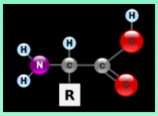
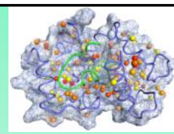
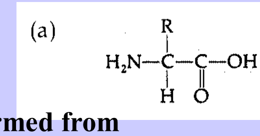




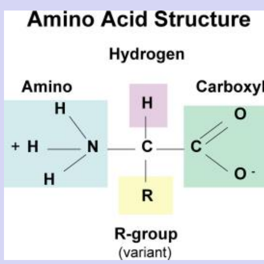
Biological Molecules: Proteins

Proteins - 1

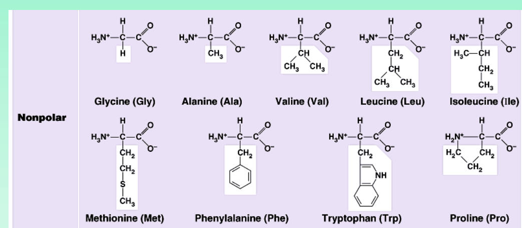


- **All proteins are formed from only 20 amino acids.**
- **Small proteins contain less than 10 aa's (e.g. insulin).**
- **Large proteins contain hundreds of aa's (e.g. hemoglobin)**

- **Amino acids** consist of four components including a hydrogen atom, a **carboxyl group**, an **amino group**, and a variable **R group** (or side chain).
- Differences in R groups produce the 20 different amino acids.



- One group of amino acids has **hydrophobic** R groups.



- Another group of amino acids has **polar** R groups, making them hydrophilic.

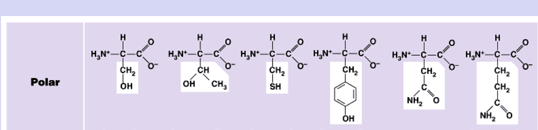


Fig. 5.15b

- The last group of amino acids includes those with functional groups that are **charged** (ionized) at cellular pH.
- Some R groups are bases, others are acids.

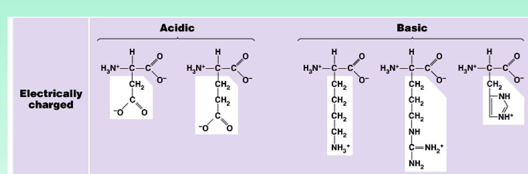
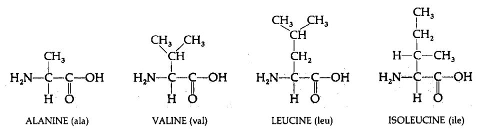
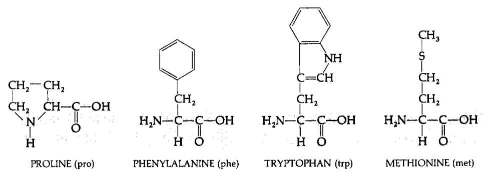


Fig. 5.15c



Various Amino Acids



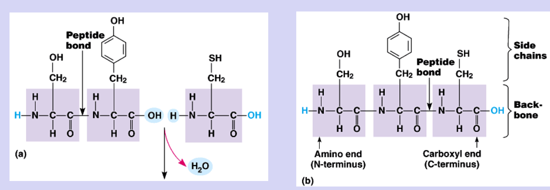
Protein Functions

Structure	Storage
Regulation	Membrane
Contraction	Toxins
Transport	Enzymes
Protection	

Sucrase	Epinephrine	Venom
Myosin	Antibodies	Silk
Hemoglobin	Antigens	Albumin

- **Proteins** are instrumental in about everything that an organism does.
- Humans have tens of thousands of different proteins, each with their own structure and function.
- Proteins are the most structurally complex molecules known.
- Each type of protein has a complex three-dimensional shape or conformation.
- All protein polymers are constructed from the same set of **20 monomers**, called **amino acids**.
- Polymers of proteins are called **polypeptides**.
- A protein consists of one or more polypeptides folded and coiled into a specific conformation.

- Amino acids are joined together when a dehydration reaction removes a hydroxyl group from the carboxyl end of one amino acid and a hydrogen from the amino group of another.
- The resulting covalent bond is called a **peptide bond**.



Proteins - Makin' 'em

R-C(=O)-OH + H-N(H)-R

Dehydration Synthesis ↓ ↑ **Hydrolysis**

R-C(=O)-N(H)-R + HOH

Dehydration synthesis produces polypeptides. Each amino acid is linked to the next by a peptide bond.

- A functional protein consists of one or more polypeptides that have been precisely twisted, folded, and coiled into a unique shape.
- It is the order of amino acids that determines what the three-dimensional conformation will be.
- In almost every case, the function depends on its ability to recognize and bind to some other molecule.
- For example, antibodies bind to particular foreign substances that fit their binding sites.
- Enzyme recognize and bind to specific substrates, facilitating a chemical reaction.
- Neurotransmitters pass signals from one cell to another by binding to receptor sites on proteins in the membrane of the receiving cell.

- Three levels of structure: primary, secondary, and tertiary structure, are used to organize the folding within a single polypeptide.
- Quarternary structure arises when two or more polypeptides join to form a protein.
- The **primary structure** of a protein is its unique sequence of amino acids.
- The precise primary structure of a protein is determined by inherited genetic information.

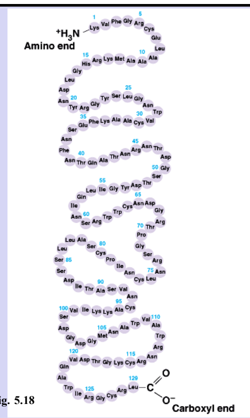


Fig. 5.18

Proteins: Levels of Organization

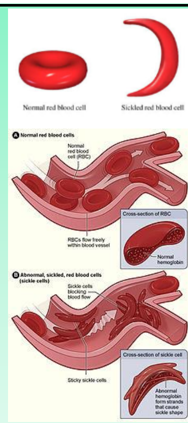
Primary (1°)

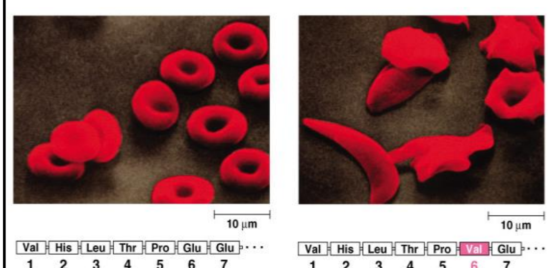
Sequence of amino acids: "a polypeptide"

arg-val-try-try-asp-ala-val-phe-glu-...

No protein functions at this level

- Even a slight change in primary structure can affect a protein's conformation and ability to function.
- In individuals with sickle cell disease, abnormal hemoglobins, oxygen-carrying proteins, develop because of a single amino acid substitution.
  - These abnormal hemoglobins crystallize, deforming the red blood cells and leading to clogs in tiny blood vessels.



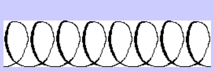


(a) Normal red blood cells and the primary structure of normal hemoglobin

(b) Sickled red blood cells and the primary structure of sickle-cell hemoglobin

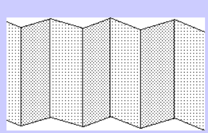
Secondary (2°)

H-bonds cause folding into a helix...



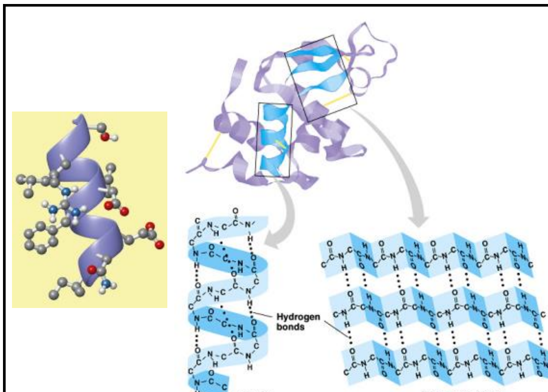
Alpha Helix

...or pleated sheet.



Beta Pleated Sheet

Fibrous proteins. Ex. collagen

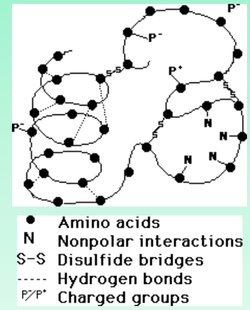


- The structural properties of silk are due to beta pleated sheets.
- The presence of so many hydrogen bonds makes each silk fiber stronger than steel fibers of the same diameter. → Golden Gate Bridge!!

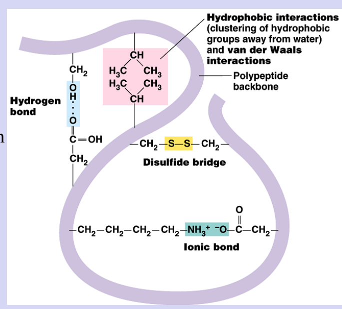
Tertiary (3º)

- **Interaction of primary and secondary structures forms larger shapes**
  - **globular proteins**

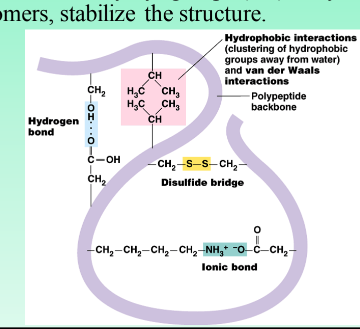
Ex. Microtubules and the enzyme chymotrypsin (*illustrated*)



- **Tertiary structure** is determined by a variety of interactions among R groups and between R groups and the polypeptide backbone.
  - These interactions include:
    - hydrogen bonds among polar and/or charged areas
    - ionic bonds between charged R groups
    - hydrophobic interactions

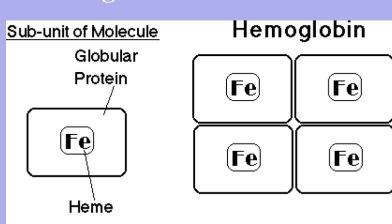


- While these three interactions are relatively weak, **disulfide bridges**, strong covalent bonds that form between the sulfhydryl groups (SH) of cysteine monomers, stabilize the structure.

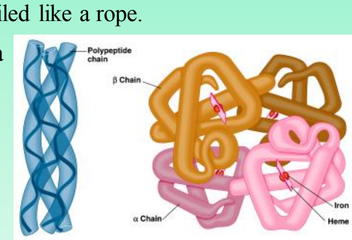


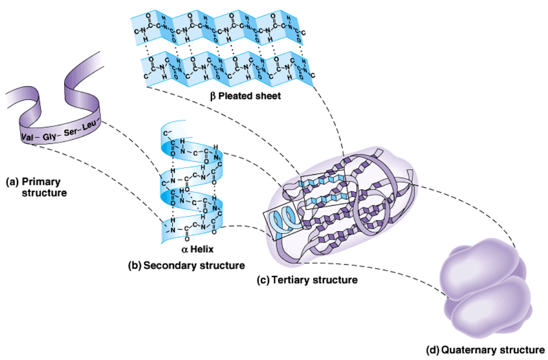
Quaternary (4º)

- **2 or more previous level polypeptides combine together.**
- **Ex. Hemoglobin**

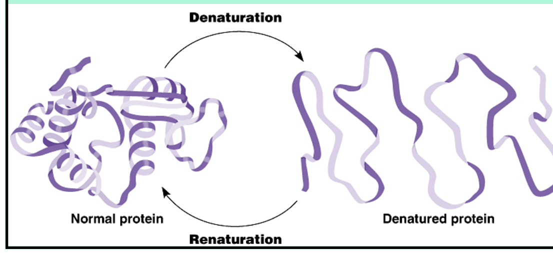


- **Quarternary structure** results from the aggregation of two or more polypeptide subunits.
- Collagen is a fibrous protein of three polypeptides that are supercoiled like a rope.
- Hemoglobin is a globular protein with two copies of two kinds of polypeptides.





- Alterations in **pH**, **salt concentration**, temperature, or other factors can unravel or **denature** a protein.
- Some proteins can return to their functional shape after **denaturation**, but others cannot, especially in the crowded environment of the cell. (egg white)



Questions?