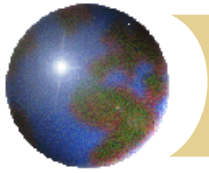


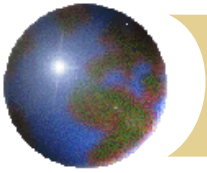
# *Ch5: Macromolecules*

## Proteins



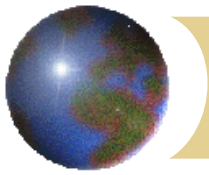
# *Essential Knowledge*

- ✚ 4.A.1 The subcomponents of biological molecules and their sequence determine the properties of that molecule
  - ✚ A. Structure and function of polymers are derived from the way their monomers are assembled
    - 2. In proteins, the specific order of amino acids in a polypeptide (primary structure) interacts with the environment to determine the overall shape of the protein, which also involves secondary, tertiary, and quaternary structure and, thus, its function.



## *Essential Knowledge*

2. The R group of an amino acid can be categorized by chemical properties (hydrophobic, hydrophilic, and ionic), and the interactions of these R groups determine structure and function of that region of the protein.



# *Essential Knowledge*

- ❑ B. Directionality influences structure and function of the polymer.
  2. Proteins have an amino ( $\text{NH}_2$ ) end and a carboxyl ( $\text{COOH}$ ) end, and consist of a linear sequence of amino acids connected by the formation of peptide bonds by dehydration synthesis between the amino and carboxyl groups of adjacent monomers



# *Proteins - General*

- ⊕ Instrumental in nearly everything organisms do
- ⊕ Account for 50% of the dry mass of most cells
- ⊕ Most structurally & functionally diverse group of macromolecules

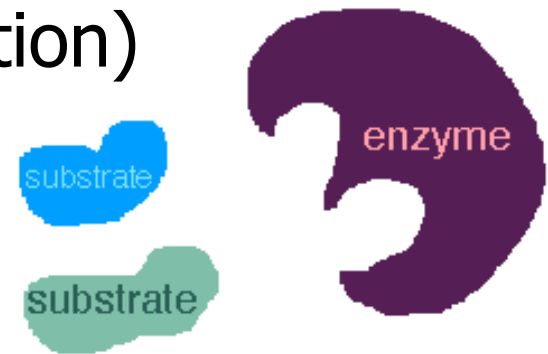
## ⊕ **Functions:**

- ⊕ \_\_\_\_\_ (enzymes)
- ⊕ \_\_\_\_\_ (keratin, collagen)
- ⊕ Carriers & transport (hemoglobin)
- ⊕ Signaling (hormones, insulin)
- ⊕ \_\_\_\_\_ & binding (cell surface receptors)
- ⊕ Contractile & motor (actin, myosin)
- ⊕ \_\_\_\_\_ (antibodies)



# *Proteins* - \_\_\_\_\_

- ❖ Regulate \_\_\_\_\_ by acting as \_\_\_\_\_
- ❖ Most important protein in the body
- ❖ Catalysts \_\_\_\_\_ chemical reactions
- ❖ Not consumed (used up by reaction)





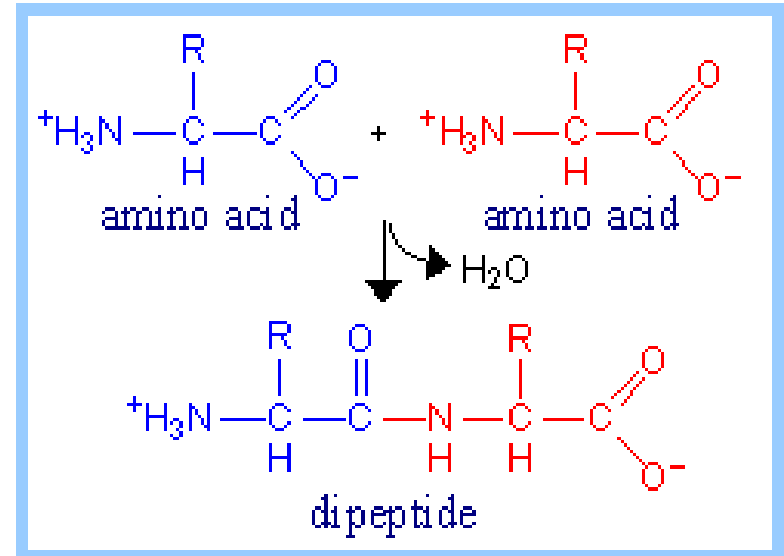
# Protein structure

## ⊕ Monomer =

- ⊞ Constructed from 20 different amino acids

## ⊕ Polymer =

- ⊞ Dehydration reactions
- ⊞ Protein can be 1 or more polypeptide chains folded and \_\_\_\_\_ together
- ⊞ \_\_\_\_\_ (covalent bond)
  - carboxyl group to amino group (polar)





# Amino Acid Structure

Central Carbon =  $\alpha$  carbon

Attached to  $\alpha$  carbon:

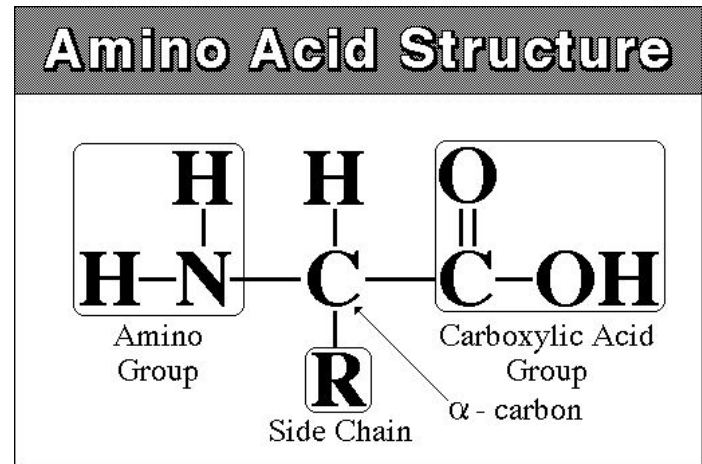
\_\_\_\_\_ (-COOH)

\_\_\_\_\_ (NH<sub>2</sub>)

\_\_\_\_\_ atom

\_\_\_\_\_ (\_\_\_\_\_ group)

- Can be as simple as an H atom
- Determines unique characteristics of the amino acid
- Polar (hydrophilic), nonpolar (hydrophobic), acid or base

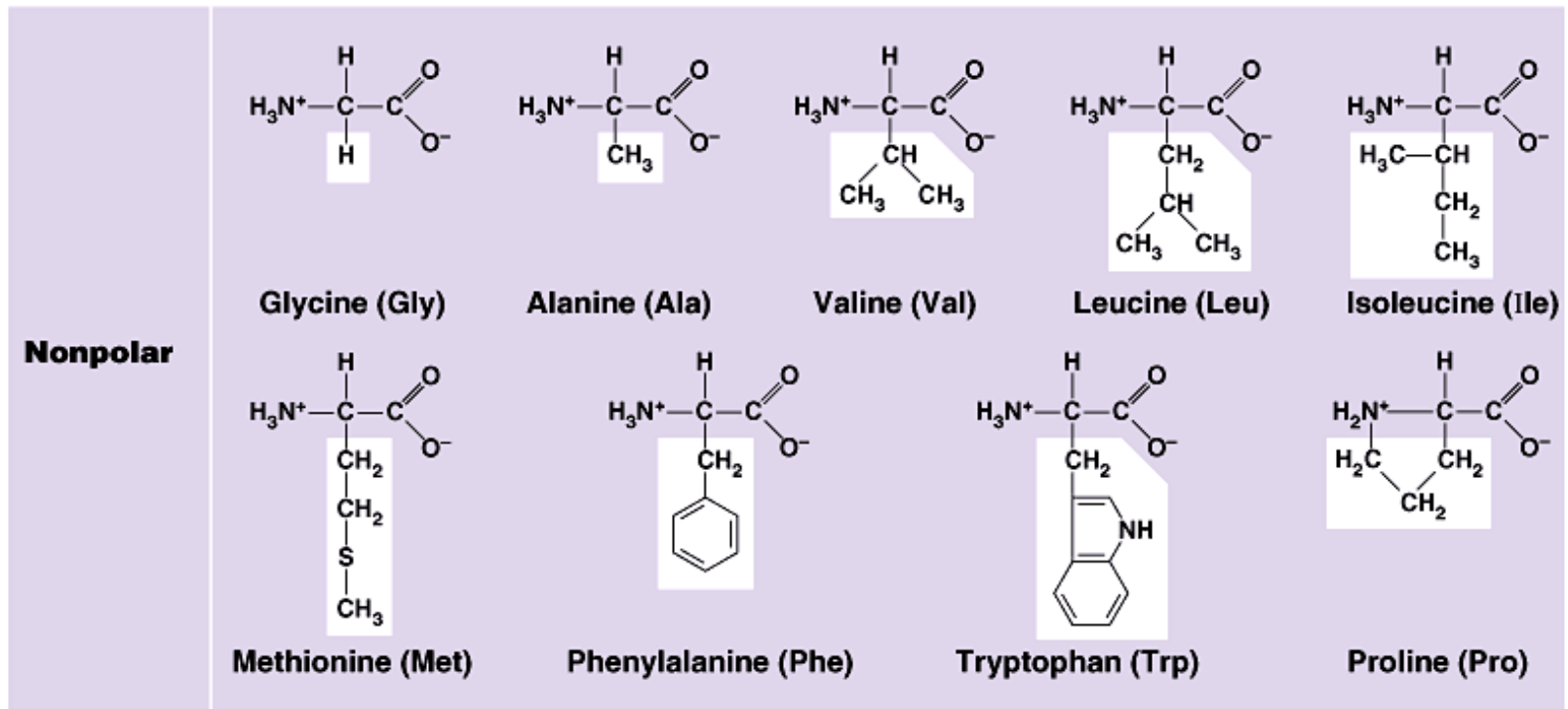


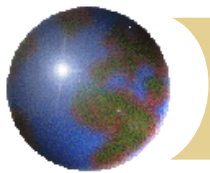




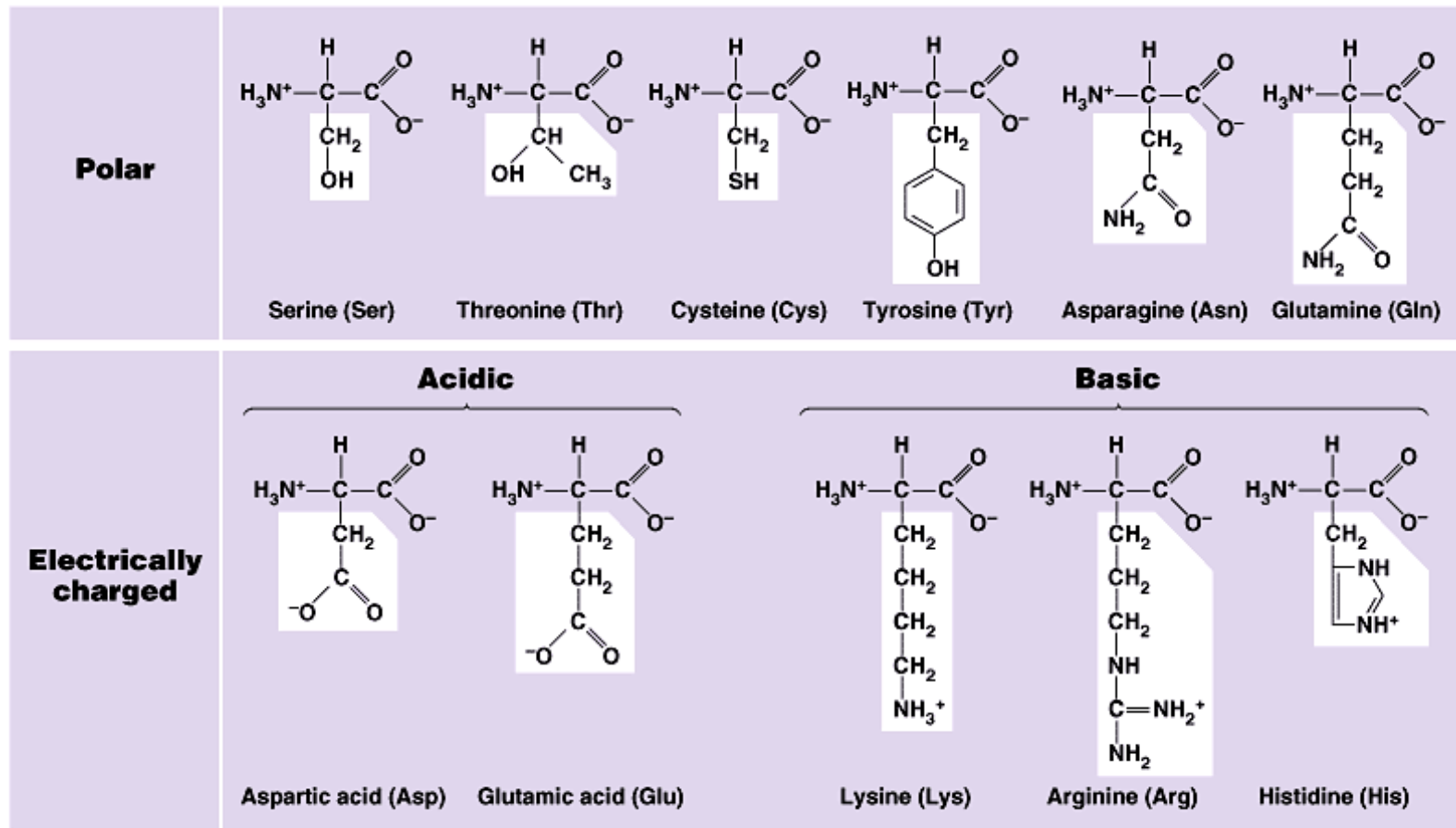
# Non Polar Amino Acids

- ⊕ Amino acids are grouped according to their side chains (R-group)





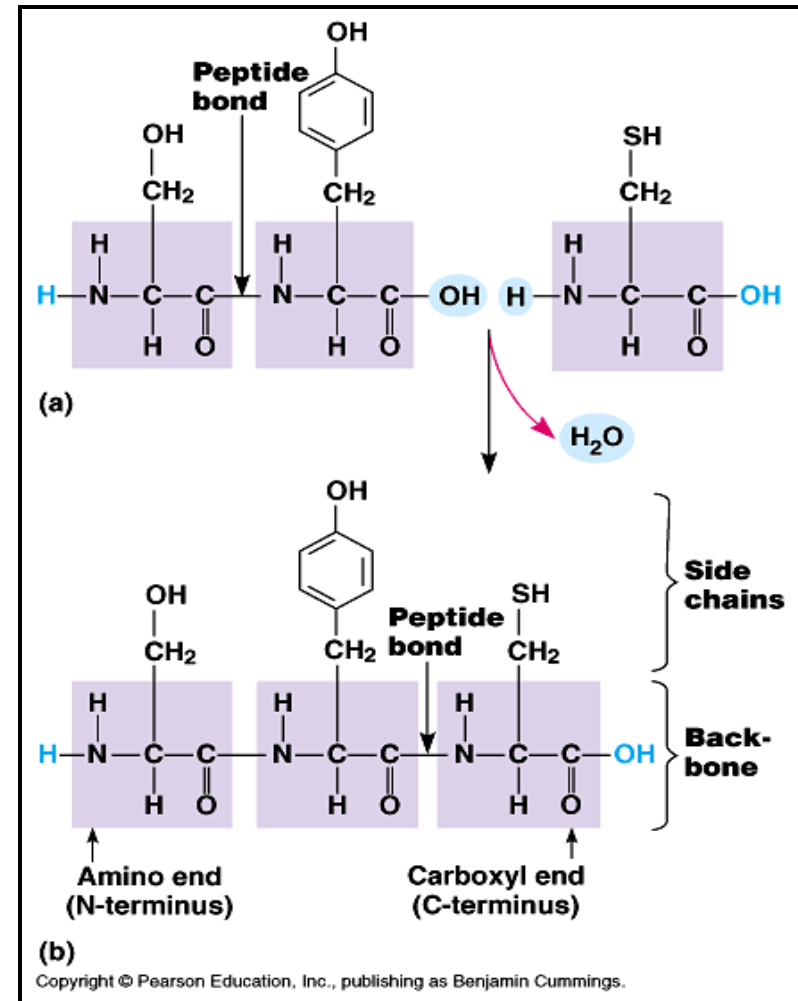
# *Polar/Charged & Hydrophilic Amino Acids*

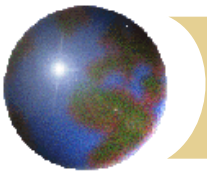




# How to build proteins

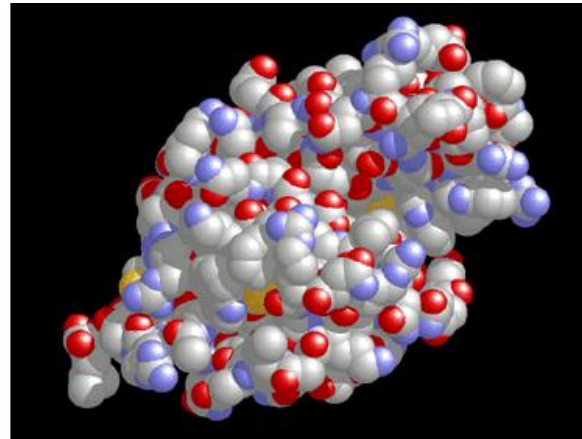
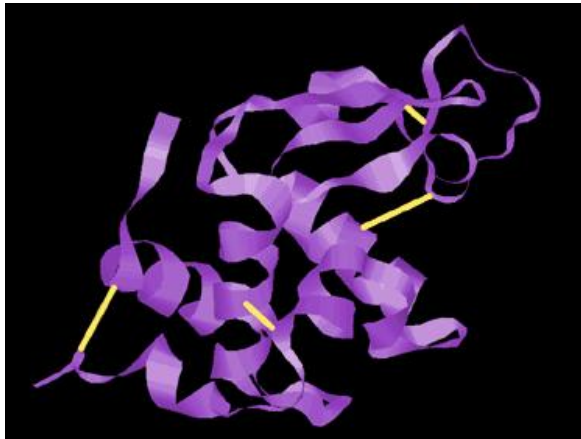
- Dehydration synthesis of 2 or more amino acids
- (-COOH) and (NH<sub>2</sub>) group are joined by a covalent **peptide bond** (C-N)
- One end of polypeptide is free (NH<sub>2</sub>) = **N-terminus**
- One end of polypeptide is free (-COOH) = **C-terminus**
- Grow from N-term → C-term
- Repeated \_\_\_\_\_ sequence is backbone of polypeptide chain**





# *Protein Structure & Function*

- ⊕ **Function depends on structure** – all starts with amino acid sequence
  - ⊕ Proteins are folded, twisted, and coiled into
- 
- ⊕ There are           **levels** of protein structure

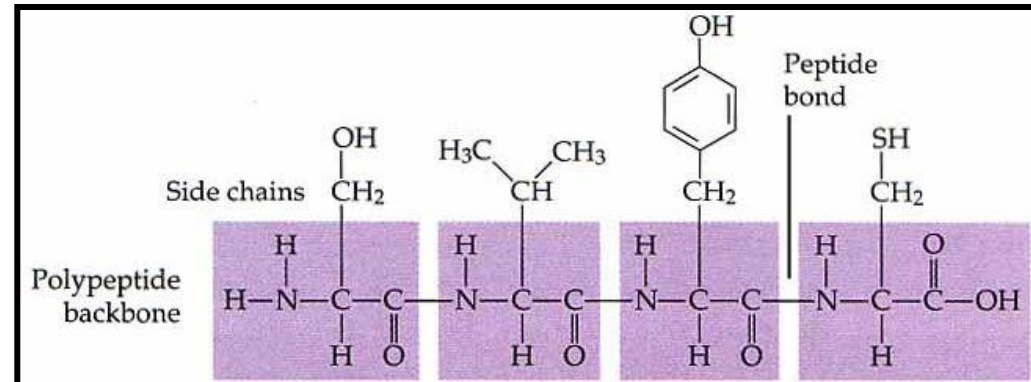
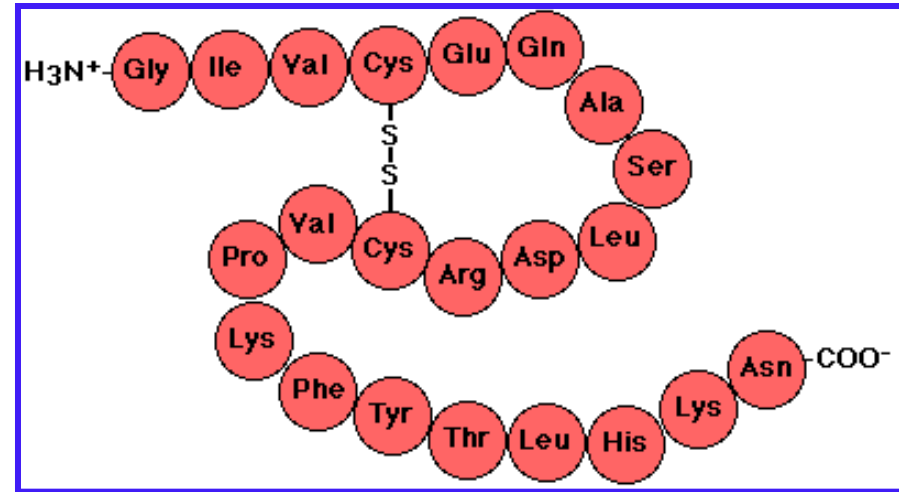


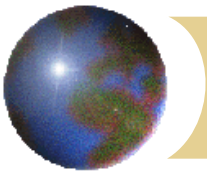
Enzyme, lysozyme is present in our tears, saliva, & sweat – prevents infection.



# Protein Structure - Primary

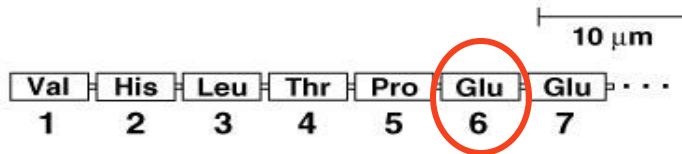
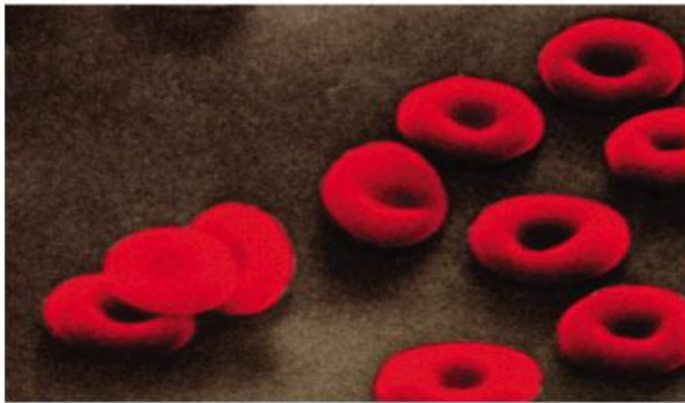
- ✦ Conformation: \_\_\_\_\_ structure based on \_\_\_\_\_ and peptide bonds
- ✦ Each type of protein has a unique primary structure of amino acids
- ✦ How is the amino acid sequence determined?
  - ✦ By the \_\_\_\_\_ sequence



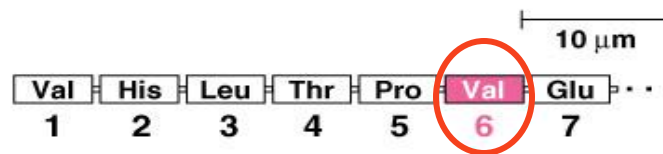


# Sickle Cell Anemia

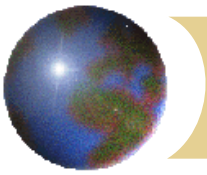
✚ Result of only one amino acid change in primary structure of hemoglobin.



(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



# Protein Structure - Secondary

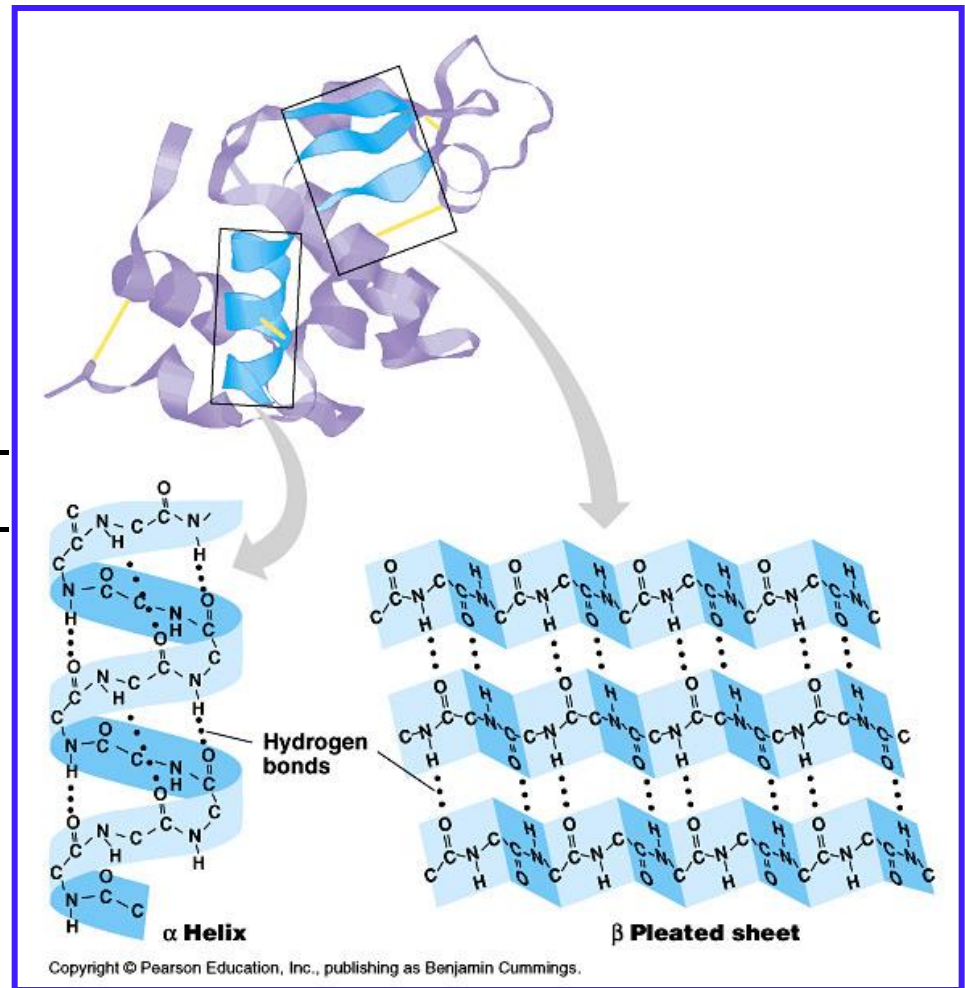
☉ Conformation: folding and coiling of the amino acid chain

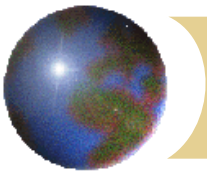
☒ Can be an \_\_\_\_\_

\_\_\_\_\_

- Ex: alpha ( $\alpha$ ) = keratin and beta ( $\beta$ ) = silk

☒ Folds are result of \_\_\_\_\_  
between R-groups

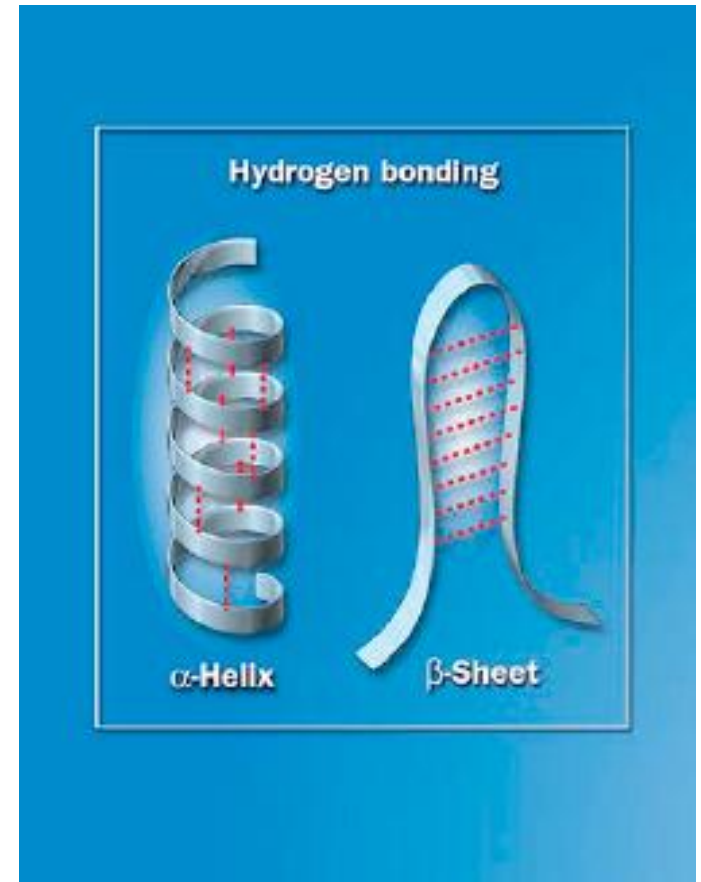




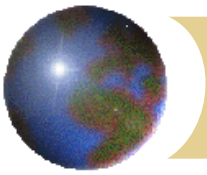
# *Protein Structure – Secondary*



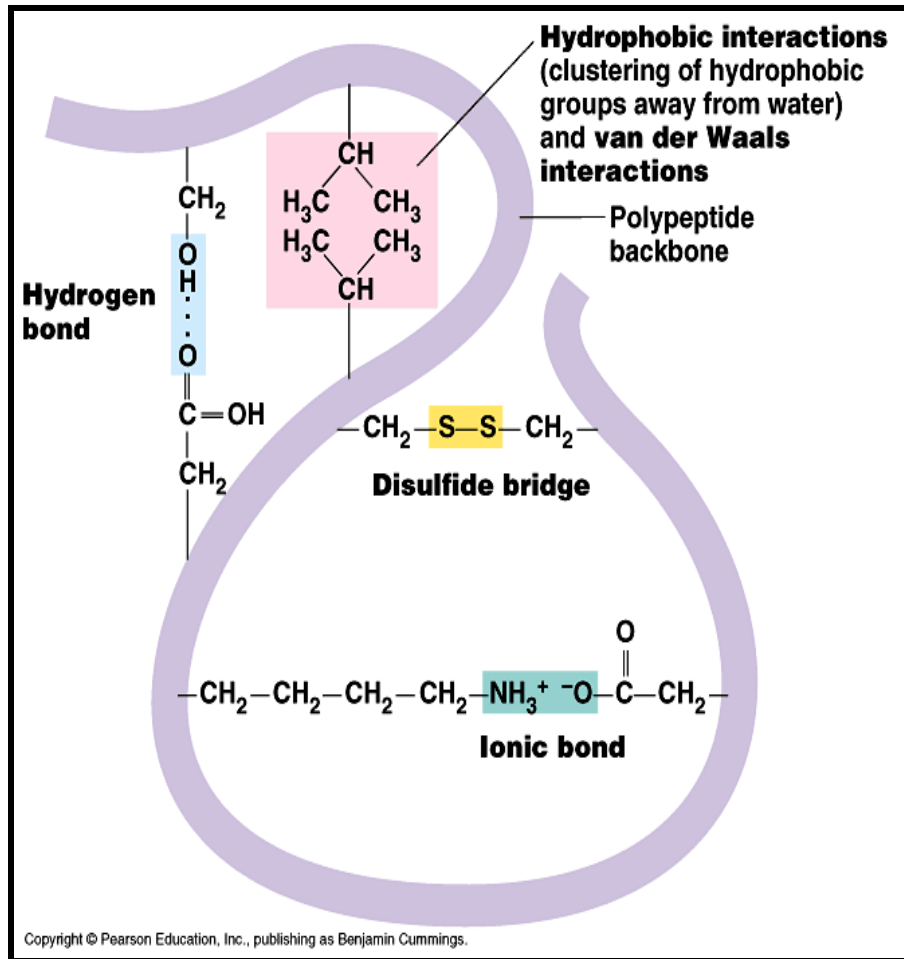
Spider silk: a structural protein containing beta ( $\beta$ ) pleated sheet







# Protein Structure – Tertiary



☉ Conformation: Determined by \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

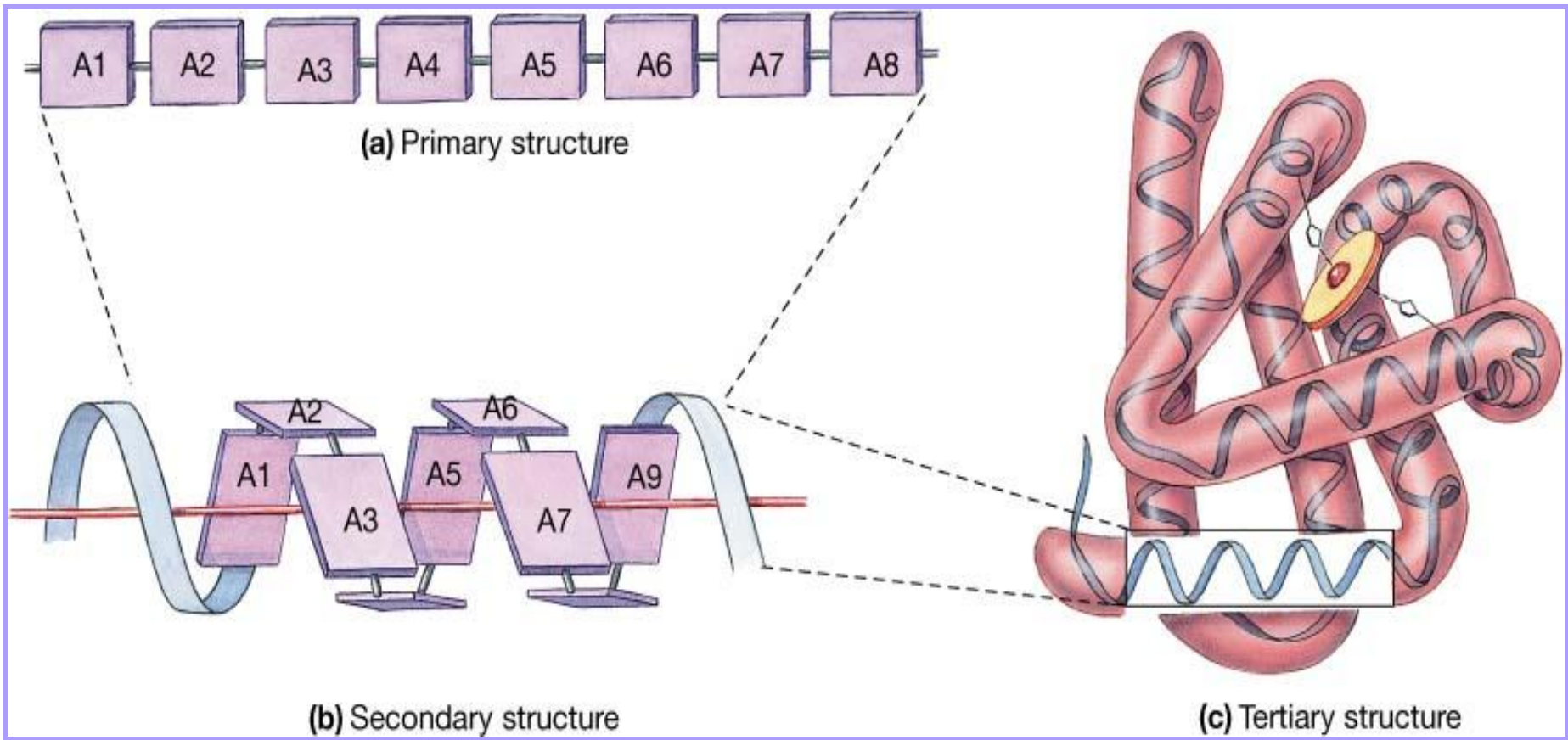
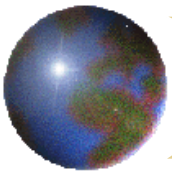
☒ Hydrophobic & Hydrophilic interactions due to water

☒ H-bonds

☒ \_\_\_\_\_ bridges

☒ \_\_\_\_\_ bonds

☒ \_\_\_\_\_ interactions





# Protein Structure – Quaternary

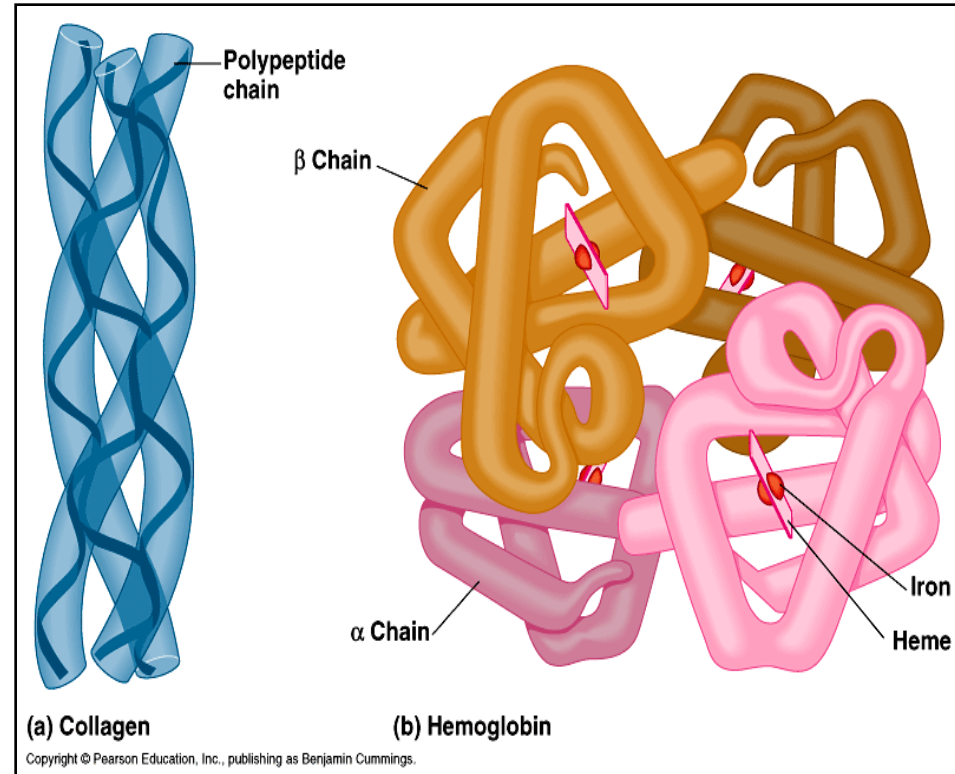
☉ Conformation: \_\_\_\_\_

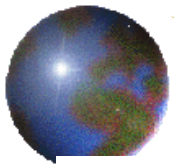
\_\_\_\_\_

\_\_\_\_\_

causing the overall protein structure

- ☒ Ex: Collagen – fibrous protein
  - helical subunits twisted into one large subunit
- ☒ Ex: Hemoglobin – oxygen binding protein of red blood cells
  - 4 polypeptide subunits
  - Two  $\alpha$  chains
  - Two  $\beta$  chains





# Protein Structure Review

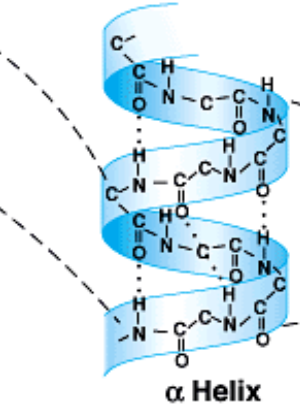
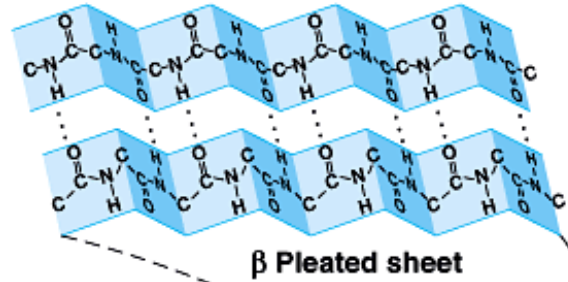
- R Groups
- Hydrophobic & Hydrophilic interactions
- H & ionic bonds
- Disulfide bridges
- Van der Waals interactions



(a) Primary structure

1°

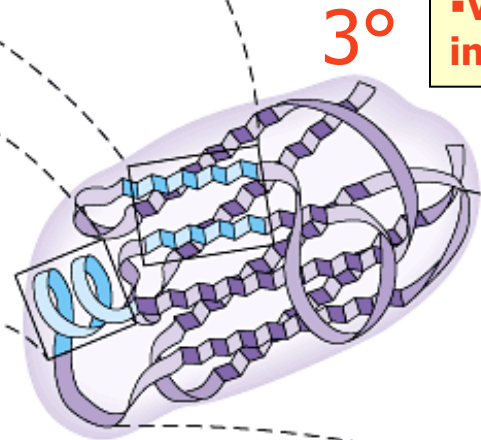
**Amino acid sequence**  
**peptide bonds**  
**Determined by DNA**



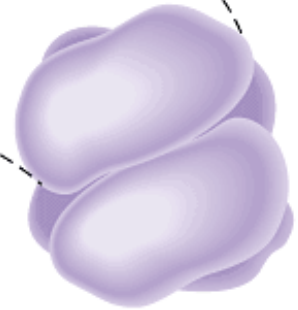
(b) Secondary structure

2°

- R Groups
- H Bonds



(c) Tertiary structure



(d) Quaternary structure

4°

- Multiple polypeptides



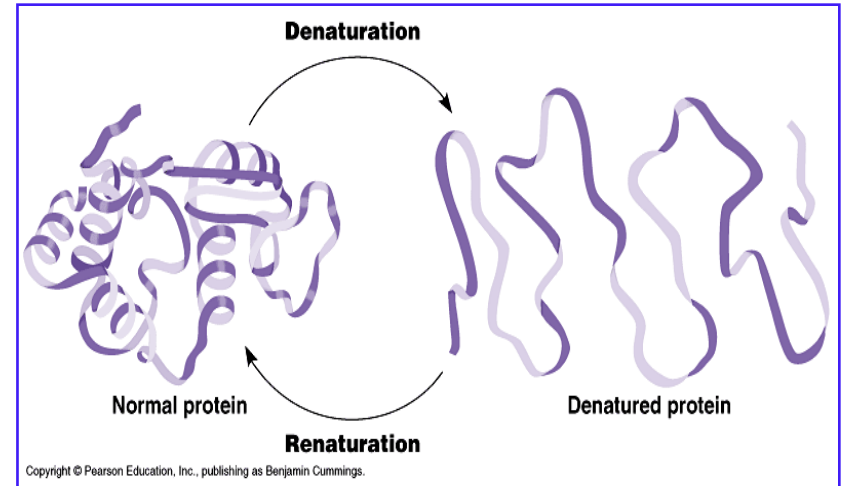
# Other Factors Affecting Protein

## Structure

- ✪ Depends on physical and chemical conditions
- ✪ Affect 3° structure:



- ✪ If the environment is not “just right” a protein will denature (unravel, lose confirmation, become dysfunctional)
  - ✪ Ex: cooking an egg denatures the egg white





# Chaperonins

- ❖ Protein molecules that \_\_\_\_\_ of other proteins.
- ❖ Aids the folding process by providing shelter from cytoplasmic influences.

