Proteins

Proteins are essential parts of living organisms and participate in virtually every process in cells.

Proteins

Which are made of

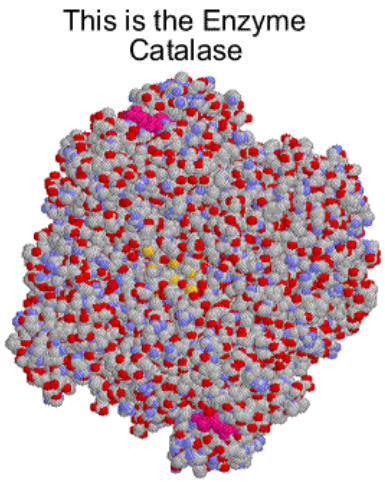
Amino Acids

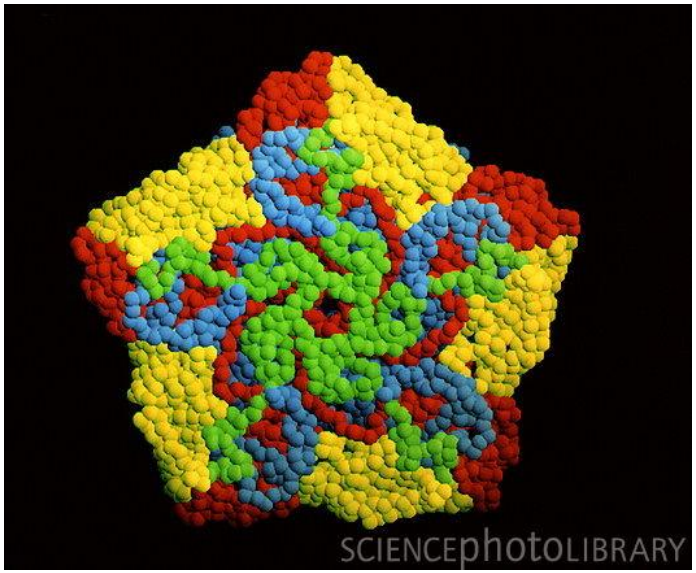
which contain

Carbon, hydrogen, oxygen, nitrogen,

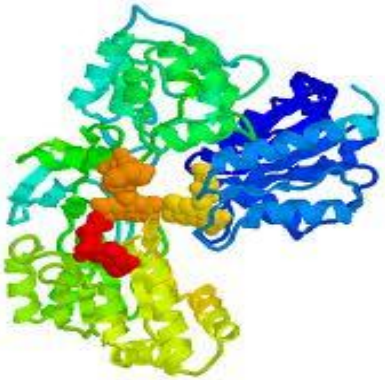
main function

CATALYSIS & STRUCTURE /SUPPORT





Protein coat of polio virus

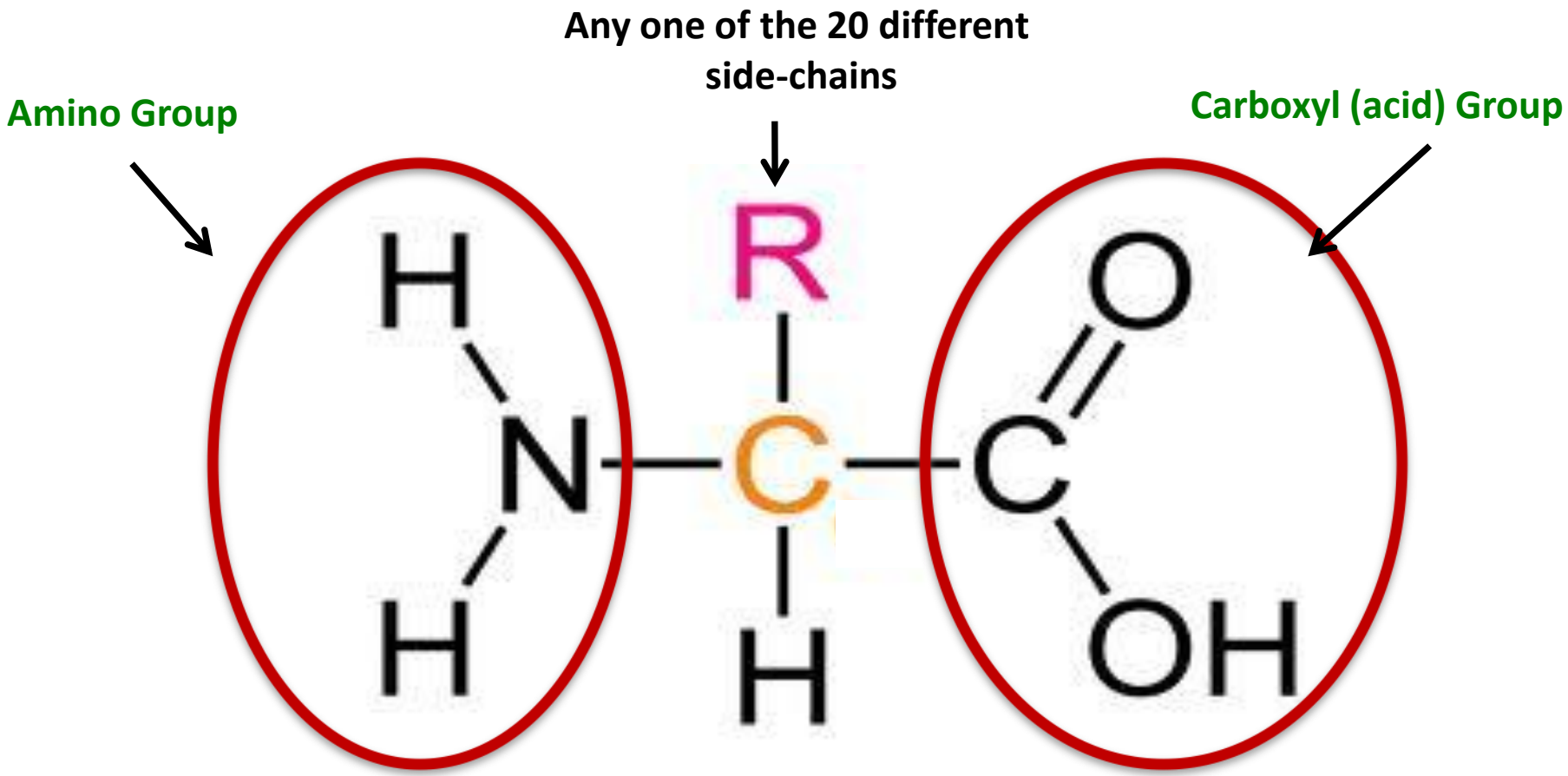


Types	Function/Example
Enzymatic **Catalytic**	**Acceleration of chemical reactions** **E.g., digestive enzymes (lactase, amylase), cellular respiration**
Structural	Collagen & elastin, keratin in hair and nails
Transport	**Transport of other substances** E.g., hemoglobin transports O_2 to cells
Hormonal	**Cellular communication** E.g., insulin secreted by the pancreas
Contractile	**Movement** E.g. actin and myosin in muscle cells
Defensive	**Protect against disease** E.g., antibodies (such as immunoglobulin) combat viruses and bacteria

Proteins and their subunits

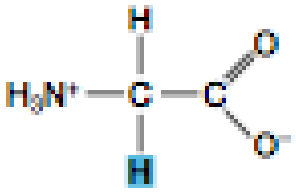
Amino acids are the building blocks of proteins

Amino Acid Structure

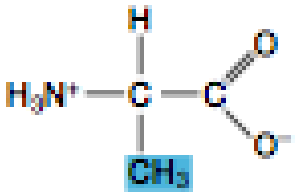


Proteins and their subunits

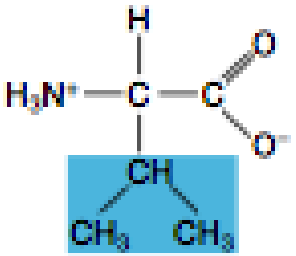
Examples of amino acids



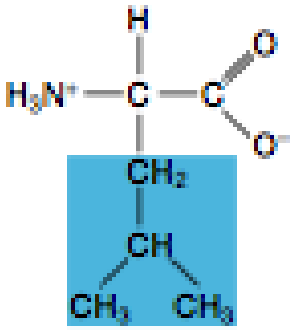
glycine



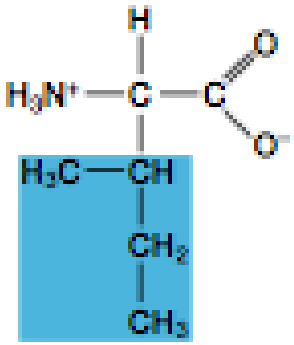
alanine



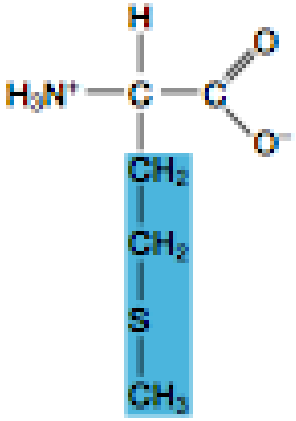
valine



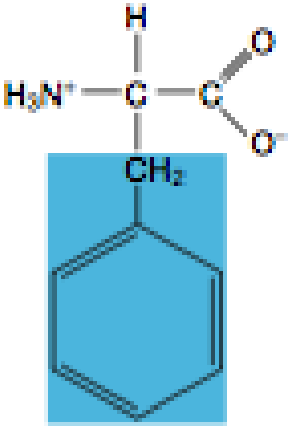
leucine



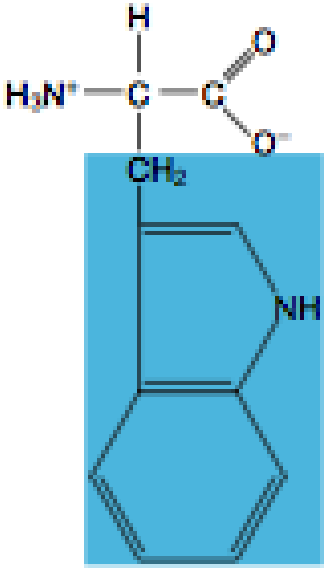
isoleucine



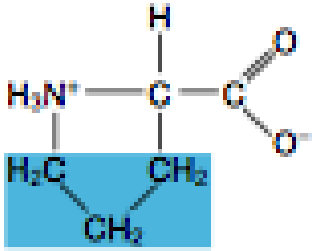
methionine



phenylalanine



tryptophan



proline

Proteins and their subunits

20 Major Amino Acids

8 are considered "essential"

1. Phenylalanine
2. Valine
3. Threonine
4. Tryptophan
5. Isoleucine
6. Methionine
7. Leucine
8. Lysine

The other 12

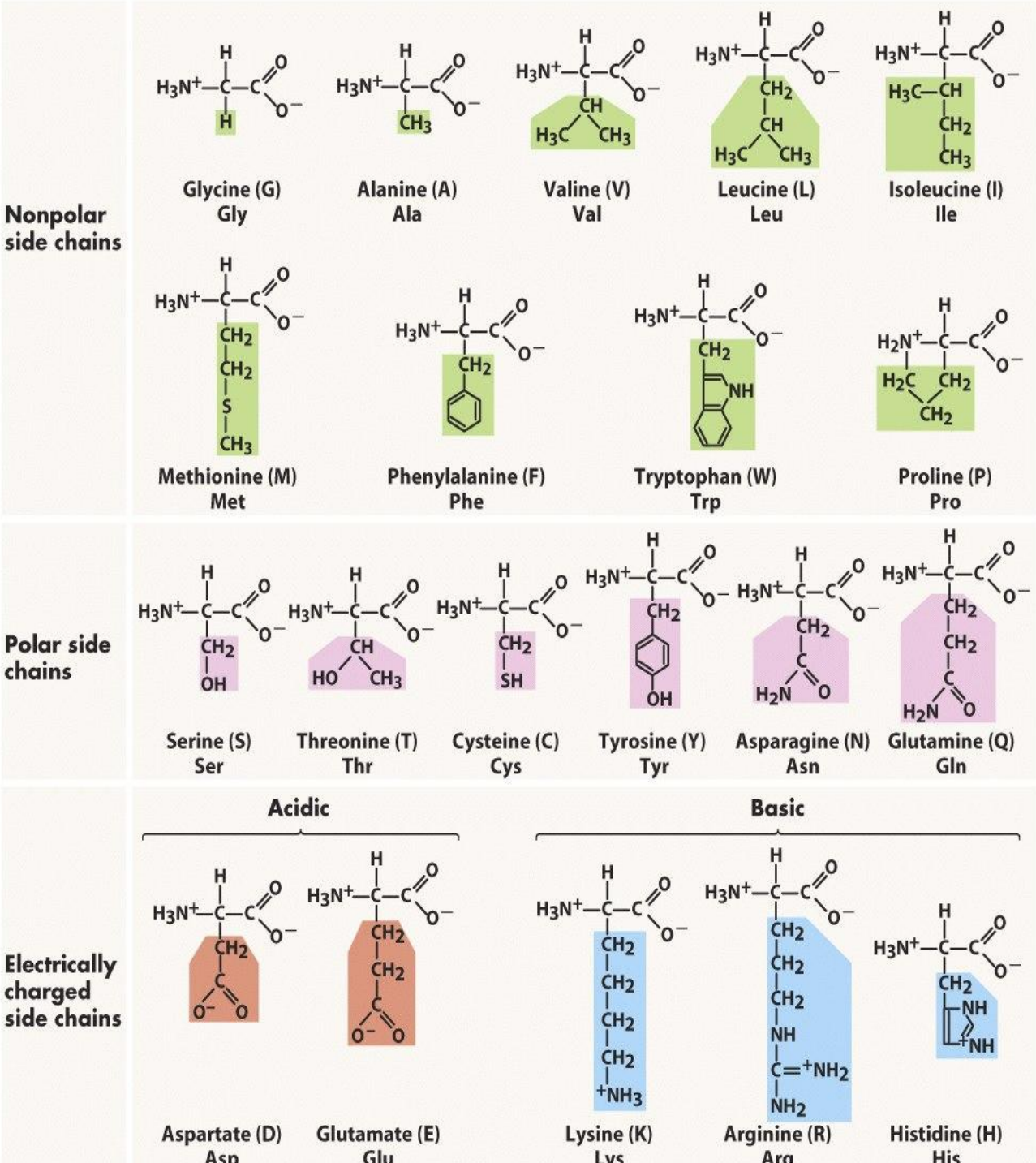
1. Glycine
2. Alanine
3. Proline
4. Serine
5. Cysteine
6. Asparagine
7. Glutamine
8. Histidine
9. Tyrosine
10. Aspartic acid
11. Glutamic acid
12. Arginine

Types of Amino Acids

Nonpolar
Polar
Polar/Acidic
Polar/Basic

Amino acids each have their own unique chemical properties.

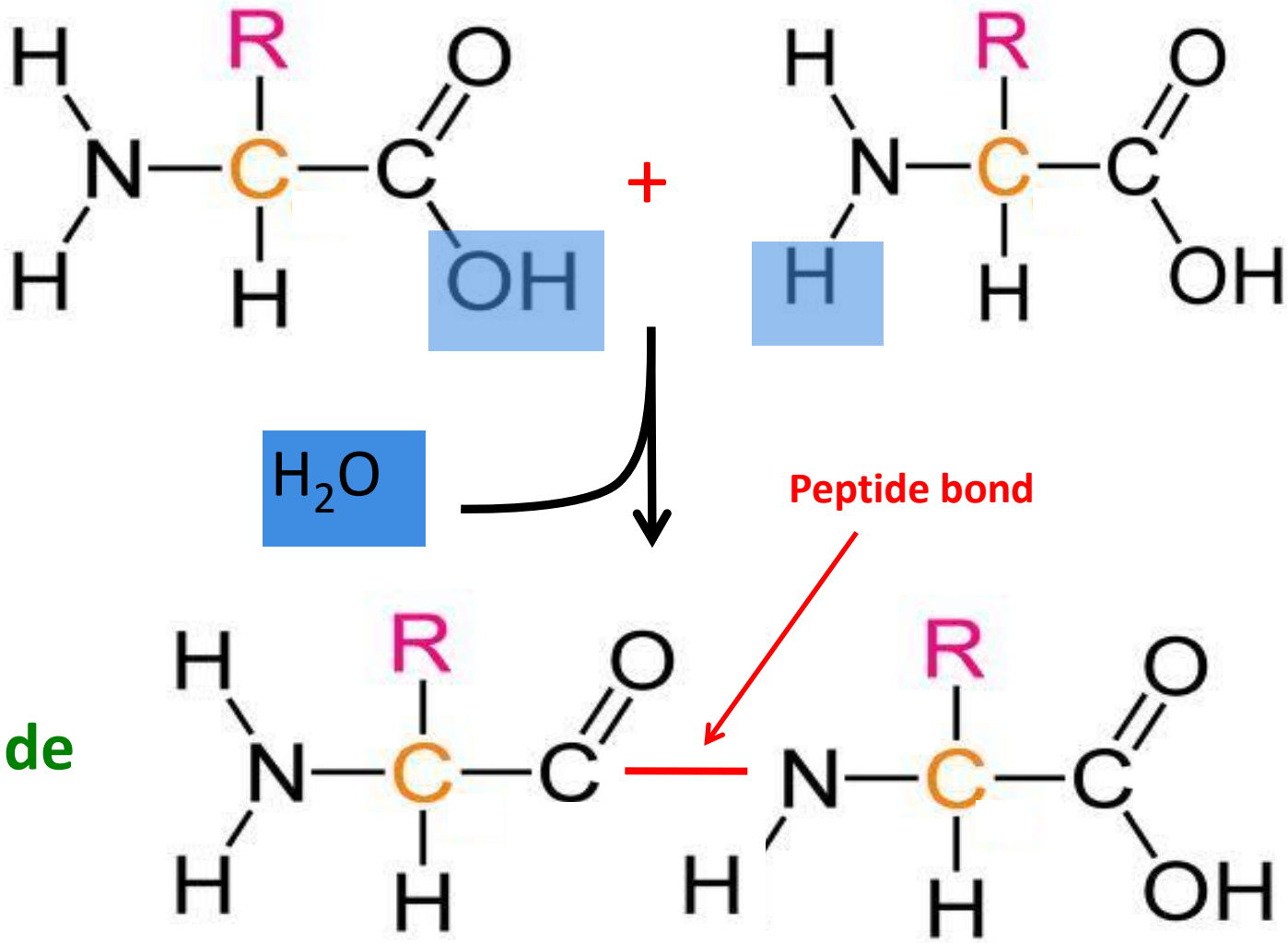
Some dissolve in water – some do not.
This is essential for transport and storage.


Nonpolar side chains
Glycine (G) Gly
Alanine (A) Ala
Valine (V) Val
Leucine (L) Leu
Isoleucine (I) Ile
Methionine (M) Met
Phenylalanine (F) Phe
Tryptophan (W) Trp
Proline (P) Pro
Polar side chains
Serine (S) Ser
Threonine (T) Thr
Cysteine (C) Cys
Tyrosine (Y) Tyr
Asparagine (N) Asn
Glutamine (Q) Gln
Electrically charged side chains
Acidic
Basic
Aspartate (D) Asp
Glutamate (E) Glu
Lysine (K) Lys
Arginine (R) Arg
Histidine (H) His

Making and Breaking Proteins

Amino acids are linked together by peptide bonds

- a special covalent bond found in proteins



Making and Breaking Proteins

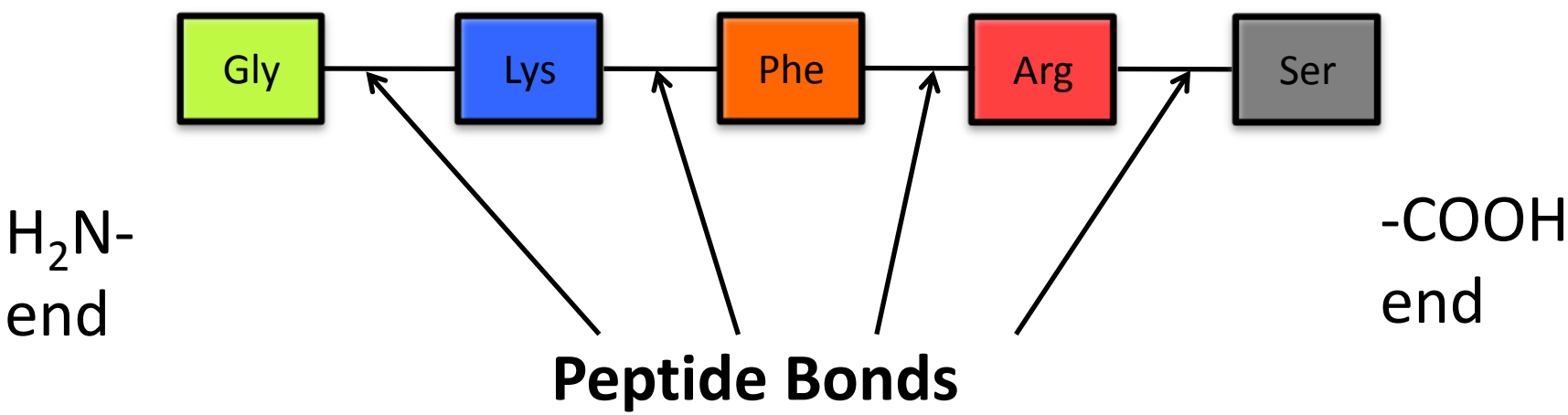
Condensation synthesis

- two amino acids join (dipeptide)
- a peptide bond is formed
- a water molecule is formed

Hydrolysis

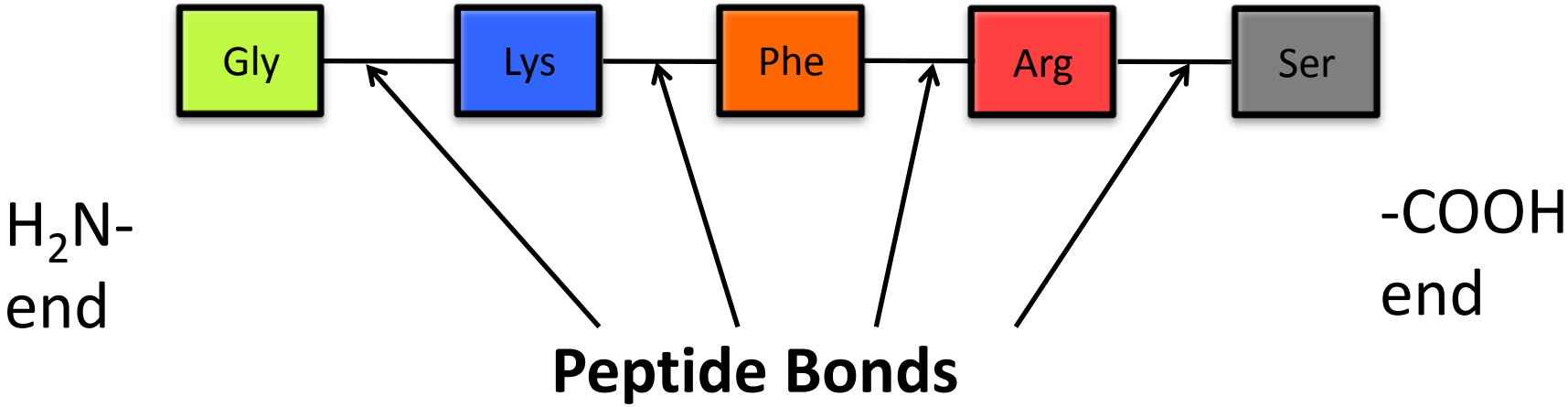
- water is added
- a peptide bond is broken
- amino acids are split apart

A chain of amino acids is called a polypeptide



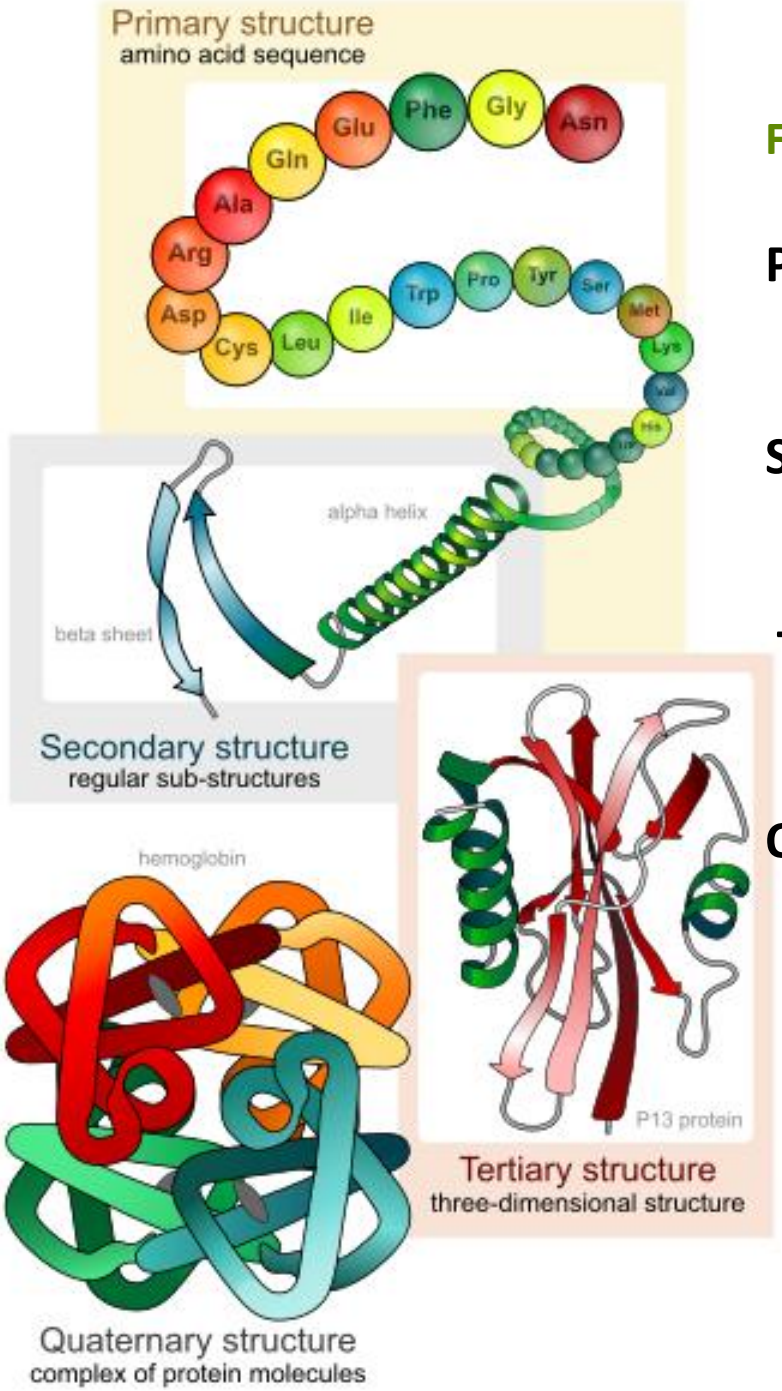
Making and Breaking Proteins

A chain of amino acids is called a polypeptide



The type of protein is determined by:

- ✓ sequence of polypeptides
- ✓ orientation in space
- ✓ 3-D shape



Four levels of protein structure:

Primary - exact sequence of amino acids before folding.

Secondary - simple folding create simple structures.

Tertiary - folding results in complex 3D structures.

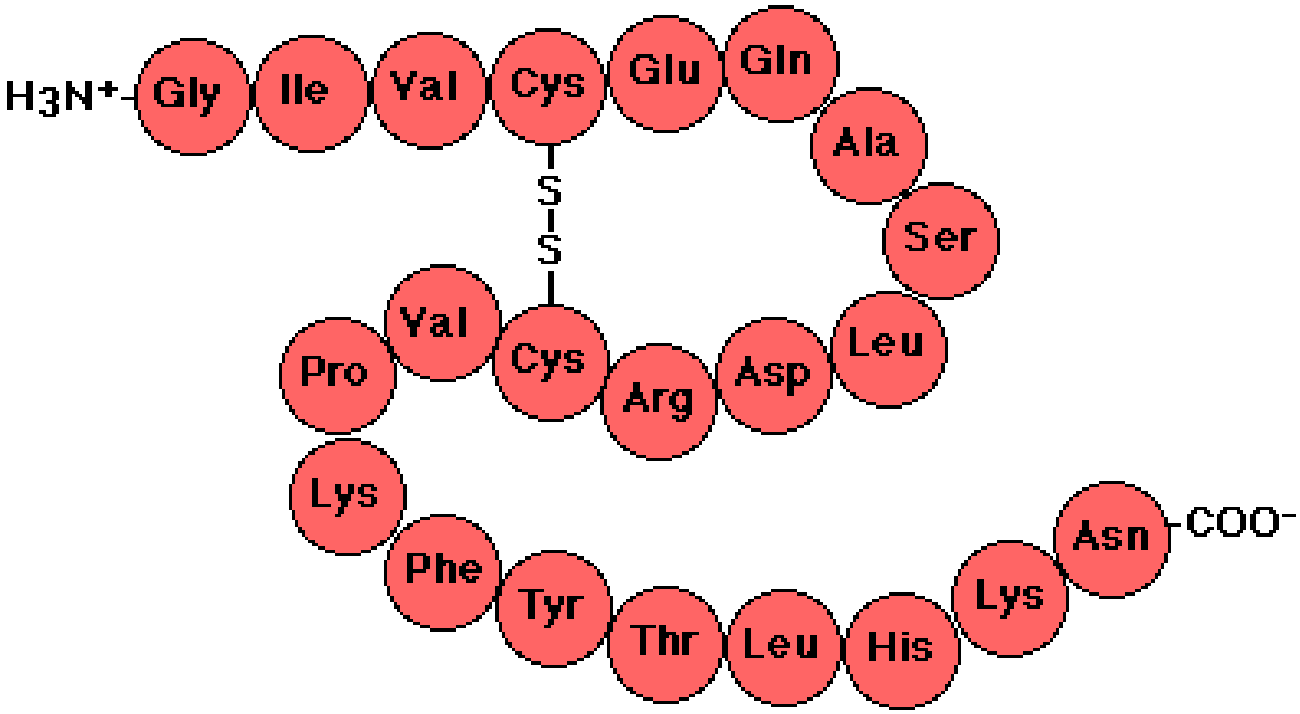
Quaternary - multiple 3D subunits organized into a bigger structure.

Sulfhydryl (-SH) functional groups can form disulfide (-S-S) bonds which contribute to a proteins tertiary structure.

7.5 Proteins – Primary Structure (1°)

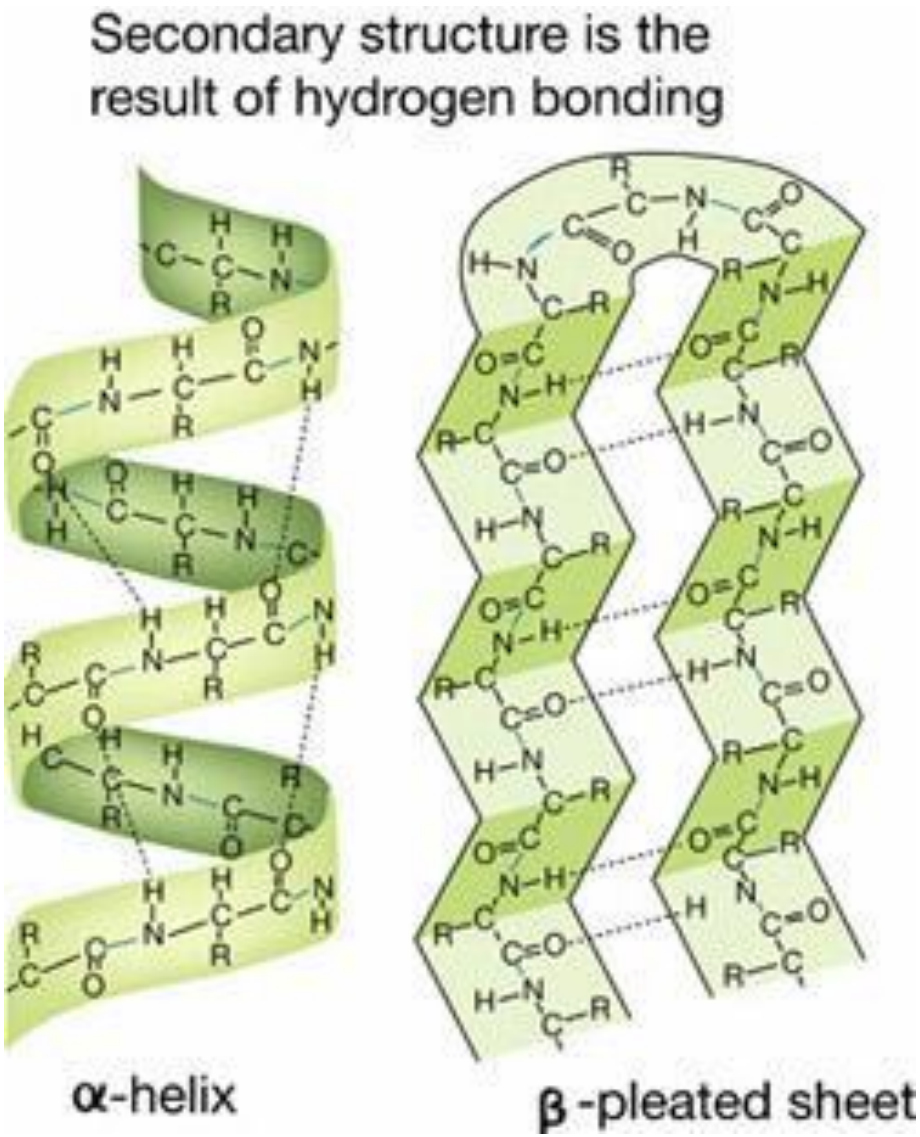
The amino acid sequence

Proteins differ in the variety, number and order of amino acids



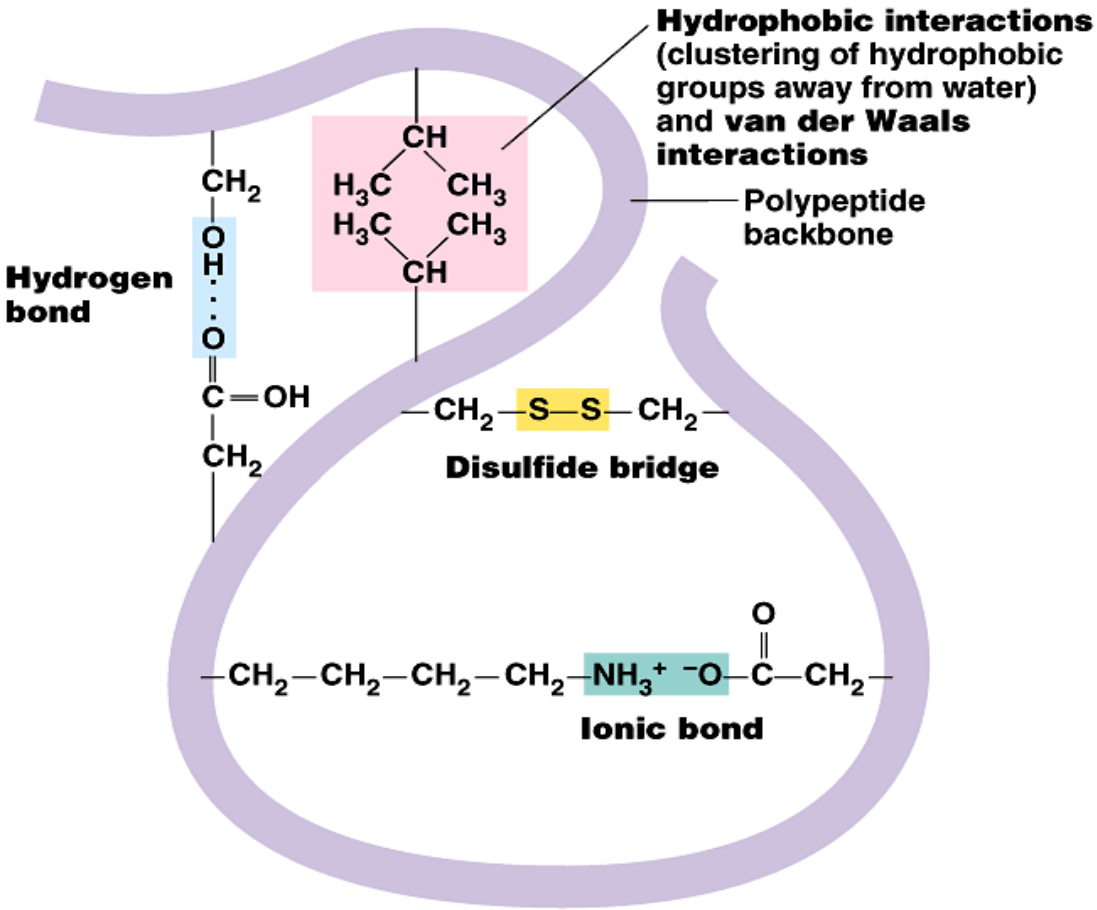
7.5 Proteins – Secondary Structure (2°)

- The way the polypeptide chain is shaped
- Due to formation of H-bonds between the carboxyl O of one aa and the amino H of another aa
- Does not involve R-groups



7.5 Proteins – Tertiary Structure (3°)

- Compact folding due to interactions between R-groups
- Unique to each proteins
- Important for determining specificity of enzymes



4 bonding types:

1)H-bonds between polar side chains

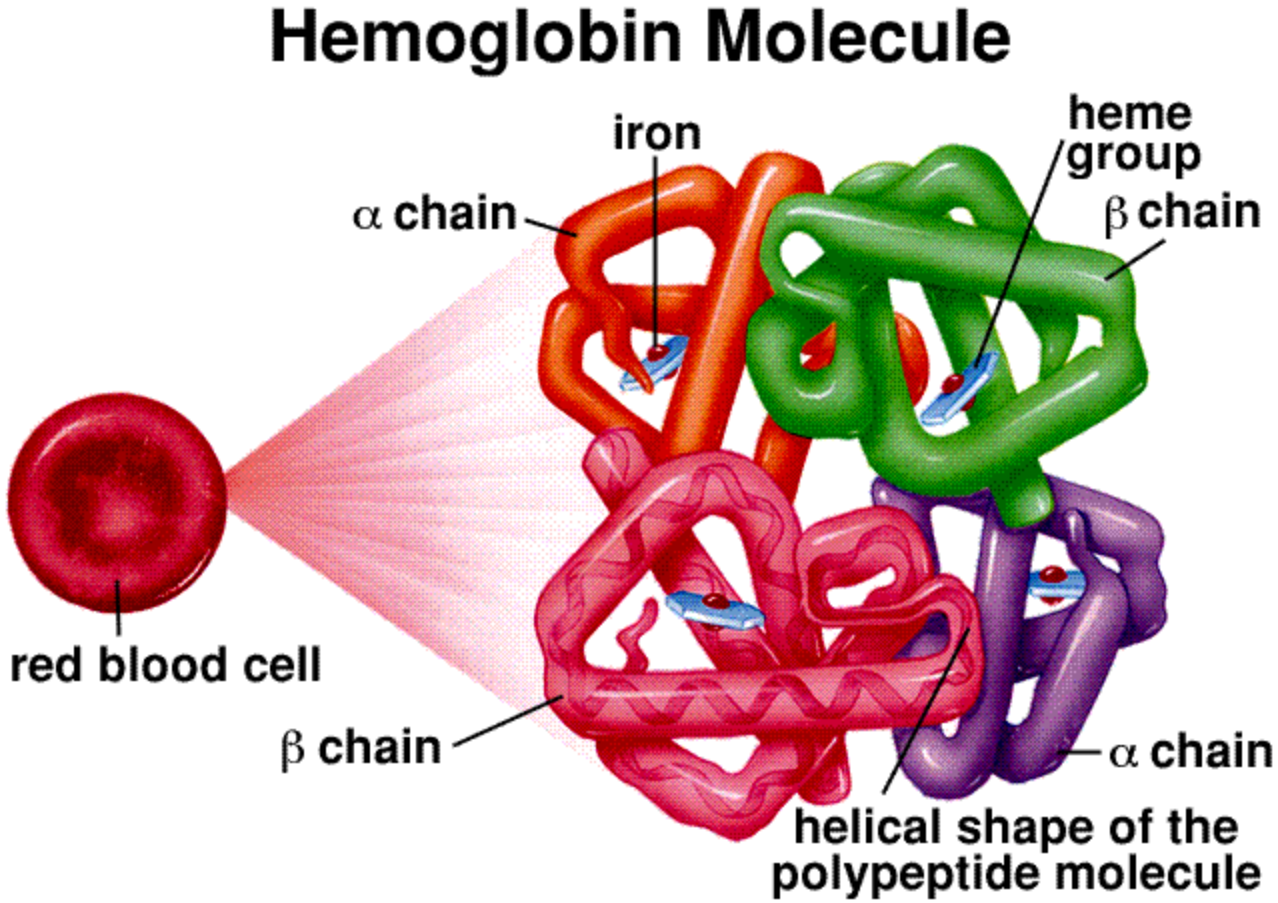
2) Van derWaals forces among hydrophobic side chains

3) Covalent bonds between two -SH groups of cysteine side chains → forms disulfide bridges

4) Ionic bonds between + and - side chains

7.5 Proteins – Quaternary Structure (4°)

- Two or more polypeptide chains together
- Often has non-polypeptide groups → conjugated protein
- Not all proteins have a quaternary structure



Hemoglobin

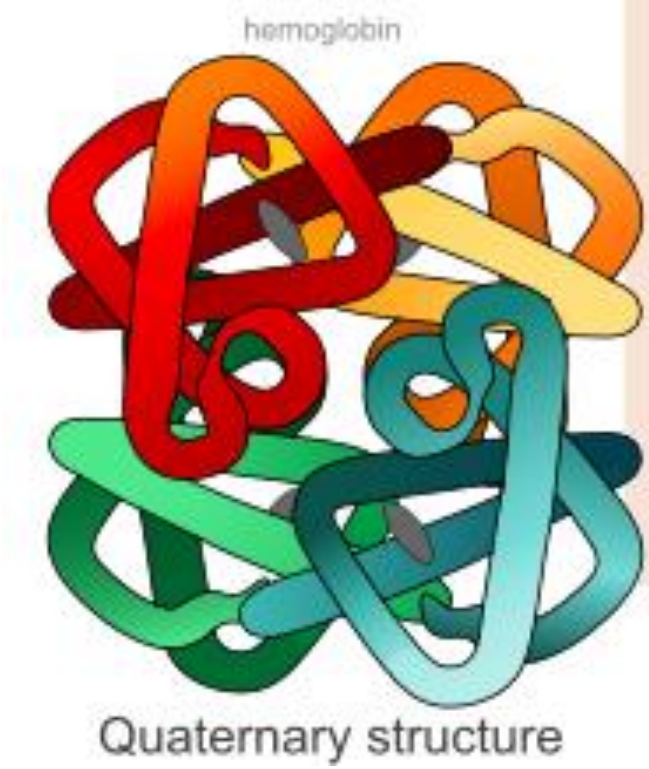
Carries oxygen in the blood
- It's made up of 4 specific 3D subunits

Proper protein function depends on correct 3D structure.

Any change in the specific primary structure can cause the protein to fold differently.

A different shape can lead to a different function (or lack of proper function).

Sickle cell anemia is an example.

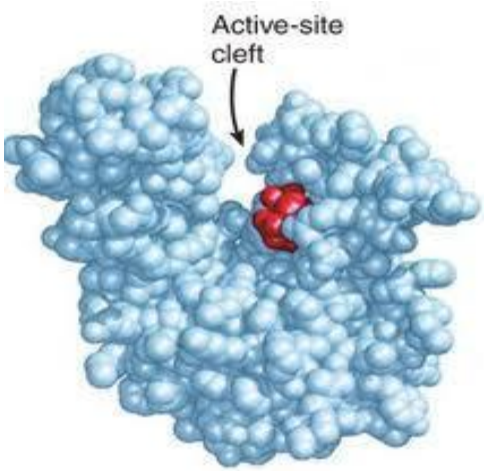


7.5 Protein Types

Globular Proteins

Water soluble and have binding sites and tend to move around.

Examples include hemoglobin and insulin



Fibrous Proteins

Insoluble in water and are involved in structure or movement.

Examples include collagen, actin, and microtubules

7.5 Polar and Non-polar Amino Acids

- AA's with **polar** R-groups= hydrophilic
- Linked to the hydrophilic areas of the cell membrane
- Create hydrophilic channels through the cell membrane which allow polar substances to move through cell membranes.
- Found on outside of cell membrane

- AA's with **non-polar** R-groups = hydrophobic
- Linked to the hydrophobic areas of the cell membrane
- Polar and non-polar aa's are important in determining the specificity of an enzyme. They act as enzyme binding sites (active sites)