

I. **Organic substances** are molecules that have C atoms bound to other atoms to form the backbone of the molecule

A. C in organic molecules may be bound to C or to other elements

1. Often have long chains of C—C bonds
 - a. Also commonly forms bonds with **H, O, N, S,** and **P**
2. Very simple C compounds are not considered organic
 - a. Ex, CO₂, H₂CO₃

B. Properties of C make organic molecules very diverse

1. Has 4 e⁻ in its valence shell
 - a. Can form 4 covalent bonds to fill its shell
 - i. Contrast to O
 - Has 6 valence e⁻
 - Can only form 2 covalent bonds
2. C—C bonds are very strong
 - a. Excellent for forming backbone of long molecules
$$\text{C—C—C—C—C—C—C...}$$
3. Covalent bonds between C atoms can be single, double, or triple
 - a. Share 1, 2, or 3 pairs of e⁻, respectively
 - ii. Triple bonds not common in biology
4. Covalent bonds between C atoms can be flexible or stiff
 - a. Single bonds can rotate
 - i. Very flexible
 - ii. Good for long molecules

- b. Double and triple bonds are stiff
 - i. Cannot rotate
 - ii. Can give shape
- C. Placement of bonds is very important
 - 1. **Isomers** – molecules with same atoms in different arrangements
 - a. Same molecular formula, different structural formulas
 - b. Slight structural changes can have large effects in chemical, physical, and biological properties
 - 2. Different types of isomers
 - a. **Structural isomers** – same atoms, different bond partners
 - i. Ex, C_2H_6O can be ethanol or dimethyl ether
 - b. **Geometric isomers** – same atoms, same bond partners
 - i. Different arrangement of atoms around a central double bond
 - ii. Has *cis*- and *trans*- forms
 - Ex, *cis*- and *trans*- fats
 - c. **Enantiomers** – mirror image isomers
 - i. Only occur when a C has 4 different atoms bound
 - ii. Result from 3D shape of carbon compounds
- D. **Functional groups** – side groups attached to the backbone of an organic molecule
 - 1. Determines behavior of the molecule
 - a. Can make a molecule hydrophobic or hydrophilic
 - b. Can determine physical state of molecule at a given temp. (solid, liquid, or gas)
 - 2. Usually written as **R—side chain**

a. **R-** means remainder

i. Shorthand so you don't have to draw out the whole molecule when only talking about part of it

b. Sometimes R- can be backbone, sometimes R- can be side chain

i. Just shows that something is attached to atoms of interest

3. Important functional groups

a. Polar side chains – make molecules more hydrophilic

i. **R—OH** – hydroxyl group.

ii. **R—COOH** – carboxyl group

- Weakly acidic

- Found in amino acids

iii. **R—COR'** – carbonyl group

- May be a ketone or aldehyde

iv. **R—NH₂** – amine group

- Weakly basic

- Found in amino acids

v. **R—PO₄** – phosphate group

- Several may be strung together in high energy bonds

- Found in phospholipids, nucleic acids, ATP, etc.

b. Nonpolar side chains – make molecules more hydrophobic

i. **R—CH₃** – methyl group

III. Many important biological molecules are **macromolecules**

A. Macromolecules are polymers *

1. **Polymers** are large molecules made of repeating smaller subunits