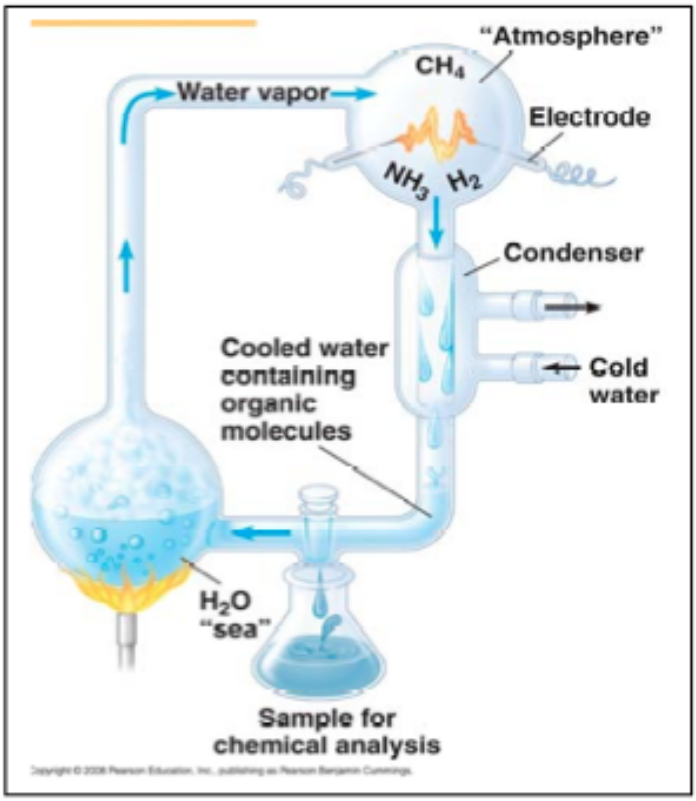
Chapter 4: Carbon and the Molecular Diversity of Life

Concept 4.1 Organic chemistry is the study of carbon compounds

1. Study this figure of Stanley Miller's experiment to simulate conditions thought to have existed on the early Earth. Explain the elements of this experiment, using arrows to indicate what occurs in various parts of the apparatus.



2. What was collected in the sample for chemical analysis? What was concluded from the results of this experiment?

Concept 4.2 Carbon atoms can form diverse molecules by bonding to four other atoms

3. Make an electron distribution diagram of carbon. It is essential that you know the answers to these questions:
   a. How many valence electrons does carbon have?

   b. How many bonds can carbon form?

   c. What type of bonds does it form with other elements?

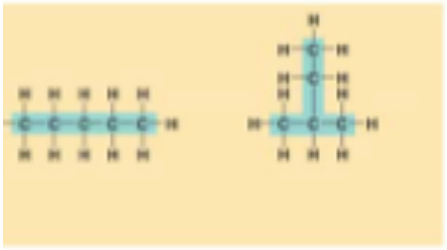
4. Carbon chains form skeletons. List here the types of skeletons that can be formed.

5. What is a *hydrocarbon?* Name two. Are hydrocarbons hydrophobic or hydrophilic?

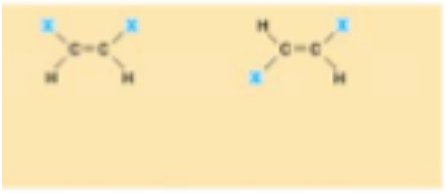
6. In Chapter 2 you learned what an *isotope* is. Since students often confuse this word with *isomer,* please define each term here and give an example.

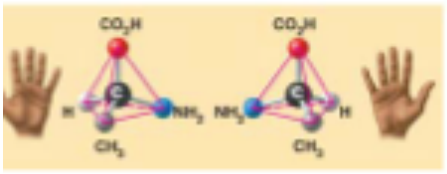
	Definition	Example
Isotope		
Isomer		

7. Use this figure to identify the three types of isomers. For each type, give a key character and an example.



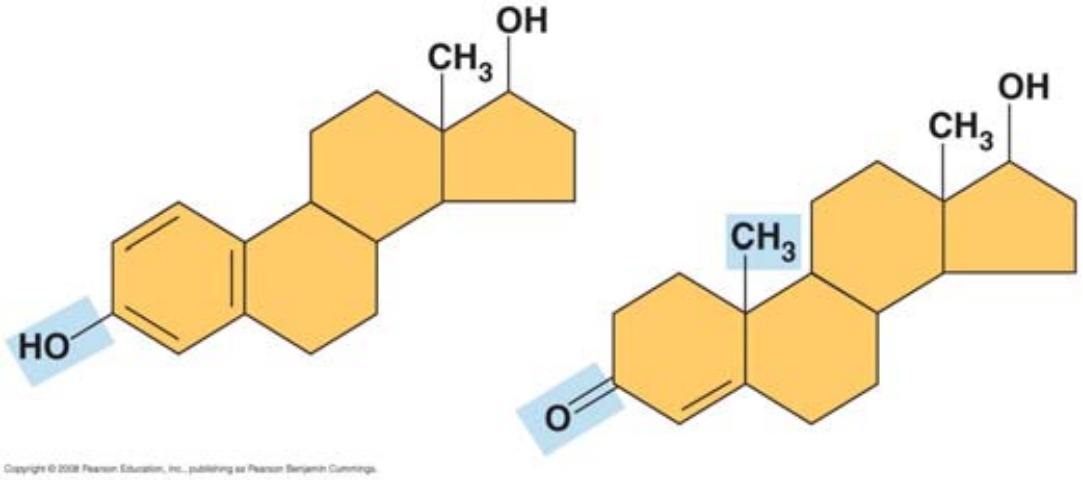
8. Give one example of enantiomers that vary in their pharmacological effect.





Concept 4.3 A small number of chemical groups are key to the functioning of biological molecules

9. Here is an idea that will recur throughout your study of the function of molecules: Change the structure, change the function. You see this in enantiomers, you will see it in proteins and enzymes, and now we are going to look at testosterone and estradiol. Notice how similar these two molecules are, and yet you know what a vastly different effect each has. Label each molecule in the sketch below, and circle the differences.



10. Define *functional group.*

11. There are seven functional groups. Complete the following chart.

	Hydroxyl	Carbonyl	Carboxyl	Amino	Sulfhydryl	Phosphate	Methyl
Structure							
Example							
Functional Properties							

12. You will need to master the chart and the information in it. Using the functional groups above, see if you can answer the following prompts:

a. $-NH_2$

b. Can form cross-links that stabilize protein structure

c. Key component of ATP

d. Can affect gene expression

e. CH_3

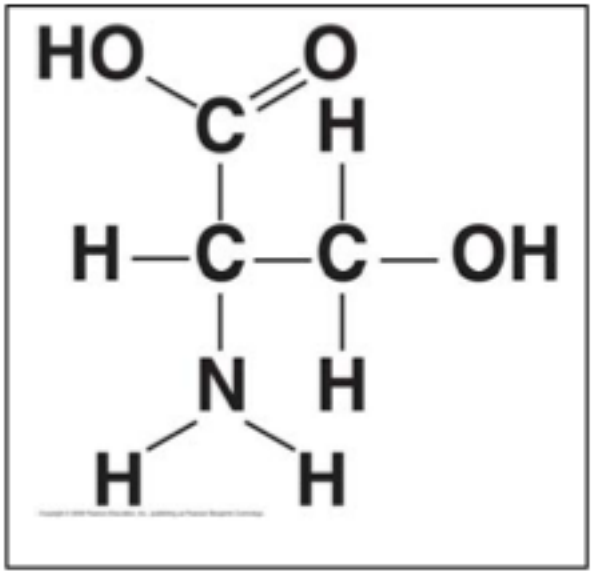
f. Is always polar

g. Determines the two groups of sugars

h. Has acidic properties

i. -COOH

j. Acts as a base



k. Circle and identify three functional groups in the molecule shown above.

Testing your Knowledge:

1. Organic chemistry is currently defined as
a. the study of compounds that can be made only by living cells
b. the study of carbon compounds
c. the study of vital forces
d. the study of natural (as opposed to synthetic) compounds
e. the study of hydrocarbons

2. Choose the pair of terms that correctly completes this sentence: Hydroxyl is to _____ as _____ is to aldehyde.

a. carbonyl; ketone
b. oxygen; carbon
c. alcohol; carbonyl
d. amine; carboxyl
e. alcohol; ketone

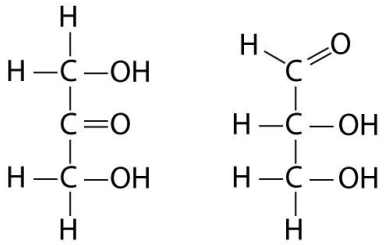
3. Which of the following hydrocarbons has a double bond in its carbon skeleton?

a. C_3H_8
b. C_2H_6
c. CH_4
d. C_2H_4
e. C_2H_2

4. The gasoline consumed by an automobile is a fossil fuel consisting mostly of

a. aldehydes
b. amino acids
c. alcohols
d. hydrocarbons
e. thiols

5. Choose the term that correctly describes the relationship between these two sugar molecules:



a. structural isomer
b. geometric isomers
c. enantiomers
d. isotopes

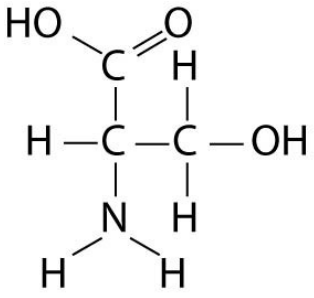
6. Which action could produce a carbonyl group?

a. the replacement of the hydroxyl of a carboxyl group with hydrogen
b. the addition of a thiol to a hydroxyl
c. the addition of a hydroxyl to a phosphate
d. the replacement of the nitrogen of an amine with an oxygen
e. the addition of a sulfhydryl to a carboxyl

7. Which functional group is most likely to be responsible of an organic molecule behaving as a base?

a. hydroxyl
b. carbonyl
c. carboxyl
d. amino
e. phosphate

8. Which functional group is *not* present in this molecule?



a. carboxyl
b. sulfhydryl
c. hydroxyl
d. amino