SBI4U- Biochemistry Unit

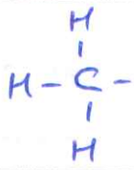
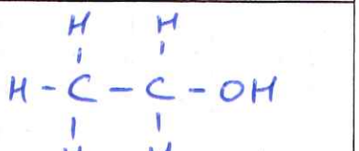
Date: _____

Molecular Model Kit Lab: Functional Groups

Reference: pg. 25

Introduction:
Macromolecules often contain one or more specific groups of atoms (sub-molecules), called **functional groups.** These sub-structural components are responsible for the chemical behaviour of a macromolecule. This lab will help you learn about the various functional groups that are found in biological macromolecules.

The **structural diagram** graphically outlines the bonding arrangement of a particular molecule. For example, ethanol's **molecular formula** is C_2H_5OH, but its structural formula is represented graphically with the hydroxyl functional group written as –OH.

Name of compound	Molecular Formula	Structural Formula
methane	CH_4	
ethanol	C_2H_5OH C_2H_6O	

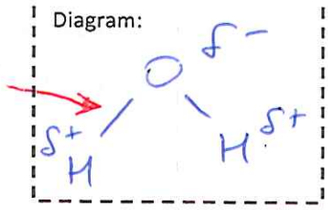
Legend:

Atom	Hydrogen	Oxygen	Nitrogen	Carbon
Colour	white	blue	red	Black
# of Bonds	one	two	Three/four	four

Procedure:
Make models of each of the following and answer the following questions in the space provided.

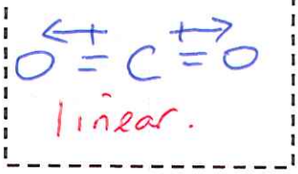
1. Construct a water molecule.
   a) *Draw a water molecule. Label the partially - and + ends.*
   b) *What specific type of bond occurs between an O and H in a molecule of water?* Polar Cov. Bond.
   c) *What specific type of bond occurs between separate water molecules?* hydrogen bonding.

Diagram:



2. Construct a carbon dioxide molecule.
   a) *How many bonds link each oxygen atom to the carbon atom?* 2
   b) *What specific type of bonds are present in the molecule?* Polar. Cov. Bond.
   c) *Is this a polar or a non-polar molecule overall? How do you know?* Non-polar → Bond dipoles cancel.

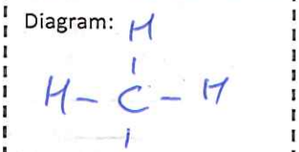
Diagram:



linear.

3. Construct a methane molecule (CH_4).
   a) *Describe the shape of the model.* tetrahedral.
   b) *Is methane a polar molecule?* No → non-polar.
   c) *Draw a methane molecule.*
   d) *Can you tell whether or not the molecules are polar from the models? Explain. (p. 16)* Yes → if you know the 3D shape.

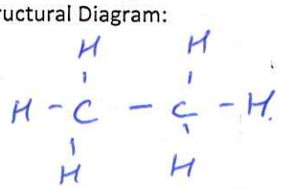
Diagram:



gas

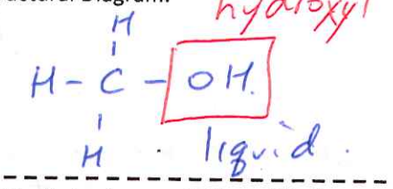
4. Now remove one H atom and replace it with a methyl group (CH_3). You have formed ethane.
   a) *Draw the structural diagram for ethane.*
   b) *Why is ethane called a hydrocarbon?*

Structural Diagram:



5. Alcohols are characterized by having an -OH group. Using your previous model for methane, make methanol and draw it.
   a) *Write its molecular formula.* CH_3OH
   b) *Name the functional group.* hydroxyl
   c) *Draw methanol.*

Structural Diagram:



   d) *Methanol is a liquid and methane is a gas. Explain why the molecules exist in this state. (see p. 17 for a hint)*

Polar → LD + H-bonding.

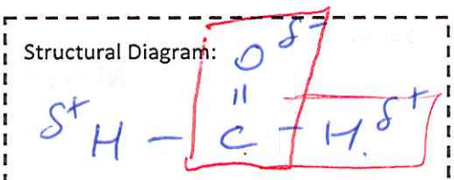
Non-polar → only LD.

6. Remake a methane molecule. Now remove two H atoms from C atom and attach one O atom (remember to make a double bond from the C to the O). You have made formaldehyde, a preservative for dissection specimens.

a) Draw the structural diagram for this molecule.

b) Is formaldehyde a polar or a non-polar molecule overall?

Structural Diagram:



an aldehyde.

c) What functional group does it contain? carbonyl **Circle it on your diagram!**

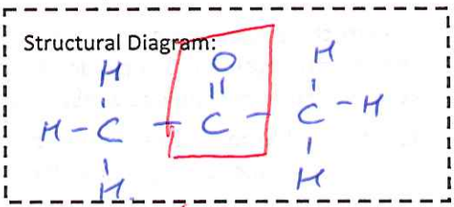
7. Remove one H atom from formaldehyde and replace it with a methyl group.

8. Remove the H atom from the central C atom (i.e. not from the methyl group) and add on another methyl group. You should now have a molecule with 2 methyl groups called acetone.

a) Draw the structural diagram for this molecule.

b) What functional group does it contain? carbonyl. **Circle it on your diagram!**

Structural Diagram:



Ketone

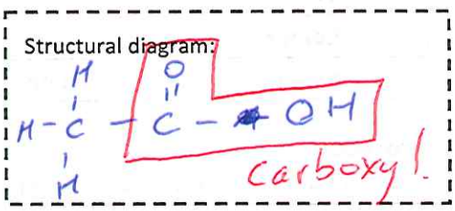
9. Remove a methyl group and add a hydroxyl group. You have produced vinegar or acetic acid.

a) Draw the structural diagram for this molecule.

b) What is the chemical formula of acetic acid.

CH_3COOH carboxylic acid.

Structural diagram:

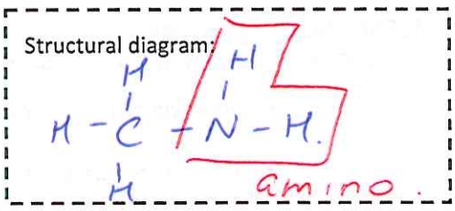


Carboxyl.

10. Construct the molecule CH_3NH_2 (called methylamine).

Draw the structural diagram for this molecule.

Structural diagram:



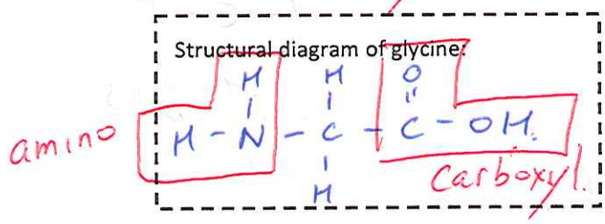
amino.

Before beginning this section it is important that you understand one more thing about amino acids. Normally an amino group will have two hydrogens bonded to a nitrogen atom, and a carboxyl will have one carbon doubled bonded to an oxygen and single bonded to an OH. However, when an amino acid is dissolved in water, such as when it is inside the human body, the hydrogen from the carboxyl group will leave and will bond to the nitrogen in the amino group. This will create an amino group with three hydrogen and a carboxyl group with only two oxygen and no hydrogen atoms.

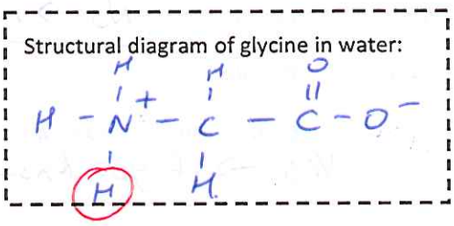
amino acid

11. Using the molecule of methylamine from step 10, remove a hydrogen from the carbon. Add a carboxyl group (-COOH) to this carbon. You have just constructed glycine, the simplest of the amino acids. Now construct glycine as it would appear when dissolved in water. *Draw BOTH structural diagrams for these molecules.*

Structural diagram of glycine:

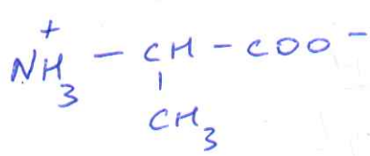


Structural diagram of glycine in water:

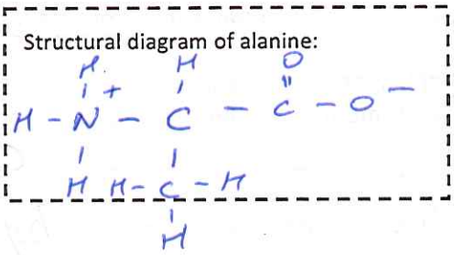


12. In this step you will continue with the molecule from step 11. Locate the central carbon and remove one of the two remaining hydrogen atoms. In place of this hydrogen add a methyl group (1 carbon bonded to 3 hydrogen atoms). This is the amino acid alanine.

Draw this molecule when it is dissolved in water.



Structural diagram of alanine:



13. Name TWO functional groups that were not constructed in this lab.

phosphate and sulfhydryl.