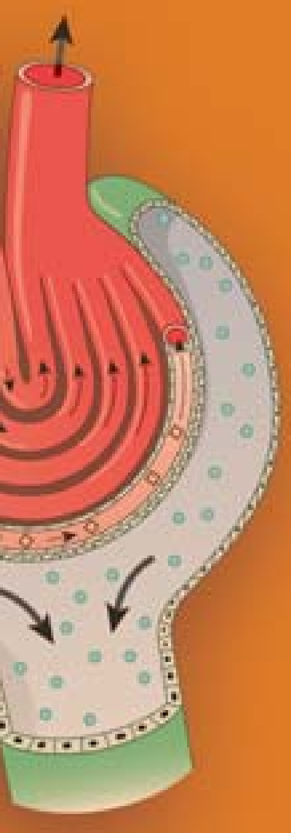
## Selected Key Terms

The following terms and other boldface terms in the chapter are defined in the Glossary



**acidosis**
**alkalosis**
**ascites**
**buffer**
**dehydration**
**edema**
**effusion**
**electrolyte**
**extracellular**
**interstitial**
**intracellular**
**pH**

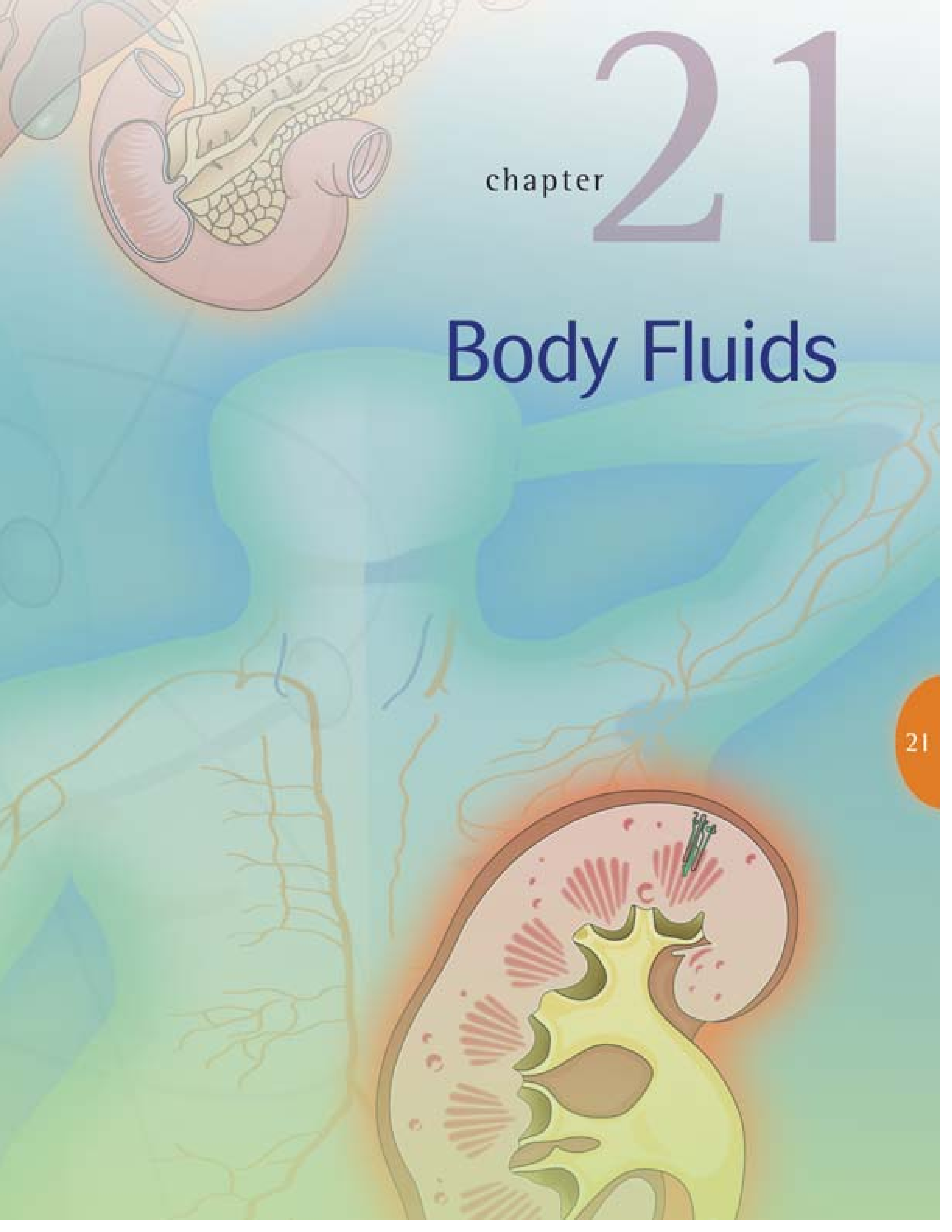
## Learning Outcomes

**After careful study of this chapter, you should be able to:**

1. Compare intracellular and extracellular fluids
2. List four types of extracellular fluids
3. Name the systems that are involved in water balance
4. Explain how thirst is regulated
5. Define *electrolytes* and describe some of their functions
6. Describe the role of hormones in electrolyte balance
7. Describe three methods for regulating the pH of body fluids
8. Compare acidosis and alkalosis, including possible causes
9. Describe some disorders involving body fluids
10. Specify some fluids used in therapy
11. Show how word parts are used to build words related to the urinary system (see Word Anatomy at the end of the chapter)

chapter 21

# Body Fluids



## The Importance of Water

Water is important to living cells as a solvent, a transport medium, and a participant in metabolic reactions. The normal proportion of body water varies from 50% to 70% of a person's weight. It is highest in the young and in thin, muscular individuals. In infants, water makes up 75% of the total body mass. That's why infants are in greater danger from dehydration than adults. With increase in the amount of fat, the percentage of water in the body decreases, because adipose tissue holds very little water compared with muscle tissue.

Various electrolytes (salts), nutrients, gases, waste, and special substances, such as enzymes and hormones, are dissolved or suspended in body water. The composition of body fluids is an important factor in homeostasis. Whenever the volume or chemical makeup of these fluids deviates even slightly from normal, disease results. (See Appendix 4, Table 3, for normal values.) The constancy of body fluids is maintained in the following ways:

- The thirst mechanism, which maintains the volume of water at a constant level
- Kidney activity, which regulates the volume and composition of body fluids (see Chapter 22, The Urinary System)
- Hormones, which serve to regulate fluid volume and electrolytes
- Regulators of pH (acidity and alkalinity), including buffers, respiration, and kidney function

The maintenance of proper fluid balance involves many of the principles discussed in earlier chapters, such as pH and buffers, the effects of respiration on pH, tonicity of solutions, and forces influencing capillary exchange. Some of these chapters will be referenced in the following sections. Additional information follows in Chapter 22 on the urinary system.

## Fluid Compartments

Although body fluids have much in common no matter where they are located, there are some important differences between fluid inside and outside cells. Accordingly, fluids are grouped into two main compartments (Fig. 21-1):

- **Intracellular fluid** (ICF) is contained within the cells. About two-thirds to three-fourths of all body fluids are in this category.
- **Extracellular fluid** (ECF) includes all body fluids outside of cells. In this group are included the following:
  - **Interstitial** (in-ter-STISH-al) **fluid,** or more simply, tissue fluid. This fluid is located in the spaces between the cells in tissues all over the body. It is estimated that tissue fluid constitutes about 15% of body weight.
  - **Blood plasma,** which constitutes about 4% of a person's body weight.
  - **Lymph,** the fluid that drains from the tissues into the lymphatic system. This is about 1% of body weight.
  - **Fluid in special compartments,** such as cerebrospinal fluid, the aqueous and vitreous humors of the eye, serous fluid, and synovial fluid. Together, these make up about 1% to 3% of total body fluids.

Fluids are not locked into one compartment. There is a constant interchange between compartments as fluids are transferred across semipermeable cell membranes by diffusion and osmosis (see Fig. 21-1). Also, fluids are lost and replaced on a daily basis.

**Checkpoint 21-1** What are the two main compartments into which body fluids are grouped?

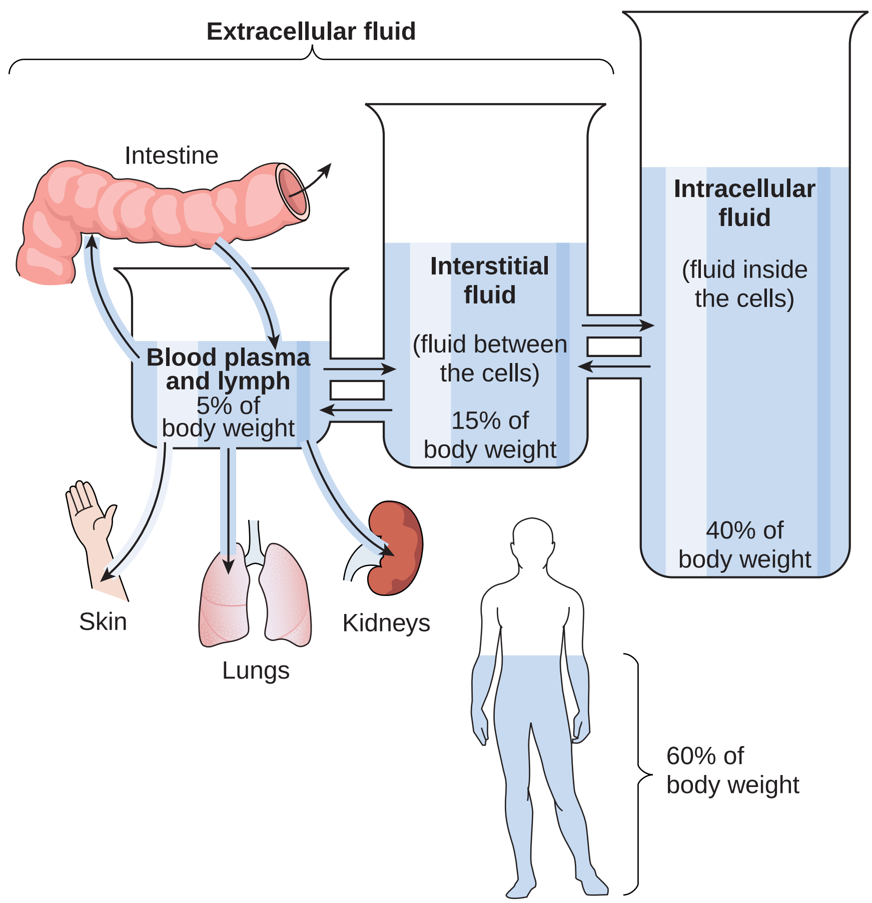



**Figure 21-1 Main fluid compartments showing relative percentage by weight of body fluid.** Fluid percentages vary but total about 60% of body weight. Fluids are constantly exchanged among compartments, and each day fluids are lost and replaced. *ZOOMING IN ✦ What are some avenues through which water is lost?*

## Water Balance

In a person whose health is normal, the quantity of water gained in a day is approximately equal to the quantity lost (output) (Fig. 21-2). The quantity of water consumed in a day (intake) varies considerably. The average adult in a comfortable environment takes in about 2300 mL of water (about 2 1/2 quarts) daily. About two-thirds of this quantity comes from drinking water and other beverages; about one-third comes from foods—fruits, vegetables, and soups. About 200 mL of water is produced each day as a by-product of cellular respiration. This water, described as *metabolic water*, brings the total average gain to 2500 mL each day.

The same volume of water is constantly being lost from the body by the following routes:

- The **kidneys** excrete the largest quantity of water lost each day. About 1 to 1.5 liters of water are eliminated daily in the urine. (Note that beverages containing alcohol or caffeine act as diuretics and increase water loss through the kidneys.)
- The **skin.** Although sebum and keratin help prevent dehydration, water is constantly evaporating from the skin's surface. Larger amounts of water are lost from the skin as sweat when it is necessary to cool the body.
- The **lungs** expel water along with carbon dioxide.
- The **intestinal tract** eliminates water along with the feces.

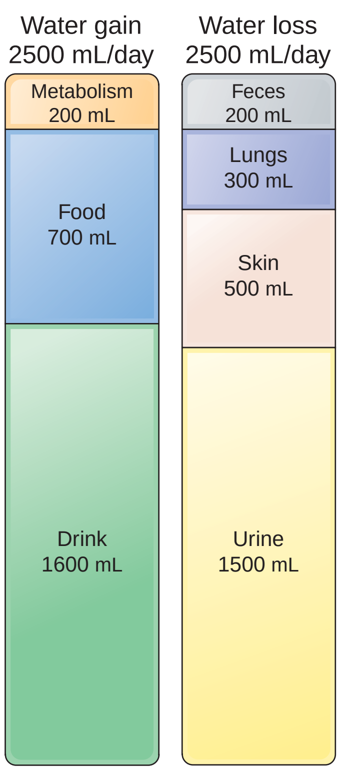



**Figure 21-2** **Daily gain and loss of water.**

In many disorders, it is important for the healthcare team to know whether a patient's intake and output are equal; in such a case, a 24-hour intake–output record is kept. The intake record includes *all* the liquid the patient has taken in. This means fluids administered intravenously as well as those consumed by mouth. The healthcare worker must account for water, other beverages, and liquid foods, such as soup and ice cream. The output record includes the quantity of urine excreted in the same 24-hour period as well as an estimation of fluid losses due to fever, vomiting, diarrhea, bleeding, wound discharge, or other causes.

**Checkpoint 21-2** What are three routes for water loss from the body?

### Sense of Thirst

The control center for the sense of thirst is located in the brain's hypothalamus. This center plays a major role in the regulation of total fluid volume. A decrease in fluid volume or an increase in the concentration of body fluids stimulates the thirst center, causing a person to drink water or other fluids containing large amounts of water. Dryness of the mouth also causes a sensation of thirst. Excessive thirst, such as that caused by excessive urine loss in cases of diabetes, is called **polydipsia** (pol-e-DIP-se-ah).

The thirst center should stimulate enough drinking to balance fluids, but this is not always the case. During vigorous exercise, especially in hot weather, the body can dehydrate rapidly. People may not drink enough to replace needed fluids. In addition, if plain water is consumed, the dilution of body fluids may depress the thirst center. Athletes who are exercising very strenuously may need to drink beverages with some carbohydrates for energy and also some electrolytes to keep fluids in balance. (See Box 21-1, Osmoreceptors: Thinking About Thirst, for more about thirst regulation).

**Checkpoint 21-3** Where is the control center for the sense of thirst located?

## Electrolytes and Their Functions

Electrolytes are important constituents of body fluids. These compounds separate into positively and negatively charged ions in solution. Positively charged ions are called *cations;* negatively charged ions are called *anions*. Electrolytes are so-named because they conduct an electrical current in solution. A few of the most important ions are reviewed next:

- Positive ions (cations):
  - **Sodium** is chiefly responsible for maintaining osmotic balance and body fluid volume. It is the main positive ion in extracellular fluids. Sodium is required for nerve

Box 21-1 A Closer Look

## Osmoreceptors: Thinking About Thirst

Osmoreceptors are specialized neurons that help to maintain water balances by detecting changes in the concentration of extracellular fluid (ECF). They are located in the hypothalamus of the brain in an area adjacent to the third ventricle, where they monitor the osmotic pressure (concentration) of the circulating blood plasma.

Osmoreceptors respond primarily to small increases in sodium, the most common cation in ECF. As the blood becomes more concentrated, sodium draws water out of the cells, initiating nerve impulses. Traveling to different regions of the hypothalamus, these impulses may have two different but related effects:

- They stimulate the hypothalamus to produce antidiuretic hormone (ADH), which is then released from the posterior pituitary. ADH travels to the kidneys and causes these organs to conserve water.
- They stimulate the thirst center of the hypothalamus, causing increased consumption of water. Almost as soon as water consumption begins, however, the sensation of thirst disappears. Receptors in the throat and stomach send inhibitory signals to the thirst center, preventing overconsumption of water and allowing time for ADH to affect the kidneys.

Both of these mechanisms serve to dilute the blood and other body fluids. Either mechanism alone can maintain water balance. If both fail, a person soon becomes dehydrated.

impulse conduction and is important in maintaining acid–base balance.

- **Potassium** is also important in the transmission of nerve impulses and is the major positive ion in intracellular fluids. Potassium is involved in cellular enzyme activities, and it helps regulate the chemical reactions by which carbohydrate is converted to energy and amino acids are converted to protein.
- **Calcium** is required for bone formation, muscle contraction, nerve impulse transmission, and blood clotting.

- Negative ions (anions):
  - **Phosphate** is essential in carbohydrate metabolism, bone formation, and acid–base balance. Phosphates are found in plasma membranes, nucleic acids (DNA and RNA) and ATP.
  - **Chloride** is essential for the formation of hydrochloric acid in the stomach. It also helps to regulate fluid balance and pH. It is the most abundant anion in extracellular fluids.

**Checkpoint 21-4** What is the main cation in extracellular fluid? In intracellular fluid?

**Checkpoint 21-5** What is the main anion in extracellular fluid?

## Electrolyte Balance

The body must keep electrolytes in the proper concentration in both intracellular and extracellular fluids (see Box 21-2). The maintenance of water and electrolyte balance is one of the most difficult problems for health workers in caring for patients. Although some electrolytes are lost in the feces and through the skin as sweat, the job of balancing electrolytes is left mainly to the kidneys, as described in Chapter 22 on the urinary system.

**The Role of Hormones** Several hormones are involved in balancing electrolytes (see Chapter 12). Aldosterone, produced by the adrenal cortex, promotes the reabsorption of sodium (and water) and the elimination of potassium. In **Addison disease,** in which the adrenal cortex does not produce enough aldosterone, there is a loss of sodium and water and an excess of potassium.

When the blood concentration of sodium rises above the normal range, the pituitary secretes more antidiuretic hormone (ADH). This hormone increases water reabsorption in the kidney to dilute the excess sodium.

Hormones from the parathyroid and thyroid glands regulate calcium and phosphate levels. Parathyroid hormone increases blood calcium levels by causing the bones to release calcium and the kidneys to reabsorb calcium. The thyroid hormone calcitonin lowers blood calcium by causing calcium to be deposited in the bones.

**Checkpoint 21-6** What are some mechanisms for regulating electrolytes in body fluids?

# Acid–Base Balance

The pH scale is a measure of how acidic or basic (alkaline) a solution is. As described in Chapter 2, the pH scale measures the hydrogen ion ($H^+$) concentration in a solution. Body fluids are slightly alkaline in a pH range of 7.35 to 7.45. These fluids must be kept within a narrow range of pH, or damage, even death, will result. A shift in either direction by three tenths of a point on the pH scale, to7.0 or 7.7, is fatal.

## Regulation of pH

The body constantly produces acids in the course of metabolism. Catabolism of fats yields fatty acids and other

Box 21-2 Clinical Perspectives

## Sodium and Potassium: Causes and Consequences of Imbalance

The concentrations of sodium and potassium in body fluids are important measures of water and electrolyte balance. An excess of sodium in body fluids is termed **hypernatremia**, taken from the Latin name for sodium, *natrium*. This condition accompanies dehydration and severe vomiting and may cause hypertension, edema, convulsions, and coma. **Hyponatremia**, a deficiency of sodium in body fluids, can come from water intoxication, heart failure, kidney failure, cirrhosis of the liver, pH imbalance, or endocrine disorders. It can cause muscle weakness, hypotension, confusion, shock, convulsions, and coma.

The term **hyperkalemia** is taken from the Latin name for potassium, *kalium*. It refers to excess potassium in body fluids, which may result from kidney failure, dehydration, and other causes. Its signs and symptoms include nausea, vomiting, muscular weakness, and severe cardiac arrhythmias. **Hypokalemia**, or low potassium in body fluids, may result from taking diuretics, which cause potassium to be lost along with water. It may also result from pH imbalance or secretion of too much aldosterone from the adrenal cortex, and it causes muscle fatigue, paralysis, confusion, hypoventilation, and cardiac arrhythmias.

acidic byproducts; cellular respiration yields pyruvic acid and, under anaerobic conditions, lactic acid; carbon dioxide dissolves in the blood and yields carbonic acid (see Chapter 18). Conversely, a few abnormal conditions may result in alkaline shifts in pH. Several systems act together to counteract these changes and maintain acid-base balance:

- **Buffer systems.** Buffers are substances that prevent sharp changes in hydrogen ion ($H^+$) concentration and thus maintain a relatively constant pH. Buffers work by accepting or releasing these ions as needed to keep the pH steady. The main buffer systems in the body are bicarbonate buffers, phosphate buffers, and proteins, such as hemoglobin in red blood cells and plasma proteins.
- **Respiration.** The role of respiration in controlling pH was described in Chapter 18. Recall that carbon dioxide release from the lungs makes the blood more alkaline by reducing the amount of carbonic acid formed. In contrast, carbon dioxide retention makes the blood more acidic. Respiratory rate can adjust pH for short-term regulation.
- **Kidney function.** The kidneys regulate pH by reabsorbing or eliminating hydrogen ions as needed. The kidneys are responsible for long-term pH regulation. The activity of the kidneys is described in Chapter 22.

**Checkpoint 21-7** What are three mechanisms for maintaining the acid–base balance of body fluids?

## Abnormal pH

If shifts in pH cannot be controlled, either acidosis or alkalosis results (Table 21-1).

**Acidosis** (as-ih-DO-sis) is a condition produced by a drop in the pH of body fluids to less than pH 7.35. This condition depresses the nervous system, leading to mental confusion and ultimately coma. Acidosis may result from a respiratory obstruction or any lung disease which prevents the release of $CO_2$. It may also arise from kidney failure or prolonged diarrhea, which drains the alkaline contents of the intestine. Long-term excessive exercise under anaerobic conditions can produce lactic acidosis.

Acidosis may also result from inadequate carbohydrate metabolism, as occurs in diabetes mellitus, ingestion of a low-carbohydrate diet, or starvation. In these cases, the body metabolizes too much fat and protein from food or body materials, leading to the production of excess acid. When acidosis results from the accumulation of ketone bodies, as in the case of diabetes, the condition is more accurately described as ketoacidosis.

**Alkalosis** (al-kah-LO-sis) results from an increase in pH to greater than 7.45. This abnormality excites the nervous system to produce tingling sensations, muscle twitches, and eventually paralysis. The possible causes of alkalosis include hyperventilation (the release of too much carbon dioxide), ingestion of too much antacid, and prolonged vomiting with loss of stomach acids.

It is convenient to categorize acidosis and alkalosis as having either respiratory or metabolic origins. Respiratory acidosis or alkalosis results from either an increase or a de-

**Table 21•1 Causes of Acidosis and Alkalosis**

| | ACIDOSIS | ALKALOSIS |
|---|---|---|
| Metabolic | Kidney failure; anaerobic metabolism; lack of carbohydrate metabolism, as in diabetes, starvation; prolonged diarrhea | Overuse of antacids; prolonged vomiting |
| Respiratory | Respiratory obstruction, lung disease such as asthma or emphysema, apnea or decreased ventilation | Hyperventilation (overbreathing due to anxiety or oxygen deficiency) |

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crease in blood $CO_2$. Metabolic acidosis or alkalosis results from unregulated increases or decreases in any other acids (see Table 21-1).

**Checkpoint 21-8** What are the conditions that arise from abnormally low or high pH of body fluids?

## Disorders of Body Fluids

**Edema** is the accumulation of excessive fluid in the intercellular spaces (Fig. 21-3). Some causes of edema are as follows:

- Interference with normal fluid return to the heart, as caused by congestive heart failure or blockage in the venous or lymphatic systems (see Chapters 14 and 15). A backup of fluid in the lungs, **pulmonary edema,** is a serious potential consequence of congestive heart failure.
- Lack of protein in the blood. This deficiency may result from protein loss or ingestion of too little dietary protein for an extended period. It may also result from failure of the liver to manufacture adequate amounts of the protein albumin, as frequently occurs in liver disease. The decrease in protein lowers the blood's osmotic pressure and reduces fluid return to the circulation. Diminished fluid return results in accumulation of fluid in the tissues.
- Kidney failure, a common clinical cause of edema, resulting from the inability of the kidneys to eliminate adequate amounts of urine

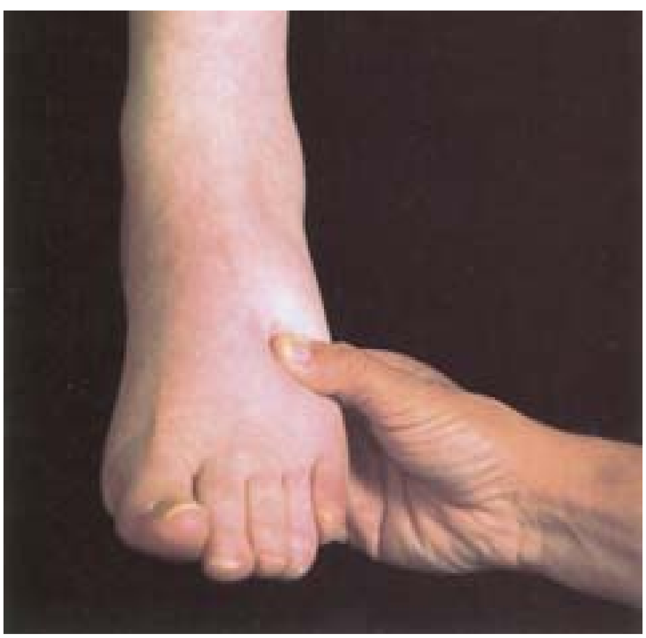

**Figure 21-3** **Edema of the foot.** (Reprinted with permission from Bickley LS. Bates' Guide to Physical Examination and History Taking. 8th ed. Philadelphia: Lippincott Williams & Wilkins, 2003.)

- Increased loss of fluid through the capillaries, as caused by injury, allergic reaction, or certain infections.

**Water intoxication** involves dilution of body fluids in both the intracellular and extracellular compartments. Transport of water into the cells results in swelling. In the brain, cellular swelling may lead to convulsions, coma, and finally death. Causes of water intoxication include an excess of ADH and intake of excess fluids by mouth or by intravenous injection.

**Effusion** (e-FU-zhun) is the escape of fluid into a cavity or a space. An example is pleural effusion, fluid within the pleural space; in this condition fluid compresses the lung, so that normal breathing is not possible. Tuberculosis, cancer, and some infections may give rise to effusion. Effusion into the pericardial sac, which encloses the heart, may occur in autoimmune disorders, such as lupus erythematosus and rheumatoid arthritis. Infection is another cause of pericardial effusion. The fluid may interfere with normal heart contractions and can cause death.

**Ascites** (ah-SI-teze) is effusion with accumulation of fluid within the abdominal cavity. It may occur in disorders of the liver, kidneys, and heart, as well as in cancers, infection or malnutrition.

**Dehydration** (de-hi-DRA-shun), a severe deficit of body fluids, will result in death if it is prolonged. The causes include vomiting, diarrhea, drainage from burns or wounds, excessive perspiration, and inadequate fluid intake, as in cases of damage to the thirst mechanism. In such cases, it may be necessary to administer intravenous fluids to correct fluid and electrolyte imbalances.

**Checkpoint 21-9** What is edema?

## Fluid Therapy

Chapter 3 discussed the rules concerning movement of water into and out of cells when they are placed in different solutions. Recall that an isotonic solution has the same concentration as the cellular fluids and will not cause a net loss or gain of water. A hypertonic solution is more concentrated than cellular fluid and will draw water out of the cells. A hypotonic solution is less concentrated than the cellular fluids and a cell will take in water when placed in this type of solution. These rules must be considered when fluid is administered.

Fluids are administered into a vein under a wide variety of conditions to help maintain normal body functions when natural intake is not possible. Fluids are also administered to correct specific fluid and electrolyte imbalances in cases of losses due to disease or injury. (Box 21-3, Emergency Medical Technicians, focuses on a healthcare professional whose role may include administering fluids.)

The first fluid administered intravenously in emergencies is normal saline, which contains 0.9% sodium

**Box 21-3 • Health Professions**

## Emergency Medical Technicians

Emergency medical technicians (EMTs) are the first health professionals to arrive at the scene of an automobile accident, heart attack, or other emergency situation. EMTs must assess and respond rapidly to a medical crisis, taking a medical history, performing a physical examination, stabilizing the patient, and, if necessary, transporting the patient to the nearest medical facility.

To perform their life-saving duties, EMTs need extensive training, including a thorough understanding of anatomy and physiology. EMTs must know how to use specialized equipment, such as backboards to immobilize injuries, electrocardiographs to monitor heart activity, and defibrillators to treat cardiac arrest, and they must also be proficient at giving intravenous fluids, oxygen, and certain life-saving medications. At medical facilities, EMTs work closely with physicians and nurses, reporting on histories, physical examinations, and measures taken to stabilize the patient. Most EMTs receive their training from a college or technical school and must be certified in the state where they are employed.

As the American population continues to age and become concentrated in urban centers, the rate of accidents and other emergencies is expected to rise. Thus, the need for EMTs remains high. For more information about this rewarding career, contact the National Association of Emergency Medical Technicians.

chloride, a concentration equal to that of plasma. Because it is isotonic, this type of solution does not change the ion distribution in the body fluid compartments.

Frequently, a patient receives 5% dextrose (glucose) in 0.45% (1/2 normal) saline. This solution is hypertonic when infused, but becomes hypotonic after the sugar is metabolized. Another common fluid is 5% dextrose in water. This solution is slightly hypotonic when infused. The amount of sugar contained in a liter of this fluid is equal to 170 calories. The sugar is soon used up, resulting in a fluid that is effectively pure water. Use of these hypotonic fluids is not advisable for long-term therapy because of the common occurrence of water intoxication. Both these dextrose solutions increase the plasma fluid volume. Small amounts of potassium chloride are often added to replace electrolytes lost by vomiting or diarrhea.

Ringer lactate solution contains sodium, potassium, calcium, chloride, and lactate. In this formulation, the electrolyte concentrations are equal to normal plasma values. The lactate is metabolized to bicarbonate, which acts as a buffer. This fluid is given when the need is for additional plasma volume with the electrolyte concentration equal to that of the blood.

In 25% serum albumin, the concentration of the plasma protein albumin is five times normal. This hypertonic solution draws fluid from the interstitial spaces into the circulation.

Fluids containing varied concentrations of dextrose, sodium chloride, potassium, and other electrolytes and substances are manufactured. These fluids are used to correct specific imbalances. Nutritional solutions containing concentrated sugar, protein, and fat are available for administration when oral intake is not possible for an extended period.



## Word Anatomy

Medical terms are built from standardized word parts (prefixes, roots, and suffixes). Learning the meanings of these parts can help you remember words and interpret unfamiliar terms.

| WORD PART | MEANING | EXAMPLE |
|---|---|---|
| ***Fluid Compartments*** | | |
| intra- | within | *Intracellular* fluid is within a cell. |
| extra- | outside of, beyond | *Extracellular* fluid is outside the cells. |
| semi- | partial, half | A *semipermeable* membrane is partially permeable. |
| ***Water Balance*** | | |
| poly- | many | *Polydipsia* is excessive thirst. |
| osmo- | osmosis | *Osmoreceptors* detect changes in osmotic concentration of fluids. |
| ***Acid-Base Balance*** | | |
| -o/sis | condition, process | *Acidosis* is a condition produced by a drop in the pH of body fluids. |
| ***Disorders of Body Fluids*** | | |
| tox/o | poison | Water *intoxication* is dilution of body fluids by excess water. |
| hydr/o | water | *Dehydration* is a severe deficit of body fluids. |

## Summary

### I. The importance of water

A. Functions
 1. Solvent
 2. Transport medium
 3. Participant in metabolic reactions
B. 50% to 70% of body weight
C. Contains electrolytes, nutrients, gases, wastes, hormones, and other substances
D. Important in homeostasis

### II. Fluid compartments

A. Intracellular fluid—contained within the cells
B. Extracellular fluid—outside the cells
 1. Blood plasma
 2. Interstitial (tissue) fluid
 3. Lymph
 4. Fluid in special compartments

### III. Water balance

A. Loss—through kidneys, skin, lungs, intestinal tract,
B. Gain—through beverages, food, metabolic water
 1. Sense of thirst
C. Control center in hypothalamus
D. Responds to fluid volume and concentration of body fluids

### IV. Electrolytes and their functions

A. Electrolytes release ions in solution
 1. Positive ions (cations)—*e.g.*, sodium, potassium, calcium
 2. Negative ions (anions)—*e.g.*, phosphate, chloride
  a. Electrolyte balance
B. Kidneys—main regulators
C. Role of hormones
 1. Aldosterone (from adrenal cortex)
  a. Promotes reabsorption of sodium
  b. Promotes excretion of potassium
 2. ADH (from pituitary)
  a. Causes kidney to retain water
 3. Parathyroid hormone (from parathyroid glands)
  a. Increases blood calcium level
 4. Calcitonin (from thyroid)
  a. Decreases blood calcium level

### V. Acid–base balance

A. Normal pH range is 7.35-7.45
 1. Regulation of pH
B. Buffers—maintain constant pH
C. Respiration—release of carbon dioxide increases alkalinity; retention of carbon dioxide increases acidity
D. Kidney—regulates amount of hydrogen ion excreted
 1. Abnormal pH
E. Acidosis—decrease in pH; causes: respiratory obstruction, lung disease, kidney failure, diarrhea, diabetes mellitus, starvation
F. Alkalosis—increase in pH; causes: hyperventilation, ingestion of antacids, prolonged vomiting

### VI. Disorders of body fluids

A. Edema—accumulation of fluid in tissues
 1. Causes
  a. Interference with fluid return to heart
  b. Lack of proteins in blood
  c. Kidney failure
  d. Fluid loss from capillaries
B. Water intoxication—dilution of body fluids
C. Effusion—escape of fluid into a cavity or space
D. Ascites—accumulation of fluid in abdominal cavity
E. Dehydration—deficiency of fluid

### VII. Fluid therapy

A. Purpose
 1. Correct fluid balance
 2. Correct electrolyte balance
 3. Provide nourishment
B. Commonly used solutions
 1. Normal saline
 2. 5% dextrose (glucose) in 0.45% (1/2 normal) saline
 3. 5% dextrose in water
 4. Ringer lactate
 5. 25% serum albumin

## Questions for Study and Review

### Building Understanding

#### Fill in the blanks

1. Excessive thirst is termed______.
2. Loss of sodium and an excess of potassium are classic signs of ______ disease.
3. Substances in the blood that prevent sharp changes in hydrogen ion concentration are called______.
4. Effusion with accumulation of fluid within the abdominal cavity is termed ______.
5. A severe deficit in body fluid is called ______.

### Matching

Match each numbered item with the most closely related lettered item.

___ 6. Essential for maintaining osmotic balance and body fluid volume; this cation is abundant in extracellular fluid

___ 7. Important in the transmission of nerve impulses and enzyme activities; this cation is abundant in intracellular fluid

___ 8. Required for bone formation, muscle contraction, and blood clotting

___ 9. Essential in bone formation and acid-base balance; this anion is found in plasma membranes, ATP and nucleic acids

___ 10. Important for gastric acid formation; this anion is abundant in extracellular fluid

a. sodium
b. potassium
c. calcium
d. phosphate
e. chloride

### Multiple choice

___ 11. Body water content is greatest in
a. infants
b. children
c. young adults
d. elderly adults

___ 12. Fluid located in the spaces between the cells is called
a. cytoplasm
b. plasma
c. interstitial fluid
d. lymph

___ 13. The organ(s) responsible for water loss through evaporation is (are) the
a. kidneys
b. skin
c. lungs
d. intestinal tract

___ 14. Which of the following is responsible for long-term regulation of pH?
a. buffer system
b. digestive system
c. respiratory system
d. urinary system

___ 15. Increased blood $CO_2$ causes
a. respiratory acidosis
b. respiratory alkalosis
c. metabolic acidosis
d. metabolic alkalosis

## Understanding Concepts

16. Compare the terms in each of the following pairs:
a. intracellular and extracellular fluid
b. aldosterone and antidiuretic hormone
c. calcitonin and parathyroid hormone

17. In a healthy person, what is the ratio of fluid intake to output?

18. Explain the role of the hypothalamus in water balance.

19. How do the respiratory and urinary systems regulate pH?

20. Compare and contrast the following disorders:
a. acidosis and alkalosis
b. edema and effusion
c. water intoxication and dehydration

21. List some causes of edema.

22. List three purposes for administering intravenous fluids.

23. Compare and contrast the following types of intravenous fluids:
a. normal saline and 5% dextrose saline
b. Ringer solution and serum albumin

## Conceptual Thinking

24. Patty Grant, 55 years old, reports severe headaches and excessive thirst and urination. What is the probable cause of Patty's symptoms?

25. Why is emphysema associated with decreased urine pH?