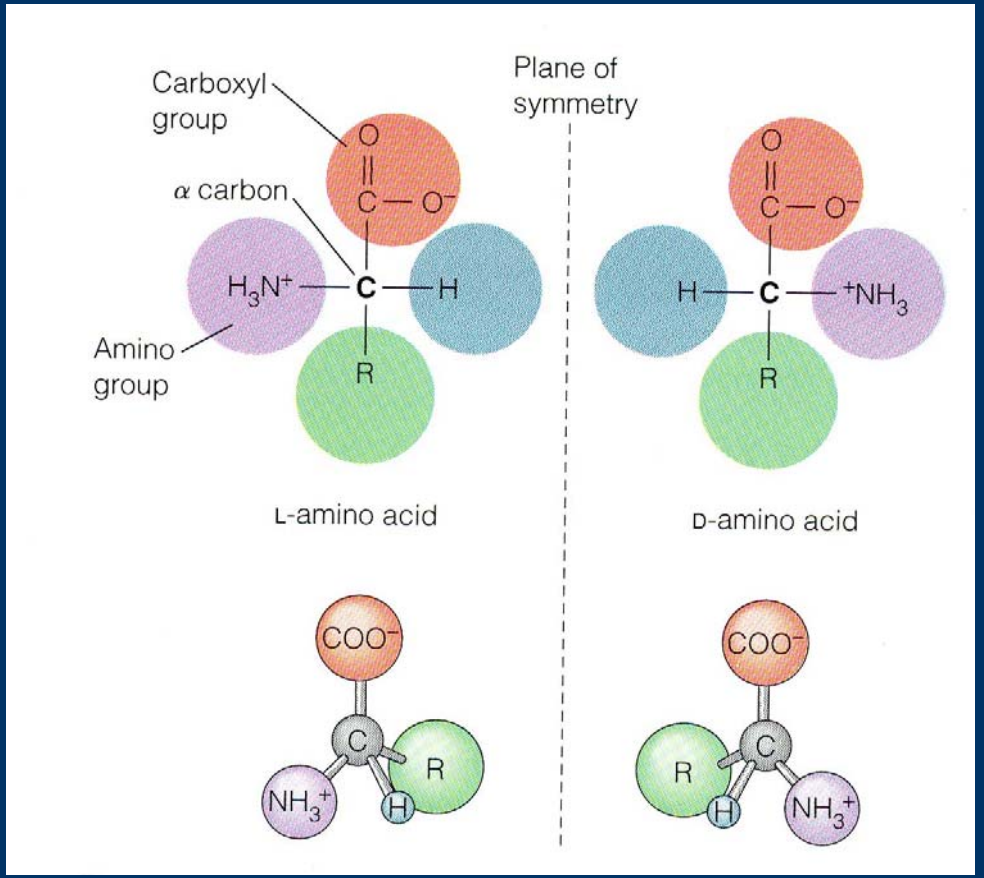
Proteins

-polymer of 20 amino acids

-L-amino acid

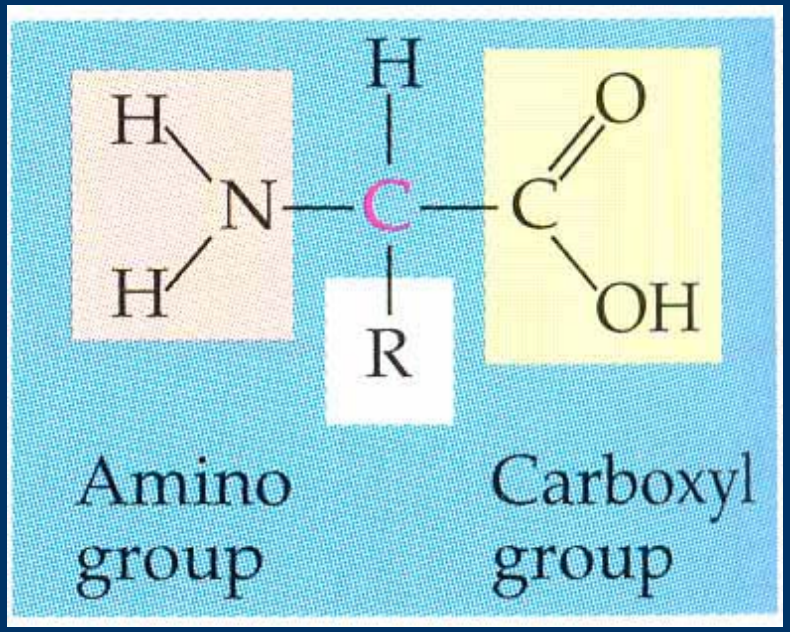
-C,H,O,N,S



-each type of protein have a unique 3-dimensional shape or conformation

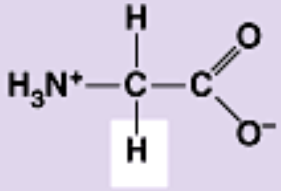
Amino acids

-organic molecule with carboxyl and amino groups
-C = asymmetric carbon called alpha carbon (α)

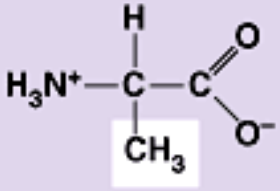


-R group determines the property of amino acid: polar, nonpolar and charge amino acid
-most amino acids exist in the form of dipolar ions and serve as a biological buffer

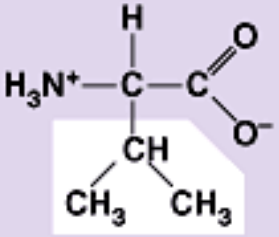
Nonpolar



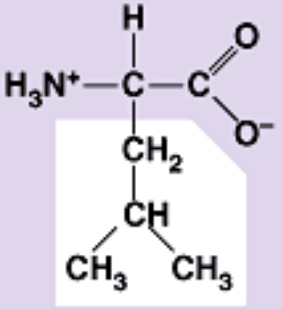
Glycine (Gly)



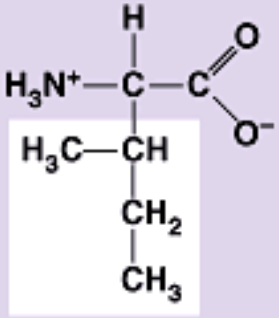
Alanine (Ala)



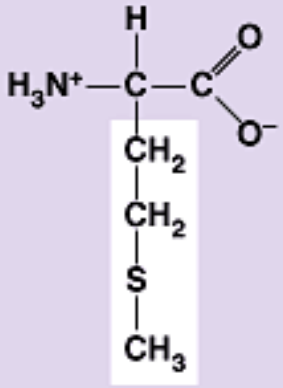
Valine (Val)



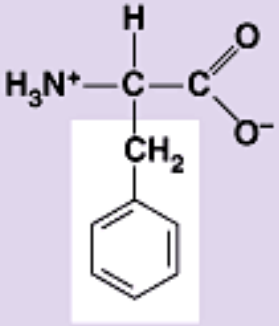
Leucine (Leu)



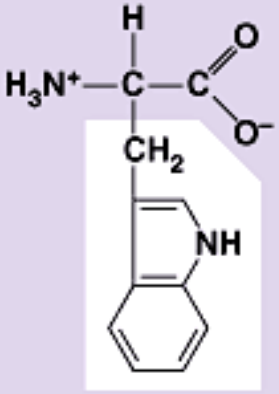
Isoleucine (Ile)



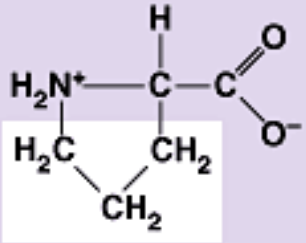
Methionine (Met)



Phenylalanine (Phe)

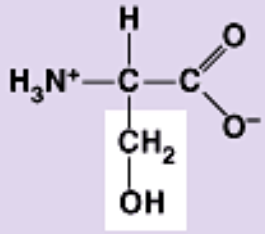


Tryptophan (Trp)

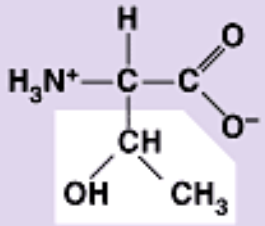


Proline (Pro)

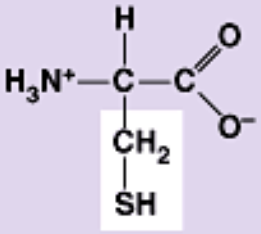
Polar



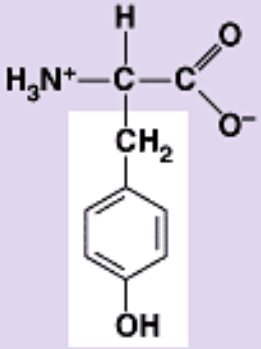
Serine (Ser)



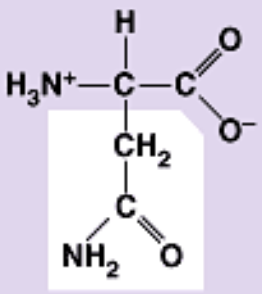
Threonine (Thr)



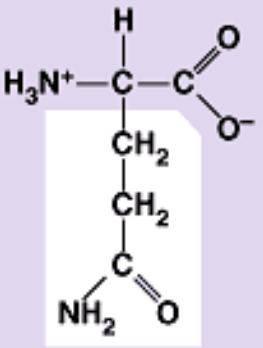
Cysteine (Cys)



Tyrosine (Tyr)



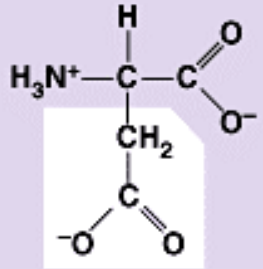
Asparagine (Asn)



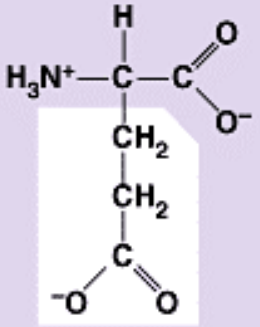
Glutamine (Gln)

Electrically charged

Acidic

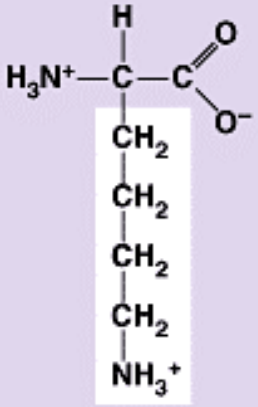


Aspartic acid (Asp)

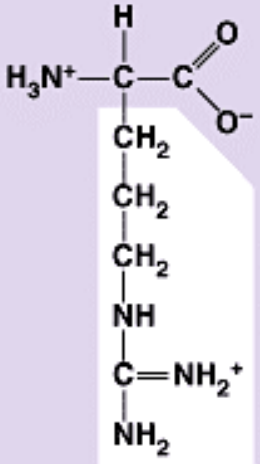


Glutamic acid (Glu)

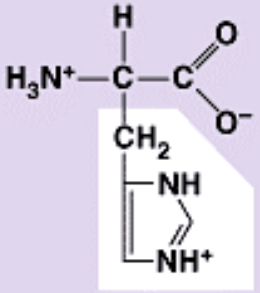
Basic



Lysine (Lys)



Arginine (Arg)

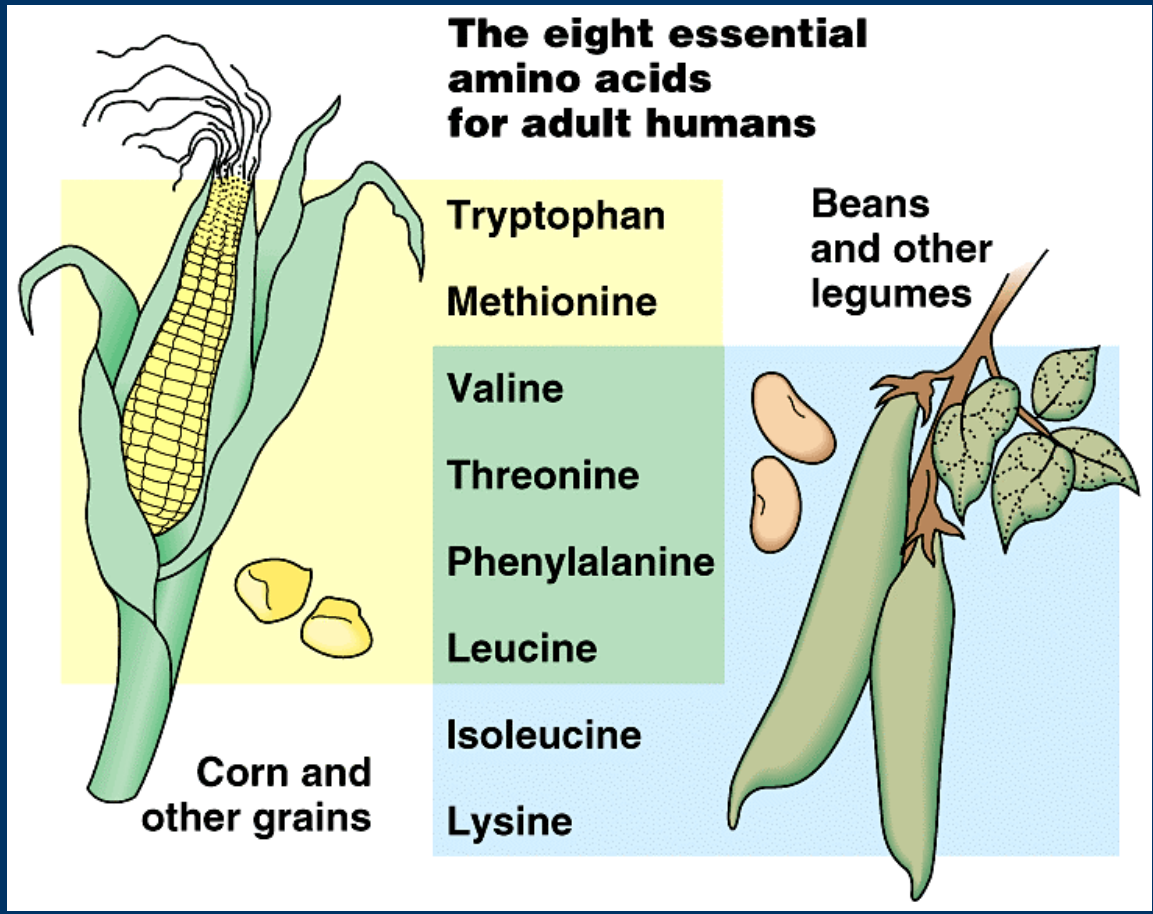


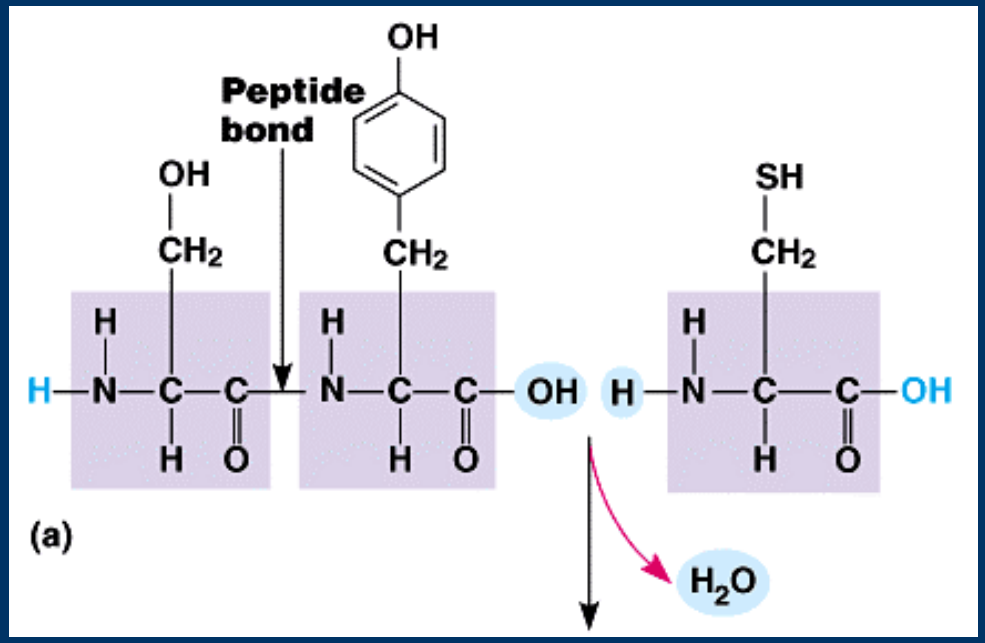
Histidine (His)

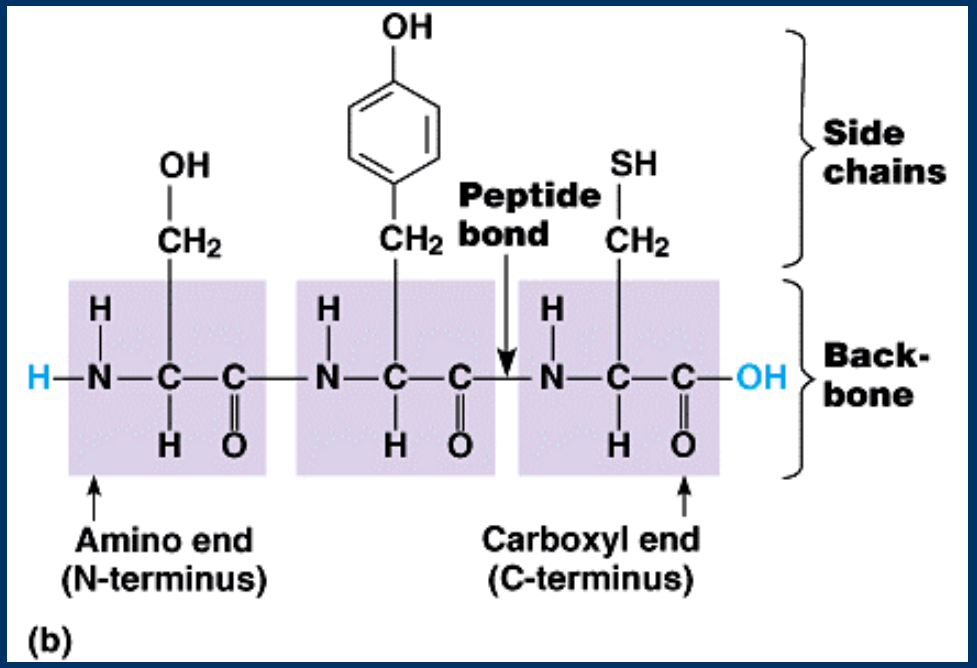
Essential amino acids = amino acids that an animal cannot synthesize itself and must obtain from food.

8 essential amino acids of adult human = Trp, Met, Val, Thr, Phe, Leu, Ile, Lys

His is essential for infant.







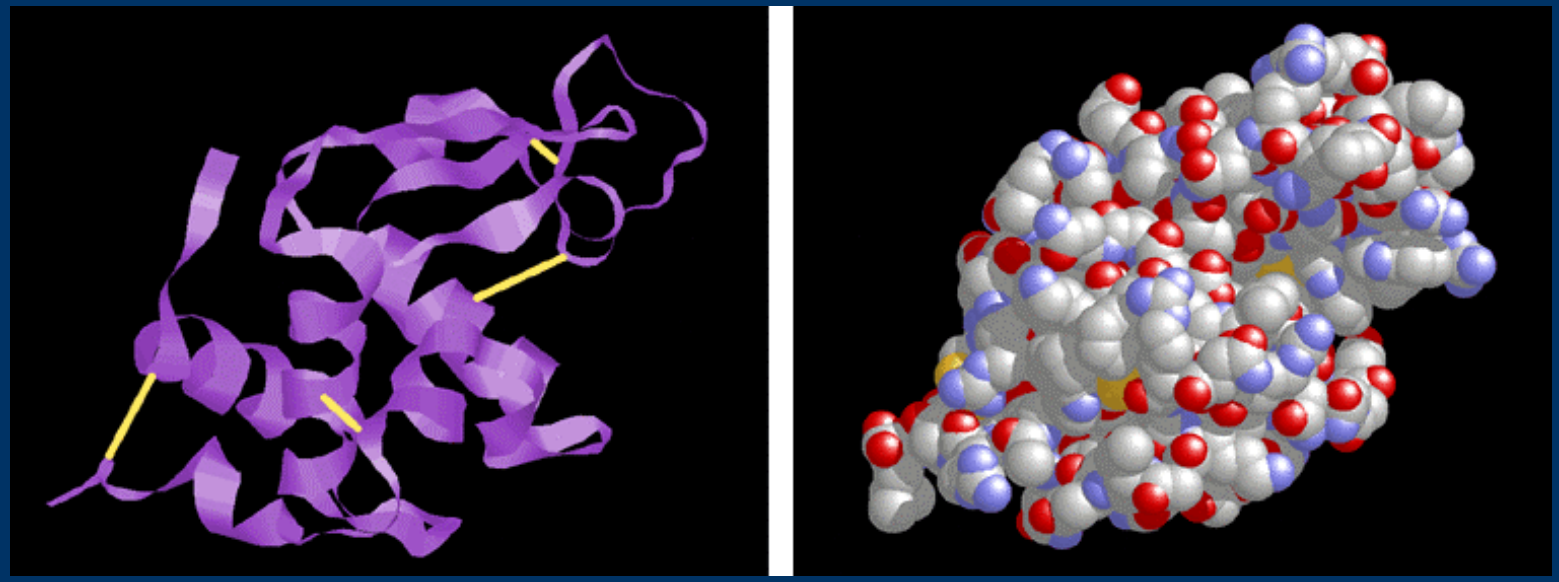
-Peptide bonds form by dehydration reactions link carboxyl group of one amino acid to the amino group of the next.

-polypeptide chain grows from N- terminus to the C-terminus.

A Protein's Function Depends on Its Specific Conformation

-functional protein consists of one or more polypeptides with proper conformation

-the order of amino acid in a polypeptide chain determines the three-dimensional conformation of that polypeptide



4 levels of protein structure

-primary

-secondary

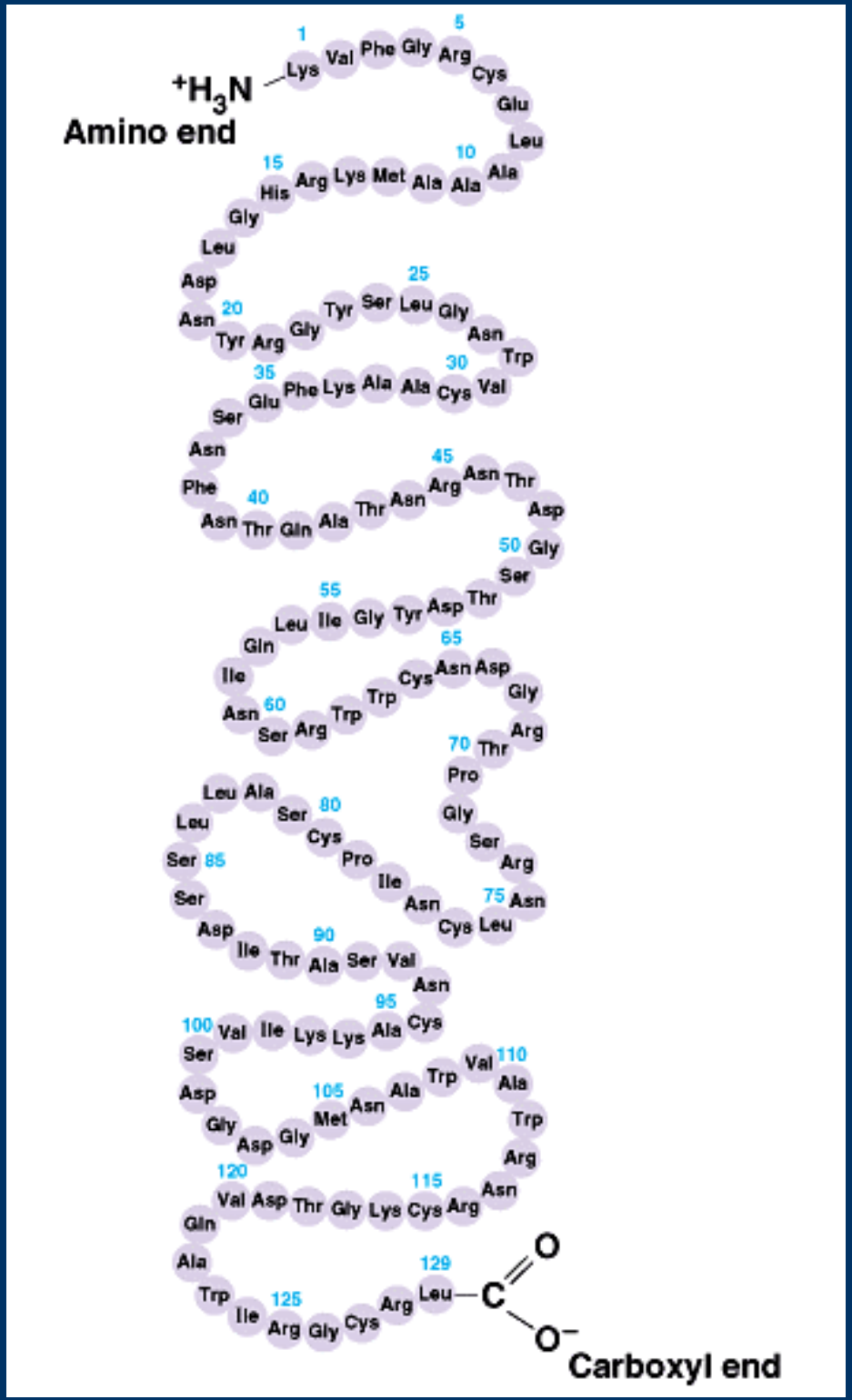
-tertiary

-quaternary

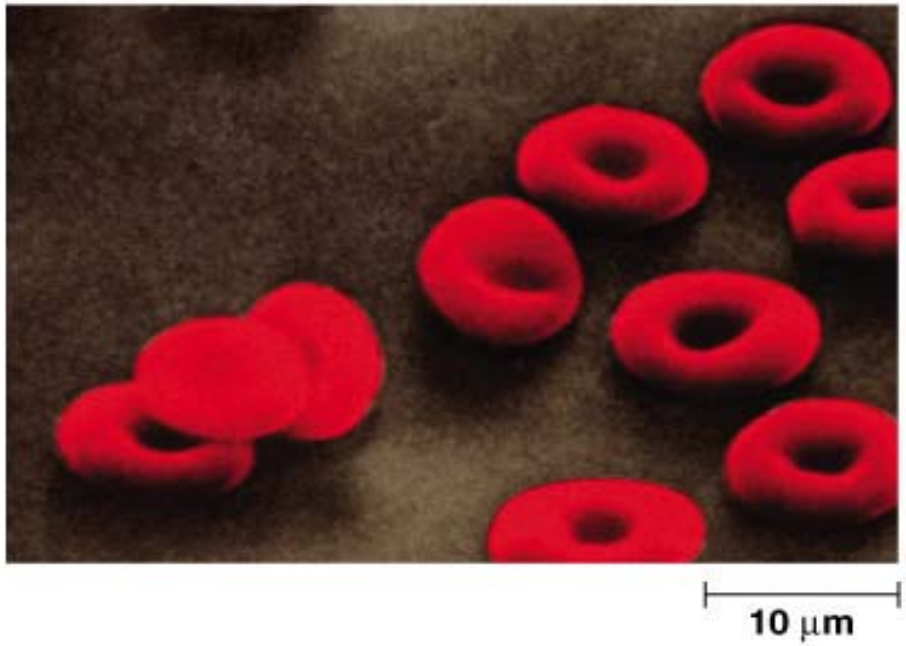
Primary structure of protein

-the unique sequence of amino acids in the polypeptide chain

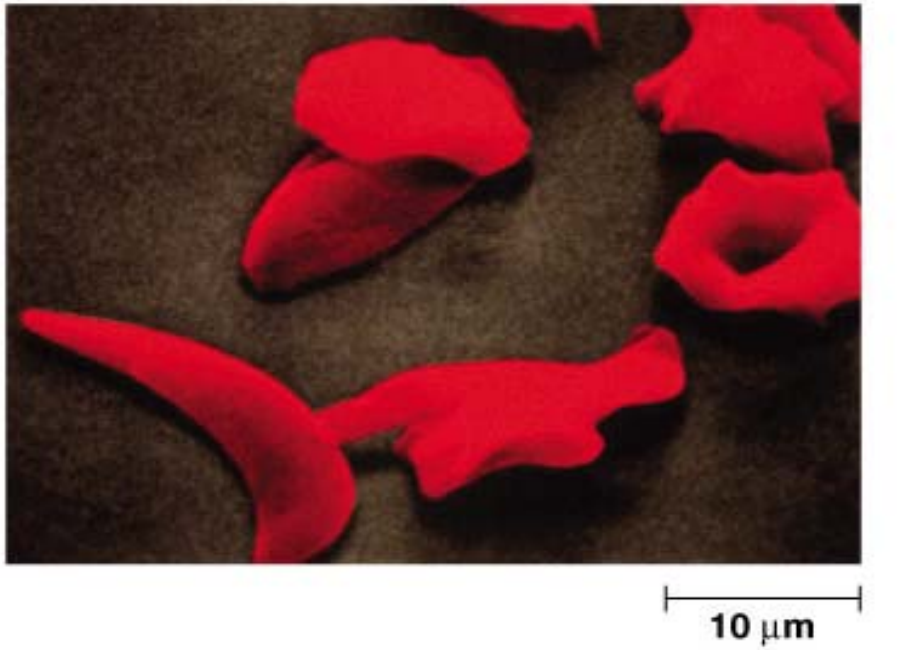
-determined by genetic codes



Changes in amino acids sequence can affect a protein's conformation and function: hemoglobin



(a) Normal red blood cells and the primary structure of normal hemoglobin



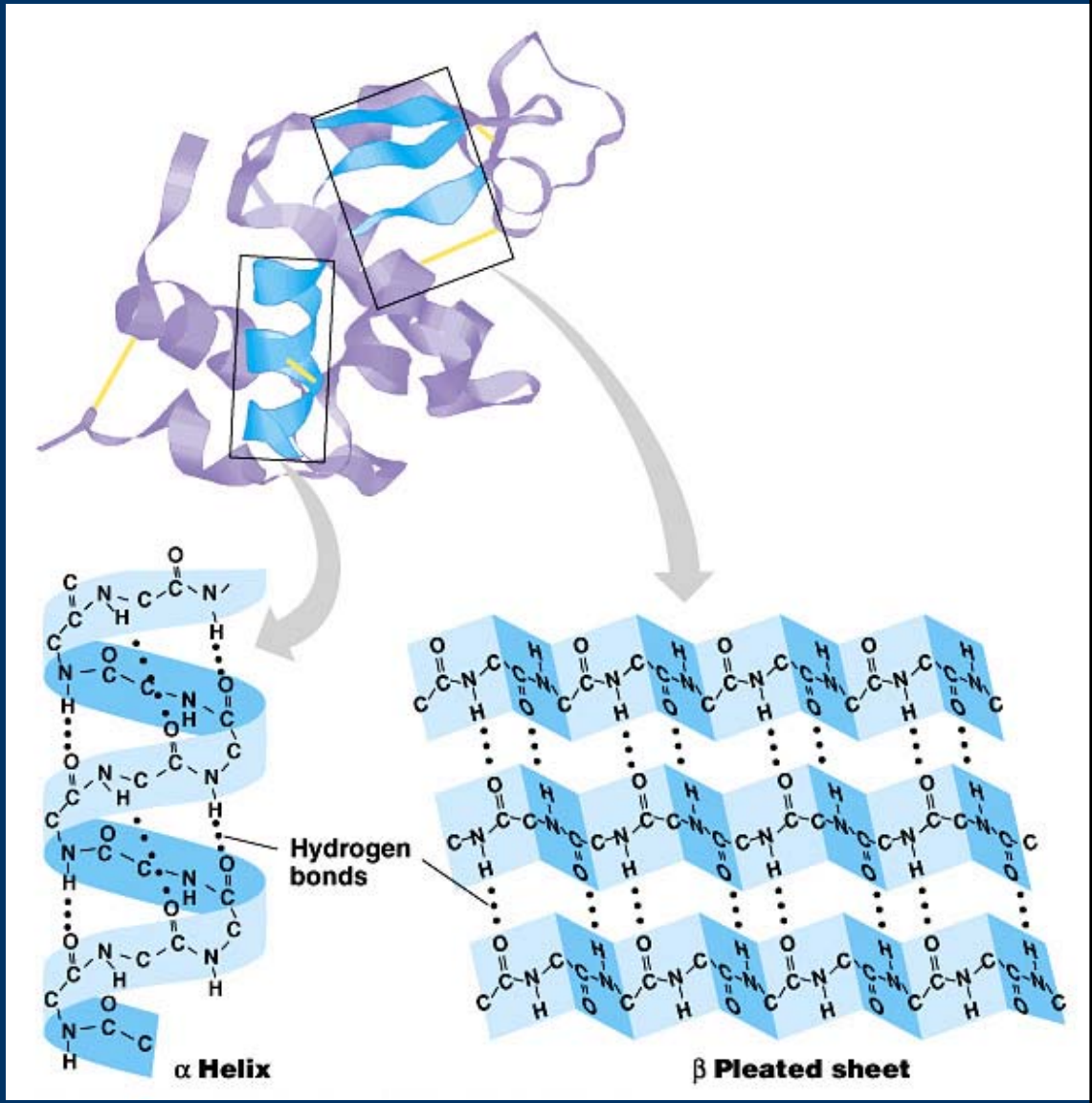
(b) Sickled red blood cells and the primary structure of sickle-cell hemoglobin

Secondary structure : α helix and β pleated sheet

-α helix = coils

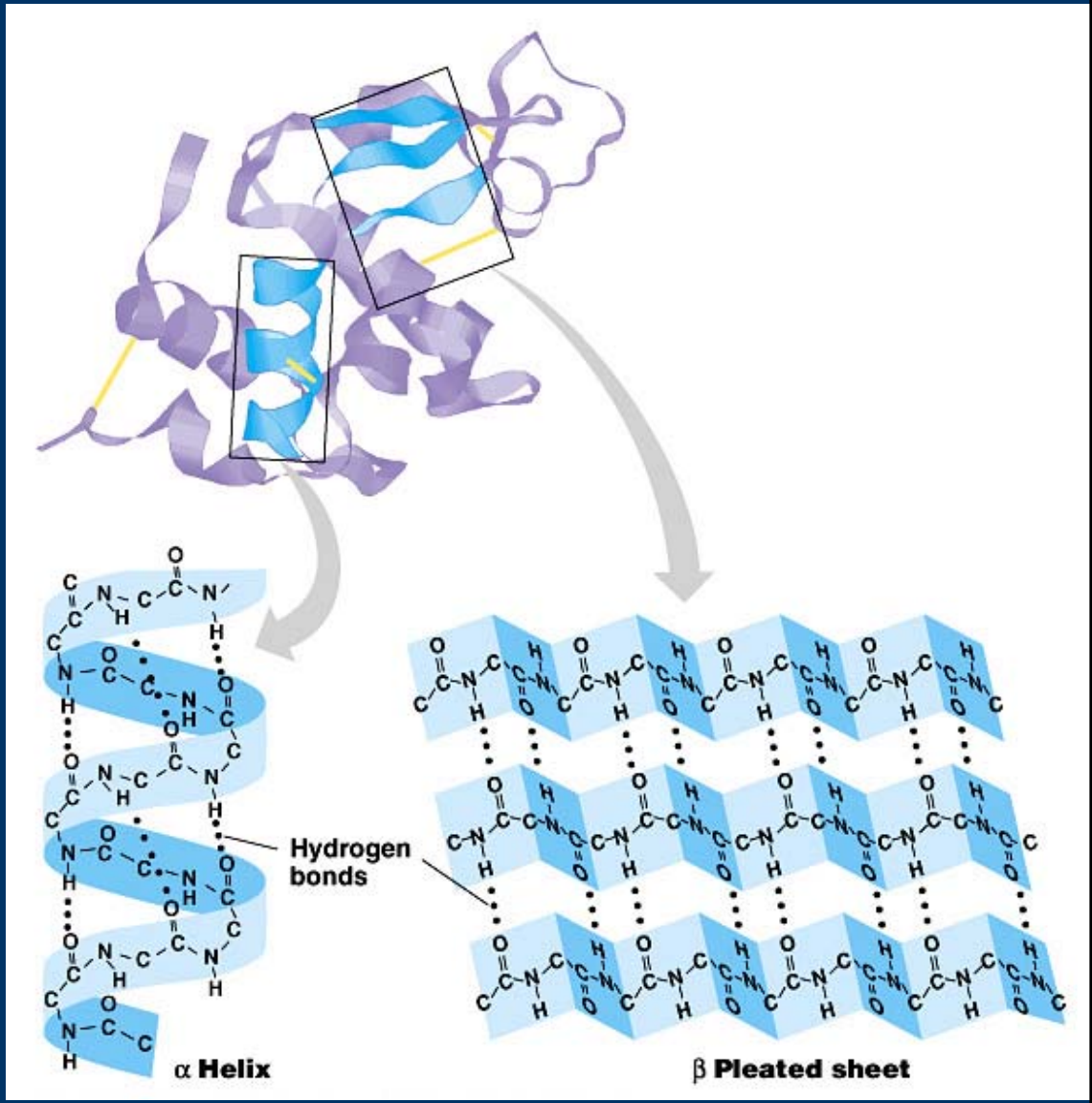
β pleated sheet = folds

-result from the hydrogen bonding between amino acids composition of polypeptide at regular intervals along the peptide backbone



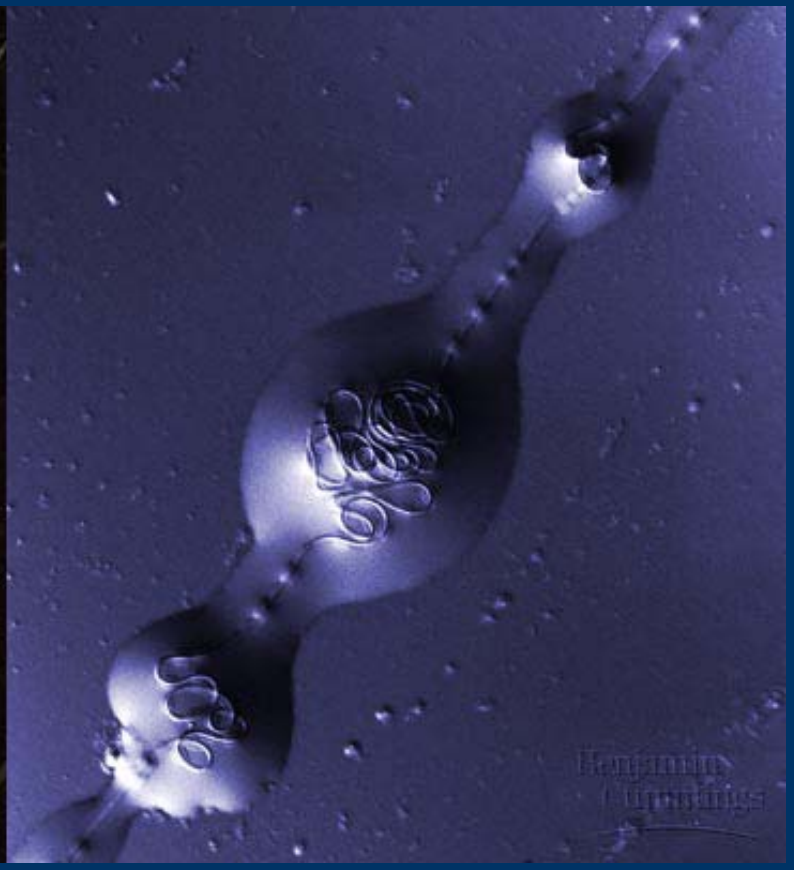
Secondary structure :α helix and β pleated sheet

-only the atoms of the backbone are involved not the R group side chain



The spider silk: β-pleated sheet

The strength of silk fiber is the result from many hydrogen bonding.



Tertiary structure: overall conformation of the polypeptide chain (interaction between R group side chain)

Bonds and interaction involved:

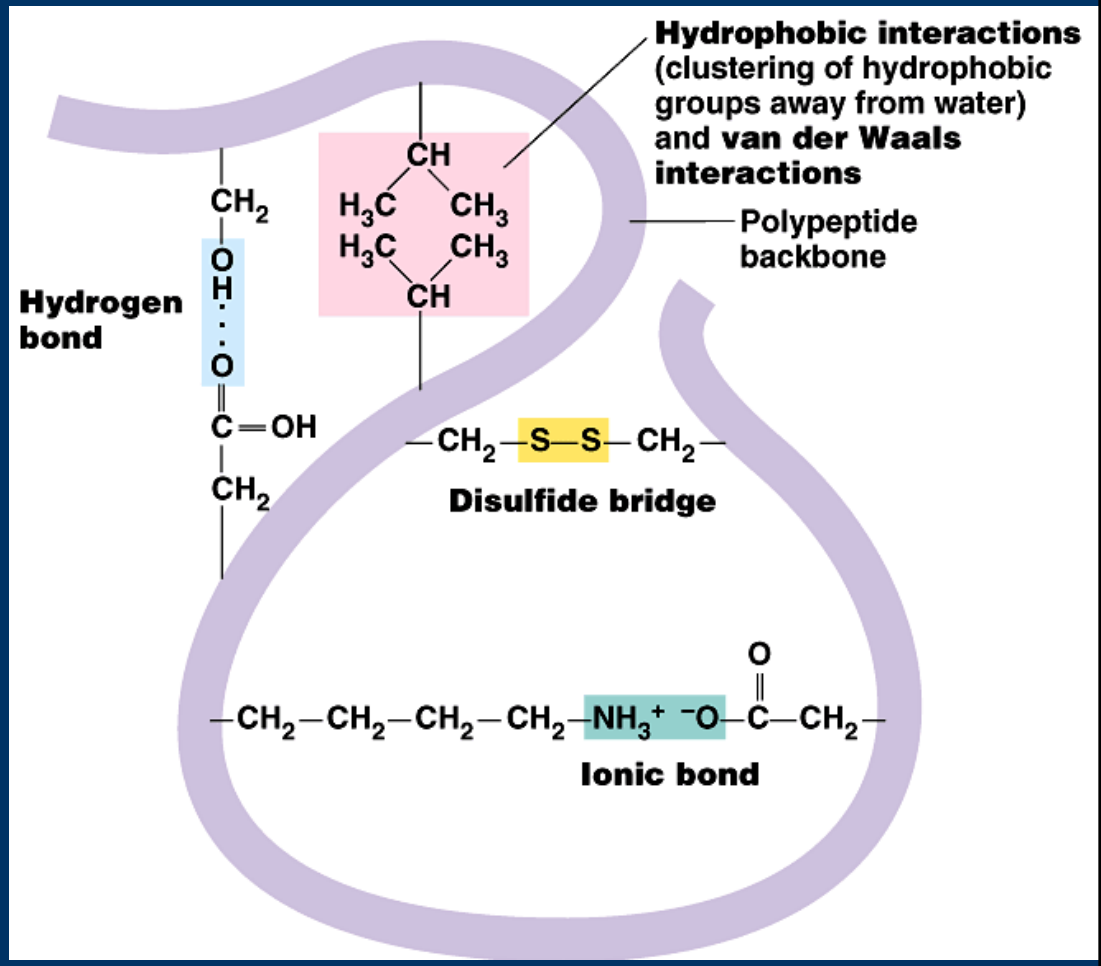
-hydrogen bonding

-ionic bonding

-disulfide linkage

-hydrophobic interaction

(the cluster of nonpolar amino acid (hydrophobic) at the core of the protein, out of contact with water)



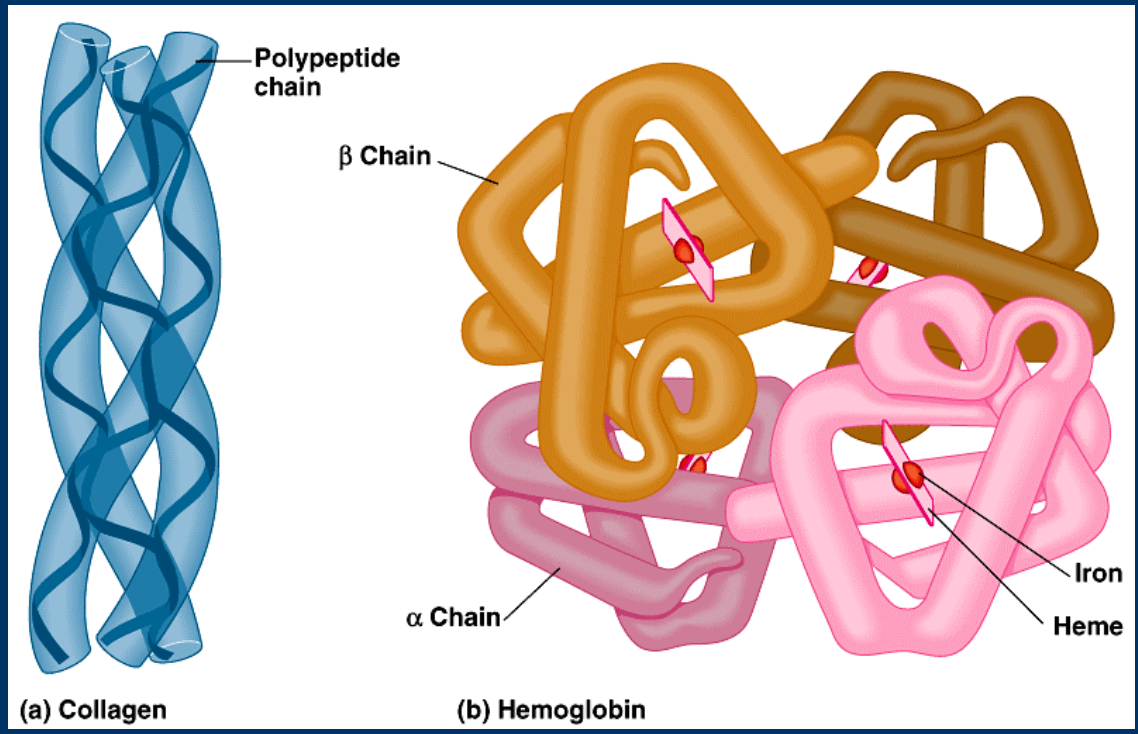
Quaternary structure:

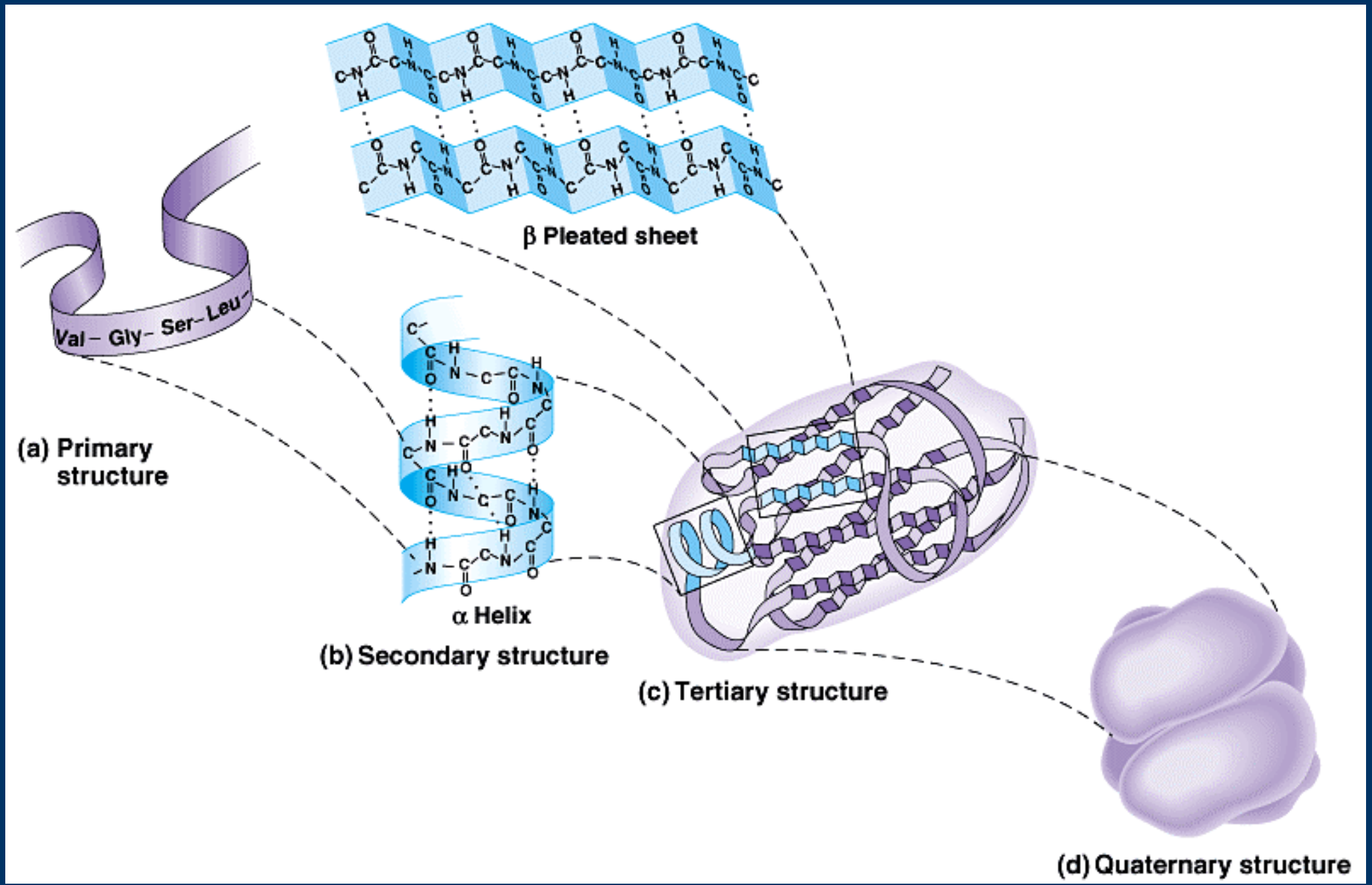
-more than 1 polypeptide

-interaction involved: the same interaction as in tertiary structure

Collagen (in connective tissue) : 3 polypeptides supercoiled like a rope

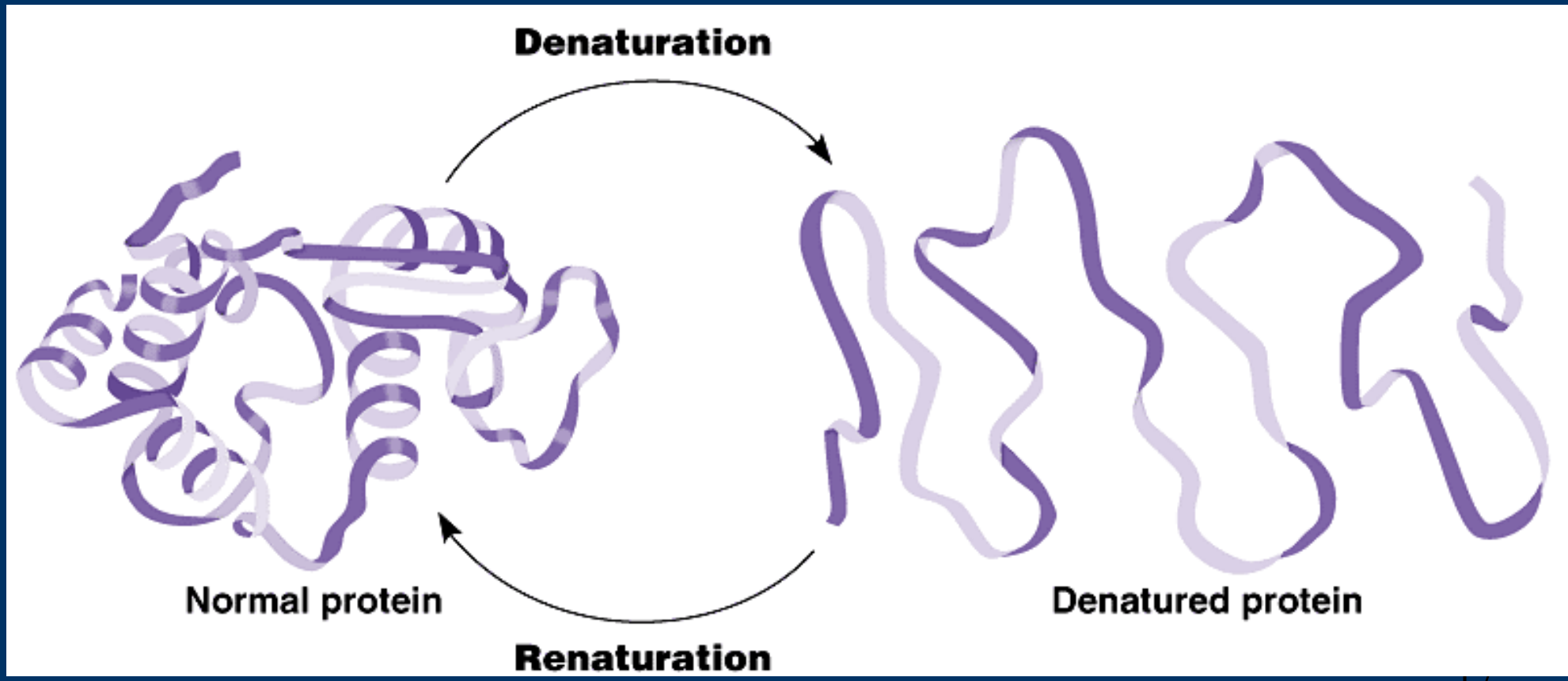
Haemoglobin = a globular protein

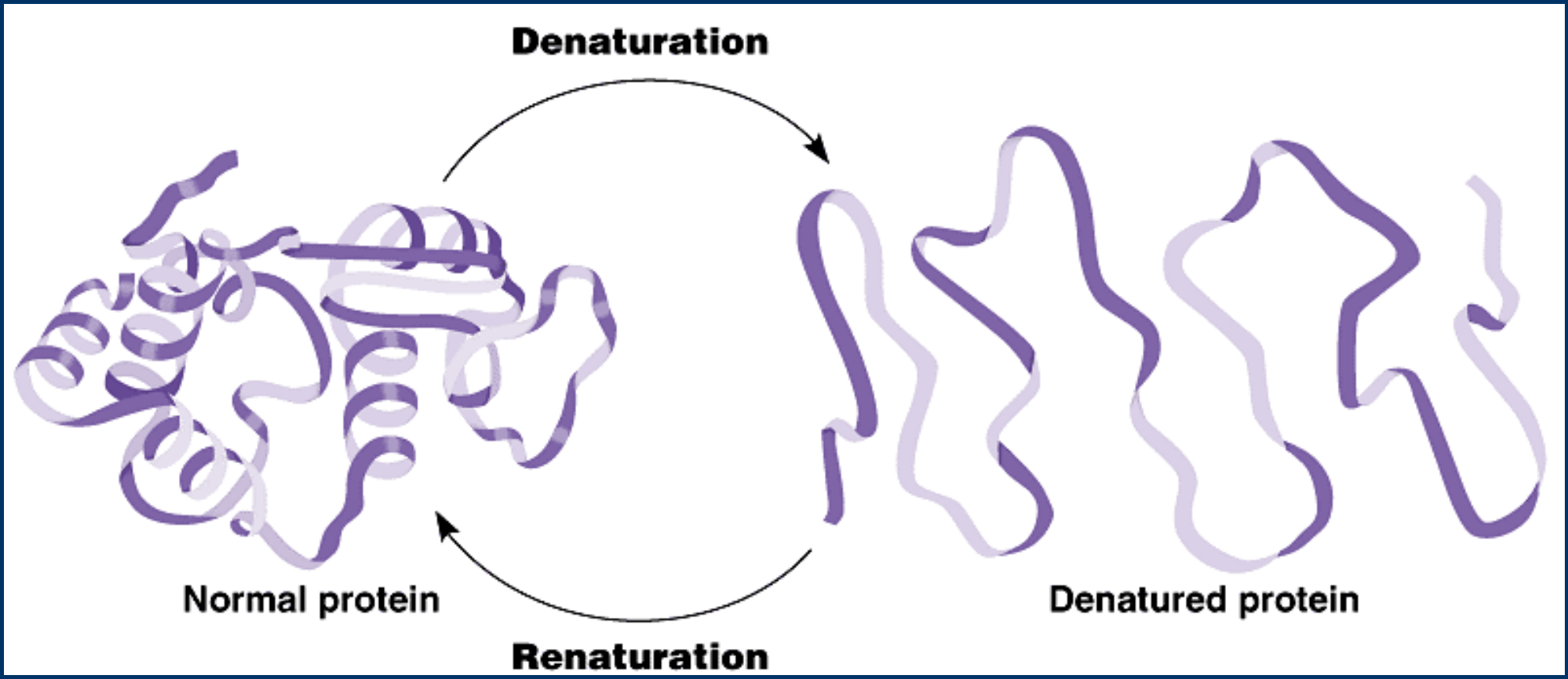



β Pleated sheet
Val – Gly – Ser – Leu –
(a) Primary structure
α Helix
(b) Secondary structure
(c) Tertiary structure
(d) Quaternary structure

Denaturation: lost of protein native conformation and function

-caused by changes of pH, temperature, solvent

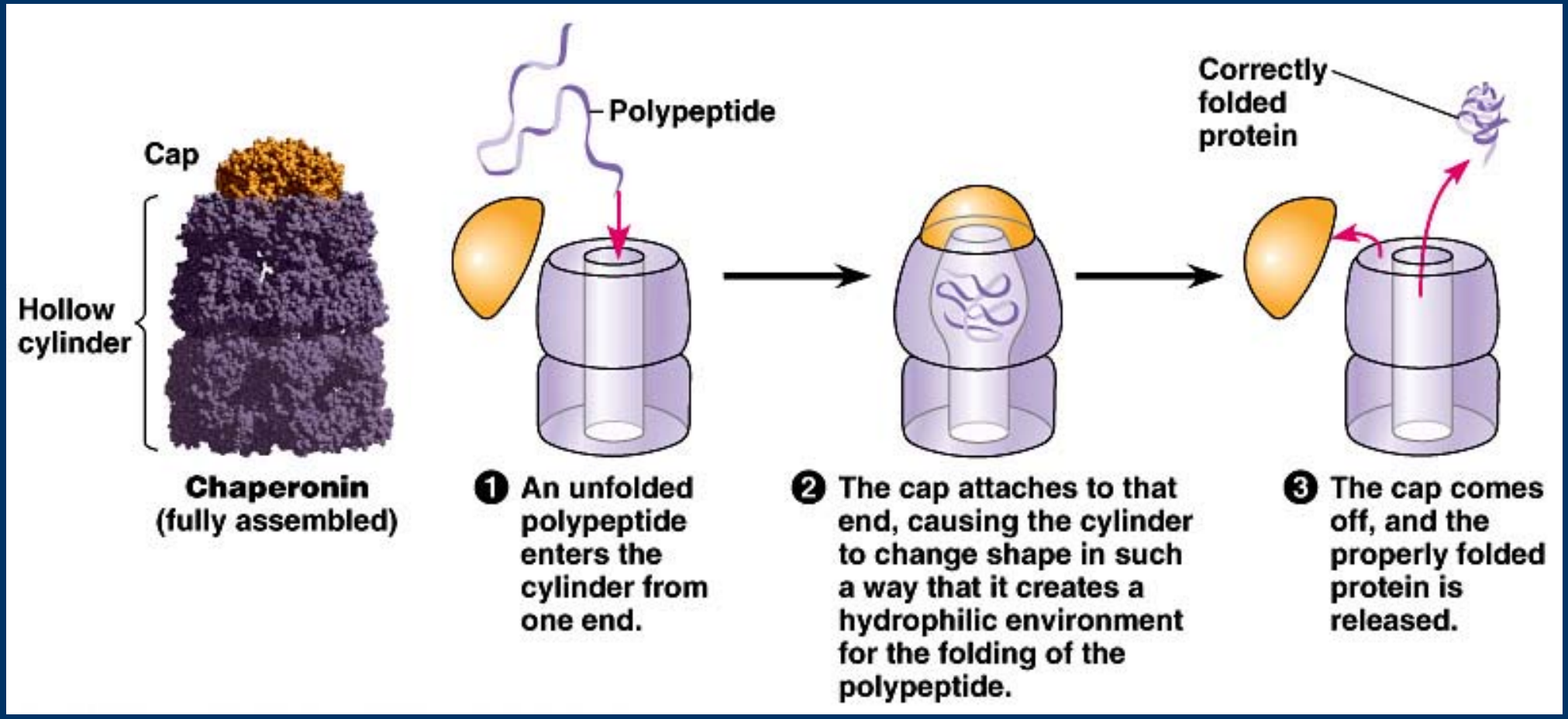




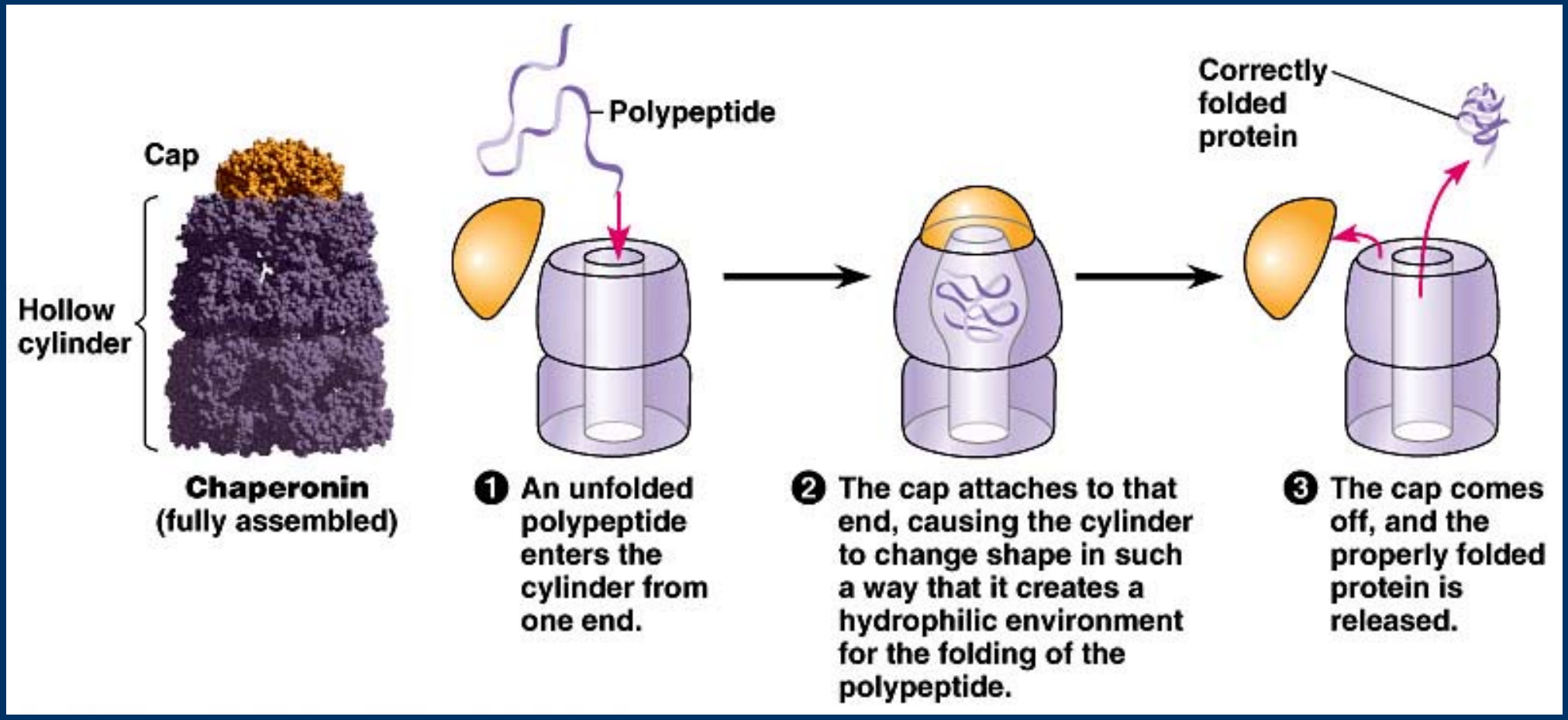
Renaturation: regain protein native 3-dimensional structure and biological activity

Protein Folding: Chaperonin, a multiprotein complex assist the proper folding of other peptides.

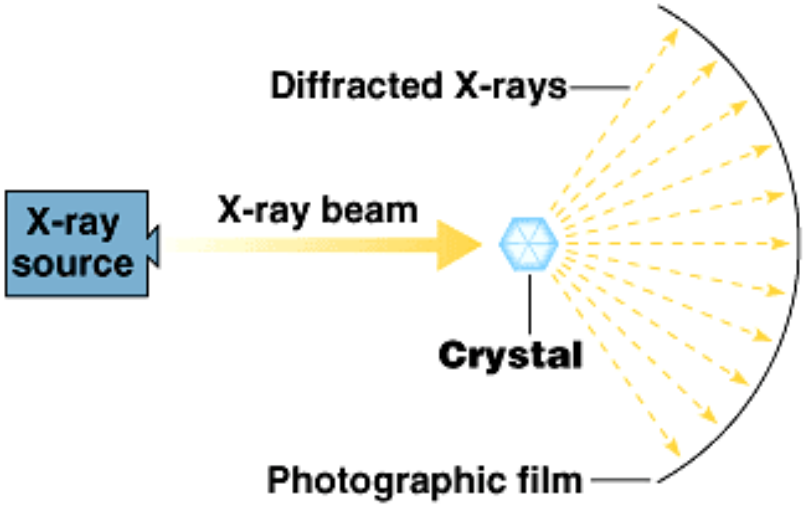
(found in both prokaryotes e.g. *E.coli* and eukaryotes)



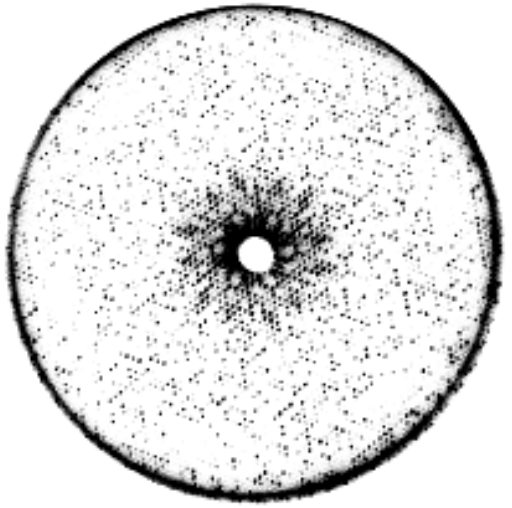
Chaperonins do not specify the final structure of a polypeptide. They work by keeping the new peptide from the cytoplasmic environment while the peptide folds spontaneously.



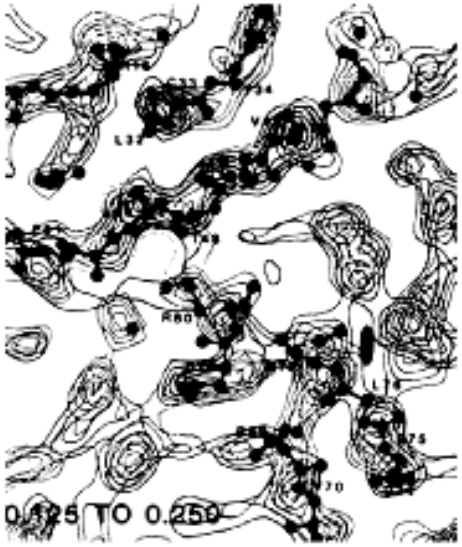
Determining the Structure of Proteins



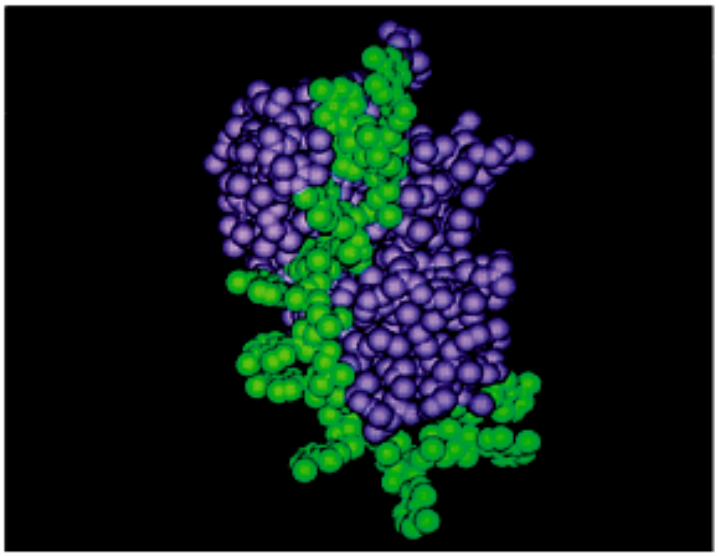
❶ X-ray crystallography



❷ X-ray diffraction pattern from the crystal of a protein



❸ Electron density map



❹ A computer graphic model of the protein ribonuclease (purple) bound to a short strand of nucleic acid (green)

Function of proteins:

1. structure/support: silk fiber, collagen, keratin in hair, horn and feather

2. storage of amino acids: ovalbumin in egg white, casein in milk

3. transport of other substances: hemoglobin

4. coordination of organism's activity: hormones

5. movement: actin and myosin in muscle

6. defense: anbtibody

7. acceleration of chemical reaction: enzymes

8. response of cell to chemical stimuli: nerve cell receptors