Proteins

What can you remember?

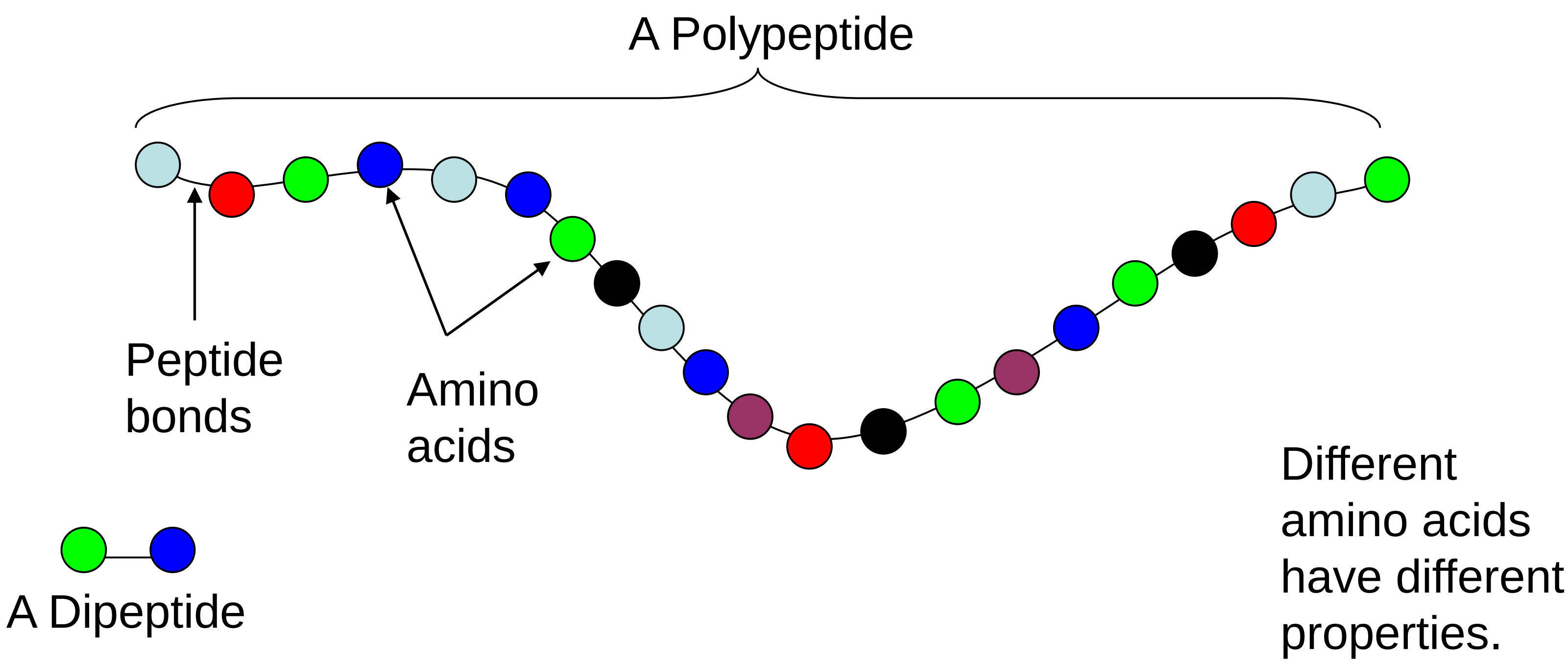
- In pairs, write down all that you can remember about proteins from previous years.

What you will learn next…

- Amino acid structure.
- Dipeptides & polypeptides.
- Primary, secondary, tertiary & quaternary protein structure.
  - Amino acid sequences.
  - α helices and β sheets.
  - H bonds, sulphur bridges and polar interactions.
  - Fibrous and globular proteins.

Amino Acids

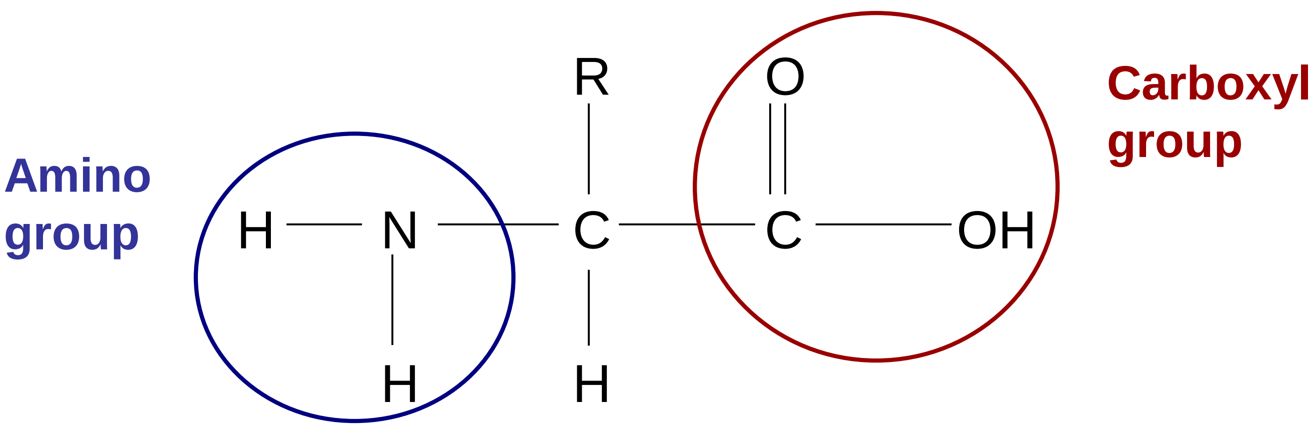
- Proteins are made of amino acid monomers.
  - Joined together like the beads on a necklace.



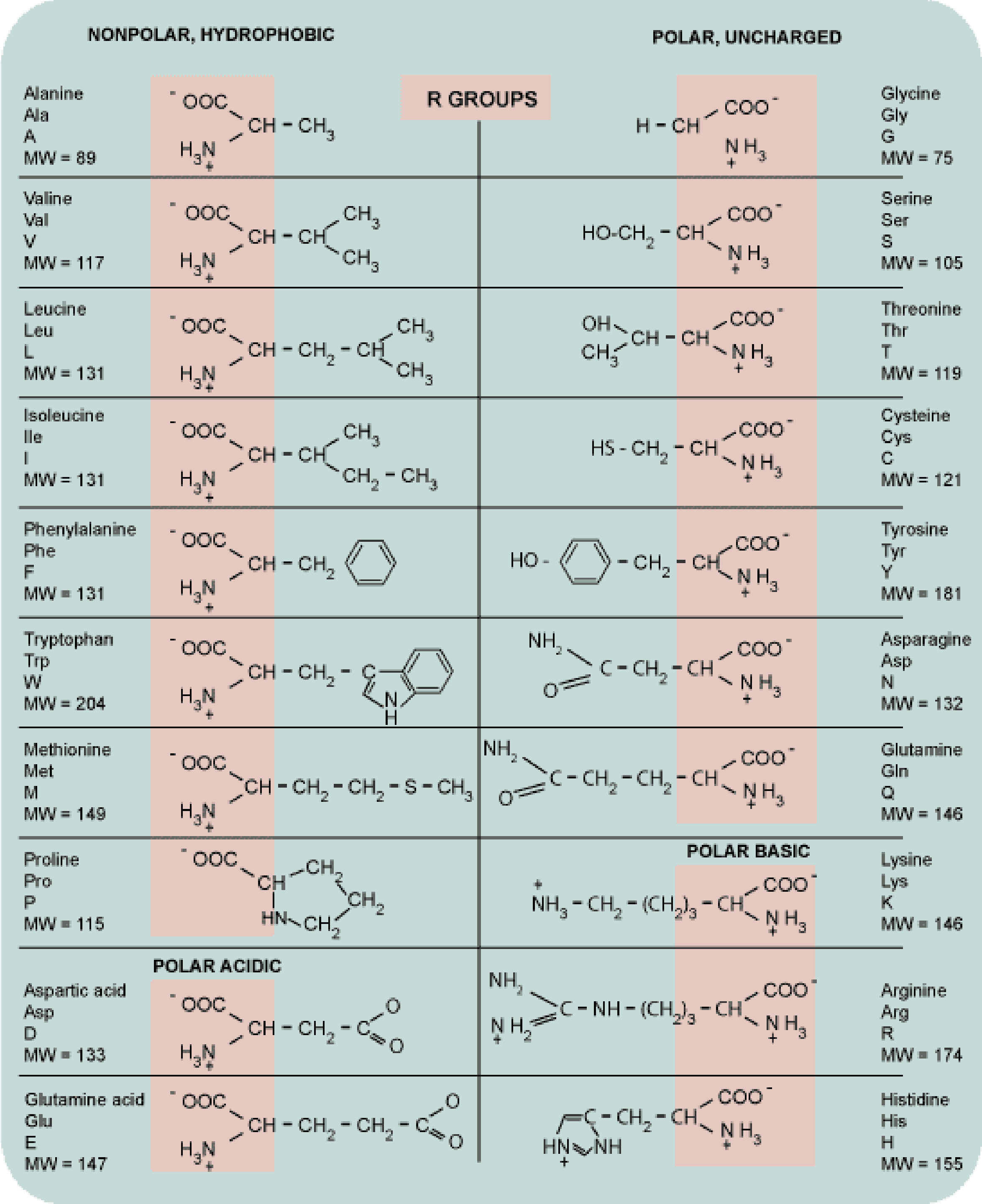
Amino Acids

- Contain an **amino** group ($-NH_2$) and a carboxylic **acid** group (-COOH).

- Have the general formula:

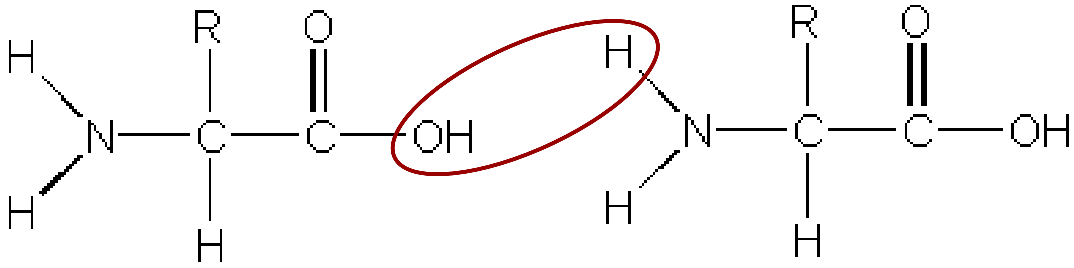


- The 20 different R groups.

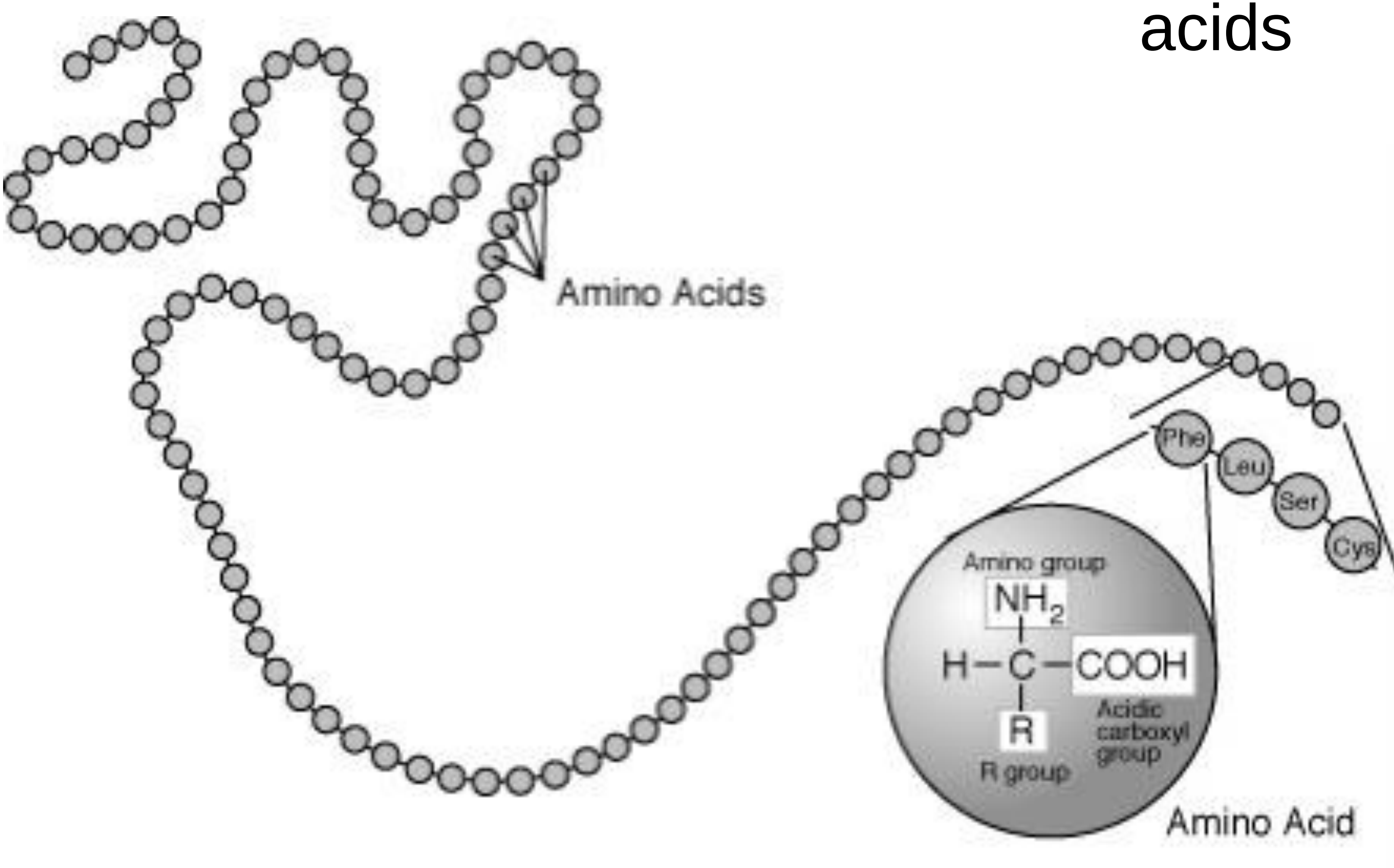


Peptide Bonds

- Formed by a condensation reaction.



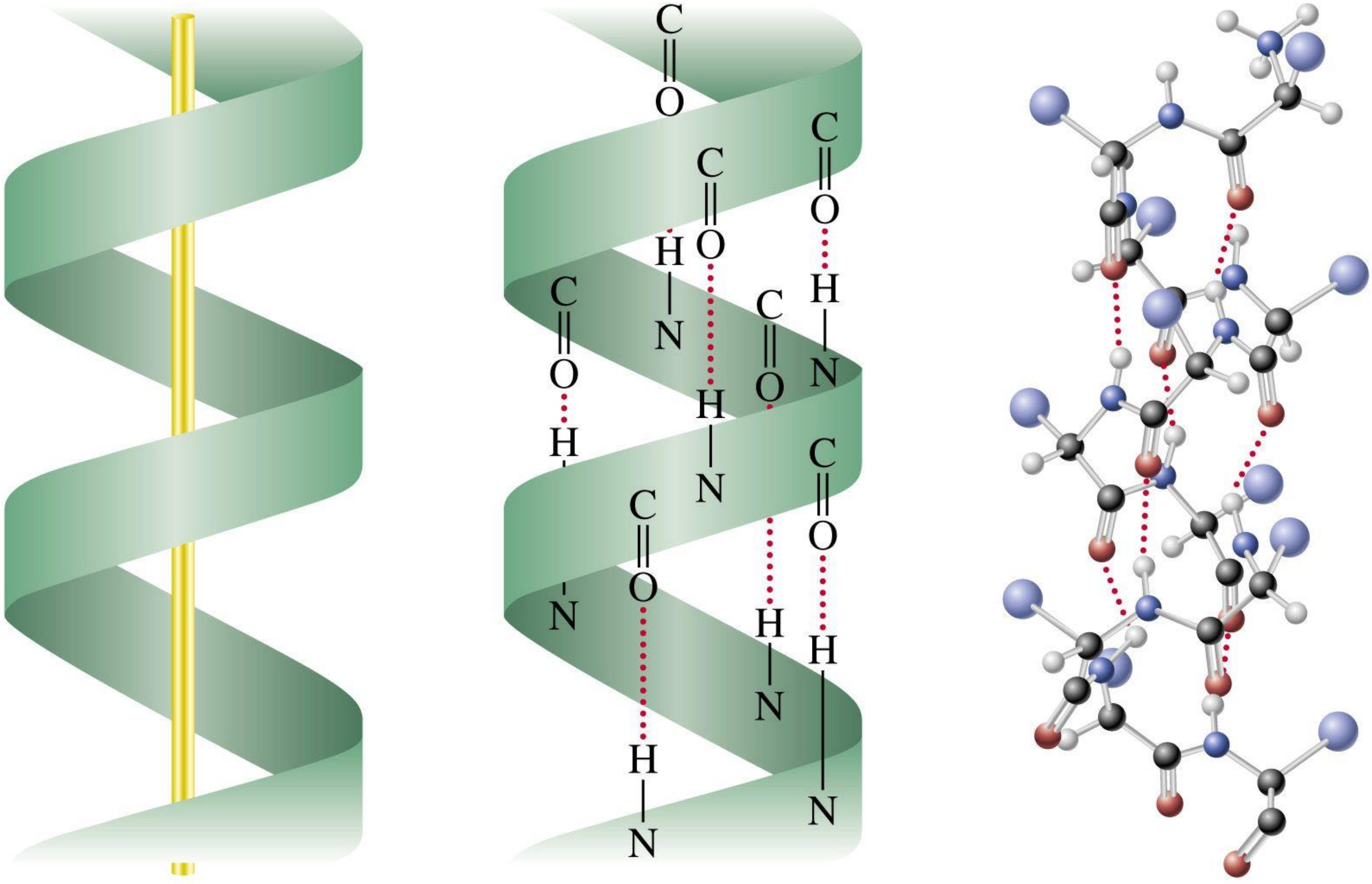
Primary Structure – the sequence of amino acids



Secondary Structure

- Hydrogen bonds can occur between the NH group in one peptide bond and the CO group in another, or between R groups.
- This causes parts of the polypeptide to fold up in a particular way.
- Common folding patterns are the α helix and the β sheet.

Alpha Helix



Beta Sheet

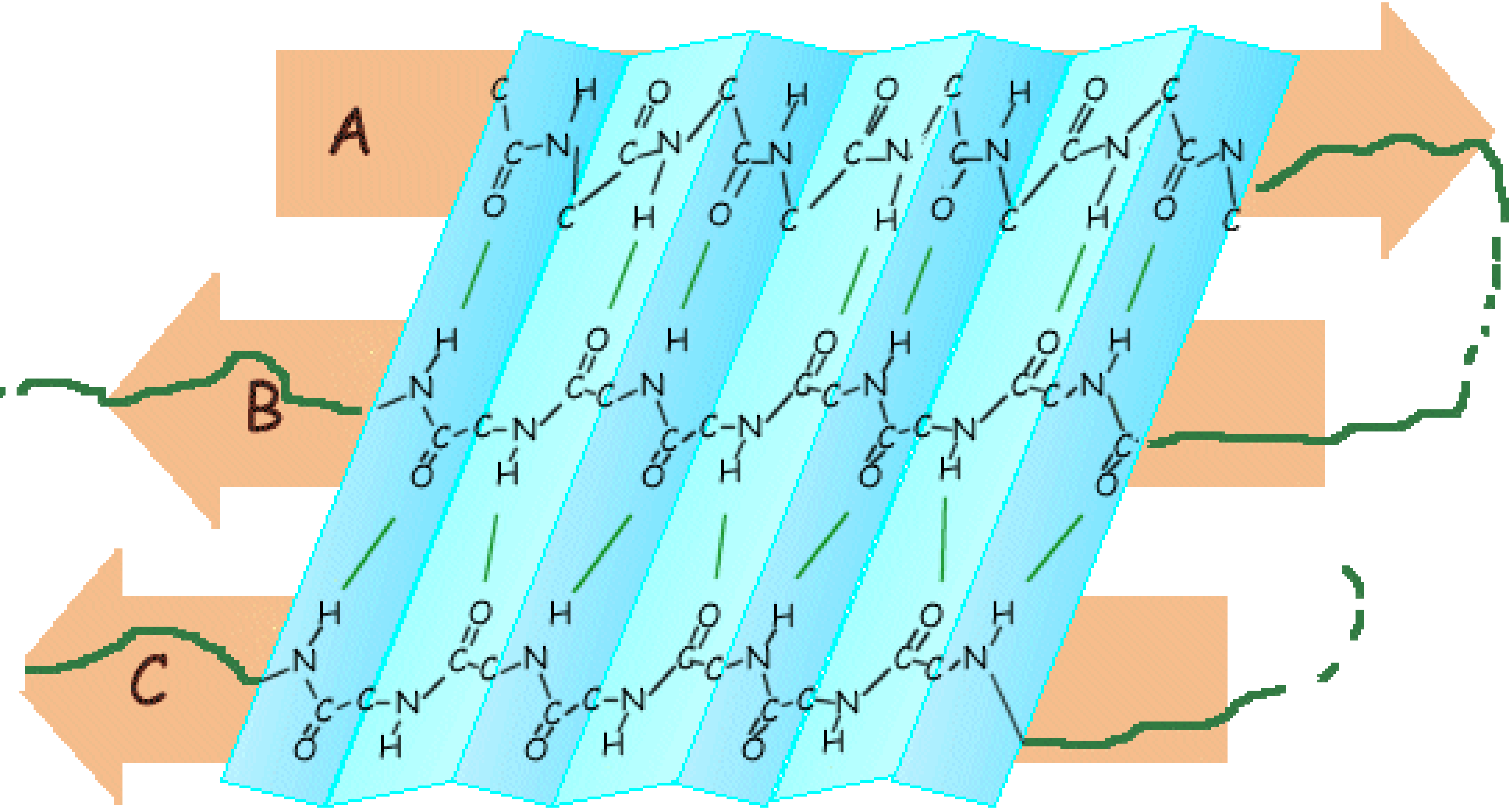
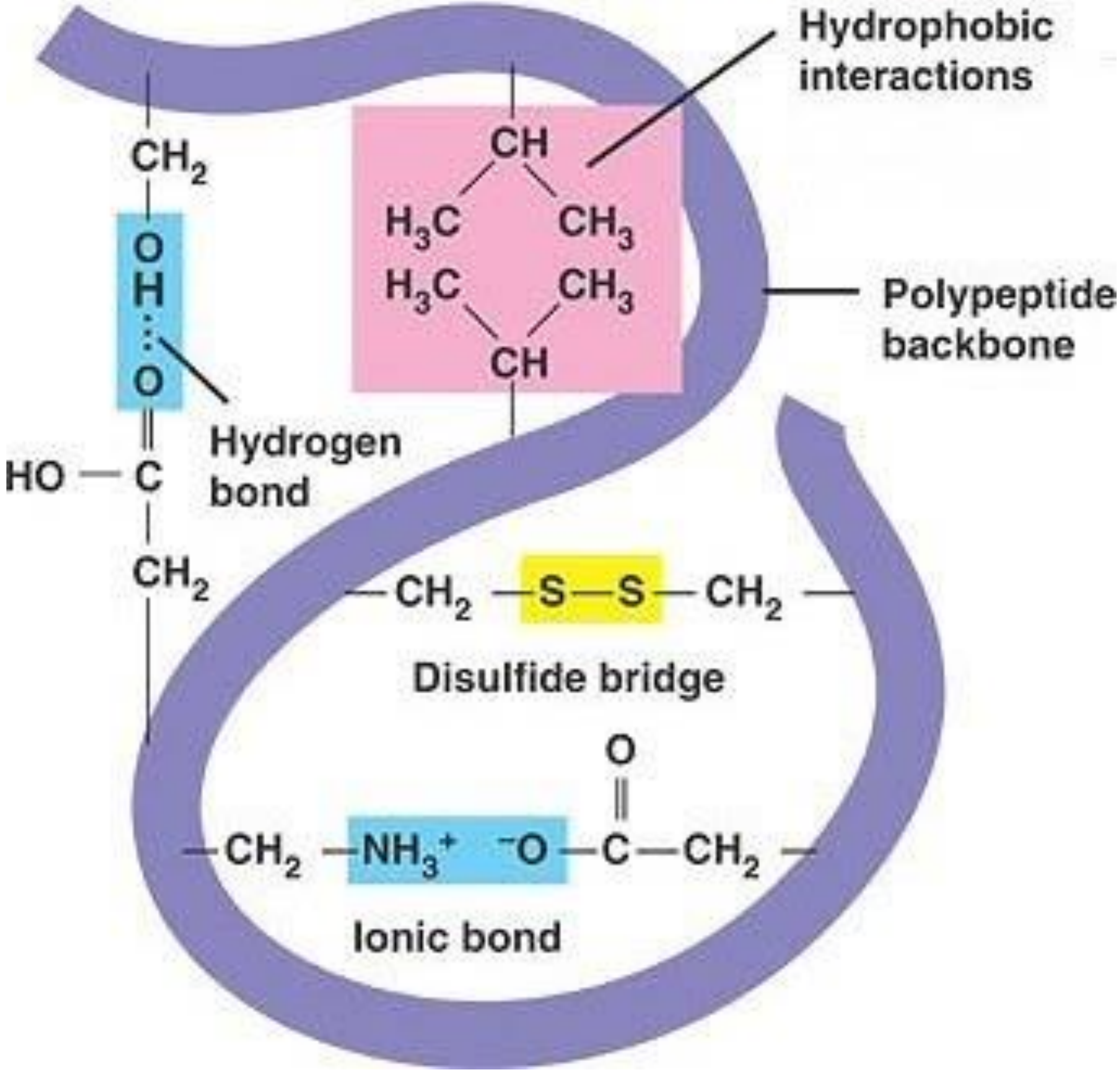


Diagram 1: Beta pleated sheet. The lateral groups (R) are not shown.

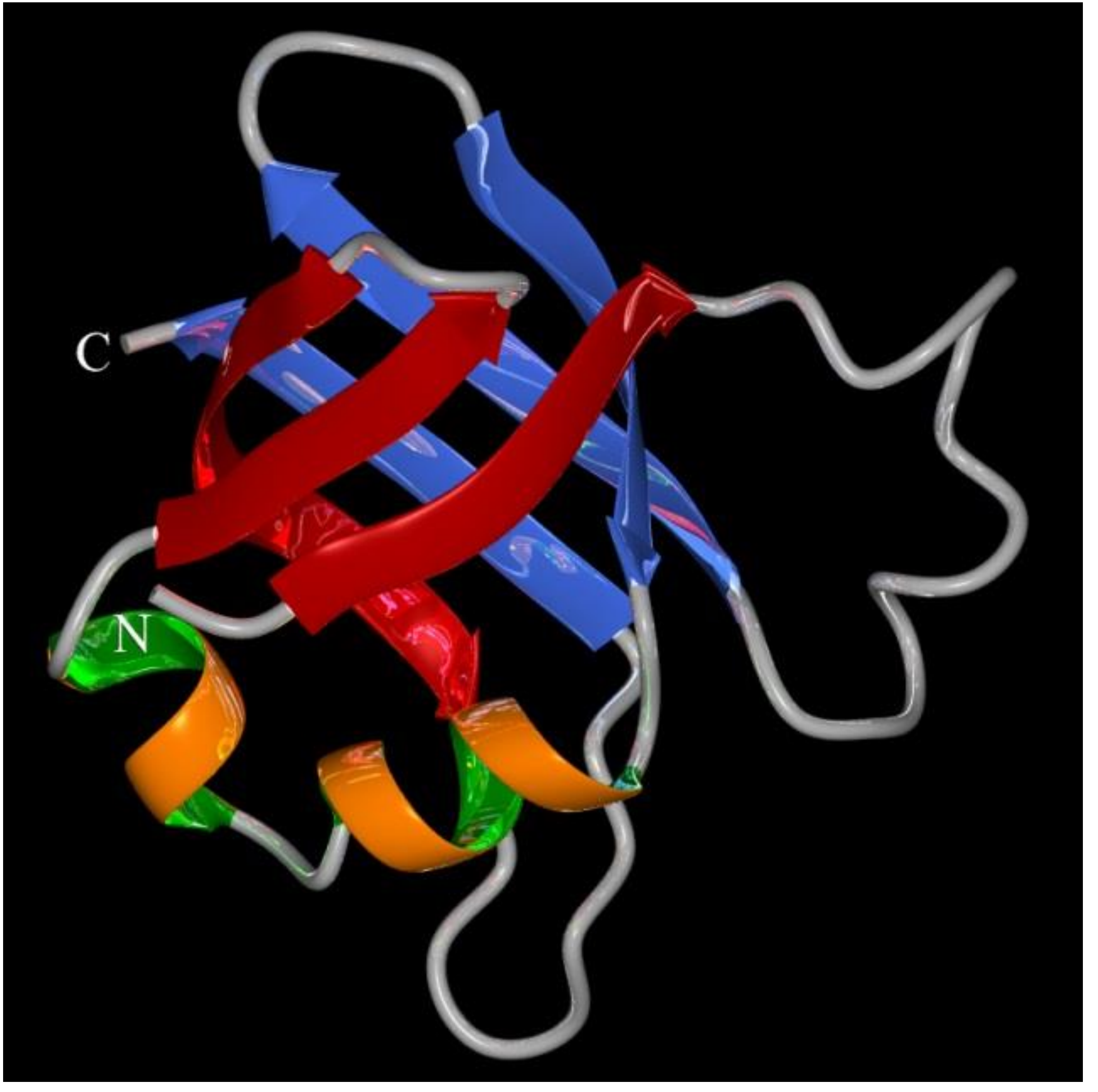
Tertiary Structure

- Secondary structures twist/fold even more to give 3D shape.
- Shape held in place by:
  - Disulphide bridges.
  - Ionic bonds.
  - Hydrogen bonds.
  - Hydrophobic/hydrophillic interactions.

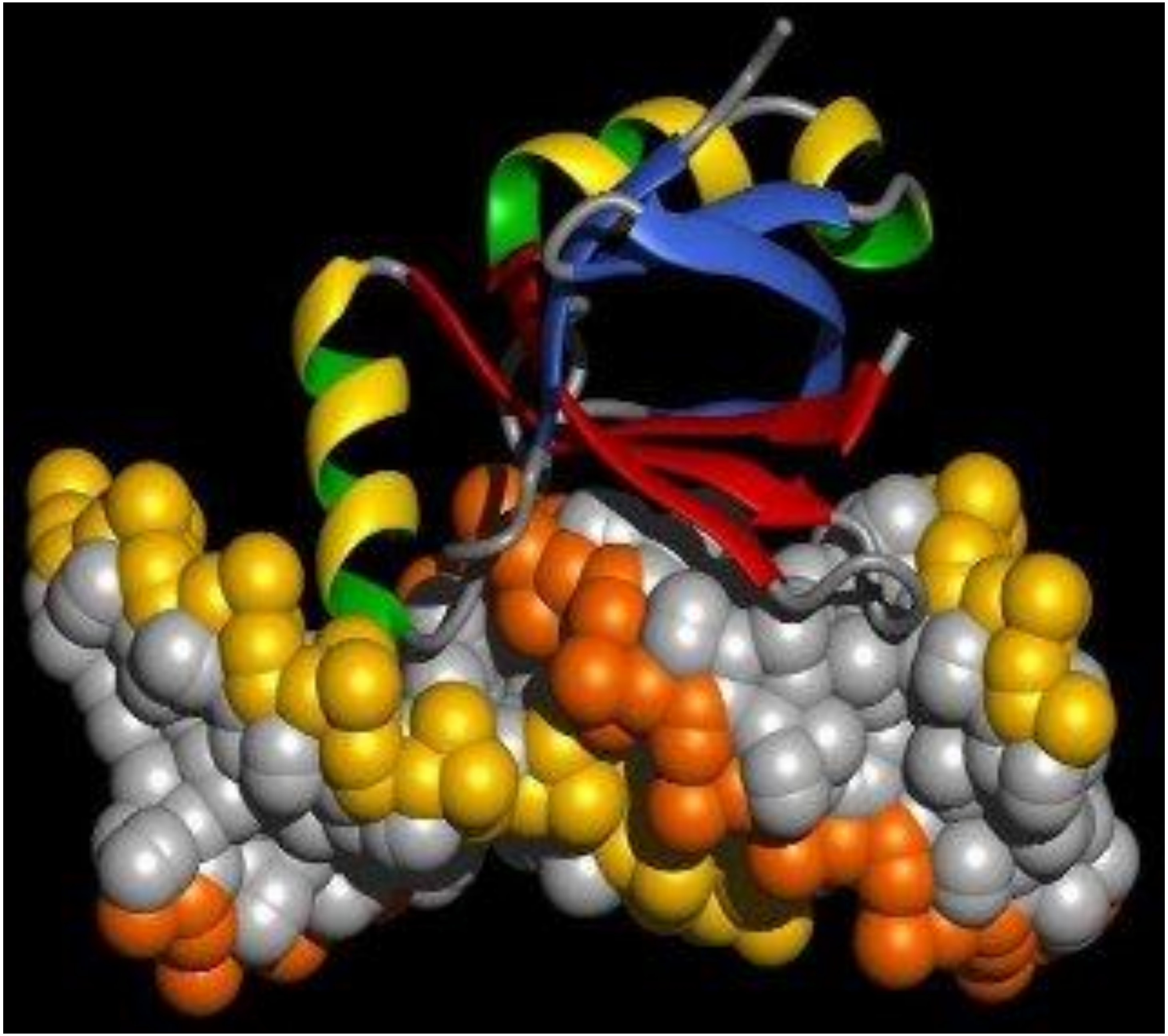
TERTIARY STRUCTURE



- A ribosomal protein



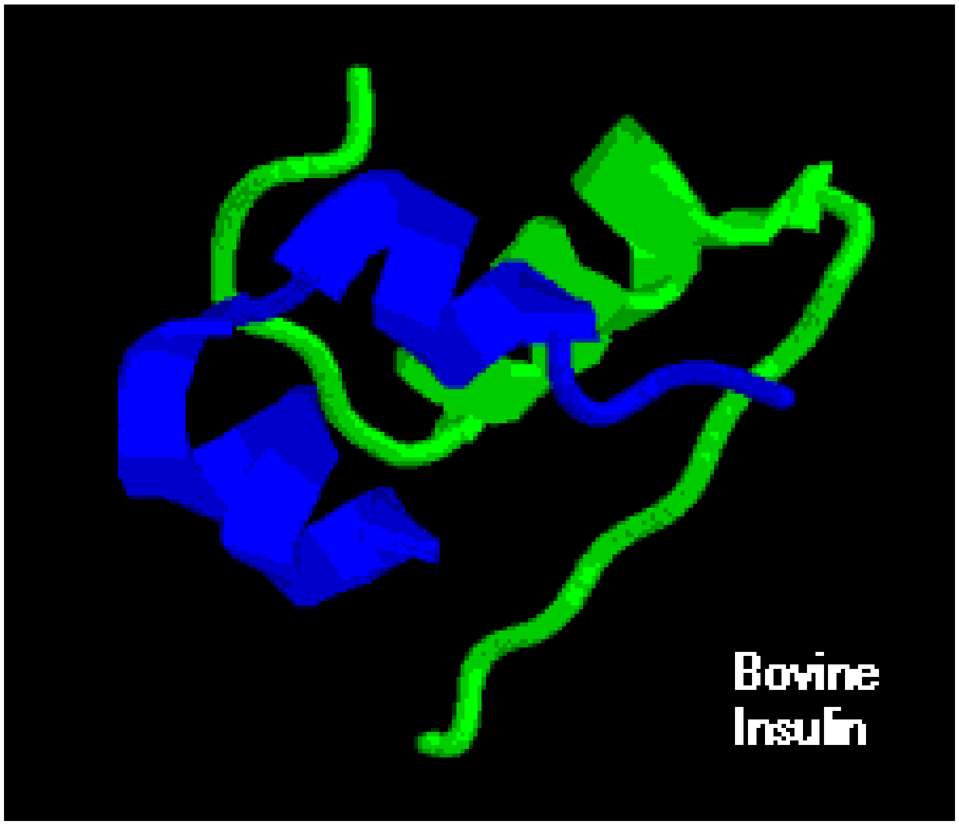
- The same ribosomal protein bound to an RNA molecule.



Quaternary Structure

- Many proteins are made of more than one polypeptide.
- Quaternary structure is the way these polypeptides join together.

Insulin



- 2 polypeptides.
- α-chain 21 AAs.
- β-chain 30 AAs.

- Chains are linked by two disulphide bridges.

10 Question Mini Test

1 What is the Primary Structure of proteins?

2 Draw the general structural formula for an amino acid.

3 What type of bond links amino acids together?

4 What type of reaction results in the formation of these bonds?

5 What are the two main secondary structures of polypeptides?

10 Question Mini Test

6 Name the 4 types of bonds involved in making up a protein’s tertiary structure.

7 Which is the strongest of these?

8 Which of these result from an attraction between $–NH_3^+$ and $–COO^-$ groups?

9 Amino acids are acids and bases at the same time. What is the name for this?

10 Draw the general structural formula of a dipeptide.

Protein Functions

- Role of a protein depends on its molecular configuration.

- Two main types:
  - Fibrous proteins
    - Structural functions
    - Eg Collagen, keratin.
  - Globular proteins
    - Metabolic functions
    - Eg hormones, enzymes.

Fibrous Proteins

- Long, straight, parallel chains of amino acids.
- Chains linked by cross bridges.
- Very stable molecules.
- Often have structural functions.

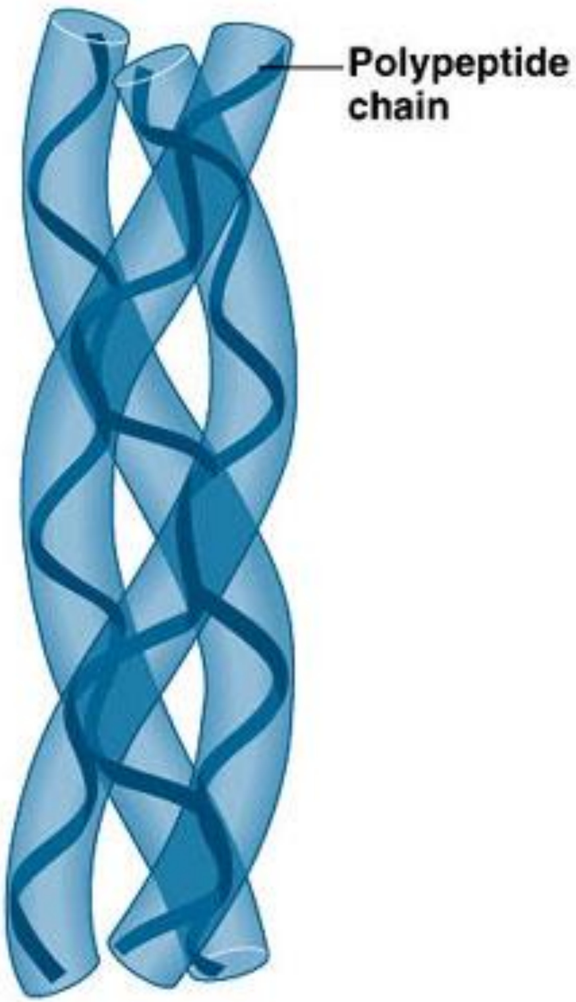
- Eg. Collagen, Elastin, Keratin.

Collagen

- Found in tissues that require strength:
  - Eg. Tendons, bones, cartilage.

- Primary structure largely repetitive
  - $[R1\text{-}R2\text{-}R3]_n$
- 2^{o} & 3^{o} structure is long helical chain.
- 4^{o} structure three chains coiled around one another to form a triple helix.

Collagen



(a) Collagen

- Flexible molecule that cannot be stretched.

Elastin

- Elastin is a highly elastic protein in connective tissue and allows many tissues in the body to resume their shape after stretching or contracting. Elastin helps skin to return to its original position when it is poked or pinched.

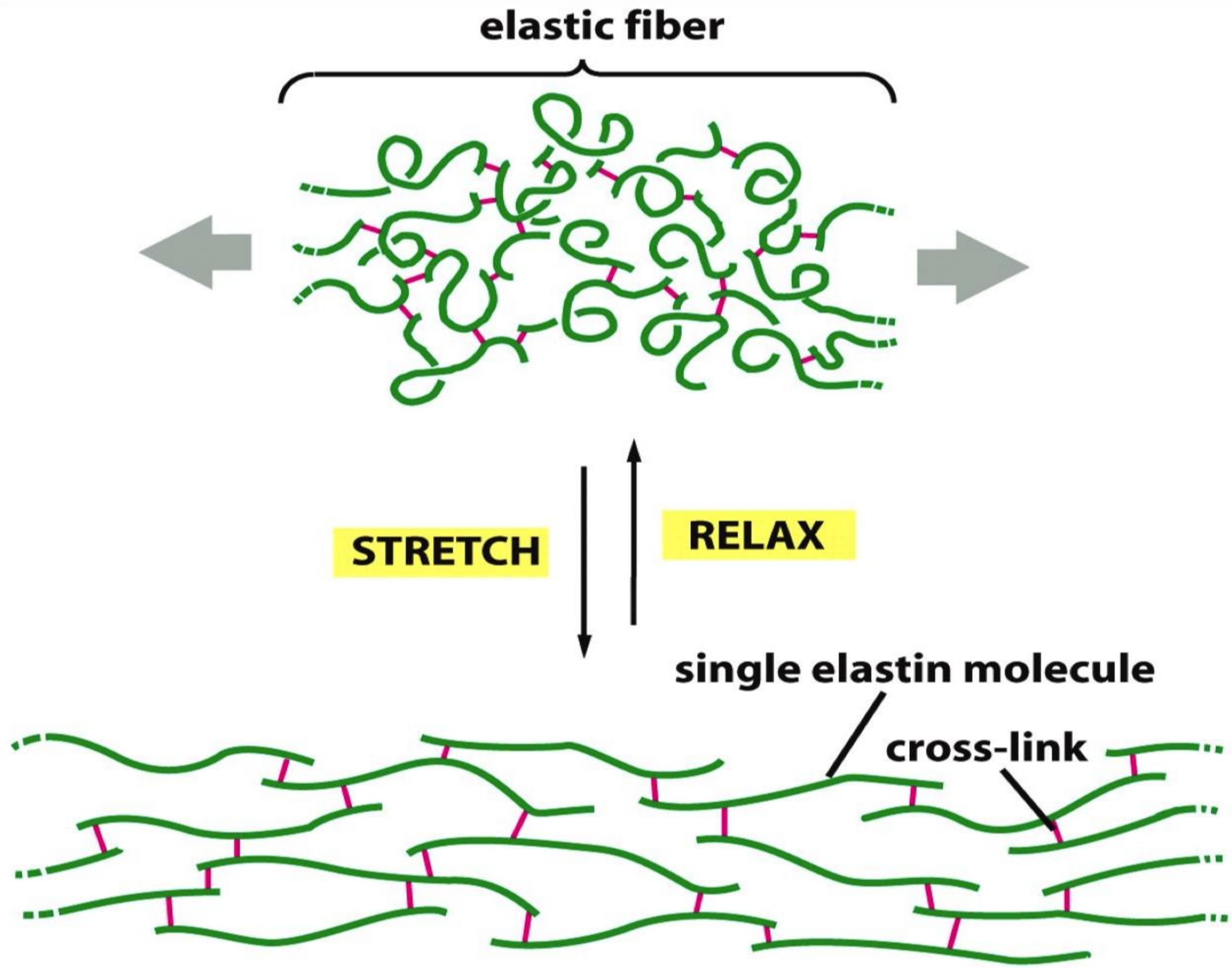
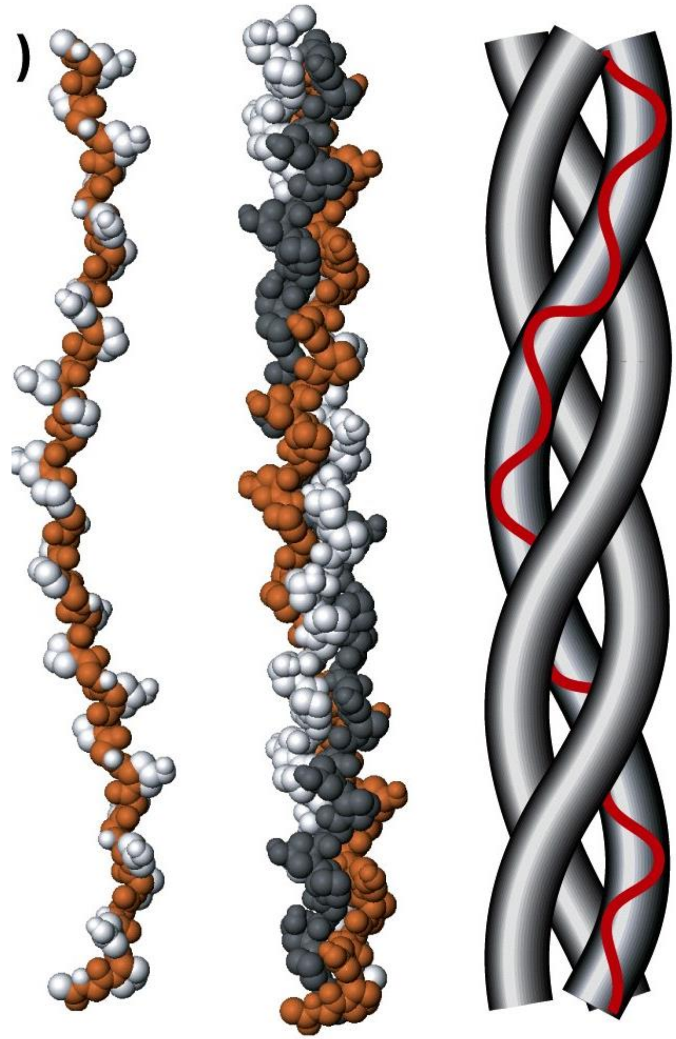


Figure 19-71 Molecular Biology of the Cell 5/e (© Garland Science 2008)

Keratin

- Similar structure to collagen.
- A fibrous protein forming the main structural constituent of hair, feathers, hoofs, claws, horns, etc.
  - Strong & inflexible
  - Lots of disulphide bridges to hold tertiary structure together.



Globular Proteins

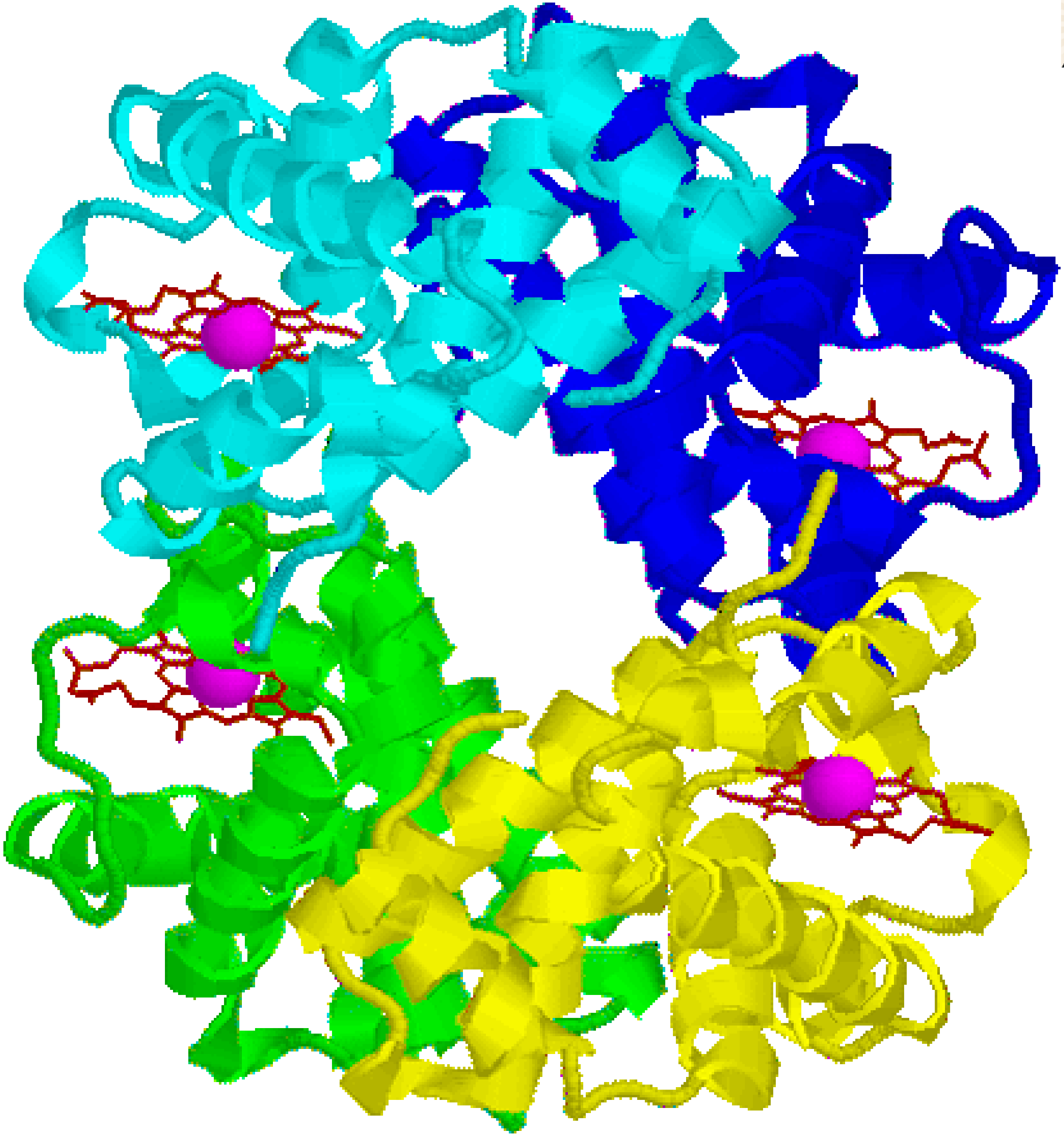
- Amino acid sequence is more varied.
- 2^{o} structures contain α-helices & β-sheets.
- Compact, ball-like 3^{o} structures.
- Highly specific shapes which are essential to their functions.
- Water soluble.

- Eg. Haemoglobin.

Haemoglobin is made of 4 separate polypeptides joined together (2 alpha and 2 beta chains).

The red molecule is a Haem group that contains an iron atom (pink) attached.

Oxygen molecules bind to each of the haem groups, so that each haemoglobin molecule can accommodate four O_2 molecules.



Fibrous v Globular Proteins

Fibrous Proteins	Globular Proteins

Conjugated Proteins

- Globular proteins which contain a prosthetic group.
  - A non-protein chemical group which is attached to the protein in some way to add to its function.
  - The haem group in haemoglobin and catalase is a prosthetic group.