The Chemistry of Life: Organic Compounds Notes
Mrs. Laux AP Biology

I. Carbon atoms form an enormous variety of structures

A. Carbon has 4 valence electrons in the outer shell and therefore may form up to 4 covalent bonds

B. Carbon tends to bond to C, H, O, N, S, and P (sponch-handy mnemonic)

1. can form large, complex molecules

a. hydrocarbons→compounds that contain H and C

i. highly explosive gases like propane

ii. with O_2, give off energy

b. prefixes

1 C – meth	**2 C – eth**
3 C – pro	**4 C – but**
5 C – pent	**6 C – hex**
7 C – hept	**8 C - oct**

c. suffixes (add formulae)

i. single bonds -ane

ii. double bonds -ene

iii. triple bonds -yne

iv. cyclic (benzene)

2. HONC

a. H-1 bond

b. O-2 bonds

c. N-3 bonds

d. C-4 bonds

3. C-H bonding is non-polar; therefore, whole chains are non- polar; hide from water (hydrophobic); non-reactive

C. Single bonds between carbon molecules allow rotation and flexibility of the molecule

II. Isomers have the same molecular formula, but different structures

A. Structural isomers differ in the arrangement of the covalent bonds

Ethanol	**Dimethyl ether**

B. Geometric isomers vary in the arrangement of groups around the double bond

Trans-2-butene (across)	Cis-2-butene (same side)

C. Enantiomers are mirror images of each other

Glyceraldehyde	Glyceraldehyde

→pharmaceutical industry issues with enantiomers-put notes here

III. Functional groups (clusters of atoms) change the properties of organic molecules

→each group has specific chemical and physical properties

-usually reactive parts

-behave consistently from 1 molecule to another

-determine unique chemical properties

A. A hydroxyl group (R-OH) is polar

-oxygen more electronegative than hydrogen

-not a base

-water soluble (hydrophilic)

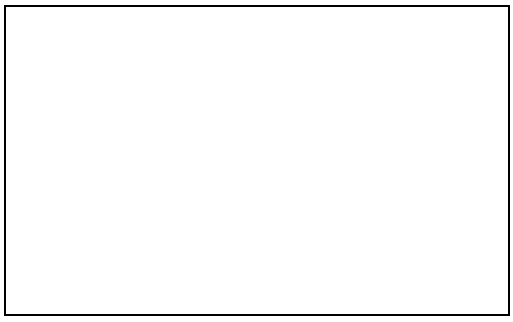
exs: alcohols: methanol, ethanol, glycerol, sugars

B. A carbonyl group (C=O) is polar

-water soluble, O more electronegative than H, hydrophilic

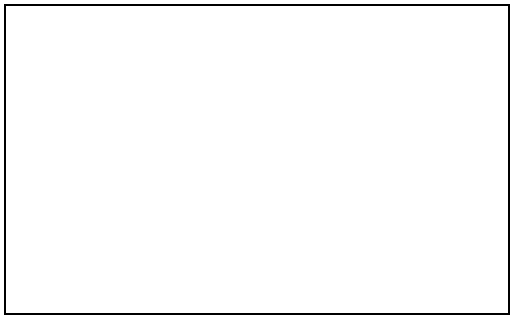
1. Aldehydes (end of C skeleton)

Exs: glyceraldehydes, formaldehyde, propanol, sugars - glucose, galactose (aldoses)



2. Ketones-found on any other C than an end C

exs: acetone, sugar-fructose (ketoses)



C. A carboxyl group (R-COOH) is weakly acidic, and is an important part of amino acids

-polar

-water soluble

-hydrophilic
Exs: carboxylic acids (organic acids), acetic acid ($C_2H_4O_2$ or CH_3COOH), amino acids, fatty acids, sugars

Ionized (prevails in cells)
Non-ionized

D. Amino groups (R-NH_2) are weakly basic, and are an important part of amino acids
-polar, soluble in water, hydrophilic, N is electronegative
-can accept H ions, giving amino group a +1 charge
Exs.: amines, glycine, amino acids

Ionized (prevails in cells)
Non-ionized

E. Phosphate groups (R-PO_4H_2) are parts of phospholipids and nucleic acids

Exs: organic phosphates, glycerol phosphate

-highly polar, soluble

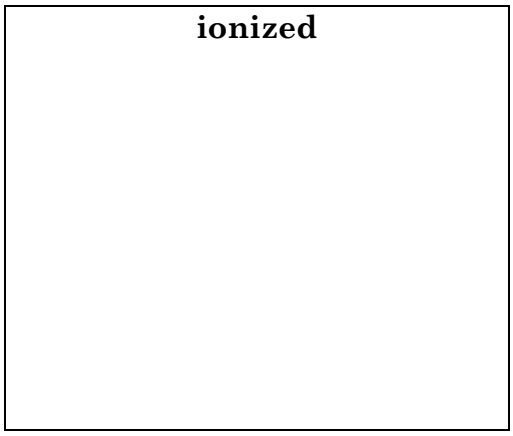
-dissociates from H3PO4 (phosphoric acid)

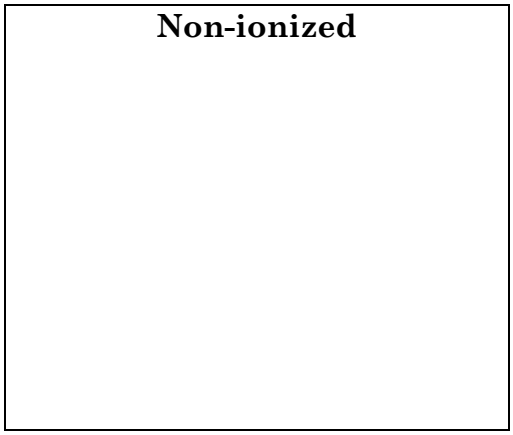
-important in cellular energy storage-ATP

-really negative

-takes lots of energy to hold those – charges so close together

-when high energy bonds broken, lots of energy released





F. Sulfhydryl groups (R-SH) are important in some amino acids

Exs: organic compounds-thiols, ethanethiol

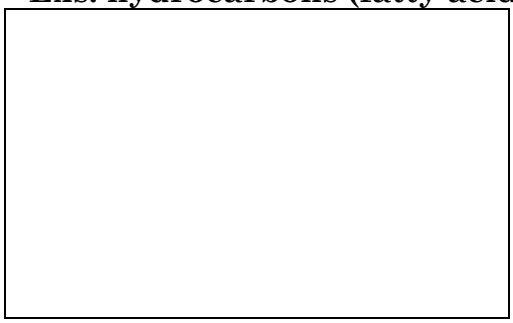
-polar, water soluble

-helps stabilize structures of proteins through disulfide bridges

-strongest interaction in protein configuration

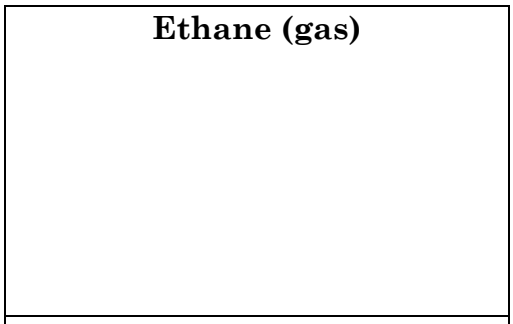
-considered permanent, unless enzyme powers reaction to break them

G. Methyl groups (R-CH_3) are non-polar, hydrophobic
Exs: hydrocarbons (fatty acids, oils, waxes)

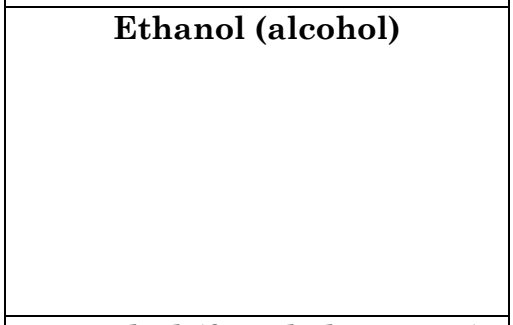


Functional groups can change molecules drastically
Exs:

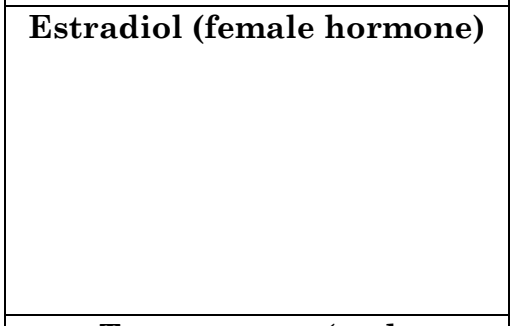
Ethane (gas)



Ethanol (alcohol)



Estradiol (female hormone)



Testosterone (male hormone)

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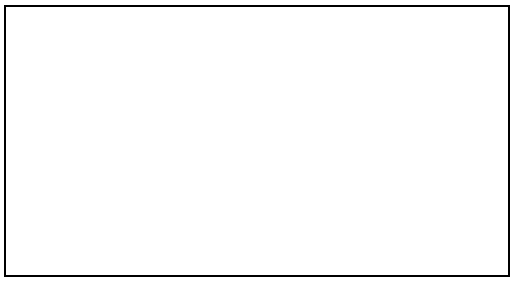

IV. Many biological molecules are polymers
- **A. Polymers are based on repeating subunits (monomers)**
- **B. Monomers are linked by condensation reactions; also called polymerization or dehydration reactions**
- **C. Polymers are degraded by hydrolysis reactions**

V. Carbohydrates include sugars, starches, and cellulose
- **A. Monosaccharides are simple sugars**
  - **1. glucose, fructose, and galactose are hexoses**
    - **a. Glucose is extremely abundant and important, particularly as an energy source**
    - **b. the hexoses form ring structures**
  - **2. deoxyribose and ribose are pentoses**
- **B. Disaccharides consist of two monosaccharide units**
  - **1. Maltose, lactose, and sucrose are disaccharides**
- **C. Polysaccharides can store energy or provide structure**
  - **1. Starch is the main storage carbohydrate of plants**
    - **a. starch is a polymer of alpha-glucose**
    - **b. amylose is an unbranched starch**
    - **c. amylopectin is a branched chain, and is more common**
    - **d. plants store starch in plastids**
  - **2. Glycogen is the main storage carbohydrate of animals**
    - **a. Glycogen is primarily stored in liver and muscle cells**
  - **3. Cellulose is a structural carbohydrate**
    - **a. Cellulose is a glucose polymer that composes cell walls**
  - **4. Most organisms cannot digest cellulose**
- **D. Some modified and complex carbohydrates have special roles**
  - **1. Glucosamine makes up chitin-important in arthropods and fungal cell walls**
  - **2. Galactosamine is a component of cartilage**
  - **3. Glycoproteins and glycolipids are important molecules of the plasma membrane**

VI. Lipids are fats or fatlike substances mmmm…..butter

A. Fats are hydrophobic and are composed primarily of hydrogen and oxygen
B. Triglycerols contain glycerol and fatty acids
1. Triglycerols are the most abundant lipids
2. Fats are an important source of energy
3. Triglycerols are composed of a glycerol head with up to 3 fatty acid chains attached
a. Saturated fats have no double bonds in the fatty acid chains
i. saturated fats are typically solid at room temperature
ii. saturated fats are often from animal sources
b. Unsaturated fats have one or more double bonds in the fatty acid chains
i. unsaturated fats are typically liquid at room temperature
ii. unsaturated fats are more healthy than saturated fats, but still 100% fat!!!
C. Phospholipids are components of cell membranes
1. Phospholipids are amphipathic (hydrophobic end and hydrophilic end in the same molecule
D. Steroids contain four rings of carbon atoms
1. Steroids include cholesterol, bile salts, and hormones such as estradiol and testosterone
VII. Proteins are macromolecules formed from amino acids
A. Amino acids are the subunits of proteins
1. Amino acids contain an amino group, a carboxyl group, an alpha carbon, and a unique R group
2. There are 20 commonly occurring amino acids
3. Essential amino acids are those that must be ingested in the diet
B. Peptide bonds join amino acids
1. Two amino acids form a dipeptide
2. Polypeptides are formed from more than 2 amino acids
C. Proteins have 4 levels of organization
1. Primary structure is the amino acid sequence
2. Secondary structure results from hydrogen bonding
a. The alpha helix is a coiled secondary structure
b. The beta-pleated sheet is formed by folding
c. A single polypeptide may have portions with both types of structure
3. Tertiary structure depends on interactions among side chains

a. R-groups interact in various ways

D. The amino acid sequence of a protein determines its conformation

E. Protein conformation determines function

1. Denaturation results in disruption of the secondary, tertiary, or quaternary structure of a protein

2. Denaturation may be due to changes in pH, temperature, or various chemicals

VIII. DNA and RNA are nucleic acids

A. Nucleic acids consist of nucleotide subunits

1. Nucleotides are composed to a pentose, a phosphate group, and a nitrogenous compound

B. Some nucleotides are important in energy transfers and other cellular function

1. ATP is the energy "currency" (EURO) of the cell

2. cAMP is important in cellular functioning

3. DNA and RNA are large nucleic acids important in genetics and protein synthesis

4. lesser known nucleic acids are NADH, NADPH, and $FADH_2$.