Protein

CHARACTERISTICS AND STRUCTURE

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Characteristics of Proteins

- Contain carbon, hydrogen, oxygen, nitrogen, and sulfur
- Serve as structural components of animals
- Serve as control molecules (enzymes)
- Serve as transport and messenger molecules
- Basic building block is the amino acid

Protein Functions

- **Structure:** Building structural components of organisms (collagen, elastin, keratin, microtubules, microfilaments)
- **Regulation of metabolic processes:** Hormones (insulin)
- **Carrying out of metabolic processes:** Enzymes
- **Membrane component:** Carrier proteins, Protein pumps, Transport of materials through membrane phospholipid layers
- **Self and non-self recognition:** Major histocompatibility complexes (Tissue rejection, immune responses).
- **Membrane receptors:** Hormone receptors and neurotransmitter receptors.

Protein Provides Energy

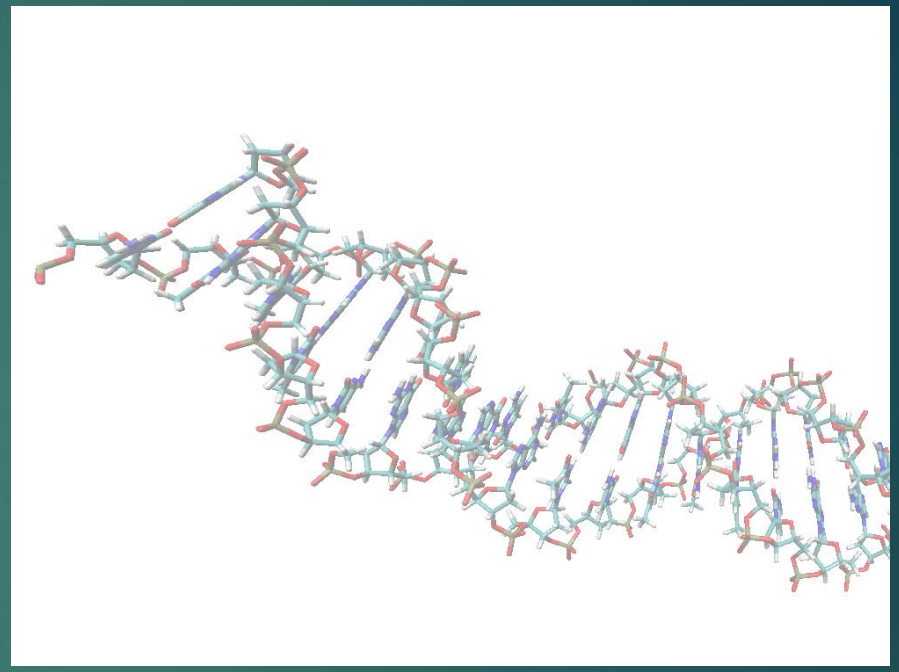
- Can take the place of some fat and carbohydrate
- Excess protein converted to energy
- Stored as fat

The best sources of Protein

- Milk
- Eggs
- Fish
- Poultry
- Meat

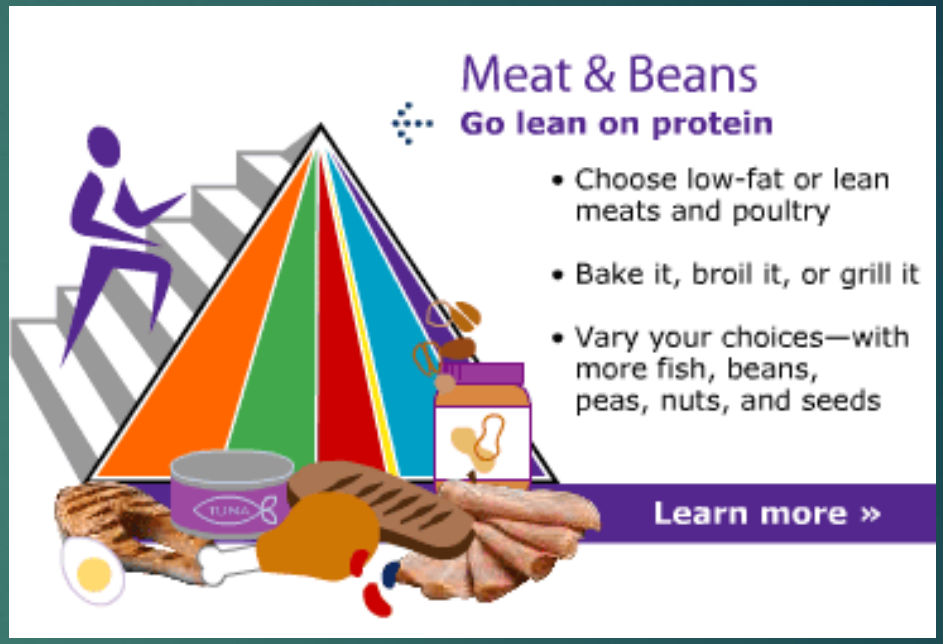
Complete Protein

- Any food that has all 9 essential amino acids.
- All animal proteins are classified as complete proteins.
- Support growth and maintenance of body tissue



Protein needs influenced by:

- Age
- Body Size
- Quality of the proteins
- Physical state of the person
- 3-6 ounces per day or 2-3 “servings”



Lack Of Protein :

- Lower one's resistance to disease,
- Damage liver
- Death
- Tiredness
- Weight loss
- Lack of energy
- Stunt growth
- Not common in U.S.

Proteins are Natural Polymers

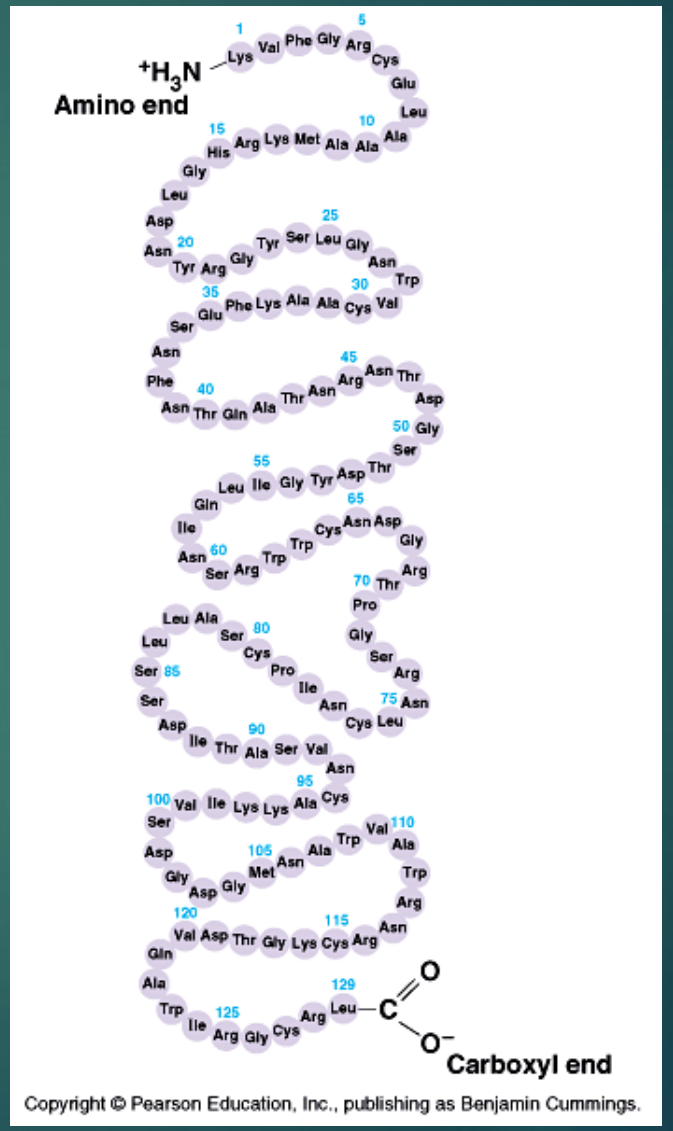
- Proteins are constructed in the body from many repeating units call amino acids
- Just like other polymers the amino acids (monomers) are joined together to make long chains (polymers) – but we call them proteins instead
- All of the polymer information applies to proteins – cross linking, rings, polarity etc.

Levels of Organization

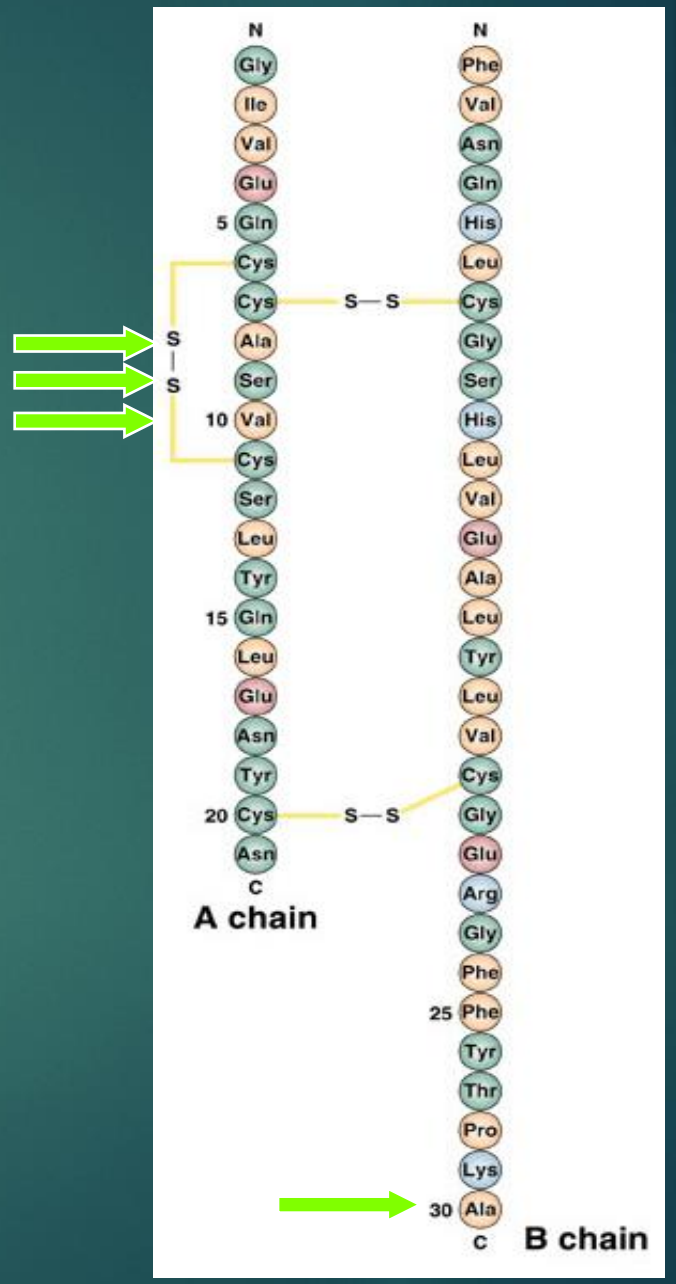
- Primary structure
  - Amino acid sequence of the protein
- Secondary structure
  - H bonds in the peptide chain backbone
    - α-helix and β-sheets
- Tertiary structure
  - Non-covalent interactions between the R groups within the protein
- Quanternary structure
  - Interaction between 2 polypeptide chains

Levels of Protein Structure

The *Primary Level* is determined by the number of amino acids, the type of amino acids, and the sequence of the amino acids in the polypeptide chain.

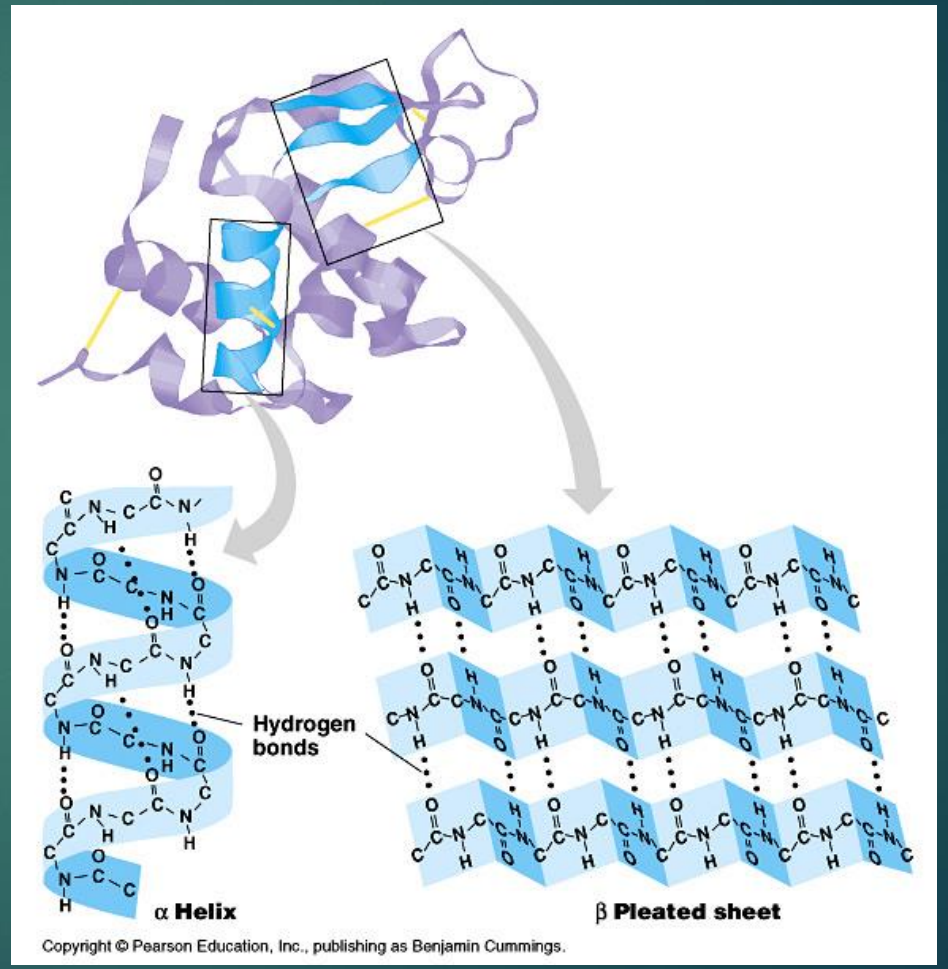


- Primary Structure
  - Sometimes small changes in the 1° structure do not alter the biological function, sometimes they do.



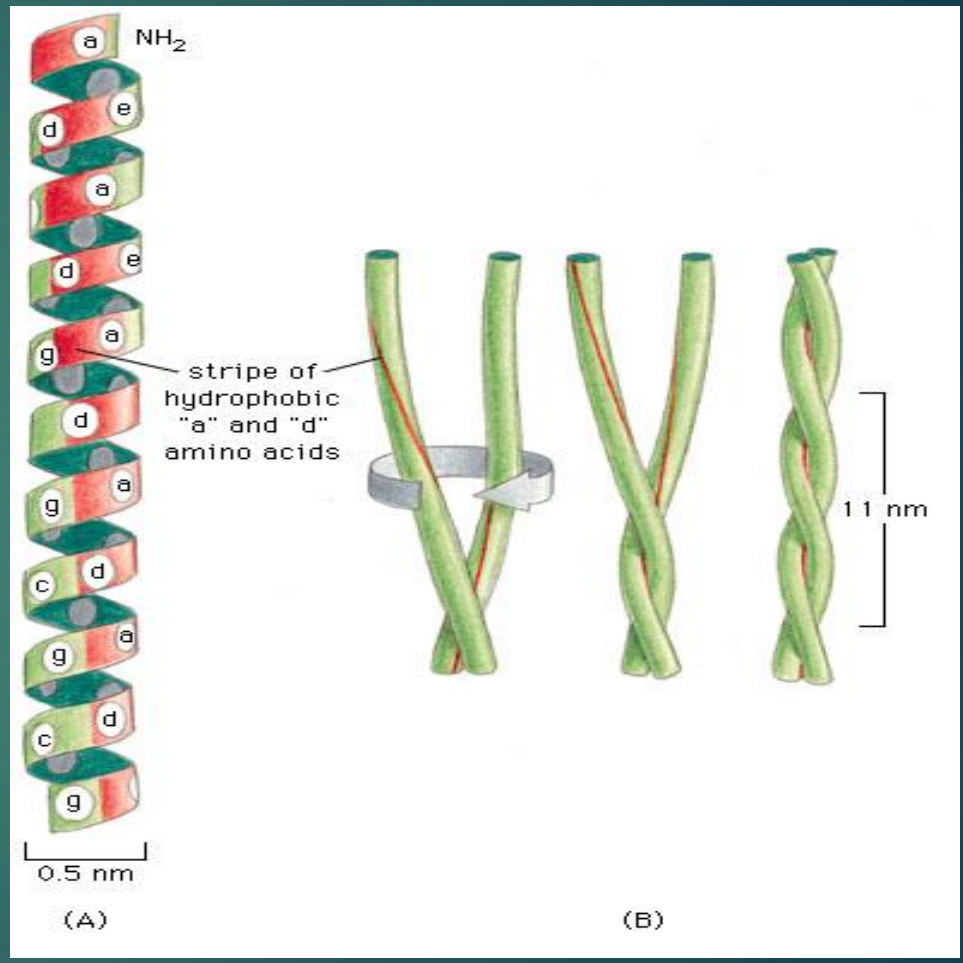
Levels of Protein Structure

The ***Secondary Level*** is due to interactions between amino acids in the chain, usually due to hydrogen bonding between oxygen and hydrogen atoms in different amino acids. Two general forms are taken. Alpha helix, a spiral structure, common in globular proteins, or a Beta pleated sheet structure, common in structural proteins.



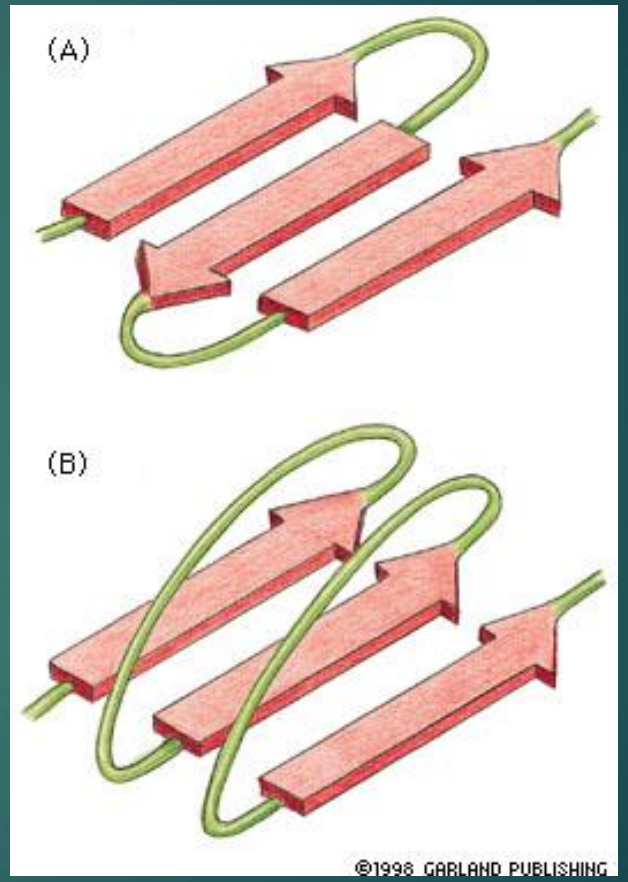
α Helix

- Formed by a H-bond between every 4th peptide bond – C=O to N-H
- Usually in proteins that span a membrane
- The α helix can either coil to the right or the left
- Can also coil around each other – coiled-coil shape – a framework for structural proteins such as nails and skin

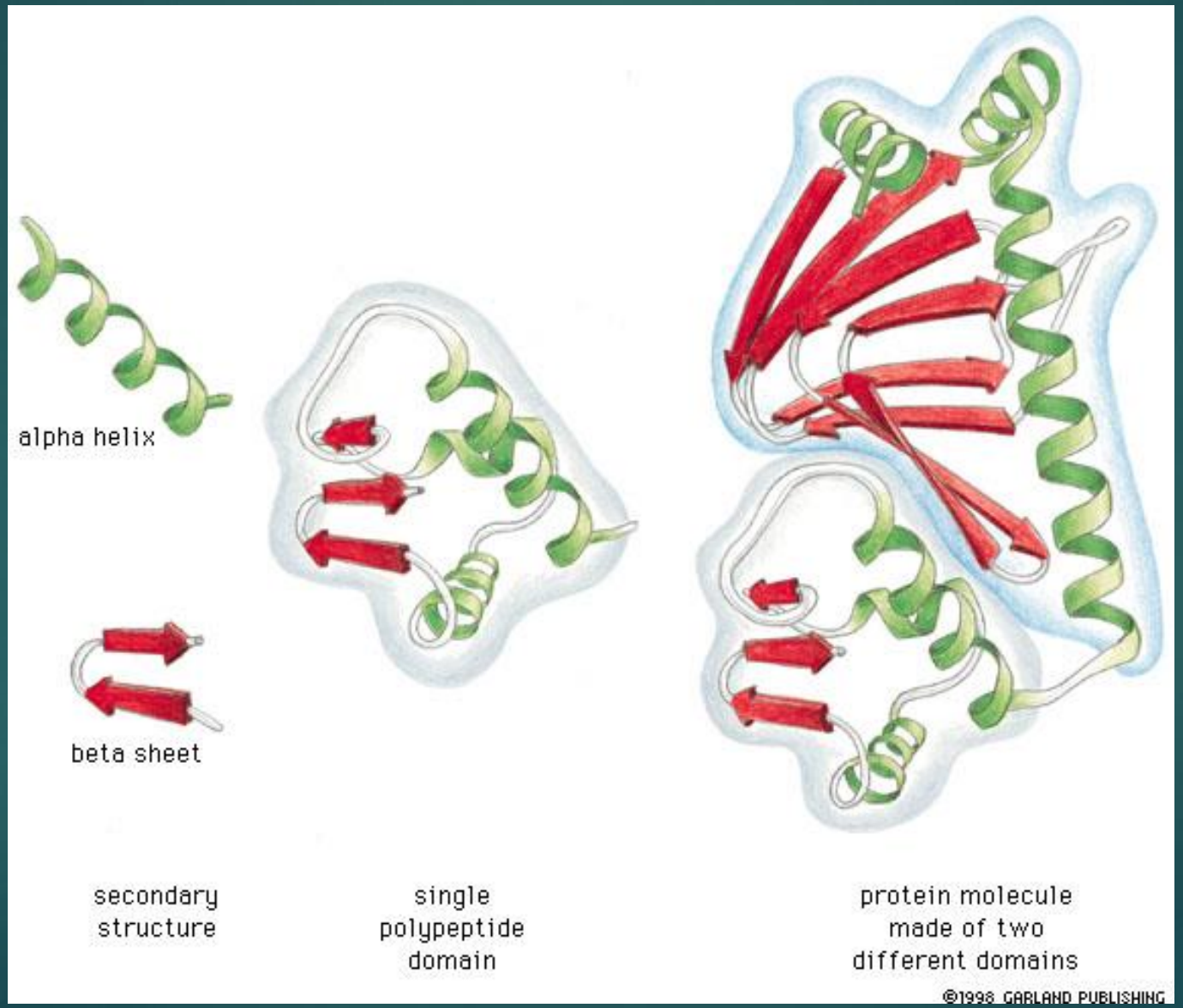


β Sheets

- Core of many proteins is the β sheet
- Form rigid structures with the H-bond
- Can be of 2 types
  - Anti-parallel – run in an opposite direction of its neighbor (A)
  - Parallel – run in the same direction with longer looping sections between them (B)

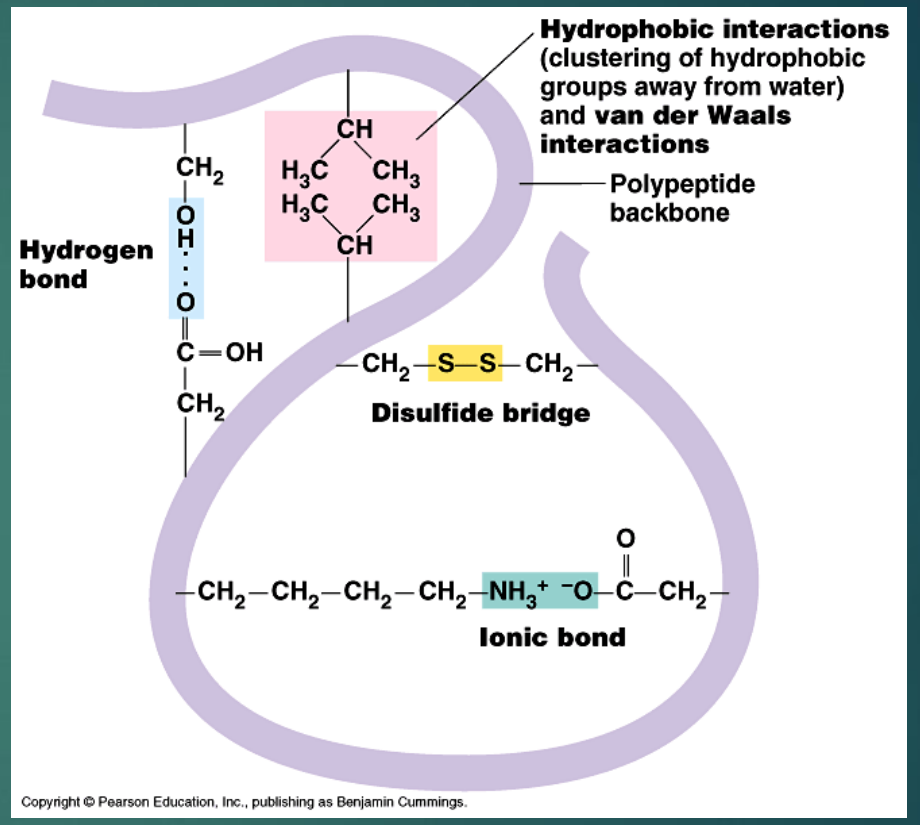


Protein Structure



Levels of Protein Structure

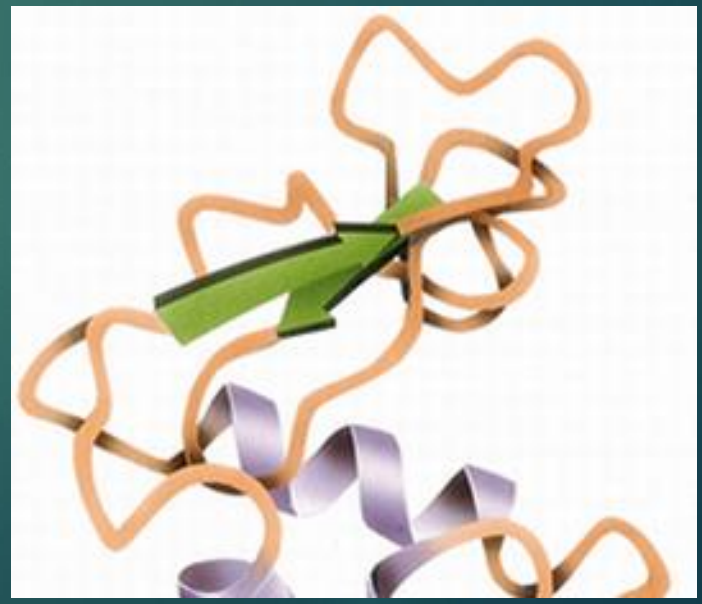
The ***Tertiary Level*** is due to the "folding over" of the alpha helical or beta pleated sheet structure on itself. This configuration is due again to hydrogen bonding, hydrophobic interactions, ionic bonding interactions, and the interaction of sulfur groups on the variable groups of some amino acids forming weak interactions called disulfide bridges.



Tertiary Structure

- The Three dimensional arrangement of every atom in the molecule
- Includes not just the peptide backbone but the side chains as well
- These interactions are responsible for the overall folding of the protein
- This folding defies its function

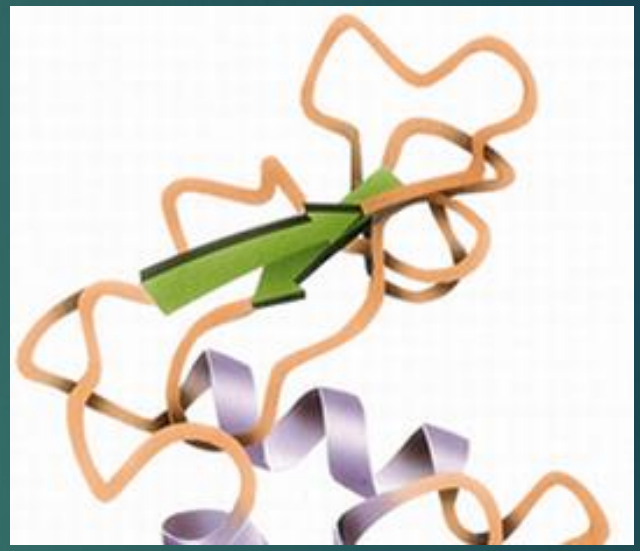
  and it's reactivity

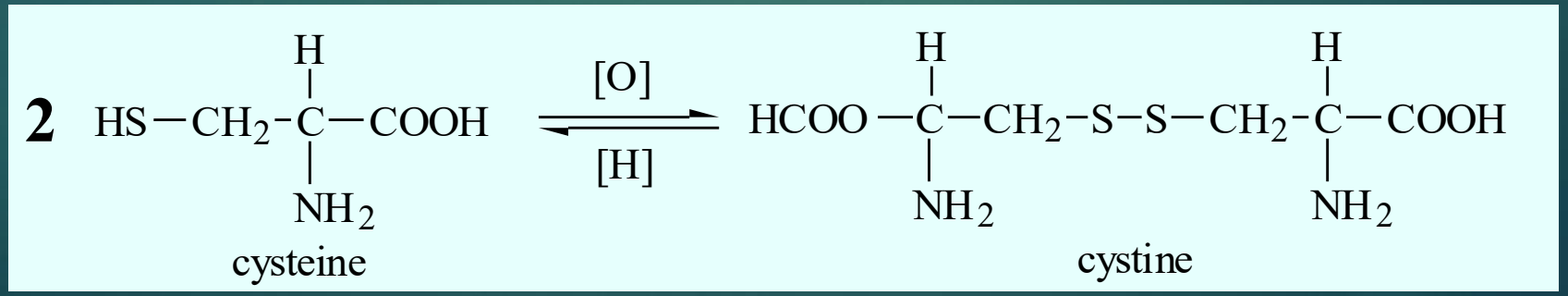


Tertiary Structure –Covalent Bonding

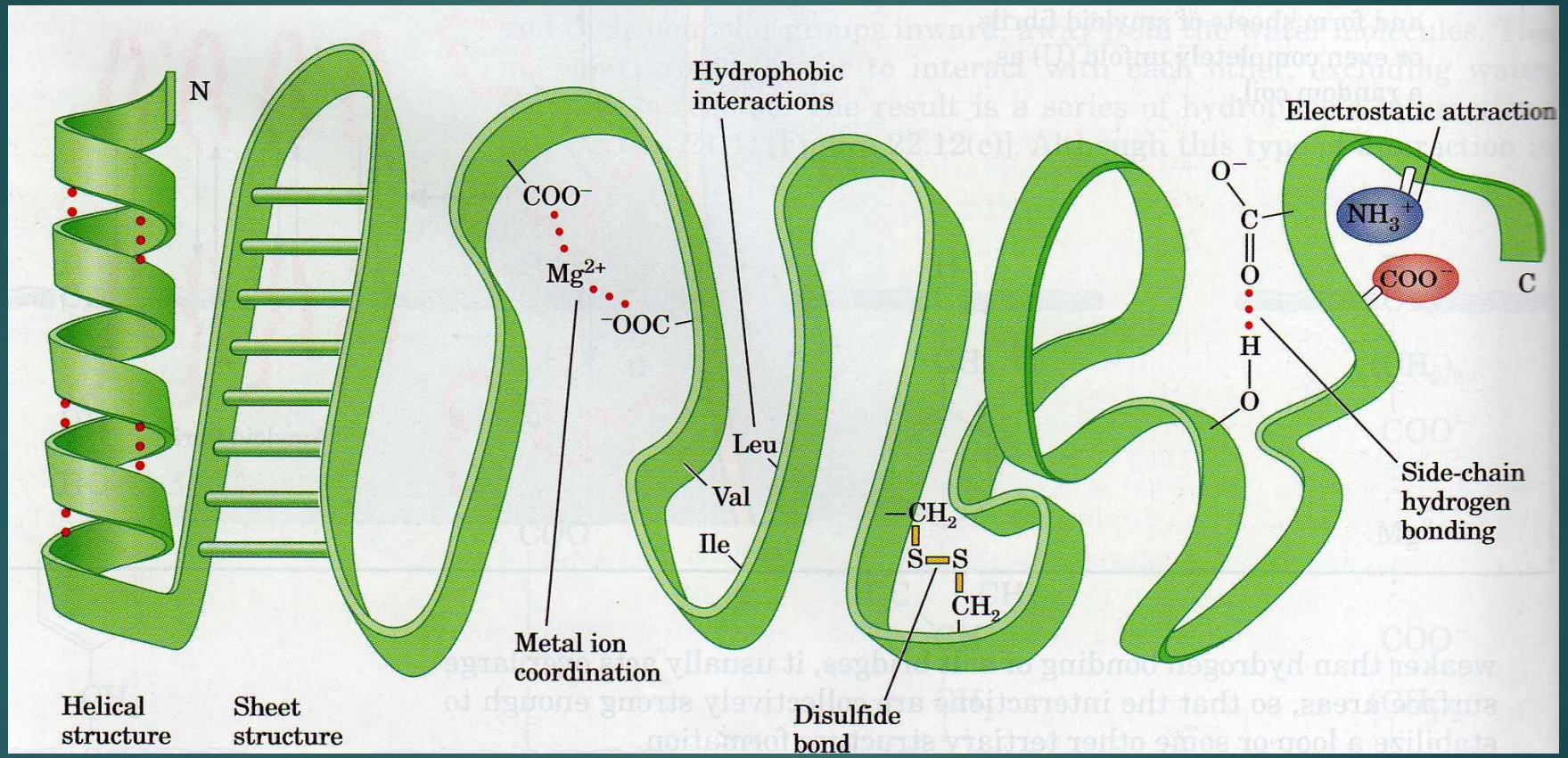
- The most common covalent bond in forming the tertiary structure is the disufide bond
- It is formed from the disulfide

  Interaction of cysteine



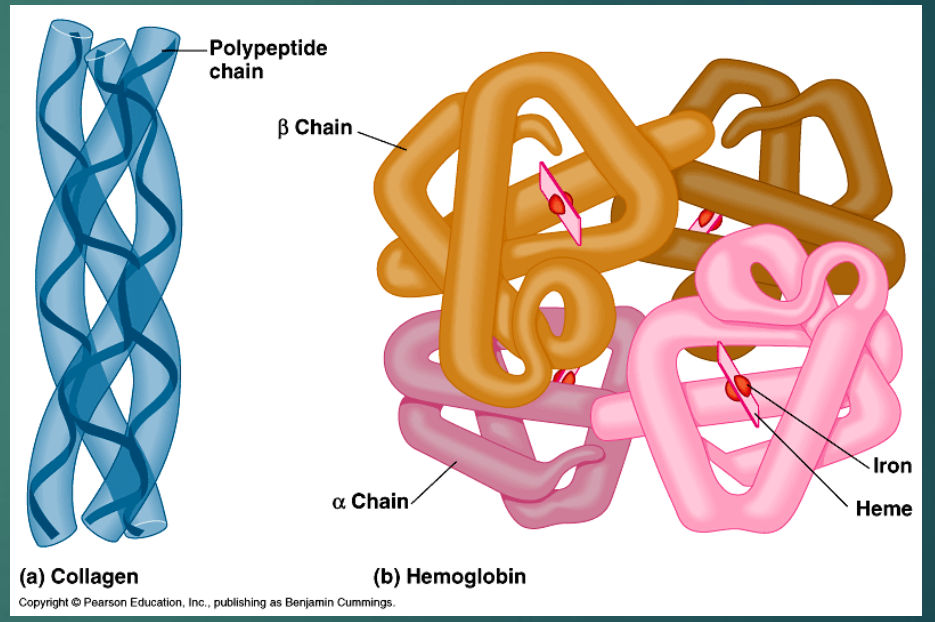


Tertiary Structure



Levels of Protein Structure

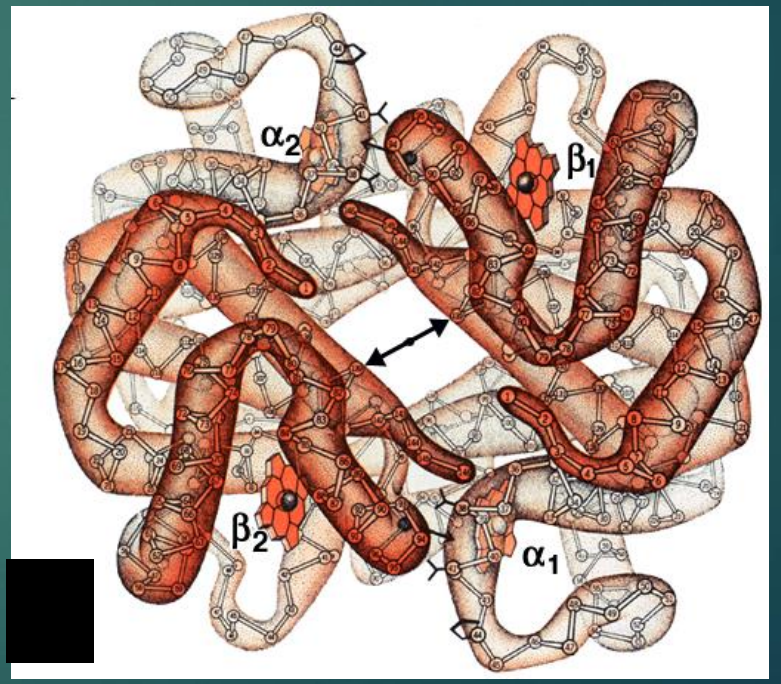
The ***Quaternary Level*** of structure is due to the interactions of more than one polypeptide chain to form the complete, functional protein. Hemoglobin and antibodies exhibit this level of structure.



Quaternary Structure

- Highest level of organization
- Determines how subunit fit together
- Example Hemoglobin (4 sub chains)
  - 2 chains 141 AA
  - 2 chains 146 AA

- Example - Collagen



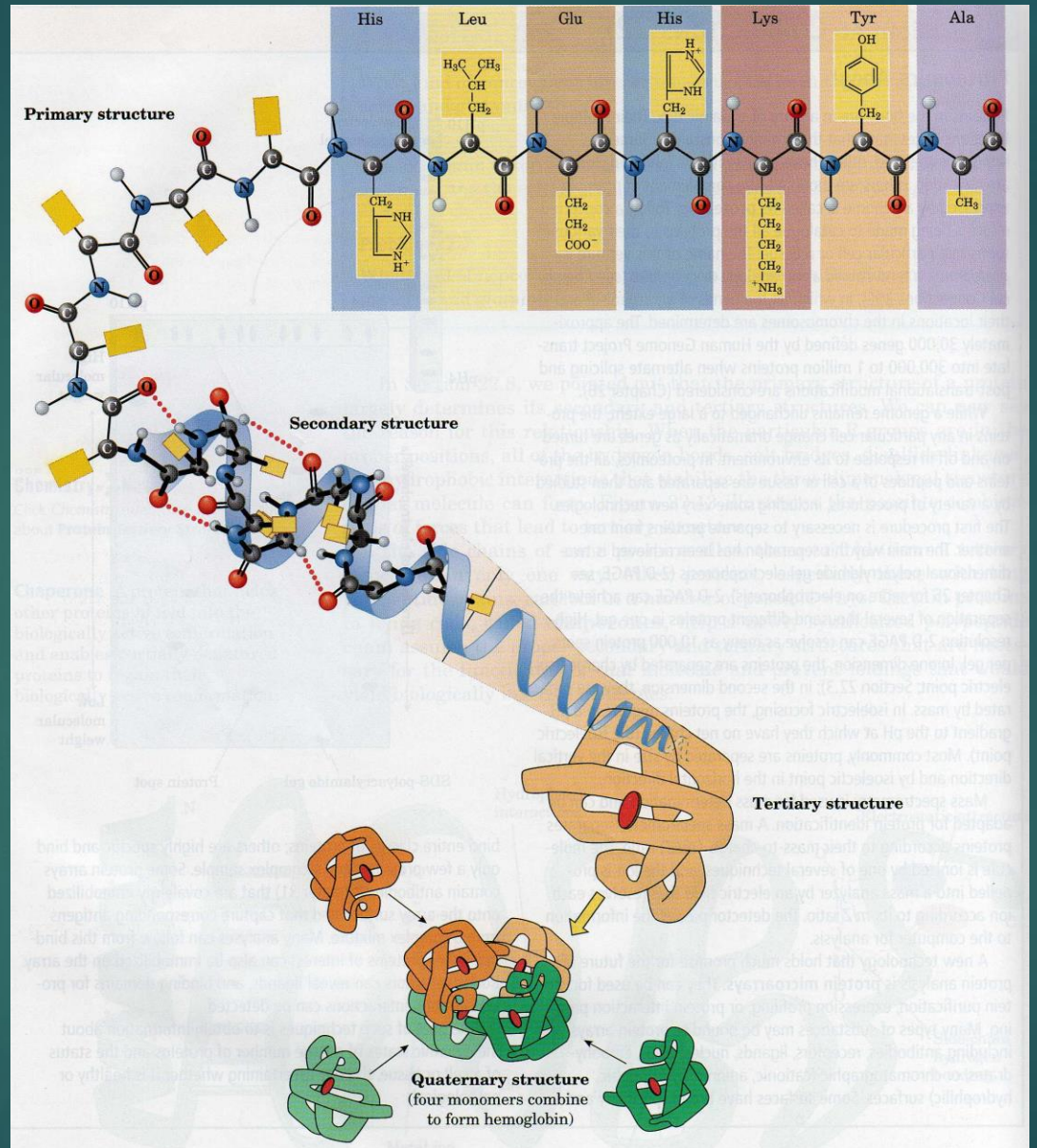
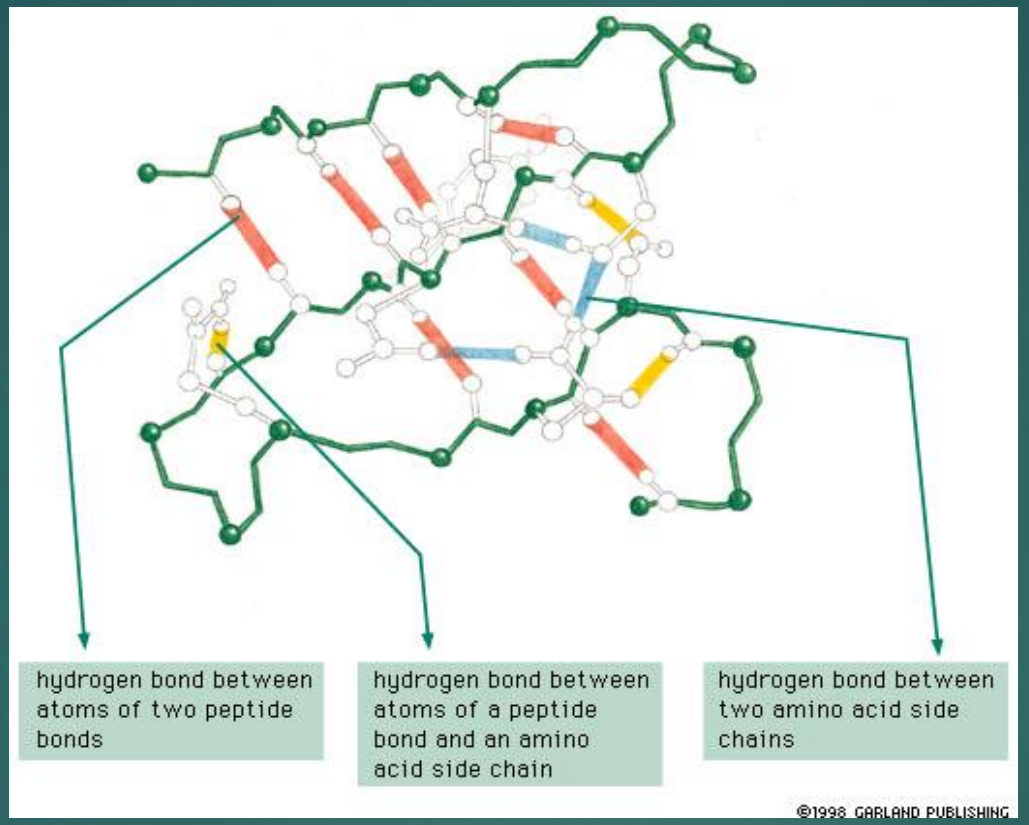


Figure 22.14 Primary, secondary, tertiary, and quaternary structures of a protein.

BONDS RESPONSIBLE FOR PROTEIN STRUCTURE

- **Non covalent bonds** :
- Hydrophobic interactions
- Electrostatic bonds
- Hydrogen bonds
- Vander Waals forces
- **Covalent bonds** – peptide bonds and disulphide bonds

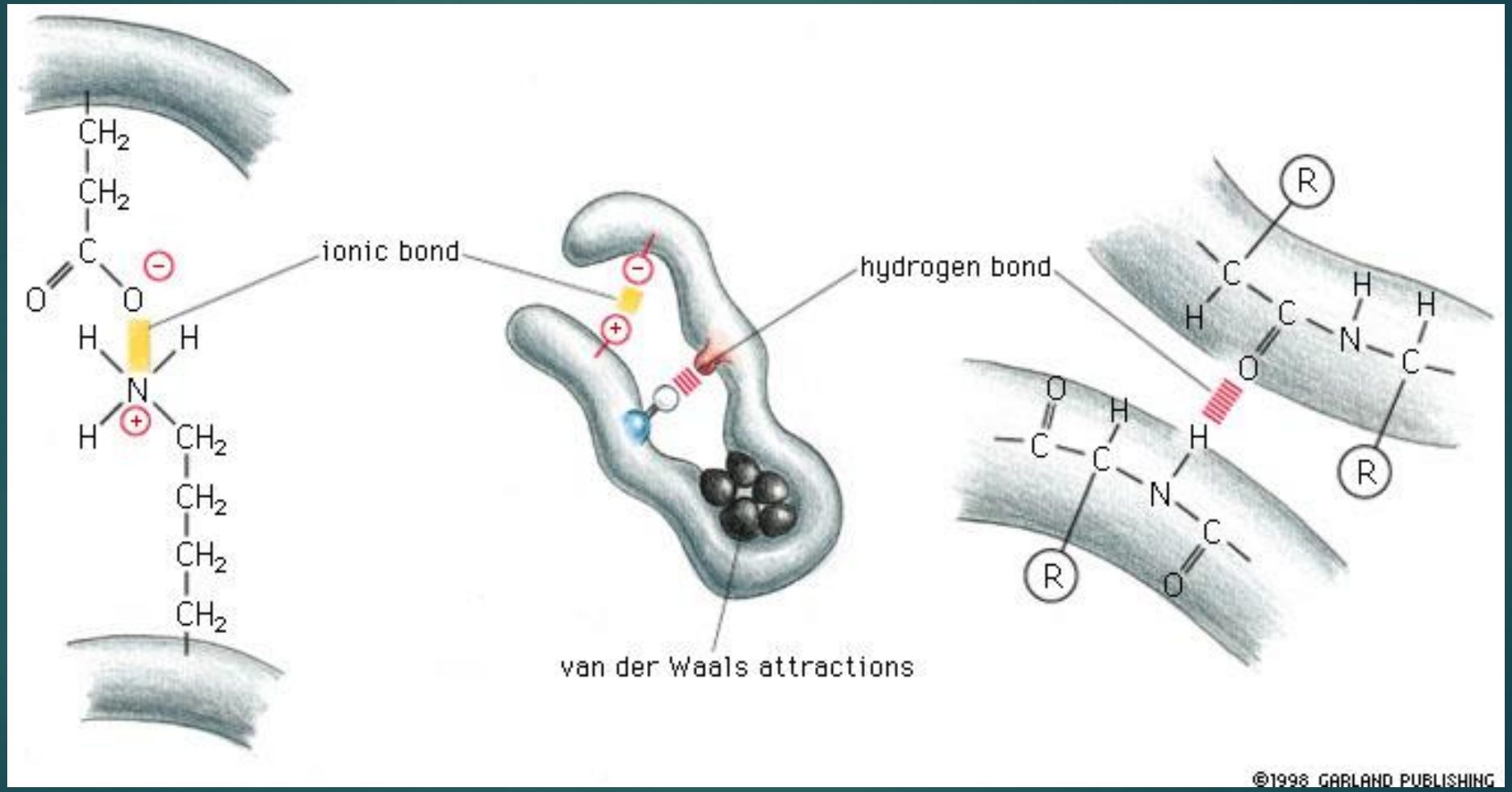
Hydrogen Bonds in Proteins



H-bonds form between:

- 1) atoms involved in the peptide bond;
- 2) peptide bond atoms and R groups;
- 3) R groups

Non-covalent Bonds in Proteins



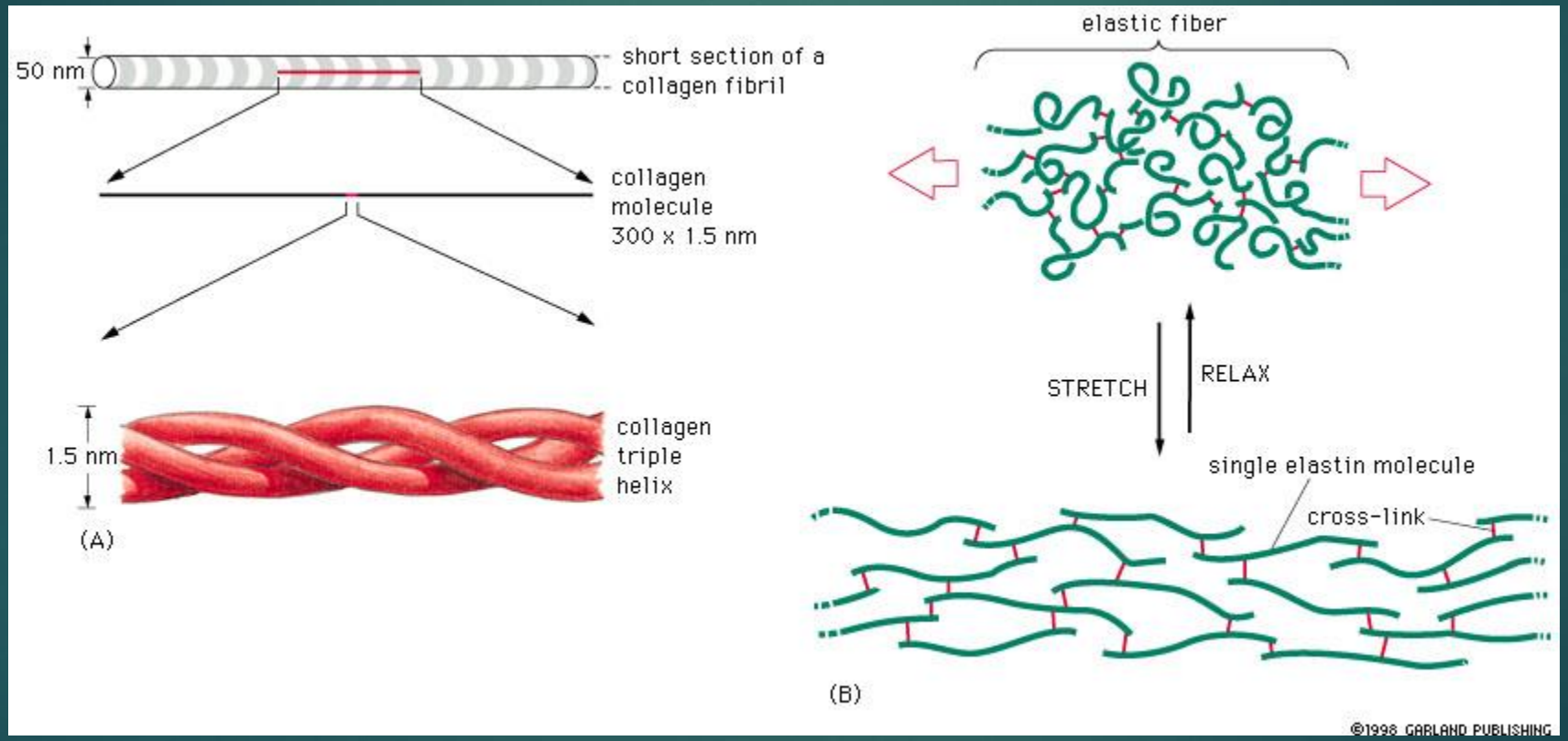
Types of Proteins

- **Globular Proteins** – most of what we have dealt with so far
  - Compact shape like a ball with irregular surfaces
  - Enzymes are globular
- **Fibrous Proteins** – usually span a long distance in the cell
  - 3-D structure is usually long and rod shaped

Important Fibrous Proteins

- Intermediate filaments of the cytoskeleton
  - Structural scaffold inside the cell
    - Keratin in hair, horns and nails
- Extracellular matrix
  - Bind cells together to make tissues
  - Secreted from cells and assemble in long fibers
    - Collagen – fiber with a glycine every third amino acid in the protein
    - Elastin – unstructured fibers that gives tissue an elastic characteristic

Collagen and Elastin



Thank You