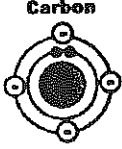
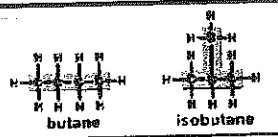
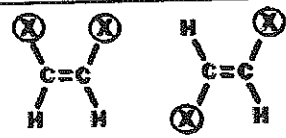
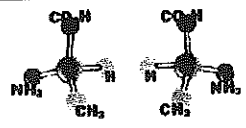


# Biology Lecture Notes

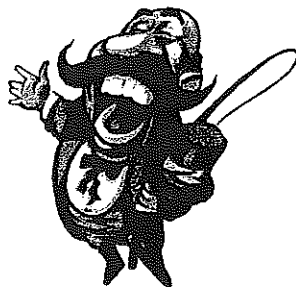
## Carbon Chemistry and Isomers

### >> Key Concepts:

- ↳ **Organic chemistry** is the chemistry of carbon-containing molecules.
- ↳ Carbon has four **valence electrons** that enable it to make four **covalent bonds**. Because of carbon's ability to form four covalent bonds, carbon can form a diversity of molecules including long branching chains, rings, and multiple bonds.
- ↳ **Structural isomers** are molecules that have the same formula, but whose atoms are arranged differently.
- ↳ **Geometric isomers** are molecules that have the same formula, but have atoms arranged differently about a double bond.
- ↳ **Enantiomers** are isomers that are mirror images of each other and are not superimposable.

<p>• Because of its structure, carbon can form an amazing array of complex molecules.</p> <p style="text-align: center;"><b>Carbon</b></p> 	<p>Carbon can form four <b>covalent bonds</b> because it has four electrons in its <b>valence shell</b>. This arrangement allows carbon to form a vast array of molecules.</p> <p>Carbon can form chains, chains with branches, double bonds, and rings.</p>
<p><b>structural isomers</b></p> <ul style="list-style-type: none"> <li>• same formula</li> <li>• different connections</li> </ul> 	<p><b>Structural isomers</b> are isomers that have the same molecular formula but a different shape because the atoms are arranged differently.</p>
<p><b>geometric isomers</b></p> <ul style="list-style-type: none"> <li>• same formula</li> <li>• same connections</li> <li>• different arrangement around a double bond</li> </ul> 	<p><b>Geometric isomers</b> are isomers that have the same molecular formula, but the groups around a double bond are arranged differently.</p>
<p><b>enantiomers</b></p> <ul style="list-style-type: none"> <li>• same formula</li> <li>• same connections</li> <li>• different arrangement in space</li> </ul> 	<p><b>Enantiomers</b> are isomers that are mirror images of one another. Like hands, they look the same but are not superimposable. Molecules in the body are only able to recognize one form of an enantiomer.</p>

# *Personal Organizer for Carbon Chemistry*



1. *What are organic compounds?*
2. *What are the three main elements that make up living things?*
  - a.
  - b.
  - c.
3. *What is the maximum number of bonds that a carbon atom can make with other groups?*
4. *What are the rules of carbon compounds?*
5. *What are hydrocarbons?*
6. *What are functional groups? Name them and draw them out.*
7. *Where do we find functional groups being used?*
8. *What is a polymer? A monomer? A hydrolysis reaction? A dehydration synthesis reaction?*
9. *What are the four main carbon molecules that make up all living organisms?*

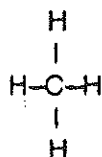
## BIOLOGY

### Class notes: VARIATION IN CARBON SKELETONS: HYDROCARBONS

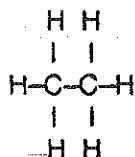
Carbon chains form the skeletons of organic molecules. The skeletons vary in length and may be straight, branched, or arranged in closed rings. Some carbon skeletons have double bonds, which vary in number and location. Such variation in carbon skeletons is one important source of the molecular complexity and diversity that characterize living matter. In addition, atoms of other elements can be bonded to the skeletons at available sites.

All the molecules shown below are hydrocarbons, organic molecules consisting only of carbon and hydrogen. Atoms of hydrogen are attached to the carbon skeleton wherever electrons are available for covalent bonding. Hydrocarbons are the major components of petroleum, which is called a fossil fuel because it consists of the partially decomposed remains of organisms that lived millions of years ago. Although hydrocarbons are not prevalent in living organisms, many of a cell's organic molecules have regions consisting of only carbon and hydrogen. For example, the molecules known as fats have long hydrocarbon tails attached to a nonhydrocarbon component. Neither petroleum nor fat mixes with water; both are hydrophobic compounds because the bonds between the carbon and hydrogen atoms are nonpolar.

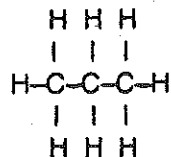
Variation in the architecture of organic molecules can be seen in isomers, compounds that have the same molecular formula but different structures and hence different properties. Compare, for example, the two butanes (below). Both have the molecular formula  $C_4H_{10}$ , but they differ in the covalent arrangement of their carbon skeletons. The skeleton is straight in butane, but branched in isobutane.



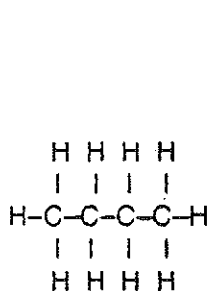
METHANE



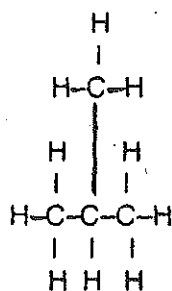
ETHANE



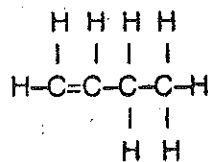
PROPANE



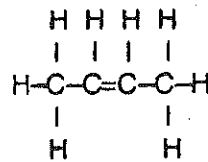
BUTANE



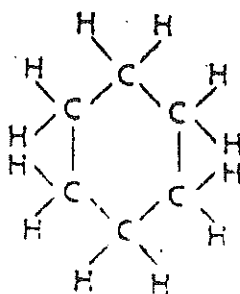
ISOBUTANE



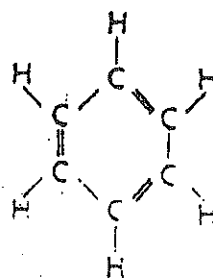
1-BUTENE



2-BUTENE



CYCLOHEXANE



BENZENE

Biology

Name: \_\_\_\_\_

Worksheet: HYDROCARBONS

Block: \_\_\_\_\_

1. Why can carbon be described as the friendliest atom in the universe?
2. What is a hydrocarbon?
3. Write the chemical formula for methane. How many carbon atoms does methane have?
4. Draw the structural formula for methane.
5. Write the chemical and structural formulas for ethane.

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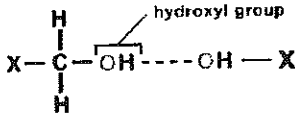












7. What is an isomer?
8. Write the chemical and structural formulas for butane and isobutane.
9. What is a double covalent bond?
10. Write the chemical and structural formulas for butene which has a double covalent bond.
11. Write the chemical and structural formulas for benzene.

# Biology Lecture Notes


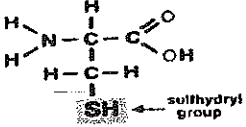

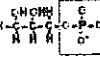
## Functional Side Groups

### >> Key Concepts:

↳ **Functional side groups** are parts of organic molecules that have their own characteristic properties. Some important functional side groups in biology are **hydroxyl**, **carbonyl**, **amine**, **sulfhydryl**, and **phosphate groups**.

<table border="1"> <thead> <tr> <th>Functional Group</th> <th>Formula</th> <th>Name of Compounds</th> <th>Example</th> </tr> </thead> <tbody> <tr> <td>Hydroxyl</td> <td>-OH</td> <td>Alcohols</td> <td></td> </tr> </tbody> </table>	Functional Group	Formula	Name of Compounds	Example	Hydroxyl	-OH	Alcohols				<p>The <b>hydroxyl group</b> consists of an —OH. The hydroxyl group has a polarized bond between the oxygen and the hydrogen because oxygen is more electronegative than hydrogen. This polar bond makes the hydroxyl group able to hydrogen-bond. Hydroxyl groups in carbon molecules make <b>alcohols</b>.</p>
Functional Group	Formula	Name of Compounds	Example								
Hydroxyl	-OH	Alcohols									
	<table border="1"> <tbody> <tr> <td rowspan="2">Carbonyl</td> <td><math>\begin{matrix} \text{O} \\ \parallel \\ \text{C} \\ \text{H} \end{matrix}</math></td> <td>Aldehydes</td> <td></td> </tr> <tr> <td><math>\begin{matrix} \text{O} \\ \parallel \\ \text{C} \end{matrix}</math></td> <td>Ketones</td> <td></td> </tr> </tbody> </table> <p>• Carbon is <b>DOUBLE</b> bonded to an oxygen.</p>			Carbonyl	$\begin{matrix} \text{O} \\ \parallel \\ \text{C} \\ \text{H} \end{matrix}$	Aldehydes		$\begin{matrix} \text{O} \\ \parallel \\ \text{C} \end{matrix}$	Ketones		
Carbonyl	$\begin{matrix} \text{O} \\ \parallel \\ \text{C} \\ \text{H} \end{matrix}$	Aldehydes									
	$\begin{matrix} \text{O} \\ \parallel \\ \text{C} \end{matrix}$	Ketones									
<table border="1"> <tbody> <tr> <td rowspan="2">Carboxyl</td> <td><math>\begin{matrix} \text{O} \\ \parallel \\ \text{C} \\ \text{OH} \end{matrix}</math></td> <td>Nonionized</td> <td rowspan="2"></td> </tr> <tr> <td><math>\begin{matrix} \text{O} \\ \parallel \\ \text{C} \\ \text{O}^- \end{matrix}</math></td> <td>Ionized</td> </tr> </tbody> </table>	Carboxyl	$\begin{matrix} \text{O} \\ \parallel \\ \text{C} \\ \text{OH} \end{matrix}$	Nonionized		$\begin{matrix} \text{O} \\ \parallel \\ \text{C} \\ \text{O}^- \end{matrix}$	Ionized	<p>The <b>carboxyl group</b> consists of a carbon with a double-bonded oxygen atom and a hydroxyl group. When this group is on a molecule, it is called a carboxylic acid. As an acid, this group can ionize and give off a proton.</p>				
Carboxyl		$\begin{matrix} \text{O} \\ \parallel \\ \text{C} \\ \text{OH} \end{matrix}$	Nonionized								
	$\begin{matrix} \text{O} \\ \parallel \\ \text{C} \\ \text{O}^- \end{matrix}$	Ionized									
<table border="1"> <tbody> <tr> <td rowspan="2">Amino</td> <td><math>\begin{matrix} \text{H} \\   \\ \text{N} \\   \\ \text{H} \end{matrix}</math></td> <td>Nonionized</td> <td rowspan="2"></td> </tr> <tr> <td><math>\begin{matrix} \text{H} \\   \\ \text{N}^+ \\   \\ \text{H} \end{matrix}</math></td> <td>Ionized</td> </tr> </tbody> </table>	Amino	$\begin{matrix} \text{H} \\   \\ \text{N} \\   \\ \text{H} \end{matrix}$	Nonionized		$\begin{matrix} \text{H} \\   \\ \text{N}^+ \\   \\ \text{H} \end{matrix}$	Ionized	<p>The <b>amine group</b> consists of an —NH<sub>2</sub> group. Amines are found in amino acids, the subunits of proteins. Amine groups can accept a proton thus acting as <b>bases</b>.</p>				
Amino		$\begin{matrix} \text{H} \\   \\ \text{N} \\   \\ \text{H} \end{matrix}$	Nonionized								
	$\begin{matrix} \text{H} \\   \\ \text{N}^+ \\   \\ \text{H} \end{matrix}$	Ionized									
$\begin{matrix} \text{H} \\   \\ \text{N} \\   \\ \text{H} \end{matrix} + \text{H}^+ \rightleftharpoons \begin{matrix} \text{H} \\   \\ \text{N}^+ \\   \\ \text{H} \end{matrix}$											

# Biology Lecture Notes

<p><b>Sulfhydryl</b></p>	<p>-SH</p>	<p><b>Thiols</b></p>		<p>A <b>sulfhydryl group</b> is found in the amino acid cysteine. When two sulfhydryl groups come together, they can form <b>disulfide bridges</b>, which are strong bonds that give a protein some of its structure.</p>
				
<p><b>Phosphate</b></p>		<p><b>Organic Phosphates</b></p>		<p><b>Phosphate groups</b> are derived from phosphoric acid. They can be found in phosphorylated intermediates, which are used to pass energy from molecule to molecule.</p>
<p>• Phosphate groups are derived from phosphoric acid (H<sub>3</sub>PO<sub>4</sub>). The phosphoric acid has ionized (lost H<sup>+</sup>s), resulting in the negatively charged oxygens.</p>				

# Organic Chemistry

Biology 😊

Name \_\_\_\_\_

Block \_\_\_\_\_

Functional Groups			
Name	Structure	Found in	Chemical characteristics
hydroxyl (alcohol)	$R-OH$	some amino acids, nucleotides, sugars	polar, forms hydrogen bonds
carboxyl (acid)	$R-C \begin{matrix} \nearrow O \\ \searrow OH \end{matrix}$	fats amino acids	polar, acidic
ketone	$R-C \begin{matrix} \uparrow O \\ \downarrow R \end{matrix}$	some sugars	polar
aldehyde	$R-C \begin{matrix} \nearrow O \\ \searrow H \end{matrix}$	some sugars	polar
amino	$R-N \begin{matrix} \nearrow H \\ \searrow H \end{matrix}$	amino acids proteins	polar, basic, forms hydrogen bonds
sulfhydryl	$R-SH$	some amino acids proteins	forms disulfide bonds
phosphate	$R-O-P \begin{matrix} \uparrow O \\ \downarrow OH \end{matrix}$	phospholipids nucleotides nucleic acids	polar, acidic

*R* = remainder of molecule

**Figure 3.2** Functional groups.

Molecules with the same type of backbone can still differ according to the type of functional group attached to the backbone. Many of these functional groups are polar, helping to make the molecule soluble in water. In this illustration, the remainder of the molecule (aside from the functional groups) is represented by an *R*.

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# BIOLOGICAL MOLECULES

## PROTEIN

## LIPIDS

## CARBOHYDRATES

## QUESTIONS

① Elements that make up molecules

② Monomer Name

③ Functional groups

④ How joined together to make polymer

⑤ Name of polysaccharides

⑥ How broken into monomers

⑦ Primary use of molecules

⑧ Type of bond:

⑨ Name of bond:

C, H, O

3c. Mono saccharides  
 5c. ribose  
 6c. glucose  
 Fructose

a. -OH hydroxyl  
 b. -CHO aldehyde  
 c. -CO- ketone

dehydration synthesis

Disaccharides  
 • maltose : glucose + glucose  
 • Sucrose : glucose + fructose

Polysaccharide  
 • plant starch  
 • glycogen : animals  
 • cellulose  
 • chitin

hydrolysis (remove bonds by H<sub>2</sub>O)

monosaccharides : short term energy  
 polysaccharides : support storage protection  
 covalent (share)

C, H, O

glycerol  
 fatty acids → saturated - all its  
 → unsaturated = double bond

a. -OH hydroxyl  
 b. -COOH Carboxyl

dehydration synthesis

• Triglyceride = glycerol + 3 fatty acids  
 • Oils - monounsaturated - polyunsaturated  
 • phospholipids → saturated polar ← phosphate - charge  
 non polar ← fatty acids no charge

• Steroids  
 • Waxes  
 hydrolysis

• long term energy storage  
 • membrane molecules  
 • water resistant: H<sub>2</sub>O polar  
 • model for hormone fat non polar covalent (share)

DRAW OUT PICTURES

Carbohydrates

Monosaccharides:

ribose:

ribulose:

glucose:

fructose:

Poly saccharides + Disaccharides

Sucrose:

maltose:

Other molecules:

DRAW OUT PICTURES

Lipids

Glycerol:

Fatty acids:

- Saturated
- Unsaturated

Triglyceride: (1 glycerol + 3 fatty acids)

Phospholipid:

Steroid:

DRAW OUT PICTURES

Proteins