

Biophysics - BIO361

Rubric Quiz-1

Total Marks : 40

Part1- Multiple Choice Questions

Total marks - 20*1=20 marks

Each Question is for one mark. No negative marking. Attempt all questions.
Correct answers are in BOLD letters.

1. What type of bond holds together the complementary base pairs in DNA?

- a) Ionic Bonds
- b) Covalent Bonds
- c) Hydrogen Bonds**
- d) Van der Waals Forces

2. Which scientist(s) are credited with the discovery of the DNA double helix structure?

- a) James Watson and Francis Crick**
- b) Rosalind Franklin**
- c) Linus Pauling
- d) Gregor Mendel

1 mark for either (a) or (b)

3. In the DNA double helix, adenine (A) always pairs with which other base?

- a) Thymine (T)**
- b) Guanine (G)
- c) Cytosine (C)
- d) Adenine (A)

4. In a DNA molecule, the sugar-phosphate backbone is located on the:

- a) Inside of the double helix
- b) Outside of the double helix**
- c) In the center of the double helix
- d) Only in RNA, not in DNA

5. Which of the following is found exclusively in RNA but not in DNA?

- a) Thymine
- b) Adenine
- c) Uracil**
- d) Cytosine

6. Which of the following techniques is used to determine the protein structures?

- a) X-ray crystallography**
- b) Kryptonics X-ray vision

- c) Magnetic resonance imaging (MRI)
 - d) None of the above
7. What is the start codon that initiates protein synthesis in most organisms?
- a) **AUG**
 - b) UAA
 - c) TGC
 - d) CAG
8. Which of the following is a purine base found in DNA and RNA?
- a. **Adenine**
 - b. Thymine
 - c. Uracil
 - d. Cytosine
9. Which of the following is a pyrimidine base found in DNA and RNA?
- a. Adenine
 - b. **Thymine**
 - c. **Uracil**
 - d. Guanine
- 1 mark for either (b) or ©
10. In a DNA molecule, if the percentage of cytosine (C) is 20%, what is the percentage of adenine (A) according to Chargaff's rule?
- a) 20%
 - b) **30%**
 - c) 40%
 - d) 50%
11. Which of the following interactions is crucial for the primary structure of proteins?
- a) Hydrogen bond
 - b) Di-sulfide bond
 - c) Van Der Waals interactions
 - d) **Peptide bond**
12. Phi and psi angles directly determine
- a) Primary structure
 - b) **Secondary structure**
 - c) Tertiary structure
 - d) quaternary structure
13. Ramachandran plot can be used to predict which of the following structure?
- a) Quaternary structure
 - b) Tertiary structure
 - c) Primary structure

d) Secondary structure

14. Which amino-acid is most flexible?

- a) Glutamate
- b) Aspartate
- c) Leucine

d) Glycine

15. Which of the following are aromatic amino acids ?

- a) Phenylalanine, Serine, Cysteine
- b) Phenylalanine, Threonine, Tryptophan
- c) Phenylalanine, Tryptophan, Tyrosine**
- d) Phenylalanine, Methionine, Cysteine

16. Choose the incorrect statement:

- a) DNA is the genetic material.
- b) RNA is the genetic material.
- c) RNA acts as genetic material when DNA is not present.
- d) RNA may act as genetic material even when DNA is present.**

17. Helical structure of DNA is determined by:

- a) Electron diffraction measurement.
- b) Neutron diffraction method.
- c) X-ray diffraction measurement.**
- d) Diffraction of visible light.

18. The information of genetic code lies in:

- a) The number of nucleotides.
- b) The sequence of nucleotides.**
- c) The kind of nucleotides.
- d) All of the above.

19. What is the energy of a hydrogen bond in water?

- a) ~ 2 kcal/mol**
- b) ~3 kcal/mol
- c) ~4 kcal/mol
- d) ~5 kcal/mol

20. Which of the following statements is/are true regarding primary structure of proteins

- a) Primary structure denote the number of amino acids in a protein
- b) Primary structure denote the sequence of amino acids in a protein**
- c) Primary structure determines the biological activity of a protein
- d) all of these

Part 2 - Short Answer-type Questions (2 marks each)

Total marks - $10 \times 2 = 20$ marks

1. Why is water such a special molecule in biophysics? (Any two points)

- Higher freezing and boiling point
- Universal solvent: Water is a universal solvent because of its tendency to dissolve various polar and ionic compounds.
- Hydrogen bonding: It has capacity to form hydrogen with one another making them critical for protein folding and maintaining DNA structure.
- Temperature Regulation: It can absorb significant amount of heat without much change in temperature due to its high boiling point.
- High specific heat

2. What do the time and length scales represent in biophysics?

- Time Scale: Microscopic time scale: femtoseconds to nanoseconds. It is the shortest time intervals representing biological processes at atomic and molecular levels. Bond vibrations and electron transfer occurs at this time scale, mesoscopic time scale: microseconds to milliseconds. Processes such as protein folding, enzyme-substrate interactions occurs in this range and macroscopic time scale: milliseconds to seconds, minutes, hours and beyond. It is the longest time periods and processes occurs at organism and population level. Muscle contraction and evolutionary changes are some of its examples.
- Length Scale: Microscopic length scale: Angstroms to some nanometers. Arrangement of molecules and atoms can be studied within this length, mesoscopic length scale: few nanometers to micrometers. Molecular complexes and protein domains is usually studied in mesoscopic length scale and macroscopic length scale: micrometers to meters and even further.

3. Explain the Central Dogma of Biology.

Central dogma is the process in which the genetic information flows from DNA to RNA, to make a functional product protein.

- DNA Replication: The process begins with DNA replication, where the genetic information stored in a DNA molecule is duplicated.
- Transcription: After DNA replication, the information encoded in the DNA is transcribed into a molecule called messenger RNA (mRNA) through a process known as transcription.
- Translation: The final step is translation, where the mRNA molecule carries the genetic code from the nucleus to the ribosomes in the cytoplasm.

4. What is the significance of central Dogma in understanding genetic processes?

The central dogma of molecular biology is significant for understanding genetic processes because:

- Aids in understanding how genetic information is stored, replicated, and used to build and regulate cellular structures and functions.
- Aids in the study of genetic diseases, gene regulation, and the development of biotechnological tools like gene editing techniques.
- Forms the basis for the study of molecular genetics and allows scientists to investigate the mechanisms behind inheritance and genetic diversity.

5. What does complementarity (in DNA) mean?

It refers to the specific base-pairing interactions between four nitrogenous bases: adenine (A), thymine (T), cytosine (C), and guanine (G). Complementarity in DNA is based on the following pairing rules:

- Adenine (A) pairs with Thymine (T): A forms two hydrogen bonds with T.
- Cytosine (C) pairs with Guanine (G): C forms three hydrogen bonds with G.

6. Explain the Chargaff's rule.

Chargaff's rules state that

- DNA from any cell of all organisms should have a 1:1 ratio (base Pair Rule) of pyrimidine and purine bases
- The amount of adenine is always equal to the amount of thymine ($A = T$), and the amount of guanine is always equal to the amount of cytosine ($G = C$)

7. Why is the peptide bond planar?

- Due to resonance and sp^2 hybridization of N and C atoms and extra electrons or double bond.
- It's also rigid due to extra electrons (partial double bond character)

8. Name three properties by which amino acids can differ.

- Polarity: Amino acids can be classified as polar, non-polar, or charged, depending on the nature of their R group
- Acidity/Basicity or Size/Shape
- Hydrophobicity: aromatic, aliphatic

9. What are the levels of structure organization in proteins?

- Primary structure denotes the sequence of amino-acids.
- The secondary structure exhibits local interactions between stretches of a polypeptide chain and includes α -helix and β -pleated sheet structures.
- Tertiary - local interactions between stretches of a polypeptide chain and includes α -helix and β -pleated sheet structures, H-bonds, electrostatic forces, disulphide linkages, and Van Der Waals forces stabilize this structure.
- Quaternary - Some of the proteins are composed of two or more polypeptide chains referred to as sub-units. The spatial arrangement of these subunits with respect to each other is known as quaternary structure.

10. Why are cis conformations almost never observed in peptide bonds?

Due to **steric clashes** between R groups attached to the α -carbon atoms, the rotation of the peptide bond is hindered, making this **conformation unstable** and favoring the trans conformation.