# Quadrant II – Transcript and Related Materials

**Programme: Bachelor of Science (Second Year)**

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**Paper Title: Animal Physiology and Biochemistry**

**Unit: 09 – Proteins**

**Module Name: Bonds Stabilizing Protein Structure**

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## Notes

**Introduction**

Proteins are polymers of amino acids. Amino acids are joined together by a peptide bond to form linear structures called polypeptides. The polypeptides are folded into specific structures to form the functional conformation of the protein. The folding of protein into specific shape is assisted and stabilized by many types of bonds in them (strong bonds and weak bonds).

**Bonds stabilizing protein structure**

Important types of bonds involved in the protein structure and conformation are:

1. **Peptide bonds**
2. **Ionic bonds**
3. **Disulfide bond**
4. **Hydrogen bond**
5. **Hydrophobic interactions**
6. **Van der Waals attraction**

1. **Peptide bonds:**

- A covalent bond formed between the carboxylic group of one amino acid and the amino group of another amino acid.
- A covalent bond is a chemical bond that involves the sharing of electron pairs between atoms.
- Peptide bond formation is an example for a condensation and elimination reaction.
- One molecule of water is eliminated during the formation of peptide bond by the condensation reaction of two amino acids.
- A resulting compound after the peptide bond is called a **dipeptide**.
- A dipeptide has a free carboxylic group at one end and free amino group at another end.
- The free amino group or carboxyl group of a dipeptide can form another peptide bond with a third amino acid and so on. Many amino acids join together in this manner to form a polypeptide.
- The primary structure of the protein is stabilized by **peptide Bond**.

2. **Ionic bond :**

- A chemical bond formed between two ions of opposite charges.
- In proteins the ionic bonds are formed between the ionized acidic (COO-) or basic (NH3+) groups of amino acids.
- Acidic groups will be negatively charged since they released the H+ ions.
- Basic group will be positively charged since the accept the H ions from the medium.
- After the ionization of side chain, the amino acids in the protein chain can attract or repel each other based on their charges.
- The attraction of oppositely charged R group the result in the formation of ionic bonds.
- Ionic bonds are weak bonds and they are very fragile in an aqueous medium.
- Even a change in the pH may break down the ionic bonds.
- This is the reason for the denaturation of proteins in the acidic or basic medium.
- Tertiary and quaternary structures of proteins are stabilized by ionic bonds.

**3. Disulfide bonds:**

- A covalent bond formed from two thiol groups of two cysteine residues in a protein.
- The cysteine (a sulfur containing amino acid) contain a highly reactive sulphuhydryl (SH)group in its side chain.
- The sulphurhydryl is highly polar and highly reactive.
- If two molecules of cysteine line-up alongside each other the neighbouring sulphuhydryl groups can be oxidised.
- This reaction results in the formation of strong permanent covalent connection between two cysteine residues called disulfide Bond.
- Disulfide bonds stabilize the tertiary structures of the protein.

**4. Hydrogen bond:**

- Hydrogen bond is a electrostatic interaction between a hydrogen atom, which is covalently bound to a high electronegative atom (such as Oxygen and nitrogen), to another electronegative atom of same or different molecules of their close vicinity.

- Hydrogen present in the -OH group or -NH2 of amino acids become slightly electropositive.
- Due to high electronegativity, oxygen and nitrogen attract the shared electron of hydrogen more towards them.
- Consequently, the slightly positive H is then attracted towards the neighbouring electronegative oxygen of C=O or nitrogen atom of NH2 group.
- The formation of hydrogen bonds give a regular shape to the polypeptide chain such as Alpha helix and beta plates.
- The formation of hydrogen bonds give a regular shape to the polypeptide chain such as Alpha helix and beta plates.
- Hydrogen bonds are very weak bonds.
- Hydrogen bonds are involved in stabilizing the secondary, tertiary and quaternary structure of proteins.

**5. Hydrophobic interactions:**

- Some are groups in the amino acids are nonpolar. (example: alanine, valine, isoleucine, leucine, methionine).
- The non polar are group are hydrophobic and they try to stay away from water.
- In a long polypeptide chain, there may be many such nonpolar amino acids which may be adjacent to each other or separated by polar R groups.
- In an aqueous environment (inside the cell) the linear polypeptide will fold into such a shape that the hydrophobic amino acids come in close contact with each other and they try to exclude the water due to its hydrophobicity.
- By this method the peptide chain of globular protein will fold into a spherical shape in the aqueous environment.

**6. Van der Waals attraction**

- The Van der Waals force is a transient, weak electrical attraction of one atom for another.
- Van der Waals attractions yield a temporary electric dipole.
- The transient dipole in one atom can induce a complementary dipole in another atom, provided the two atoms are quite close.
- These short-lived, complementary dipoles provide a weak electrostatic attraction, the Van der Waals force.
- Van der Waals attractions, although transient and weak, can provide an important component of protein structure because of their sheer number.