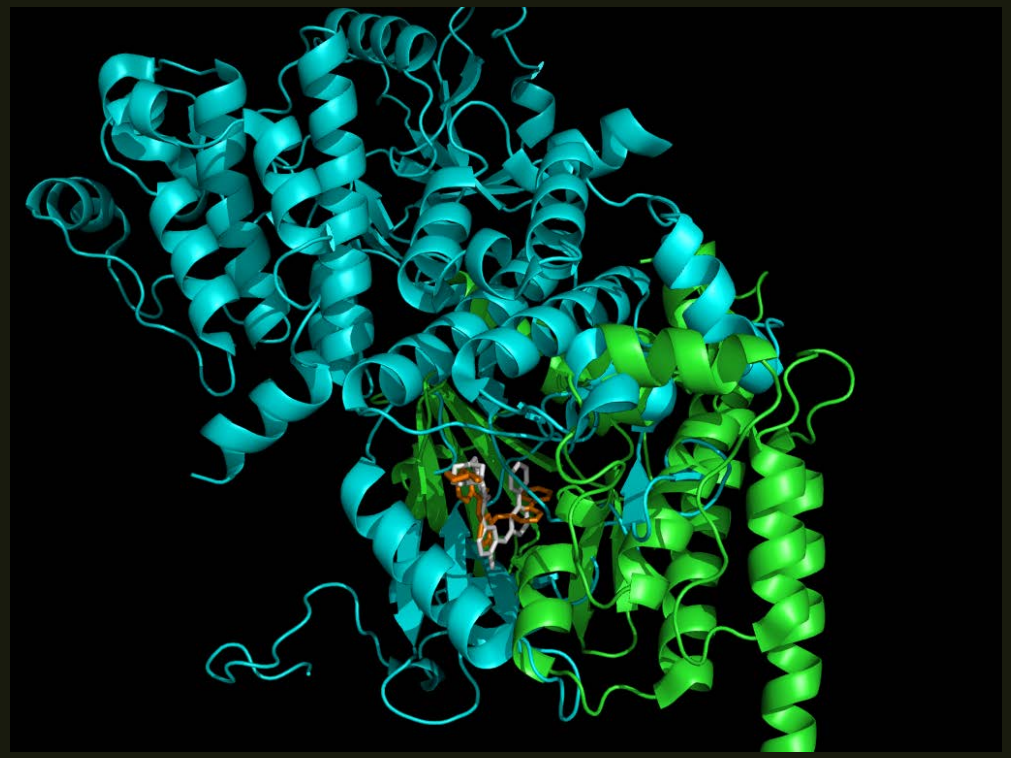


Chapter 3a

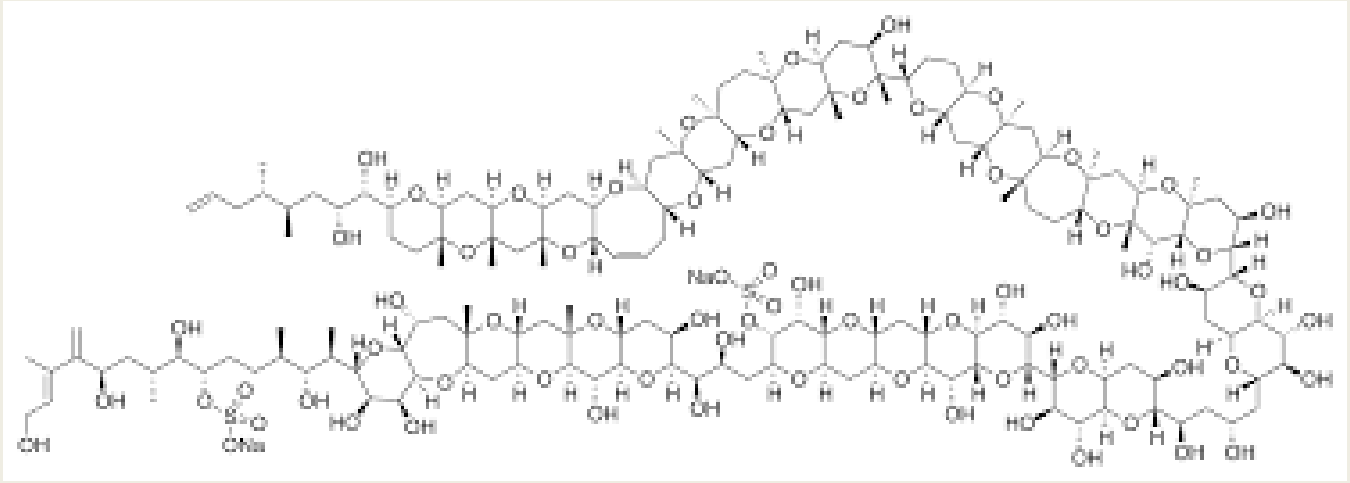
CARBON AND THE MOLECULAR DIVERSITY OF LIFE

You Must Know:

- The properties of carbon that make it so important.

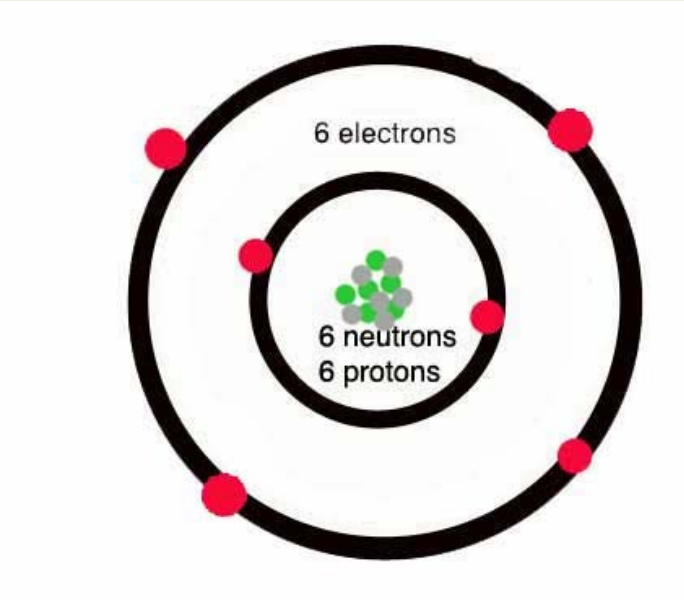
I. Importance of Carbon

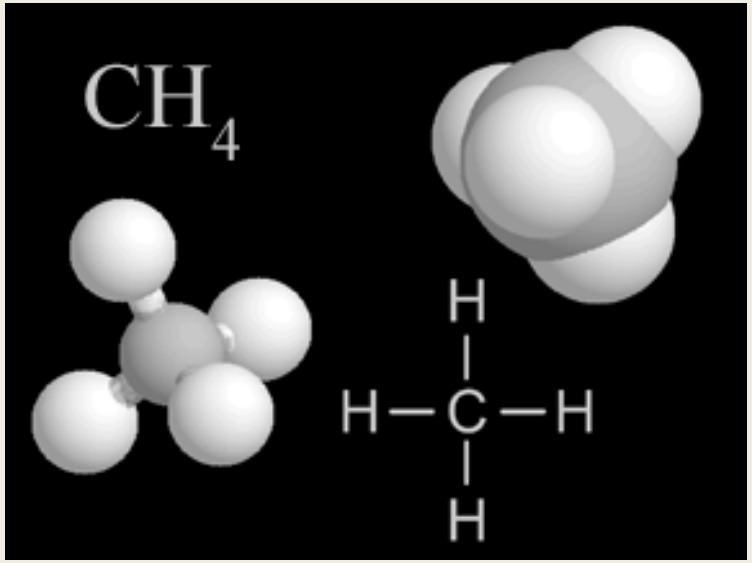
- **Organic chemistry**: branch of chemistry that specializes in study of carbon compounds
- **Organic compounds**: contain Carbon (& H)
- **Major elements of life**: CHNOPS
- Carbon can form large, complex, and diverse molecules



II. Diversity of Carbon

- It has 4 valence electrons **(tetravalence)**

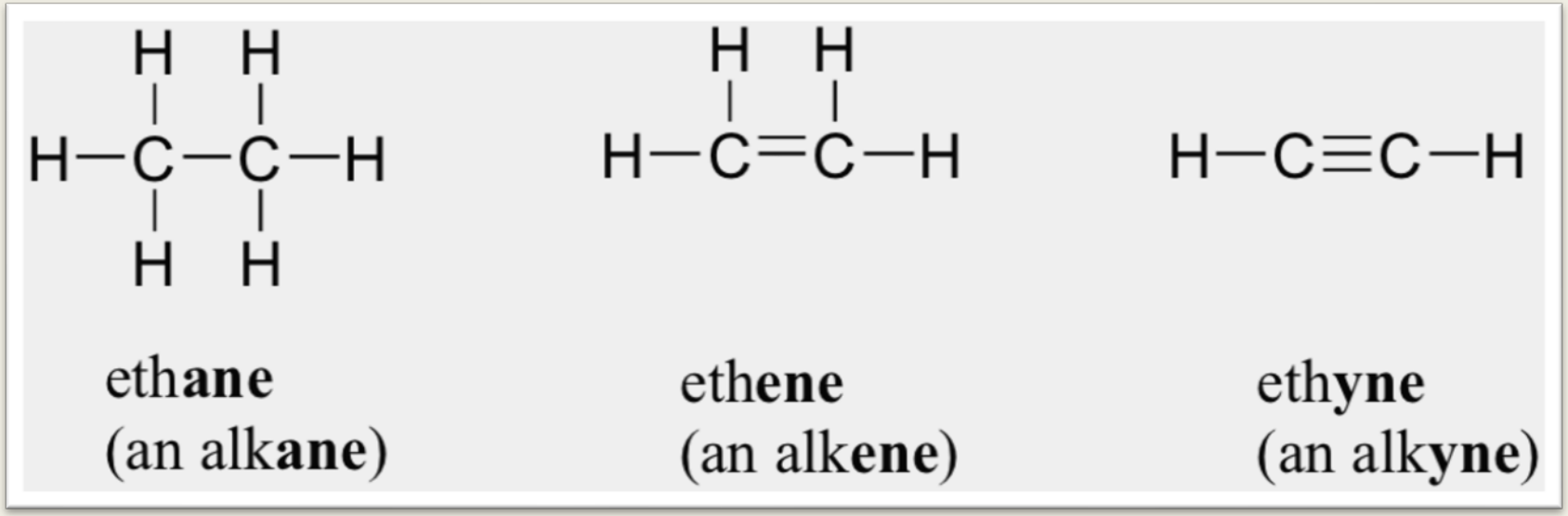




- It can form up to 4 covalent bonds
  - *Most frequent bonding partners: H, O, N*

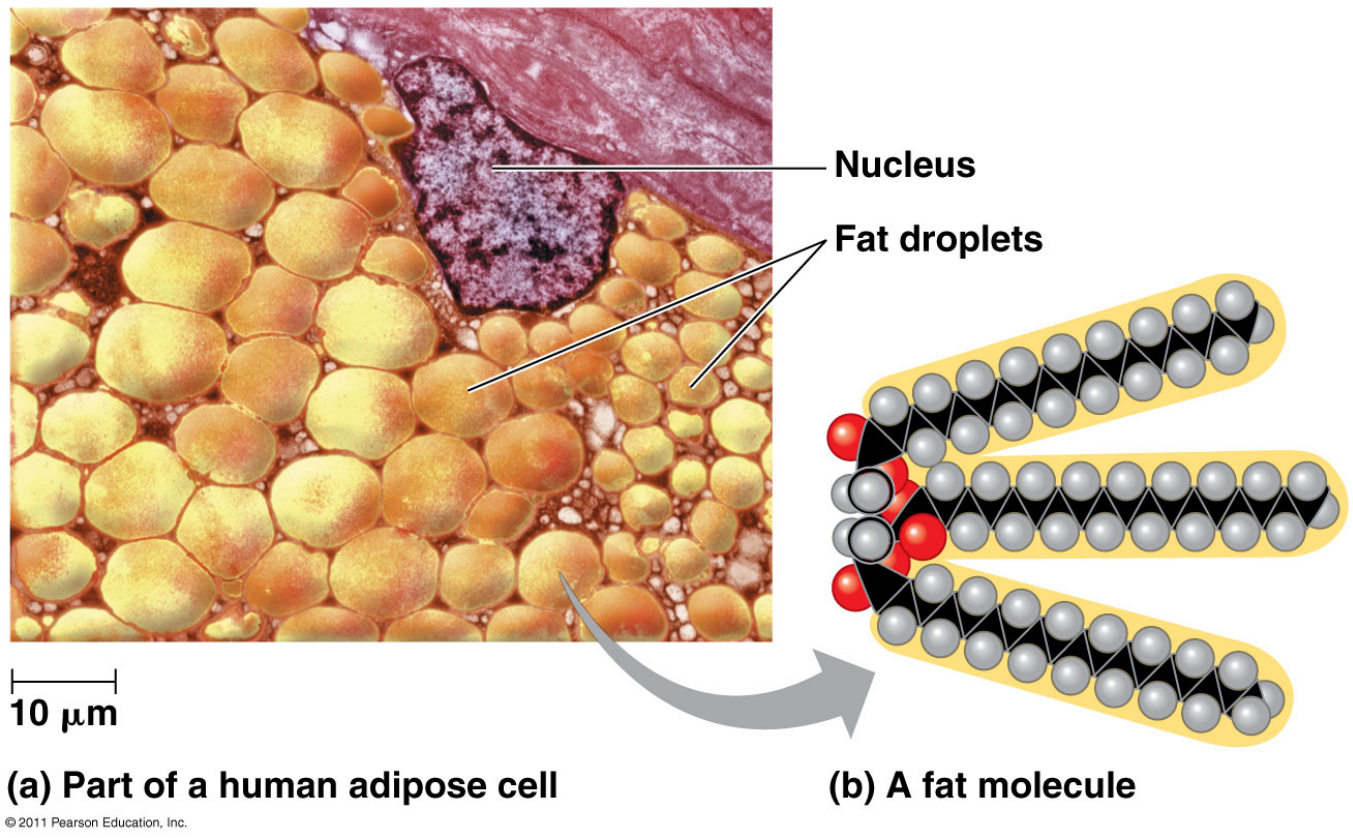
II. Diversity of Carbon

3. Bonds can be single, double, or triple covalent bonds.



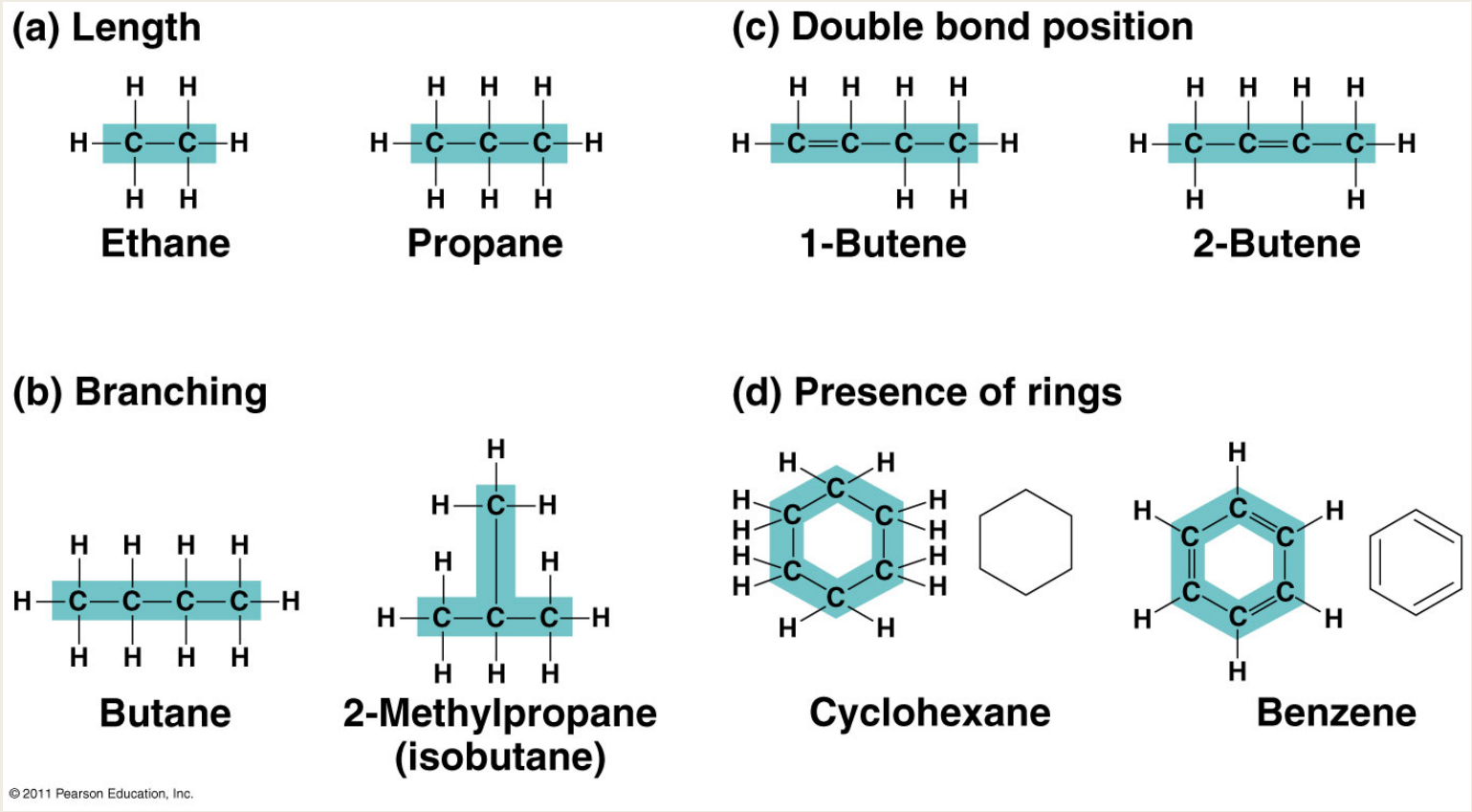
II. Diversity of Carbon

4. Carbon can form large molecules
   - *4 classes of **macromolecules**: carbohydrates, proteins, lipids, nucleic acids*



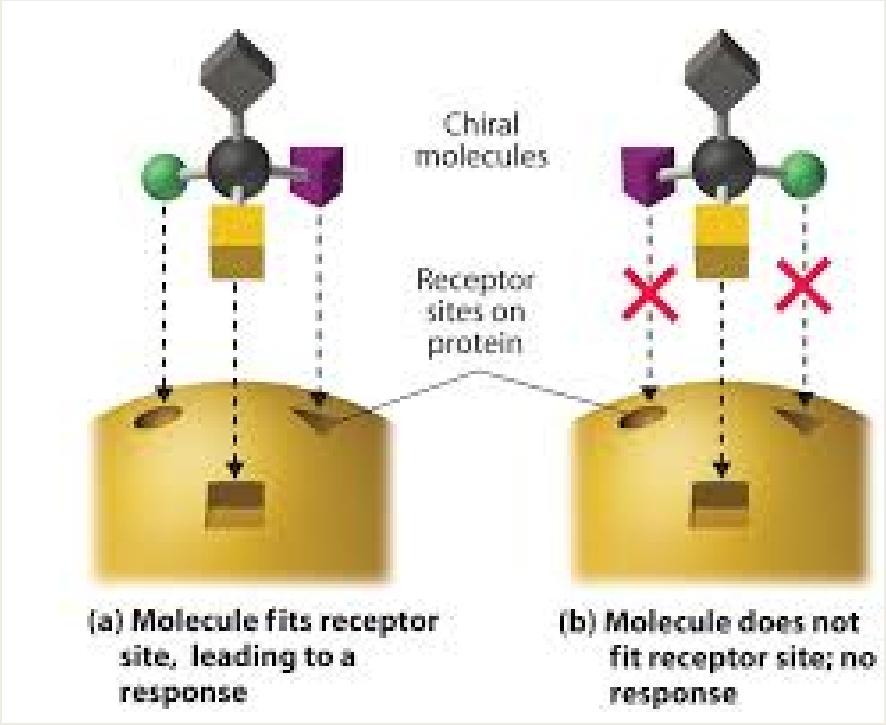
II. Diversity of Carbon

5. Molecules can be chains, ring-shaped, or branched

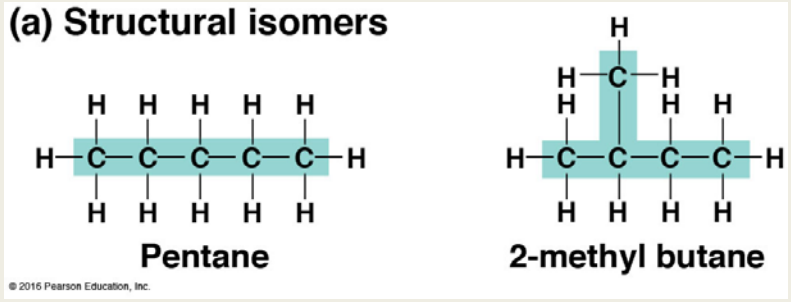


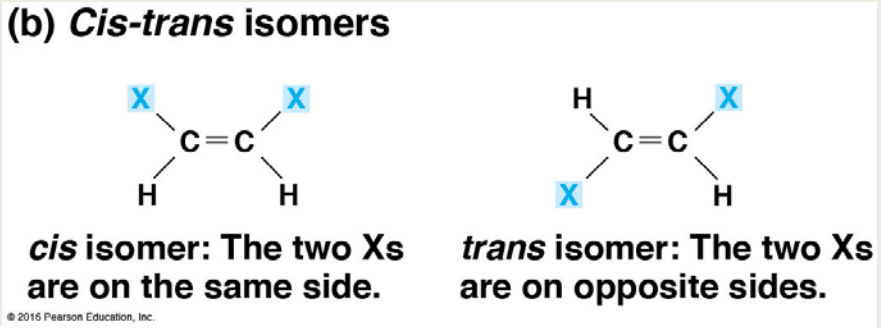
II. Diversity of Carbon

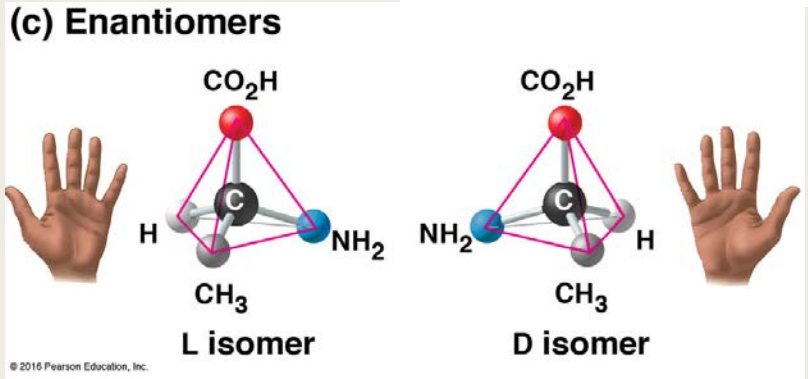
6. Forms **isomers**
   - *Molecules have same molecular formula, but differ in atom arrangement*
   - *different structures* → *different properties/functions*



Structural Isomer	Cis-Trans Isomer	Enantiomers
Varies in covalent arrangement	Differ in spatial arrangement	Mirror images of molecules







Drug manufacturing:

Thalidomide =

- *"good" enantiomer → reduce morning sickness*
- *"bad" enantiomer → cause birth defects*
- *"good" converts to "bad" in patient's body*
- *Now used to treat cancers, leprosy, HIV*

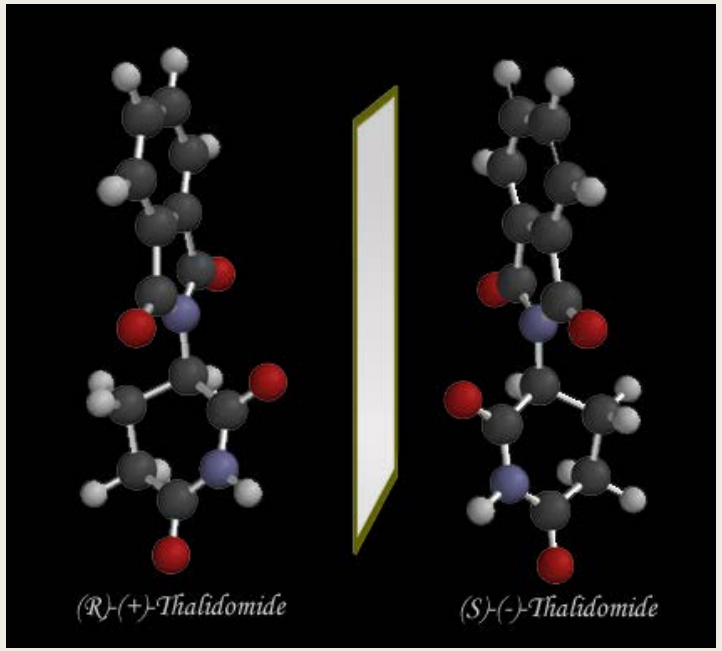
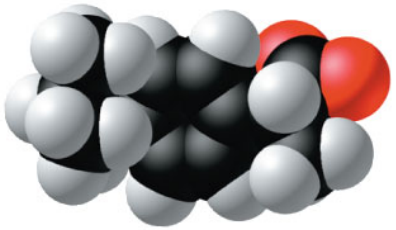
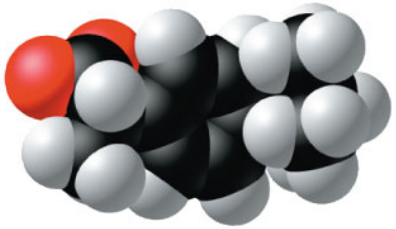
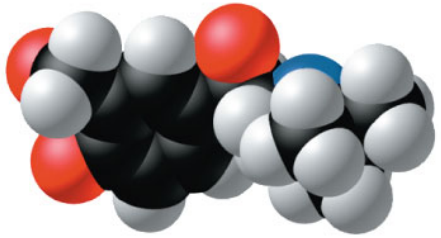
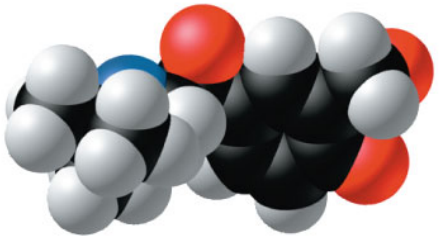
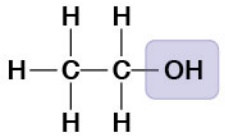
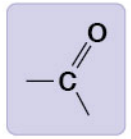
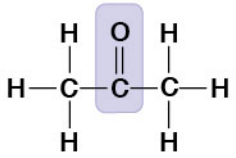
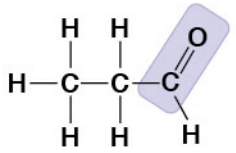
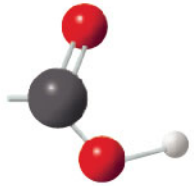
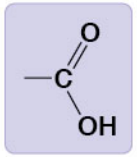
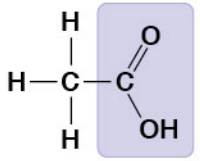
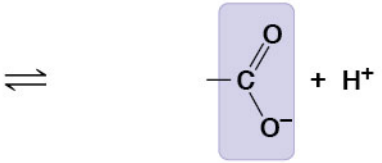
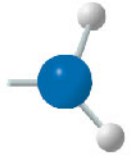
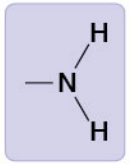
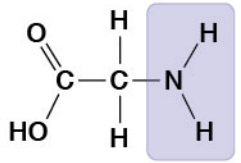
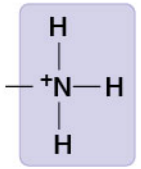


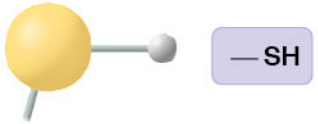
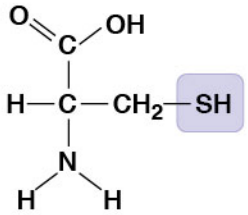
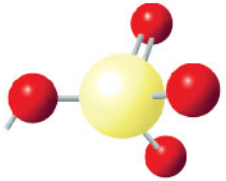
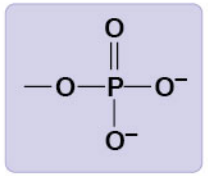
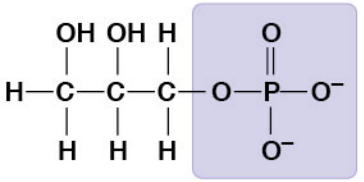
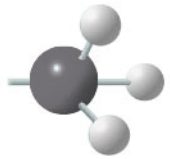
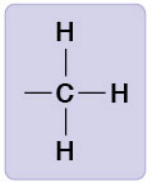
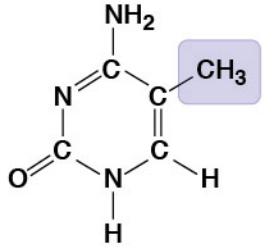
Fig. 4.8 The pharmacological importance of enantiomers

Drug	Condition	Effective Enantiomer	Ineffective Enantiomer
Ibuprofen	Pain; inflammation	 *S*-Ibuprofen	 *R*-Ibuprofen
Albuterol	Asthma	 *R*-Albuterol	 *S*-Albuterol

III. Functional Groups

- Behavior of organic molecules depends on functional groups
- Most common functional groups:
  - *Hydroxyl*
  - *Carbonyl*
  - *Carboxyl*
  - *Amino*
  - *Sulfhydryl*
  - *Phosphate*
  - *Methyl*

Chemical Group	Compound Name	Examples
Hydroxyl group (—OH)   (may be written HO—)	Alcohol	 Ethanol
Carbonyl group (>C=O)  	Ketone Aldehyde	 Acetone  Propanal
Carboxyl group (—COOH)  	Carboxylic acid, or organic acid	 Acetic acid  Ionized form of —COOH
Amino group ($—NH_2$)  	Amine	 Glycine  Ionized form of $—NH_2$

Chemical Group	Compound Name	Examples
Sulfhydryl group (—SH) 	Thiol	 Cysteine
Phosphate group ($-OPO_3^{2-}$)  	Organic phosphate	 Glycerol phosphate
Methyl group ($-CH_3$)  	Methylated compound	 5-Methyl cytosine