



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

Carbon

Hydrogen

Oxygen

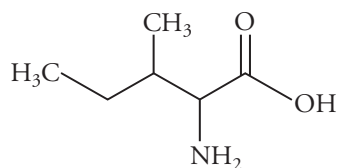
4. Which types of drawings in Model 1 provide more accurate images of the shape of a molecule? Justify your reasoning.

5. Refer to Model 1.

*a.* Symbols or atoms of what element(s) are missing from 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?

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.



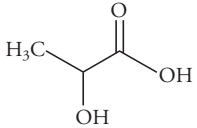
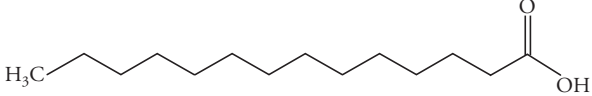
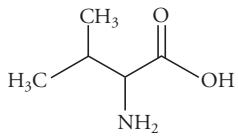
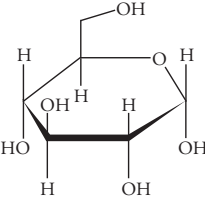
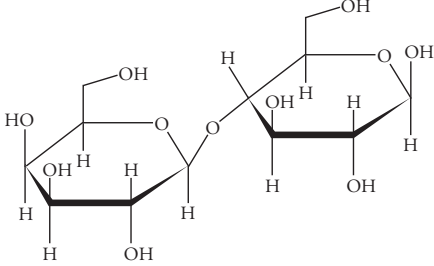
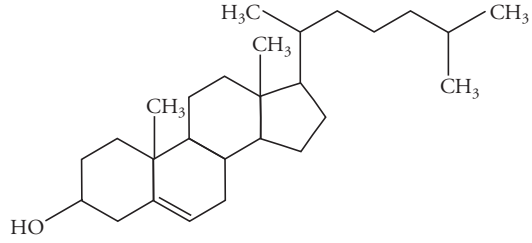
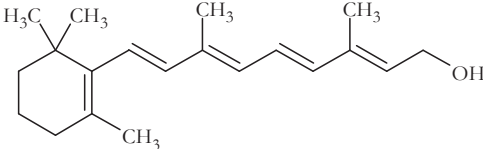
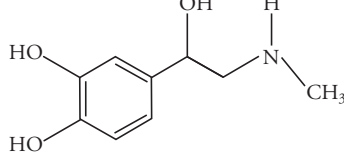
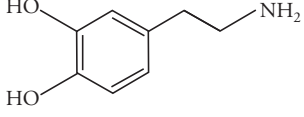
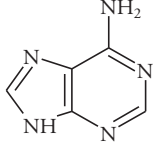
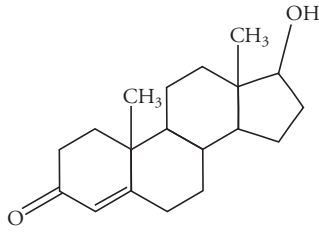
Isoleucine

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.

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.

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

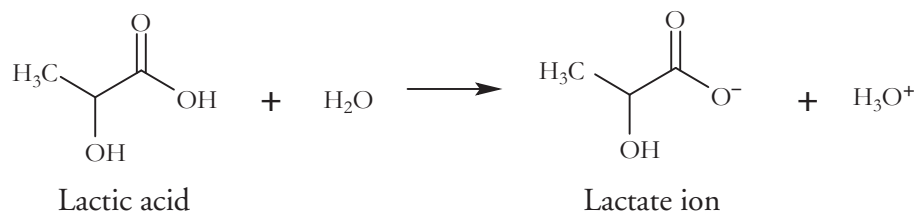
## Model 2 – Properties of Biological Molecules

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?
  - What property do atoms of these elements have that helps make the molecules they are in polar?
  - Can nonpolar molecules also have atoms of these elements? If yes, what distinguishes a nonpolar molecule from a polar 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?
  - Is oil polar or nonpolar?
  - Which of the substances in Model 2 would dissolve well in water? Justify your reasoning.
  - Which of the substances in Model 2 are more likely to dissolve well in oil? Justify your reasoning.
  - 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.
12. Refer to Model 2.
- What is another term for a polar molecule?
  - What is another term for a nonpolar molecule?
  - Give the literal translation for the terms you gave in parts *a* and *b* above.

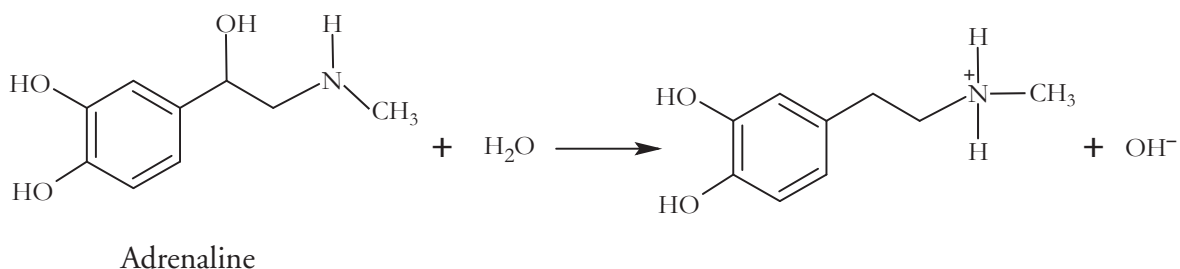
13. Functional groups are key groups of atoms in biological molecules. Describe the carboxyl functional group that both acidic molecules in Model 2 have in common.

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



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

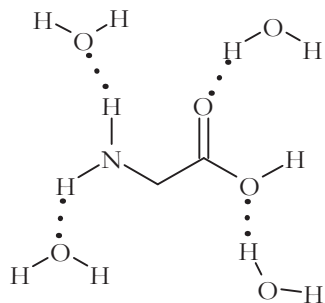
16. Recall the definition of a base that you learned in chemistry. Explain how the reaction below illustrates the basic properties of adrenaline.



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	_____	Dopamine	_____
Amino acid	_____	Lactose	_____

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.

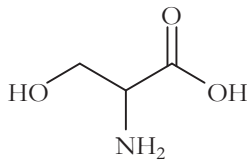
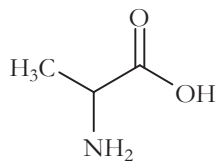


- a.* Label at least two covalent bonds in the diagram above.
- b.* Label at least one hydrogen bond in the diagram above.
19. Which of the molecules in Model 2 would form hydrogen bonds with itself (that is, other molecules of the same type) or with water molecules if in a solution?

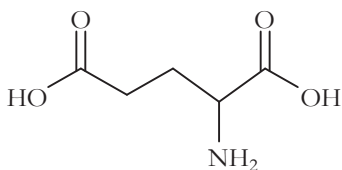
## Extension Questions

20. Although amino acids have “acid” in their name, some are acidic in water solutions, some are basic, and others are neutral. Propose an explanation for this observation based on the structures and descriptions of the amino acids below.

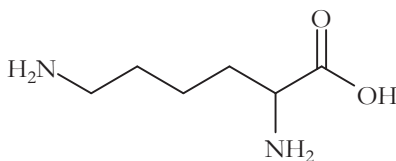
Neutral amino acids



Acidic amino acid

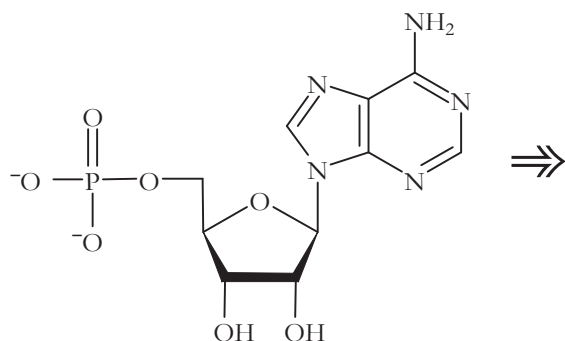


Basic amino acid



21. The structure shown below is a line drawing of noncyclic AMP, an important messenger molecule in molecular communication systems.

a. Draw the missing carbon and hydrogen atoms on the molecule.



b. Write the chemical formula for a molecule of noncyclic AMP.

22. The phosphate functional group in the noncyclic AMP molecule of Question 21 contains “acidic hydrogens.”

*a.* Explain what this phrase means.

*b.* Draw the noncyclic AMP molecule after it has dissolved in water.