Class IV: Proteins

- The machinery of the cell
  - Protein functions include structural support, storage, transport, cellular communications, movement, and defense against foreign substances
- They are the most complex biological molecule
- Proteins account for more than 50% of the dry mass of most cells

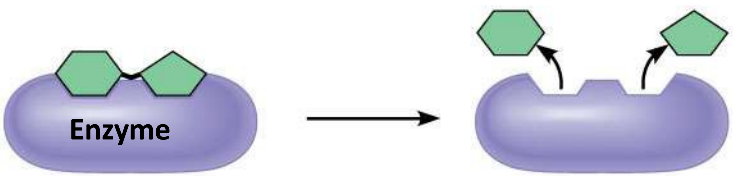
Figure 5.15-a

Examples of Proteins

Enzymatic proteins

Function: Selective acceleration of chemical reactions

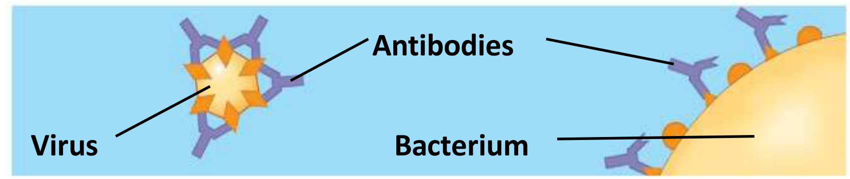
Example: Digestive enzymes catalyze the hydrolysis of bonds in food molecules.



Defensive proteins

Function: Protection against disease

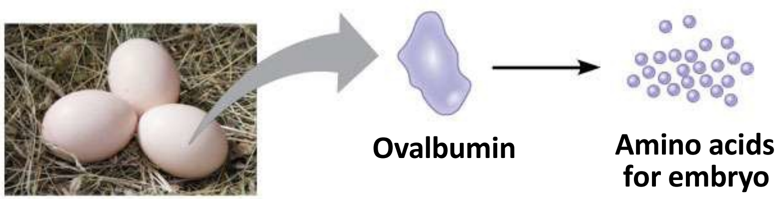
Example: Antibodies inactivate and help destroy viruses and bacteria.



Storage proteins

Function: Storage of amino acids

Examples: Casein, the protein of milk, is the major source of amino acids for baby mammals. Plants have storage proteins in their seeds. Ovalbumin is the protein of egg white, used as an amino acid source for the developing embryo.



Transport proteins

Function: Transport of substances

Examples: Hemoglobin, the iron-containing protein of vertebrate blood, transports oxygen from the lungs to other parts of the body. Other proteins transport molecules across cell membranes.

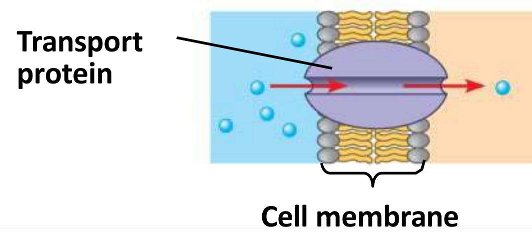
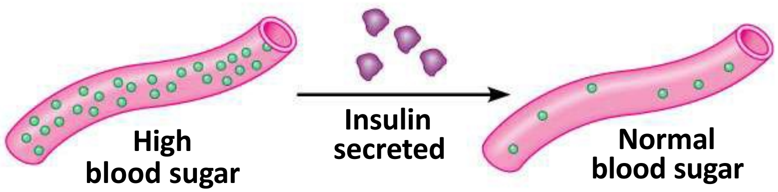


Figure 5.15-b

Hormonal proteins

Function: Coordination of an organism's activities

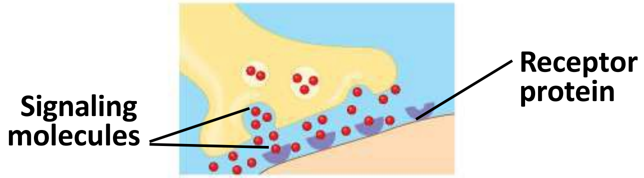
Example: Insulin, a hormone secreted by the pancreas, causes other tissues to take up glucose, thus regulating blood sugar concentration



Receptor proteins

Function: Response of cell to chemical stimuli

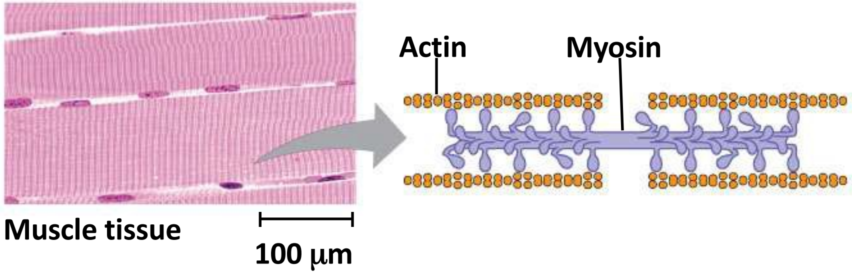
Example: Receptors built into the membrane of a nerve cell detect signaling molecules released by other nerve cells.



Contractile and motor proteins

Function: Movement

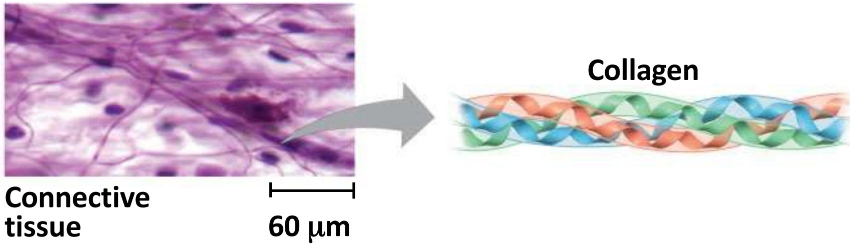
Examples: Motor proteins are responsible for the undulations of cilia and flagella. Actin and myosin proteins are responsible for the contraction of muscles.



Structural proteins

Function: Support

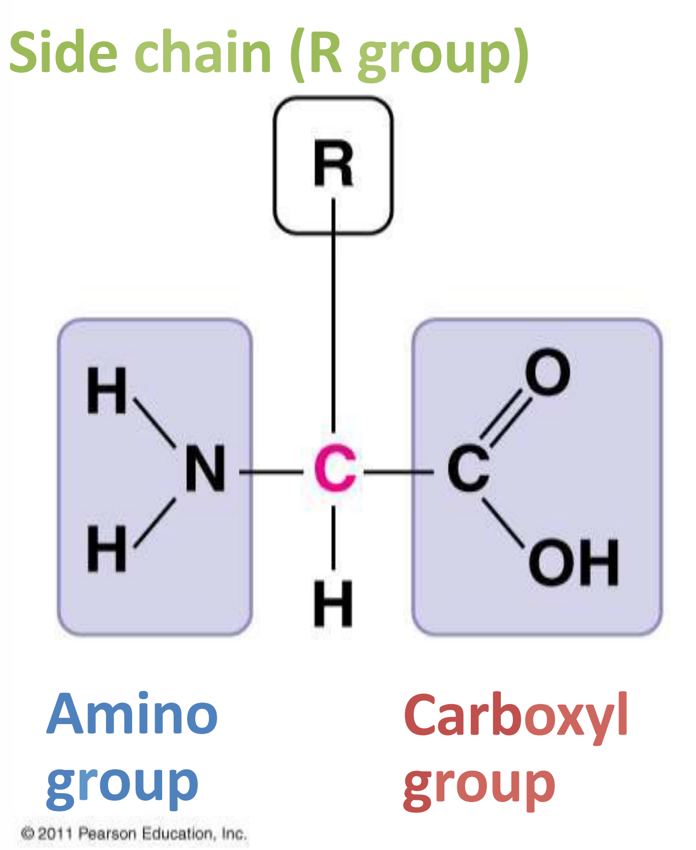
Examples: Keratin is the protein of hair, horns, feathers, and other skin appendages. Insects and spiders use silk fibers to make their cocoons and webs, respectively. Collagen and elastin proteins provide a fibrous framework in animal connective tissues.



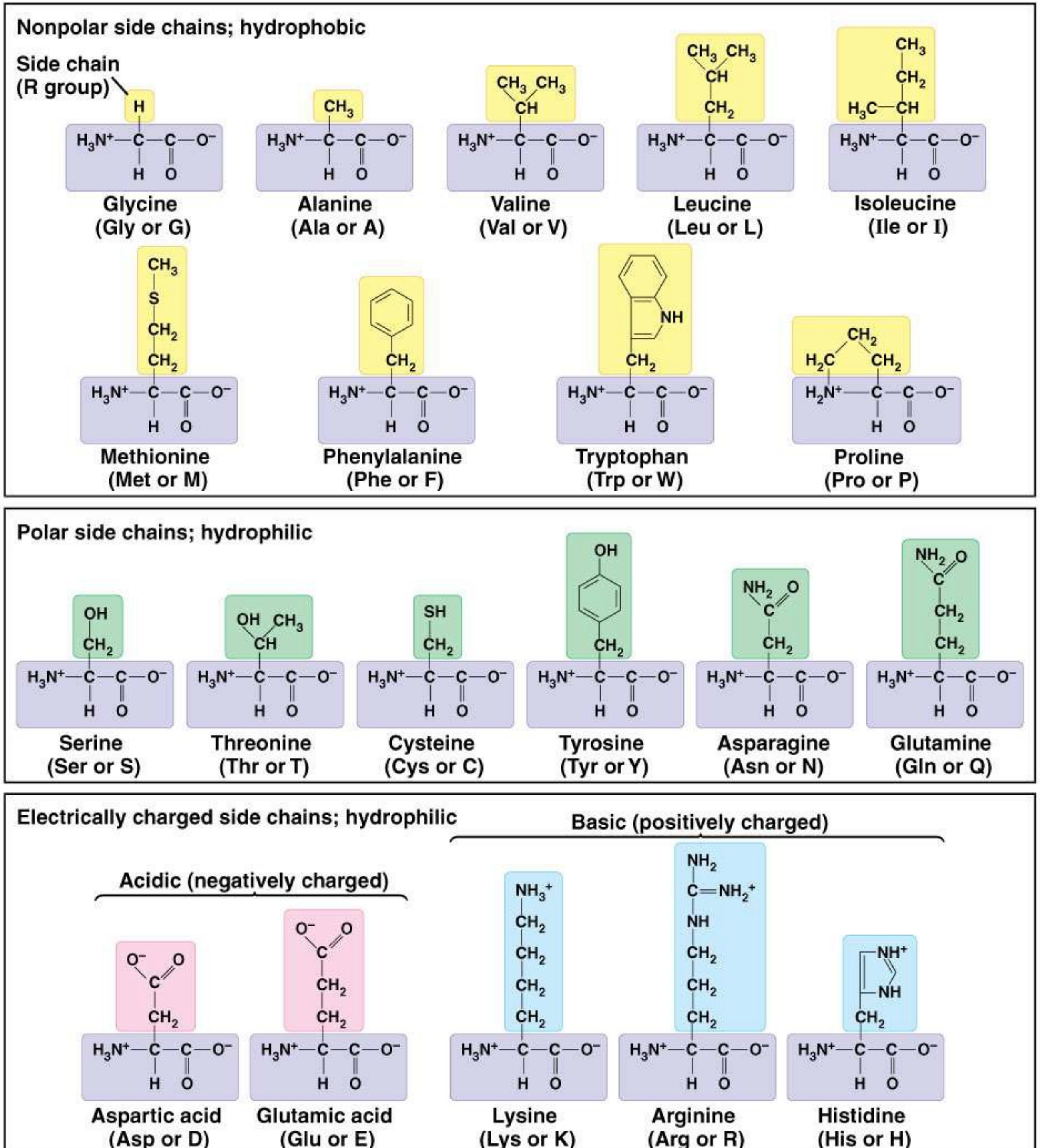
Amino acids: the monomers of proteins

- **Amino acids** are the monomers of proteins
- The polymers are called polypeptides
- **Polypeptides** are unbranched polymers built from A combination of the 20 amino acids
- A **protein** is a biologically functional molecule that consists of one or more polypeptides

Structure of amino acids

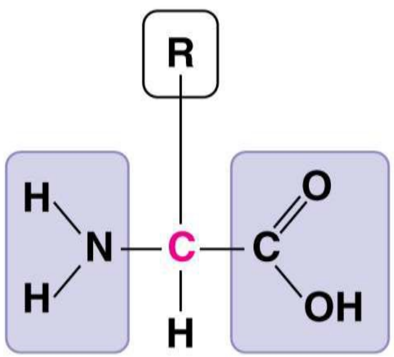


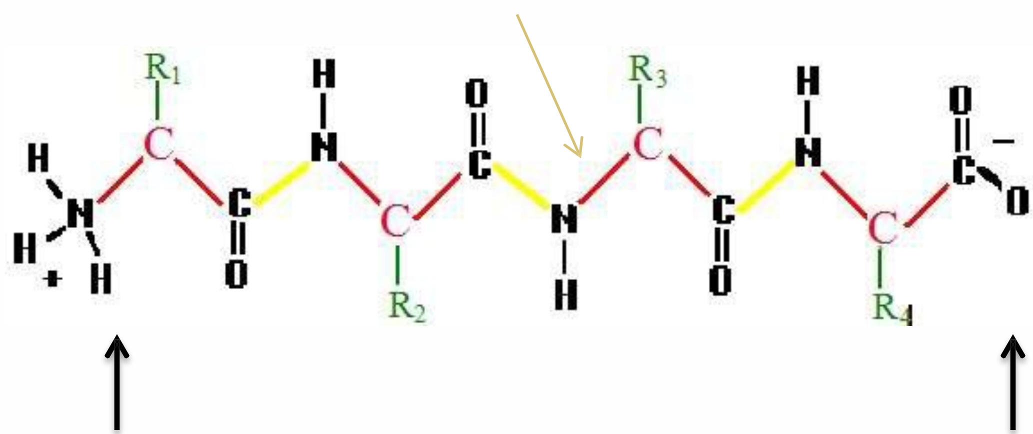
- **Amino acids** contain a carboxyl (carbon and oxygen) and amino (nitrogen) groups
- There are 20 amino acids important to humans. Each one has an amino and carboxyl group, but different R group


Nonpolar side chains; hydrophobic
Side chain (R group)
Glycine (Gly or G)
Alanine (Ala or A)
Valine (Val or V)
Leucine (Leu or L)
Isoleucine (Ile or I)
Methionine (Met or M)
Phenylalanine (Phe or F)
Tryptophan (Trp or W)
Proline (Pro or P)
Polar side chains; hydrophilic
Serine (Ser or S)
Threonine (Thr or T)
Cysteine (Cys or C)
Tyrosine (Tyr or Y)
Asparagine (Asn or N)
Glutamine (Gln or Q)
Electrically charged side chains; hydrophilic
Acidic (negatively charged)
Basic (positively charged)
Aspartic acid (Asp or D)
Glutamic acid (Glu or E)
Lysine (Lys or K)
Arginine (Arg or R)
Histidine (His or H)

Amino acid polymers

- Polypeptides are linked by **peptide bonds**
- Polypeptides range in length from a few to more than a thousand monomers
- Each polypeptide has a unique sequence of amino acids



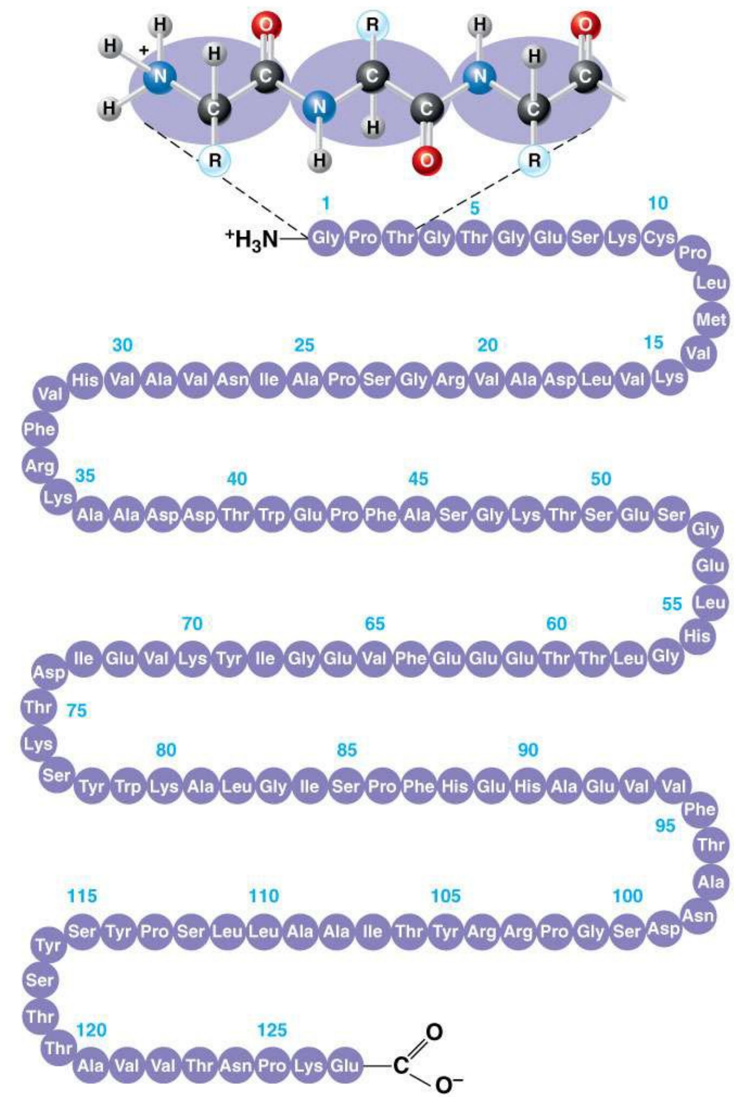


How do polypeptides create a 3D shape?

- A protein is made up of one or more polypeptide chains twisted and folded into a unique 3D shape
- It is the 3D shape that gives the protein its function
- There are four levels of protein structure:
  - Primary
  - Secondary
  - Tertiary
  - Quaternary

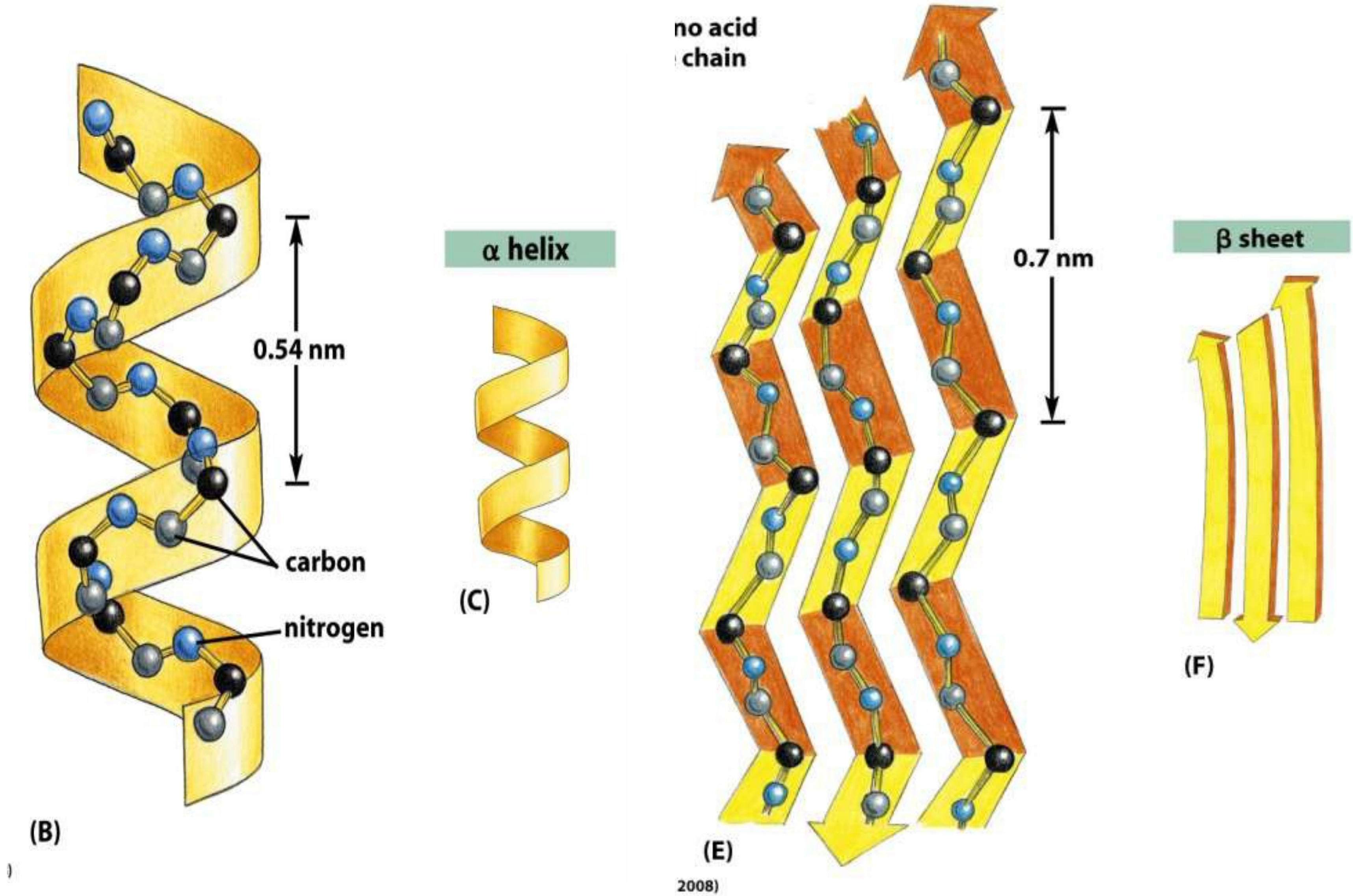
Primary protein structure

- The sequence of amino acids in a polypeptide chain
- Primary structure is like the order of letters in a long word



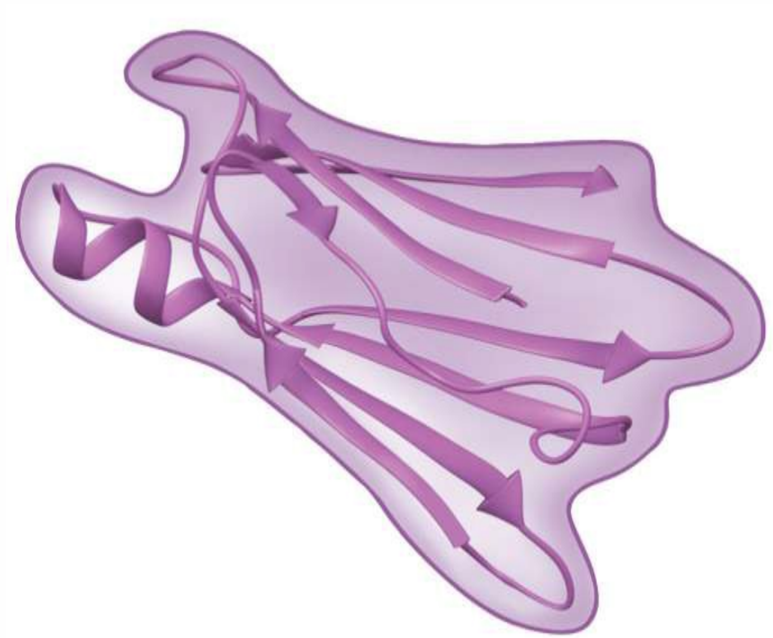
Secondary protein structure

- **Secondary structure** interacts between the amino acids that result in distinct patterns
- The two types of secondary structures are a coil called an **α-helix** and a folded structure called a **β-sheet**


no acid
chain
0.54 nm
carbon
nitrogen
(B)
α helix
(C)
0.7 nm
(E)
2008)
β sheet
(F)

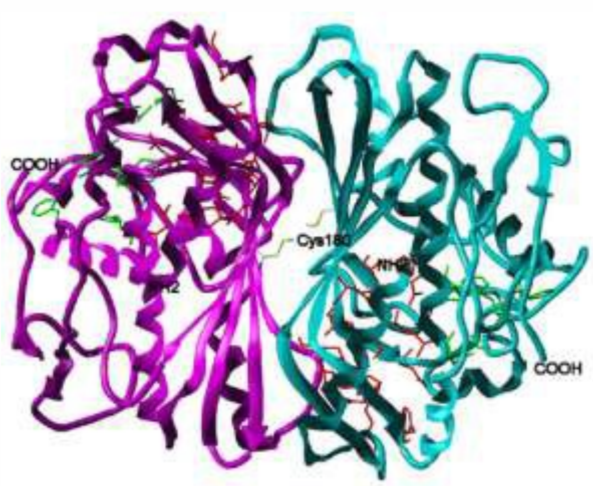
Tertiary protein structure

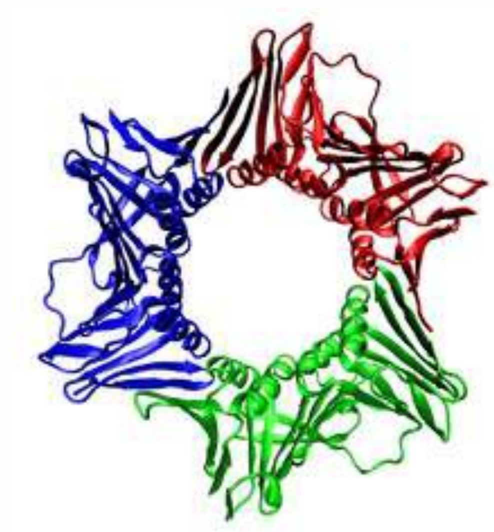
- **Tertiary structure** is the final step in how protein folds
- Interactions in R-groups allow the secondary elements o fit together



Quaternary protein structure

- **Quaternary structure** results when two or more separate polypeptides interact
- Not all proteins have quaternary structure





Vocabulary – Part I

- Polymer, monomer
- Monosaccharide, disaccharide, polysaccharide
- Glucose, fructose
- Sucrose, lactose
- Fats, glycerol, fatty acids
- Saturated fats,
- Steroids
- Phospholipid, Phospholipid bilayer

Vocabulary – Part II

- DNA, RNA
- Base pairing
- Nucleotide
- Pyrimidine, purine
- Deoxyribose, ribose
- A, T, C, G, U
- Complementary base-pairing
- Enzymes
- Protein
- Polypeptide
- Amino acid
- Primary, secondary, tertiary, quaternary structure