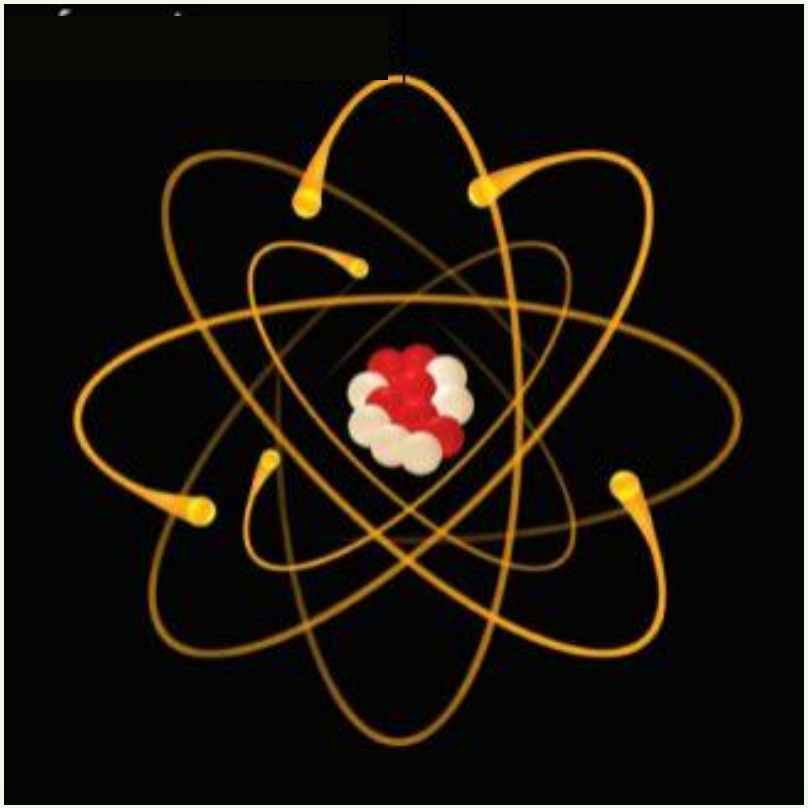
Chapter 4



Carbon &

The Molecular

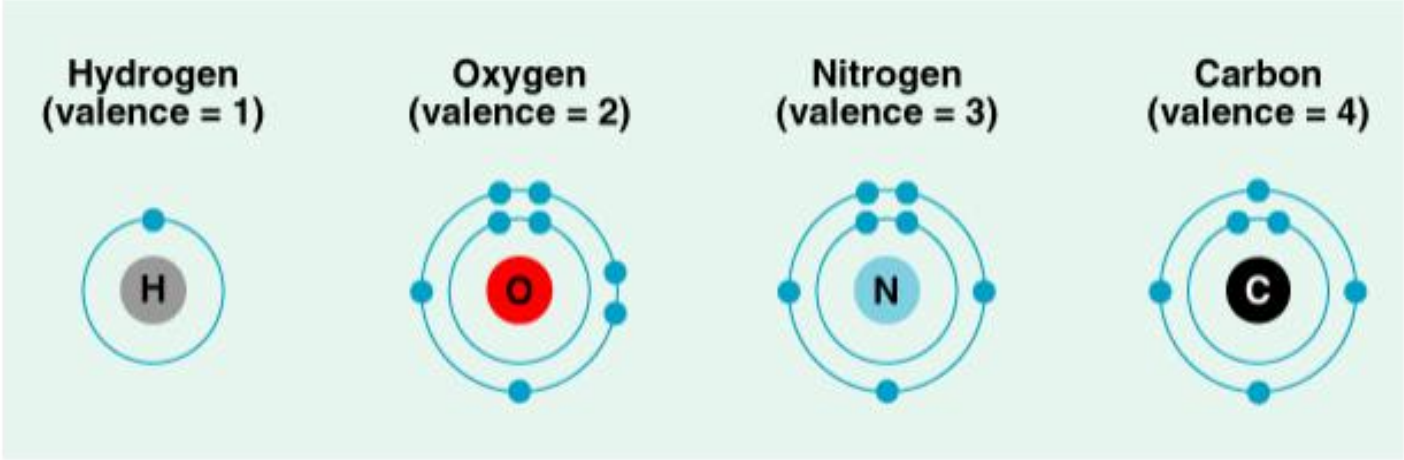
Diversity of Life

Essential Knowledge

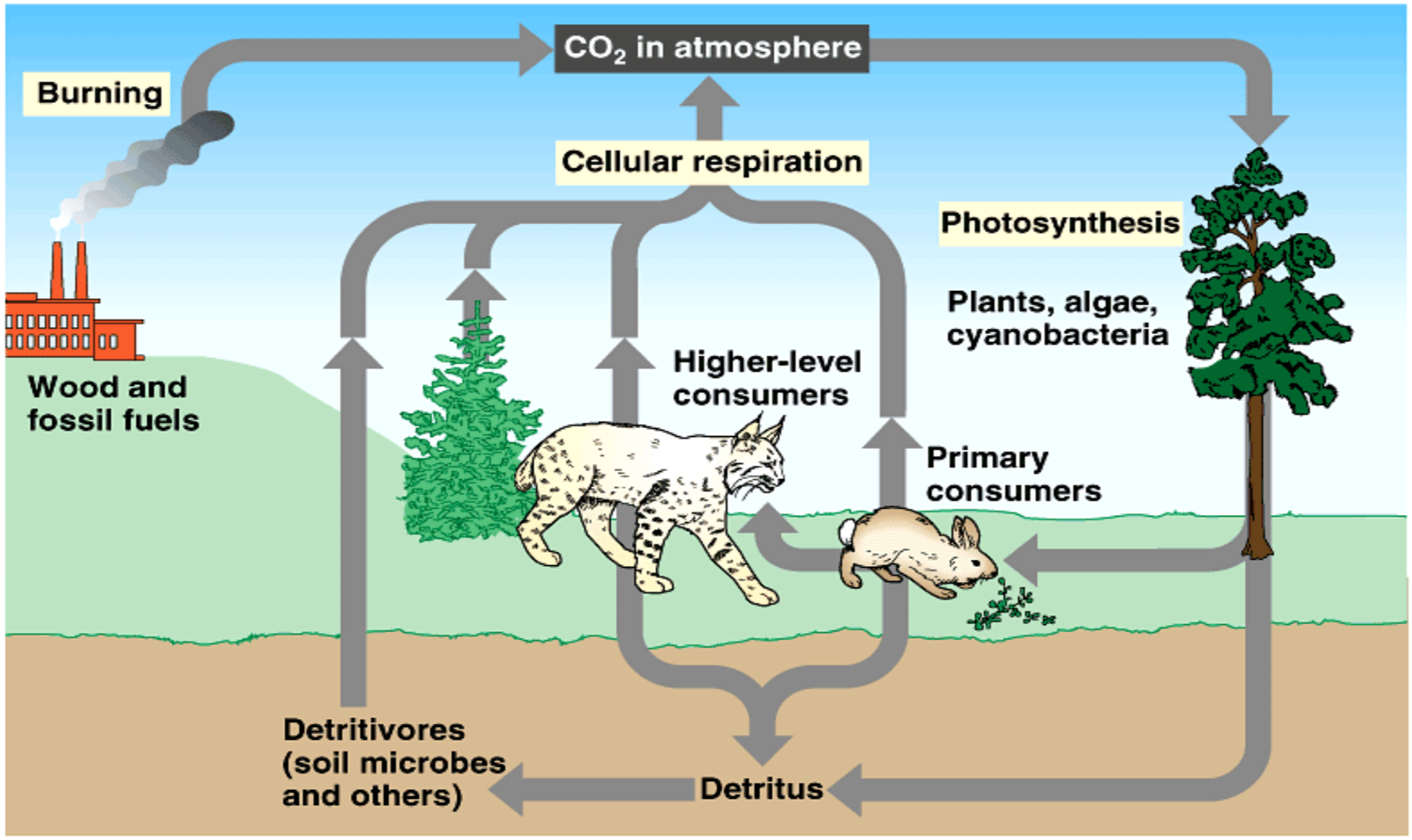
- 1.D.1 There are several hypotheses about the natural origin of life on Earth, each with supporting scientific evidence
- 2.A.3 Organisms must exchange matter with the environment to grow, reproduce and maintain organization

Organic chemistry

- **Carbon**
  - Basis for all life along with hydrogen
  - Cycles through the environment from the air as CO_2 to molecules of life in plants using solar energy
  - Finally, carbon is passed to animals as they feed on plants



Carbon Cycle



Organic Chemistry

- Carbon and Evolution
  - Organic molecules forming in the lab abiotically under conditions believed to have been found on early Earth
    - Miller and Urey
    - Hypothesized the Earth's atmosphere contained methane (CH_4), Ammonia (NH_3), Hydrogen

Carbon Structure

- 4 valence electrons
- Can form up to 4 covalent bonds
  - Single, double, or triple bonds
- Can form large molecules
  - In chains, rings, or branched

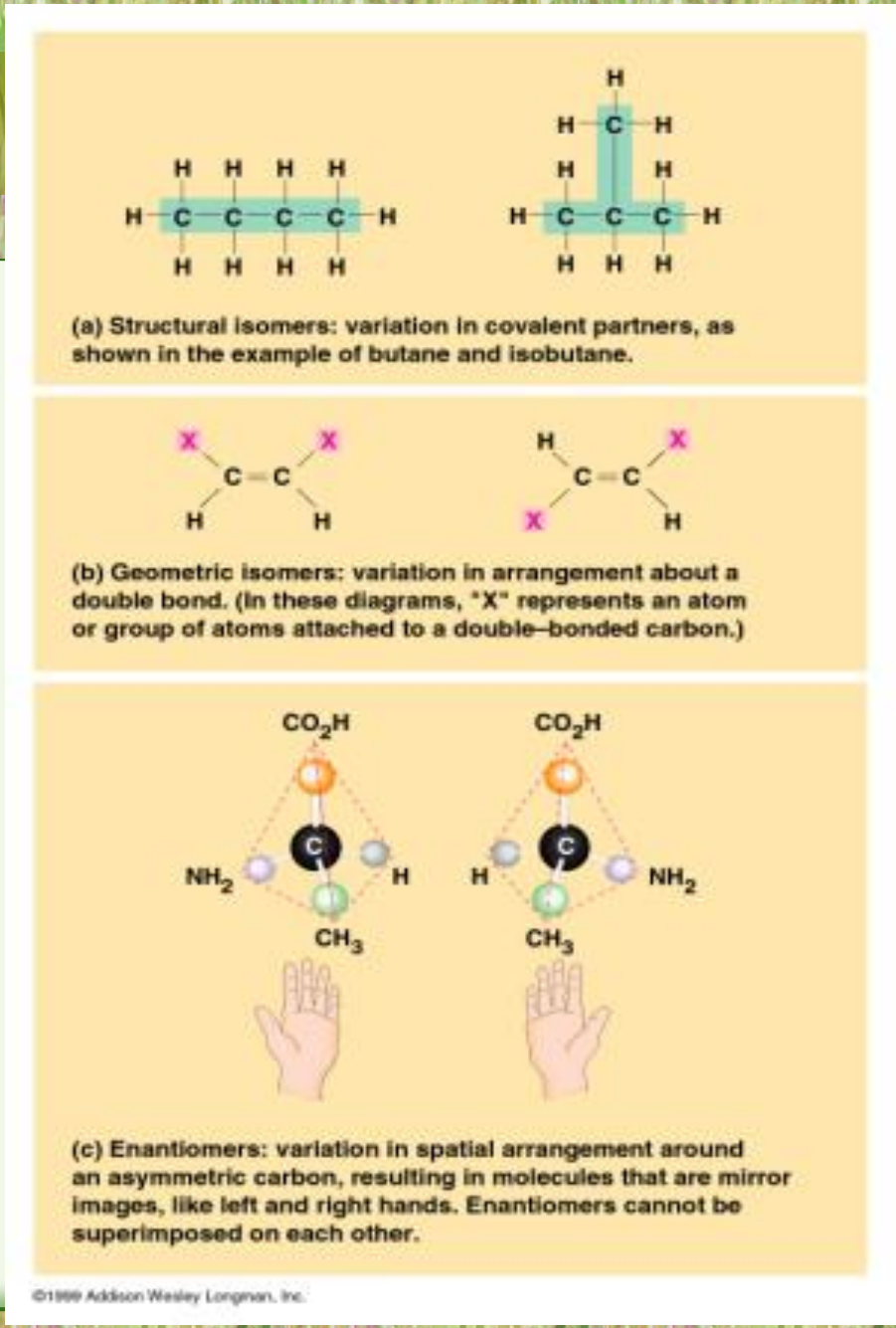
<u>Hydrocarbons</u>

- Only carbon & hydrogen (petroleum; lipid ‘tails’)
- Covalent bonding; nonpolar
- High energy storage

Isomers

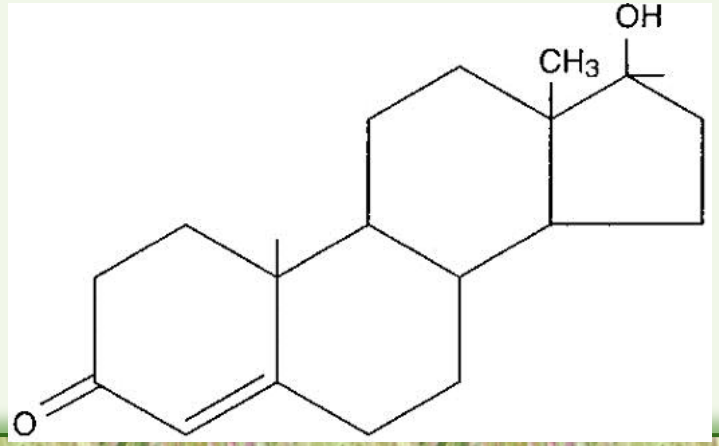
Isomers (same molecular formula, but different structure & properties)

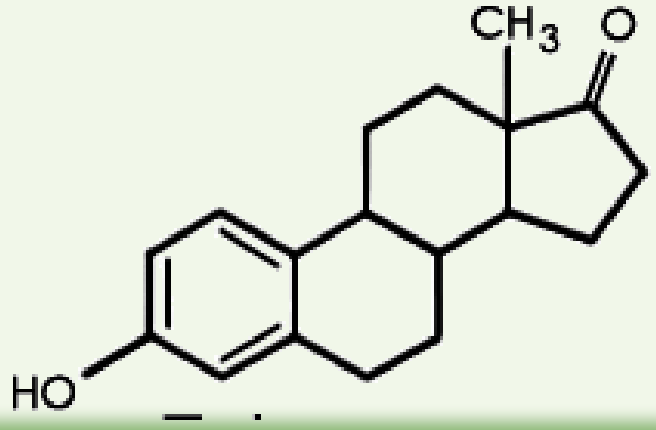
- **Structural** = differing covalent bonding arrangement
- **Geometric** = differing spatial arrangement
- **Enantiomers** = mirror images; pharmacological industry (thalidomide)



Functional Groups

- Functional Groups: chemical groups that affect molecular function by being directly involved in chemical reactions
  - Ex: Testosterone and estrogen are both steroids that have similar structures, but different arrangements of functional groups create different functions



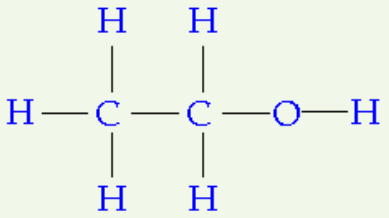


Functional Groups

- Attachments that replace one or more of the hydrogen bonded to the carbon skeleton of the hydrocarbon
- Each has a unique property from one organic to another
- Affects molecule's function in a reaction

- Hydroxyl Group

H bonded to O;
alcohols;
polar (oxygen);
soluble in water



- Carbonyl Group

C double bond to O;
At end of carbon skeleton: aldehyde
Within: ketone

Carbonyl	–C=O
Ketones	C=O
Aldehydes	–C=O, H

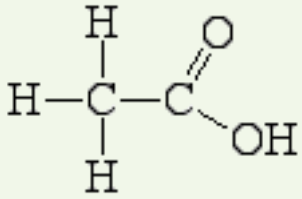
Functional Groups

- Carboxyl Group

  O double bonded to C to hydroxyl;

  carboxylic acids;

  acidic properties because covalent bond between O and H is so polar; dissociation of H ion

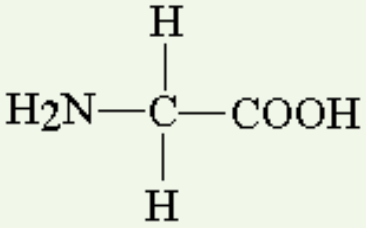


- Amino Group

  N to 2 H atoms;

  amines;

  acts as a base (+1)

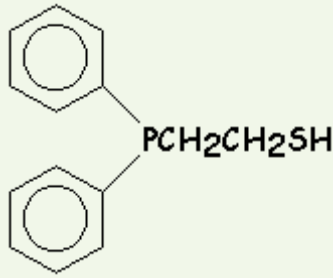


glycine

- Sulfhydral Group

  sulfur bonded to H; thiols

  helps stabilize protein structure



- Phosphate Group

  negative ion; covalently attached by 1 of its O to the C skeleton;

  releases energy