden Treasure Lock Key: For a long time, it was thought that access and crystallization for structural studies of these important proteins buried inside the membrane were impossible. What seemed impossible was finally achieved by Hartmut Michel, Johann Deisenhofer and Robert Huber, for which they received the Nobel Prize in Chemistry in 1988. The first ones who managed to discover the full details of how to make a membrane bound protein and revealed the structure of the molecule atom by atom.

27-Image of the building blocks of life: Life is a chemical phenomenon. The Nobel Prize in Chemistry was awarded to Aaron Klug in 1982 for the development of crystallographic electron microscopy and structural elucidation of biologically important nucleic acid-protein complexes. Kellogg's method allows to determine the structures with high resolution of functionally important molecular seeds.

28-Nucleic acid: The Nobel Prize in Chemistry was awarded in 1980, half to Paul Berg for his fundamental studies on the biochemistry of nucleic acids, with respect to recombinant DNA, and the other half jointly to Walter Gilbert and Frederick Sanger for their contributions to sequencing. base was donated in nucleic acids.

29-Enzymatic chemistry: The key to life is enzymes. Everything that humans do occurs through enzymatic reactions. The 1972 Nobel Prize in Chemistry was awarded, half to Christian B. Anfinsen for his work on ribonuclease, particularly on the relationship between amino acid sequence and biologically active compound, and half jointly to Stanford Moore and William H. Stein was awarded for their help in understanding the relationship between the chemical structure and the catalytic activity of the active center of the ribonuclease molecule.

30-Natural Weapon: We all owe a huge debt to antibodies. 1972 Nobel Prize in Physiology or Medicine to Gerald M. Edelman and Rodney R. Porter were awarded for their discoveries about the chemical structure of antibodies.

31-The role of genetics in protein synthesis: The instructions for making proteins are in our DNA. The 1968 Nobel Prize in Physiology or Medicine was jointly awarded to Robert W. Holley, Har Gobind Khorana and Marshall W. Nirenberg was awarded for interpreting the genetic code and its function in protein synthesis.

32-An eye for structure: The ability of scientists to manipulate data and "see" structure is critical. The Nobel Prize in Chemistry was awarded to Dorothy Crowfoot Hodgkin in 1964 for determining the atomic structures of important biochemical substances using X-ray crystallographic techniques.

33- Identification of complex protein structure: The Nobel Prize in Chemistry was awarded in 1962 to Max Ferdinand Perutz and John Cowdery Kendrew for their studies on the structure of globular proteins.

34- The secret of life: How can a molecule that has been simple and ineffective for a long time hold the secret of life?
Erwin Schrödinger's idea that physics could help solve the mysteries of biology was the spark that led many researchers to try to unravel the mysteries of the book of life, the structure of DNA. In 1962, the Nobel Prize in Physiology or Medicine was awarded to Francis Harry Compton Crick, James Dewey Watson and Maurice Hugh Frederick Wilkins, for their discoveries about the molecular structure of DNA and their importance for the transmission of information in living materials.

35-Insulin protein structure: The Nobel Prize in Chemistry was awarded to Frederick Sanger in 1958 for his work on the structure of proteins, especially insulin. Sanger's work on insulin enabled chemists to synthesize synthetic insulin.

Conclusion:
Biophysics helps to understand complex biological processes, develop new technologies, advance medicine, and improve our understanding of the natural world. Despite all these issues, this science faces challenges such as the complexity of biological systems, massive data analysis, integration of different scales of analysis. Advances in technology, computational methods, and interdisciplinary collaborations are and will be opportunities that pave the way for these challenges. Interdisciplinary collaboration opens the mind to new possibilities. When we bring together scientists from across disciplines and fields, something amazing happens: a whole new way of thinking about a topic that no one has considered before. Getting out of your comfort zone in meeting people outside the scientific field will help the researcher grow. It should be remembered that a team always presents a more comprehensive picture of research. Interdisciplinary collaboration leads to creativity and innovation. Working with different disciplines expands the researcher's network and makes him a stronger professional. As summarized in this text, many Nobel Prizes have been the brilliant result of team research. One of the significant advantages of interdisciplinary collaboration is that it crosses traditional boundaries of academic disciplines or schools of thought in accordance with new needs and emerging specialties. In this way, it is necessary that the **scientists of the Islamic World Academy of Sciences as well as scientists from other nations** have organized the strategic meetings to determine the topic for joint cooperation and to define the important unknown questions of science for human development and the welfare of humanity with the research possibilities existing and cooperation to develop interdisciplinary sciences and the results of this cooperation to be published in high impact literature.

About the authors:

Ali A. Moosavi-Movahedi
Institute of Biochemistry and Biophysics (IBB), University of Tehran, Tehran, Iran.

Ali A. Moosavi-Movahedi is Professor of Biophysics and Head of Institute of Biochemistry and Biophysics, University of Tehran (UT). Born in Shiraz, Iran, in 1953; BSc in Chemistry, National University of Iran,1975; MSc in Chemistry, Eastern Michigan University, USA, 1979; PhD in Biophysical Chemistry, University of Manchester, UK, 1986. His research career has been mostly marked on Biothermodynamics and protein structure function relationship. He is already the Fellow of Iran Academy of Sciences, Fellow of Islamic World Academy of Sciences, Fellow of The World Academy of Sciences (TWAS), and the Chair-holder of UNESCO Chair on Interdisciplinary Research in Diabetes, at UT. *Email: moosavi@ut.ac.ir*
Web: ibb.ut.ac.ir/~moosavi

Niku Mohebalizadeh
Institute of Biochemistry and Biophysics (IBB), University of Tehran, Tehran, Iran.

Niku Mohebalizadeh is PhD candidate in Biophysics, University of Tehran (UT). Born in Maku, West Azerbaijan, Iran, in 1996; BSc in Biology, University of Tabriz, Iran, 2019; MSc in Biophysics, University of Tabriz, Iran, 2021. Her PhD thesis deals with the study of albumin protein from the perspective of liquid-liquid phase separation. She is a member of Iran Society of Biophysical Chemistry (ISOBC).