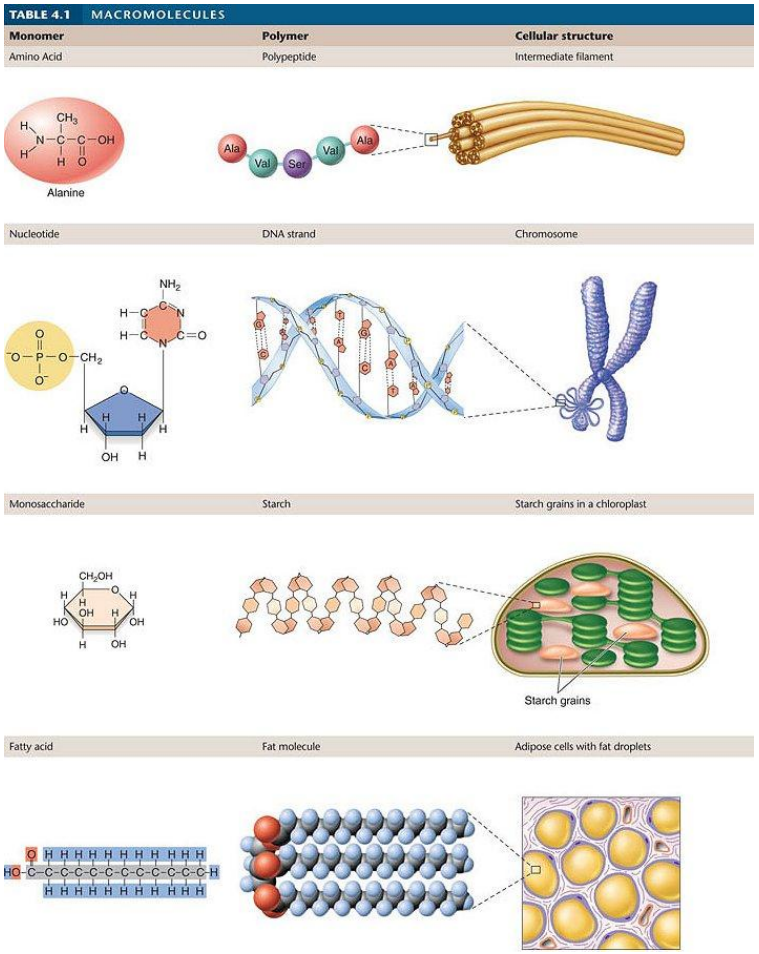
Structure and Function of Large Biological Molecules

Large Biological Molecules

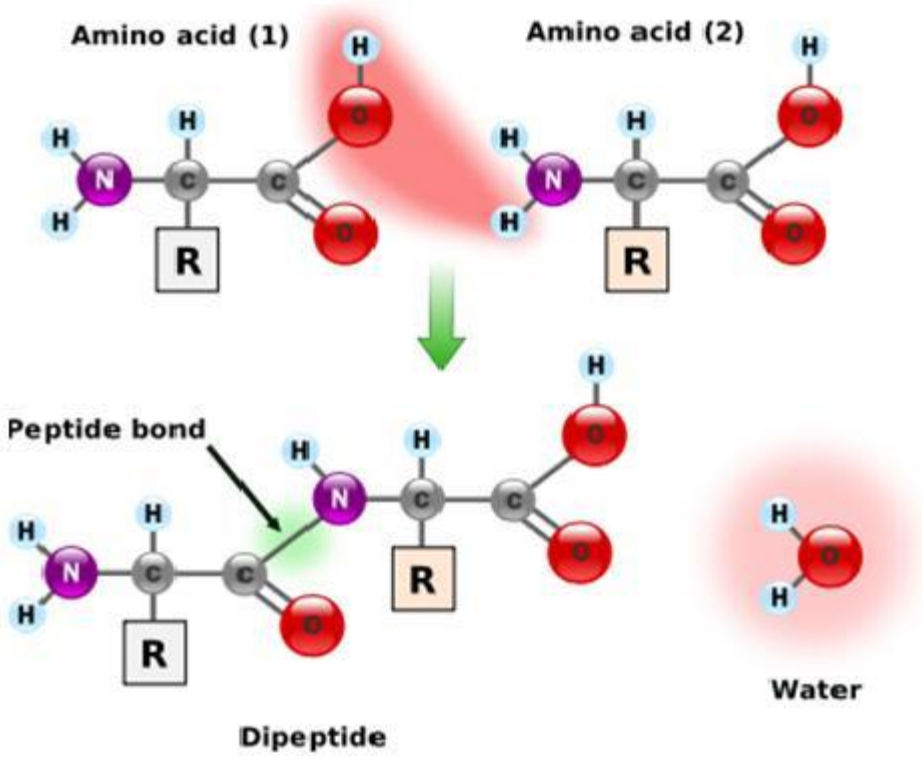
- Critically important molecules in all living things divided into 4 classes:
- Lipids (fats)
- Carbohydrates (sugars)
- Proteins
- Nucleic Acids (DNA & RNA)
- **Carbs, Proteins and Nucleic Acids are Polymers**



http://www.yellowtang.org/images/joh86670_t04_01.jpg

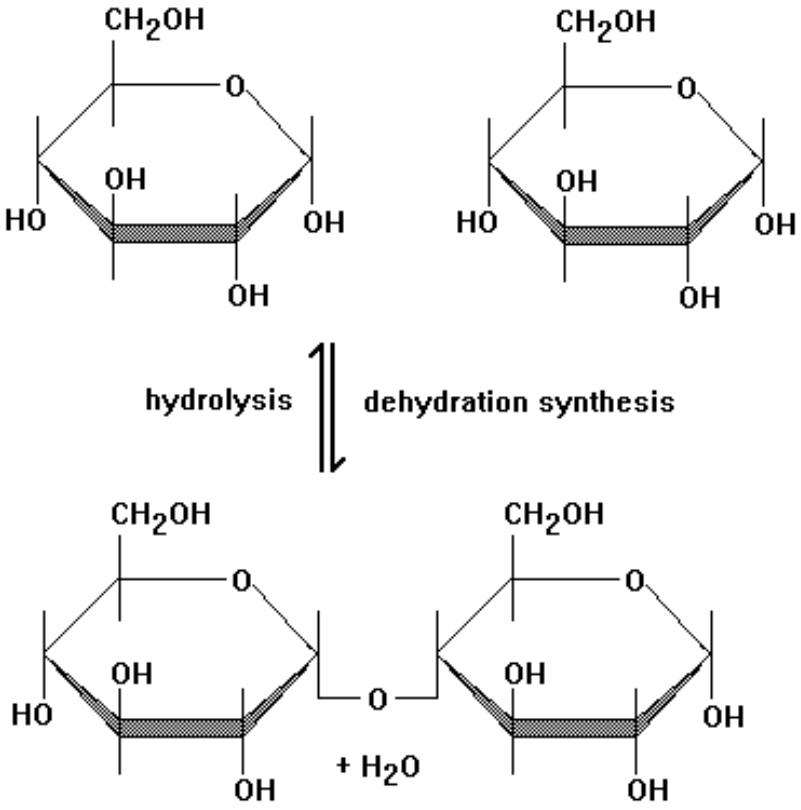
Polymers are built from Monomers

- Polymers (large) are made of covalently bonded monomers (building blocks)
- Polymers built by dehydration synthesis
- Polymers broken into monomers by hydrolysis
- The order of the monomer determines the function and shape of the polymer.



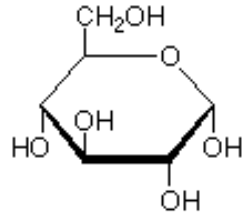
Hydrolysis & Dehydration synthesis

- Hydrolysis
  - Breaks bonds in a polymer by adding water
- Dehydration Synthesis
  - Bond forms between 2 monomers & a water molecule is lost
  - Facilitated by enzymes

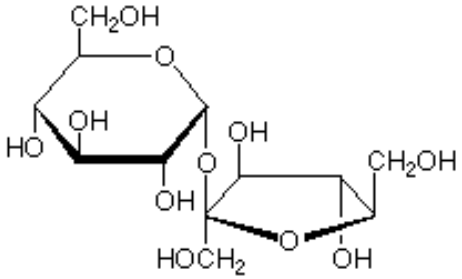


Monosaccharides: simple sugars

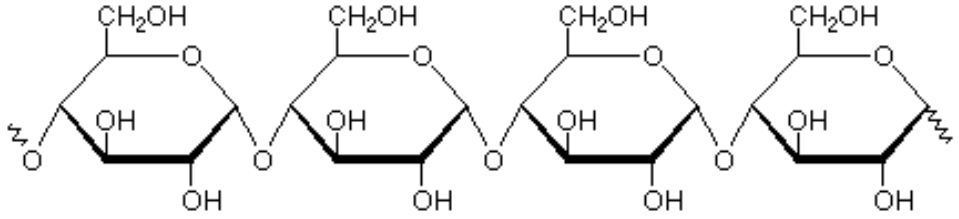
- **Monosaccharides** generally have molecular formulas that are some multiple of the unit CH_2O.
- Glucose has the formula $C_6H_{12}O_6$. Quick energy for cells
- Monosaccharides: one ring structure
- Disaccharides: 2 ring structure
- Polymer: many rings
- Most names for sugars end in *–ose*.
- Glucose, an aldose, and fructose, a ketose, are structural isomers.
- Monosaccharides are also classified by the number of carbons in the carbon skeleton



monosaccharide (glucose)



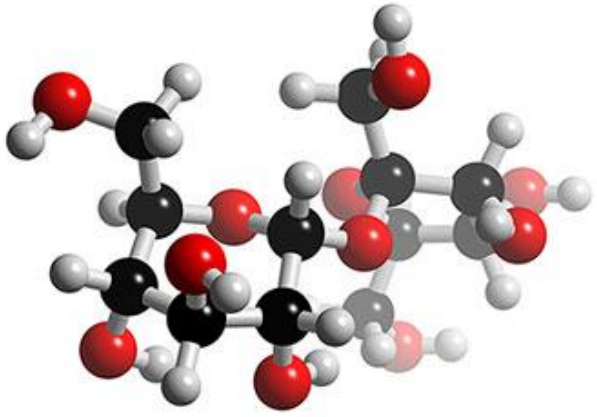
disaccharide (sucrose)



polysaccharide (amylose starch)

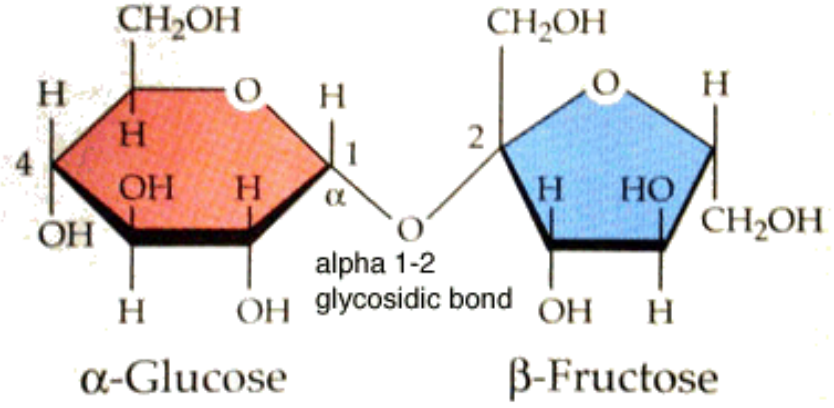
Disaccharides

- Consist of 2 monosaccharides joined by a glycosidic linkage (covalent bond formed by dehydration synthesis)
- Glucose + fructose= sucrose
- Glucose + galactose = lactose



http://www.3dchem.com/imagesofmolecules/Sucrose.jpg

Sucrose has the molecular formula $C_{12}H_{22}O_{11}$



Sucrose

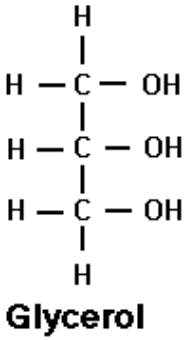
http://www.chm.bris.ac.uk/motm/glucose/sucrose.gif

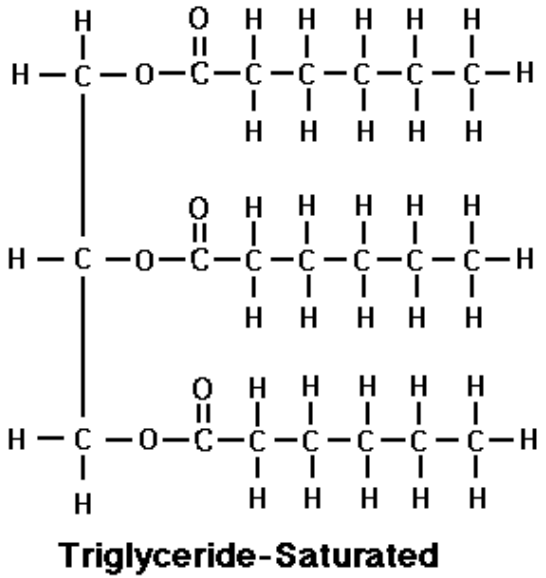
Polysaccharides

- **Polysaccharides** – many saccharides
- Energy storage (alpha glucose) - helical
  - **Starch** – plants
    - Amylose - unbranched
    - Amylopectan - branched
  - **Glycogen** – animals, liver and muscle energy stores
- Structure and support (beta glucose) – straight
  - **Cellulose** – plants, structural support creates a cable like structure called microfibrils by H-bonding to adjacent cellulose molecules
  - **Chitin** – exoskeletons and fungi
    - Contains nitrogen

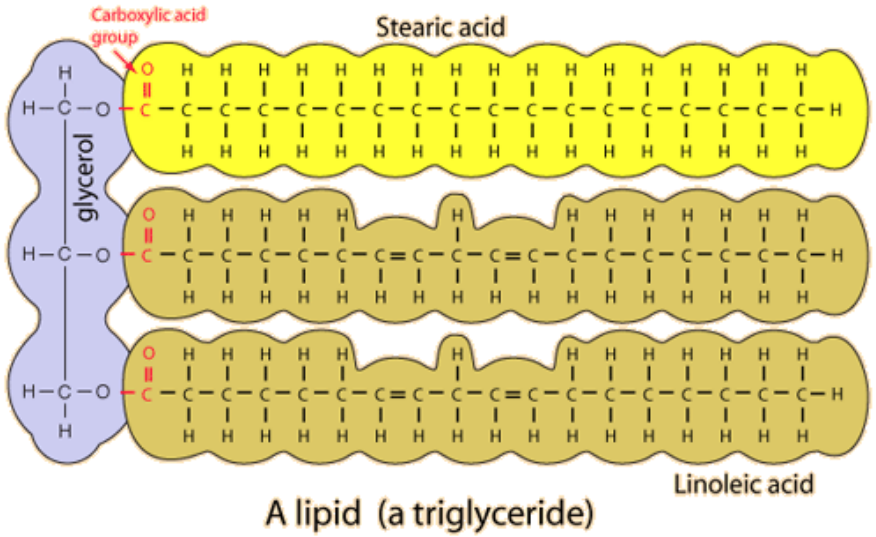
Lipids

- Lipids are hydrophobic, mostly hydrocarbons with non-polar covalent bonds
- In a fat, three fatty acids are joined to glycerol = triglyceride
- Glycerol: an alcohol with 3 carbons each with a hydroxyl group



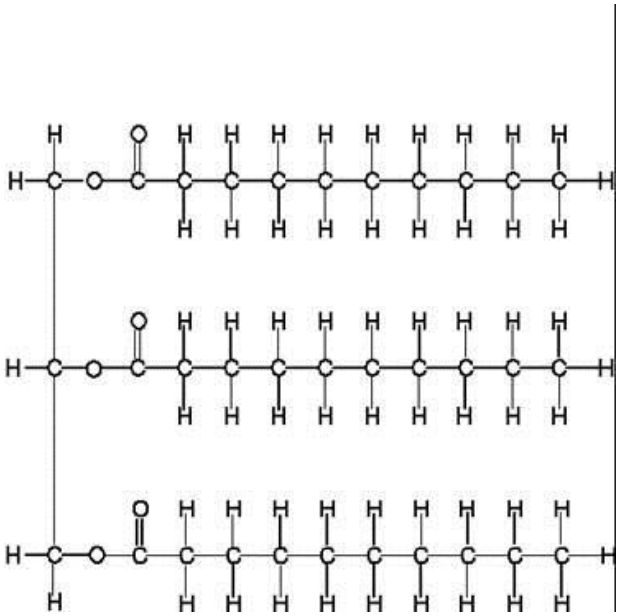


http://www.raw-milk-facts.com/images/GlycerolTrigly.gif

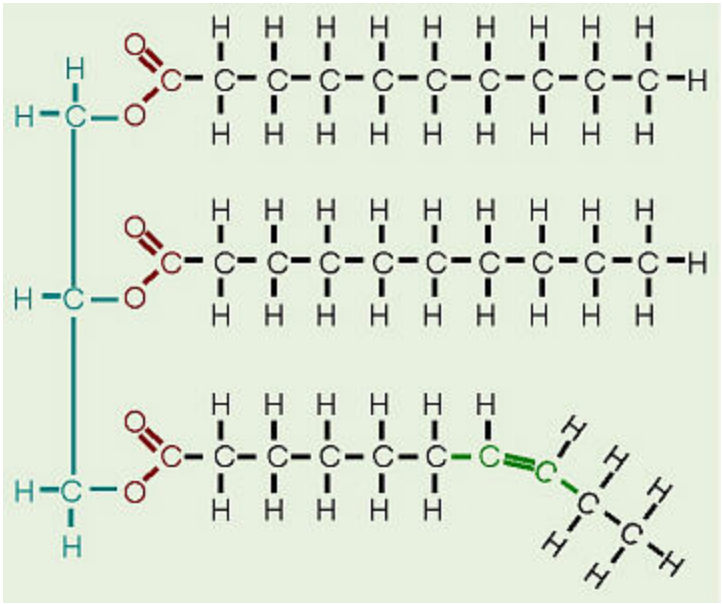


Saturated vs. Unsaturated Fats

- Saturated Fats:
  - Have all single bonds between C atoms, solid at room temperature
- Unsaturated Fats:
  - Have double or triple bonds between C atoms, liquid at room temperature



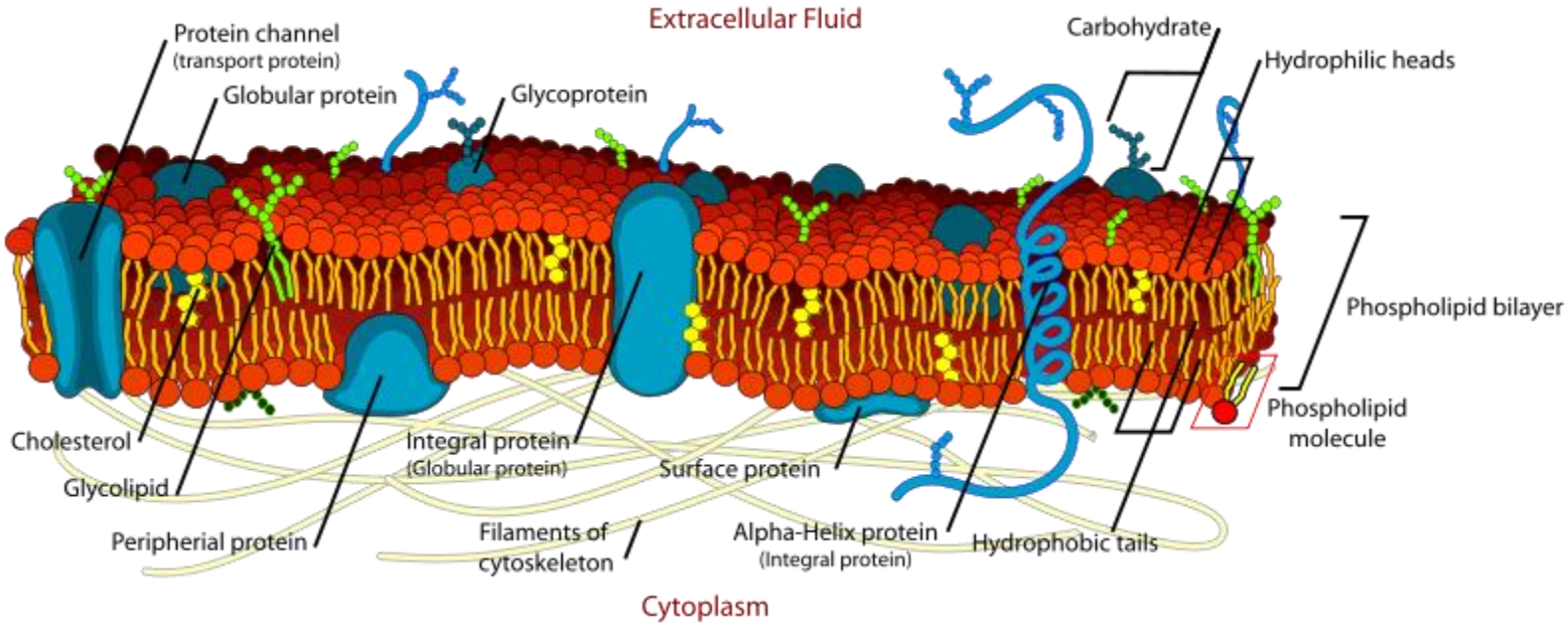
http://www.highperformanceliving.com/assets/images/cid_image002.jpg



http://biology.clc.uc.edu/graphics/bio104/fat.jpg

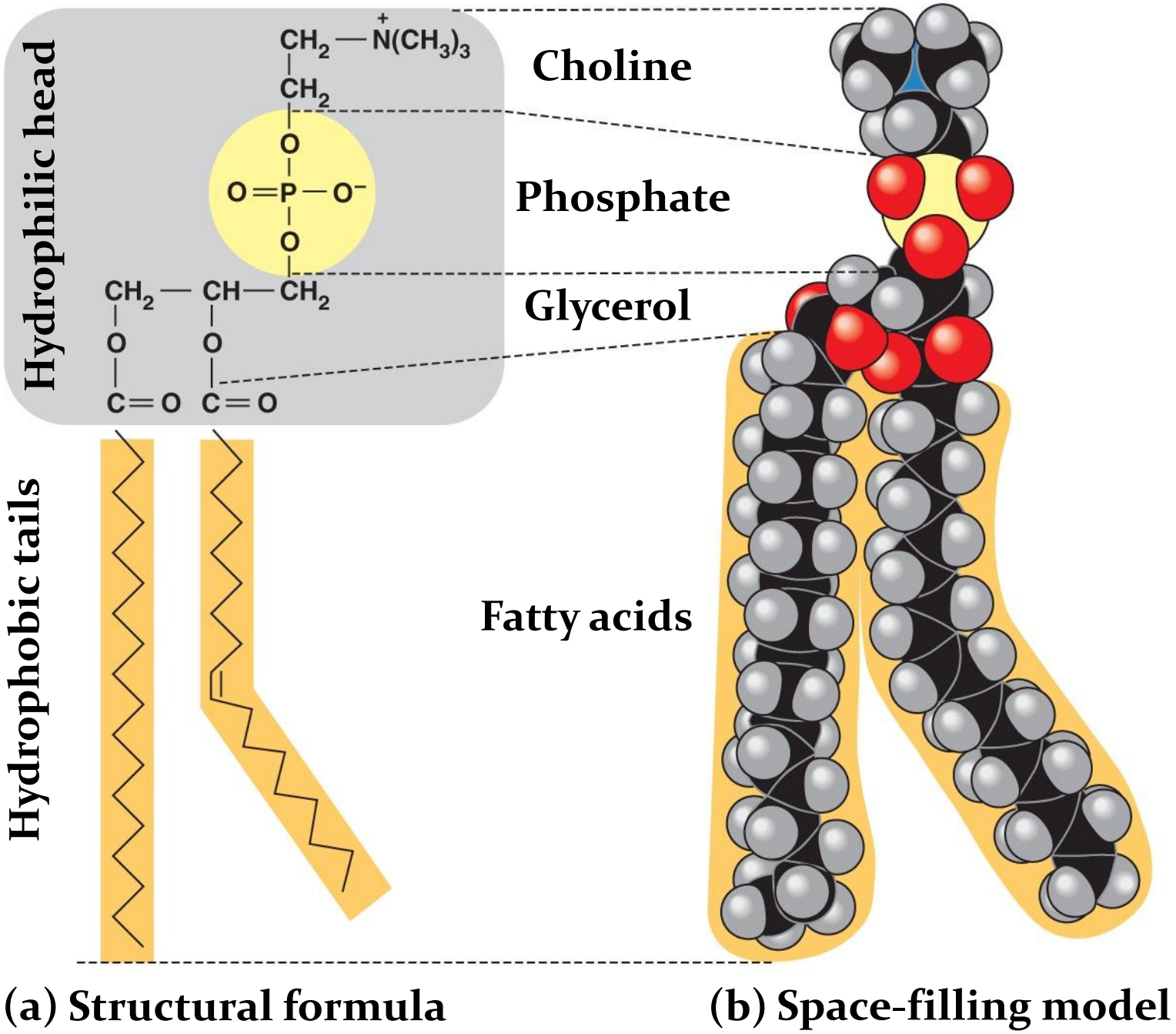
Fats and Cell Membranes

- In a **phospholipid**, two fatty acids and a phosphate group are attached to glycerol: <u>the main component of cell membranes</u>
- The two fatty acid tails are hydrophobic, but the phosphate group and its attachments form a hydrophilic head



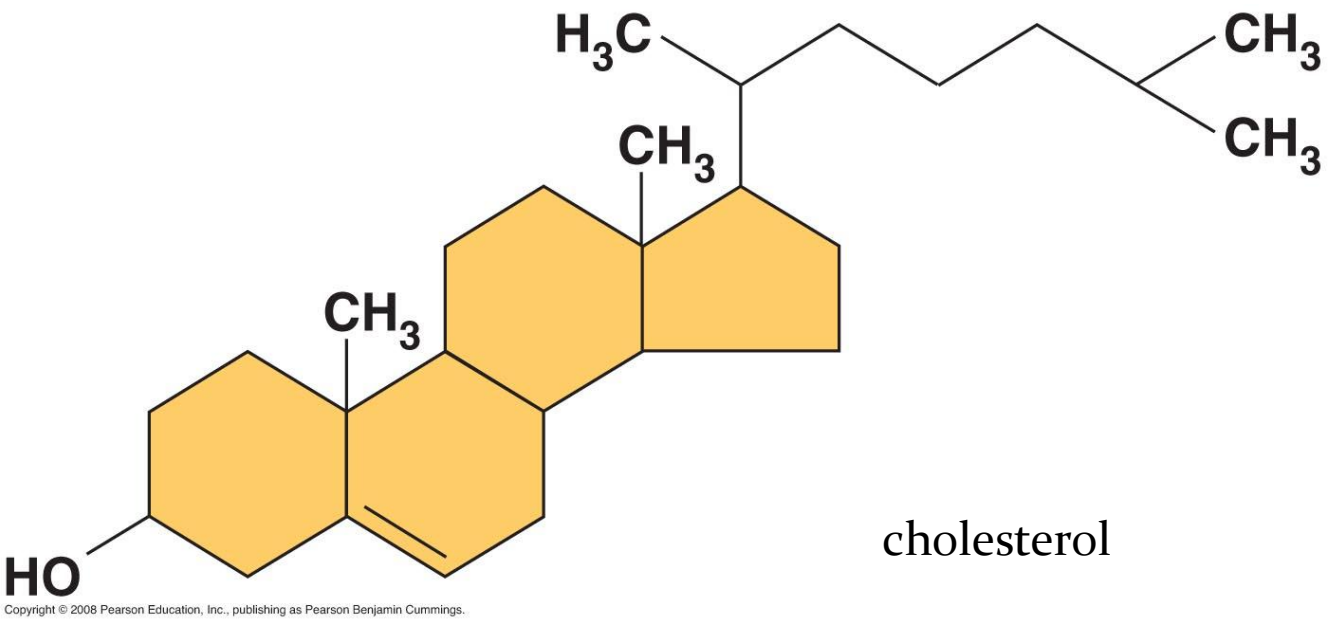
http://cellbiology.med.unsw.edu.au/units/images/Cell_membrane.png

Fig. 5-13ab



Steroids

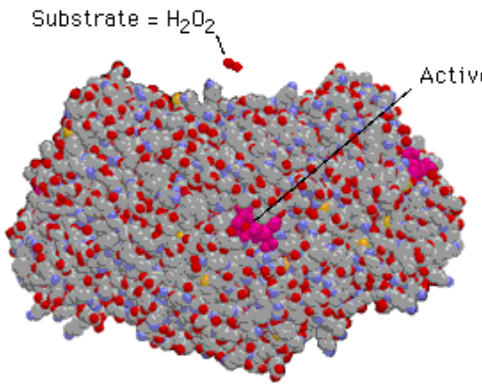
- Lipids characterized by a carbon skeleton of 4 fused rings
- Cholesterol and many other hormones (sex hormones) important in cell membranes
- Too much builds up in the arteries = atherosclerosis
- Trans fats: artificially made fats, no enzymes to break them down = heart disease



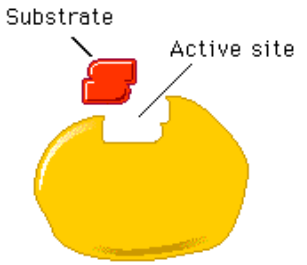
cholesterol

Proteins

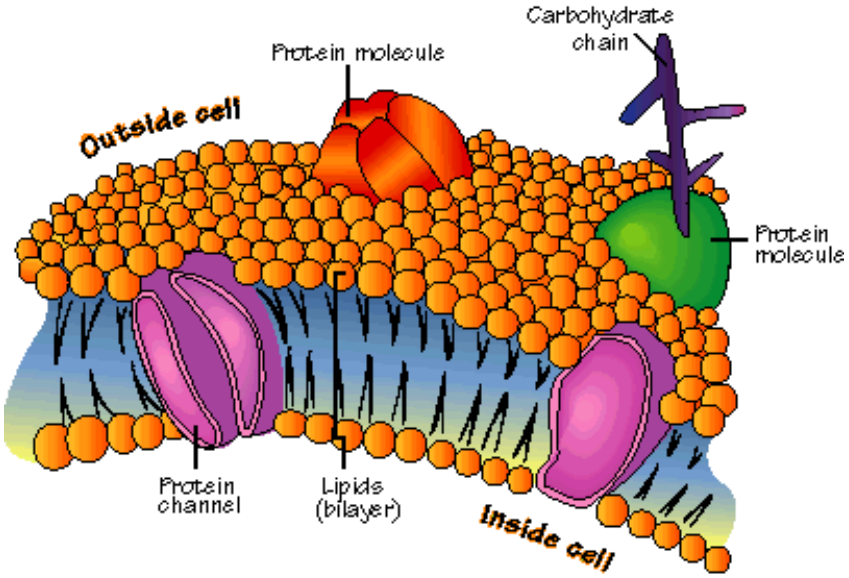
- Enzymes – catalysts
- Structural support
- Storage
- Transport
- Cell communication
- Movement
- Defense



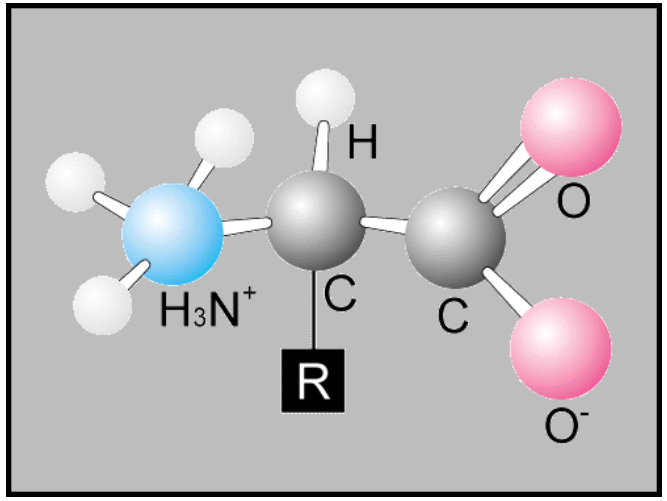
Molecular model of catalase

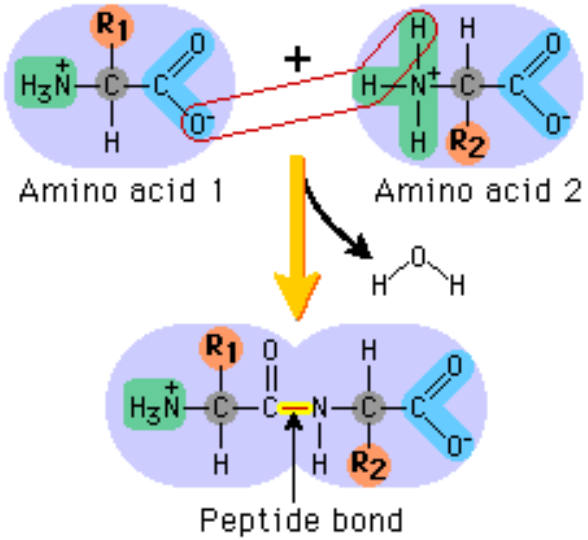


Schematic model of an enzyme



Proteins





- **Protein** – made of one or more polypeptides
- **Polypeptide** – polymer of amino acids joined by **peptide bonds** amino acids are alternately flipped upside down
- **Amino acid** – contains an amine group and a carboxyl group
  - 20 different
  - Differ in properties due to R groups or side chains

http://www.schenectady.k12.ny.us/putman/biology/data/images/translation/peptbond.gif

Protein Structure

- Primary: Amino Acid Sequence
- Secondary: α helix or β pleated sheet (H bonds between a.a.)
- Tertiary: the folding of the secondary structure 3-D due to hydrogen bonds and disulfide bridges
- Quaternary: 2 or more polypeptide chains put together by chaperone proteins (errors in folding cause disease: Alzheimer's and Parkinson's, sickle cell anemia)

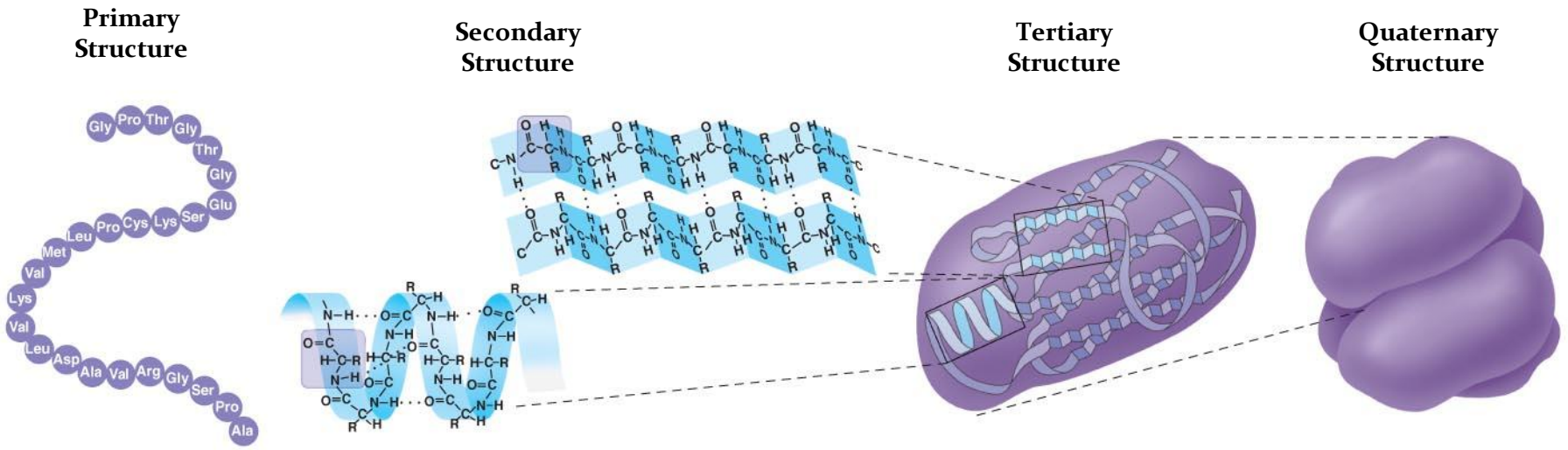
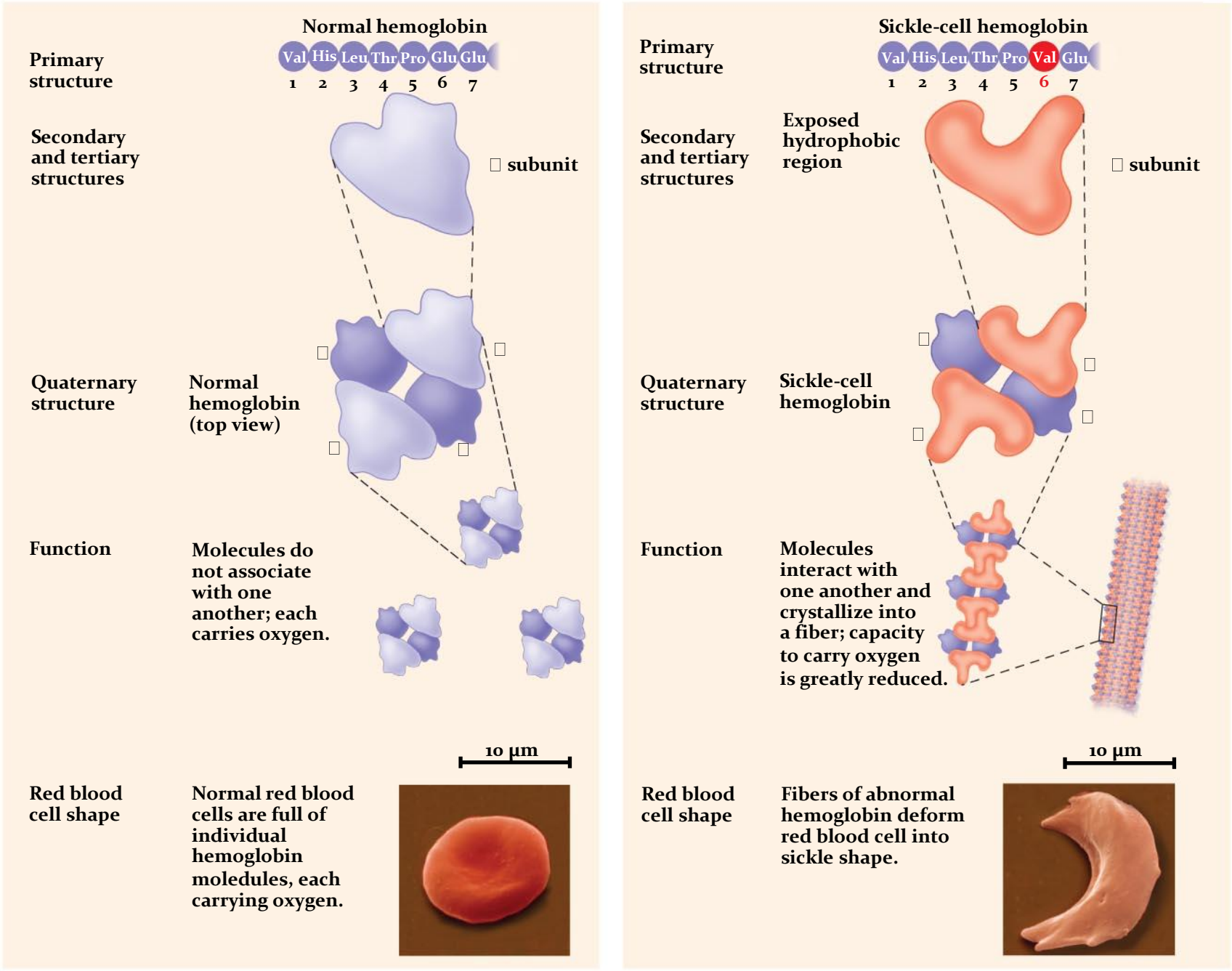
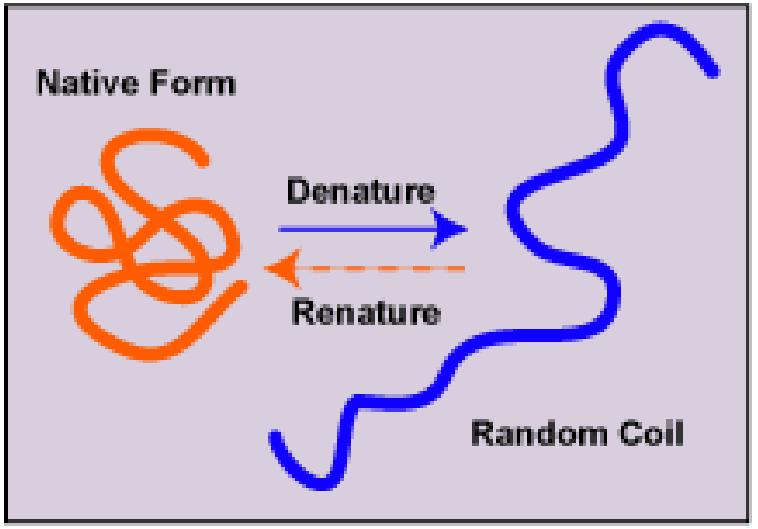


Fig. 5-22



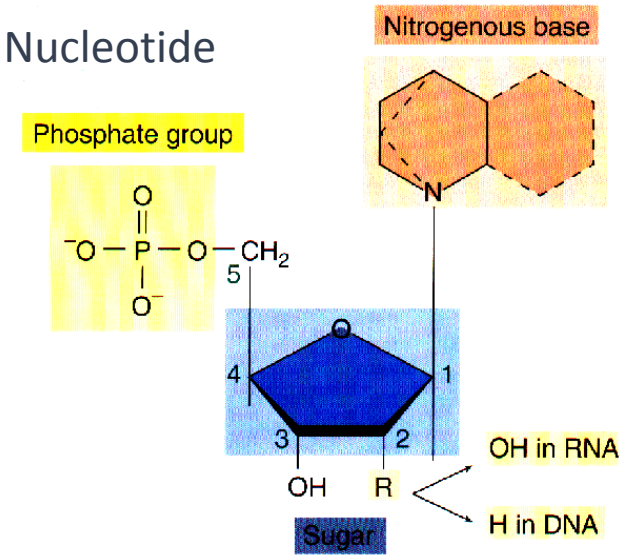
Proteins

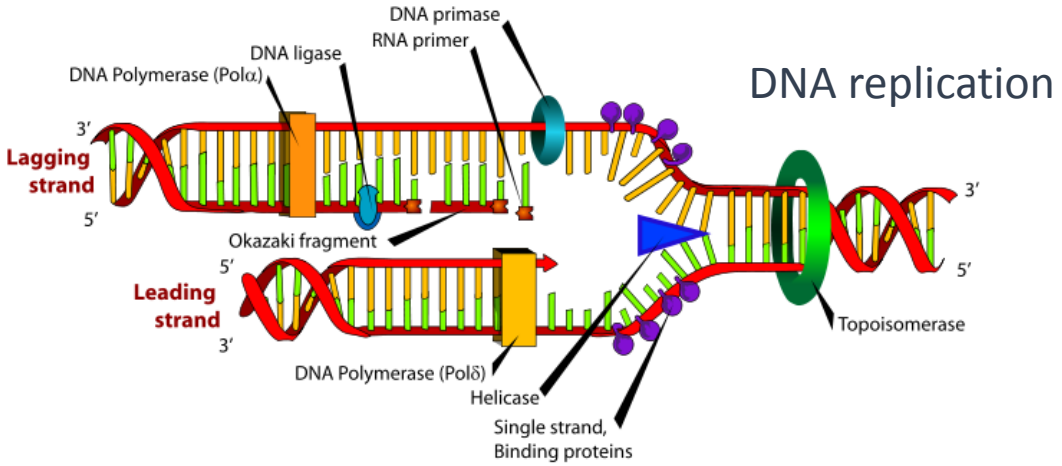
- **<u>Denaturation</u>** – the unfolding of a protein
- Depends on chemical and physical conditions
  - pH, Ionic concentration, temperature
- **<u>Chaperonins</u>** – aid in the folding process



Nucleic Acids

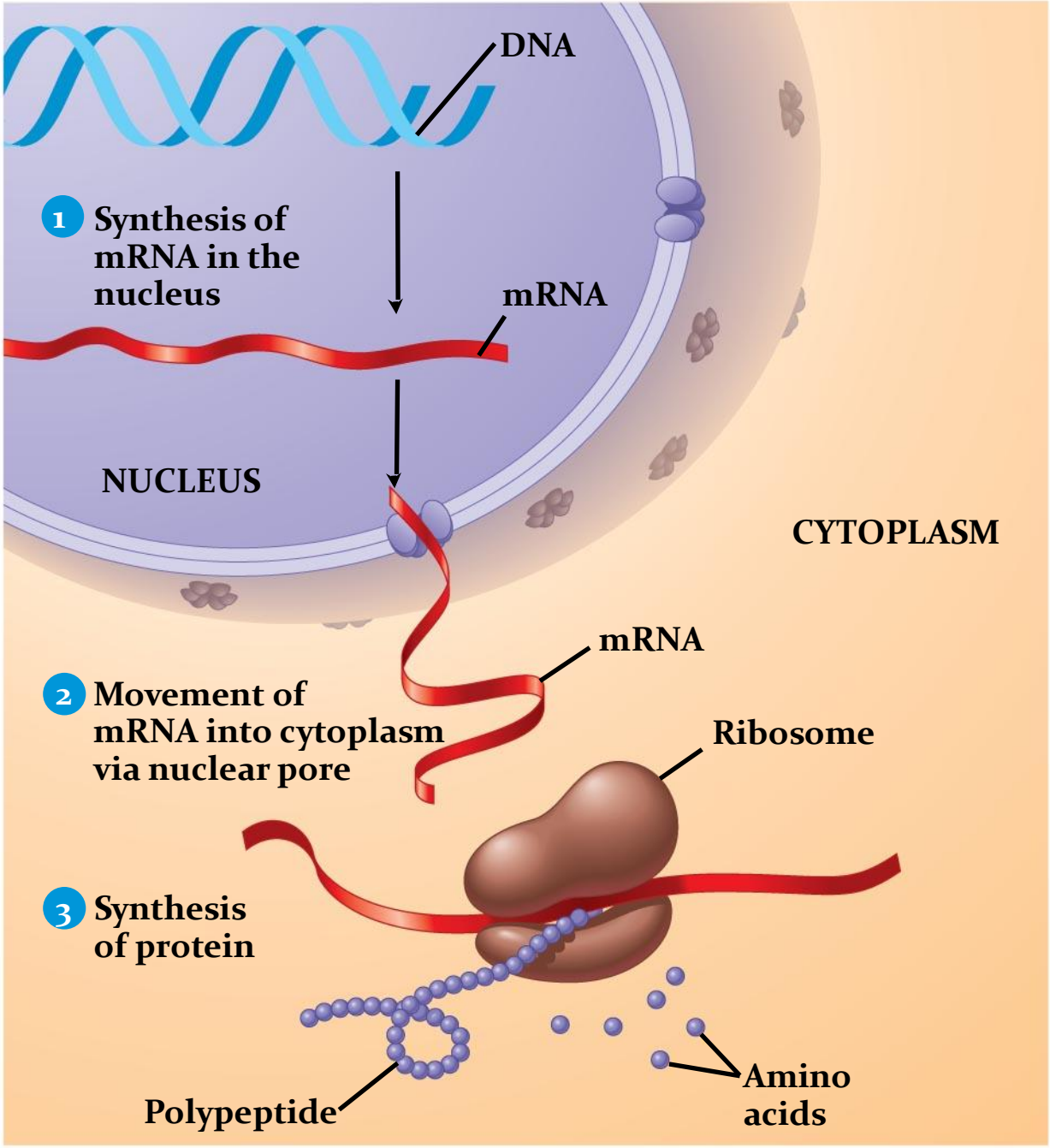
- **Genes** - Store and transmit genetic information and are made of nucleic acids
  - DNA – deoxyribonucleic acid
  - RNA – ribonucleic acid
- Proteins are made from info in nucleic acids
- **Nucleotides** are the monomers of nucleic acids
  - Sugar
    - Ribose
    - Deoxyribose
  - Phosphate
  - Base
    - Purines - AG
    - Pyrimadines - CT





http://lams.slcusd.org/pages/teachers/saxby/wordpress/wp-content/uploads/2009/11/DNA_replication_fork1.png

Fig. 5-26-3



Graphic Organizer for the large Biological Molecules