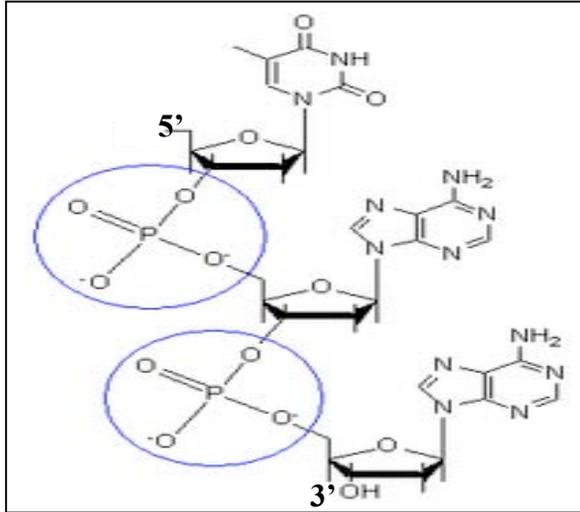


Section 3- Solution key:

1. Nucleic acids are of two major types: double helical DNA and single stranded RNA.

- i. Draw the chemical structure of a DNA molecule composed of three deoxy-ribonucleotides. Label the 3' and 5' ends.



- ii. How is a nucleotide different from a nucleoside?

A nucleoside is comprised of a nucleic acid base (A, T, G, C, U) and ribose/deoxyribose sugar. In comparison, the nucleotide has the base, sugar and the phosphate group.

- iii. Why the two strands of DNA are anti-parallel to each other?

The anti-parallel arrangement of the two strands in a DNA duplex allows the complementary bases to stack in a manner that allows them to hydrogen bond with each other. This arrangement also ensures that both the strands replicate in a 5' → 3' direction (you will learn more about this in your Molecular biology lectures).

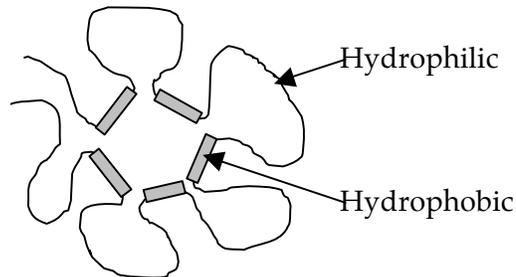
- iv. Why is RNA more reactive compared to a DNA?

The extra -OH group at the 2'C of the ribose sugar allows RNA to be more reactive compared to DNA.

- v. RNA is single stranded. However, it can have a very complex three-dimensional structure. Certain regions of RNA may show intra- molecular base pairing. Is the base pairing observed in RNA similar to or different from that in DNA?

Yes, the intra-molecular base pairing in RNA follows the same complementary base-pairing rule as DNA where A forms two hydrogen bonds with U and C forms three hydrogen bonds with G.

2. A certain protein has this structure, where a line indicates a hydrophilic region and a box represents a hydrophobic region.



- iii. Why do you think the protein might fold this way when dissolved in salt water?

The boxed hydrophobic regions try to hide in the non-aqueous interior away from the surrounding hydrophilic environment of the salt water. In comparison, the hydrophilic regions, shown by the lines, remain exposed to the salt water and may form hydrogen bonds and / or ionic bonds with the molecules in the surrounding environment.

- iv. How do you think the protein might fold differently if it were dissolved in cooking oil?

The folding will be reversed. The boxed hydrophobic regions will be exposed and may undergo hydrophobic interaction with the surrounding hydrophobic environment whereas the hydrophilic regions, shown by the lines, will be hidden in the interior away from the surrounding hydrophobic environment.

3. You are studying a protein that comes from a bacterial species that lives in your gut. This protein also has enzymatic function. If you boil this protein, you will disrupt Hydrogen bonds and ionic bonds, but not covalent bonds. If this enzyme is most active (100% active) in the cytoplasm of a bacterial cell (37°C) in your gut, what would be the effect of protease treatment on the activity of this protein?

Protease treatment will cleave the covalent peptide bonds that hold the amino acids of the proteins one after the other to form its primary structure. The effect of such treatment is irreversible since the primary structure of the protein is disrupted.

4. Pepsin is a digestive enzyme that acts on proteins in stomach. This requires the presence of HCl for its normal functioning.

- iii. What may be the type of reaction catalyzed by pepsin?

Pepsin digests the proteins to small polypeptides at acidic pH.

- iv. Pepsin functions well in the stomach but it ceases to function in the intestine. Explain why pepsin does not function in the intestine?

Each enzyme maintains its active three-dimensional conformation at a specific pH. The acidic pH in the stomach is the required pH for pepsin activity whereas the alkaline pH of the intestine is not.

5. The formation, maturation and folding of secreted proteins takes place in the endoplasmic reticulum and the golgi body. These steps normally occur without any error. However, very rarely a misfolded protein may be produced which (if not destroyed) can lead to severe, life threatening diseases. How do the cells normally get rid of these misfolded proteins?

The misfolded proteins are degraded by the lysosomal enzymes. Alternatively, they may bind to heat shock proteins, which act as molecular chaperons to cage the misfolded proteins.

6. Enzymes, which are usually proteins, act as biological catalysts. Of the properties mentioned in the following table, state which are not changed by the enzymes.

Properties	Does enzyme change this property (Yes/No)?
ΔG of reaction	No
Rate of reaction	Increases

7. Working in a research lab you happen to identify a novel protein. This protein serves as an enzyme, which catalyses the following reaction.



You observe that if you increase the concentration of substrate A, there occurs a simultaneous increase in the rate of reaction, but only up to a certain point. Explain **why**.

If you increase the substrate concentration, more substrate molecules will be available to bind to the active site of the enzyme and get converted to products B and C. This causes an initial increase in the rate of enzyme-catalyzed reaction. However, after some time, the active sites of all the available enzyme molecules are already saturated with the substrate molecules i.e. enzyme itself becomes a limiting factor. At this point, even if the substrate concentration is increased, there occurs no further increase in the rate of reaction i.e. reaction rate reaches a plateau phase.

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