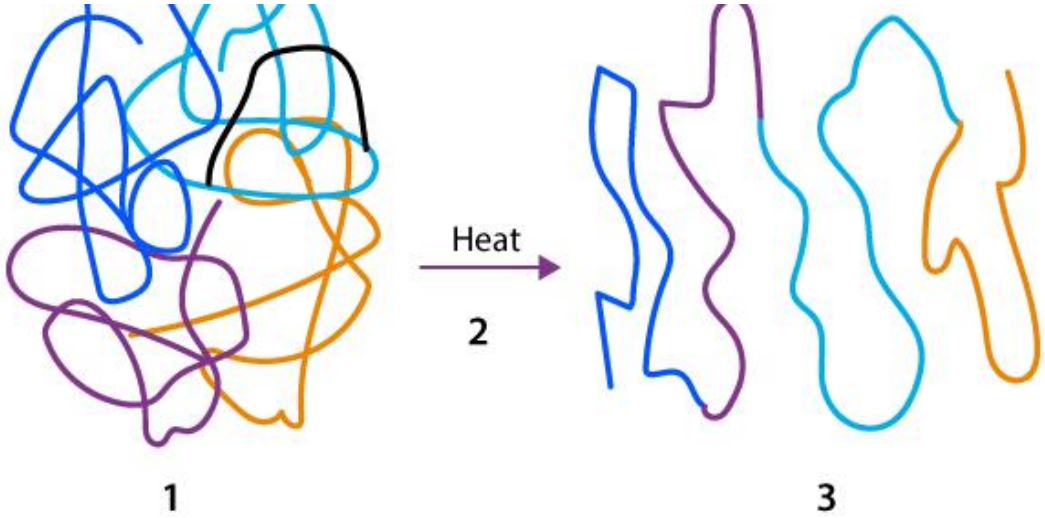
Tishk International University
Faculty of Applied Science
Nutrition and Dietetics Department
Principles of Food Science

Denaturation of Protein



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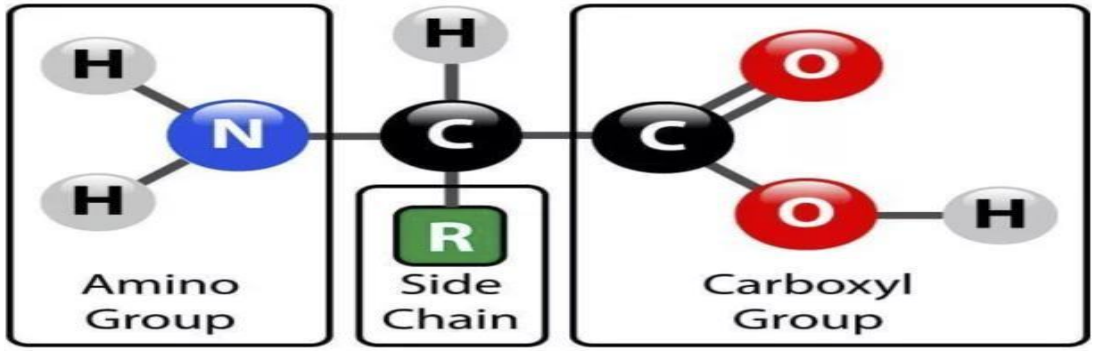
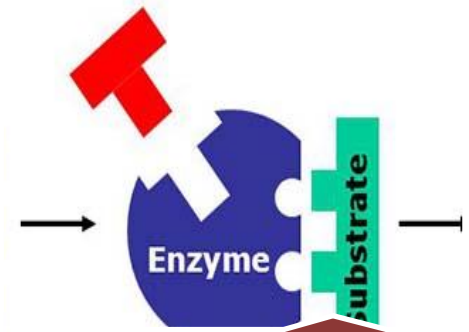
What are proteins?

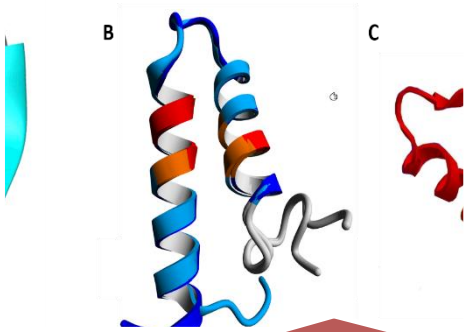
- Proteins are large biological molecules made of amino acids linked together.
- They are essential for almost every structure and function in the body
  Classification of proteins refers to the grouping of proteins based on characteristics such as their **composition, shape, or function**.
  Amino acids are the basic building blocks of proteins, consisting of an amino group (–NH_2), a carboxyl group (–COOH), a hydrogen atom, and a variable side chain (R-group).
  Classification of amino acids refers to organizing them based on nutritional needs, chemical properties, or metabolic fate—such as essential vs. non-essential, polar vs. non-polar, acidic vs. basic..



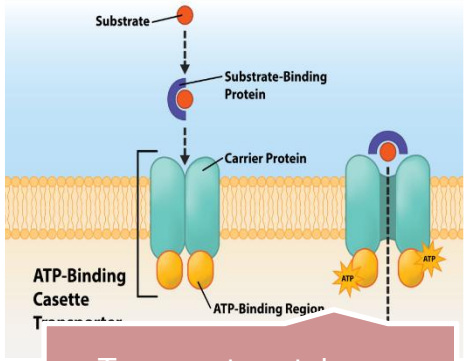
Biological Functions of Proteins:



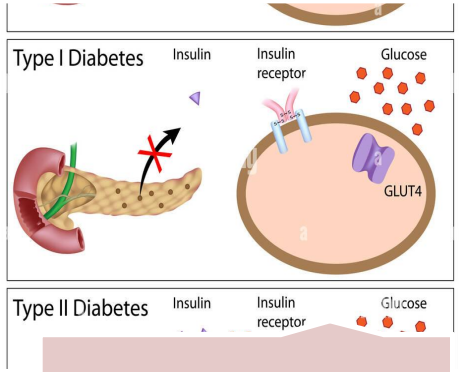
Enzymes → speed up chemical reactions



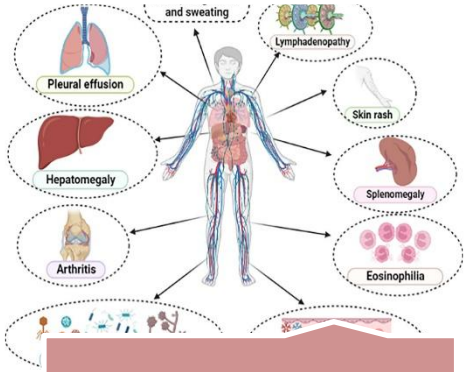
Structural proteins → hair, nails, muscles



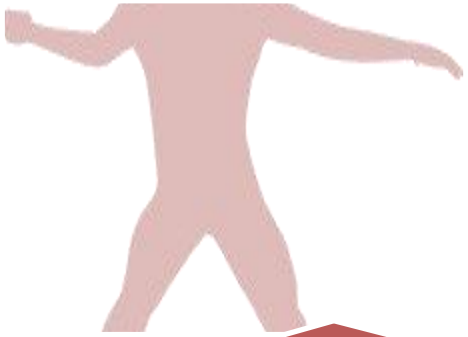
Transport proteins → hemoglobin carries oxygen



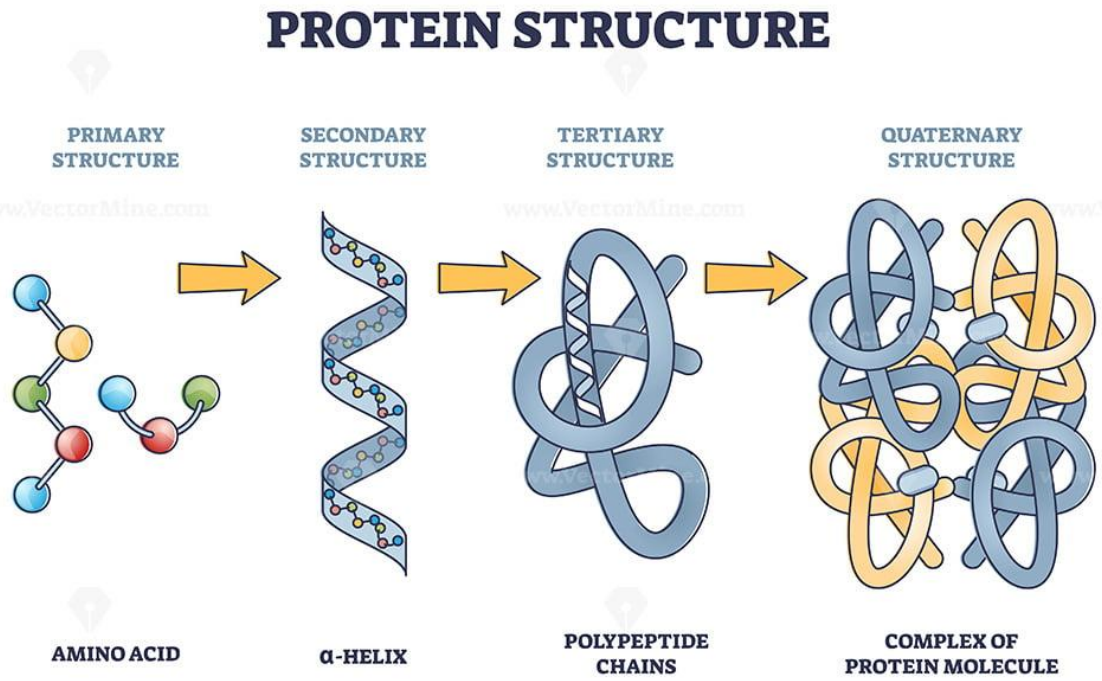
Hormones → insulin



Defense → antibodies



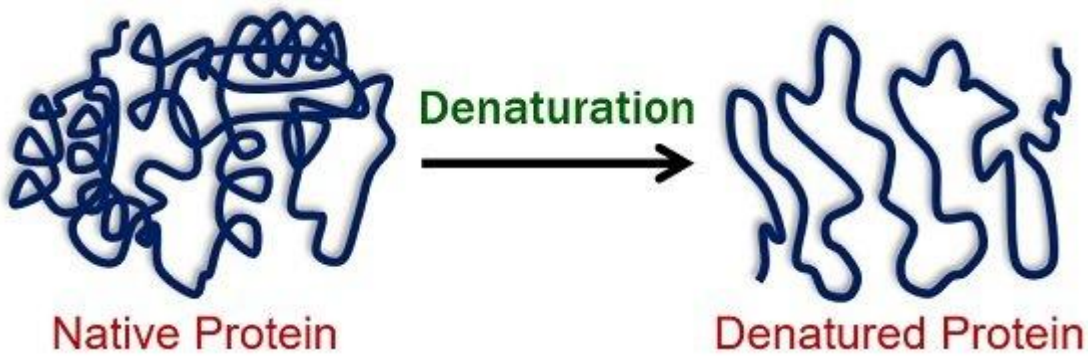
Movement → actin and myosin in muscles



STRUCTURE LEVEL	DESCRIPTION	KEY FEATURES
Primary	Linear amino acid sequence	Peptide bonds
Secondary	Local folding into alpha-helices and beta-sheets	Hydrogen bonds
Tertiary	Overall 3D shape of a single chain	R-group interactions, disulfide bonds
Quaternary	Assembly of multiple polypeptide chains	Subunit arrangement

Denaturation of Protein

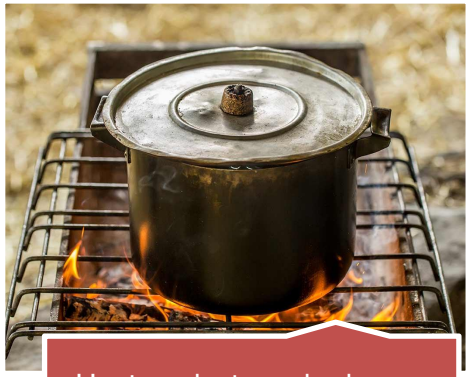
- Denaturation is the loss of a protein's natural 3D structure without breaking the peptide bonds.
- The protein unfolds.
- It loses its biological activity (cannot function normally).Only secondary, tertiary, and quaternary structures are affected.
- Primary structure remains intact.



Denaturation can be reversible or irreversible, depending on the conditions.

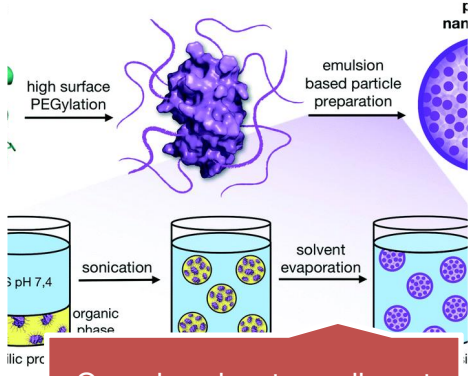
Causes of Denaturation

Common factors that break the weak interactions holding protein structure:

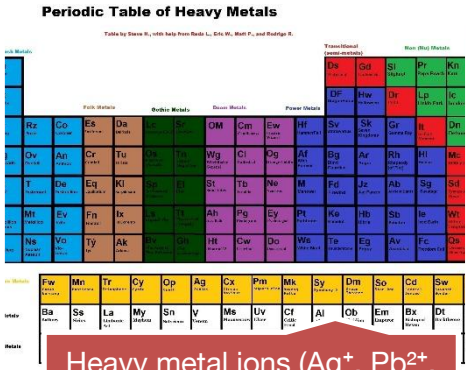


Heat → destroys hydrogen bonds

pH changes → alters charges on amino acids



Organic solvents → disrupt hydrophobic interactions



Heavy metal ions (Ag^{+}, Pb^{2+}, Hg^{2+}) → form strong bonds with proteins

Detergents → break hydrophobic regions

Examples of Denaturation

Cooking an egg → egg white becomes solid

Curdling of milk → acid causes casein protein to denature

Using alcohol for disinfection → alcohol denatures microbial proteins

Straightening hair with heat → heat changes keratin structure

Procedure (Steps)

1. Prepare the Egg

- Take one fresh egg.
- Place it gently into a beaker or pot.

2. Add Water

- Fill the beaker with enough water to fully cover the egg.Place the beaker on the hot plate.

3. Begin Heating

- Turn on the heat and slowly warm the water.
- Observe the water temperature rising.

4. Observe Protein Denaturation

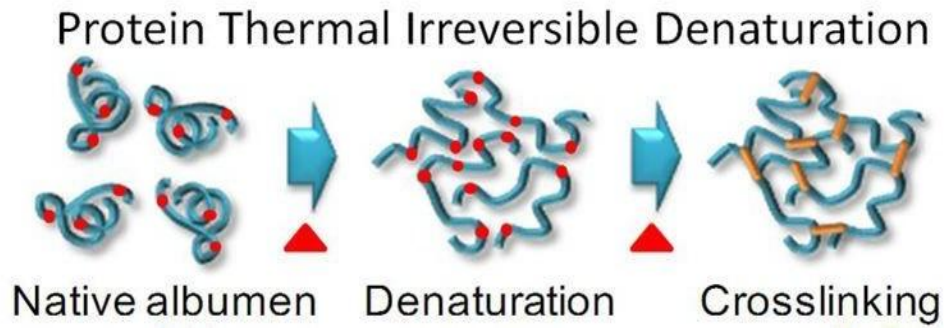
As the water heats:

- Around 60–65°C → egg white proteins (albumin) start to denature and turn cloudy.
- Around 70–80°C → egg white becomes opaque and firm.
- Around 65–70°C → egg yolk thickens as its proteins denature.
- Over 80–90°C → yolk becomes fully solid.5.

Finish Cooking

- After about 8–12 minutes, turn off the heat.
- Remove the egg using tongs or a spoon.
- Let it cool before handling.

Define what it means for a protein to denature.

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