

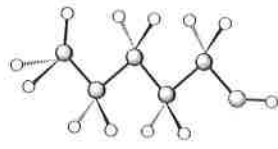
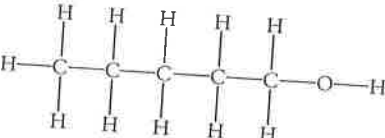
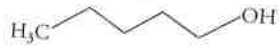
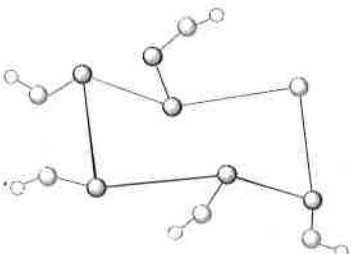
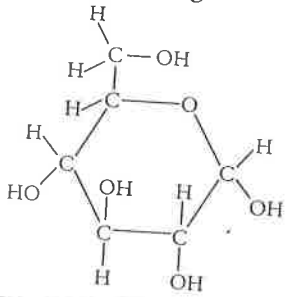
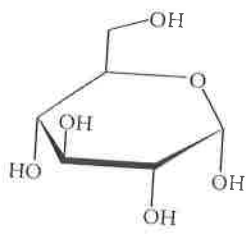
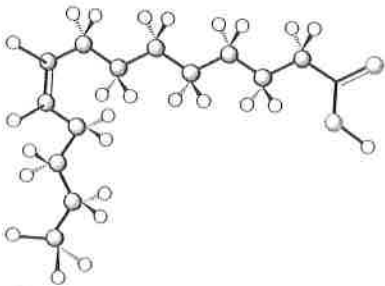
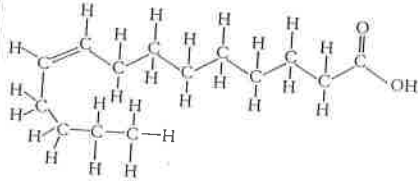
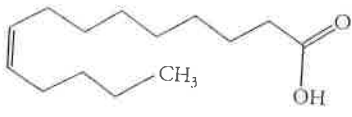
# Biochemistry Basics

What concepts from chemistry are helpful in studying biology?

## Why?

Typically chemistry is a prerequisite course for advanced biology courses. This is because everything in your body, everything in a plant, everything in a virus, etc. is made of atoms. The structures and properties of the molecules in an organism determine the features and properties of the organism. Which molecules are polar, which are nonpolar? Which molecules have acidic properties, which have basic properties? A quick review of these concepts at the beginning of your advanced biology course will help you to understand the molecular basis for life.

## Model 1 – Molecular Drawings

<p>Ball-and-stick model of 1-pentanol</p> 	<p>Lewis structure of 1-pentanol</p> 	<p>Line drawing of 1-pentanol</p> 
<p>Ball-and-stick model of glucose</p> 	<p>Lewis structure of glucose</p> 	<p>Line drawing of glucose</p> 
<p>Ball-and-stick model of unsaturated fatty acid</p> 	<p>Lewis structure of unsaturated fatty acid</p> 	<p>Line drawing of unsaturated fatty acid</p> 

1. Name the three molecules that are illustrated in Model 1.

*1-pentanol, glucose, and a fatty acid.*

2. Name the three types of drawings that are used to illustrate the molecules in Model 1.

*Ball-and-stick model, Lewis structure, and line drawing.*

3. How many bonds are typically formed by each of the following atoms:

Carbon	Hydrogen	Oxygen
4 bonds	1 bond	2 bonds

4. Which types of drawings in Model 1 provide more accurate images of the shape of a molecule? Justify your reasoning.

*The ball-and-stick models and the line drawings show the shapes more accurately than Lewis structures, which do not convey any three-dimensional information.*

5. Refer to Model 1.

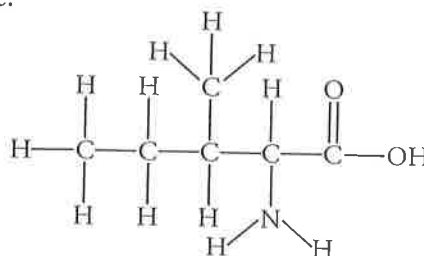
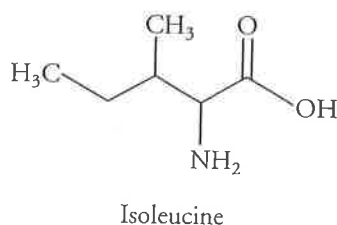
- a. Symbols or atoms of what element(s) are missing from the line drawings?

*Most carbon and hydrogen atoms are not shown in the line drawings.*

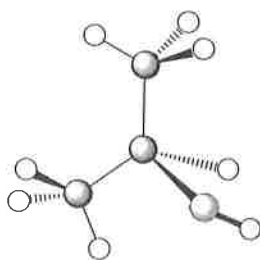
- b. In reading a line drawing, how do you know where atoms of these elements are in the structure if they are missing from the drawing?

*The carbon atoms are at the vertex of each angle. The hydrogen atoms would be attached to the carbons so that each carbon has four bonds total.*

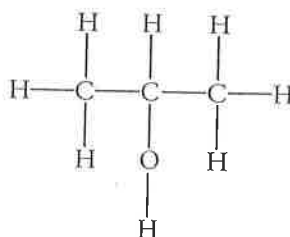
6. Locate the carbon and hydrogen atoms in the line drawing of isoleucine shown below and draw them in as if the drawing were a Lewis structure.



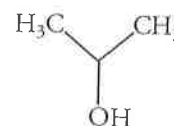
7. Isopropyl alcohol is a three-carbon molecule with an -OH group attached to the middle carbon atom. Draw this molecule using all three types of drawings.



*Ball-and-stick*



*Lewis structure*



*Line drawing*

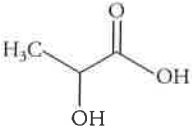
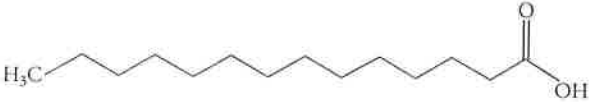
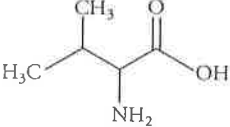
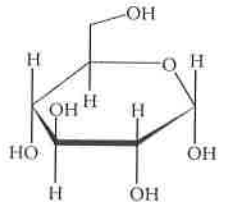
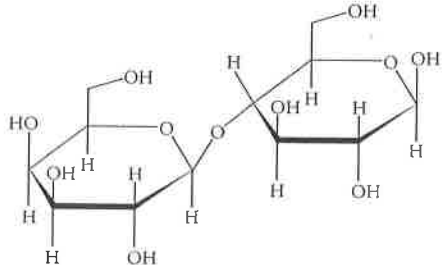
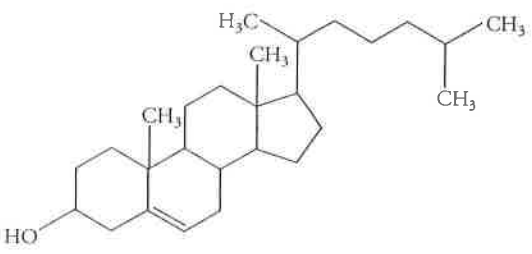
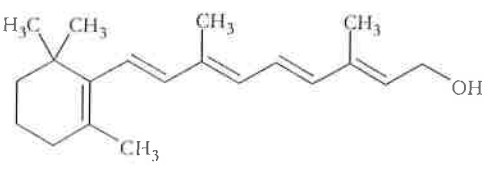
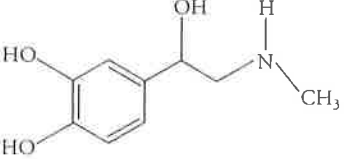
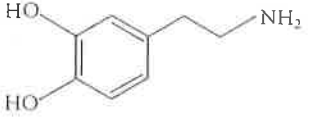
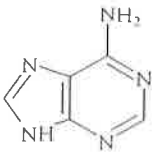
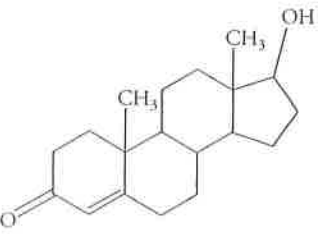
8. If you were asked to write the chemical formula for one of the compounds in Model 1, which type of the drawing would be the easiest to use? Justify your reasoning.

*The Lewis structure would be the easiest to use because it shows the labels of all the atoms.*

9. What is the advantage to a scientist in using a line drawing rather than a ball-and-stick model or Lewis structure?

*Answers will vary. Line drawings will save the scientist time in drawing details.*

## Model 2 – Properties of Biological Molecules

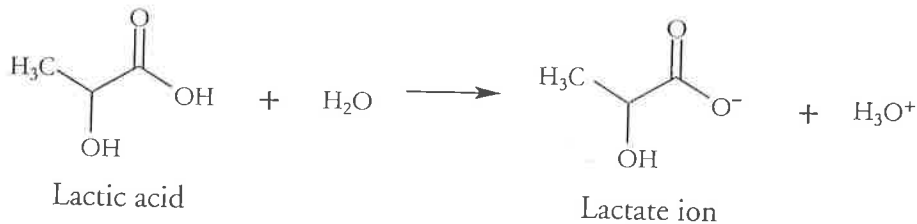
Polar Molecules (hydrophilic)	Nonpolar Molecules (hydrophobic)
<p><b>Acidic</b></p>  <p>Lactic acid</p>	<p><b>Acidic</b></p>  <p>Fatty acid</p>
<p><b>Neutral</b></p>  <p>Valine (amino acid)</p>  <p>Glucose</p>  <p>Lactose</p>	<p><b>Neutral</b></p>  <p>Cholesterol</p>  <p>Vitamin A</p>
<p><b>Basic</b></p>  <p>Adrenaline</p>  <p>Dopamine</p>  <p>Adenine</p>	 <p>Testosterone</p>

10. Consider the polar molecules in Model 2.
- In general, the presence of atoms of what element(s) makes a molecule polar?  
*The presence of oxygen and nitrogen atoms generally makes a molecule polar.*
  - What property do atoms of these elements have that helps make the molecules they are in polar?  
*Atoms of oxygen and nitrogen are highly electronegative, so they attract electrons more strongly in a covalent bond, causing an unequal distribution in charge in the bond.*
  - Can nonpolar molecules also have atoms of these elements? If yes, what distinguishes a nonpolar molecule from a polar molecule?  
*Yes, nonpolar molecules can have oxygen and/or nitrogen atoms as well, but there are usually far fewer compared to the number of carbon atoms in the molecule. Also, some molecules with polar bonds are nonpolar because of the overall three-dimensional shape of the molecule.*
11. In chemistry there is a saying “like dissolves like,” which means things will mix with or dissolve into each other best when their polarities are similar.
- Is water polar or nonpolar?  
*Water is polar.*
  - Is oil polar or nonpolar?  
*Oil is nonpolar.*
  - Which of the substances in Model 2 would dissolve well in water? Justify your reasoning.  
*Any of the polar molecules from Model 2 would dissolve well in water because their polarity is similar to that of water.*
  - Which of the substances in Model 2 are more likely to dissolve well in oil? Justify your reasoning.  
*Most of the nonpolar molecules from Model 2 should dissolve well in oil because their polarity is similar to that of oil.*
  - Which class of substances in Model 2, polar or nonpolar, is more likely to be found in high concentrations in the bloodstream of a vertebrate? Justify your reasoning.  
*The solvent for blood is water, so the polar molecules would be found in high concentrations in blood.*
12. Refer to Model 2.
- What is another term for a polar molecule?  
*Hydrophilic.*
  - What is another term for a nonpolar molecule?  
*Hydrophobic.*
  - Give the literal translation for the terms you gave in parts *a* and *b* above.  
*Hydrophilic = water lover; hydrophobic = water hater.*

13. Functional groups are key groups of atoms in biological molecules. Describe the carboxyl functional group that both acidic molecules in Model 2 have in common.

*Both acidic molecules have COOH groups.*

14. Recall the definition of an acid that you learned in chemistry. Explain how the reaction below illustrates the acidic properties of lactic acid.

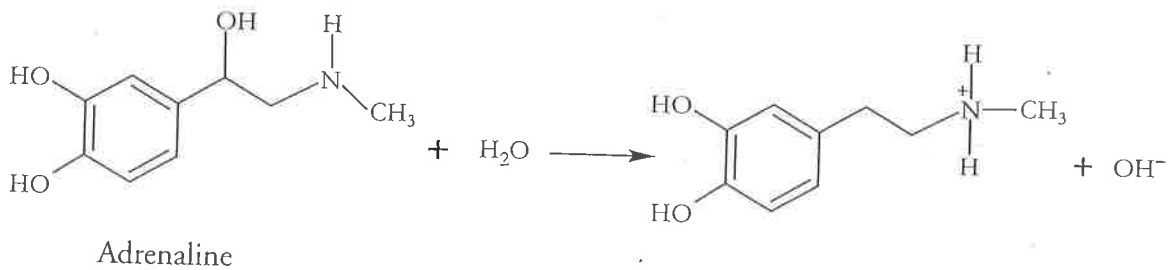


*An acid is a hydrogen ion donor, or any compound that produces hydronium ions in water. The hydrogen from the -COOH group of lactic acid is donated to a water molecule to make a hydronium ion in this reaction.*

15. Describe the functional group, called an amine group, that the basic molecules in Model 2 all have in common?

*They all have NH<sub>2</sub> groups.*

16. Recall the definition of a base that you learned in chemistry. Explain how the reaction below illustrates the basic properties of adrenaline.



*A base is a hydrogen ion acceptor, or any compound that produces hydroxide ions in water. A nitrogen atom or amine group from the adrenaline accepts a hydrogen ion from the water molecule leaving hydroxide ion.*

17. Predict the approximate pH (pH = 7, pH > 7 or pH < 7) of fairly concentrated aqueous solutions of the following compounds from Model 2.

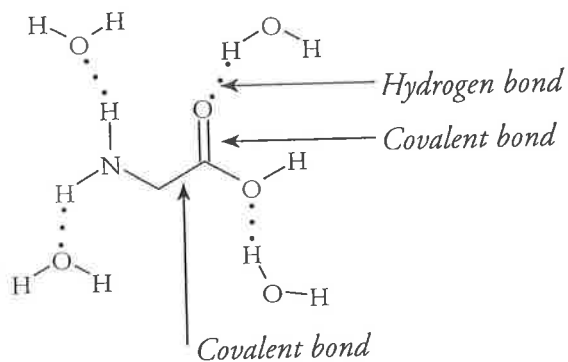
Lactic acid pH < 7

Dopamine pH > 7

Amino acid pH = 7

Lactose pH = 7

18. In chemistry you learned that covalent bonds are one type of intramolecular bond. They occur between nonmetal atoms in a molecule. You may have also learned about a type of intermolecular bond called a hydrogen bond. Hydrogen bonds are weak attractive forces between polar molecules containing the very polar bonds such as H-O, H-N or H-F.



- a. Label at least two covalent bonds in the diagram above.
- b. Label at least one hydrogen bond in the diagram above.
19. Which of the molecules in Model 2 would form hydrogen bonds with itself (that is, other molecules of the same type) or with water molecules if in a solution?
- All of the polar molecules would form hydrogen bonds with water or other molecules of the same type.*