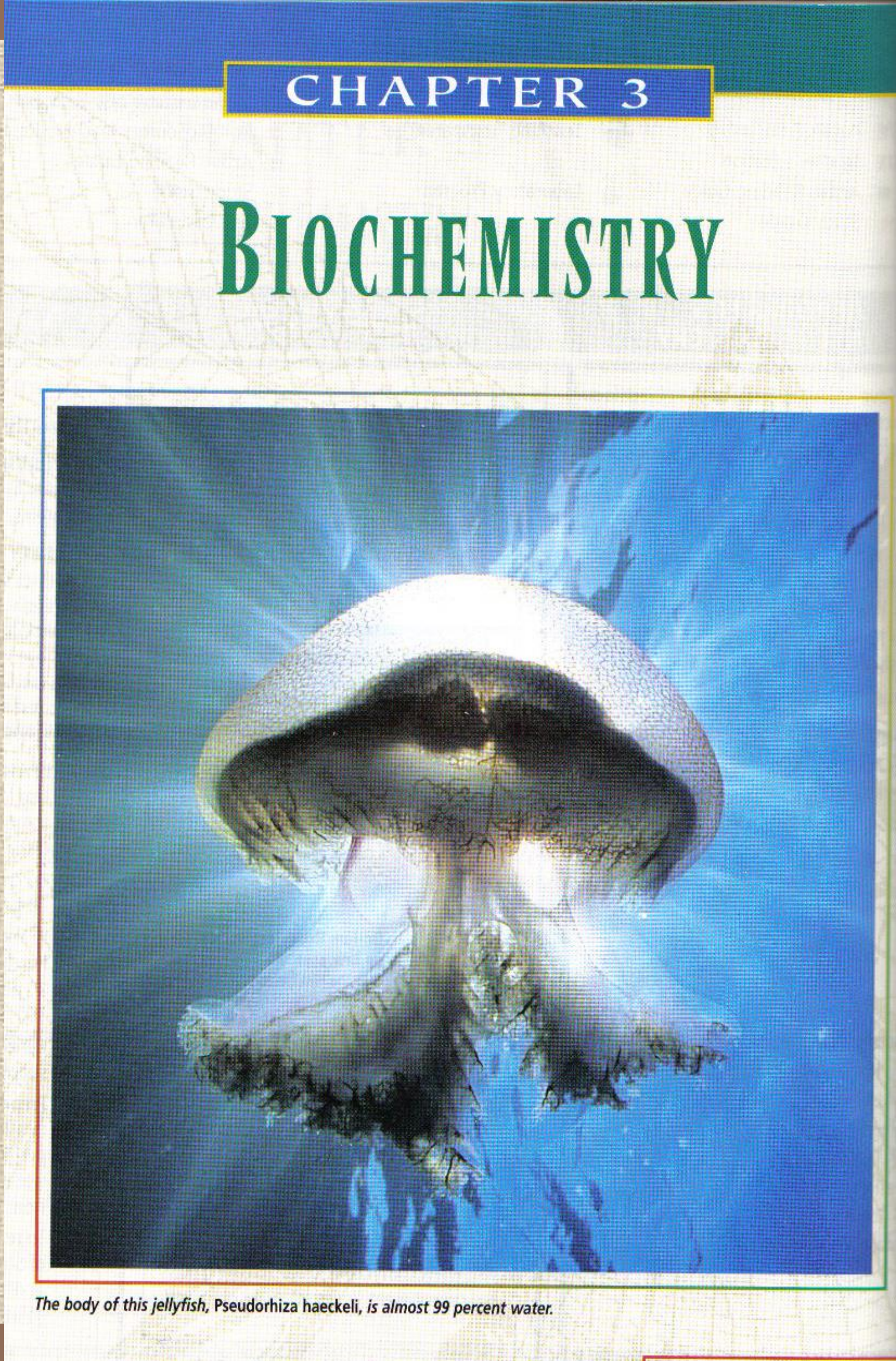
WATER AND CARBON COMPOUNDS

2.3 and 3.1



The body of this jellyfish, Pseudorhiza haeckeli, is almost 99 percent water.

WATER AND CARBON COMPOUNDS- (2.3/3.1) 14 WORDS

ADHESION	**CAPILLARITY**
COHESION	
HYDROGEN BOND	
POLAR	**ALCOHOL**
ADENOSINE TRIPHOSPHATE (ATP)	
HYDROLYSIS	
CONDENSATION REACTION	
MACROMOLECULE	
FUNCTIONAL GROUP	**POLYMER**
ORGANIC COMPOUND	**MONOMER**

I. Polarity of H_2O

A. Oxygen's nucleus with its greater positive charge compared to both hydrogens nuclei with a smaller positive charge pulls the shared electrons closer to itself than the hydrogens.

B. The oxygen part of a water molecule has a slightly negative charge because of the position of the electrons.

C. The hydrogen part of a water molecule has a slightly positive charge because of the position of the electrons.

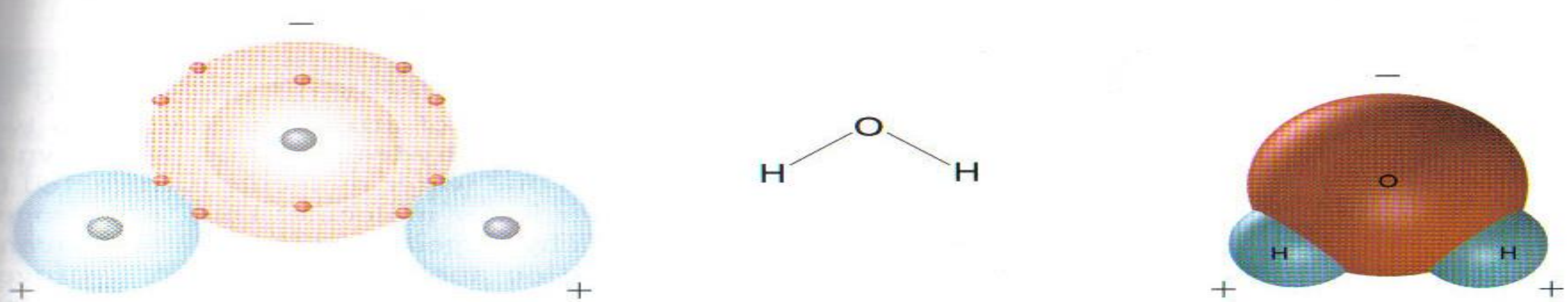
D. Since each end of a water molecule has a slightly opposite charge it is referred to as a <u>polar compound</u>

and therefore one positive charge. With its greater positive charge, the nucleus of the oxygen atom pulls the shared electrons toward its nucleus and away from the nucleus of the hydrogen atom. As a result, the electrical charge is unevenly distributed, as shown in the models of a water molecule shown in Figure 3-1.

Notice too in Figure 3-1 that the three atoms in a water molecule are not arranged in a straight line as you might expect. Rather, the two hydrogen atoms bond with the single oxygen atom at an angle. Although the total electrical charge on a water molecule is neutral, the region of the molecule where the oxygen atom is located has a

FIGURE 3-1

The oxygen region of the water molecule is weakly negative, and the hydrogen regions are weakly positive. Notice the three very different ways to represent water, H_2O. You are familiar with the electron-energy-level model (a) from Chapter 2. The structural formula (b) is compact and easy to understand. The space-filling model (c) shows the three-dimensional structure of a molecule.



(a) Electron-energy-level model **(b)** Structural formula **(c)** Space-filling model

1. H_2O reacts with other polar compounds by dissolving them.

2. Other polar compounds are: sugars, proteins, and salts.
3. Dissolved molecules and ionic compounds are vital for our cells to survive.

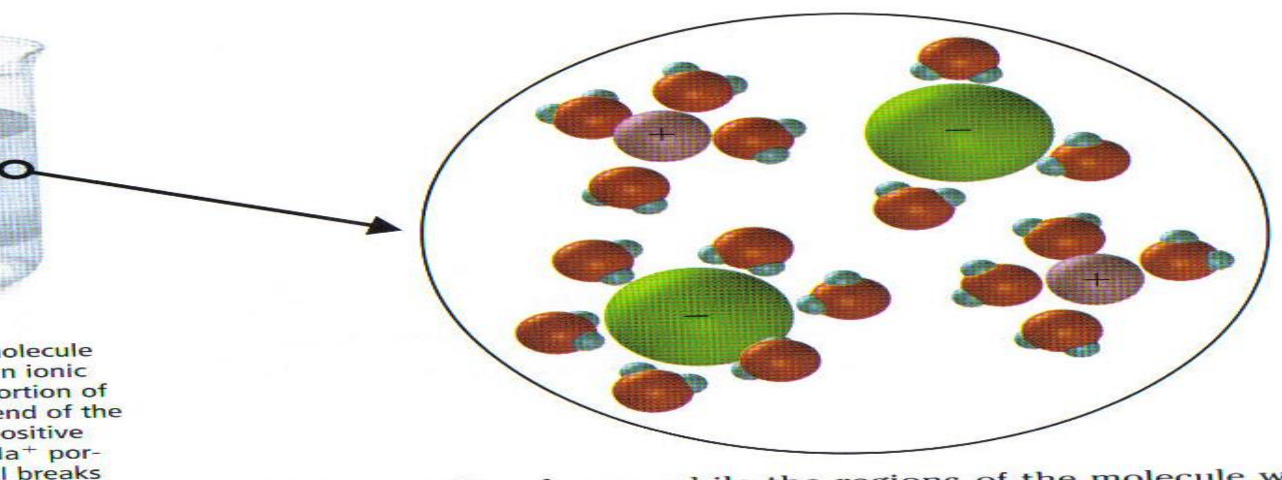



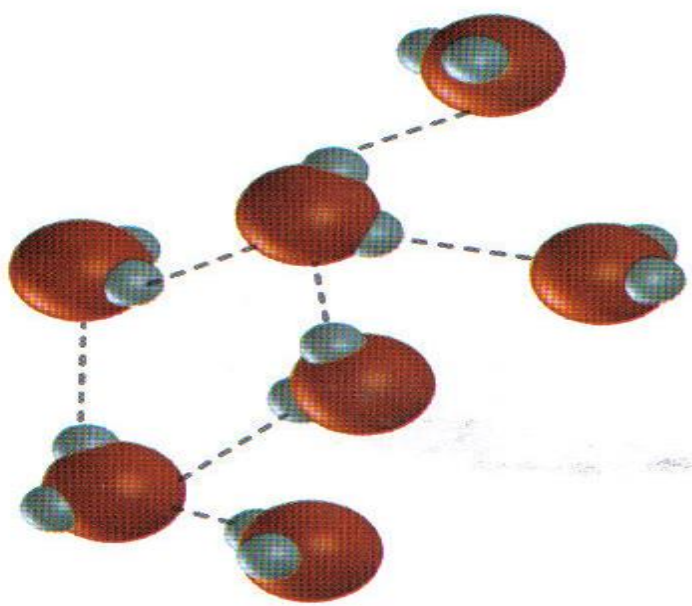
FIGURE 3-2
The positive end of a water molecule attracts the negative end of an ionic compound, such as the Cl⁻ portion of NaCl. Similarly, the negative end of the water molecule attracts the positive end of the compound—the Na⁺ portion of NaCl. As a result, NaCl breaks apart, or dissociates, in water.

slightly negative charge, while the regions of the molecule where each of the two hydrogen atoms are located have a slightly positive charge. Because of this uneven pattern of charge, water is called a

II. Hydrogen bonding

FIGURE 3-3

The dotted lines in this figure represent hydrogen bonds. A hydrogen bond is a weak force of attraction between a hydrogen atom in one molecule and a negatively charged atom in a second molecule.



A. The positive hydrogen end of one H_2O is bonded to the negative oxygen end of another H_2O.

III. Cohesion is an attractive force between particles of the same kind.

- A. Ex. The surface tension of water

IV. Adhesion is the attractive force between unlike substances.

V. Capillarity is the movement of water against the force of gravity through small spaces.

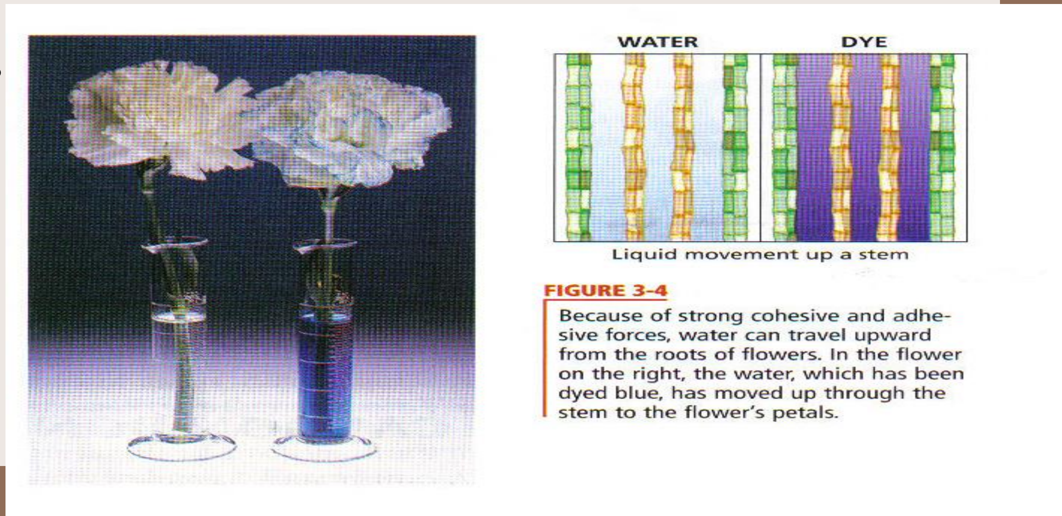


FIGURE 3-4

Because of strong cohesive and adhesive forces, water can travel upward from the roots of flowers. In the flower on the right, the water, which has been dyed blue, has moved up through the stem to the flower's petals.

VI. Temperature Moderation

A. Water must lose or gain a relatively large amount of energy for its temperature to change.
   1. Thermal energy must break the hydrogen bonds of H_2O before this energy will cause H_2O molecules to move faster.
   2. A large amount of thermal energy must be given off before H_2O will show a decrease in temperature.
   3. In cells, the ability of H_2O to retain heat when environmental temperatures drop helps homeostasis.

VII. Carbon Bonding

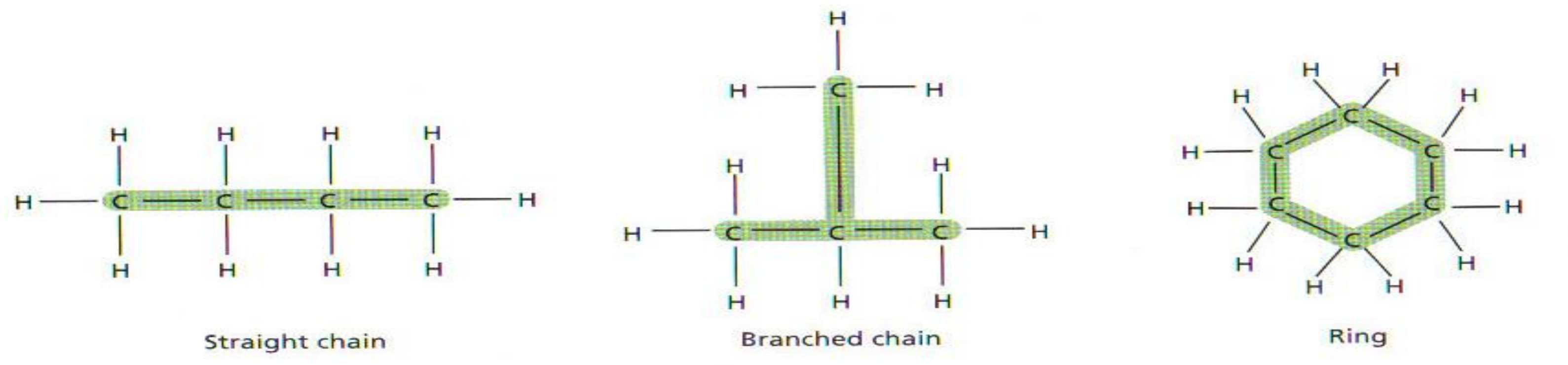
A. Carbon has four electrons in its outermost energy level.

B. Carbon will form four covalent bonds with more carbon or with other elements.

FIGURE 3-5

Carbon can bond in a number of ways to produce molecules of very different shapes, including straight chains, branched chains, and rings. These structures form the backbone of many different kinds of organic molecules.

have formed a ring. Notice that each carbon atom forms four covalent bonds: a single bond with another carbon atom, a single bond with a hydrogen atom, and a double bond with a second carbon atom. In a double bond—represented by two parallel lines—atoms share two pairs of electrons. A triple bond, the sharing of three pairs of electrons, is shown in Figure 3-6b.



C. Carbon bonding with more carbon forms straight chains, branched chains, and rings. Organic compounds contain carbon atoms bonded into these three basic shapes.

D. C – C: the line represents a single covalent bond of a pair of electrons between the carbons

E. C = C: A double bond

F. C ≡ C: A triple bond

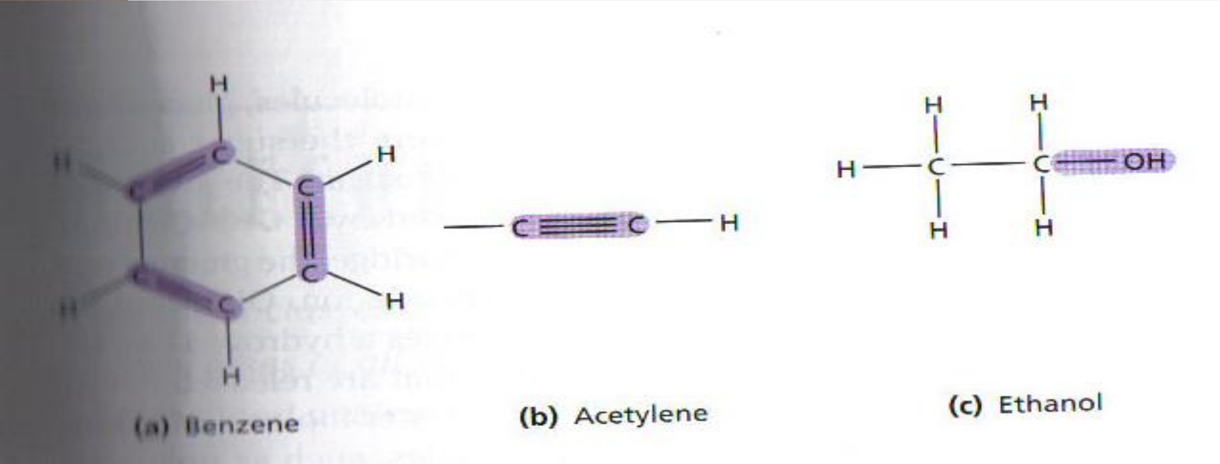
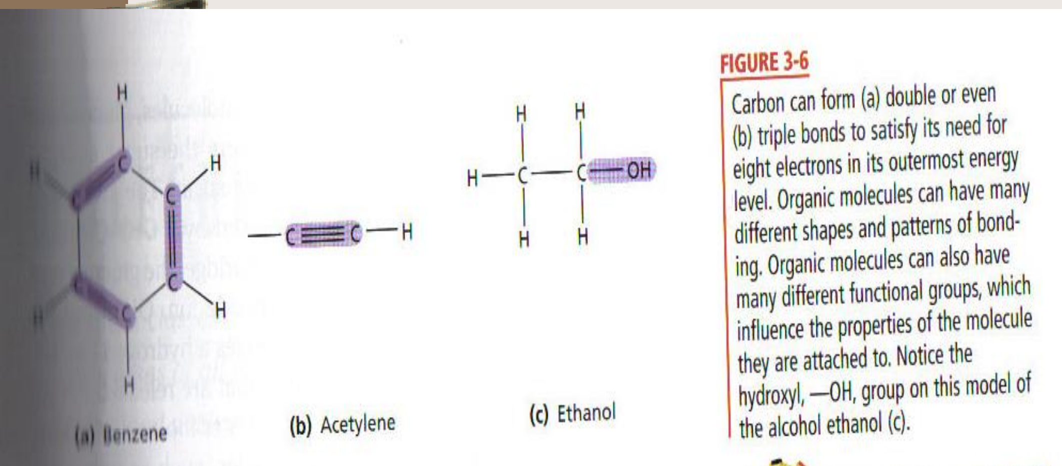


FIGURE 3-6

Carbon can form (a) double or even (b) triple bonds to satisfy its need for eight electrons in its outermost energy level. Organic molecules can have many different shapes and patterns of bonding. Organic molecules can also have many different functional groups, which influence the properties of the molecule they are attached to. Notice the hydroxyl, —OH, group on this model of the alcohol ethanol (c).

VIII. <u>Functional groups:</u> these are clusters of atoms that affect the properties of the molecules that they compose.



A. -OH is called hydroxyl group. It causes molecules to become polar.

1. Alcohol has a -OH
2. Glycerol is needed for our metabolism
3. Ethanol and methanol can kill our cells

IX. Large carbon molecules

A. Monomers are small carbon compounds that link together to build larger polymers.

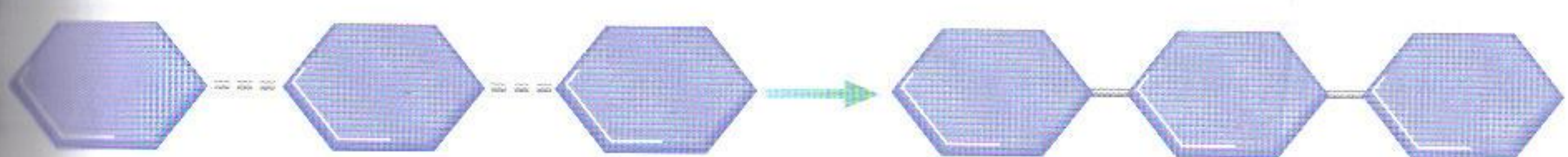
1. Macromolecules are large polymers

to one another to form complex molecules known as polymers. A **polymer** consists of repeated, linked units. The units may be identical or structurally related to each other. Large polymers are called **macromolecules.**

Monomers link to form polymers through a chemical reaction called a **condensation reaction.** In the condensation reaction shown

FIGURE 3-7

A polymer is the result of bonding between monomers. The six-sided shape is an organic structural model of a molecule with a central carbon ring. The organic structure of a molecule shows the arrangement of carbon atoms in organic molecules.



B. In condensation reaction, H_2O molecules are released. This opens up electron bonds for atoms to share. This results in larger molecules forming from the joining of smaller ones. This process is also called dehydration synthesis.

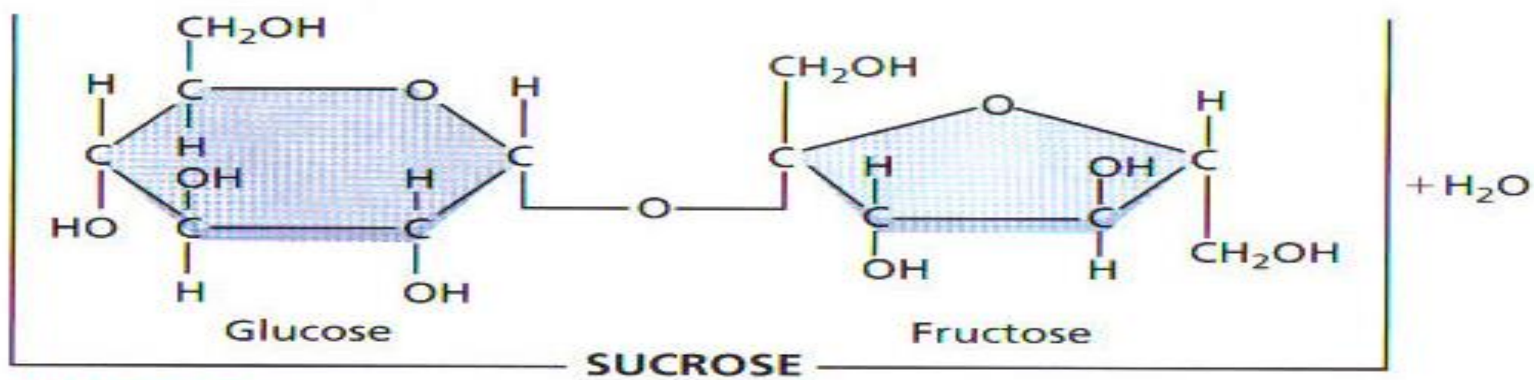
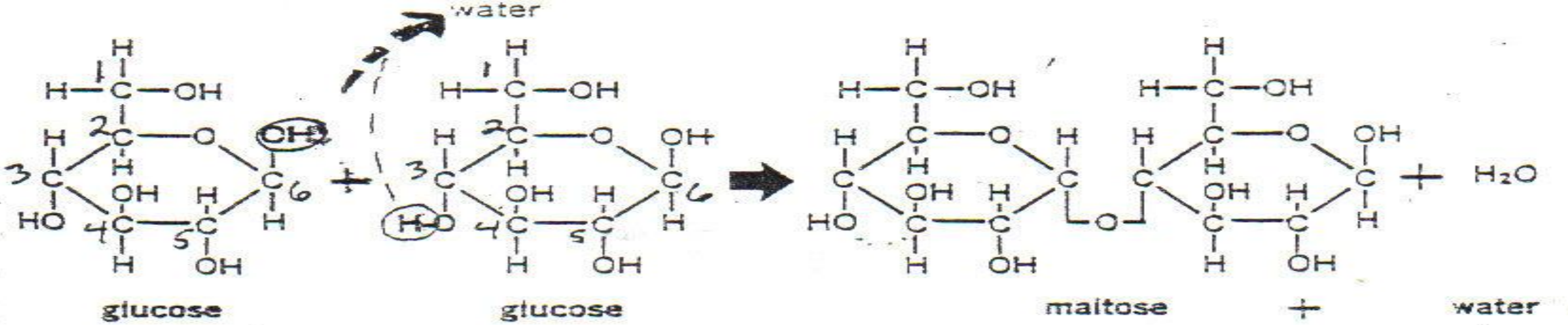
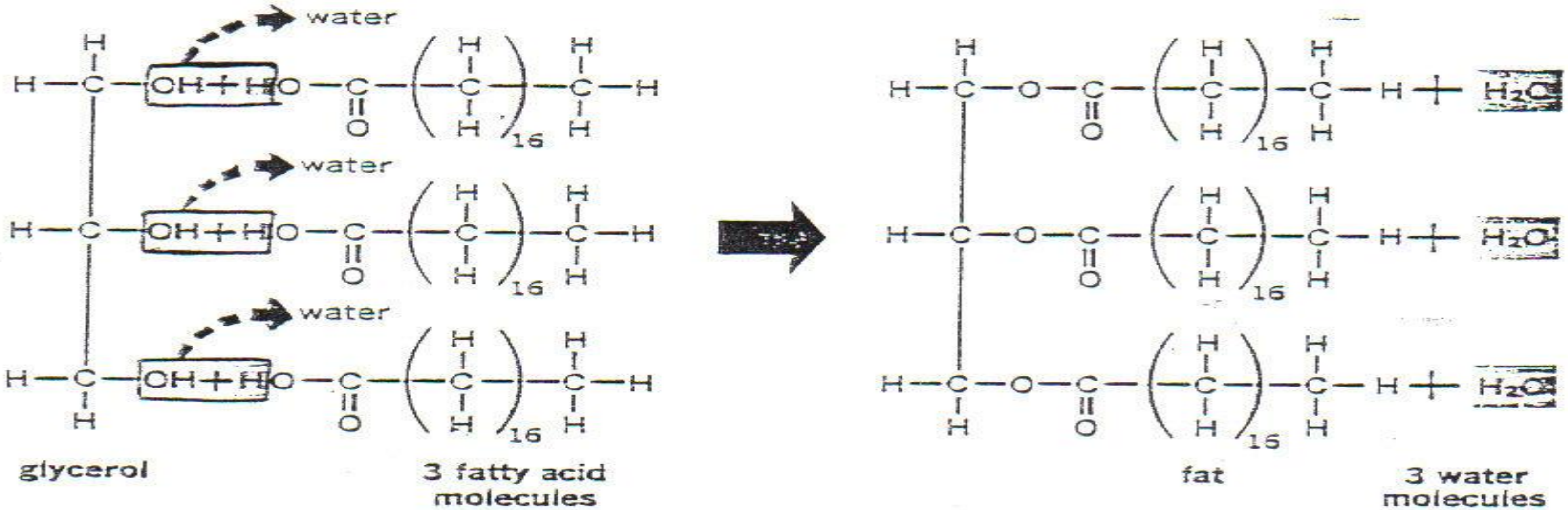


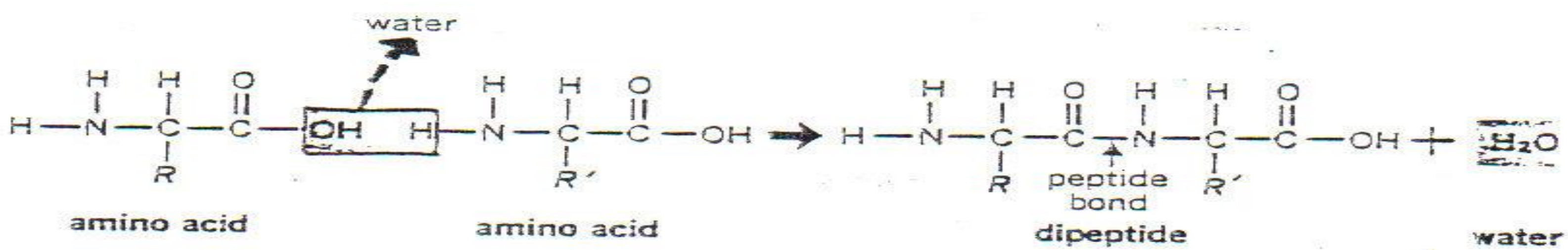
FIGURE 3-8

The condensation reaction of one glucose molecule with one fructose molecule yields sucrose and water. One water molecule is produced each time two monomers form a covalent bond.

The breakdown c
occurs through a
Hydrolysis is a reve
water to some com
tain conditions can


water
glucose
glucose
maltose
+
water
H_2O


water
water
water
glycerol
3 fatty acid molecules
fat
3 water molecules


water
amino acid
amino acid
peptide bond
dipeptide
water

C. In hydrolysis, polymers are broken down into monomers by the addition of H_2O molecules which breaks electron bonds.

X. Energy Currency

A. Life processes require energy.

B. Adenosine triphosphate (ATP) contains much stored energy

C. ATP releases energy when one of its phosphate groups has its covalent bonds broken.

1. ADP is left after this reaction takes place.

FIGURE 3-9
The hydrolysis of ATP yields adenosine diphosphate and inorganic phosphate. In hydrolysis, a hydrogen ion from a water molecule bonds to one of the new molecules, and a hydroxide ion bonds to the other new molecule. Most hydrolysis reactions are exergonic.

Figure 3-9 shows the structure of an ATP molecule. Notice the three linked phosphate groups, $-PO_4^-$, that are attached to one another by covalent bonds. The covalent bond that holds the last phosphate group to the rest of the molecule is easily broken. When this bond is broken, much more energy is released than was required to break the bond. This conversion of energy is used by the cell to drive the chemical reactions that enable an organism to function.