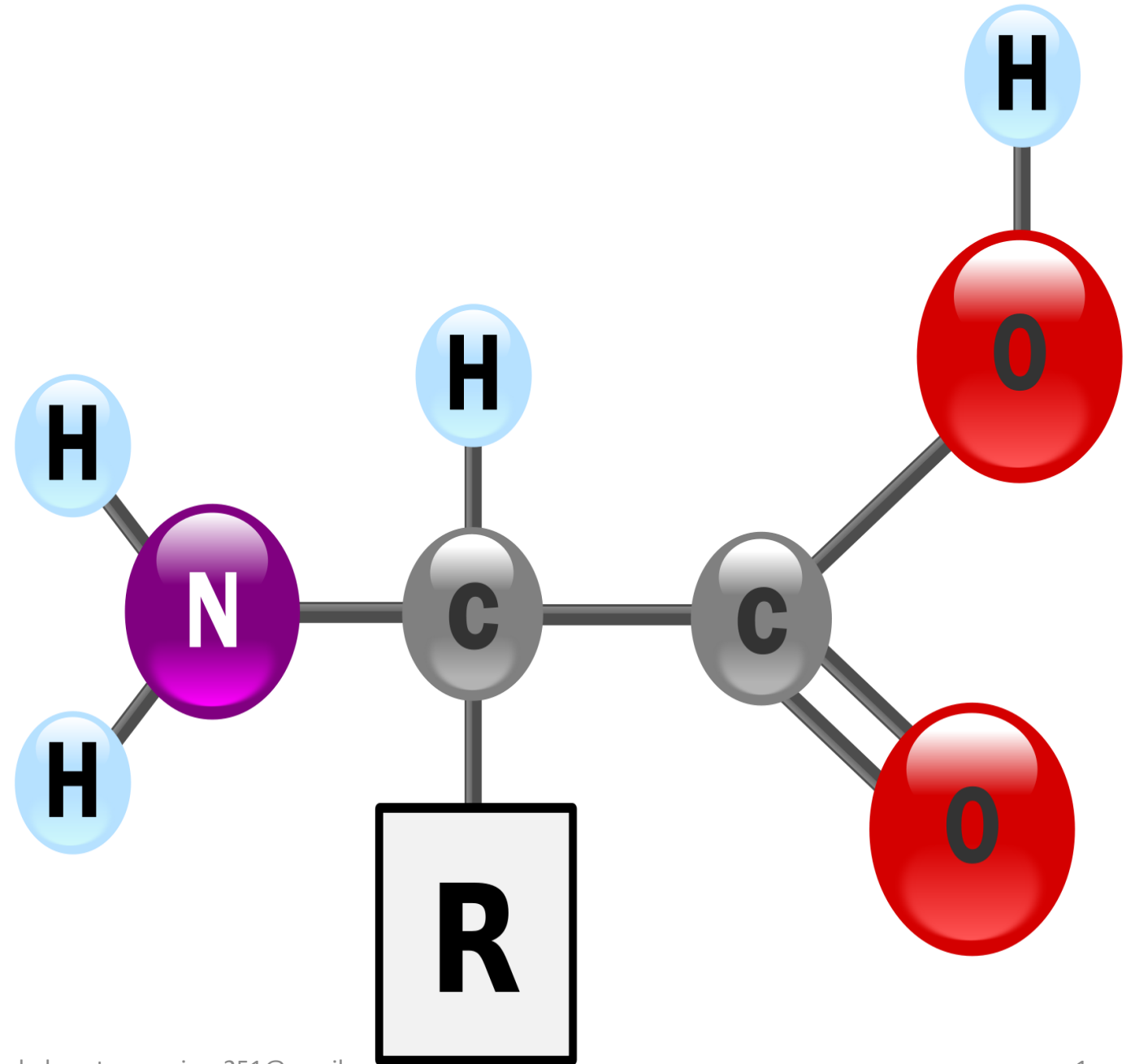


AMINO ACIDS



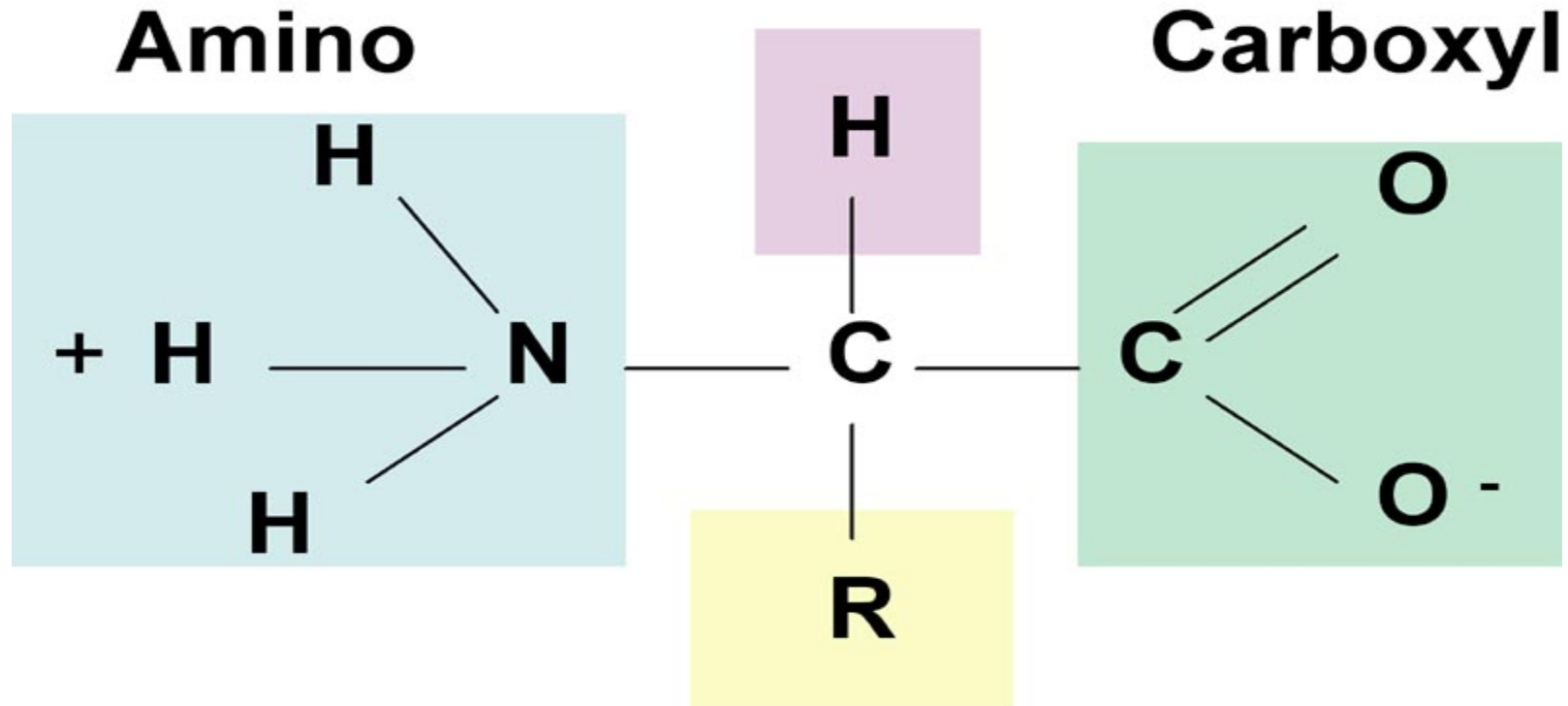
PROTEINS

Biomolecules made up of long chains of amino acid residues joined together via *peptide bonds*.

- The peptide bonds can be hydrolyzed to produce the free amino acid units called *residues*.
- Amino acids are thus the building blocks of proteins.
- There are **20** naturally occurring amino acids in protein

Amino Acid Structure

Hydrogen

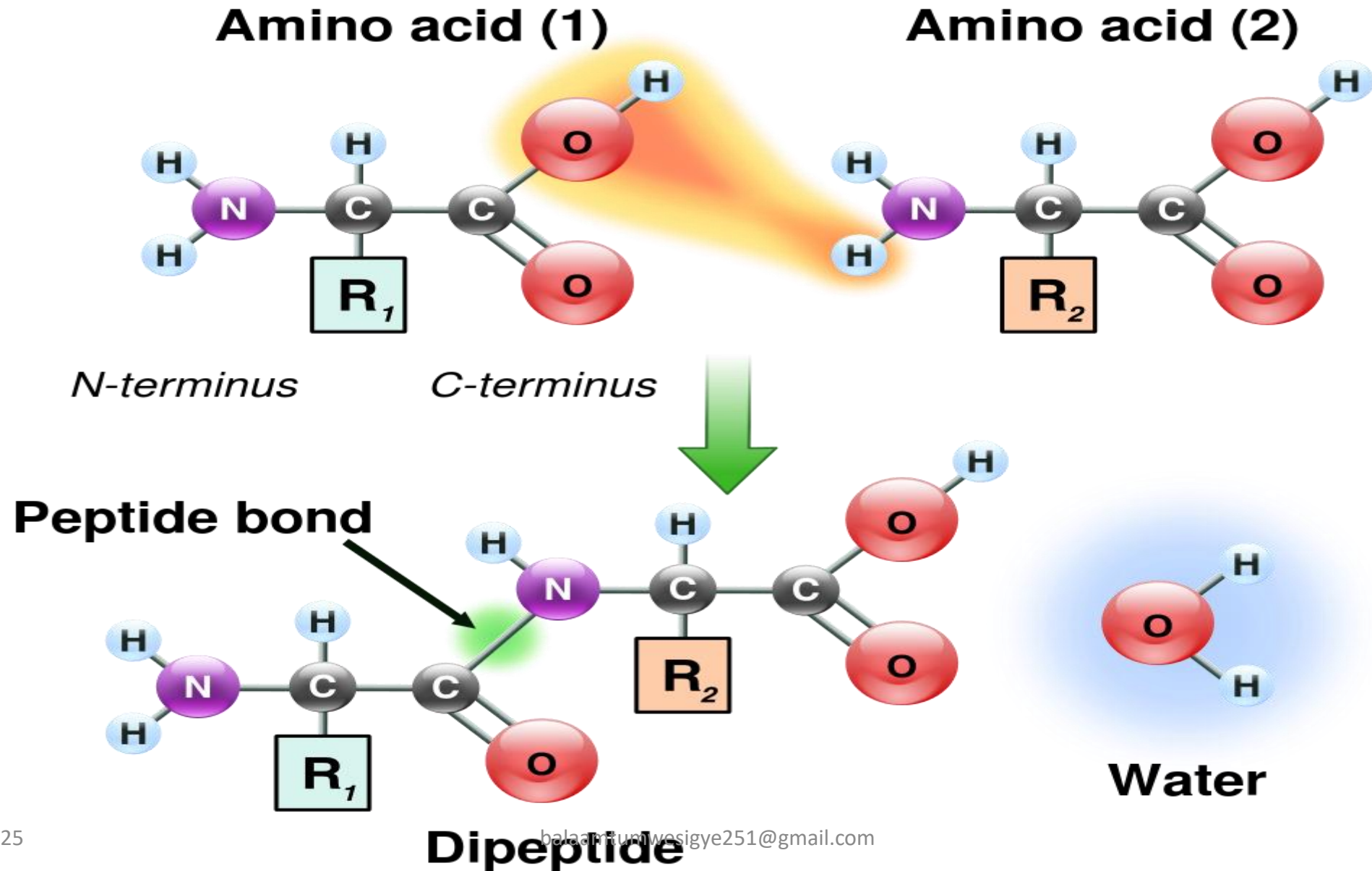


Amino

Carboxyl

R-group
(variant)

Formation of a peptide bond



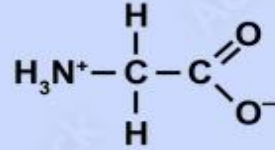
Polar and Nonpolar Amino acids

20 amino acids

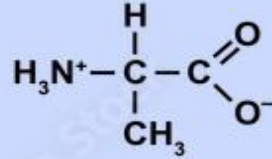
AMINO ACID		SIDE CHAIN	
Aspartic acid	Asp D	negative	
Glutamic acid	Glu E	negative	
Arginine	Arg R	positive	
Lysine	Lys K	positive	
Histidine	His H	positive	
Asparagine	Asn N	uncharged polar	
Glutamine	Gln Q	uncharged polar	
Serine	Ser S	uncharged polar	
Threonine	Thr T	uncharged polar	
Tyrosine	Tyr Y	uncharged polar	

AMINO ACID		SIDE CHAIN	
Alanine	Ala A	nonpolar	
Glycine	Gly G	nonpolar	
Valine	Val V	nonpolar	
Leucine	Leu L	nonpolar	
Isoleucine	Ile I	nonpolar	
Proline	Pro P	nonpolar	
Phenylalanine	Phe F	nonpolar	
Methionine	Met M	nonpolar	
Tryptophan	Trp W	nonpolar	
Cysteine	Cys C	nonpolar	

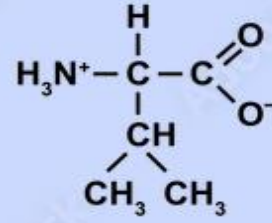
Nonpolar Amino Acids



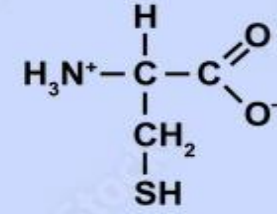
Glycine
(Gly/G)



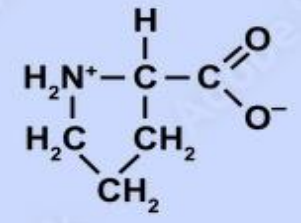
Alanine
(Ala/A)



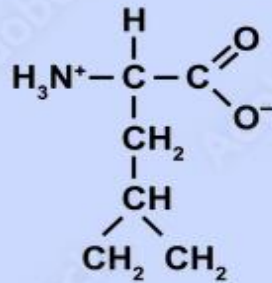
Valine
(Val/V)



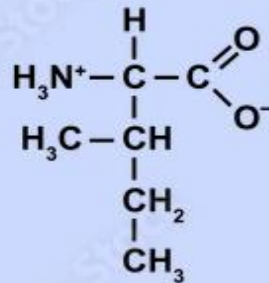
Cysteine
(Cyc/C)



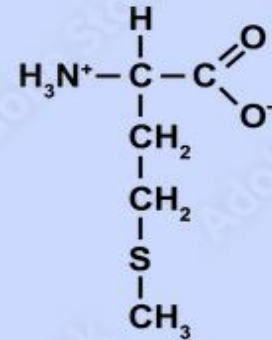
Proline
(Pro/P)



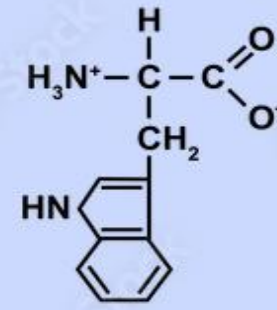
Leucine
(Leu/L)



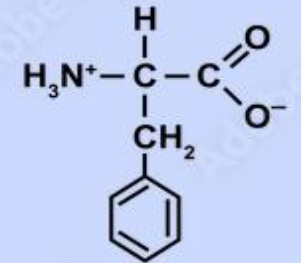
Isoleucine
(Ile/I)



Methionine
(Met/M)



Tryptophan
(Trp/W)

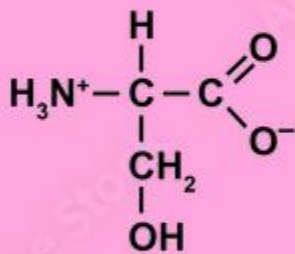


Phenylalanine
(Phe/F)

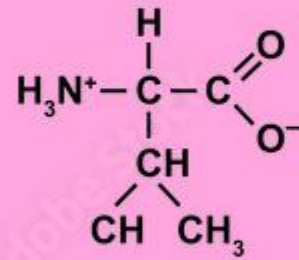
Structure

Adobe Stock | #501955425

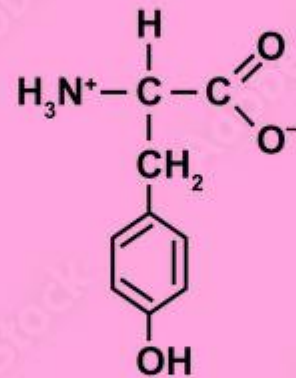
Polar Amino Acids



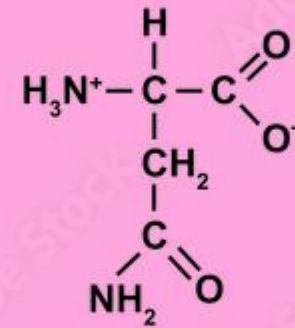
Serine
(Ser/S)



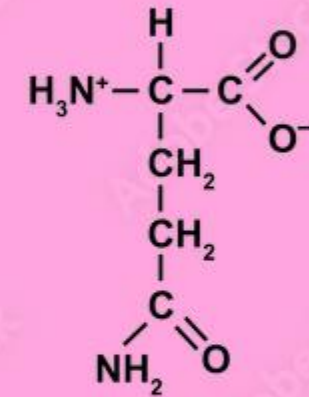
Threonine
(Thr/T)



Tyrosine
(Tyr/Y)



Asparagine
(Asn/N)



Glutamine
(Gln/Q)

Classification of Proteins

1. Complete and Incomplete Proteins

Complete Proteins: Contain all nine essential amino acids (EAAs) in adequate proportions required for human nutrition.

Examples: Animal-based proteins (meat, fish, poultry, eggs, dairy) and some plant-based sources (soybeans, quinoa, amaranth, hempseed, buckwheat, spirulina).

Exception: Gelatin is an incomplete animal protein.

2. Incomplete Proteins

May contain all EAAs but lack them in optimal proportions for human biological functions.

Examples

Most plant-based proteins (legumes, grains, vegetables).

Limiting Amino Acids:

Lysine: Often deficient in cereal grains like corn.

Methionine & Threonine: Sometimes limited in plant proteins.

Classification of Amino Acids

The body produces about half of the 20 amino acids necessary for human health (**Non-Essential Amino Acids**), the other half must be obtained from an outside source such as food or supplements.

- Low levels or deprivation of essential amino acids may result in degradation of the body's proteins potentially leading to hormonal imbalances, lack of concentration, irritability, and even depression.

Three classes of amino acids

(i) Essential: cannot be made by the human body since the body lacks the enzymes necessary for their biosynthesis. They are obtained through food /diet.

There are nine, they include: **Histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine.**

(ii) Non-Essential: are capable of being synthesized within our body without the presence of food **e.g. alanine, asparagine, aspartic acid, and glutamic acid.**

(iii) Conditional or Conditionally Essential

Are usually not required in the diet unless the body is stressed or ill, in which case these amino acids need to be supplied exogenously (from an outside source) as it is unable to synthesize specific amino acids in adequate amounts to support good health.

- (In short, these are only needed when there is something wrong with the body that prevents it from producing essential amino acids.) e.g. include: **arginine, cysteine, glutamine, tyrosine, glycine, ornithine, proline, and serine.**

Functions of Proteins

- **Enzymatic catalysis:** Enzymes are proteins that speed up chemical reactions e.g. metabolic enzymes.
- **Transport and storage** e.g. Hb, Mb, transferrin and ferritin. Some proteins transport molecules in the blood e.g. hemoglobin carries oxygen.
- **Coordination of motion** e.g. muscle proteins, spindle, tubulins etc.. Actin and myosin accounts for movement in cells and the ability for muscles to contract.
- **Impulse generation and signal transmission** e.g. rhodopsin of eye and acetylcholine at synapses.

Other functions of proteins

- **Mechanical support** e.g. collagen in skin, flesh, tendons, muscles and bone. Keratin makes up hair and nails and Collagen which gives support to ligaments, tendons and skin are structural proteins.
- **Body defense (immunity)** e.g. antibodies (Ig), clotting factors and complements. Antibodies are proteins that combine with foreign substances and destroy them.
- **Impulse generation and signal transmission** e.g. rhodopsin of eye and acetylcholine at synapses.
- Proteins in the plasma membrane form channels that allow substances to enter the cell and are carriers that transport molecules into and out of the cell.
- **Growth regulation and differentiation** e.g. hormone, growth factors, cytokines etc.. Hormones are proteins that influence cellular metabolism such as growth.

Properties of proteins

- A pure protein is **tasteless and odorless**.
- Most proteins are **soluble in water** but form colloidal solution due to large MW.
- Are **charged amphoteric molecules** due to **-NH₂** and **-COOH**
- Are **precipitated by salts and heavy metals** e.g. **Pb, Hg, Cu and Zn**
- **Denatured by heat** to form insoluble precipitate or coagulum.

Denaturation

- Occurs when the normal bonding patterns of proteins are disturbed causing the shape of the protein to change.

This can be caused by changes in **temperature, pH, or salt concentration** e.g. acid causes milk to curdle and heat or cooking causes egg whites to coagulate because the proteins within them denature.

- If the protein is not severely denatured, it may regain its normal structure.

Protein structure

PRIMARY structure

SECONDARY structure

TERTIARY structure

QUATERNARY structure



Amino acid

Beta sheet

Peptide

Protein

Primary Structure

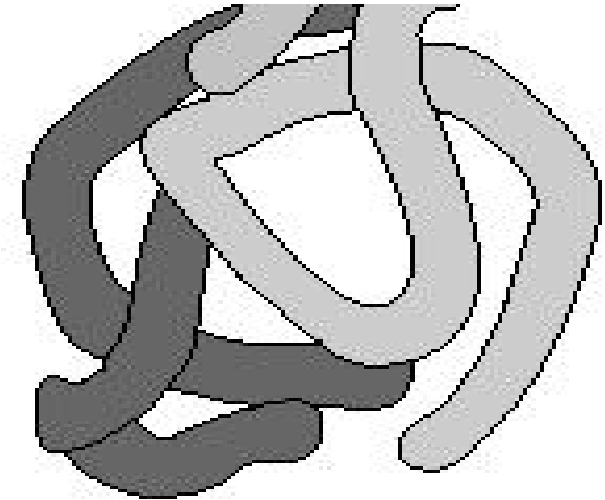
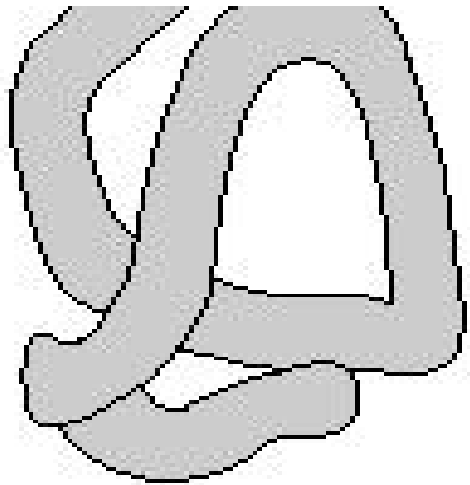
- Primary structure refers to the sequence of amino acids in a protein.
- Below is the primary structure of one of the polypeptide chains of hemoglobin.

val his leu thr pro glu glu lys ser ala val thr ala leu tyr gly lys val asn
val asp glu val gly gly glu ala leu gly arg leu leu val val tyr pro try thr
gln arg phe phe glu ser phe gly asp leu ser thr pro asp ala val met gly
asn pro lys val lys ala his gly lys lys val leu gly ala phe ser asp gly leu
ala his leu asp asp leu lys gly thr phe ala thr leu ser gln leu his cys
asp lys leu his val asp pro glu asn phe arg leu leu gly asn val leu val
cys val leu ala his his phe gly lys glu phe thr pro pro val gln ala al

Tertiary And Quaternary Structure

Some proteins contain two or more polypeptide chains that associate to form a single protein.

- These proteins have quaternary structure e.g. hemoglobin contains four polypeptide chains.

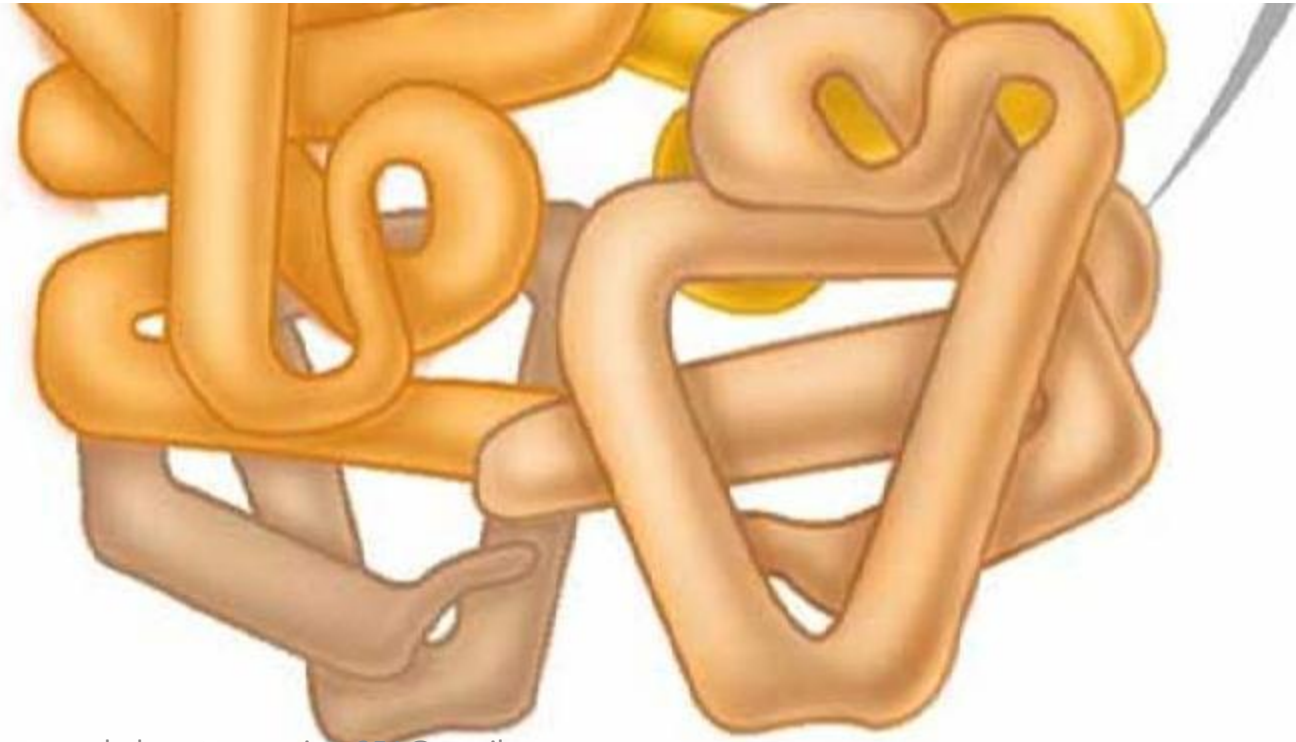


Tertiary structure (bonding between R groups, covalent bonding, hydrogen bonding. It has a 3 dimensional shape)

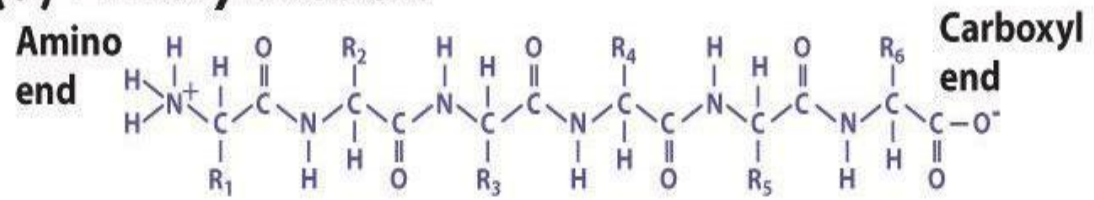
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Quaternary structure of hemoglobin contains four polypeptide chains ($\alpha_2 \beta_2$).

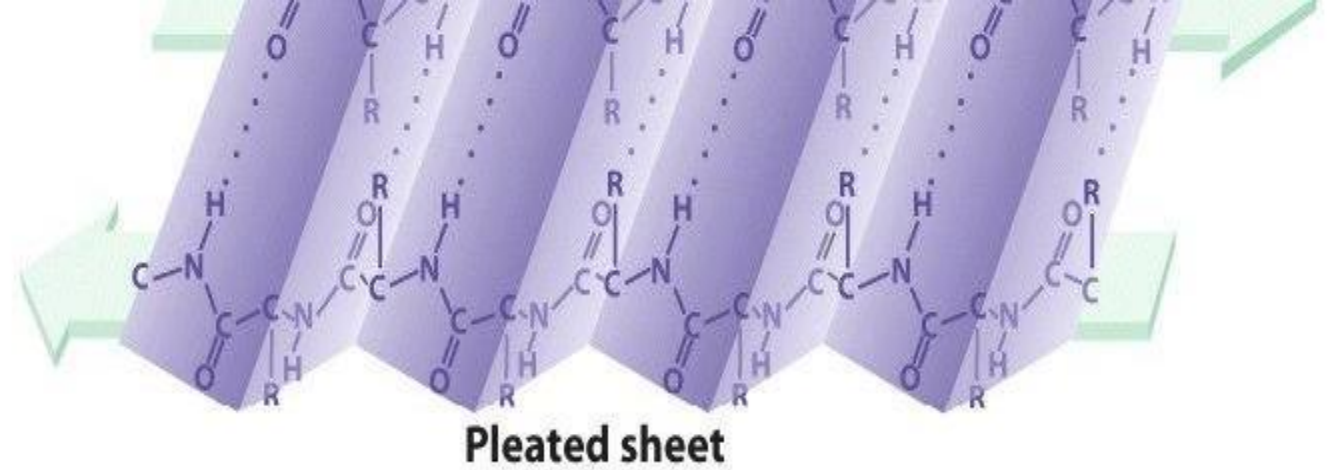
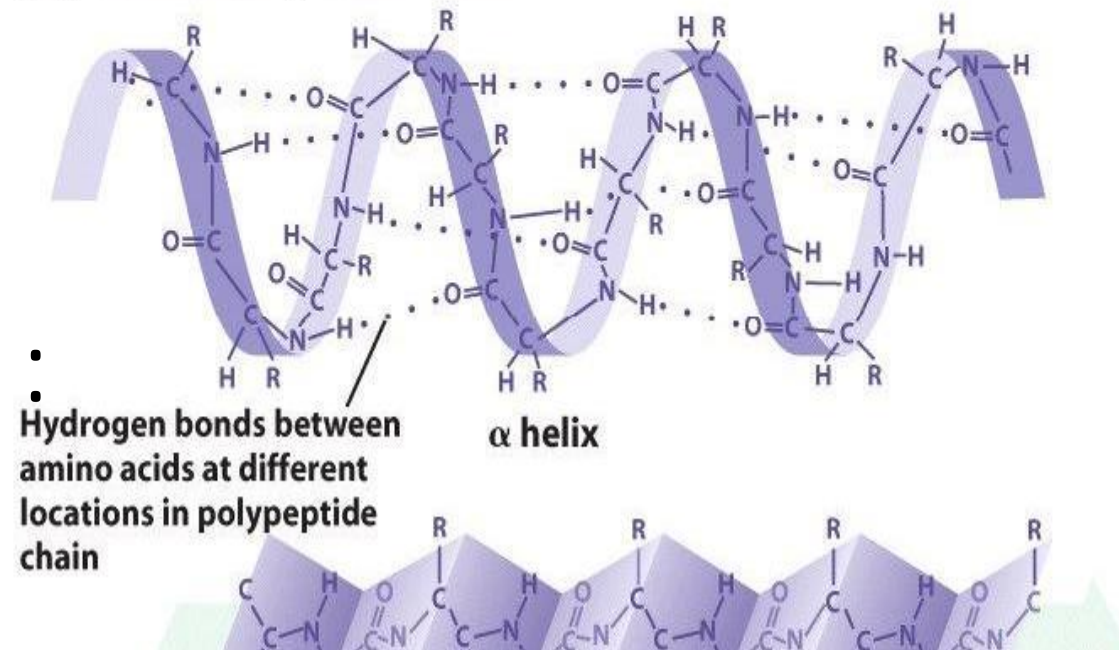
Quaternary structure



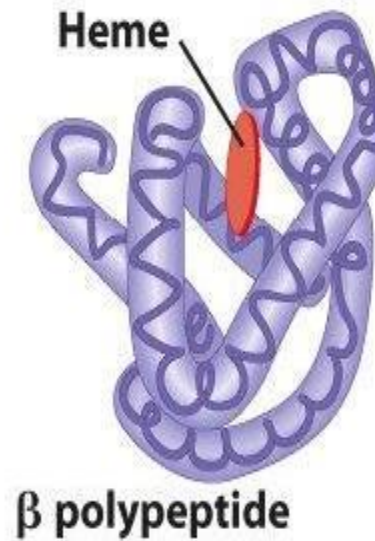
(a) Primary structure



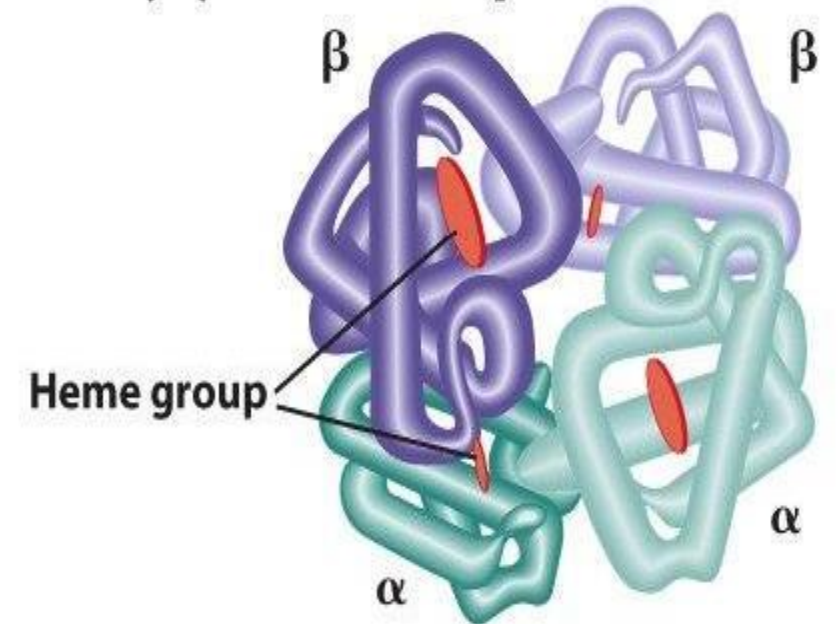
(b) Secondary structure



(c) Tertiary structure

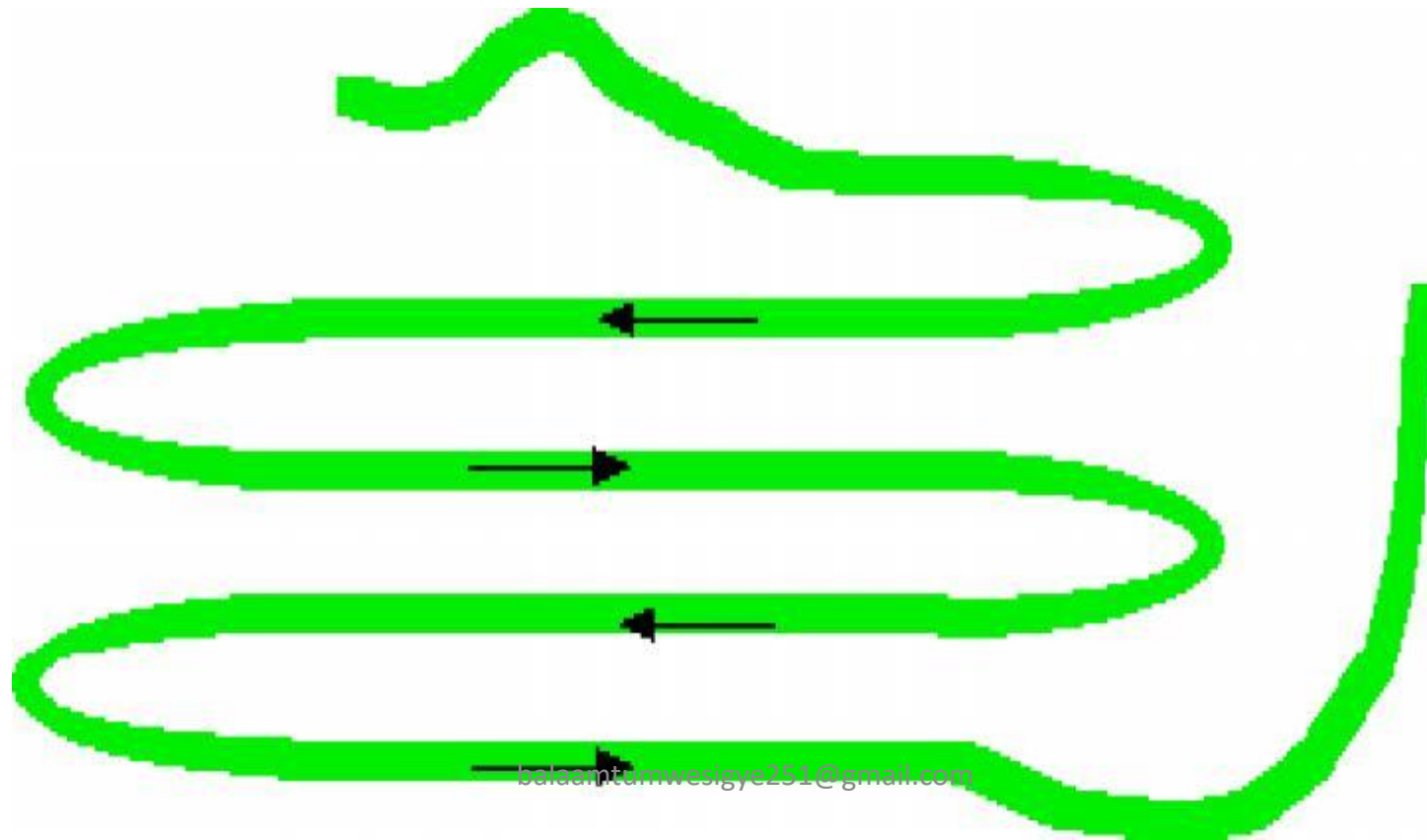


(d) Quaternary structure



Beta-pleated sheets

- In a beta-pleated sheet, the chains are folded so that they lie alongside each other e.g. the diagram shows an "anti-parallel" sheet. Meaning that the next- door chains head in opposite directions.



ANY QUESTIONS