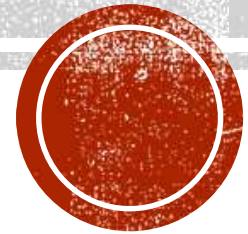
BIOCHEMISTRY

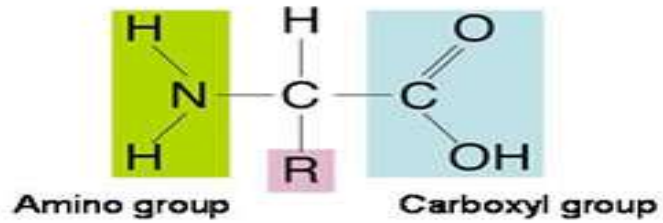


BY: KAREEM HUSSIEN

PROTEINS

WHAT IS .. ?

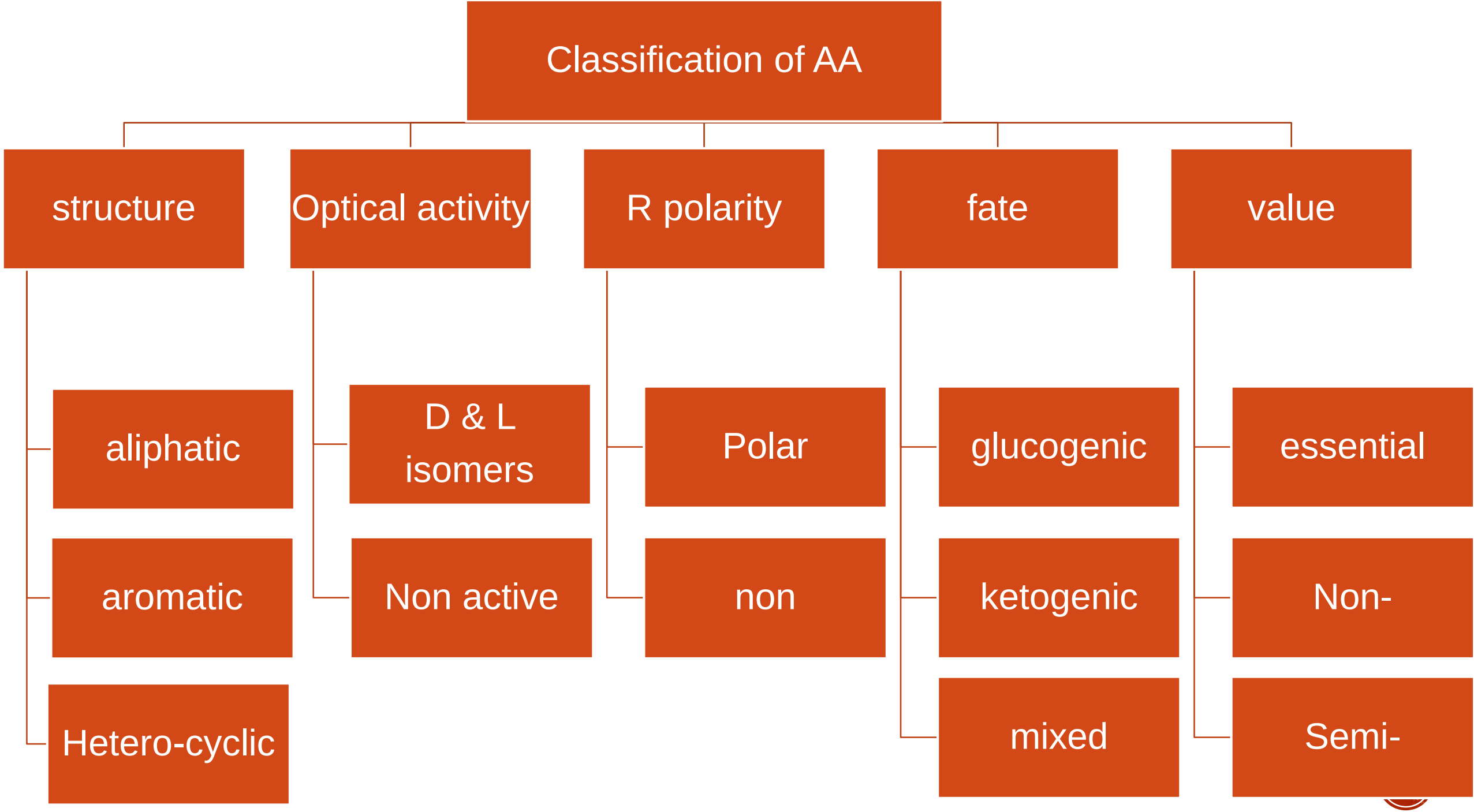
- Proteins are organic nitrogenous compounds formed of C H O & “N”
- Proteins are the polymers of **20** naturally occurring <u>amino acids</u>
- Amino acids are organic acids in which one H is replaced by NH3 usually at **α** carbon (next to COOH group)
- All amino acids have in common
  - central α carbon to which COOH & H & NH2 are attached
  - α carbon is also attached to a side chain called R group which is different for each amino acid
  - N and C terminals
- There are 3 categories of Amino acids
  1. Primary protein amino acids
  2. Non primary protein amino acids
  3. Non protein amino acids



General structure

FUNCTIONS OF PROTEINS

- DYNAMIC
  1. Transport of molecules across cell membrane or between cells
     - Haemoglobin carries oxygen
     - Protein carriers carry glucose across cell membrane
     - Transferrin carry iron
     - Albumin carries Ca, fatty acids and bile pigments
  2. Catalytic role : **Enzymes** that are protein in nature
  3. Metabolic regulations : some hormones are protein like **Insulin**
  4. Contraction of the muscle : actin and myosin are proteins
  5. Storage : ferritin is storage form of iron
- STRUCTURAL
  1. They are components of cell membrane, cytoplasm and cell organelles
  2. Mechanical support
     - Collagen and elastin → ligaments tendon and blood vessels
     - Keratin → skin, hair and nails
     - Ossien → bone


Classification of AA
structure
Optical activity
R polarity
fate
value
aliphatic
aromatic
Hetero-cyclic
D & L isomers
Non active
Polar
non
glucogenic
ketogenic
mixed
essential
Non-
Semi-

1. STRUCTURE

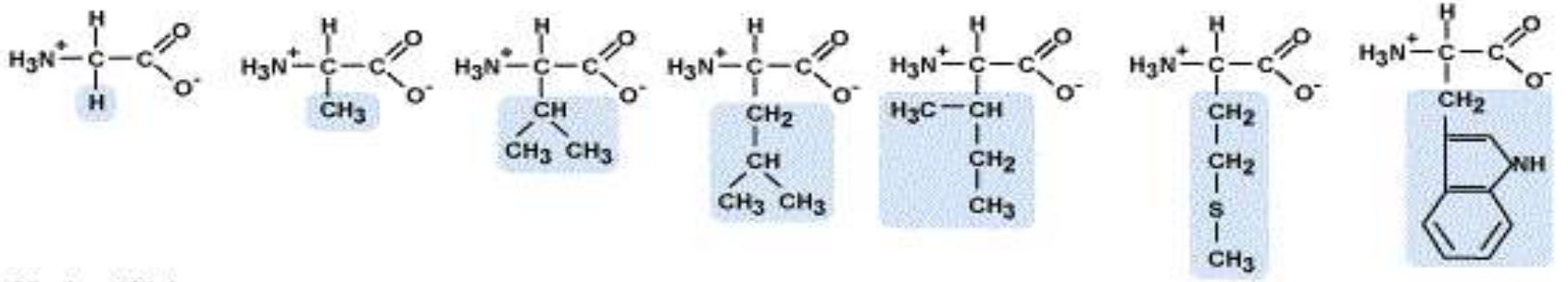
A. **Aliphatic** (have no ring structure)
   1. Neutral : (NH2=COOH) ex. Glycine
   2. Basic : (NH2>COOH) ex. arginine
   3. Acidic : (COOH>NH2) ex. Aspartic acid
   4. With NH2 in their side chain ex. Asparagine

B. **Aromatic** (with benzene or phenol rings)

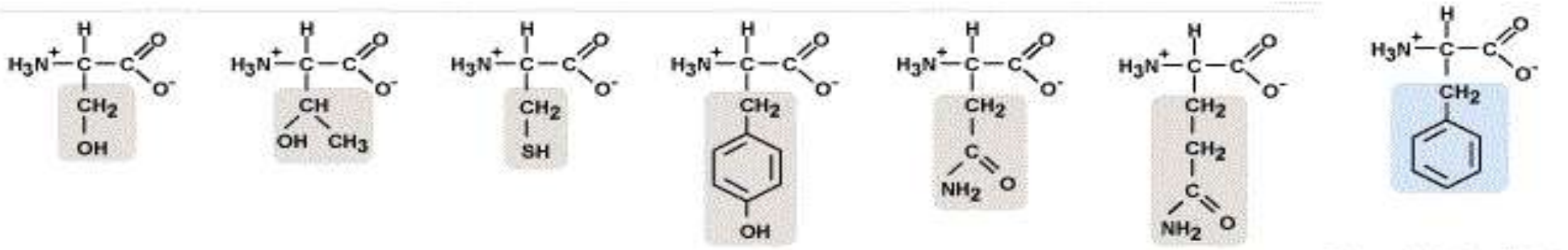
   Ex. Phenylalanine & tyrosine

C. **Heterocyclic** (has also other types of rings)

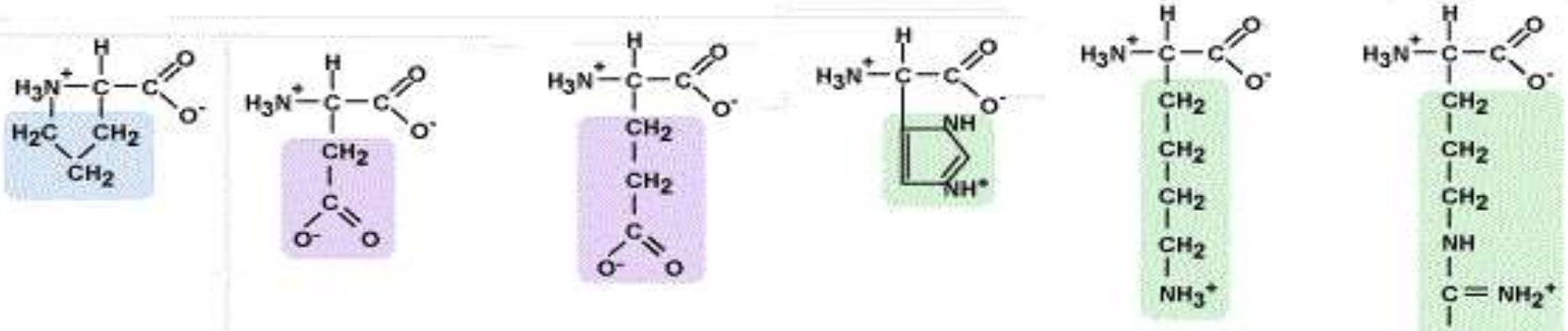
   Ex. Histidine & tryptophan



Glycine (Gly) Alanine (Ala) Valine (Val) Leucine (Leu) Isoleucine (Ile) Methionine (Met) Tryptophan (Trp)



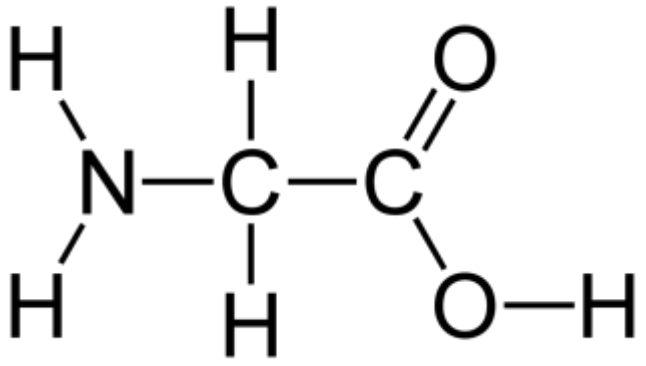
Serine (Ser) Threonine (Thr) Cysteine (Cys) Tyrosine (Tyr) Asparagine (Asn) Glutamine (Gln) Phenylalanine (Phe)

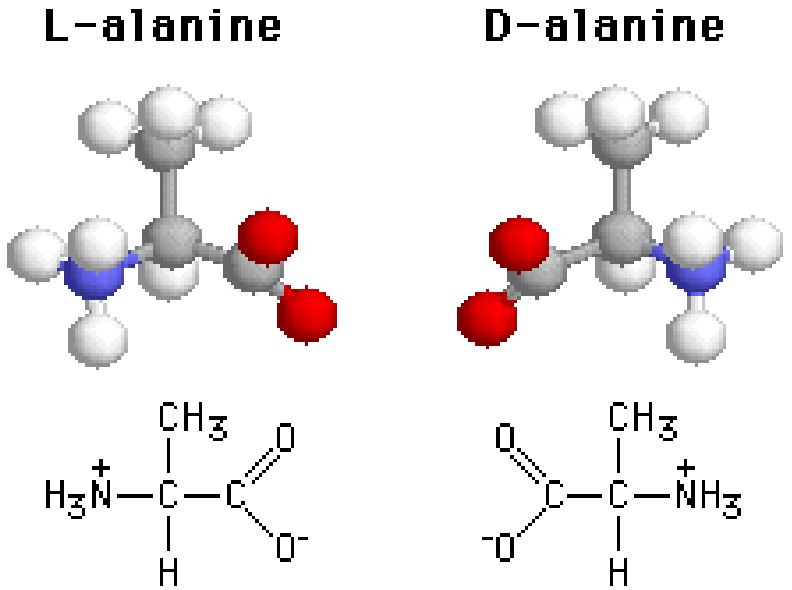


Proline (Pro) Aspartic Acid (Asp) Glutamic Acid (Glu) Histidine (His) Lysine (Lys) Arginine (Arg)

2. OPTICAL ACTIVITY

- All amino acids are Optically active and show D & L Isomers as they contain an asymmetric **α** carbon except “glycine” which is non optically active
- D-amino acids : with their NH2 to the right of **α** carbon
- L-amino acids : with their NH2 to the left of **α** carbon
- All of the amino acids in our body are of the L-amino acids (3aks el sugars)





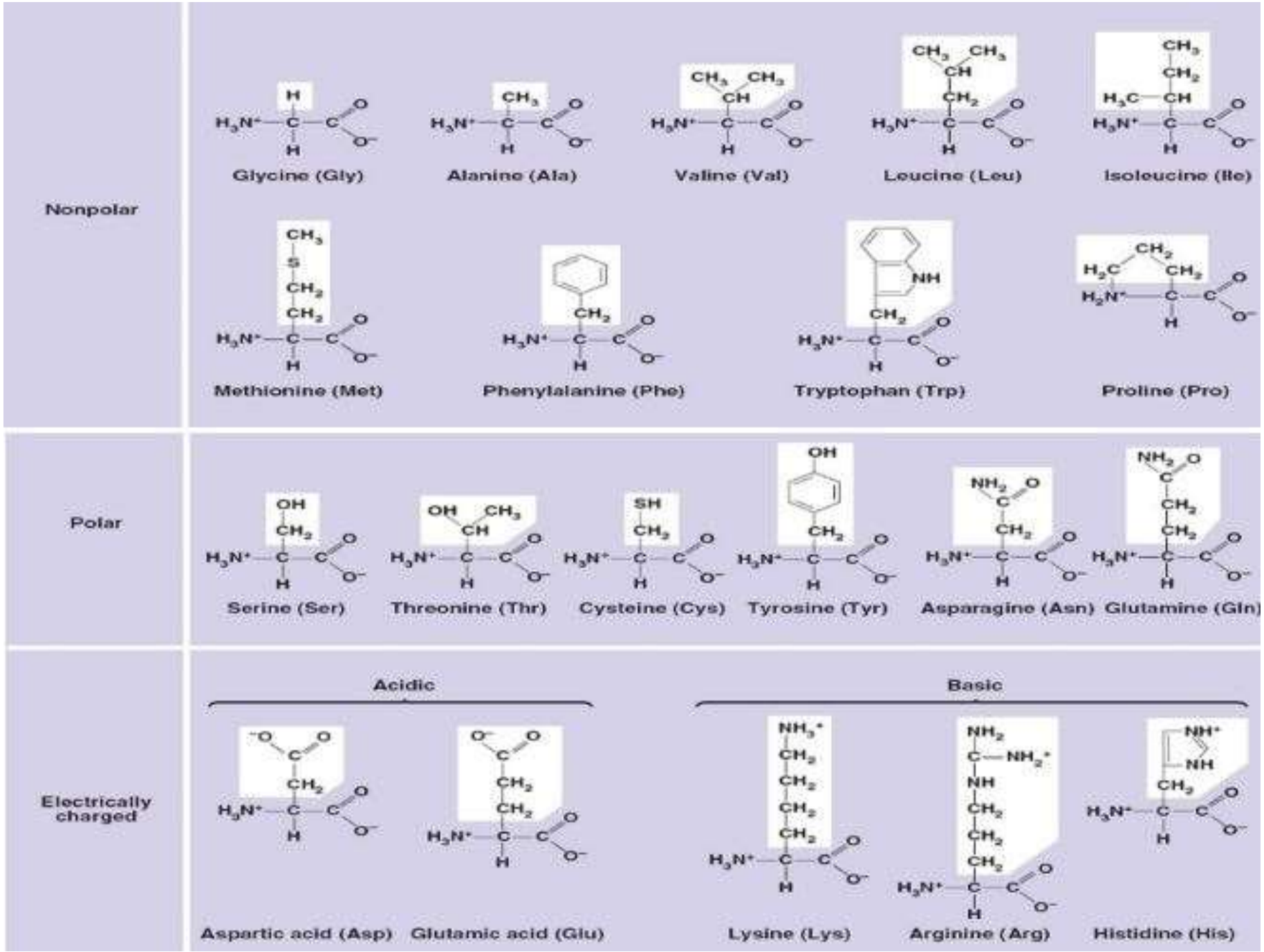
3. POLARITY OF “R”

1. **Non polar** (hydrophobic) (have no reacting groups) (least soluble in water) (do not bind or give protons)

   Ex. Alanine , leusine

   - Their side chains tend to coalesce interiorly in an aqueous solution (hydrophobicity) like a drop of oil in water

2. **Polar** (hydrophilic) (have reacting groups)
   A. Polar Uncharged (have Neutral polar functional group that can hydrogen bond with water) (containing OH, SH OR NH)
   B. Polar Charged (have an active reactive group) (offering or demanding protons) so they may be ACIDIC or BASIC


Nonpolar
Glycine (Gly)
Alanine (Ala)
Valine (Val)
Leucine (Leu)
Isoleucine (Ile)
Methionine (Met)
Phenylalanine (Phe)
Tryptophan (Trp)
Proline (Pro)
Polar
Serine (Ser)
Threonine (Thr)
Cysteine (Cys)
Tyrosine (Tyr)
Asparagine (Asn)
Glutamine (Gln)
Electrically charged
Acidic
Basic
Aspartic acid (Asp)
Glutamic acid (Glu)
Lysine (Lys)
Arginine (Arg)
Histidine (His)

4. NUTRITIONAL VALUE

1. **Essential** amino acids

Cant be synthesized in the body so must be taken in the diet

Ex. Valine , leucine , isoleucine ,…..

1. **Non essential** amino acids

Can be synthesized in the body

Ex. Glycine , alanine , aspartic ,…..

- Arginine and Histidine are called **semi-essential** because they are synthesized in the body in a rate enough for adults but not for growing individuals

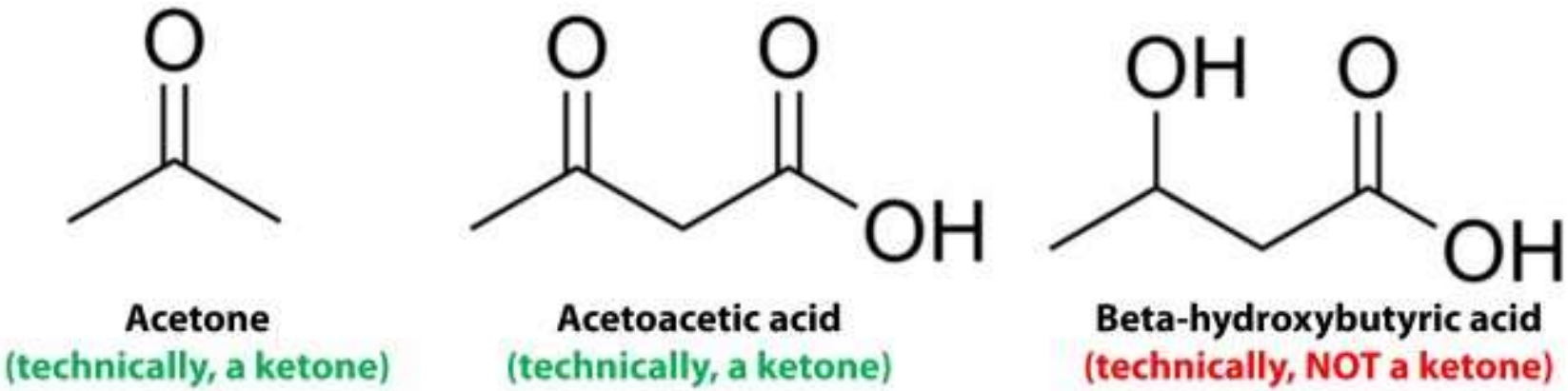
Essential Amino Acids	Non-Essential Amino Acids
Histidine	Alanine
Isoleucine*	Arginine**
Leucine*	Asparagine
Lysine	Aspartic acid
Methionine	Cysteine**
Phenylalanine	Glutamic acid
Threonine	Glutamine**
Tryptophan	Glycine**
Valine*	Proline**
	Selenocysteine**
	Serine
	Taurine**
	Tyrosine**

**Branched-chain amino acid*

***Conditionally essential amino acid*

5. METABOLIC FATE

1. **Ketogenic** amino acids



Part will enter the fatty acid metabolic pathway .. The other into glucose pathway

Ex. Lysine , tryptophan ,….

Gluconeogenic	Gluconeogeneic or ketogeneic	Ketogeneic
Glycine	Threonine	Leucine
Serine	Isoleucine	Lysine
Valine	Phenylalanine	
Histidine	Tryptophan	
Arginine	Tyrosine	
Cysteine		
Proline		
Alanine		
Glutamate		
Glutamine		
Aspartate		
Asparagine		
Methinoine		

PROPERTIES OF AMINO ACIDS

1. **Optical activity**
2. **Amphoteric property**

In solution, amino acids act as both acid and alkali d.t the presence of acidic group (COOH-) and basic group (-NH2)

3. **Isoelectric point** (zwitter ion state)

It's the pH at which the protein carries equal +ve and –ve charges

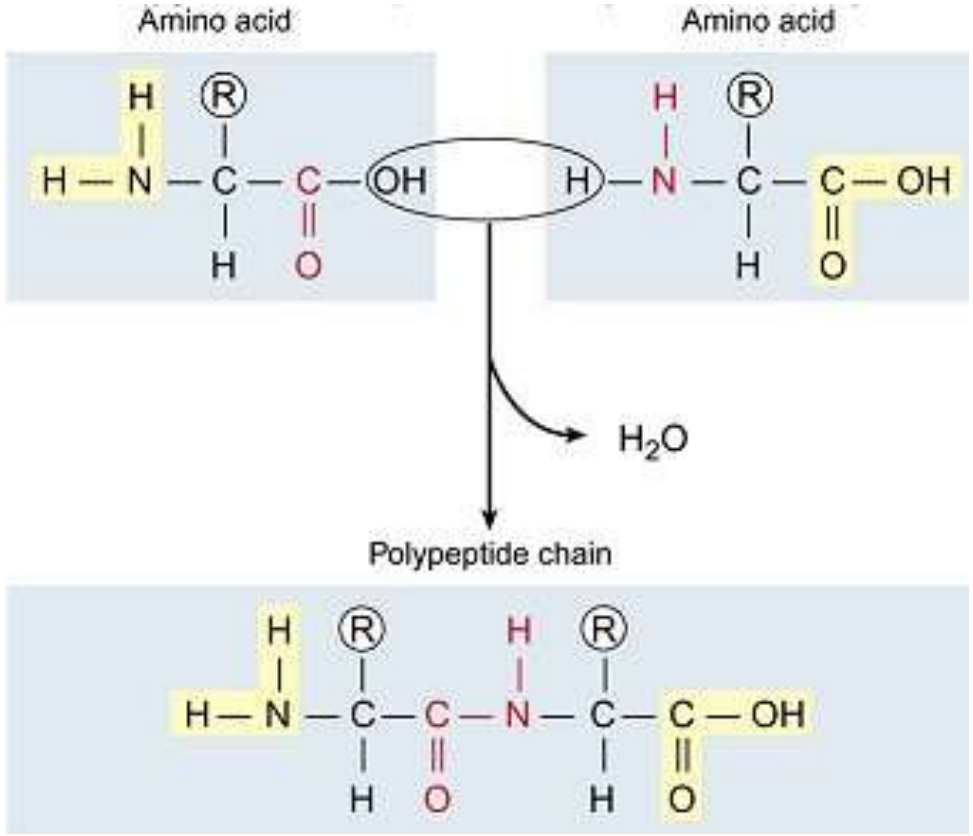
At this point

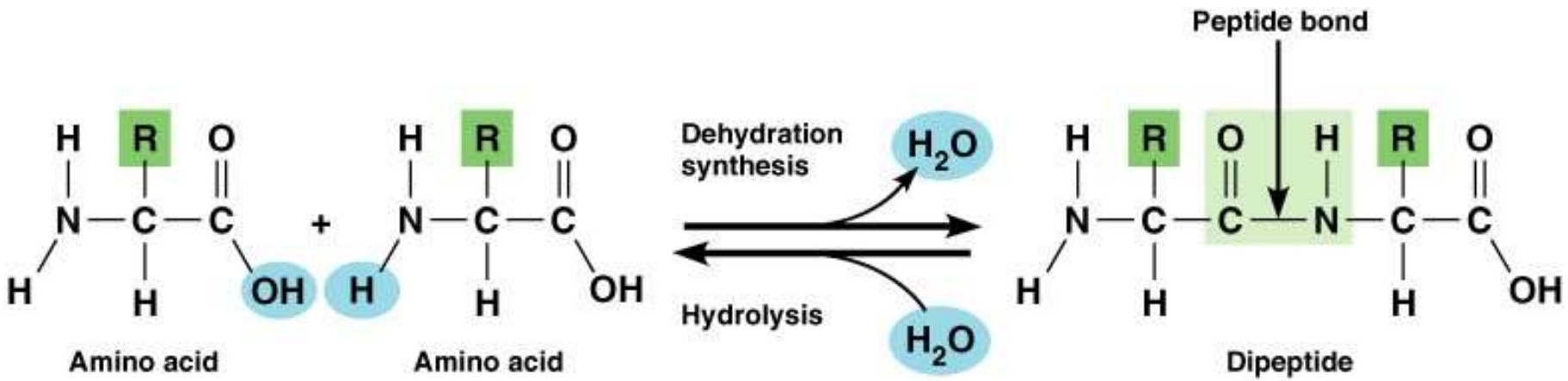
- Proteins and enzymes loose their function
- Their viscosity in solution becomes maximal
- Their solubility becomes minimal (easily precipitated)

FORMATION OF PROTEINS

- Amino acids → peptide and polypeptides → protein
- Amino acids form peptides in a “dehydration” reaction (peptide bonds)
- Polypeptides contain 10-100 amino acid .. Peptides with more than 100 amino acids are called proteins
- 2 types of bonds are responsible for the structure

1. **Covalent** (strong bonds)(favor stability resist denaturation)
   A. Peptide bonds : COOH combines NH_3 with removal of water
   B. Disulphide bonds : between 2 Cysteine a.a in the same or diff polypeptide chains
2. **Non covalent** (weak bonds)(favor protein folding)
   A. Hydrogen bonds
   B. Hydrophobic bonds (help stabilize protein structure)
   C. Ionic bonds (repulsive or attractive)

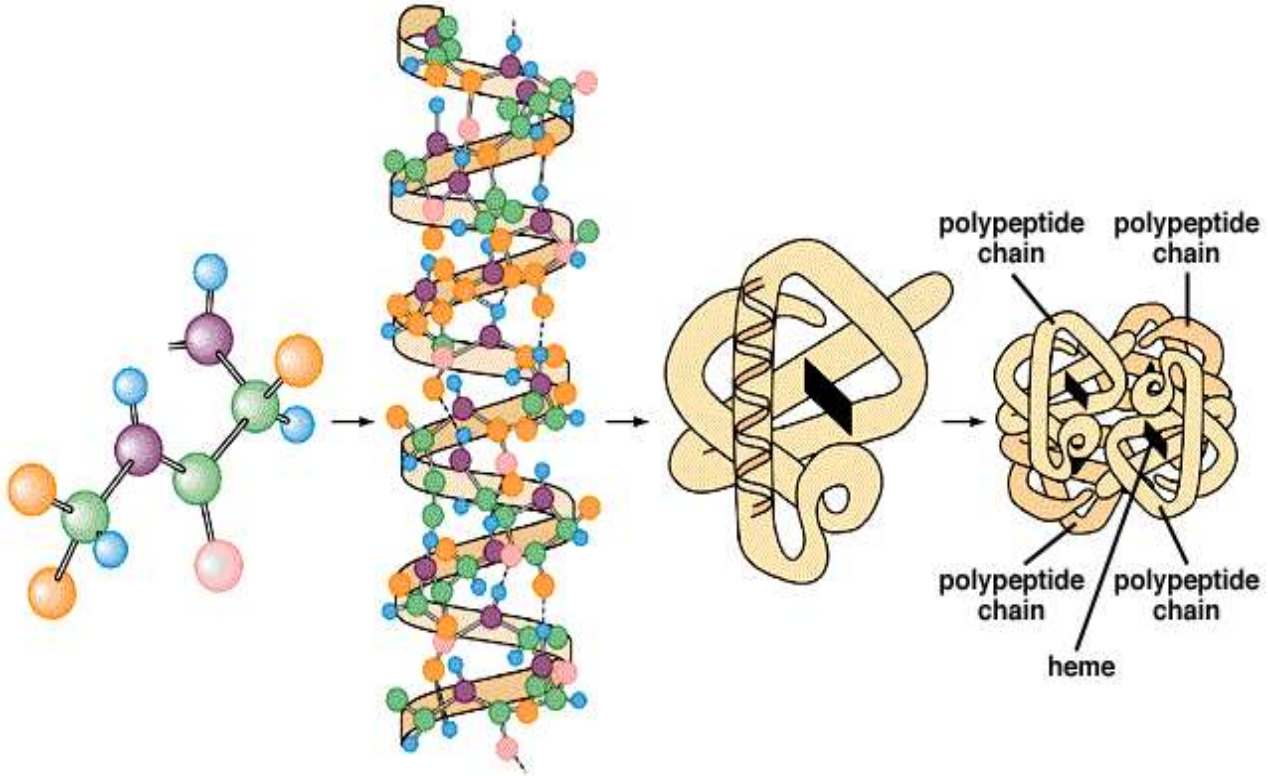




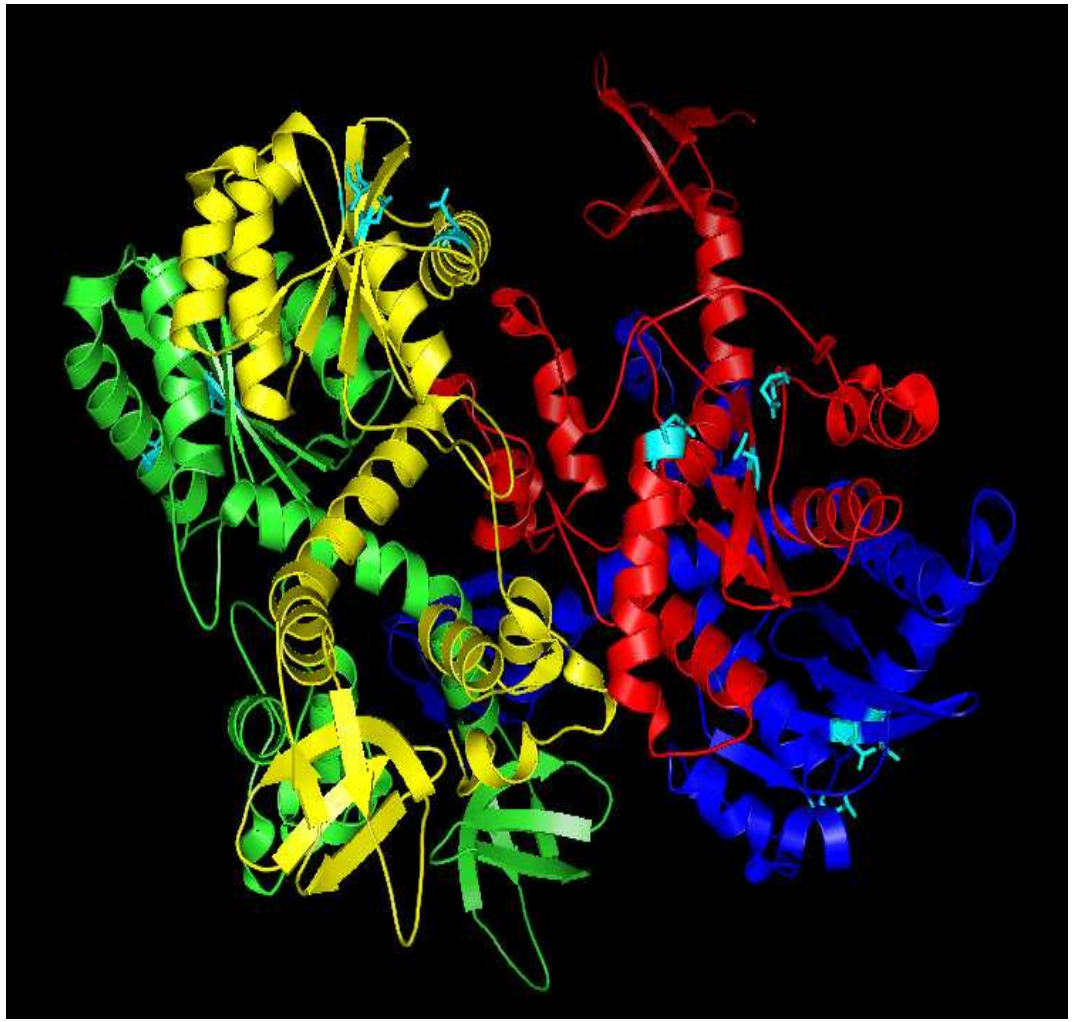
CONFORMATION OF PROTEINS

- Proteins have a 3 dimensional shape (primary, secondary and tertiary structure) that is required for its function .. Some proteins formed of 2 or more polypeptide chains have also a quaternary structure
- Primary : refers to no. and sequence of a.a in polypeptide chain (straight)
- Secondary : as a result of coiling and folding of the polypeptide chain, it takes two forms either (α-helical) or (β-pleated sheets)
- Tertiary : it is the three dimensional structure of each polypeptide chain, it takes the form of either (fibrous) or (globular) domains
- Quaternary : in proteins of 2 or more polypeptide chains .. An example of this is hemoglobin made of 2 α and 2 β chains

The Four Levels of Protein Structure



Summary of the four levels of protein structure, using hemoglobin as an example.



DENATURATION OF PROTEINS

- Loss of native structure by many causes leading to changes in secondary, tertiary and quaternary structure due to rupture of non covalent bonds (never peptide bond) with loss of biological activity
- All levels of structure are disrupted except primary (strong peptide bond)
- CAUSES
  - **Physical causes :** heating above 70, powerful shaking, repeated freezing and melting, UV and high pressure
  - **Chemical causes :** urea, alcohol, strong bases & acids, salts of heavy metals as MG
- EFFECTS
  - Decreased solubility and rate of diffusion
  - Increased viscosity due to unfolding
  - Loss of activity
  - Change in antigenic property