Proteins

What are proteins? (from Google)

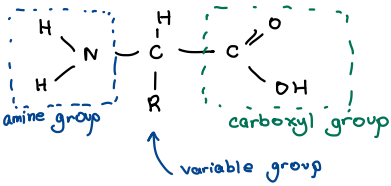
- Proteins are macromolecules (big) formed by amino acids. Proteins are polymers of structural unit called amino acids.

What are the functions of proteins?

- Structural roles (muscles)
- Metabolic roles (e.g. enzymes)
- Antibodies for immune response
- Transport roles (e.g haemoglobin)

Amino Acid

- All amino acids have the same basic structure.
- There are only 20 amino acids.

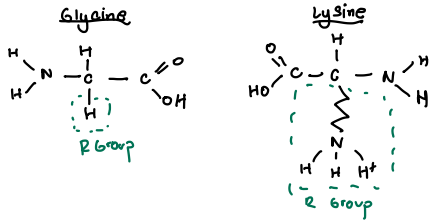


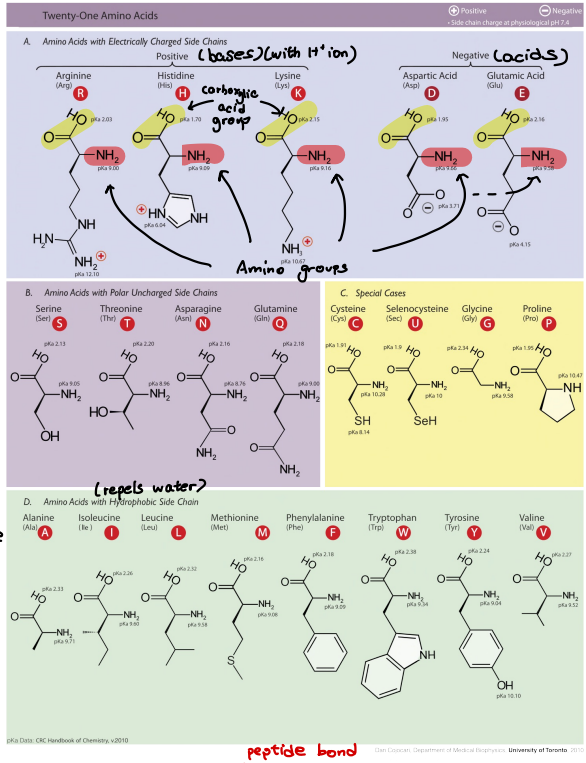
What are amino acids?

- Amino acids are the monomer units used to make proteins. All amino acids have the same basic structure with different R groups.

What's in the R Groups?

- R Groups Differ massively in size.
- R groups generally contain carbon, except glycine:



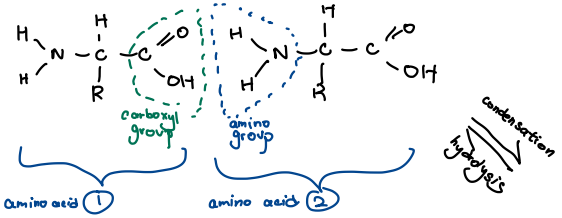


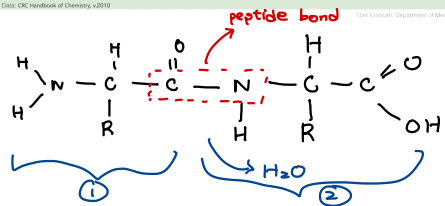
Polypeptide

Under condensation reactions:

- 2 amino acids join together to create dipeptide
- Many amino acids join together to create a polypeptide
- Proteins are made up of one or more polypeptides.

Dipeptide formation





Protein Structure

Primary Structure

- The primary structure of a protein is the sequence of amino acids. (order)

= Polypeptide X

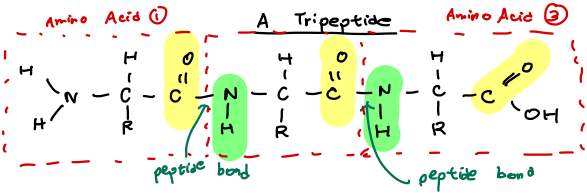
- The combinations possible are MASSIVE. (20 amino acid combinations)

Example of a protein - Casein

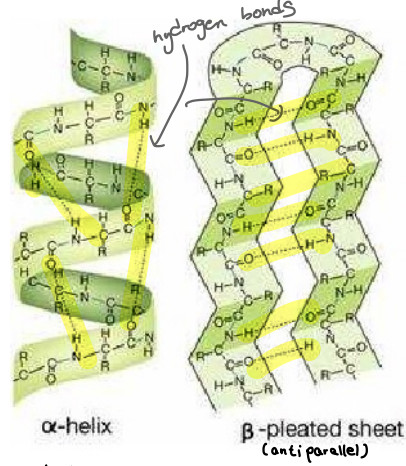
- Casein is a phosphoprotein (a protein with a phosphate group attached)
- Found in milk (80% of proteins in cow's milk)
- As a food source, casein supplies amino acids, carbohydrates, calcium and phosphorus.
- No disulfide bridges hence little tertiary structure.
- Relatively hydrophobic, making it poorly soluble in water.
- For protein supplements: casein is very efficient in nutrient supply - provides a sustained slow release of amino acids into the blood stream. Often casein is available as hydrolyzed casein, whereby it is hydrolyzed by a protease such as trypsin.
- Also used in paint, glue, food items and cheesemaking.
- Great for muscle growth.

Secondary Structure

- The polypeptide chain is NOT FLAT :(. It could coil into an alpha helix or a beta pleated sheet.
- This is due to hydrogen bonds between the amino acids.



- The hydrogen in -NH is positive and the oxygen in -C=O is negative
- This results in a hydrogen bond between amino acids.

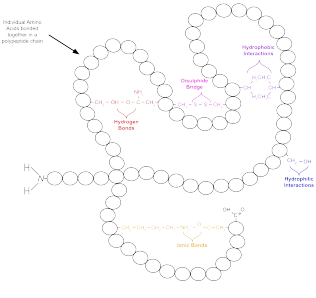


- Although hydrogen bonds are weak, hundreds of them keep the secondary structure stable.

→ The secondary structure of a protein is the curling or folding of the polypeptide chain into α-helices and β-pleated sheets due to the formation of hydrogen bonds.

Tertiary Structure (Shape of protein)

- The α-helices and β-pleated sheets also twist and turn to form a protein with a unique 3D structure.



Bond Types

Hydrophobic Interactions: These amino acids orient themselves towards the center of the polypeptide to avoid the water

Disulphide Bridge: The amino acid cysteine forms a bond with another cysteine through its R group

Hydrogen Bonds: Polar "R" groups on the amino acids form bonds with other Polar R groups

Hydrophilic Interactions: These amino acids orient themselves outward to be close to the water

Ionic Bonds: Positively charged R groups bond together

- Hydrogen bonds form between polar R Groups.
- Ionic bonds form between positive and negatively charged R-Group.
- Disulfide bridges also form when two molecules of cystein comes close together. (very strong covalent bond)

↓ hence

- The primary structure determines the tertiary structure.
  ∴ The overall 3D structure is a result of R group properties and interactions.

→ The tertiary structure of a protein is the overall specific 3D shape of a protein. This is determined by interactions between R-groups and properties of R groups.

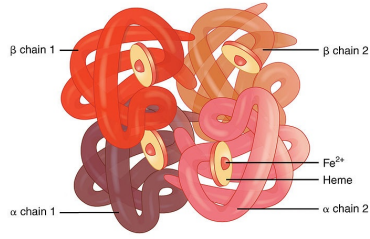
Quaternary Structure

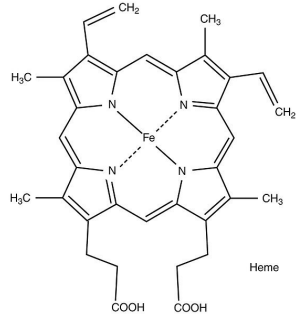
- Some proteins are made of several different polypeptide chains held together by bonds: e.g. haemoglobin, insulin, collagen, chlorophyll.
- The quaternary structure is the way these polypeptide chains are assembled together.
- Prosthetic groups may also be associated with the polypeptide chains.

→ The quaternary structure of a protein is the specific 3D shape of a protein that is determined by the multiple polypeptide chains and/or prosthetic groups bonded together.

Protein shape and function

- A protein's shape determines its function.
- All proteins have different structures and shapes which makes them specialised to carry out particular jobs.
- Examples of proteins include:





Protein Examples

Enzymes

- Spherical in shape due to tight folding of the polypeptide chains
- Have roles in metabolism and synthesise (make) large molecules.

Pumps

- Na^+ K^+ pump in cell membranes

Motors

- Myosin (muscle), kinesin

Antibodies

- Involved in the immune response
- Made up of two light polypeptide chains and two heavy polypeptide chains bonded together

Transport proteins

- Channel proteins are present in cell membranes
- These proteins fold up and transport molecules and ions across membranes.

Structural proteins

- Strong proteins as they consist of long polypeptide chains lying parallel to each other with cross-links between them.
- Structural proteins include keratin (found in hair and nails) and collagen (found in connective tissue)
- Collagen has 3 polypeptide chains tightly coiled together, which makes it strong.