- Matter – anything that has weight and takes up space.
  - Includes solids, liquids, and gases
- All matter is composed of elements.
  - There are 118 known elements
    - Ex. Iron, copper, silver, aluminum, carbon, hydrogen, oxygen
- Living organisms require about 20 elements.
- Of these, oxygen, carbon, hydrogen and nitrogen make up more than 95% of the human body.
- Elements are composed of tiny particles called atoms.
- Atoms are the smallest complete units of elements.
- Molecule – when two or more atoms bond. $CO_2$ , $O_2$ , $H_2$ and $H_2O$ are all molecules.
- Compound – when different elements combine. $CO_2$ and $H_2O$ are molecules, but they are also compounds because they are molecules containing more than one element.

# Organic and Inorganic Compounds

- **Organic compounds –** contain both carbon and hydrogen
- Ex. **Carbohydrates, proteins, lipids and nucleic acids.**

- **Inorganic compounds –** any molecule that does not contain both carbon and hydrogen
- Ex. **Water, metals, salts, oxygen, carbon dioxide.**

**Macromolecules** are large molecules that are formed by joining smaller organic molecules together. These large molecules are also called polymers.

**Polymers** are molecules made from repeating units of identical or nearly identical compounds called monomers that are linked together by a series of covalent bonds.

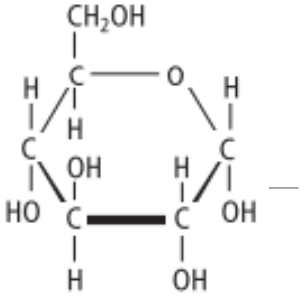
**Table 6.1 Biological Macromolecules**

| Group | Example | Function |
|---|---|---|
| Carbohydrates |  | • Store energy<br>• Provide structural support |
| Lipids |  | • Store energy<br>• Provide barriers |
| Proteins |  Hemoglobin | • Transport substances<br>• Speed reactions<br>• Provide structural support<br>• Make hormones |
| Nucleic acids |  DNA stores genetic information in the cell's nucleus. | • Store and communicate genetic information |

# Carbohydrates (CH2O)n

- **Elements**: (CHO) Carbon, Hydrogen & Oxygen in a 1:2:1 ratio

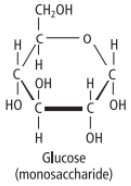
**Monomer**: **Monosaccharide (single sugar)**

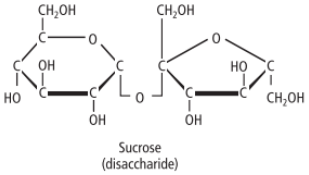


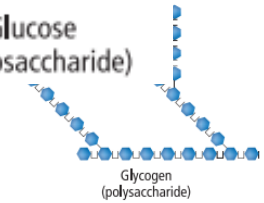

## Monosaccharides

- Single sugars (one monosacharide)

* **glucose, fructose**




## Disaccharides

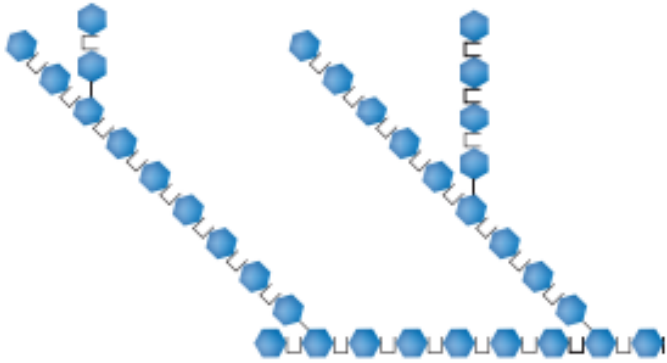
- Combination of two monosaccharides

* **sucrose** = glucose + fructose
* **lactose** = glucose + galactose

## Polysaccharides

- Macromolecules (polymers)

* **glycogen, cellulose, chitin**



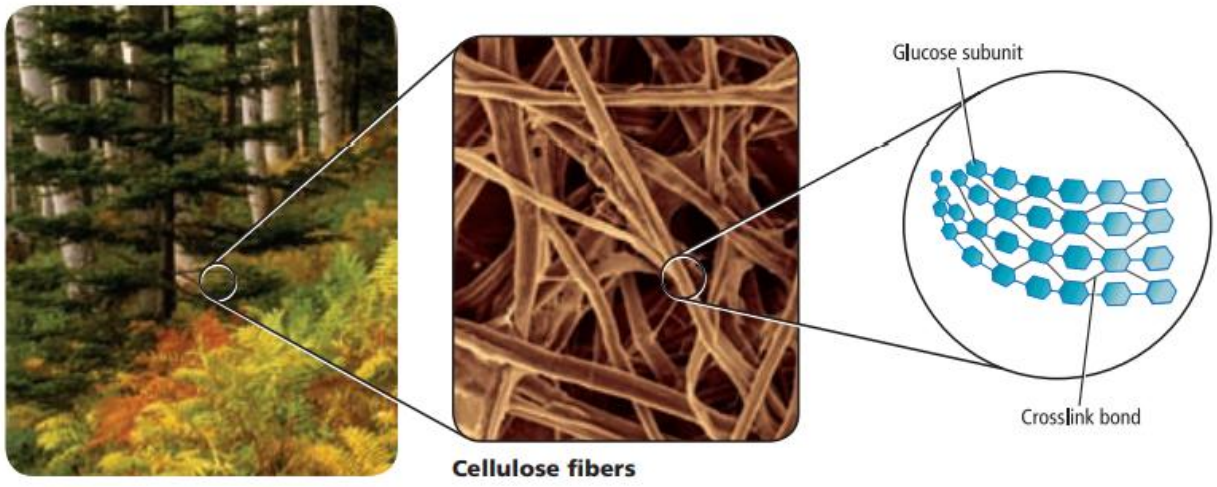
•**Function**:

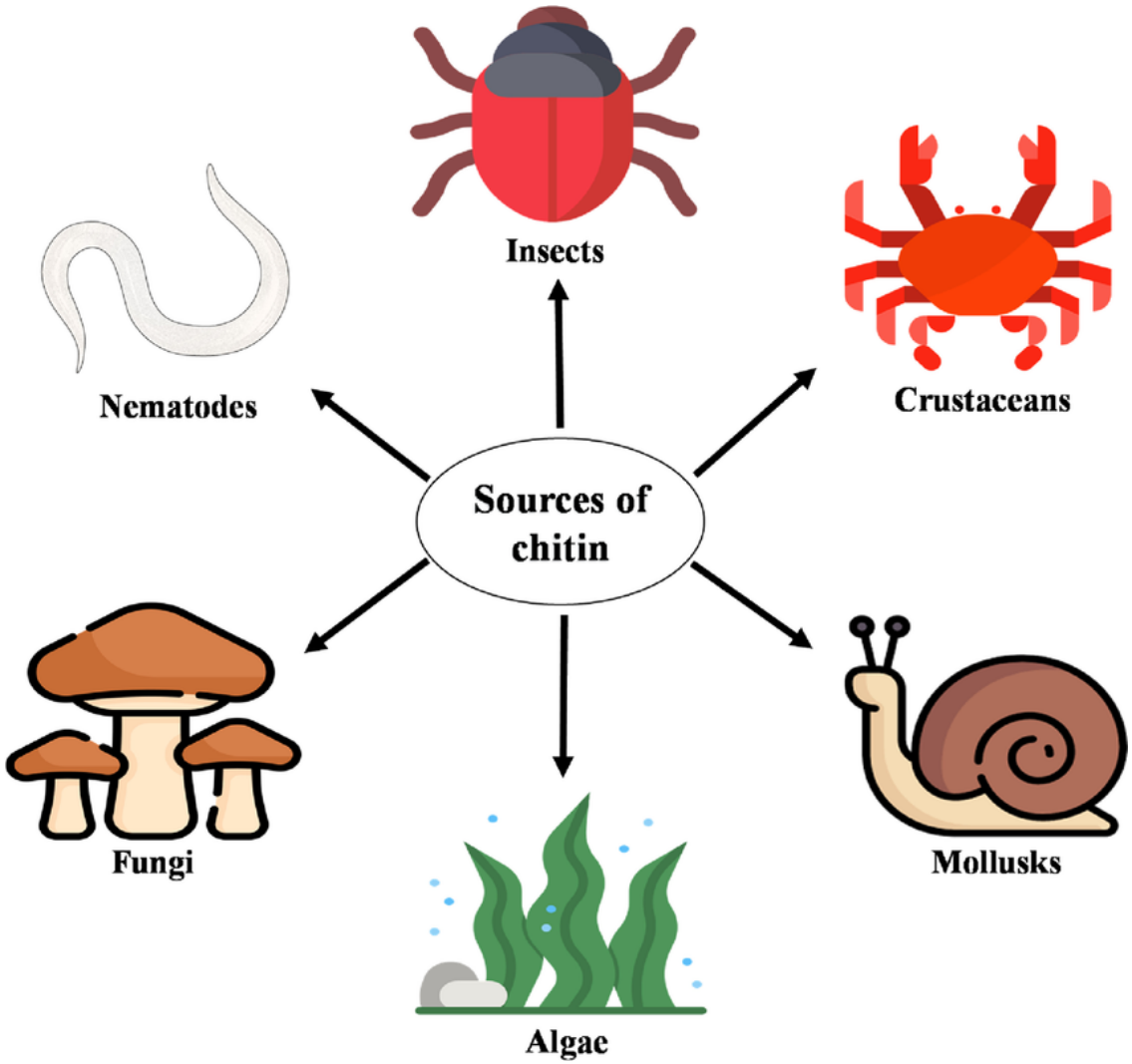
**1.main source of energy**

**2.structural role**

•**food storage carbs**: **glycogen** (animals) **starch** (plants)
•**structural carbs**: **chitin** (insects, animals), **cellulose** (plants)

**Figure 6.27** The cellulose in plant cells provides the structural support for trees to stand in a forest.



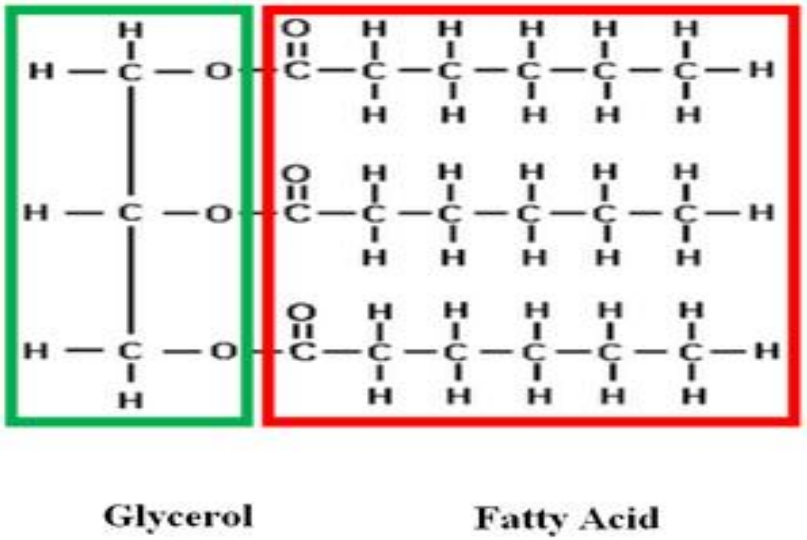


Insects
Nematodes
Crustaceans
Sources of chitin
Fungi
Mollusks
Algae

# Lipids

- **Elements:** CHO- Carbon, Hydrogen & Oxygen
- **They make up the fats, oils, and waxes.**

- **Structure: Glycerol & fatty acids** (not a true monomer)

- **Functions:**
  1. **The primary function of lipids is to store energy**
  2. **Make up cell membranes (Phospholipids).**
  3. **Waterproof covering**



Glycerol Fatty Acid

**Saturated Fats-** contain only a single bond between the C atoms because no more H can bond to the tails and are mostly from animal sources.

**Unsaturated Fats (oils)-** contain double bonds between the C atoms and and more H can bond to the tails, are mostly from plant sources.

---

**Phospholipid**- consists of parts that dissolve easily in water and parts that do not.

**Steroids (cholesterol and hormones)-** complex molecules that include four connected carbon rings
Examples: Cholesterol, estrogen, progesterone, testosterone

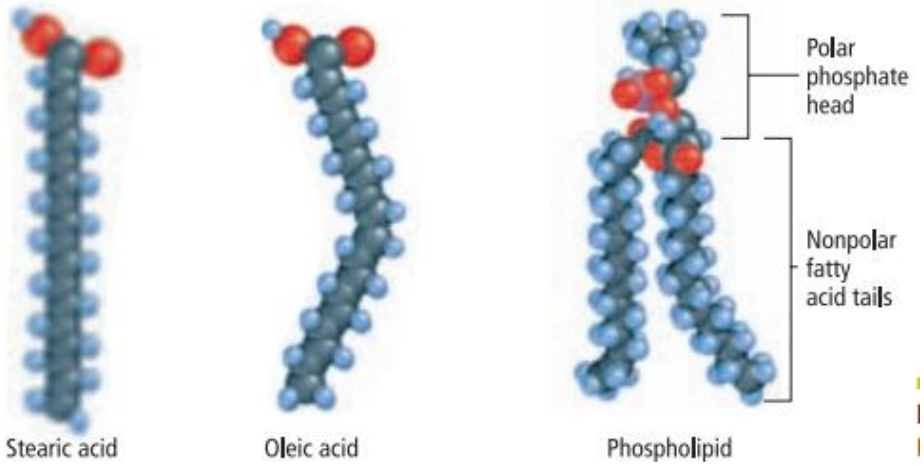
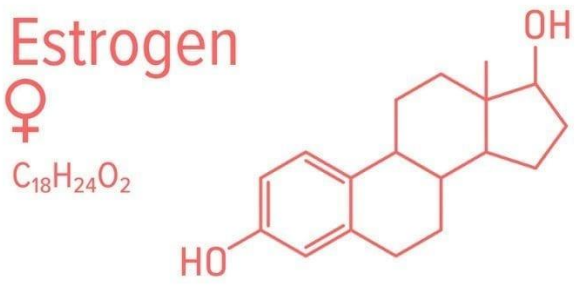
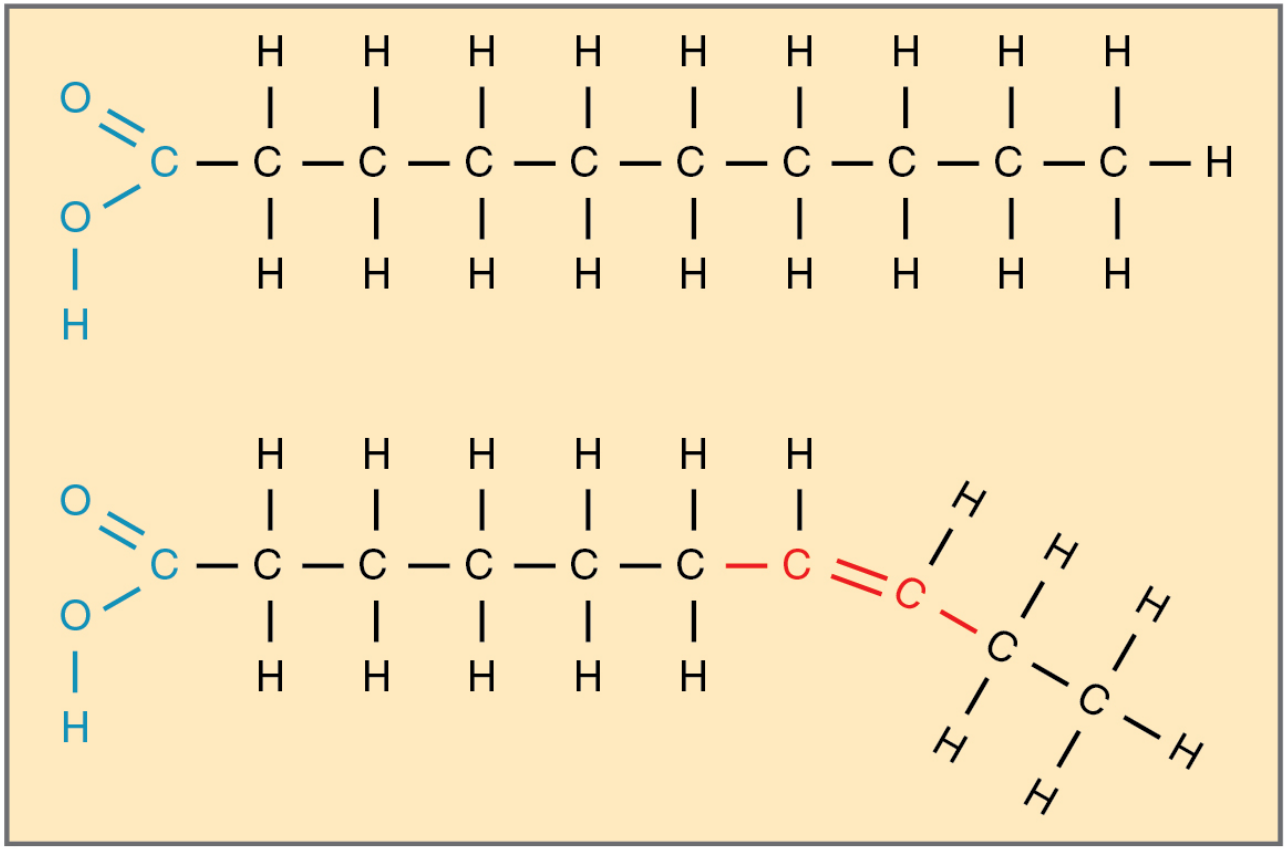



**Figure 6.28** Stearic acid has no double bonds between carbon atoms; oleic acid has one double bond. Phospholipids have a polar head and two nonpolar tails.




(a) Saturated

(b) Unsaturated

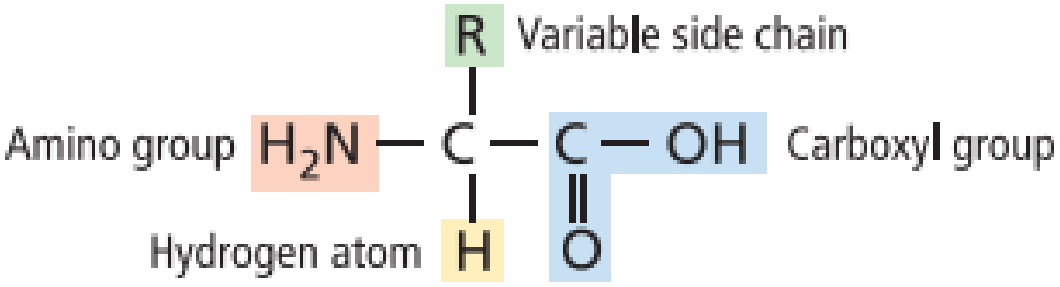


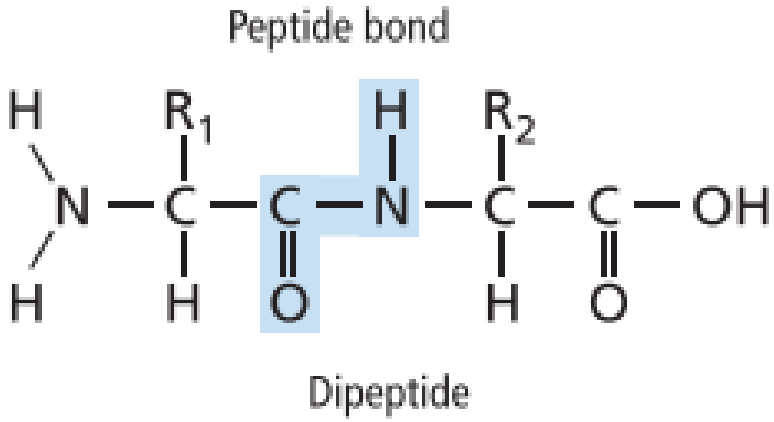
# Proteins

**Elements:** CHON- Carbon, Hydrogen, Oxygen & Nitrogen

- **Monomer: Amino acids**

- **Amino acid structure: contains an amine & carboxyl group**



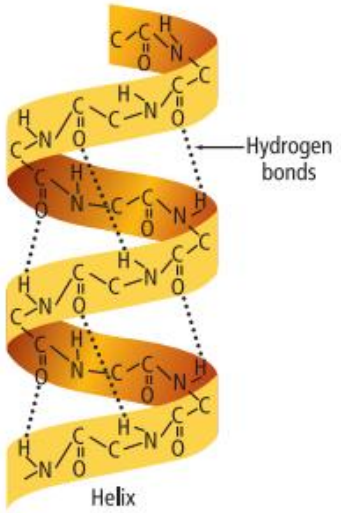
- The protein's primary structure is defined from the number of amino acids in a chain and the order in which the amino acids are joined.

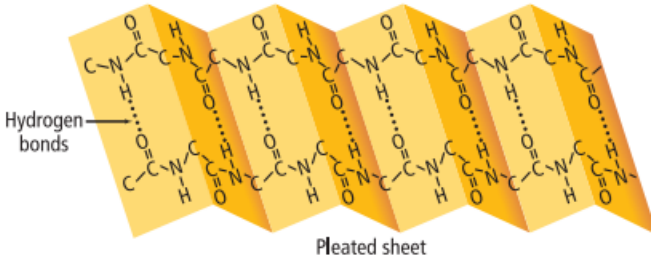
- The protein's secondary structure is defined after an amino acid chain is formed, it folds into a unique three-dimensional shape.

- The protein's tertiary structure mostly is globular, such as the hemoglobin protein shown in Table 6.1, but some proteins form long fibers.

- The protein's quaternary structure is defined when some proteins form a fourth level of structure by combining with other proteins.

**Figure 6.30** The shape of a protein depends on the interactions among the amino acids. Hydrogen bonds help the protein hold its shape.



**Proteins perform many functions in cells, including:**

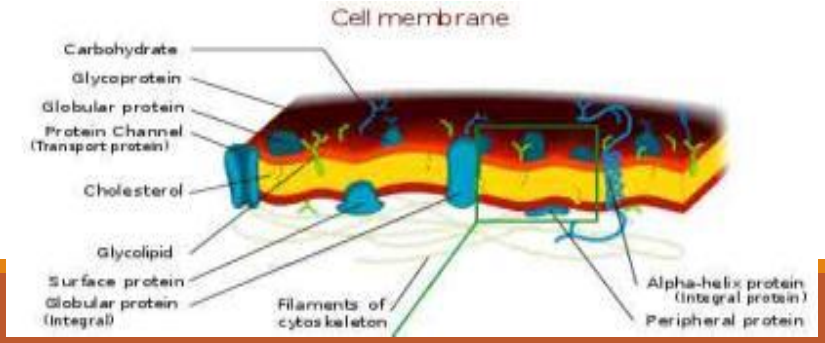
1. **Structural**
• Components (15 percent of your total body mass) in **cell walls, membranes**, and **within cells** themselves.

2. **Enzymes**
• Chemicals that speed up a **chemical reaction.**

3. **Regulation**
• Some **regulate cell function** by stimulating or hindering either the action of other proteins or the expression of genes.


4. **Transportation**
• Some act as channels and "pumps" that **move substances into or out of cells.**

5. **Defense**
• **Antibodies** = proteins that defend your body against microorganisms
• Some bacteria produce proteins (bacteriocins) that kill other bacteria.

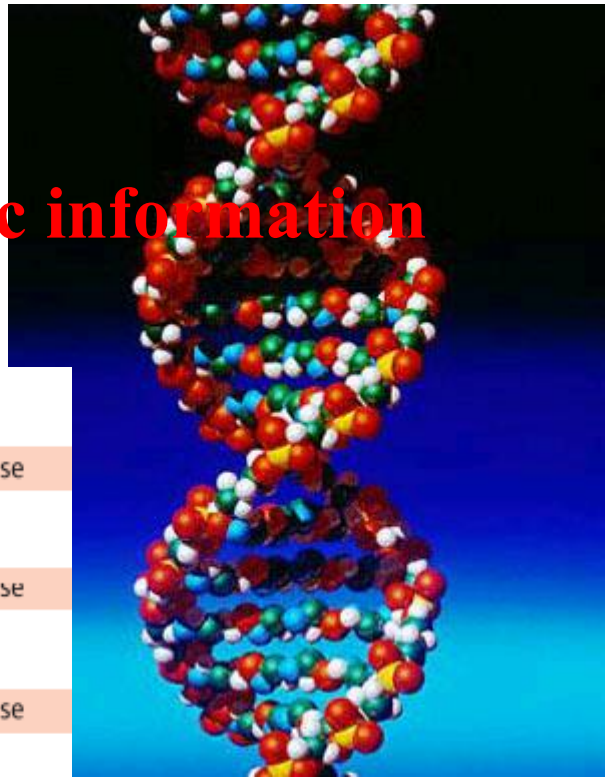


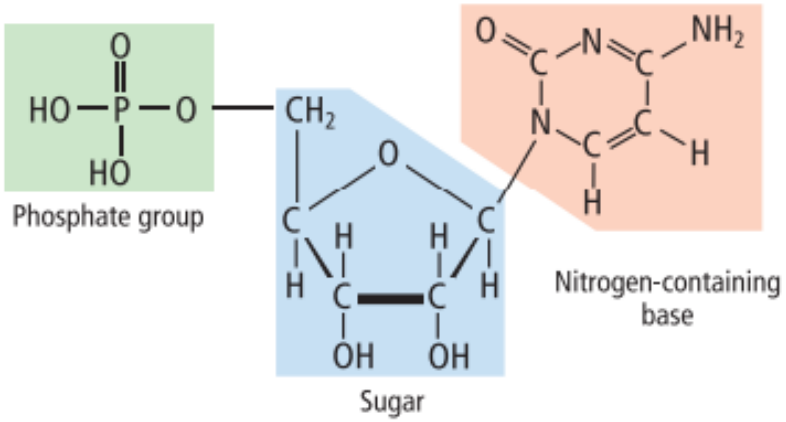
# Nucleic Acids

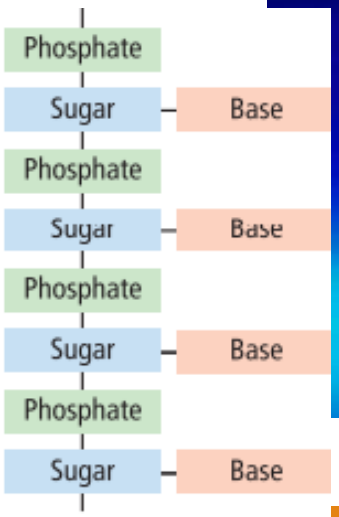
- **Elements:** CHONP- carbon, hydrogen, oxygen, nitrogen & phosphorus
- **Monomer: Nucleotide**

---

- **There are 2 types of nucleic acids:**
  - **RNA-** contains the **sugar ribose**
  - **DNA-** contains the **sugar deoxyribose**
- **Function**: **stores & transmits genetic information**





A nucleotide with three phosphate groups is adenosine triphosphate (ATP). It releases energy when the bond between the second and third phosphate group is broken.

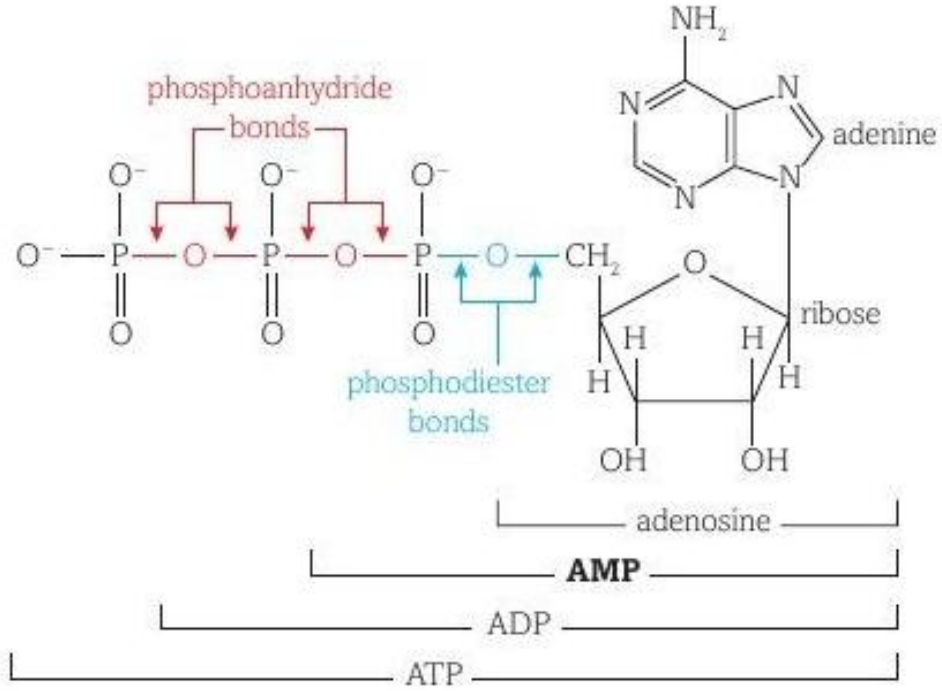
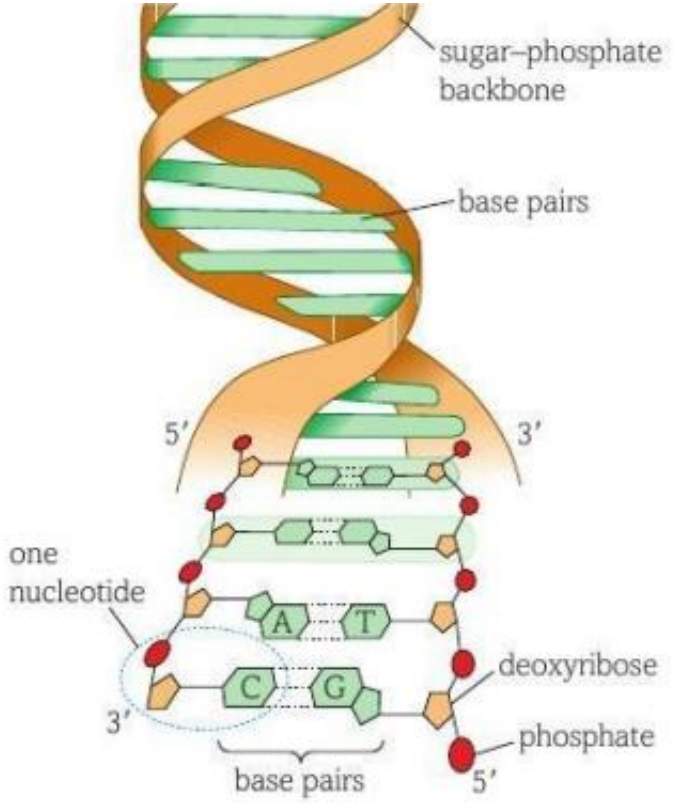
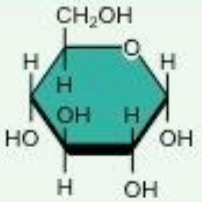
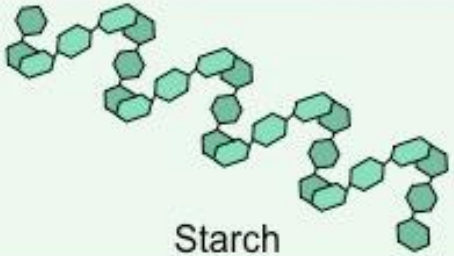
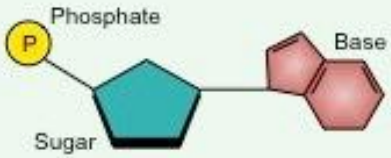
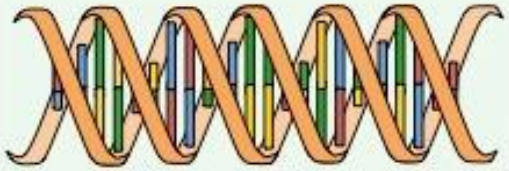
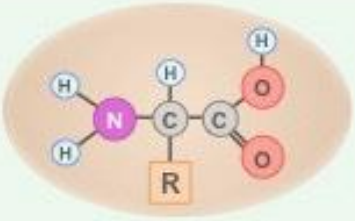
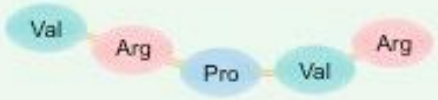
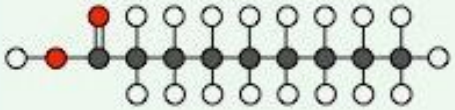
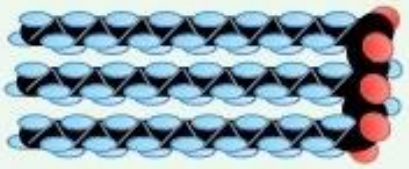
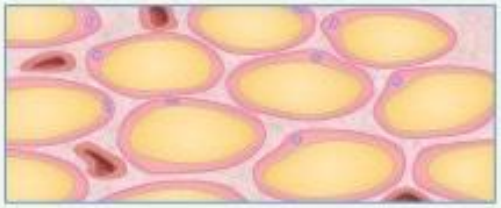
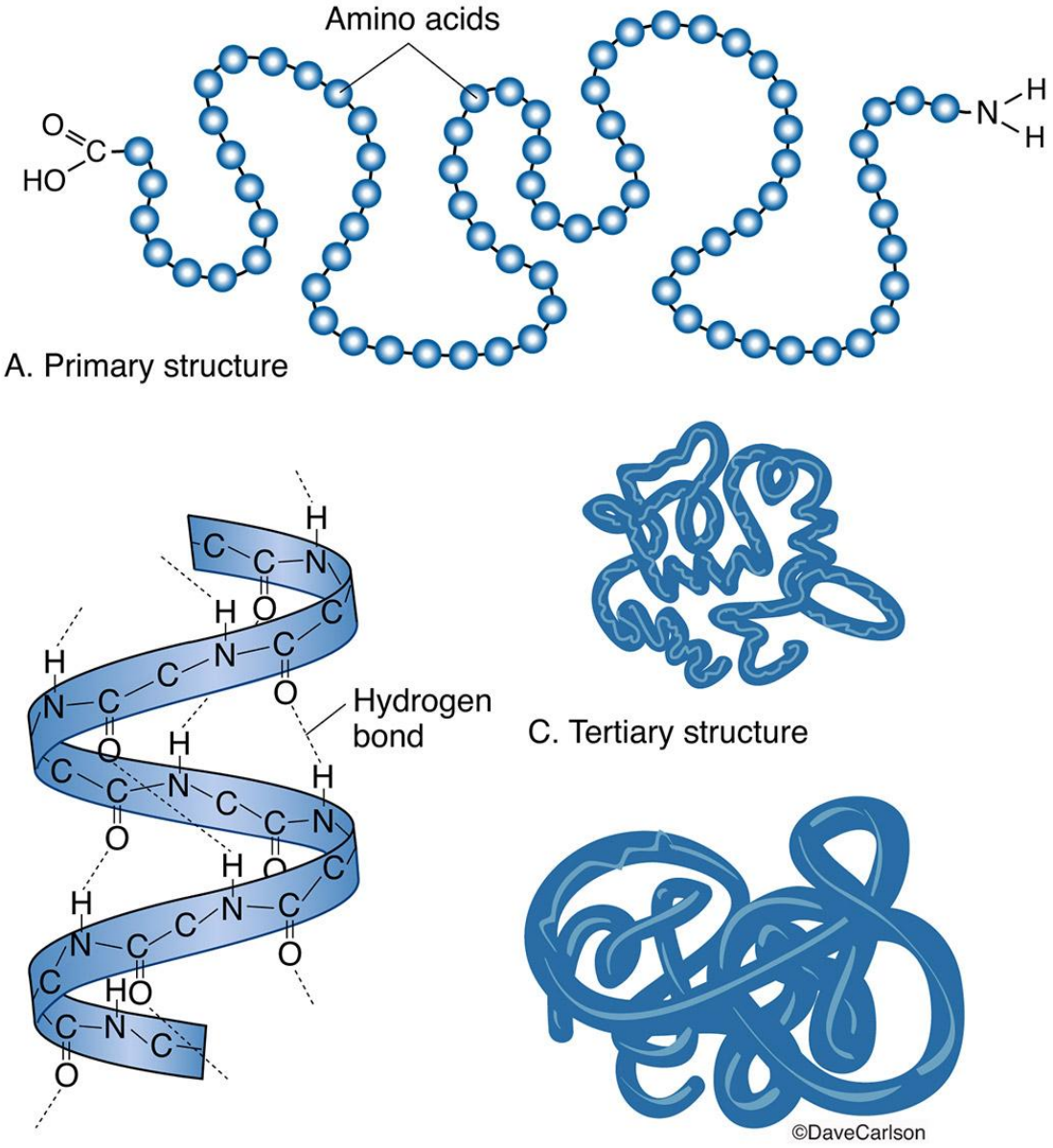



**Figure 2** The structure of ATP.

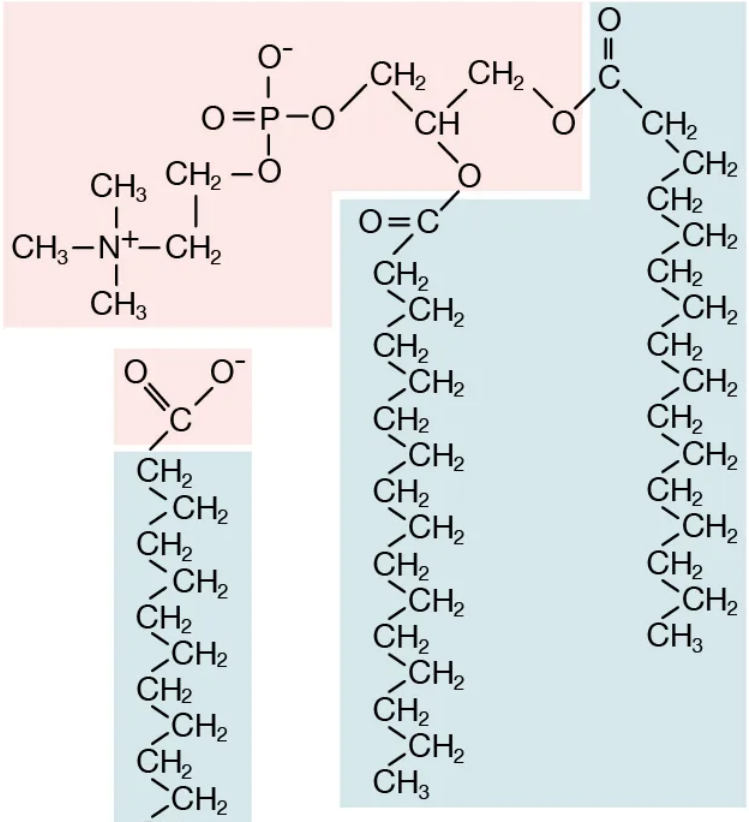


| | Monomer / Subunit | Polymer | Cellular Structure |
|---|---|---|---|
| Carbohydrate |   Monosaccharide |  Starch |  Granules in Chloroplasts |
| Nucleic Acid |   Nucleotide |  Double Helix (DNA) |  Chromosome |
| Protein |   Amino Acid |   Polypeptide |  Intermediate Filaments |
| Lipid |  Fatty Acid |  Triglyceride |  Adipose Cells |


Amino acids
A. Primary structure
Hydrogen bond
B. Secondary structure
C. Tertiary structure
D. Quaternary structure
©DaveCarlson

## structural formula

phospholipid (phosphatidylcholine)

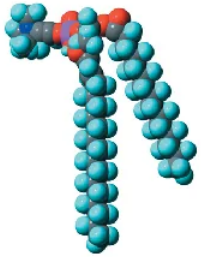


fatty acid (stearic acid)



## space-filling model

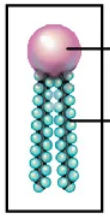
phospholipid molecule



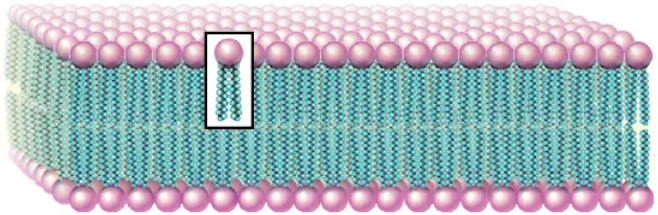
fatty acid molecule

## generic simplified depiction

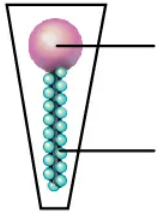
phospholipid molecule

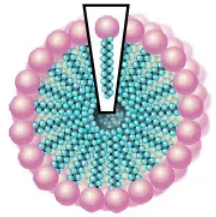



lipid bilayer

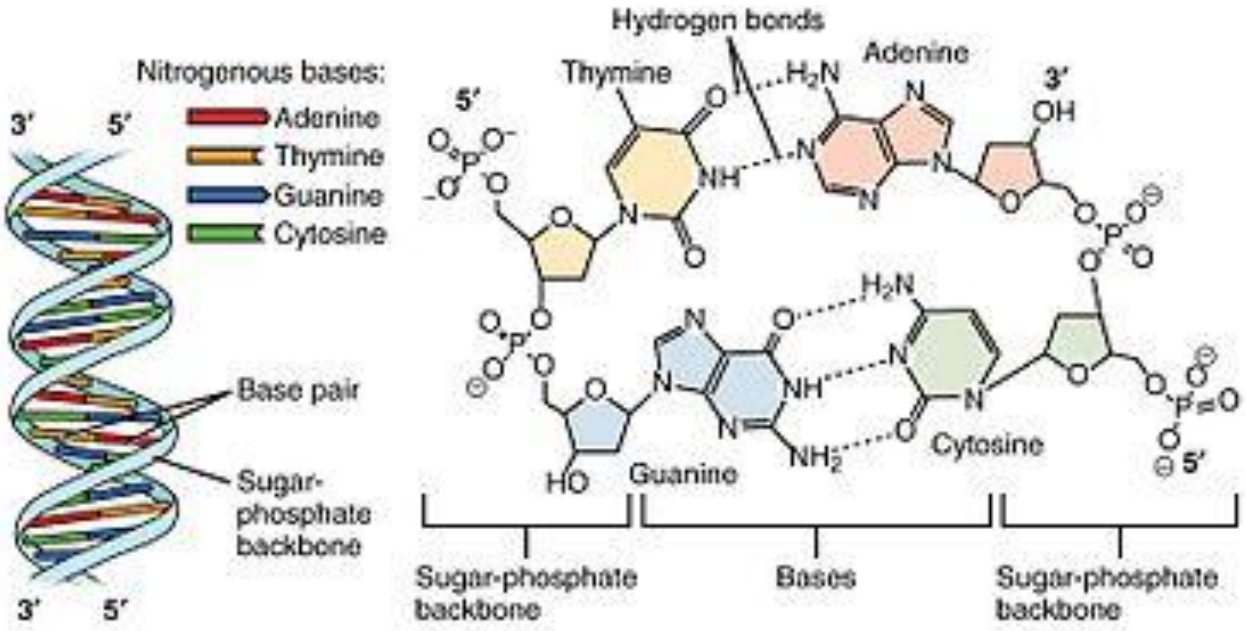


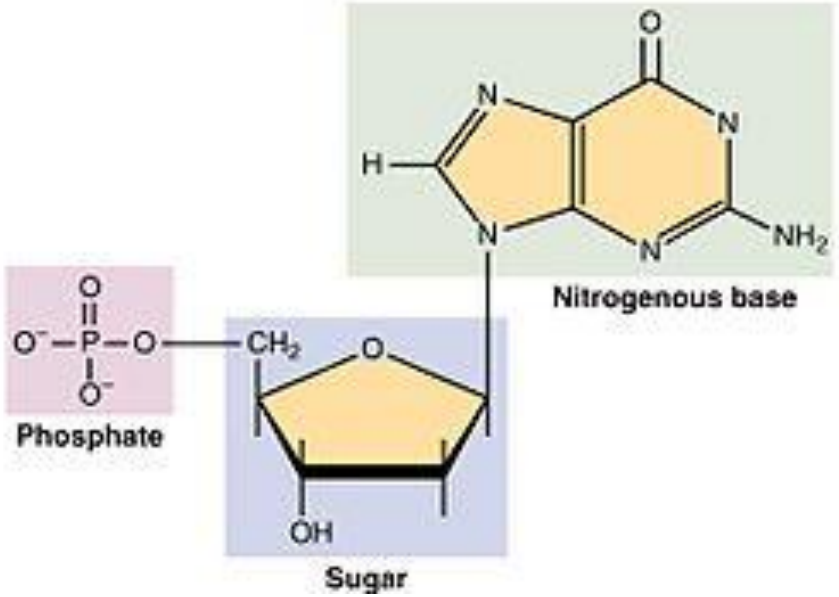
fatty acid molecule



micelle

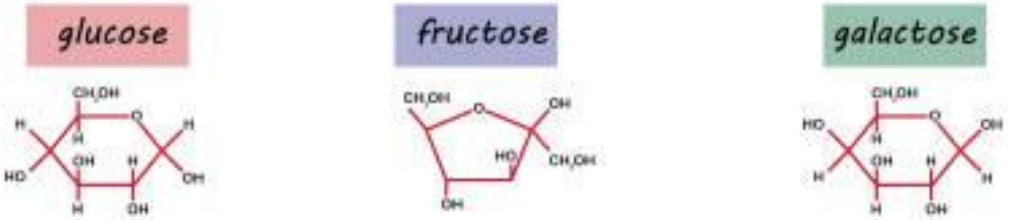

Nitrogenous bases:
Adenine
Thymine
Guanine
Cytosine
3′
5′
Base pair
Sugar-phosphate backbone
3′
5′
Hydrogen bonds
Thymine
Adenine
5′
3′
OH
Guanine
Cytosine
5′
Sugar-phosphate backbone
Bases
Sugar-phosphate backbone


Nitrogenous base
Phosphate
Sugar
OH

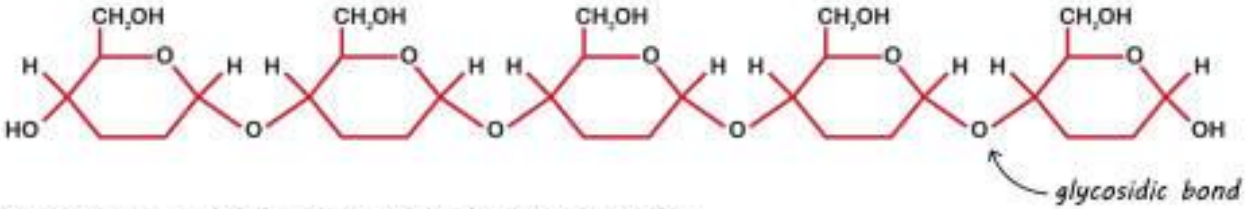
Biology

# Carbohydrate

- Carbohydrate is polymer, made from monosaccharide




- Monosaccharide link together by condensation to form polysaccharide




- Formation and function of polysaccharide