AL- Mustaqpal University

Science College

Dep. Medical Biotechnology

Second Stage

Lec 1

General Concepts of Biophysics

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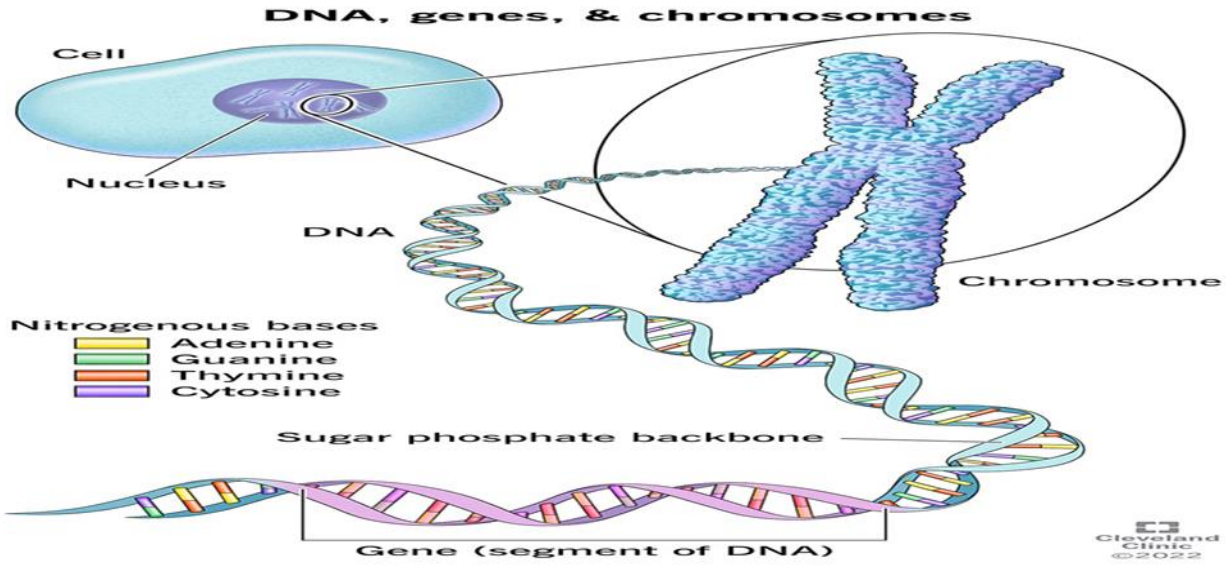
General concepts of biophysics

Biophysics interdisciplinary science that uses the methods of physics to study biological systems

And is that branch of knowledge that applies the principles of physics and chemistry and the methods of mathematical analysis and computer modeling to biological systems, with the ultimate goal of understanding at a fundamental level the structure, dynamics, interactions, and ultimately the function of biological systems. Biophysics seeks to explain biological function in terms of the physical properties of specific molecules.

The size of these molecules varies from small fatty acids and sugars (~1 nm = 10^{-9} m), to macromolecules like proteins (5–10 nm), starches (>1000 nm), and the enormously elongated DNA molecules (over 10,000,000 nm = 1 cm long but only 20 nm wide).



These building blocks of living organisms, assemble into cells, tissues, and whole organisms by forming complex individual structures with dimensions of 10, 100, 1000, 10,000 nm and larger.

Thus, proteins assemble into the casein micelles of milk, which aggregate to form the curd of cheese; proteins and ribonucleic acids assemble into ribosomes, the machinery for building proteins; lipids and proteins assemble into cell membranes, the external barriers and internal surfaces of cells; and proteins and DNA wind up into chromosomes, the carriers of the genetic code.

Much effort in biophysics is directed to determining the structure and dynamics of specific biological molecules and of the larger architecture into which they assemble. Some of this effort involves inventing new methods and building new instruments for viewing these dynamic structures in action.
In addition, biophysicists are increasingly concerned with the mechanical properties of biological systems, on length scales from nanometers to meters. Biophysics is relevant to medicine, and many biophysicists direct their investigations towards biomolecules that play a key role in disease.
For examples include Alzheimer's disease, HIV, diabetes, breast cancer, and multiple sclerosis. Consequently, although the central focus of Biophysics is on basic science rather than medical applications, many of biophysicists have close interactions with Faculty of Medicine, and many hold appointments in the Faculty of Medicine.

The biological questions of interest to biophysics are as diverse as the organisms of biology:

- How do linear polymers of only 20 different amino acids fold into proteins with precise three-dimensional structures and specific biological functions ?
- How does a single, enormously long DNA molecule untwist and exactly replicate itself during cell division ?
- How does RNA fold into complex 3-D structures and carry out highly sophisticated transactions when it is composed of four chemically-similar nucleotides ?
- How are sound waves, or photons, or odors, or flavors, or touches, detected by a sensory organ and converted into electrical impulses that provide the brain with information about the external world ?
- How does a muscle cell convert the chemical energy of ATP hydrolysis into mechanical force and movement ?
- How does the cell membrane, a lipid barrier impermeable to water-soluble molecules, selectively transport such molecules through its non-polar interior ?

Biophysics seeks to answer these questions using a highly interdisciplinary approach that combines chemical and biochemical analysis for identifying molecules and spectroscopic techniques and computational methods to examine relationships between their physical properties and biological function. In so doing, Biophysics explains biological functions in terms of molecular mechanisms: precise physical descriptions of how individual molecules work together like tiny “nanomachines” to produce specific biological functions.

In the context of biophysics, scientists work to analyze and understand the interactions and processes that occur at the molecular and cellular level within living organisms. Scientists in this field study the structures of biological molecules such as proteins and nucleic acids, and try to explain how this delicate biological system interacts. These molecular studies also include examining the physical properties of biological components and understanding the effects of changes in ambient conditions on these processes.

What is the specialty of biophysics ?

It is an interdisciplinary field that integrates physics and biology. It applies physical principles to understand biological systems, extending from molecular to organismal levels by using quantitative methods, scientists in this field explore topics such as biomolecular dynamics, cellular processes, and neurophysics.

Benefits of working in this field

1- **Making contributions to society**: Working in this specialty allows you to contribute to solving pressing issues such as disease and hunger by developing new and effective methods.
2- **Developing valuable skills**: Scientists in this field acquire valuable skills such as project management and data analysis, which enhances their capabilities in other fields in addition to biophysics.

In the end, it can only be said that biophysics is an exciting field of great importance in our time as it allows the individual to explore a wide range of professional fields, while providing sustainable opportunities for scientific advancement and innovation and contributing to the progress and well-being of humanity.

Discussion

1. What is biophysics ?

a) A branch of physics that studies biological systems

b) A branch of biology that applies physical principles

c) An interdisciplinary science that uses methods of physics to study biological systems.

d) A field that only studies DNA molecules

E) None of the above

2. What is the ultimate goal of biophysics ?

a) To study the structure of DNA molecules

b) To understand biological function at a fundamental level.

c) To study the physical properties of specific molecules

d) To explain biological function in terms of chemistry

E) None of the above

3. What is the size range of biological molecules ?

a) 1 nm to 10 nm

b) 1 nm to 10,000,000 nm.

c) 1 nm to 100 nm

d) 1 nm to 1 cm

E) None of the above

4. What do biophysicists seek to explain ?

a) Biological function in terms of chemistry

b) Biological function in terms of physical properties of specific molecules.

c) Biological function in terms of DNA molecules

d) Biological function in terms of mathematical analysis

E) None of the above

5. What is an example of a biological system studied in biophysics ?

a) Casein micelles of milk

b) Cell membranes

c) Both a and b.

d) DNA molecules

E) None of the above

6. Why is biophysics relevant to medicine ?

a) Because it studies DNA molecules

b) Because it applies physical principles to understand biological systems

c) Because it seeks to explain biological function in terms of physical properties of specific molecules

d) Because many biophysicists direct their investigations towards biomolecules that play a key role in disease.

E) None of the above

7. What is a benefit of working in biophysics ?

a) Making contributions to society

b) Developing valuable skills

c) Both a and b.

d) Only studying DNA molecules

E) None of the above

8. What is the focus of biophysics ?

a) Basic science rather than medical applications.

b) Medical applications rather than basic science

c) Both a and b

d) Only DNA molecules

E) None of the above

9. What do biophysicists use to examine relationships between physical properties and biological function ?

a) Chemical and biochemical analysis

b) Spectroscopic techniques and computational methods

c) Only mathematical analysis

d) Both a and b.

E) None of the above

10. What is the scope of biophysics ?

a) From molecular to organismal levels.

b) Only at the molecular level

c) Only at the cellular level

d) Only at the organismal level

E) None of the above