INTRODUCTION TO BIOCHEMISTRY

PROTEIN

R. MAITI

LECTURER IN PHARMACY

PROTEIN

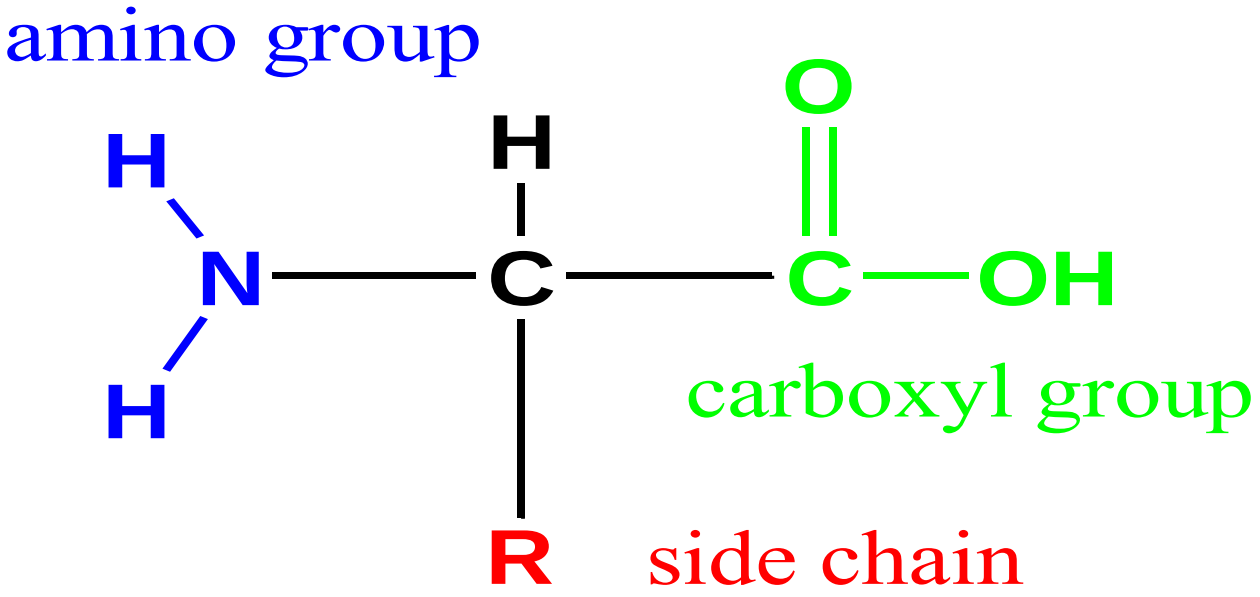
- Proteins are the most structurally and functionally diverse group of biomolecules. They also make up the majority of the dry weight of all living cells.
- Proteins are used as motors, structural elements, enzymes, receptors, channels through membranes, intra-cellular transporters, regulatory switches, 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 (NH_2), a carboxyl group (COOH), and a variable side chain – shown as "R" below.



Amino Acids

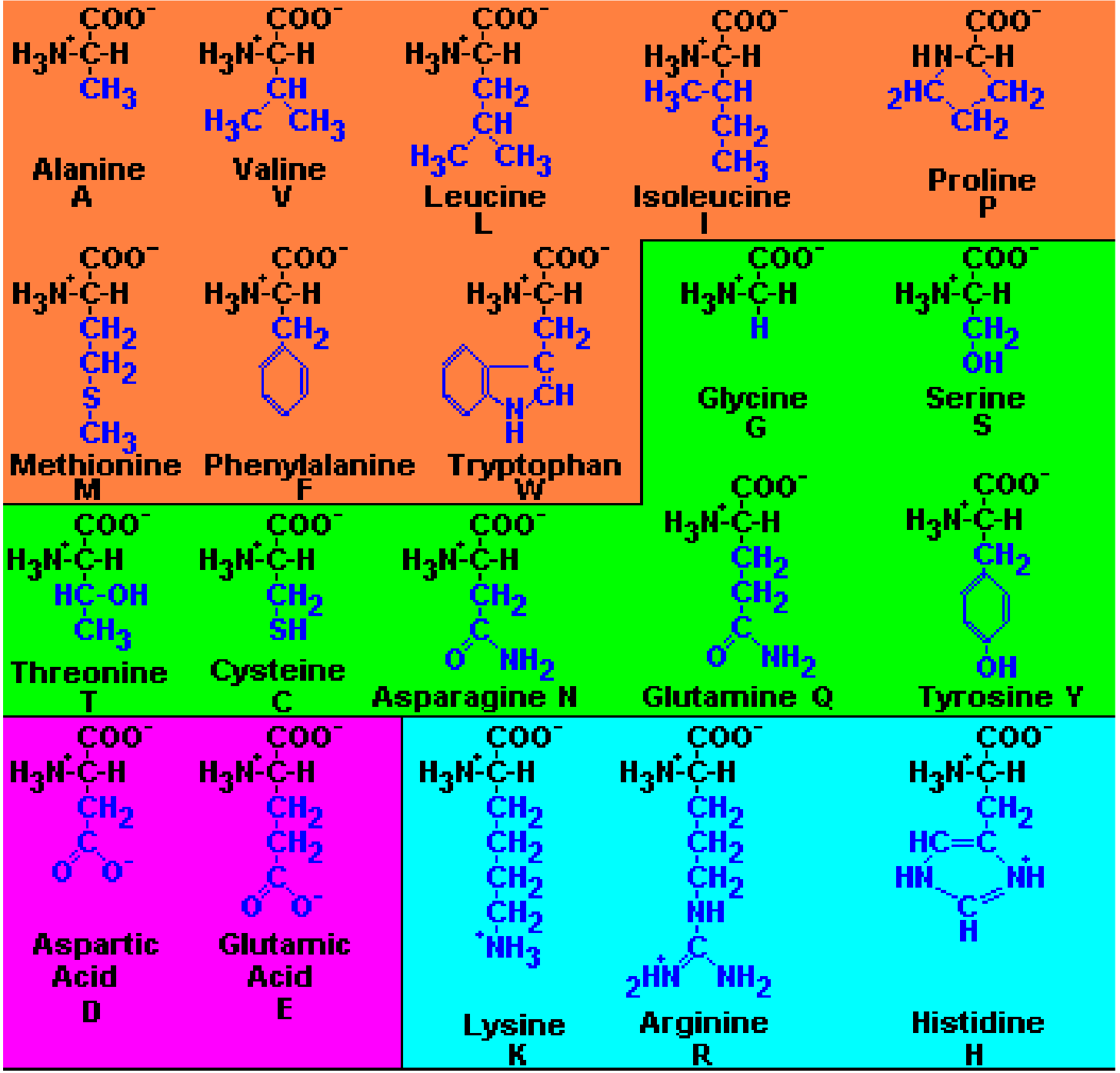
- The 20 kinds of amino acids each have a different group as the side chain,
- The amino acids can be divided into sub-groups based on the chemical properties of their side chains.
  - The non-polar amino acids have simple hydrocarbon side chains, which tend to make them insoluble in water (hydrophobic)

    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


Alanine
A
Valine
V
Leucine
L
Isoleucine
I
Proline
P
Methionine
M
Phenylalanine
F
Tryptophan
W
Glycine
G
Serine
S
Threonine
T
Cysteine
C
Asparagine N
Glutamine Q
Tyrosine Y
Aspartic
Acid
D
Glutamic
Acid
E
Lysine
K
Arginine
R
Histidine
H

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 ½ the reqmt**
  - **Phenylalanine -- tyrosine may provide ½ 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

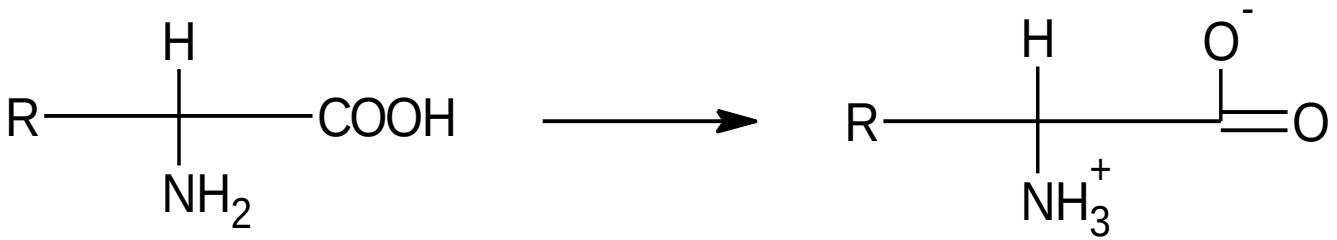
  - This restricts further protein synthesis until a new supply of amino acids comes along

  - 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.



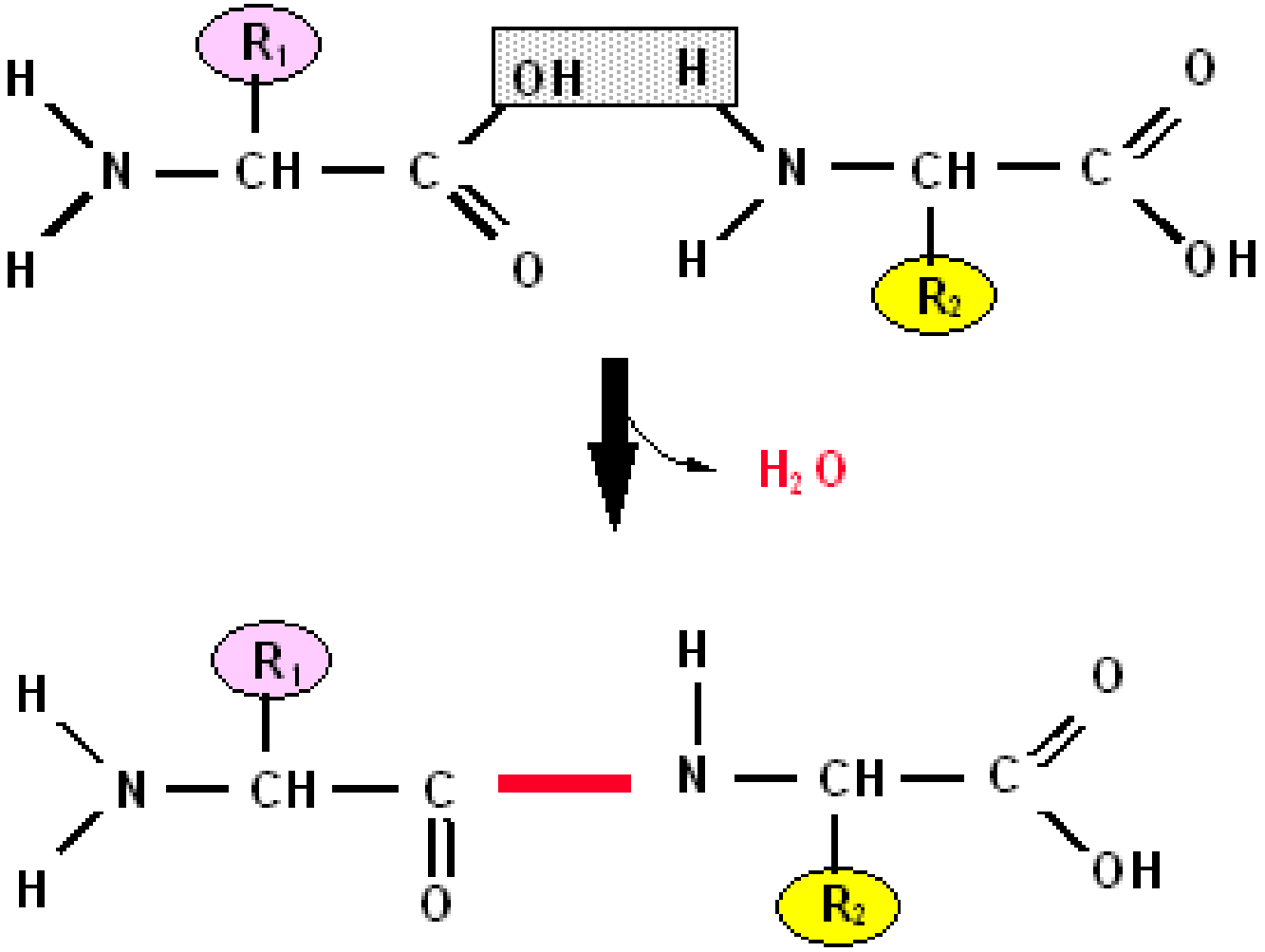
AMINO ACID

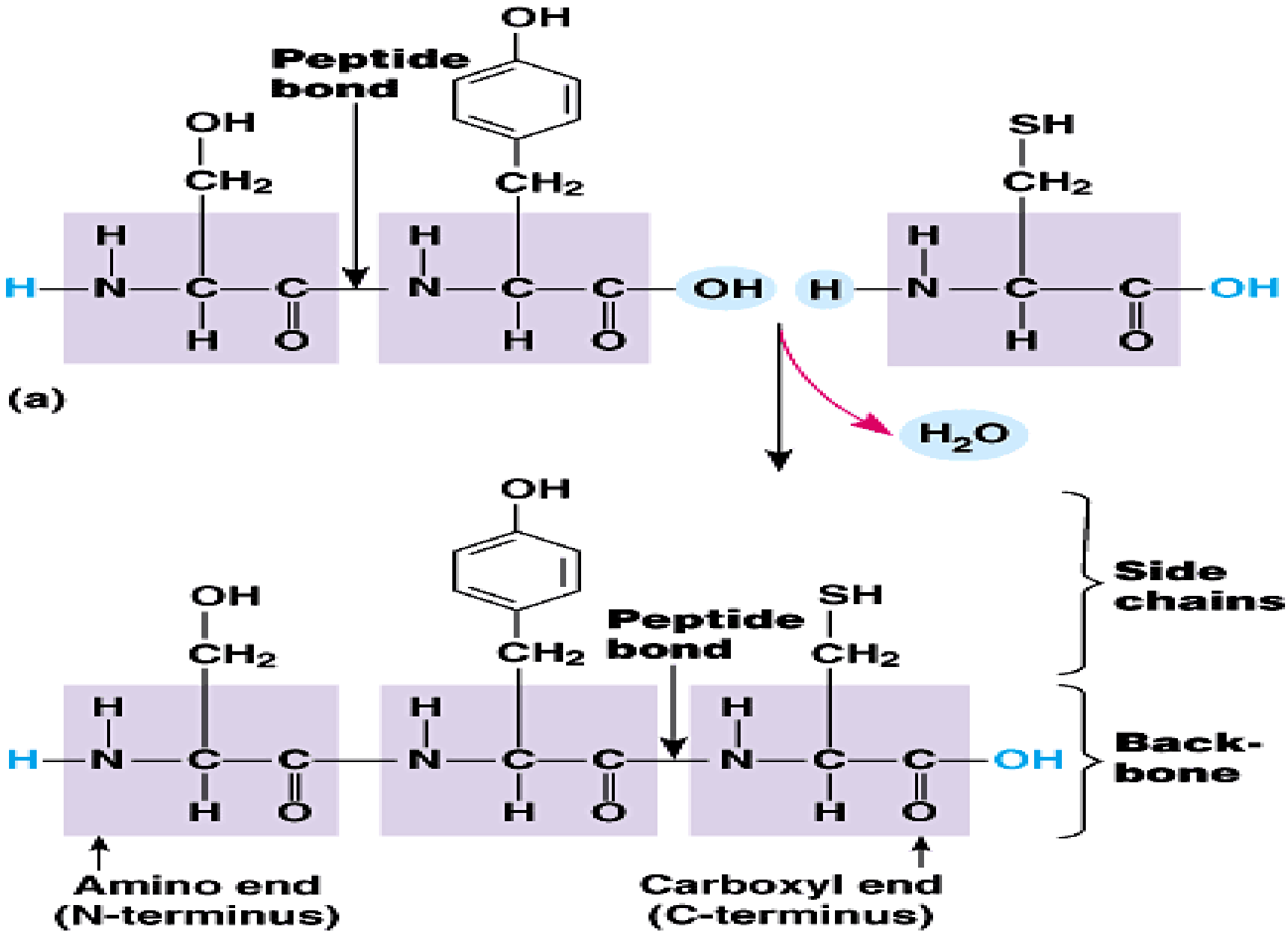
AMINO ACID AS ZWITTERION

- 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)**

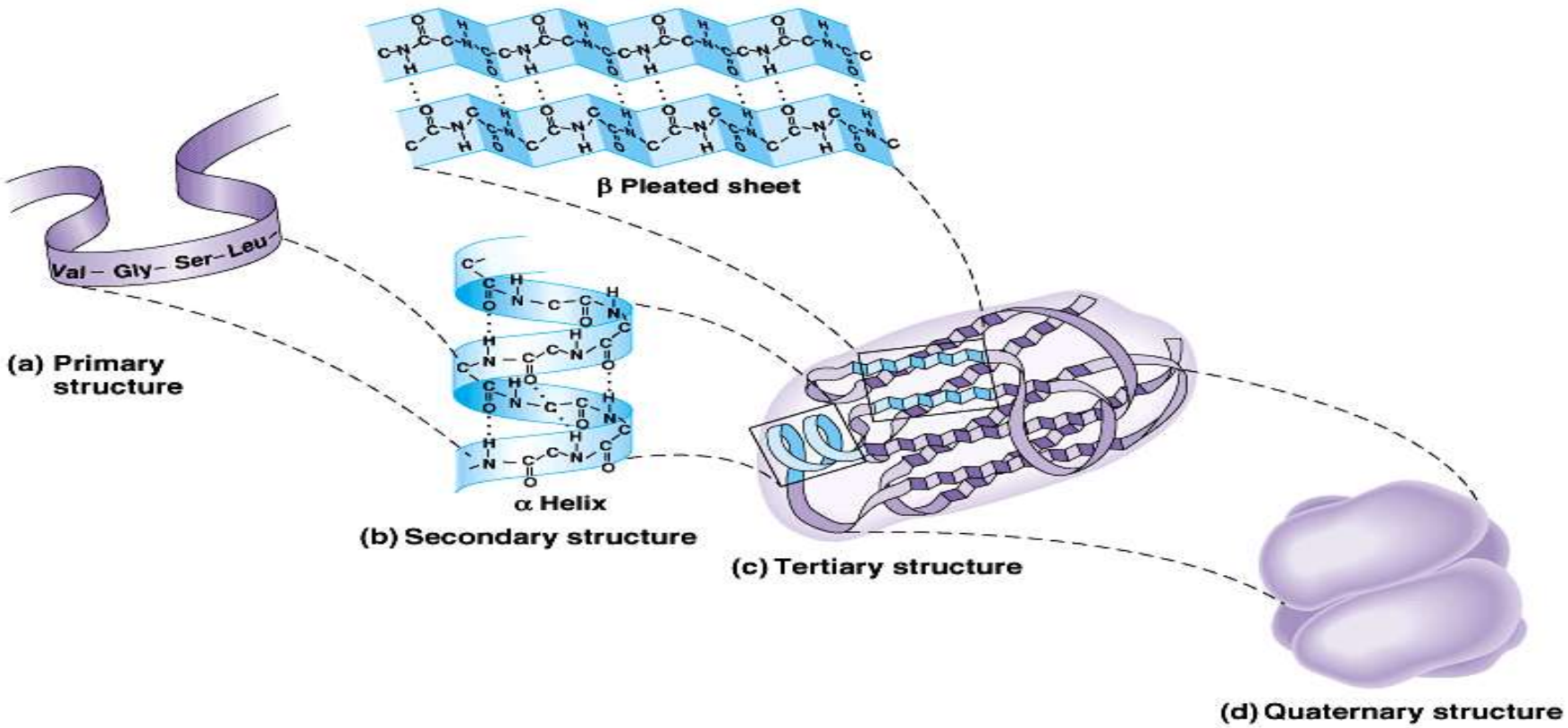

R1
OH
H
O
H
N
CH
C
O
H
N
CH
C
O
OH
R2
H2O
R1
H
N
CH
C
O
H
H
N
CH
C
O
OH
R2



Levels Of Protein Structure

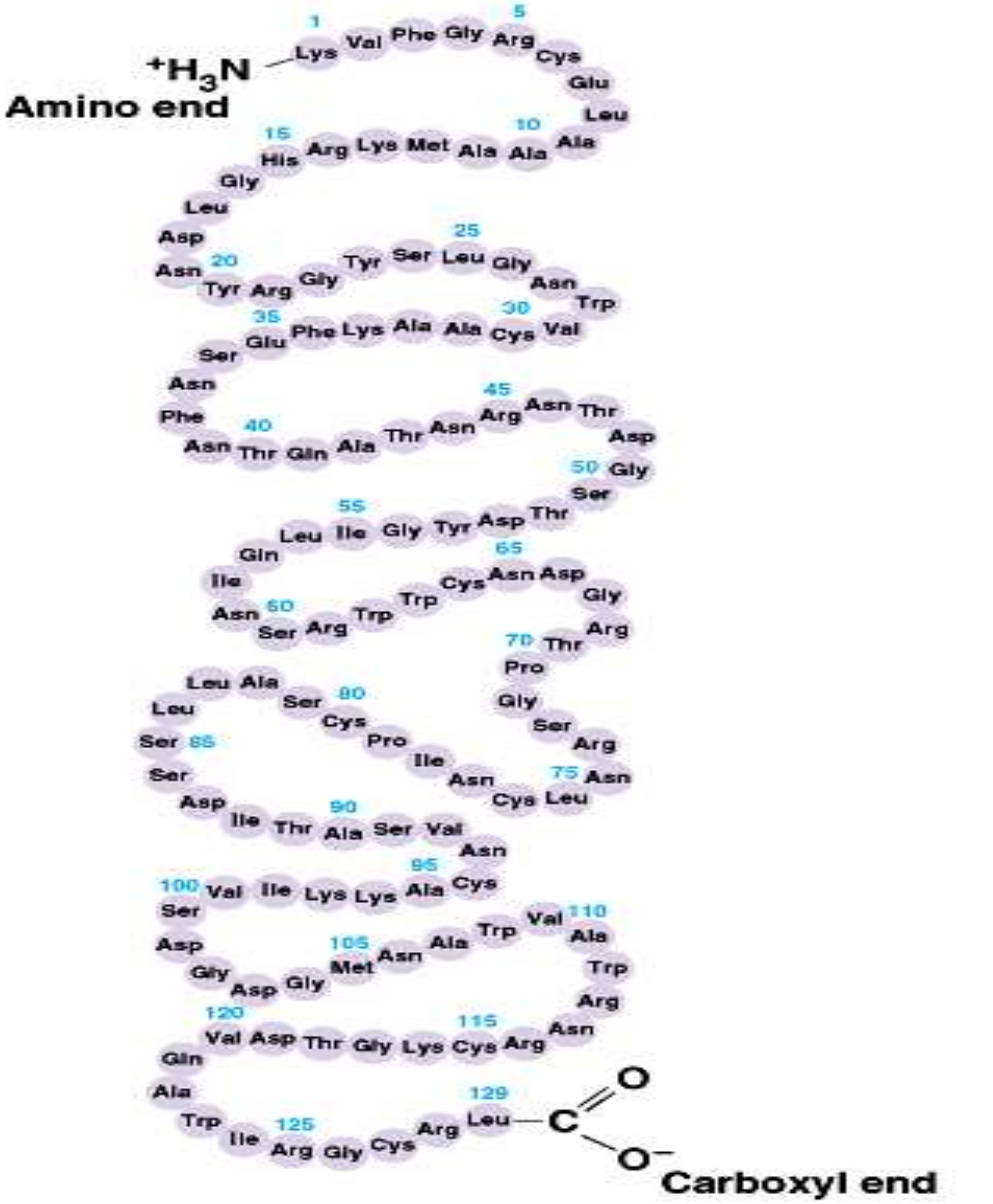
Organizing the polypeptide into its 3-D functional shape.

- **-Primary**
- **-Secondary**
- **-Tertiary**
- **-Quaternary**



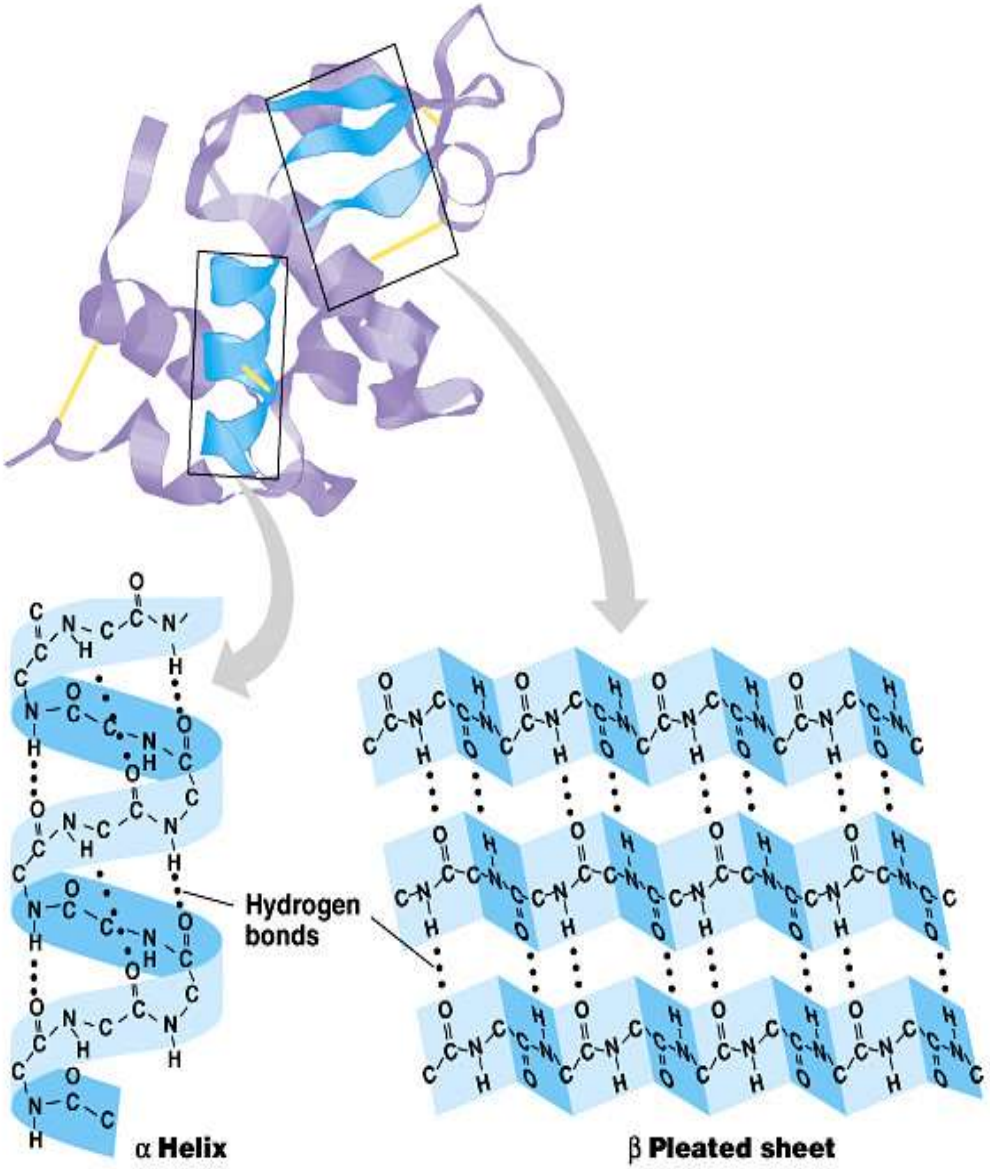
Primary Structure

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



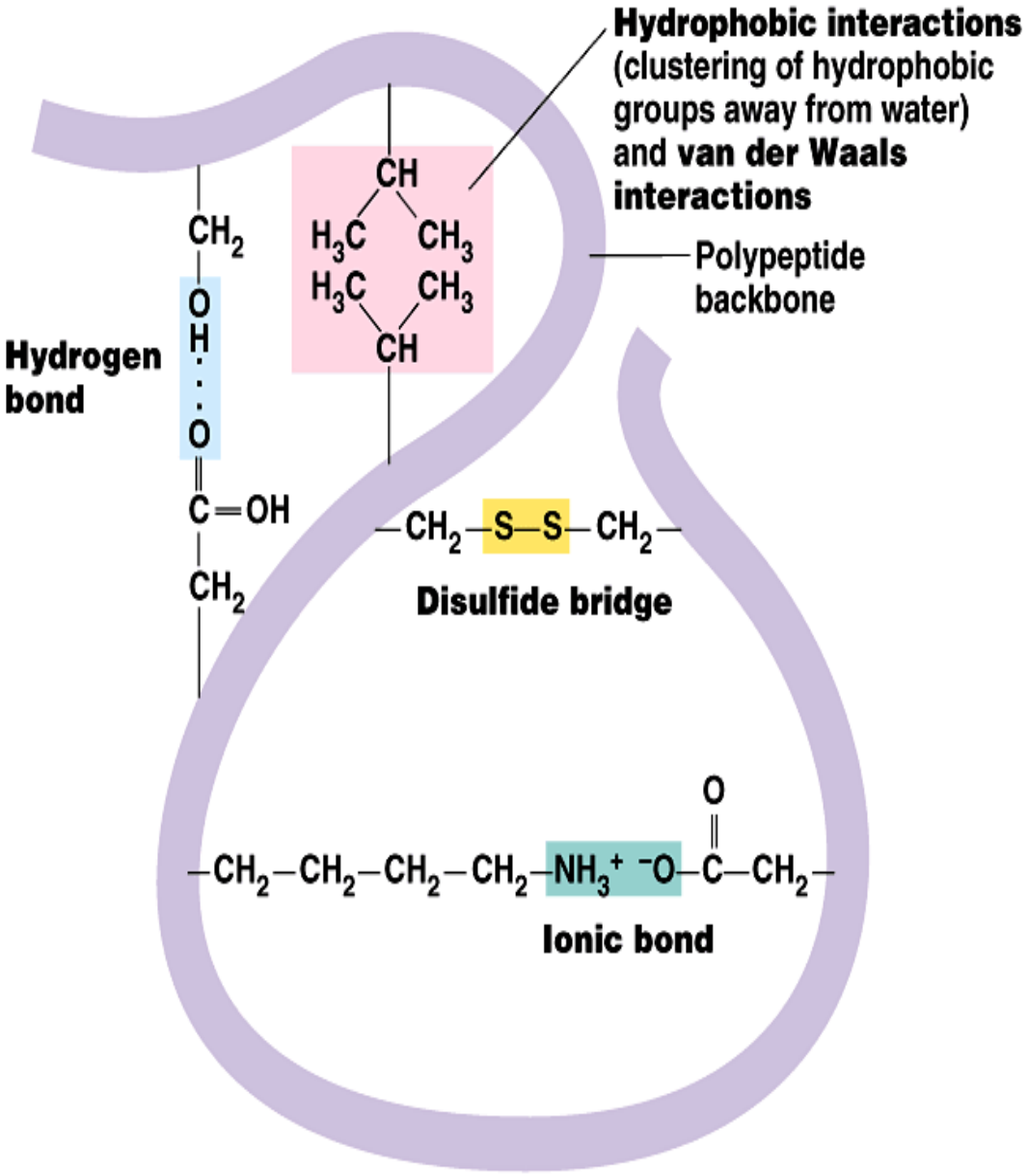
Secondary Structure

- **3-D structure formed by hydrogen bonding between the R groups.**
- **Two main secondary structures:**
  - **α helix**
  - **β pleated sheets**



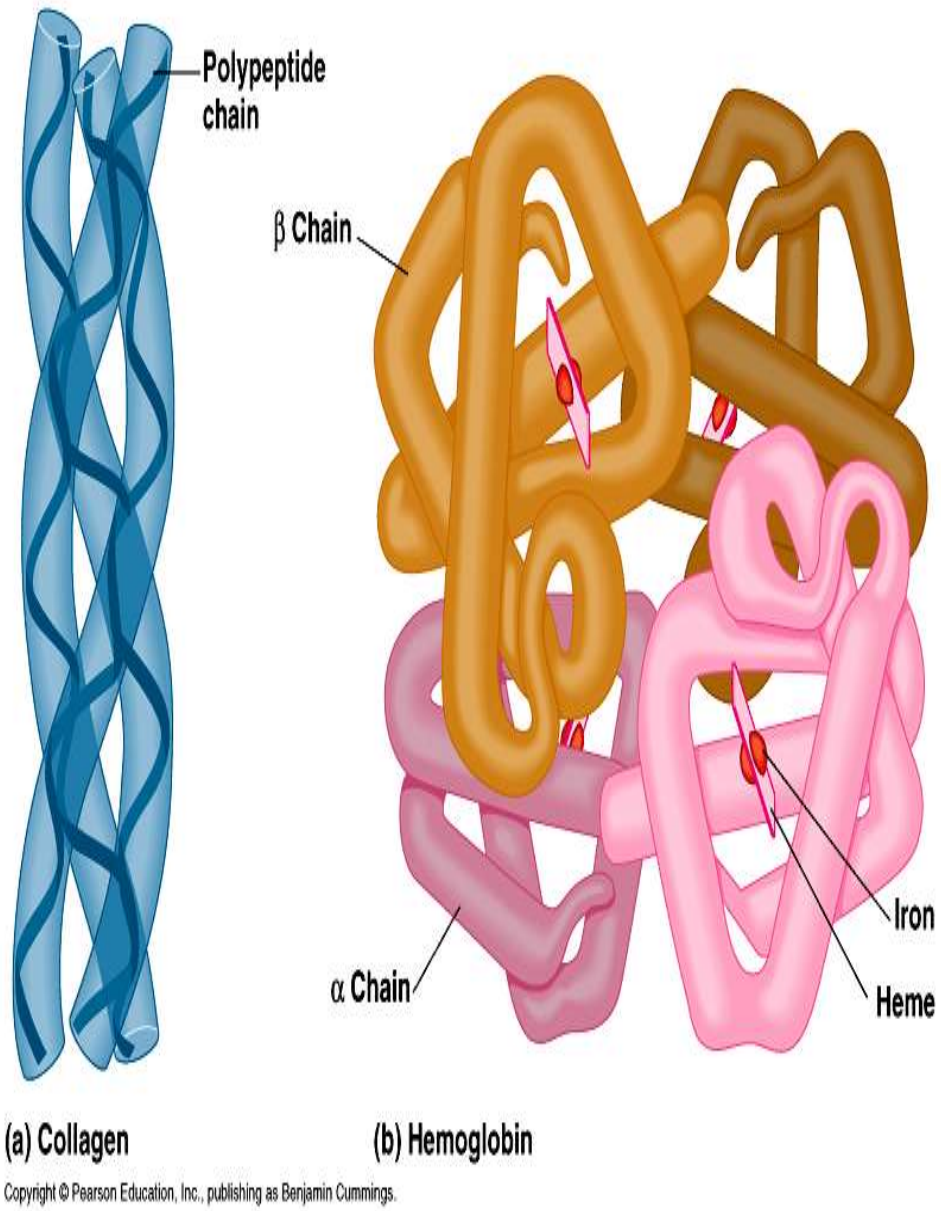
Tertiary Structure

- 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**



Denaturation of Protein

Change of shape is called *DENATURATION*

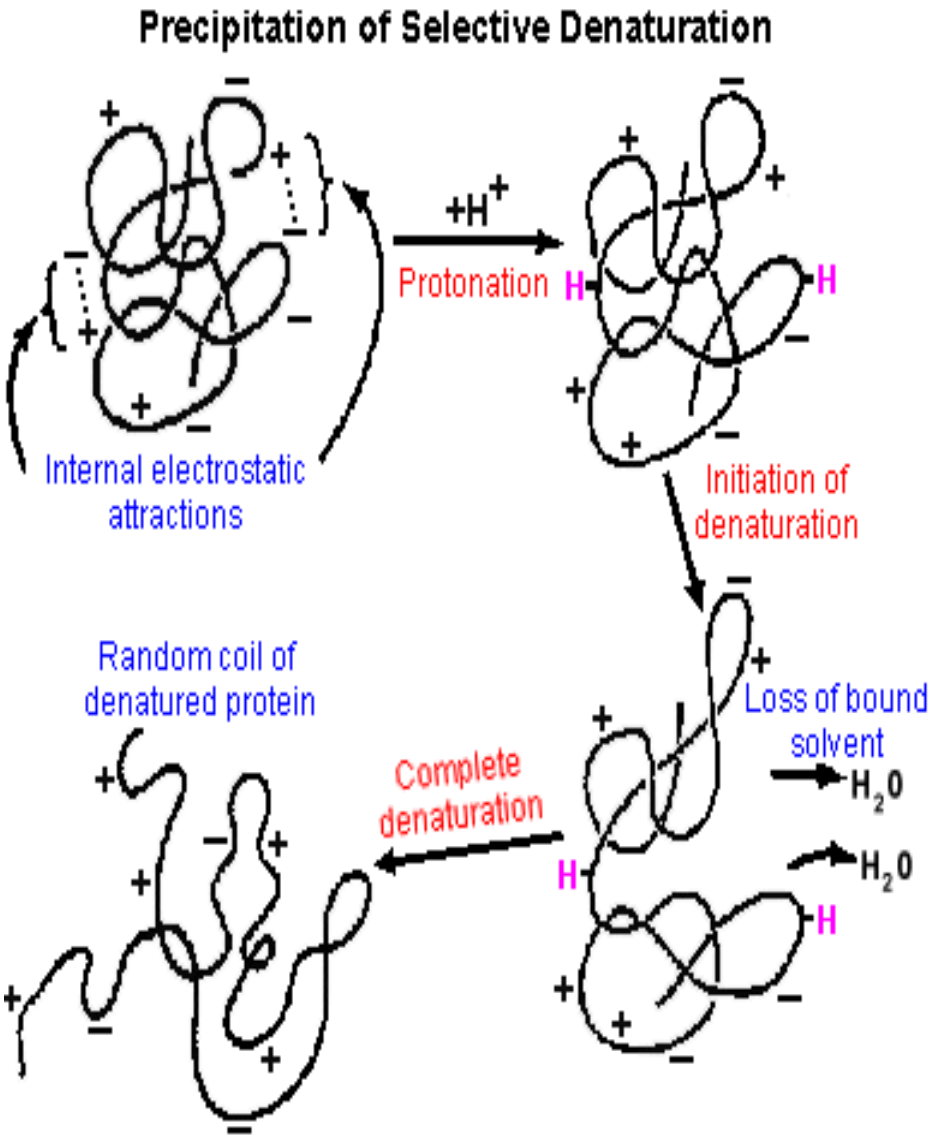
What causes change of shape?

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)



THANKS