Section 2

Acids, Bases, and Salts

NEW TERMS

acid
pH
base
salt

OBJECTIVES

- Describe the properties and uses of acids and bases.
- Explain the difference between strong acids and bases and weak acids and bases.
- Identify acids and bases using the pH scale.
- Describe the properties and uses of salts.

Have you ever noticed a change in your tea when you added lemon? When you squeeze lemon juice into tea, the color of the tea becomes lighter, as shown in **Figure 6.** Lemon juice contains a substance called an acid that changes the color of a substance in the tea. The ability to change the color of certain chemicals is one property used to classify substances as acids or bases. A third category of substances, called salts, will also be discussed in this section. Salts are formed by the reaction of an acid with a base.

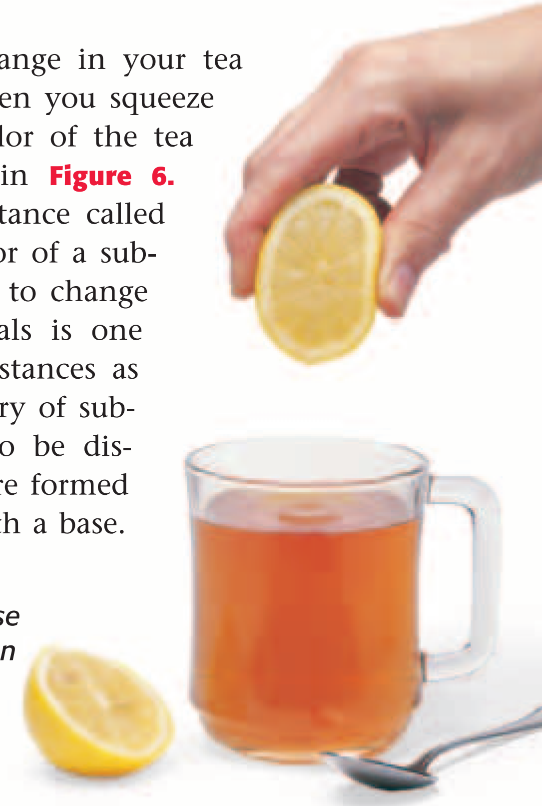


Figure 6 *Acids, like those found in lemon juice, can change the color of tea.*

Acids

An **acid** is any compound that increases the number of hydrogen ions when dissolved in water, and whose solution tastes sour and can change the color of certain compounds.

Properties of Acids If you have ever had orange juice, you have experienced the sour taste of an acid. The taste of lemons, limes, and other citrus fruits is a result of citric acid. Taste, however, should NEVER be used as a test to identify an unknown chemical. Many acids are *corrosive,* meaning they destroy body tissue and clothing, and many are also poisonous.

In **Figure 7** you see the result of placing a piece of zinc into a hydrochloric acid solution. Acids react with some metals to produce hydrogen gas. Adding an acid to baking soda or limestone produces a different gas, carbon dioxide. Vinegar contains acetic acid. When vinegar is added to baking soda, bubbles of carbon dioxide are produced.

Solutions of acids conduct an electric current because acids break apart to form ions in water. Acids increase the number of hydrogen ions, H^+, in a solution. However, the hydrogen ion does not normally exist alone. In a water solution, the hydrogen ions strongly attract water molecules. Each hydrogen ion attaches to a water molecule to form a hydronium ion, H_3O^+.

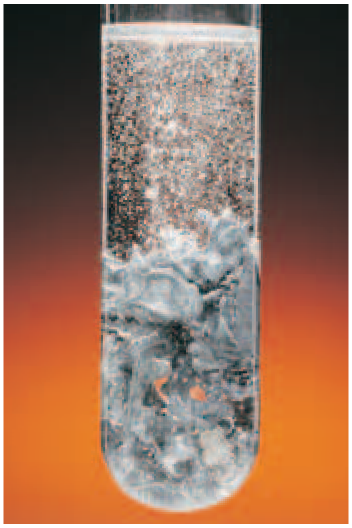


Figure 7 *Bubbles of hydrogen gas are produced when zinc metal reacts with hydrochloric acid.*

Some hydrangea plants act as indicators. Leaves on the plants change from pink to blue as the soil becomes more acidic.

As mentioned earlier, a property of acids is their ability to change the color of a substance. An *indicator* is a substance that changes color in the presence of an acid or base. A commonly used indicator is litmus. Paper strips containing litmus are available in both blue and red. When an acid is added to blue litmus paper, the color of the litmus changes to red, as shown in **Figure 8.** (Red litmus paper is used to detect bases, as will be discussed shortly.) Many plant materials, such as red cabbage, contain compounds that are indicators.

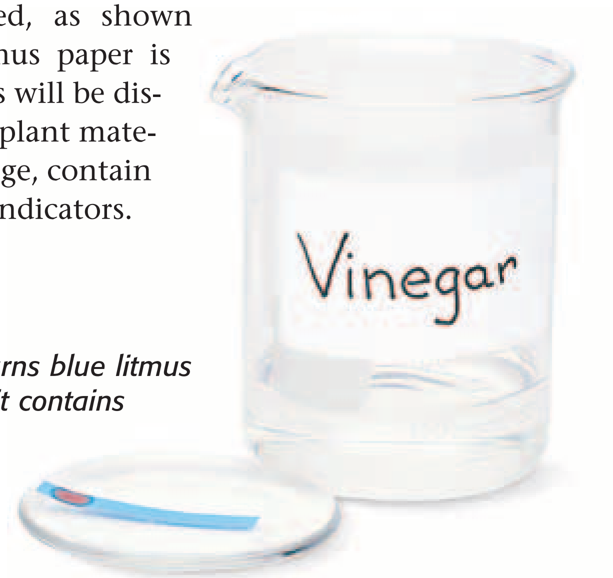


Figure 8 *Vinegar turns blue litmus paper red because it contains acetic acid.*

Figure 9 *The label on this car battery warns you that sulfuric acid is found in the battery.*

Uses of Acids Acids are used in many areas of industry as well as in your home. Sulfuric acid is the most widely produced industrial chemical in the world. It is used in the production of metals, paper, paint, detergents, and fertilizers. It is also used in car batteries, as shown in **Figure 9.** Nitric acid is used to make fertilizers, rubber, and plastics. Hydrochloric acid is used in the production of metals and to help keep swimming pools free of algae. It is also found in your stomach, where it aids in digestion. Citric acid and ascorbic acid (vitamin C) are found in orange juice, while carbonic acid and phosphoric acid help give extra "bite" to soft drinks.

Strong Versus Weak As an acid dissolves in water, its molecules break apart and produce hydrogen ions. When all the molecules of an acid break apart in water to produce hydrogen ions, the acid is considered a strong acid. Strong acids include sulfuric acid, nitric acid, and hydrochloric acid.

When few molecules of an acid break apart in water to produce hydrogen ions, the acid is considered a weak acid. Acetic acid, citric acid, carbonic acid, and phosphoric acid are all weak acids.

Bases

A **base** is any compound that increases the number of hydroxide ions when dissolved in water, and whose solution tastes bitter, feels slippery, and can change the color of certain compounds.

LabBook

To determine how acidic or basic a solution is, just use your head—of cabbage! Try it for yourself on page 582 of the LabBook.

Properties of Bases If you have ever accidentally tasted soap, then you have experienced the bitter taste of a base. Soap also demonstrates that a base feels slippery. However, NEVER use taste or touch as a test to identify an unknown chemical. Like acids, many bases are corrosive. If you are using a base in an experiment and your fingers begin to feel slippery, it might mean that some of the base got on your hands. You should immediately rinse your hands with large amounts of water.

Solutions of bases conduct an electric current because bases form ions in water. Bases increase the number of hydroxide ions, OH^-, in a solution. A hydroxide ion is actually a hydrogen atom and an oxygen atom bonded together. An extra electron gives the ion a negative charge.

Like acids, bases change the color of an indicator. Most indicators turn a different color for bases than they do for acids. For example, bases will change the color of red litmus paper to blue, as shown in **Figure 10.**

NEVER touch or taste a concentrated solution of a strong base.

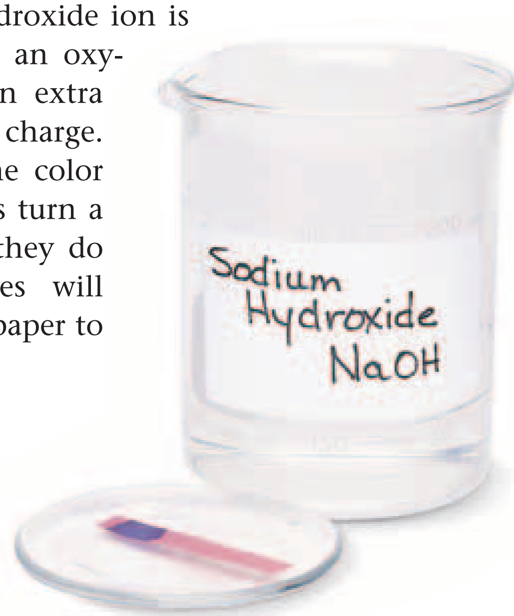
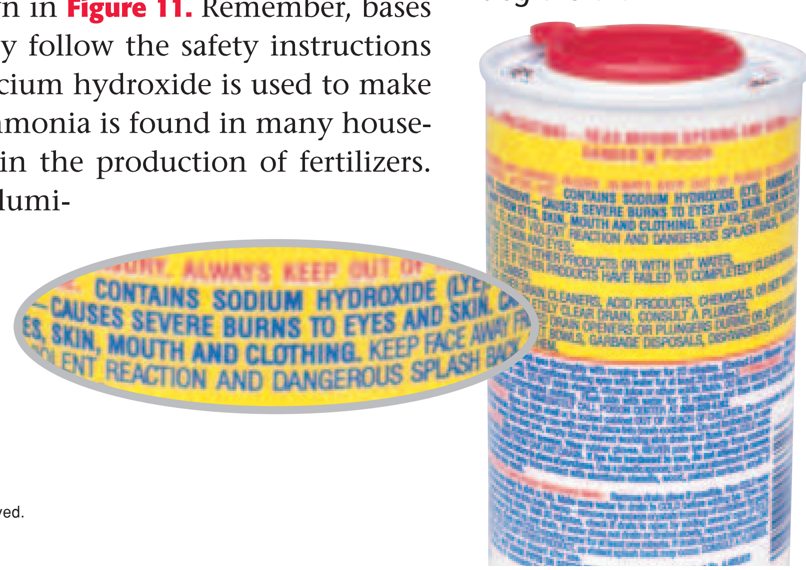


Figure 10 *Sodium hydroxide, a base, turns red litmus paper blue.*

Uses of Bases Like acids, bases have many uses. Sodium hydroxide is used to make soap and paper. You can find sodium hydroxide in your home in oven cleaners and in products that unclog your drain, as shown in **Figure 11.** Remember, bases can harm your skin, so carefully follow the safety instructions when using these products. Calcium hydroxide is used to make cement, mortar, and plaster. Ammonia is found in many household cleaners and is also used in the production of fertilizers. Magnesium hydroxide and aluminum hydroxide are used in antacids to treat heartburn.

Figure 11 *This drain cleaner contains sodium hydroxide to help dissolve grease that can clog the drain.*



Strong Versus Weak When all the molecules of a base break apart in water to produce hydroxide ions, the base is called a strong base. Strong bases include sodium hydroxide, calcium hydroxide, and potassium hydroxide.

When only a few of the molecules of a base produce hydroxide ions in water, the base is called a weak base. Ammonia, magnesium hydroxide, and aluminum hydroxide are all weak bases.

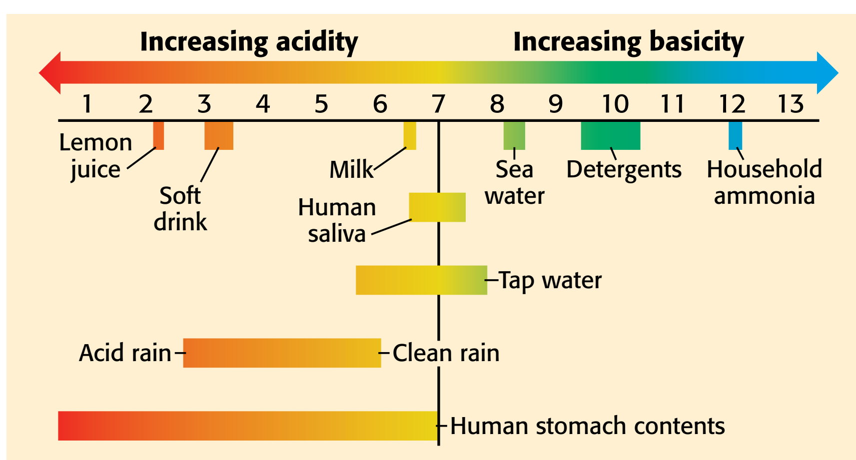
Acids and Bases Neutralize One Another

If you have ever suffered from an acid stomach, or heartburn, as shown in **Figure 12,** you might have taken an antacid. Antacids contain weak bases that soothe your heartburn by reacting with and neutralizing the acid in your stomach. Acids and bases neutralize one another because the H^+ of the acid and the OH^- of the base react to form water, H_2O. Other ions from the acid and base are also dissolved in the water. If the water is evaporated, these ions join to form a compound called a salt. You'll learn more about salts later in this section.

Figure 12 *Have heartburn? Take an antacid! Antacid tablets contain a base that neutralizes the acid in your stomach.*

The pH Scale Indicators such as litmus can identify whether a solution contains an acid or base. To describe how acidic or basic a solution is, the pH scale is used. The **pH** of a solution is a measure of the hydronium ion concentration in the solution. By measuring the hydronium ion concentration, the pH is also a measure of the hydrogen ion concentration. On the scale, a solution that has a pH of 7 is neutral, meaning that it is neither acidic nor basic. Pure water has a pH of 7. Basic solutions have a pH greater than 7, and acidic solutions have a pH less than 7. Look at **Figure 13** to see the pH values for many common materials.

Figure 13 **pH Values of Common Materials**



QuickLab

pHast Relief!

1. Fill a **small plastic cup** halfway with **vinegar.** Test the vinegar with **red** and **blue litmus paper.** Record your results in your ScienceLog.
2. Carefully crush an **antacid tablet,** and mix it with the vinegar. Test the mixture with litmus paper. Record your results in your ScienceLog.
3. Compare the acidity of the solution before and after the reaction.

Many indicators, including litmus, have only two colors. This allows you to determine if a solution is acidic or basic, but it does not identify its pH. A mixture of different indicators can be used to determine the pH of a solution. After determining the colors for this mixture at different pH values, the indicators can be used to determine the pH of an unknown solution, as shown in **Figure 14.** Indicators can be used as paper strips or solutions, and they are often used to test the pH of soil and of water in pools and aquariums. Another way to determine the acidity of a solution is to use an instrument called a pH meter, which can detect and measure hydrogen ions electronically.

Figure 14 *The paper strip contains several indicators. The pH of a solution is determined by comparing the color of the strip to the scale provided.*

pH and the Environment Living things depend on having a steady pH in their environment. Plants are known to have certain preferred growing conditions. Some plants, such as pine trees, prefer acidic soil with a pH between 4 and 6. Other plants, such as lettuce, require basic soil with a pH between 8 and 9. Fish require water near pH 7. As you can see in Figure 13, rainwater can have a pH as low as 3. This occurs in areas where compounds found in pollution react with water to make the strong acids sulfuric acid and nitric acid. As this acid precipitation collects in lakes, it can lower the pH to levels that may kill the fish and other organisms in the lake. To neutralize the acid and bring the pH closer to 7, a base can be added to the lakes, as shown in **Figure 15.**

life science CONNECTION

Human blood has a pH of between 7.38 and 7.42. If the pH is above 7.8 or below 7, the body cannot function properly. Sudden changes in blood pH that are not quickly corrected can be fatal.

Figure 15 *This helicopter is adding a base to an acidic lake. Neutralizing the acid in the lake might help protect the organisms living in the lake.*

Self-Check

Which is more acidic, a soft drink or milk? (Hint: Refer to Figure 13 to find the pH values of these drinks.) *(See page 596 to check your answer.)*

Salts

When you hear the word *salt,* you probably think of the table salt you use to season your food. But the sodium chloride found in your salt shaker is only one example of a large group of compounds called salts. A **salt** is an ionic compound formed from the positive ion of a base and the negative ion of an acid. You may remember that a salt and water are produced when an acid neutralizes a base. However, salts can also be produced in other reactions, as shown in **Figure 16.**

Explore

Write the formula of the salt produced by each of the following pairs of acids and bases:

1. $HCl + LiOH$

2. $HBr + Ca(OH)_2$

Neutralization of an acid and a base:

$$HCl + KOH \longrightarrow H_2O + KCl$$

Reaction of a metal with an acid:

$$2K + 2HCl \longrightarrow 2KCl + H_2$$

Reaction of a metal and a nonmetal:

$$2K + Cl_2 \longrightarrow 2KCl$$

Figure 16 *The salt potassium chloride can be formed from several different reactions.*

Uses of Salts Salts have many uses in industry and in your home. You already know that sodium chloride is used to season foods. It is also used in the production of other compounds, including lye (sodium hydroxide), hydrochloric acid, and baking soda. The salt calcium sulfate is made into wallboard, or plasterboard, which is used in construction. Sodium nitrate is one of many salts used as a preservative in foods. Calcium carbonate is a salt that makes up limestone, chalk, and seashells. Another use of salts is shown in **Figure 17.**

Figure 17 *Salts are used during icy weather to help keep roads free of ice.*

REVIEW

1. What ion is present in all acid solutions?
2. What are two ways scientists can measure pH?
3. What products are formed when an acid and base react?
4. **Comparing Concepts** Compare the properties of acids and bases.
5. **Applying Concepts** Would you expect the pH of a solution of soap to be 4 or 9?

Section 3

Organic Compounds

NEW TERMS

organic compounds
biochemicals
carbohydrates
lipids
proteins
nucleic acids
hydrocarbons

OBJECTIVES

- Explain why so many organic compounds are possible.
- Describe the characteristics of carbohydrates, lipids, proteins, and nucleic acids and their functions in the body.
- Describe and identify saturated, unsaturated, and aromatic hydrocarbons.

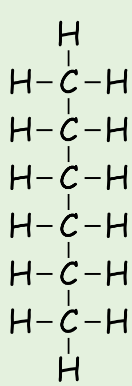
Of all the known compounds, more than 90 percent are members of a group of compounds called organic compounds. **Organic compounds** are covalent compounds composed of carbon-based molecules. Sugar, starch, oil, protein, nucleic acid, and even cotton and plastic are organic compounds. How can there be so many different kinds of organic compounds? The huge variety of organic compounds is explained by examining the carbon atom.

Each Carbon Atom Forms Four Bonds

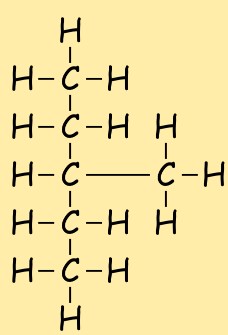
Carbon atoms form the backbone of organic compounds. Because each carbon atom has four valence electrons (electrons in the outermost energy level of an atom), each atom can make four bonds. Thus, a carbon atom can bond to one, two, or even three other carbon atoms and still have electrons remaining to bond to other atoms. Three types of carbon backbones on which many organic compounds are based are shown in the models in **Figure 18.**

Some organic compounds have hundreds or even thousands of carbon atoms making up their backbone! Although the elements hydrogen and oxygen, along with carbon, make up many of the organic compounds, sulfur, nitrogen, and phosphorus are also important—especially in forming the molecules that make up all living things.

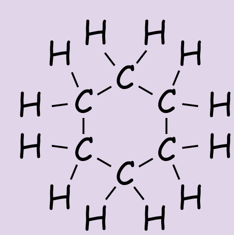
Figure 18 *These models, called structural formulas, are used to show how atoms in a molecule are connected. Each line represents a pair of electrons shared in a covalent bond.*



Straight Chain All carbon atoms are connected one after another in a line.



Branched Chain The chain of carbon atoms continues in more than one direction where a carbon atom bonds to three or more other carbon atoms.



Ring The chain of carbon atoms forms a ring.

Biochemicals: The Compounds of Life

Many different compounds are found in living things. Some compounds are composed of very small, simple molecules that are not based on carbon. These compounds, including water and salt, are considered *inorganic*. Organic compounds made by living things are called **biochemicals.** The molecules of most biochemicals are very large. There are hundreds of thousands of different biochemicals, which can be divided into four categories: carbohydrates, lipids, proteins, and nucleic acids. Each type of biochemical has important functions in living organisms.

Carbohydrates Starch and cellulose are examples of carbohydrates. **Carbohydrates** are biochemicals that are composed of one or more simple sugars bonded together; they are used as a source of energy and for energy storage. The energy you get from these biochemicals is stored in the form of chemical bonds in the molecules. There are two types of carbohydrates: simple carbohydrates and complex carbohydrates. A single sugar molecule, represented using a hexagon, or a few sugar molecules bonded together are examples of simple carbohydrates, as illustrated in **Figure 19.** Glucose is a simple carbohydrate produced by plants through photosynthesis.

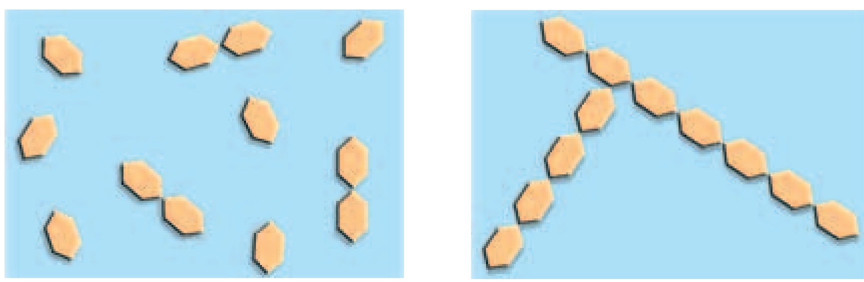


Figure 19 *The sugar molecules in the left image are simple carbohydrates. The starch in the right image is a complex carbohydrate because it is composed of many sugar molecules bonded together.*

When an organism has more sugar than it needs, its extra sugar may be stored for later use in the form of complex carbohydrates, as shown in Figure 19. Molecules of complex carbohydrates are composed of hundreds or even thousands of sugar molecules bonded together. Because carbohydrates are used to provide you with energy you need each day, you should include sources of carbohydrates in your diet, such as the foods shown in **Figure 20.**

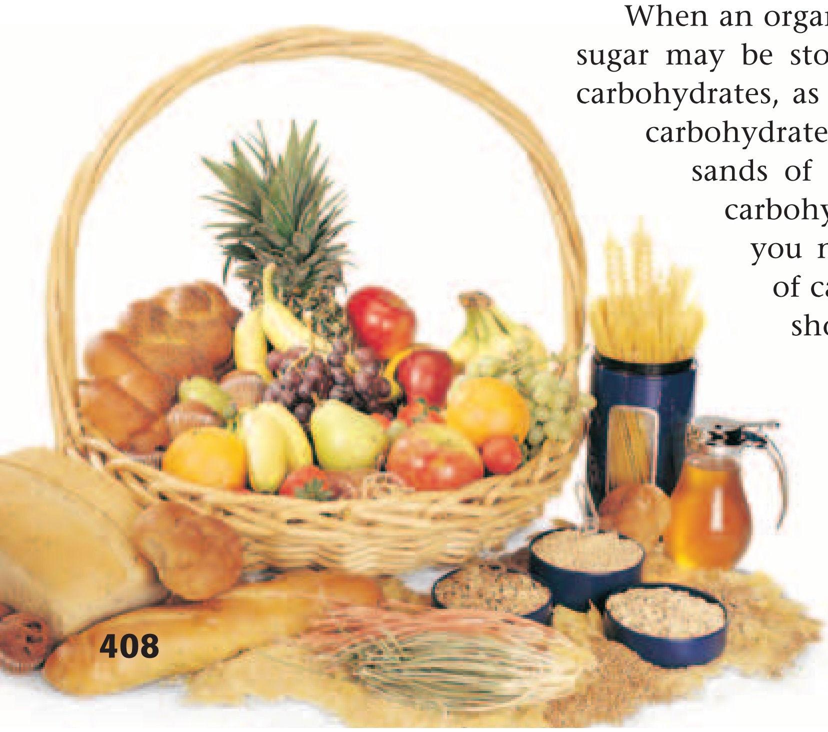


Figure 20 *Simple carbohydrates include sugars found in fruits and honey. Complex carbohydrates, such as starches, are found in bread, cereal, and pasta.*

Lipids Fats, oils, waxes, and steroids are examples of lipids. **Lipids** are biochemicals that do not dissolve in water and have many different functions, including storing energy and making up cell membranes. Although too much fat in your diet can be unhealthy, some fat is extremely important to good health. The foods in **Figure 21** are sources of lipids.

Figure 21 *Vegetable oil, meat, cheese, nuts, and milk are sources of lipids in your diet.*

Lipids store excess energy in the body. Animals tend to store lipids primarily as fats, while plants store lipids as oils. When an organism has used up most of its carbohydrates, it can obtain energy by breaking down lipids. Lipids are also used to store vitamins in the body. Vitamins that do not dissolve in water will often dissolve in fat.

Lipids make up a structure called a cell membrane that surrounds each cell. Much of the cell membrane is formed from molecules of phospholipids. The structure of phospholipid molecules plays an important part in the phospholipid's role in the cell membrane. A phospholipid molecule has two regions with very different properties. The tail of a phospholipid molecule is a long, straight-chain carbon backbone composed only of carbon and hydrogen atoms. The tail is not attracted to water. In addition to carbon and hydrogen atoms, the head of a phospholipid molecule is composed of phosphorus, oxygen, and nitrogen atoms, which cause the head of the molecule to be attracted to water. When phospholipids are in water, the tails are forced together as water is attracted to the heads of the molecules. The result is the double layer of phospholipid molecules shown in the model in **Figure 22.** This arrangement of phospholipid molecules creates a barrier to help control the flow of chemicals into and out of the cell.

BRAIN FOOD

Deposits of the lipid cholesterol in the body have been linked to health problems such as heart disease. However, cholesterol is needed in nerve and brain tissue as well as to make certain hormones that regulate body processes such as growth.

Figure 22 *A cell membrane is composed primarily of two layers of phospholipid molecules.*

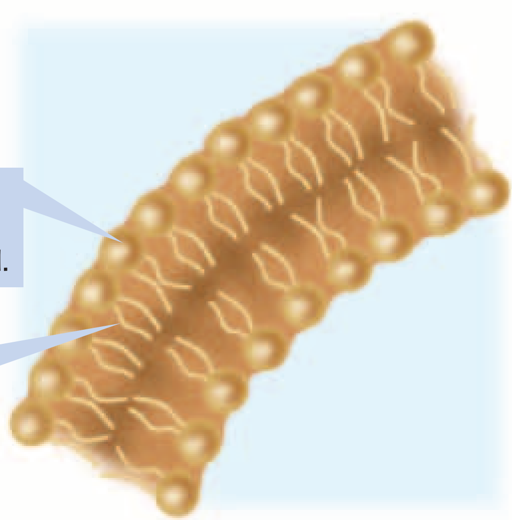


Figure 23 *Meat, fish, cheese, and beans contain proteins, which are broken down into amino acids as they are digested.*

Proteins Most of the biochemicals found in living things are proteins. In fact, after water, proteins are the most abundant molecules in your cells. **Proteins** are biochemicals that are composed of amino acids; they have many different functions, including regulating chemical activities, transporting and storing materials, and providing structural support.

Every protein is composed of small "building blocks" called *amino acids*. Amino acids are smaller molecules composed of carbon, hydrogen, oxygen, and nitrogen atoms. Some amino acids also include sulfur atoms. Amino acids chemically bond to form proteins of many different shapes and sizes, from short chains of only a few amino acids to large, twisted structures consisting of thousands of amino acids. The function of a protein depends on the shape that the bonded amino acids adopt. If even a single amino acid is missing or out of place, the protein may not function correctly or at all. The foods shown in **Figure 23** provide amino acids that your body needs to make new proteins.

Enzymes are proteins that regulate chemical reactions in the body by acting as catalysts to increase the rate at which the reactions occur. Some hormones that help control your bodily functions are proteins. Insulin, a hormone that helps regulate the level of sugar in your blood, is one of the smallest proteins, consisting of only 51 amino acids. Oxygen is carried by the protein hemoglobin, allowing red blood cells to deliver oxygen throughout your body. There are also large proteins that extend through cell membranes and help control the transport of materials into and out of cells. Proteins that provide structural support often form structures that are easy to see, like those in **Figure 24.**

life science CONNECTION

All the proteins in your body are made from just 20 amino acids. Nine of these amino acids are called essential amino acids because your body cannot make them. You must get them from the food you eat.

Figure 24 *Hair and spider webs are made up of proteins that are shaped like long fibers.*

Nucleic Acids The largest molecules made by living organisms are nucleic acids. **Nucleic acids** are biochemicals that store information and help to build proteins and other nucleic acids. Nucleic acids are sometimes called the "blueprints of life" because they contain all the information needed for the cell to make all of its proteins.

Like proteins, nucleic acids are long chains of smaller molecules joined together. These smaller molecules are composed of carbon, hydrogen, oxygen, nitrogen, and phosphorus atoms. Nucleic acids are much larger than proteins even though nucleic acids are composed of only five building blocks.

There are two types of nucleic acids: DNA and RNA. DNA (**d**eoxyribo**n**ucleic **a**cid), like that shown in **Figure 25,** is the genetic material of the cell. DNA molecules can store an enormous amount of information because of their length. If the DNA molecules in a single human cell were placed end to end and stretched out, their overall length would be about 2 m—that's over 6 ft long! When a cell needs to make a certain protein, it gets information from the DNA in the cell. The important part of the DNA molecule is copied. The information copied from DNA directs the order in which amino acids are bonded together to make that protein. DNA also contains information used to build the second type of nucleic acid, RNA (**r**ibo**n**ucleic **a**cid). RNA is involved in the actual building of proteins.

across the sciences CONNECTION

Nucleic acids store information—even about ancient peoples. Read more about these incredible biochemicals on page 418.

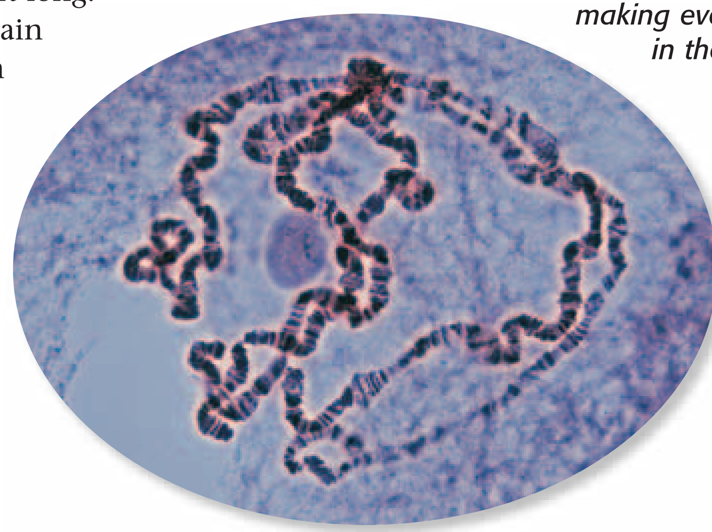


Figure 25 *The DNA from a fruit fly contains all of the instructions for making proteins, nucleic acids . . . in fact, for making everything in the organism!*

REVIEW

1. What are organic compounds?
2. What are the four categories of biochemicals?
3. What are two functions of proteins?
4. What biochemicals are used to provide energy?
5. **Inferring Relationships** Sickle-cell anemia is a condition that results from a change of one amino acid in the protein hemoglobin. Why is this condition a genetic disorder?

Hydrocarbons

Organic compounds that are composed of only carbon and hydrogen are called **hydrocarbons.** Hydrocarbons are an important group of organic compounds. Many fuels, including gasoline, methane, and propane, are hydrocarbons. Hydrocarbons can be divided into three categories: saturated, unsaturated, and aromatic.

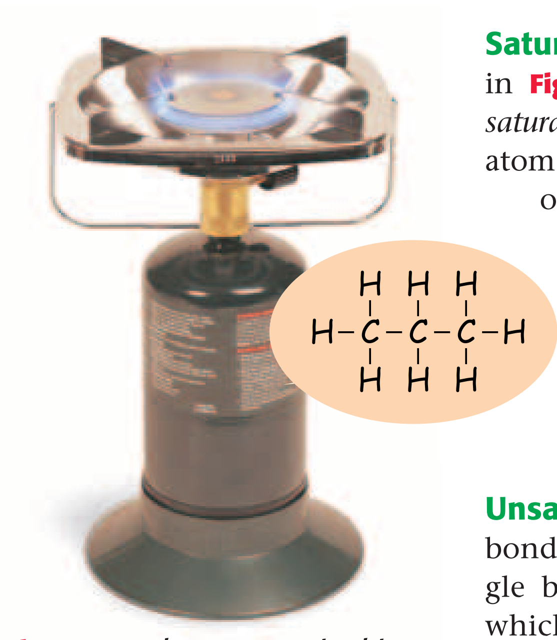


Figure 26 *The propane in this camping stove is a saturated hydrocarbon.*

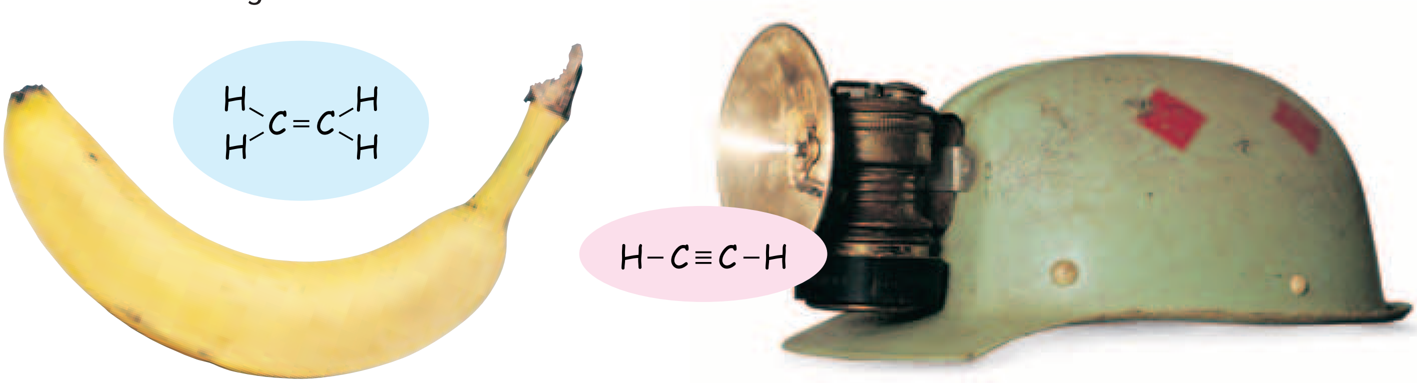
Saturated Hydrocarbons Propane, like that used in the stove in **Figure 26,** is an example of a saturated hydrocarbon. A *saturated hydrocarbon* is a hydrocarbon in which each carbon atom in the molecule shares a single bond with each of four other atoms. A single bond is a covalent bond that consists of one pair of shared electrons. Hydrocarbons that contain carbon atoms connected only by single bonds are called saturated because no other atoms can be added without replacing an atom that is part of the molecule. Saturated hydrocarbons are also called *alkanes.*

Unsaturated Hydrocarbons Each carbon atom forms four bonds. However, these bonds do not always have to be single bonds. An *unsaturated hydrocarbon* is a hydrocarbon in which at least two carbon atoms share a double bond or a triple bond. A double bond is a covalent bond that consists of two pairs of shared electrons. Compounds that contain two carbon atoms connected by a double bond are called *alkenes.*

A triple bond is a covalent bond that consists of three pairs of shared electrons. Hydrocarbons that contain two carbon atoms connected by a triple bond are called *alkynes.*

Hydrocarbons that contain double or triple bonds are called unsaturated because the double or triple bond can be broken to allow more atoms to be added to the molecule. Examples of unsaturated hydrocarbons are shown in **Figure 27.**

Figure 27 *Fruits produce ethene, which helps ripen the fruit. Ethyne, better known as acetylene, is burned in this miner's lamp and is also used in welding.*



Aromatic Hydrocarbons Most aromatic compounds are based on benzene, the compound represented by the model in **Figure 28.** Look for this structure to help identify an aromatic hydrocarbon. As the name implies, aromatic hydrocarbons often have strong odors and are therefore used in such products as air fresheners and moth balls.

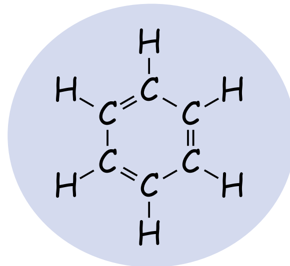


Figure 28 *Benzene has a ring of six carbons with alternating double and single bonds. Benzene is the starting material for manufacturing many products, including medicines.*

Other Organic Compounds

Many other types of organic compounds exist that have atoms of halogens, oxygen, sulfur, and phosphorus in their molecules. A few of these types of compounds and their uses are described in the chart below.

Types and Uses of Organic Compounds

Type of compound	Uses	Examples
Alkyl halide	starting material for Teflon refrigerant (freon)	chloromethane (CH_3Cl) bromoethane (C_2H_5Br)
Alcohols	rubbing alcohol gasoline additive antifreeze	methanol (CH_3OH) ethanol (C_2H_5OH)
Organic acids	food preservatives flavoring	ethanoic acid (CH_3COOH) propanoic acid (C_2H_5COOH)
Esters	flavorings fragrances clothing (polyester)	methyl ethanoate (CH_3COOCH_3) ethyl propanoate ($C_2H_5COOC_2H_5$)

REVIEW

1. What is a hydrocarbon?
2. How many electrons are shared in a double bond? a triple bond?
3. **Comparing Concepts** Compare saturated and unsaturated hydrocarbons.

Chapter Highlights

SECTION 1

Vocabulary

ionic compounds *(p. 398)*
covalent compounds *(p. 399)*

Section Notes

- Ionic compounds contain ionic bonds and are composed of oppositely charged ions arranged in a repeating pattern called a crystal lattice.
- Ionic compounds tend to be brittle, have high melting points, and dissolve in water to form solutions that conduct an electric current.
- Covalent compounds are composed of elements that are covalently bonded and consist of independent particles called molecules.
- Covalent compounds tend to have low melting points. Most do not dissolve well in water and do not form solutions that conduct an electric current.

SECTION 2

Vocabulary

acid *(p. 401)*
base *(p. 403)*
pH *(p. 404)*
salt *(p. 406)*

Section Notes

- An acid is a compound that increases the number of hydrogen ions in solution. Acids taste sour, turn blue litmus paper red, react with metals to produce hydrogen gas, and react with limestone or baking soda to produce carbon dioxide gas.
- A base is a compound that increases the number of hydroxide ions in solution. Bases taste bitter, feel slippery, and turn red litmus paper blue.
- When dissolved in water, every molecule of a strong acid or base breaks apart to form ions. Few molecules of weak acids and bases break apart to form ions.
- When combined, an acid and a base neutralize one another to produce water and a salt.
- pH is a measure of hydronium ion concentration in a solution. A pH of 7 indicates a neutral substance. A pH of less than 7 indicates an acidic substance. A pH of greater than 7 indicates a basic substance.
- A salt is an ionic compound formed from the positive ion of a base and the negative ion of an acid.

Labs

Cabbage Patch Indicators *(p. 582)*
Making Salt *(p. 584)*

Skills Check

Visual Understanding

LITMUS PAPER You can use the ability of acids and bases to change the color of indicators to identify a chemical as an acid or base. Litmus is an indicator commonly used in schools. Review Figures 8 and 10, which show how the color of litmus paper is changed by an acid and by a base.

pH SCALE Knowing whether a substance is an acid or a base can help explain some of the properties of the substance. The pH scale shown in Figure 13 illustrates the pH ranges for many common substances.

SECTION 3

Vocabulary

organic compounds *(p. 407)*
biochemicals *(p. 408)*
carbohydrates *(p. 408)*
lipids *(p. 409)*
proteins *(p. 410)*
nucleic acids *(p. 411)*
hydrocarbons *(p. 412)*

Section Notes

- Organic compounds are covalent compounds composed of carbon-based molecules.
- Each carbon atom forms four bonds with other carbon atoms or with atoms of other elements to form straight chains, branched chains, or rings.
- Biochemicals are organic compounds made by living things.
- Carbohydrates are biochemicals that are composed of one or more simple sugars bonded together; they are used as a source of energy and for energy storage.
- Lipids are biochemicals that do not dissolve in water and have many functions, including storing energy and making up cell membranes.
- Proteins are biochemicals that are composed of amino acids and have many functions, including regulating chemical activities, transporting and storing materials, and providing structural support.
- Nucleic acids are biochemicals that store information and help to build proteins and other nucleic acids.
- Hydrocarbons are organic compounds composed of only carbon and hydrogen.
- In a saturated hydrocarbon, each carbon atom in the molecule shares a single bond with each of four other atoms.
- In an unsaturated hydrocarbon, at least two carbon atoms share a double bond or a triple bond.
- Many aromatic hydrocarbons are based on the six-carbon ring of benzene.
- Other organic compounds, including alkyl halides, alcohols, organic acids, and esters, are formed by adding atoms of other elements.

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TOPIC: Ionic Compounds	***sci*LINKS NUMBER:** HSTP355
TOPIC: Covalent Compounds	***sci*LINKS NUMBER:** HSTP360
TOPIC: Acids and Bases	***sci*LINKS NUMBER:** HSTP365
TOPIC: Salts	***sci*LINKS NUMBER:** HSTP370
TOPIC: Organic Compounds	***sci*LINKS NUMBER:** HSTP375

Chapter Review

USING VOCABULARY

To complete the following sentences, choose the correct term from each pair of terms listed below:

1. Compounds that have low melting points and do not usually dissolve well in water are ___?___. *(ionic compounds* or *covalent compounds)*
2. A(n) ___?___ turns red litmus paper blue. *(acid* or *base)*
3. ___?___ are composed of only carbon and hydrogen. *(Ionic compounds* or *Hydrocarbons)*
4. A biochemical composed of amino acids is a ___?___. *(lipid* or *protein)*
5. A source of energy for living things can be found in ___?___. *(nucleic acids* or *carbohydrates)*

UNDERSTANDING CONCEPTS

Multiple Choice

6. Which of the following describes lipids?
   a. used to store energy
   b. do not dissolve in water
   c. make up most of the cell membrane
   d. all of the above
7. An acid reacts to produce carbon dioxide when the acid is added to
   a. water.
   b. limestone.
   c. salt.
   d. sodium hydroxide.

8. Which of the following does NOT describe ionic compounds?
   a. high melting point
   b. brittle
   c. do not conduct electric currents in water
   d. dissolve easily in water
9. An increase in the amount of hydrogen ions in solution ___?___ the pH.
   a. raises
   b. lowers
   c. does not affect
   d. doubles
10. Which of the following compounds makes up the majority of cell membranes?
    a. lipids
    b. ionic compounds
    c. acids
    d. nucleic acids
11. The compounds that store information for building proteins are
    a. lipids.
    b. hydrocarbons.
    c. nucleic acids.
    d. carbohydrates.

Short Answer

12. What type of compound would you use to neutralize a solution of potassium hydroxide?
13. Explain why the reaction of an acid with a base is called *neutralization.*
14. What characteristic of carbon atoms helps to explain the wide variety of organic compounds?
15. Compare acids and bases based on the ion produced when each compound is dissolved in water.