Chapter 4: Carbon

AP Biology 2011

1

Backbone of Molecules

- All living organisms are made up of chemicals based mostly on carbon
- Compounds based on carbon are called organic compounds
  - Can range from simple molecules like methane (CH_4) to complex proteins with masses in excess of 100,000 daltons
- Organic chemistry is the study of compounds that contain carbon

2

Synthesis of Organic Compounds

- Stanley Miller demonstrated abiotic synthesis of organic compounds
- Once thought that organic compounds could only be made by living things
- Proven now that under the right conditions, organic compounds can synthesize spontaneously

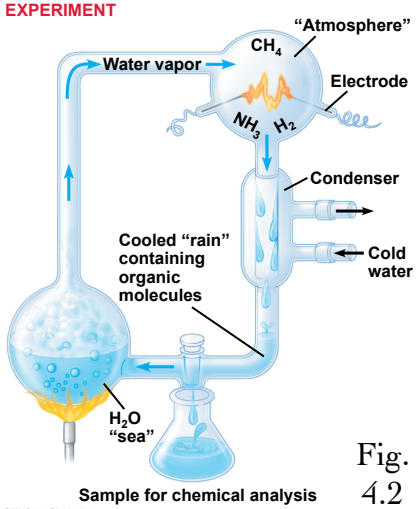


Fig. 4.2

3

Bonding

- Electron configuration is key to an atom's characteristics (determines the kinds and number of bonds an atom will form with other atoms)
- Carbon has 2 electrons in its first shell and 4 in its outer shell
- Because of this it can form 4 bonds (tetravalence)
- Bond angles 109.5°

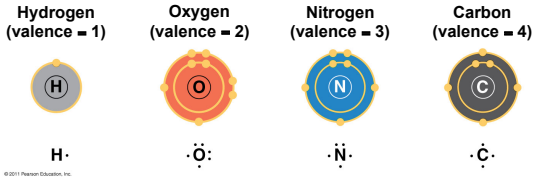
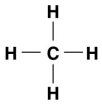
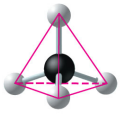
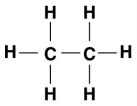
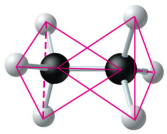
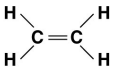
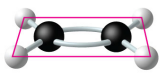


Fig. 4.4

4

Carbon Bonding Versatility

Name and Comment	Molecular Formula	Structural Formula	Ball-and-Stick Model	Space-Filling Model
(a) Methane	CH_4			
(b) Ethane	C_2H_6			
(c) Ethene (ethylene)	C_2H_4			

5

Variations in Carbon Chains

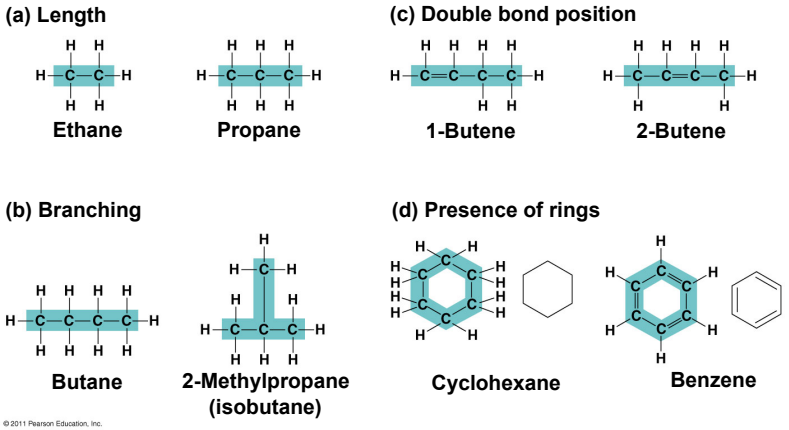


Fig. 4.5

6

Variations in Carbon Chains

- Hydrocarbons - organic molecules consisting of only carbon and hydrogen
  - Major component of petroleum
  - Major components of fats

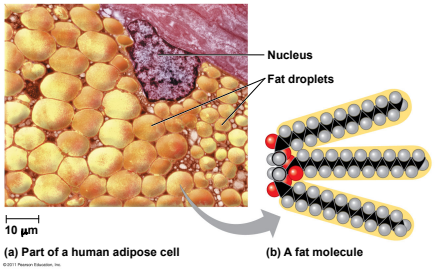
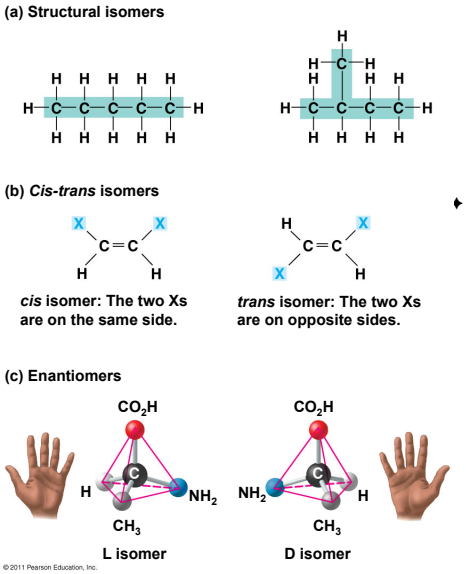


Fig. 4.6

7



Isomers

- Isomers - compounds that have the same numbers of atoms but different structures and different properties

Fig. 4.7

8

Enantiomers

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

Fig. 4.8

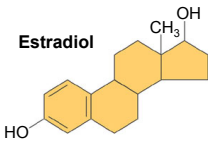
9

Functional Groups

- Functional groups are most important in chemistry of life
- Each functional group behaves the same regardless of which molecule it is on
- Give each molecule unique properties

Female lion

Male lion



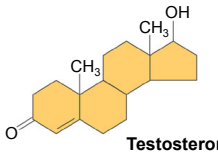


Fig. 4.9

10

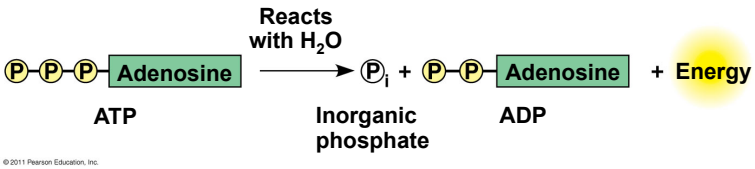
Six Key Functional Groups

- Hydroxyl
- Carbonyl
- Carboxyl
- Amino
- Sulfhydryl
- Phosphate
- Methyl

11

ATP

- Source of energy in cellular processes
- Adenosine triphosphate
- Consists of:
  - Adenosine (organic molecule)
  - Three phosphates
- Energy released by stripping a phosphate to become ADP



12