

# INTRODUCTION TO BIOCHEMISTRY

## PROTEIN

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# PROTEIN

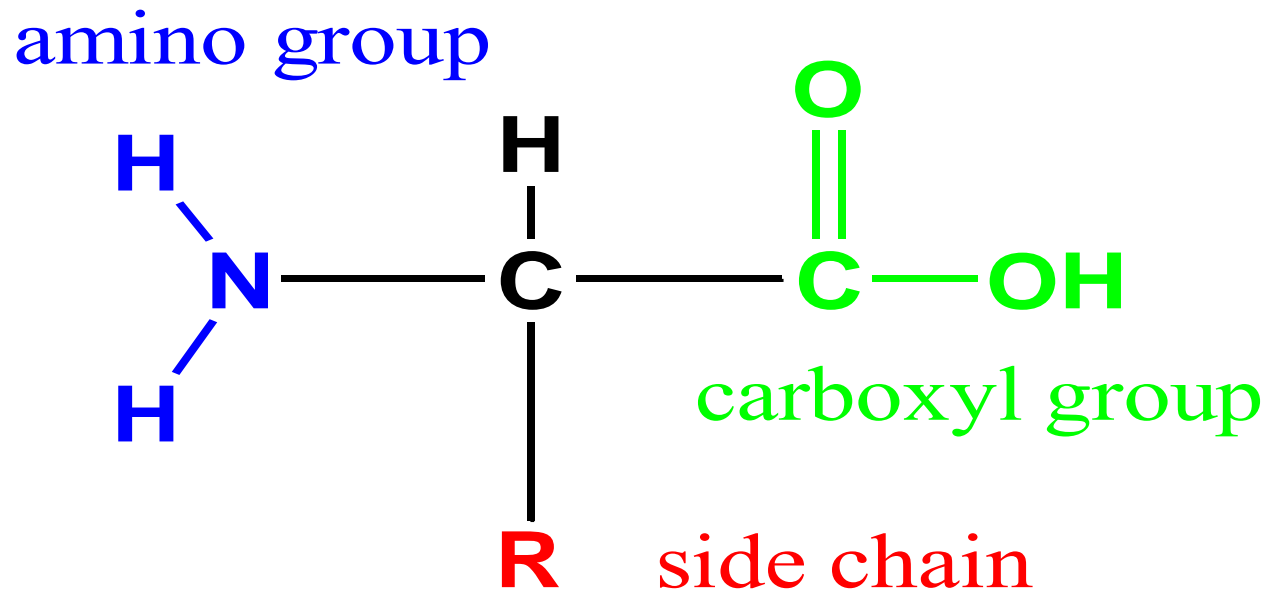
- Proteins are the most structurally and functionally diverse group of biomolecules. They also make up the majority of the dry weight of all living cells.
- Proteins are used as motors, structural elements, enzymes, receptors, channels through membranes, intra-cellular transporters, regulatory switches, and much more.
- **Made of C,H,O,N, and sometimes S.**

# Uses Of Proteins

- **Structural Proteins**: used to make skin, hair, muscles, etc...
- **Enzymes**: Control Metabolism
- **Antibodies**: Provide protection against foreign substances
- **Transport Proteins**: Transport molecules across membranes
- **Storage**: such as ovalbumin in eggs

# Amino Acid Polymers

- Proteins are a polymer of amino acids.
  - There are 20 different types of amino acids, but they all have the same basic structure.
- A central carbon atom is linked to an amino group ( $\text{NH}_2$ ), a carboxyl group ( $\text{COOH}$ ), and a variable side chain – shown as “ $\text{R}$ ” below.

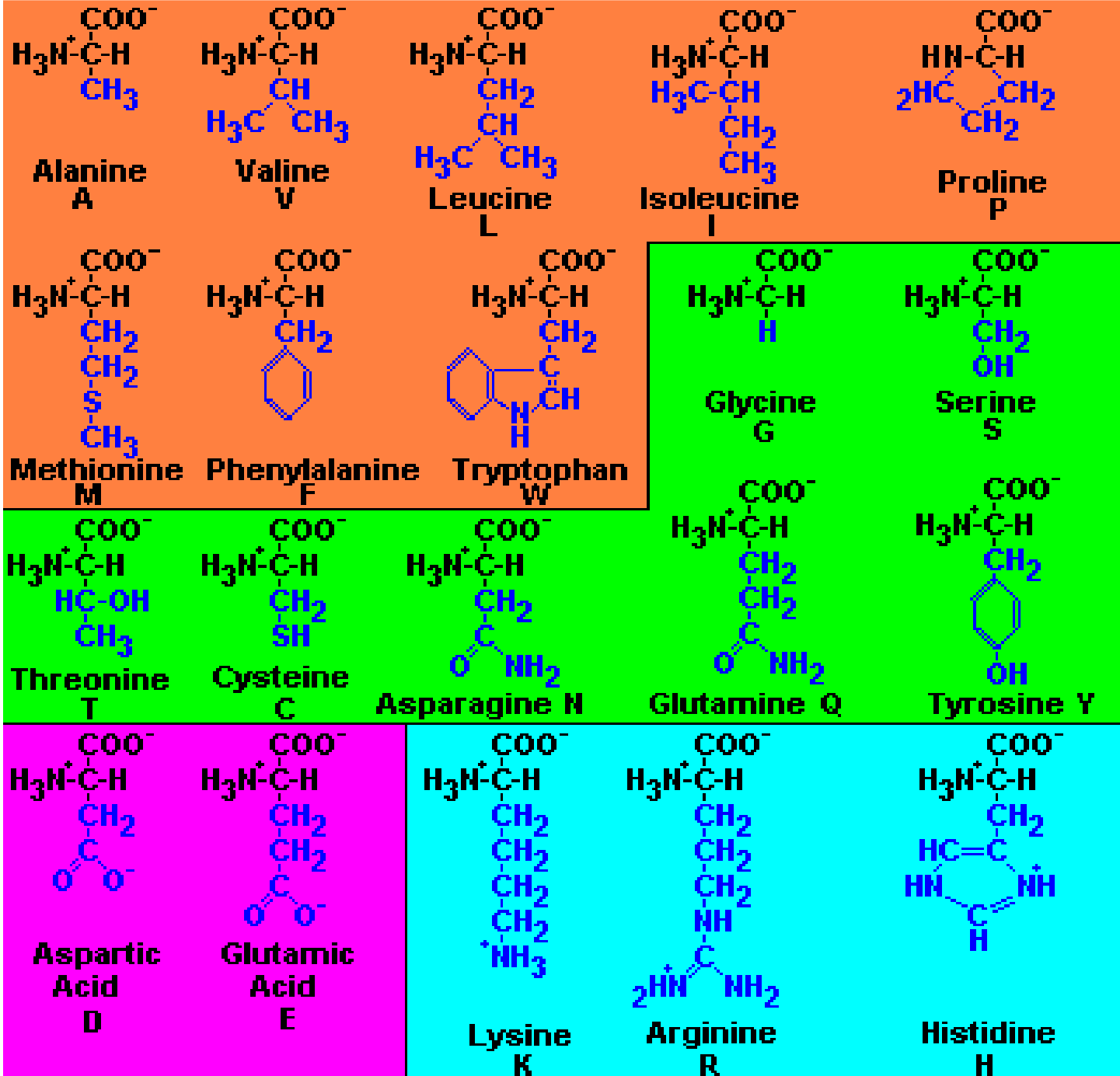


# Amino Acids

- The 20 kinds of amino acids each have a different group as the side chain,
- The amino acids can be divided into sub-groups based on the chemical properties of their side chains.
  - The non-polar amino acids have simple hydrocarbon side chains, which tend to make them insoluble in water (hydrophobic)  
alanine, valine, leucine, isoleucine, proline, methionine, phenylalanine, tryptophan
  - Another group is polar, but has a neutral charge/pH  
glycine, serine, threonine, cysteine, asparagines, glutamine, tyrosine
  - Aspartic acid and glutamic acid are negatively charged in water.
  - Lysine, arginine, and histidine are positively charged in water.

# CLASSIFICATION OF AMINO ACIDS

- 1. Aliphatic amino acids
- 2. Hydroxyamino acids
- 3. Acidic amino acids
- 4. Amide amino acids
- 5. Basic amino acids
- 6. Sulfur-containing amino acids
- 7. Aromatic amino acids
- 8. Secondary amino acids



# ESSENTIAL AMINO ACIDS

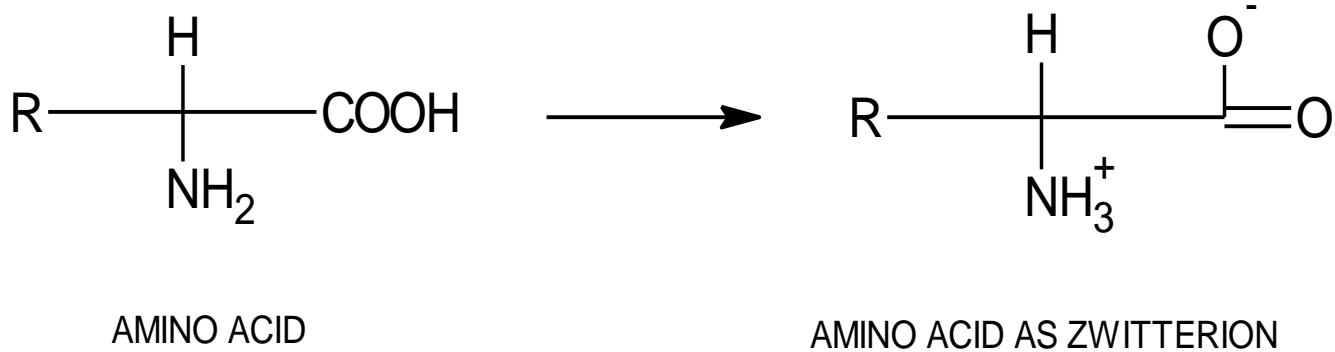
- Dietary Essential AA -- an amino acid required by an animal and can not be synthesized by the animal in the amounts needed; and therefore must be present and available in the diet
  - Arginine
  - Histidine
  - Isoleucine
  - Leucine
  - Lysine
  - Methionine – S-containing, Cystine may provide  $\frac{1}{2}$  the reqmt
  - Phenylalanine -- tyrosine may provide  $\frac{1}{2}$  of the requirement
  - Threonine
  - Tryptophan
  - Valine
- Nonessential AA -- required by the animal but can be produced in adequate amounts



- **Limiting amino acid:** the essential amino acid in a feed or ration that becomes depleted first during protein synthesis
  - This restricts further protein synthesis until a new supply of amino acids comes along
  - Therefore an animal's absolute requirement is not for protein per se, but for required amounts of each essential amino acid
  - Not the same amounts and proportions of amino acids in ingested food and what is to be synthesized in the body

# Zwitterions

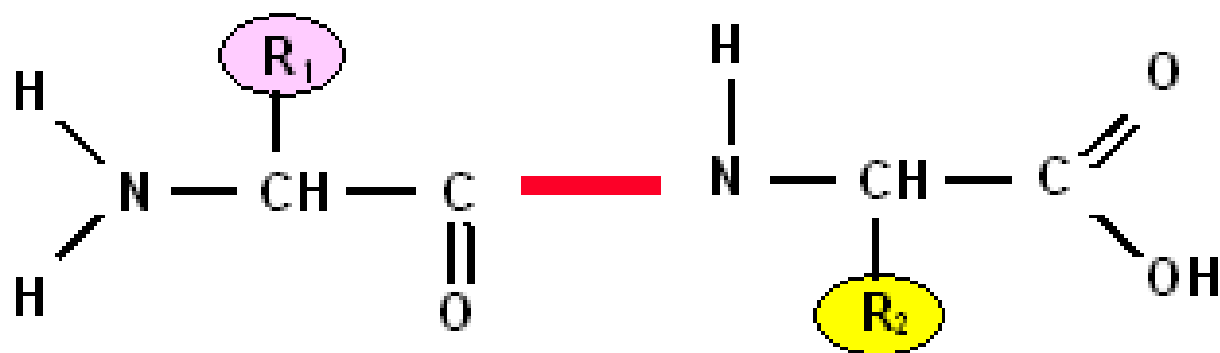
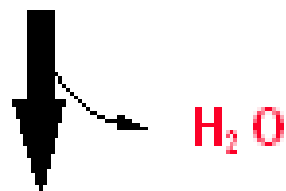
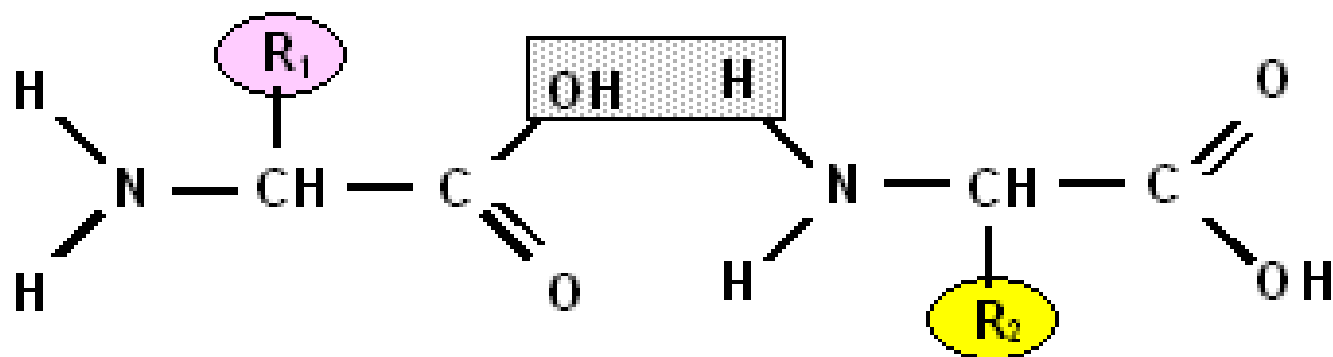
- A **zwitterion** is a neutral molecule with a positive and a negative electric charge at different locations within that molecule. Zwitterions are sometimes also called **inner salts**.
- Unlike simple amphoteric compounds that might only form *either* a cationic or anionic species depending on external conditions, a zwitterion simultaneously has both ionic states in the same molecule.

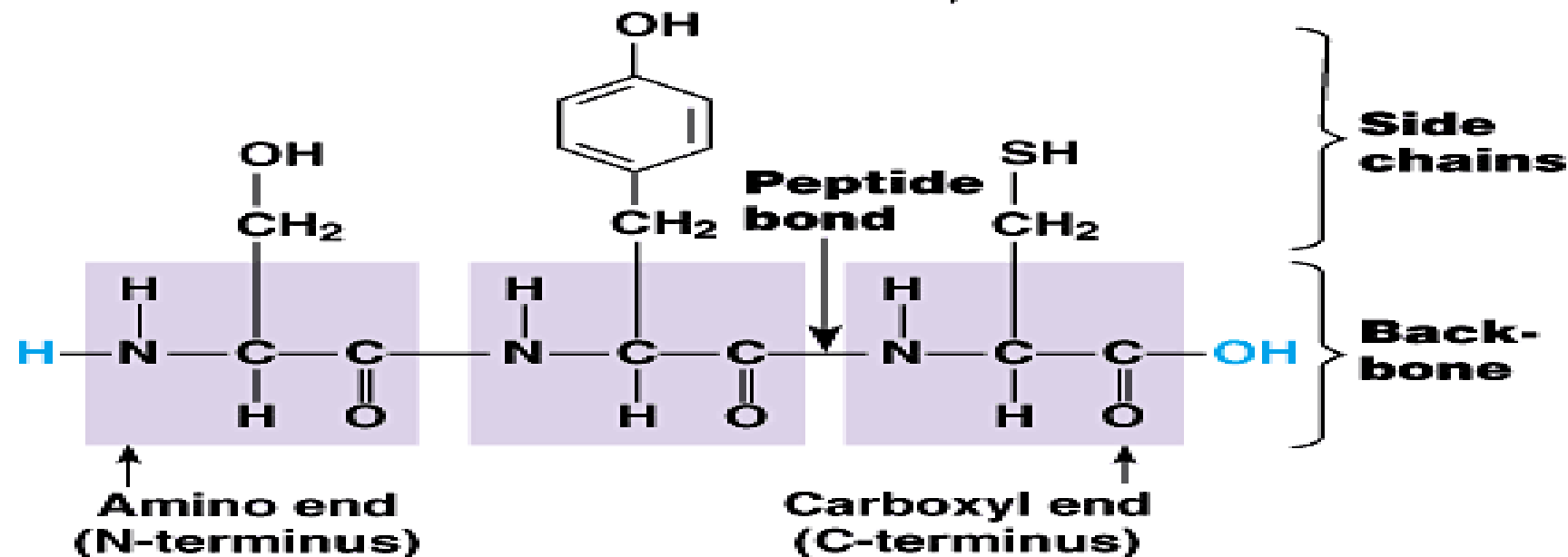
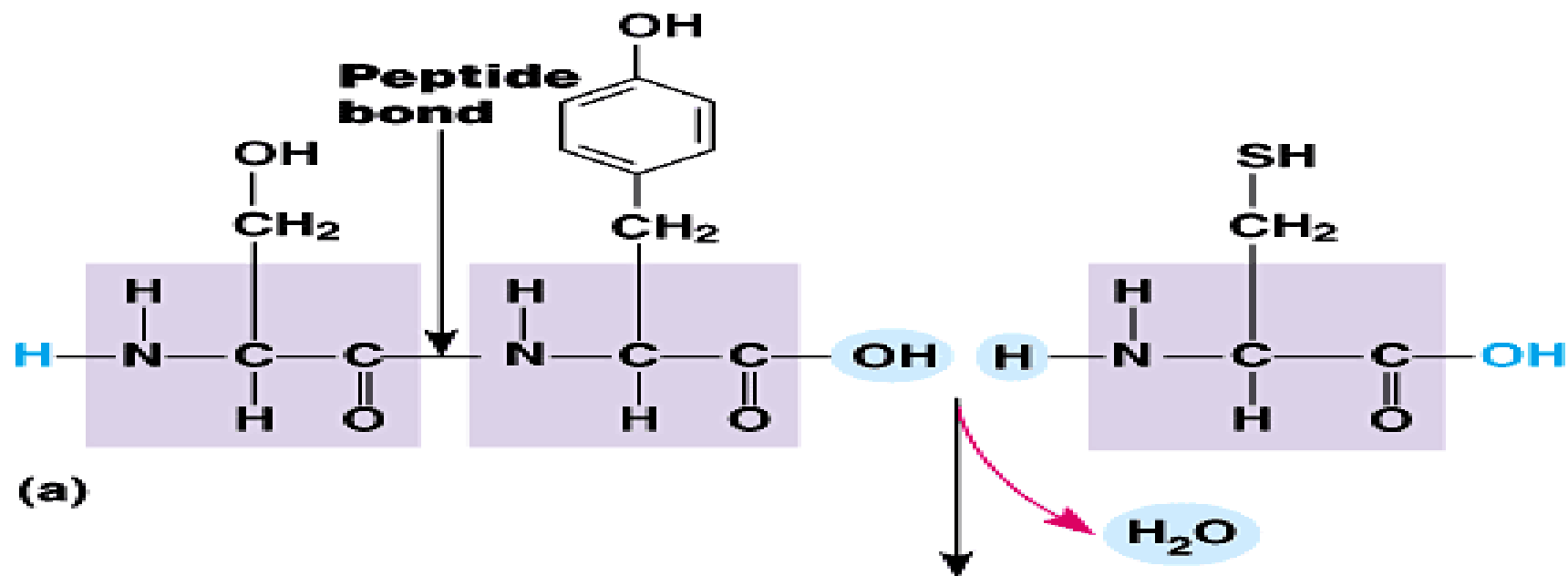


- The **isoelectric point (pI)**, sometimes abbreviated to **IEP**, is the pH at which a particular molecule or surface carries no net electric charge.

# Peptide Bonds

- Amino acids are joined together by peptide bonds to form poly-peptide chains.
- The peptide bond forms between the **amino group** of one amino acid and the **carboxyl** group of another
  - an **–OH** is lost from the carboxyl and an **–H** from the amino to form a **C–N** bond plus a free water molecule.
- The resulting poly-peptide chain has a free amino group at one end and a free carboxyl group at the other end (the **N-terminal** and **C-terminal ends**)



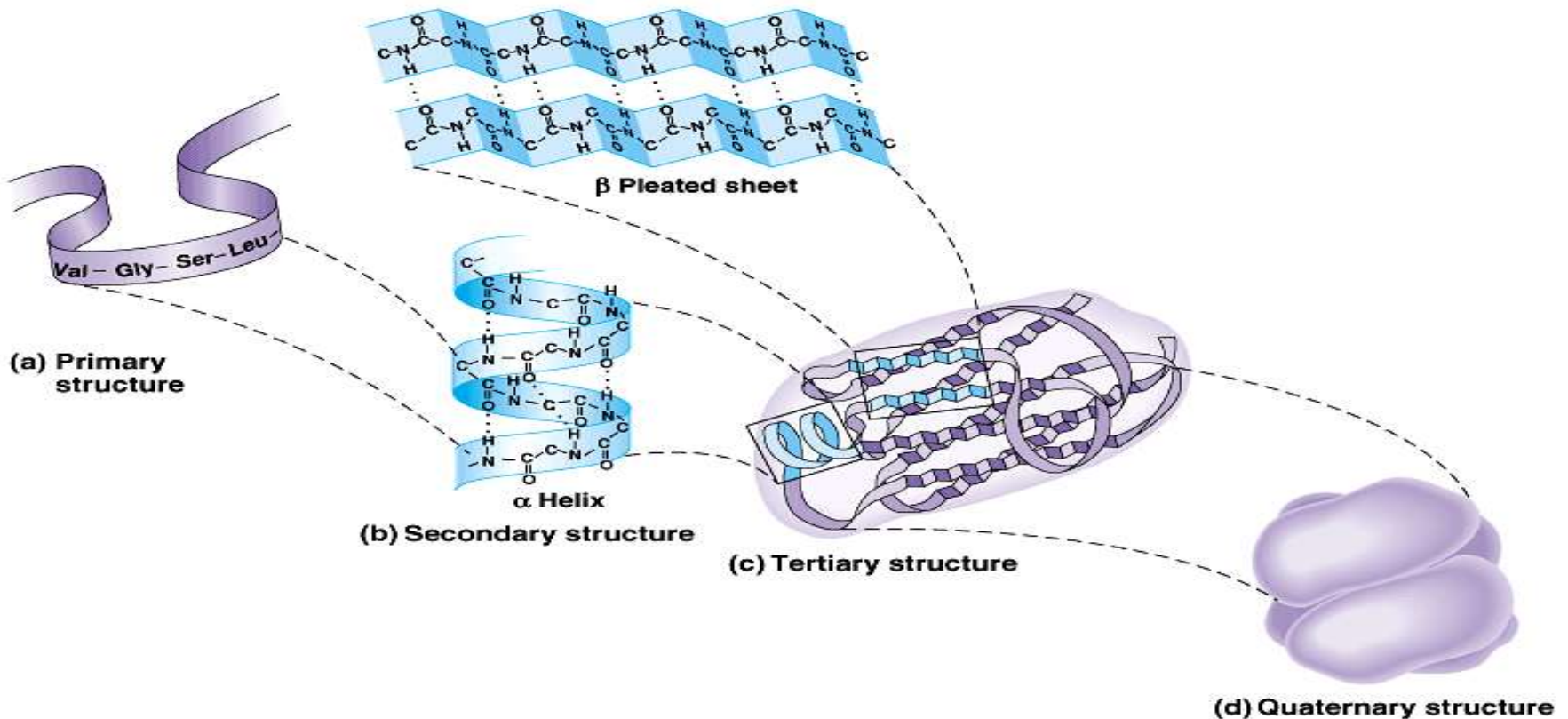


(b)

# Levels Of Protein Structure

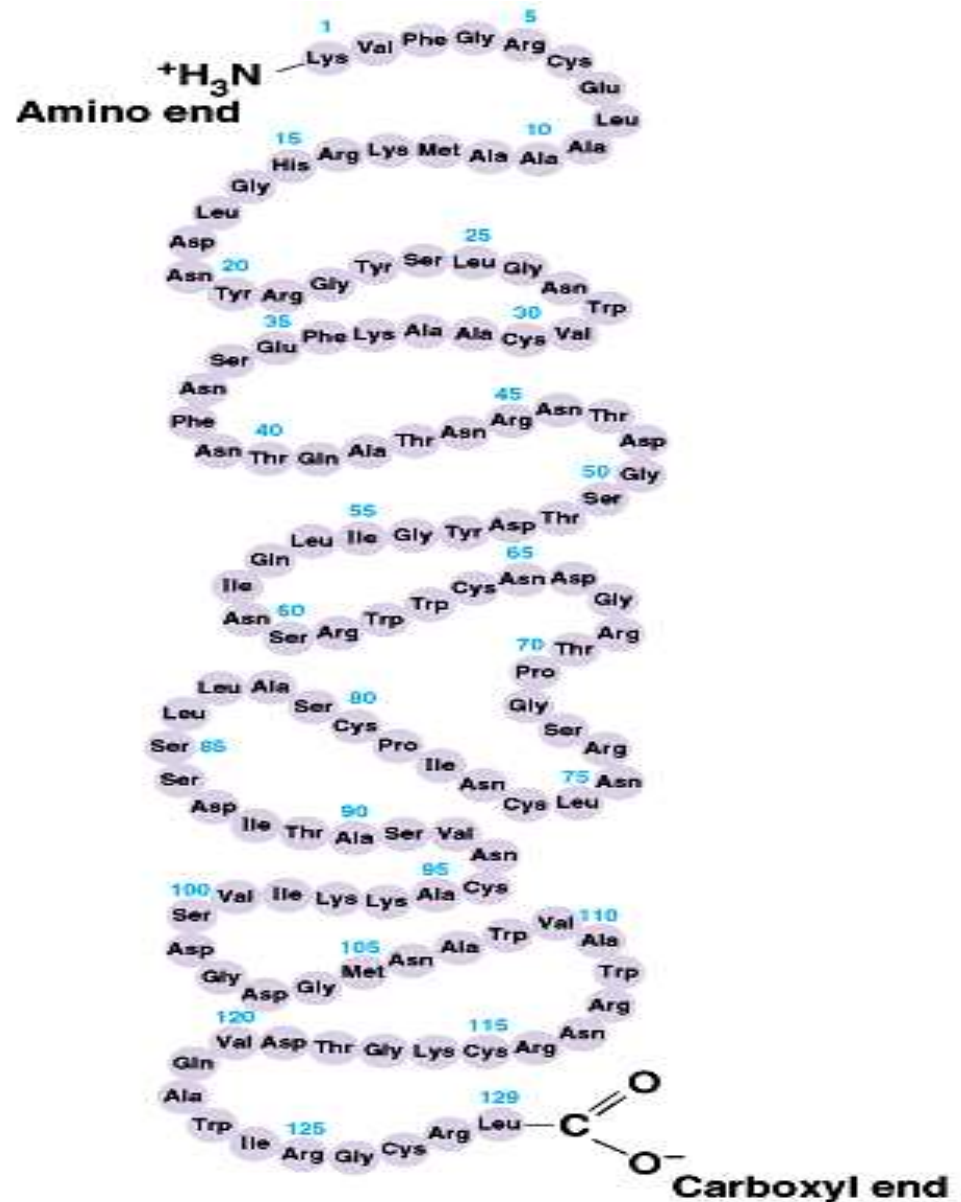
Organizing the polypeptide into its 3-D functional shape.

- Primary
- Secondary
- Tertiary
- Quaternary



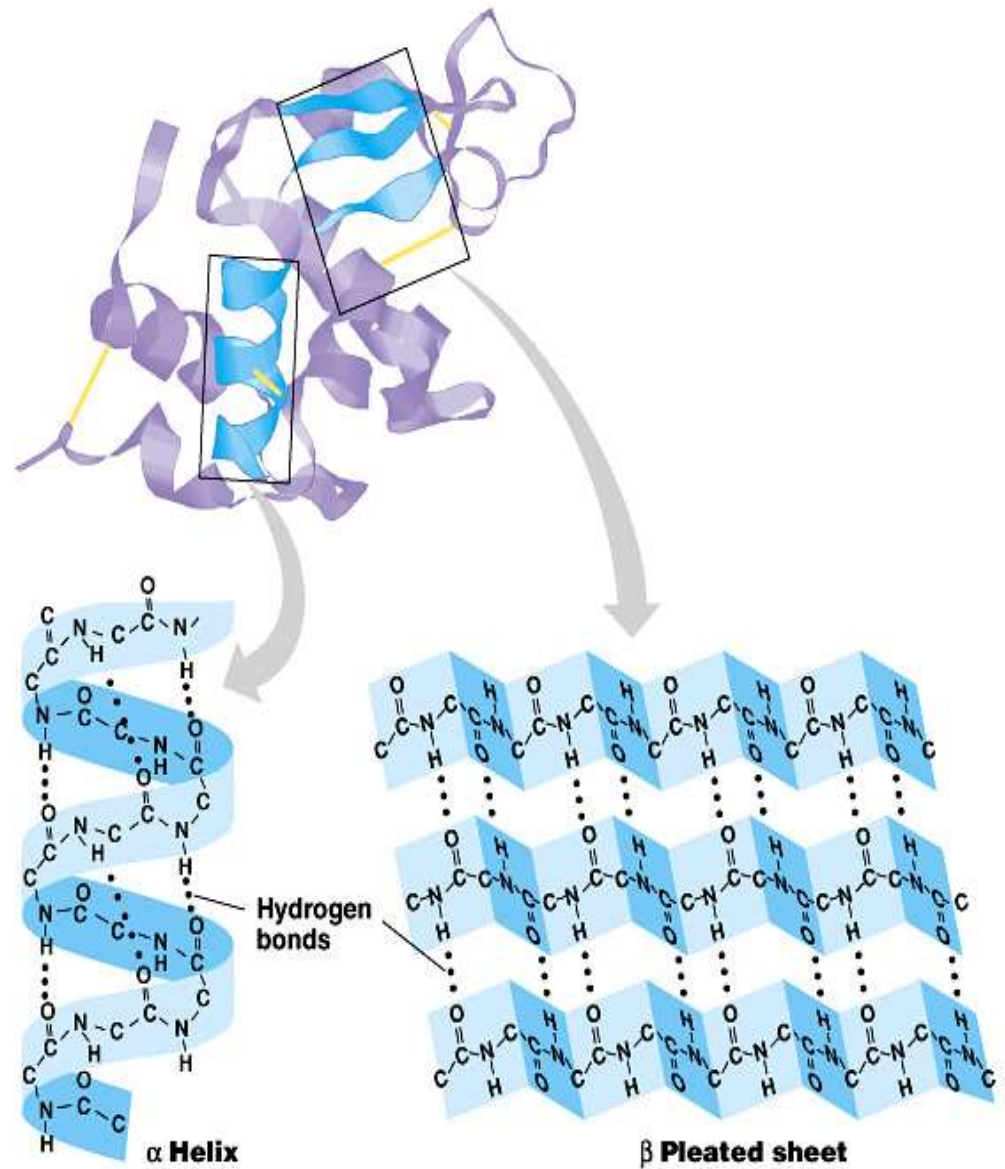
# Primary Structure

Order of amino acids in the polypeptide chain. Many different sequences are possible with 20 AAs.



# Secondary Structure

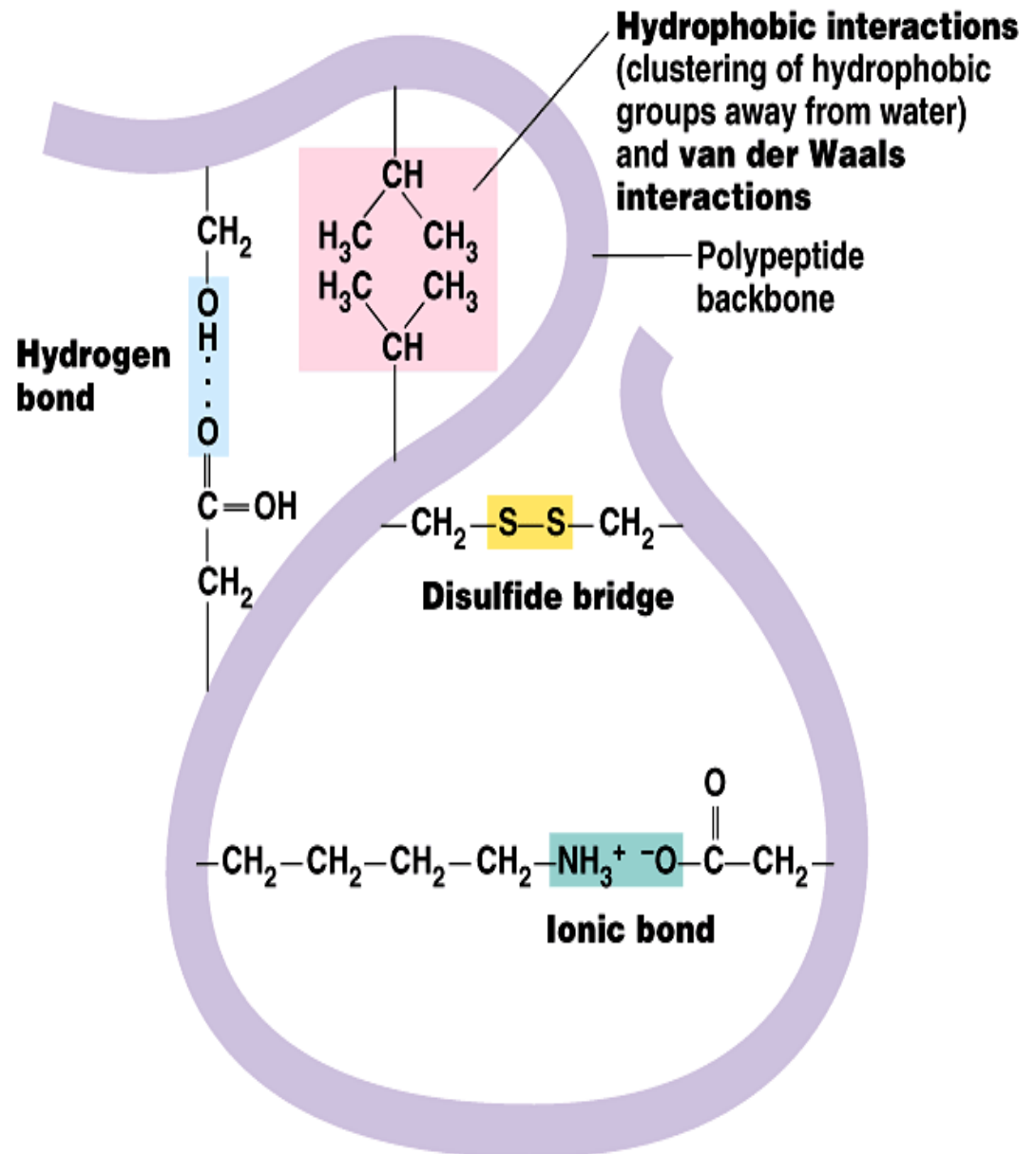
- 3-D structure formed by hydrogen bonding between the R groups.
- Two main secondary structures:
  - $\alpha$  helix
  - $\beta$  pleated sheets





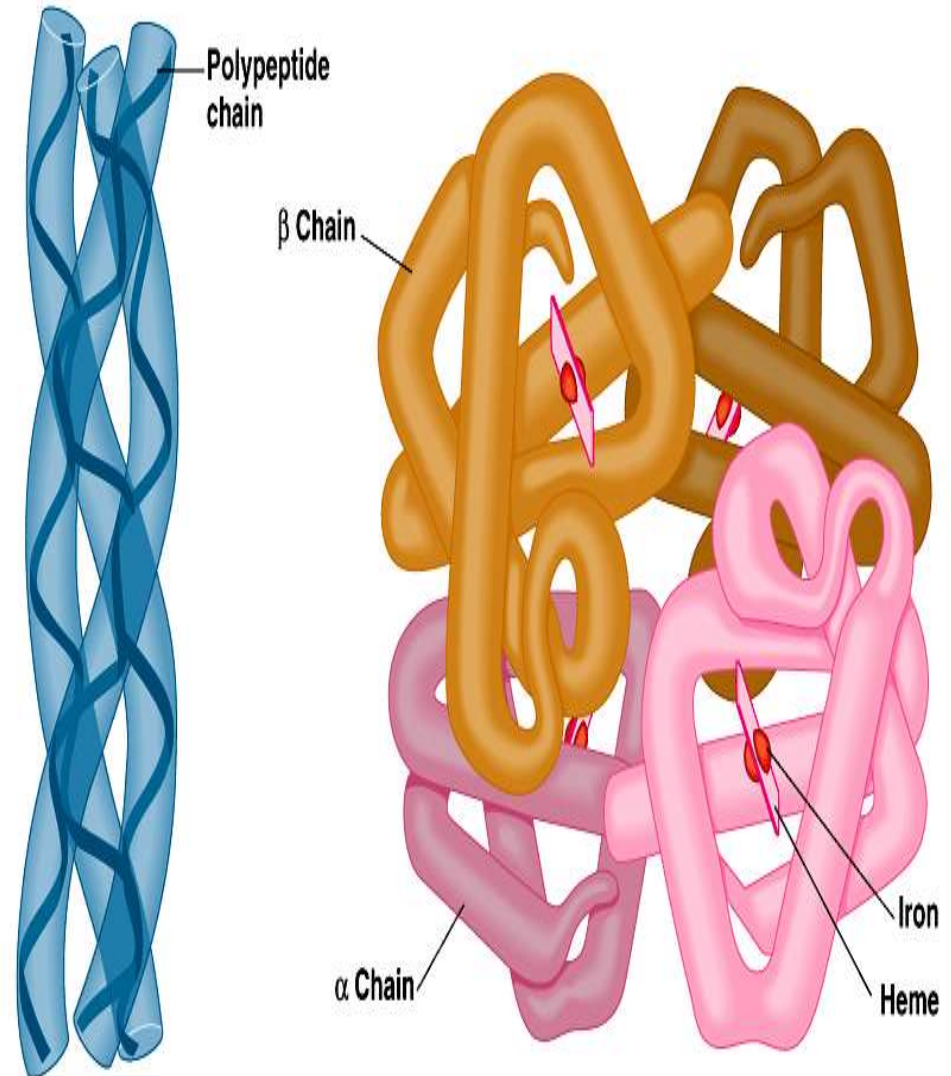
# Tertiary Structure

- 3D shape as bonding occurs between the R groups.
- Examples:
  - Hydrophobic interactions
  - Ionic bonding
  - Disulfide bridges
  - Hydrogen Bonding



# Quaternary Structure

- When two or more polypeptides unite to form a functional protein.
- Example: hemoglobin



(a) Collagen

(b) Hemoglobin

# Denaturation of Protein

Change of shape  
is called  
***DENATURATION***

What causes  
change of  
shape?

acid (like the stomach  
low pH) or base (high  
pH)

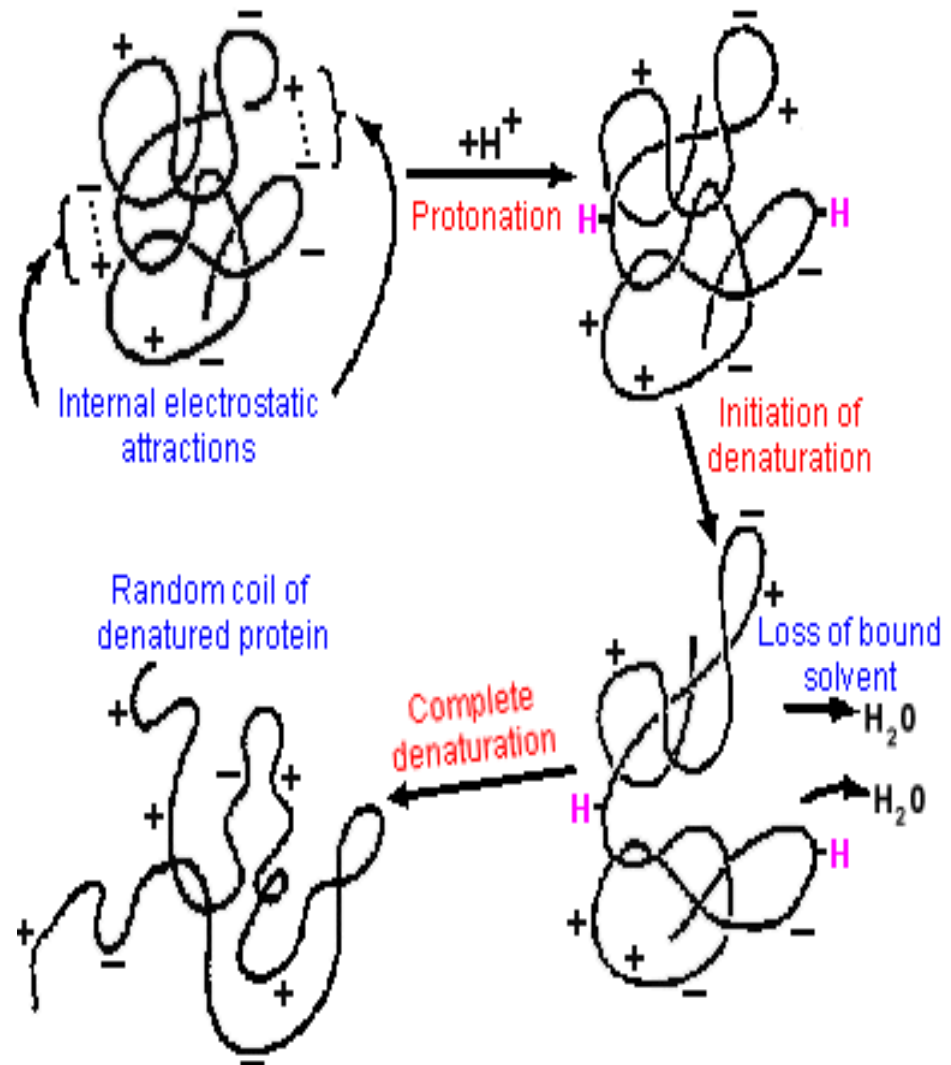
alcohol

mechanical

agitation (beating  
an egg white)

heat (heat an egg  
white) or heavy  
metals (mercury)

## Precipitation of Selective Denaturation



**THANKS**