

The Excretory System

Reading Preview

Key Concepts

- What are the structures and function of the excretory system?
- How do the kidneys filter wastes from the blood?
- How does excretion contribute to homeostasis?

Key Terms

- excretion • urea • kidney
- urine • ureter
- urinary bladder • urethra
- nephron

Target Reading Skill

Previewing Visuals Before you read, preview Figure 11. Then, write two questions that you have about the diagram in a graphic organizer like the one below. As you read, answer your questions.

How the Kidneys Filter Wastes

Q. Where are nephrons located?

A.

Q.

Lab
zone

Discover Activity

How Does Filtering a Liquid Change the Liquid?

1. Your teacher will give you 50 mL of a liquid in a small container. Pour a small amount of sand into the liquid.
2. Use a glucose test strip to determine whether glucose is present in the liquid.
3. Put filter paper in a funnel. Then, put the funnel into the mouth of a second container. Slowly pour the liquid through the funnel into the second container.
4. Look for any solid material on the filter paper. Remove the funnel, and carefully examine the liquid that passed through the filter.
5. Test the liquid again to see whether it contains glucose.



Think It Over

Observing Which substances passed through the filter, and which did not? How might a filtering device be useful in the body?

The human body faces a challenge that is a bit like trying to keep your room clean. Magazines, notebook paper, and CD wrappers tend to pile up in your room. You use all of these things, but sooner or later you must clean your room if you don't want to be buried in trash. Something similar happens in your body. As your cells use nutrients in respiration and other processes, wastes are created. Different organs in the body have roles for the removal of these wastes. The removal process is known as **excretion**.

If wastes were not removed from your body, they would pile up and make you sick. Excretion helps keep the body's internal environment stable and free of harmful materials. **The excretory system is the system in the body that collects wastes produced by cells and removes the wastes from the body.**

The Excretory System

Objectives

After this lesson, students will be able to

- D.4.3.1** Identify the structures and functions of the excretory system.
D.4.3.2 State how the kidneys filter wastes from the blood.
D.4.3.3 Explain how excretion contributes to homeostasis.

Target Reading Skill

Previewing Visuals Explain that looking at the visuals before they read helps students activate prior knowledge and predict what they are about to read.

Answers

Possible student questions and answers are these: **Where are nephrons located?** (*In the kidneys*) **What three main materials are filtered out of the blood?** (*Urea, water, glucose*) **What happens to these filtered materials?** (*Most of the water and glucose are reabsorbed. Most of the urea remains as urine.*)

All in One Teaching Resources

- [Transparency D37](#)

Preteach

Build Background Knowledge

L2

Importance of Waste Removal

Have students list some typical items that families discard as trash. Ask: **What would happen if no one ever removed this trash from their apartment?** (*Sample answer: The trash could build up until it overflowed the trash cans, started to fill living areas, and became a health hazard.*) Point out that the body produces “trash” substances that need to be eliminated.

Lab
zone

Discover Activity

Skills Focus Observing

L1

Materials glucose solution, sand, two small plastic containers, glucose test strip, plastic funnel, filter paper

Time 15 minutes

Tips Prepare the glucose solution, using 5 g of glucose per liter of water. Each plastic container should hold at least 75 mL.

Expected Outcome The glucose solution will pass through the filter, but the sand will not.

Think It Over The glucose and water passed through the filter; the sand did not. A filtering device could remove wastes in the body.

Instruct

The Excretory System

Teach Key Concepts

L2

Excretory System Function

Focus Remind students that the body produces wastes and removes wastes.

Teach Explain that the kidneys, the major organs of the excretory system, remove wastes from the blood. Ask: **What are examples of wastes that need to be removed?** (*Urea and excess water*) **What parts of the excretory system function to eliminate these wastes from the body?** (*Kidneys, urinary bladder, and urethra*)

Apply Ask: **What might happen if wastes were not eliminated daily?** (*They would build up and keep the body from functioning as it should and eventually cause illness.*)

learning modality: verbal

All in One Teaching Resources

- [Transparency D38](#)

Independent Practice

L2

All in One Teaching Resources

- [Guided Reading and Study Worksheet: The Excretory System](#)

 **Student Edition on Audio CD**

Filtration of Wastes

Teach Key Concepts

L2

Stages of Waste Removal

Focus Tell students that during the first stage of waste removal blood enters the kidneys.

Teach Direct students' attention to each stage shown in Figure 11. Ask students to identify the artery, nephron, and capillaries and tell how each functions in the stages of urine formation.

Apply Ask: **What might urine analysis tell?** (*It might tell if substances are in the urine that should not be there, such as glucose.*) **learning modality:** visual

All in One Teaching Resources

- [Transparency D39](#)

The Excretory System

Two wastes that your body must eliminate are excess water and urea. **Urea** (yoo REE uh) is a chemical that comes from the breakdown of proteins. **The structures of the excretory system that eliminate urea, water, and other wastes include the kidneys, ureters, urinary bladder, and urethra.**

Your two **kidneys**, which are the major organs of the excretory system, remove urea and other wastes from the blood. The kidneys act like filters. They remove wastes but keep materials that the body needs. The wastes are eliminated in **urine**, a watery fluid that contains urea and other wastes. Urine flows from the kidneys through two narrow tubes called **ureters** (yoo REE turz). The ureters carry urine to the **urinary bladder**, a sacklike muscular organ that stores urine. Urine leaves the body through a small tube called the **urethra** (yoo REE thruh).



What is the role of the ureters?

Filtration of Wastes

The kidneys are champion filters. Each of your kidneys contains about a million **nephrons**, tiny filtering factories that remove wastes from blood and produce urine. **The nephrons filter wastes in stages. First, both wastes and needed materials, such as glucose, are filtered out of the blood. Then, much of the needed material is returned to the blood, and the wastes are eliminated from the body.** Follow this process in Figure 11.

Filtering Out Wastes During the first stage of waste removal, blood enters the kidneys. Here, the blood flows through smaller and smaller arteries. Eventually it reaches a cluster of capillaries in a nephron. The capillaries are surrounded by a thin-walled, hollow capsule that is connected to a tube. In the capillary cluster, urea, glucose, and some water move out of the blood and into the capsule. Blood cells and most protein molecules do not move into the capsule. Instead, they remain in the capillaries.

Formation of Urine Urine forms from the filtered material in the capsule. This material flows through the long, twisting tube. As the liquid moves through the tube, many of the substances are returned to the blood. Normally, all the glucose, most of the water, and small amounts of other materials pass back into the blood in the capillaries that surround the tube. In contrast, urea and other wastes remain in the tube.

Lab zone Skills Activity

Classifying

A number of materials enter the kidney, where they are filtered by the nephrons.

- What materials enter a nephron?
- What materials are returned to the blood?
- What materials leave the body in urine?

Lab zone Skills Activity

Skills Focus Classifying

Materials None

Time 5 minutes

Tips Remind students that blood carries many substances, including nutrients, glucose, hormones, wastes, and dissolved gases.

L2

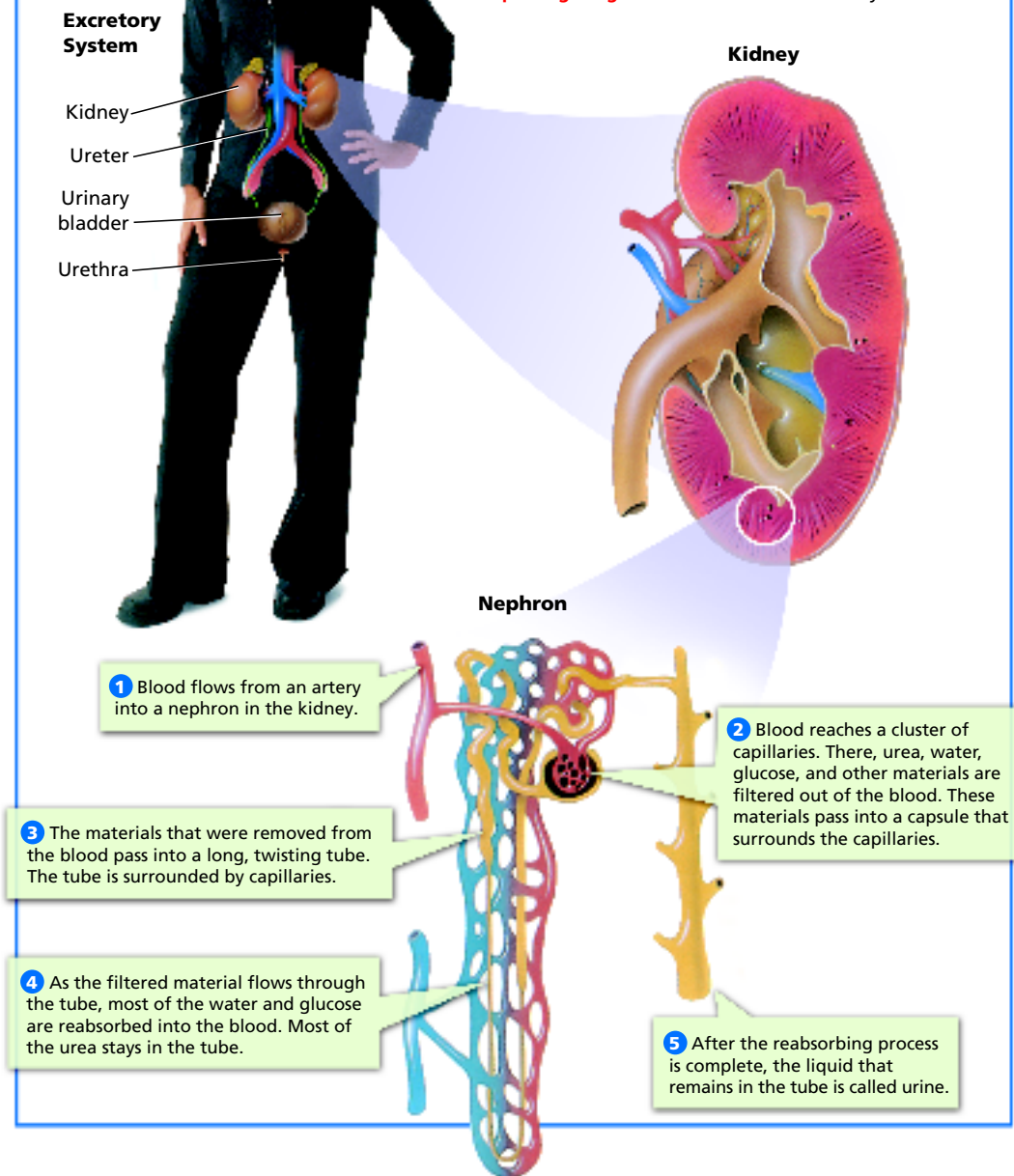
Expected Outcome Urea, water, glucose are filtered from the blood into the nephron. Most of the water and glucose and a small amount of the other materials are returned to the blood. Urea and other wastes leave the body in urine.

FIGURE 11

How the Kidneys Filter Wastes

The structures of the excretory system include the kidneys, urinary bladder, and urethra. Each kidney contains about a million tiny filtering units called nephrons. Urine is produced in the nephrons.

Interpreting Diagrams Where are the kidneys located?



Kidney Function

Materials 30-cm section of cellophane dialysis tubing, 2 large beakers, string, 10 mL of salt-water solution, distilled water, hand-held conductivity tester, ruler

Time 40 minutes

Focus Explain that an important function of the kidneys is to return sodium to the blood during the formation of urine. This activity will demonstrate this process.

Teach Soak the tubing for several hours in a beaker filled with distilled water. Use string to tie one end of the dialysis tubing tightly closed. After the tubing is tied, store it in the container of distilled water. On the day of the activity, prepare a salt solution by mixing a few teaspoons of table salt in 100 mL of water. Fill the tubing three quarters full with the salt solution and then tie the open end of the bag tightly closed with string. Suspend the tubing in a beaker of distilled water by tying it to a ruler placed across the rim. Do not allow the beaker to overflow. Tell students that the bag contains a salt solution, that salt contains sodium, and that the tester indicates the presence of salt in solution. After 20 minutes, test the solution in the beaker with the conductivity tester. (It should light.)

Apply Ask: **How did the salt get into the distilled water, and how does this model the movement of sodium during the formation of urine?** (The salt in the tubing passes into the water the way sodium in the kidney tubes passes back into the blood in the capillaries that surround the tubes.) **learning modality: visual**

Differentiated Instruction

Gifted and Talented

Making a Display Have a group of students work cooperatively to investigate the causes of kidney stones, their treatment, and how the incidence of kidney stones can be reduced. Ask that group members prepare visuals to use as a display to present their findings to the class. **learning modality: visual**

L3

Less Proficient Readers

Illustrating the System Give each student several index cards. Have them write a Key Term on the front of each card, and its definition on the back. Have them refer to the cards as they study Figure 11. **learning modality: visual**

L1

Monitor Progress

L2

Writing Have students list the functions of the kidneys.

Answers

Figure 11 The kidneys are located above the hips.



The ureters carry urine from the kidneys to the urinary bladder.

Excretion and Homeostasis

Teach Key Concepts

L2

Maintaining Homeostasis

Focus Explain that homeostasis is the process that keeps the body's internal environment stable in spite of changes in the external environment. Homeostasis includes balancing the volume of fluids in the body and eliminating wastes.

Teach Ask: What organs are involved in eliminating water from the body? (*Kidneys, lungs, and skin*) What role does the liver have in maintaining homeostasis? (*It helps break down wastes so they can be recycled or eliminated.*)

Apply Ask: Why is more water absorbed by the kidneys during a hot day? (*Because water is needed to balance the amount of water lost due to perspiration*) **learning modality:** logical/mathematical



L1

Perspiration

Materials plastic sandwich bag for each student, masking tape

Time 10 minutes

Focus Remind students that the sweat glands of the skin also function in excretion of wastes.

Teach Have each student place a plastic bag over one hand and then use masking tape to close the bag at the wrist. After a few minutes, students should observe condensation inside the bag.

Apply Ask: Does the skin remove wastes from the body all the time or just when you are aware you are perspiring? (*All the time*) **learning modality:** kinesthetic

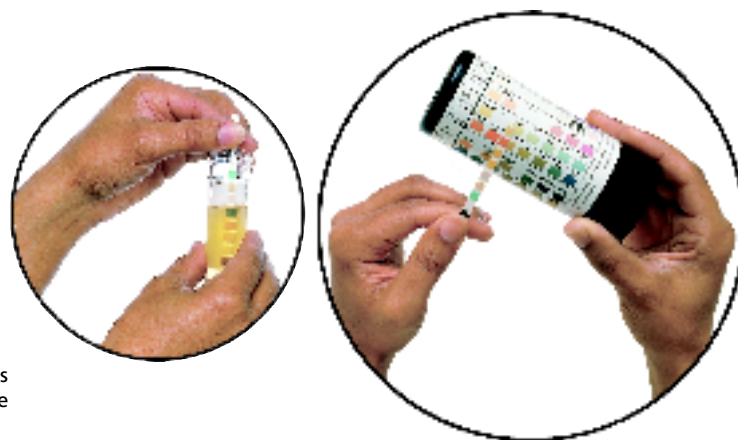


FIGURE 12

Analyzing Urine

Lab technicians can analyze urine by using a dipstick that changes color in the presence of glucose and other substances. The technician dips the dipstick into a urine sample and compares the results to a color chart.

Applying Concepts What are two substances for which urine can be tested?

Analyzing Urine for Signs of Disease When people go to a doctor for a medical checkup, they usually have their urine analyzed. A chemical analysis of urine can be useful in detecting some medical problems. Normally, urine contains almost no glucose or protein. If glucose is present in urine, it may indicate that a person has diabetes, a condition in which body cells cannot absorb enough glucose from the blood. Protein in urine can be a sign that the kidneys are not functioning properly.



What could it mean if there is glucose in the urine?

Excretion and Homeostasis

Eliminating wastes, such as urea, excess water, and carbon dioxide, is important for maintaining homeostasis. **Excretion maintains homeostasis by keeping the body's internal environment stable and free of harmful levels of chemicals. In addition to the kidneys, organs of excretion that maintain homeostasis include the lungs, skin, and liver.**

Kidneys As the kidneys filter blood, they help to maintain homeostasis by regulating the amount of water in your body. Remember that as urine is being formed, water passes from the tube back into the bloodstream. The exact amount of water that is reabsorbed depends on conditions both outside and within the body. For example, suppose that it's a hot day. You've been sweating a lot, and you haven't had much to drink. In that situation, almost all of the water in the tube will be reabsorbed, and you will excrete only a small amount of urine. If, however, the day is cool and you've drunk a lot of water, less water will be reabsorbed. Your body will produce a larger volume of urine.



For: Links on organs of excretion
Visit: www.SciLinks.org
Web Code: scn-0443



For: Links on organs of excretion
Visit: www.SciLinks.org
Web Code: scn-0443

Download a worksheet that will guide students' review of Internet resources on organs of excretion.

Lungs and Skin Most of the wastes produced by the body are removed through the kidneys. However, the lungs and skin remove some wastes from the body as well. When you exhale, carbon dioxide and some water are removed from the body by the lungs. Sweat glands in the skin also serve an excretory function because water and urea are excreted in perspiration.

Liver Have you ever torn apart a large pizza box so that it could fit into a wastebasket? If so, then you understand that some wastes need to be broken down before they can be excreted. The liver performs this function. For example, urea, which comes from the breakdown of proteins, is produced by the liver. The liver also converts part of the hemoglobin molecule from old red blood cells into substances such as bile. Because the liver produces a usable material from old red blood cells, you can think of the liver as a recycling facility.



What substances are excreted in perspiration?

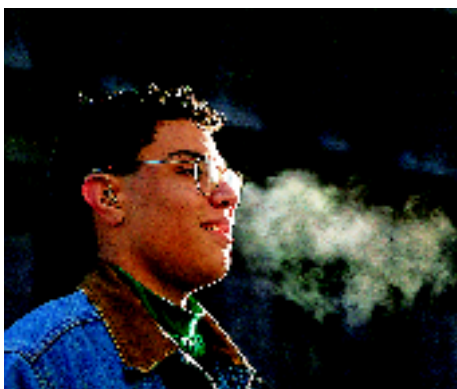


FIGURE 13

Excretion Through the Lungs

Your lungs function as excretory organs. When you exhale on a cold morning, you can see the water in your breath.

Section 3 Assessment



Target Reading Skill **Previewing Visuals**

Compare your questions and answers about Figure 11 with those of a partner.

Reviewing Key Concepts

- a. Reviewing** What is the role of the excretory system in the body?
 b. Sequencing Name the structures of the excretory system in order of their roles in producing and eliminating urine. Describe the function of each structure.
- a. Reviewing** What are the two main stages of waste removal by the kidneys?
 b. Describing What happens as wastes are filtered in a nephron?
 c. Relating Cause and Effect Why is protein in the urine a sign that something could be wrong with the kidneys?

- a. Identifying** What is the role of excretion in maintaining homeostasis?
 b. Explaining How do the kidneys help maintain homeostasis?
 c. Predicting On a long bus trip, a traveler does not drink any water for several hours. How will the volume of urine she produces that day compare to the volume on a day when she drinks several glasses of water? Explain.

Writing in Science

Explanation Write a paragraph explaining how wastes are filtered in the kidneys. To help you with your writing, first make two lists—one that includes materials removed from the blood in the kidneys and one that includes materials returned to the blood.

Monitor Progress L2

Answers

Figure 12 Urine can be tested for glucose and protein.



It may indicate that a person has diabetes.



Water and urea are excreted in perspiration.

Assess

Reviewing Key Concepts

- a.** The excretory system collects wastes produced by cells and removes them from the body. **b.** kidneys (removes urea and wastes from blood), ureters (carries urine), urinary bladder (stores urine), urethra (excretes urine)
- a.** First, both wastes and needed materials, such as glucose, are filtered from the blood into a nephron. Then, much of the needed material is returned to the blood, while the wastes are eliminated from the body in urine. **b.** Blood flows into a cluster of capillaries in the nephron. Here, urea, glucose, and water move out of the blood. Blood cells and protein remain in the blood. The urea, glucose, and water then pass into a capsule that surrounds the capillary cluster. **c.** Protein molecules do not usually move into the capsule but remain in the capillaries. Movement of protein into the capsule could be a sign that the nephron is malfunctioning.
- a.** It keeps the body's internal environment stable and free of harmful chemicals. **b.** They regulate the amount of water in your body by adjusting the amount of water reabsorbed during excretion. **c.** She will probably produce less urine because most of the water she is taking in will be reabsorbed.

Reteach L1

Have students list each of the structures of the excretory system in the order of their roles. Next to each identified structure, have students explain the structure's function.

Performance Assessment L2

Writing Have students explain how one organ in the excretory system functions.

All in One Teaching Resources

- [Section Summary: The Excretory System](#)
- [Review and Reinforce: The Excretory System](#)
- [Enrich: The Excretory System](#)



Chapter Project

Keep Students on Track By now students should be creating their ads. Groups should have assigned roles for the production of their ads. For example, if students are producing newspaper or magazine ads, original drawings or images from other sources will be needed. If preparing TV or radio ads, actors and props will need to be arranged.

Writing in Science

Writing Mode Description

Scoring Rubric

- Includes accurate, detailed description of process
- Includes accurate description with few details
- Includes minimum description and no details
- Includes inaccurate description

Clues About Health

Prepare for Inquiry

Key Concept

Urine tests can provide evidence of disease.

Skills Objective

After this lab, students will be able to

- observe color changes as solutions react with the test solutions
- interpret data and draw conclusions about the presence or absence of glucose and protein in the solutions



Prep Time 20 minutes

Class Time 40 minutes

Advance Planning

Make up the patients' samples to match the Sample Data Table or according to your own preferences. Prepare a 1% glucose solution by dissolving 10 g of glucose in 990 mL of water. Make a 1% protein solution by dissolving 10 g of albumin or pepsin in 990 mL of water. Add food coloring to make the solutions a pale yellow (like urine), if desired. Use these solutions to make the simulated urine samples. Glucose test strips and Biuret solution can be obtained from biological supply companies.

All in One Teaching Resources

- [Lab Worksheet: Clues About Health](#)

Guide Inquiry

Invitation

Ask students to list substances that are filtered from the blood and to identify which of those substances should be reabsorbed. (*Sugar is one substance that should be reabsorbed.*) Students should conclude that some substances should not be in the urine of a healthy person.

Introduce the Procedure

Ask: **What is the purpose of testing known solutions?** (*They show how the test materials work.*)

Troubleshooting the Experiment

- Food coloring may distort color changes and make them less noticeable.
- Droppers should be labeled and returned to the proper test tube to avoid contamination.

Clues About Health

Problem

How can you test urine for the presence of glucose and protein?

Skills Focus

observing, interpreting data, drawing conclusions

Materials

- 6 test tubes
- test-tube rack
- 6 plastic droppers
- water
- glucose solution
- protein solution
- marking pencil
- white paper towels
- 6 glucose test strips
- Biuret solution
- 3 simulated urine samples

Procedure



PART 1 Testing for Glucose

1. Label six test tubes as follows: *W* for water, *G* for glucose, *P* for protein, and *A*, *B*, and *C* for three patients' "urine samples." Place the test tubes in a test-tube rack.
2. Label six glucose test strips with the same letters: *W*, *G*, *P*, *A*, *B*, and *C*.

3. Copy the data table into your notebook.

4. Fill each test tube about $\frac{3}{4}$ full with the solution that corresponds to its label.

5. Place glucose test strip *W* on a clean, dry section of a paper towel. Then, use a clean plastic dropper to place 2 drops of the water from test tube *W* on the test strip. Record the resulting color of the test strip in your data table. If no color change occurs, write "no reaction."

6. Use the procedure in Step 5 to test each of the other five solutions with the correctly labeled glucose test strip. Record the color of each test strip in the data table.

PART 2 Testing for Protein

7. Obtain a dropper bottle containing Biuret solution. Record the original color of the solution in your notebook.

8. Carefully add 30 drops of Biuret solution to test tube *W*. **CAUTION:** *Biuret solution can harm skin and damage clothing. Handle it with care.* Gently swirl the test tube to mix the two solutions together. Hold the test tube against a white paper towel to help you detect any color change. Observe the color of the final mixture, and record that color in your data table.

9. Repeat Step 8 for each of the other test tubes.

Data Table						
Test for	Test Tube					
	W (water)	G (glucose)	P (protein)	A (Patient A)	B (Patient B)	C (Patient C)
Glucose						
Protein						



Analyze and Conclude

- Observing** What color reaction occurred when you used the glucose test strip on sample W? On sample G?
- Interpreting Data** What do the changes in color you observed in Part 1 indicate? Explain.
- Observing** What happened when you added Biuret solution to test tube W? To test tube P?
- Interpreting Data** What do the changes in color of the Biuret solution you observed in Part II indicate? Explain.
- Drawing Conclusions** Which of the three patients' urine samples tested normal? How do you know?

- Drawing Conclusions** Which urine sample(s) indicated that diabetes might be present? How do you know?
- Drawing Conclusions** Which urine sample(s) indicated that kidney disease might be present? How do you know?
- Communicating** Do you think a doctor should draw conclusions about the presence of a disease based on a single urine sample? Write a paragraph in which you discuss this question based on what you know about gathering data in experiments.

More to Explore

Propose a way to determine whether a patient with glucose in the urine could reduce the level through changes in diet.

Expected Outcome

- Glucose test strips will turn green if glucose is present.
- The solution will turn purple-pink when Biuret solution is added if protein is present.
- A 50/50 mix (simulated urine sample) should give positive results for both glucose and protein.

Analyze and Conclude

- Sample W showed no change in color. Sample G showed a color change to green.
- It is a positive test result for glucose.
- The contents of sample W were light blue, the same color as the Biuret solution. The contents of sample G turned purple.
- It is a positive test result for protein.
- The normal urine sample (B) is negative in both glucose and protein tests.
- The urine sample that tests positive for glucose (C) indicates possible diabetes.
- A urine sample that tests positive for protein (A) indicates possible kidney disease.
- No. A single test does not provide enough evidence. The person should go for further testing.

Extend Inquiry

More to Explore Students might suggest the patient eat fewer sugary foods. The amount of glucose in the patient's urine can be monitored to determine if diet affects the glucose level.

Sample Data Table						
Test for	W (water)	G (glucose)	P (protein)	A (Patient A)	B (Patient B)	C (Patient C)
Glucose	Yellow	Green	Yellow	Yellow	Yellow	Green
Protein	Lt. Blue	Lt. Blue	Purple	Purple	Lt. Blue	Lt. Blue