Chemistry word scramble

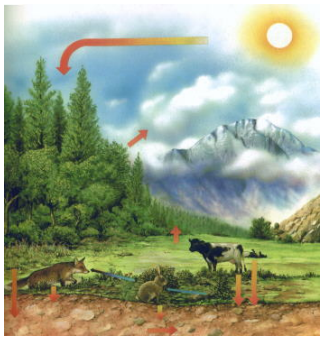
Unscramble the words below:

1. amot_____
2. emoelluc_____
3. uslnceu_____
4. tnproo_____
5. urnenot_____
6. etlornce_____
7. aecnlve_____
8. icino_____
9. ghdneryo_____
10. lshel_____

Chapter 4

Carbon and the Molecular Diversity of Life

Carbon: The backbone of life



Key concepts

- Organic chemistry is the study of carbon compounds
- Carbon atoms can form diverse molecules by bonding to four other atoms
- A small number of chemical groups are key to the functioning of biological molecules

Organic chemistry is the study of carbon compounds

The term "organic" chemistry came from the misconception that only carbon-based compounds were always connected to life

Exception: 

Importance of Carbon

- 70 to 95% of cells are water, but carbon makes up the rest of the compounds.
- Organic compounds are the molecules of life. Organic compounds can range from simple (CO_2 or CH_4) to complex molecules, like proteins.
- The number of possible compounds that contain carbon is inexhaustible.
- While the percentages of major elements do not vary within or amongst species, variations in organic molecules can distinguish even between individuals of a single species.

- Organic compound contain carbon and at least 1 hydrogen. Combinations of carbon and hydrogen form hydrocarbons, many of which we use: Gasoline propane etc...
- Organic compounds also form biological molecules, that are large and called macromolecules: carbohydrates, lipids, proteins, and nucleic acids.
- These macromolecules are made from simple sugars, amino acids, nucleotides, and fatty acids.

Organic chemistry is the study of carbon compounds

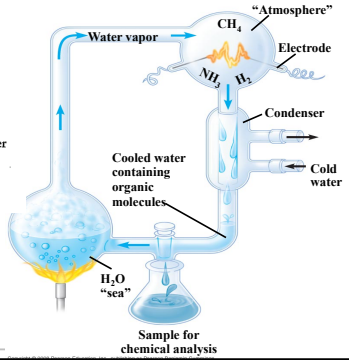
Exception:

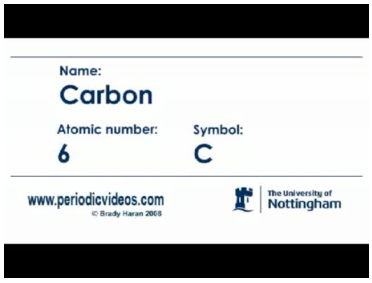
Manuscript received September 15, 1952.

A Production of Amino Acids Under Possible Primitive Earth Conditions

Stanley L. Miller[1, 2]

G. H. Jones Chemical Laboratory, University of Chicago, Chicago, Illinois





Carbon atoms can form diverse molecules by bonding to four other atoms

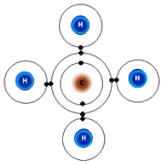
The key to an atom's chemical characteristics is its electron configuration

Carbon's valence shell is half-full…or is it half-empty?

Carbon atoms can form diverse molecules by bonding to four other atoms

Carbon usually completes its valence shell by sharing electrons with other atoms in covalent bonds

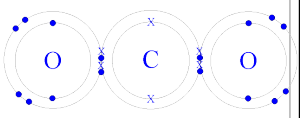
These bonds can be single
- Tetrahedral shape



Carbon atoms can form diverse molecules by bonding to four other atoms

Carbon usually completes its valence shell by sharing electrons with other atoms in covalent bonds

Carbon can also form double bonds
- Forms when two electrons are shared between two atoms
- Forms a flat molecule



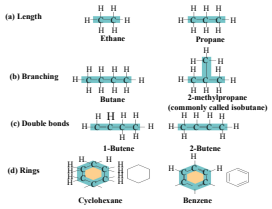
Bonding versatility

– Allows carbon to form many diverse molecules, including carbon skeletons

Name and Comments	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			

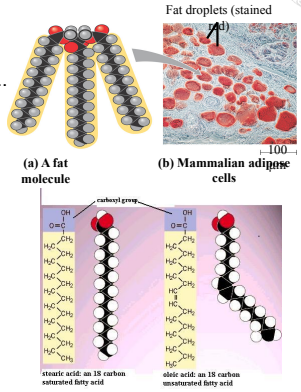
Molecular Diversity Arising from Carbon Skeleton Variation

- Sources of diversity:
  - chain length
  - branching
  - rings
  - double bonds



Hydrocarbons

– Diverse due to ....

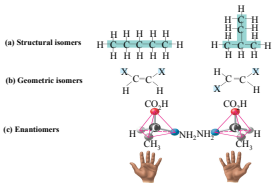


Other forms of diversity

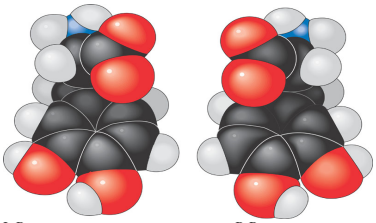
- Isomers
  - molecules with the same molecular formula but different structures and properties

Three types of isomers

– Structural
– Geometric
– Enantiomers



- Enantiomers
  - Are important in the pharmaceutical industry



L-Dopa
(effective against Parkinson's disease)

D-Dopa
(biologically inactive)

Functional groups

We've been focusing on the carbon skeleton….what's attached impacts form and function

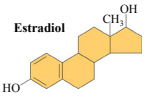
A small number of chemical functional groups are key to the function of biological molecules

- Properties of the molecule will also depend on the molecular components attached to the carbon skeleton
- Functional groups can replace H
- These groups participate in chemical reactions and change the molecular shape

Functional groups

- Give organic molecules distinctive chemical properties
- These then interact with different targets in the body.

Female lion



Male lion

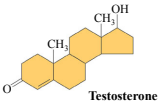
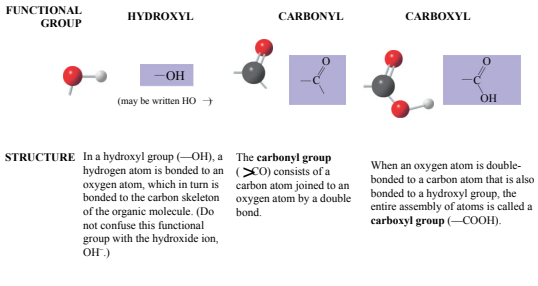


Figure 4.9

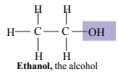
- Six functional groups are important in the chemistry of life
  - Hydroxyl
  - Carbonyl
  - Carboxyl
  - Amino
  - Sulfhydryl
  - Phosphate



NAME OF COMPOUNDS

Alcohols (their specific names usually end in *-ol*)

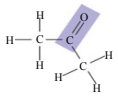
EXAMPLE



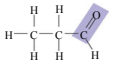
Ethanol, the alcohol present in alcoholic beverages

Ketones if the carbonyl group is within a carbon skeleton

Aldehydes if the carbonyl group is at the end of the carbon skeleton

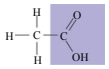


Acetone, the simplest ketone



Propanal, an aldehyde

Carboxylic acids, or organic acids



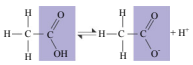
Acetic acid, which gives vinegar its sour tatste

FUNCTIONAL PROPERTIES

- Is polar as a result of the electronegative oxygen atom drawing electrons toward itself.
- Attracts water molecules, helping dissolve organic compounds such as sugars (see Figure 5.3).

- A ketone and an aldehyde may be structural isomers with different properties, as is the case for acetone and propanal.

- Has acidic properties because it is a source of hydrogen ions. The covalent bond between oxygen and hydrogen is so polar that hydrogen ions (H^+) tend to dissociate reversibly; for example,

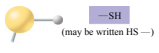


- In cells, found in the ionic form, which is called a carboxylate group.

AMINO

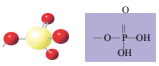
The **amino group** (—NH_2) consists of a nitrogen atom bonded to two hydrogen atoms and to the carbon skeleton.

SULFHYDRYL

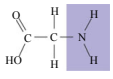


The **sulfhydryl group** consists of a sulfur atom bonded to an atom of hydrogen; resembles a hydroxyl group in shape.

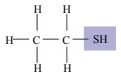
PHOSPHATE



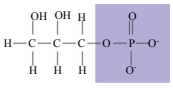
In a **phosphate group,** a phosphorus atom is bonded to four oxygen atoms; one oxygen is bonded to the carbon skeleton; two oxygens carry negative charges; abbreviated P. The phosphate group ($—OPO_3^{2-}$) is an ionized form of a phosphoric acid group ($—OPO_3H_2$; note the two hydrogens).



Glycine



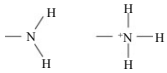
Ethanethiol



Glycerol phosphate

Because it also has a carboxyl group, glycine is both an amine and a carboxylic acid; compounds with both groups are called amino acids.

- Acts as a base; can pick up a proton from the surrounding solution:



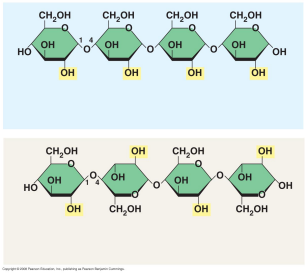
(nonionized) (ionized)

- Ionized, with a charge of 1+, under cellular conditions.

- Two sulfhydryl groups can interact to help stabilize protein structure (see Figure 5.20).

- Makes the molecule of which it is a part an anion (negatively charged ion).
Can transfer energy between organic molecules.

Can you identify any of the common functional groups on the following biological molecules?



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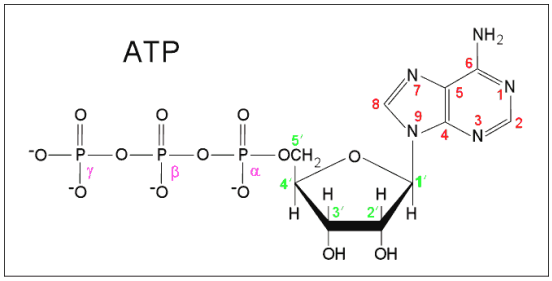

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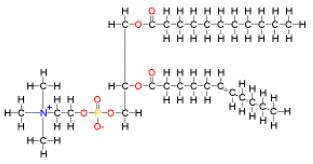
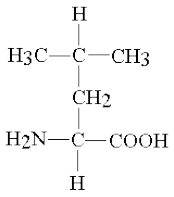


Phospholipid

Can you identify any of the common functional groups on the following biological molecules?



leucine

Key concepts

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