# Picture Perfect

As she drove back to the museum where she worked, Bryn was thrilled with the box and its precious contents on the seat beside her. For several decades a 19th-century portrait of a local family had hung in the museum. Today, the family's descendants had donated the dress worn by the little girl in the picture. Although they had discovered it in a forgotten trunk in an unheated barn, the dress was in surprisingly good condition.

Once she arrived back at the museum, Bryn immediately went to the curators' workroom to give the dress to Rob, the museum's textile conservator. Seeing Rob intently working, she quietly knocked on the half-open door. He put down his tools and looked up.

"Rob," she said excitedly. "Here it is! The dress I told you about from the painting! The donor was about to have it cleaned, but I'm so glad he called here first."

"You're not kidding! It's easy to ruin old fabrics," Rob said as he accepted the box with the tissue-wrapped dress. After putting on gloves, he unwrapped the old dress carefully and laid it flat on a clean table to examine it. He saw that the cotton dress was slightly yellowed and there was a small, stiff stain near the neckline. He wondered if that spot might prove troublesome. "This is terrific, Bryn. I'll do my magic, and with luck these discolorations and spots should disappear."

Bryn laughed, knowing that Rob's work had nothing to do with magic or luck. As she left the workroom, Rob grabbed an *Object Description and Restoration* form and began to fill it out in pencil. Next he began the cleaning process by gently brushing the dress with a soft brush. Using a metal probe, he carefully scraped the stain at the neckline in order to gather a sample for a microscope slide.

As Rob examined the slide with the microscope, he noticed several granules mixed in with a few longer fibers. He was not surprised to see cotton fibers, which he knew to be cellulose. The granules, though, which were smooth and oval-shaped with a diameter of about 75 μm (micrometers), came from the stain itself. He added a drop of a weak, yellowish iodine solution to the slide. The granules turned dark blue, confirming his suspicion that the stain was caused by starch. He wrote his observations on the form, and under *Treatment Plan* wrote "Neckline stain: use amylase cleaning solution"—an enzymatic solution specific for removing starch.

**Figure 1.1** Museum textile conservators apply their knowledge of the structure and function of macromolecules to clean, restore, and preserve old fabrics such as this dress.

# Core Investigations

## I. Critical Reading

1. In the case narrative, Rob learned that the stain near the neckline of the dress contained starch. What specific type of macromolecule are starch and cellulose?

2. What monomer is found in starch and cellulose?

3. Contrast the structure and function of starch with that of cellulose in plant cells.

4. What is an enzyme?

5. To remove the stain from the dress, Rob treated the stain with a cleaner containing the hydrolytic enzyme *amylase*. Explain what happens to starch at the molecular level when it is acted upon by amylase. You may wish to sketch the structure of starch to show how this enzyme works

6. Under the right conditions, amylase breaks down amylose efficiently; however, the enzyme is not very effective in breaking down amylopectin. read the related text in your textbook. Use your observations to propose a hypothesis for why amylase breaks down amylose much more effectively than amylopectin.

| Label on Wallpaper | Substance | Approximate % of Wallpaper and Paste Removed |
|---|---|---|
| A | remover with 0.5% amylase | 100 |
| B | remover with 0.1% amylase | 75 |
| C | rubbing alcohol | 10 |
| D | vinegar | 50 |
| E | water | 10 |

1. Which substance worked best? What does this tell you about the composition of wallpaper paste?

2. Describe how the most effective substance worked to remove the paste.

3. Considering that vinegar is an acid, explain the results seen with the vinegar.

4. Why was it important that Hildy also test the effect of water alone on the wallpaper paste?

# Additional Investigations

## IV. Structure and Function of Starches

**A. Kinds of Starch.** Starches are a significant part of the typical human diet, making up 40–80% of total energy intake. Some plants store more starch than others. Humans have discovered many varieties of starchy plants that satisfy our hunger and taste buds, such as corn, cassava, and potatoes, originally from South America; sweet potatoes and yams, from tropical Africa and South America; chickpeas, from Turkey; plantains, originally from India; rice, originally from Asia; soybeans, originally from China; and wheat, from the Middle East.

Plants store starch as highly condensed granules that do not dissolve easily in water. The composition and size of these granules vary in different types of plants.

5. *Optional.* Conduct the experiment you designed using the software provided in the *Chapter 41 Investigation: What Role Does Amylase Play in Digestion?* found on the Campbell Biology website or CD-ROM. Turn in a screen capture of the table showing your results. *Note:* Experiments involving IKI tests of cellulose will not give the correct results due to a bug in the software.

## III. Off the Wall: Starch Degradation Investigation

Hildy planned to surprise her parents by remodeling their living room while they were away for the weekend. First she had to remove the wallpaper so that she could paint. When she started scraping at the edge of the dry wallpaper, only a few small pieces came off. "What's up with this wallpaper?" Hildy asked herself. "It's just not coming off!"

Hildy got a spray bottle and filled it with warm water. She sprayed the walls to moisten large areas. After several minutes, she scraped at the wallpaper again. Larger pieces came off this time, but big patches of hardened paste remained. Hildy couldn't spend the whole weekend scraping! She rummaged around the house and found some alcohol and some vinegar.

Unsure of what these substances would do to the walls, she also went out and bought two different types of commercial wallpaper remover. "I wonder which of these will work the best?" she thought.

To test which one would work best, she chose a section of the wall behind the couch and applied the five substances to a 10-$cm^2$ section of the wall. She labeled each patch to remember which substance had been applied to each square. After twenty minutes, she noted how much wallpaper she could remove with one scrape from each patch. See the results of her experiment in Figure 1.3.

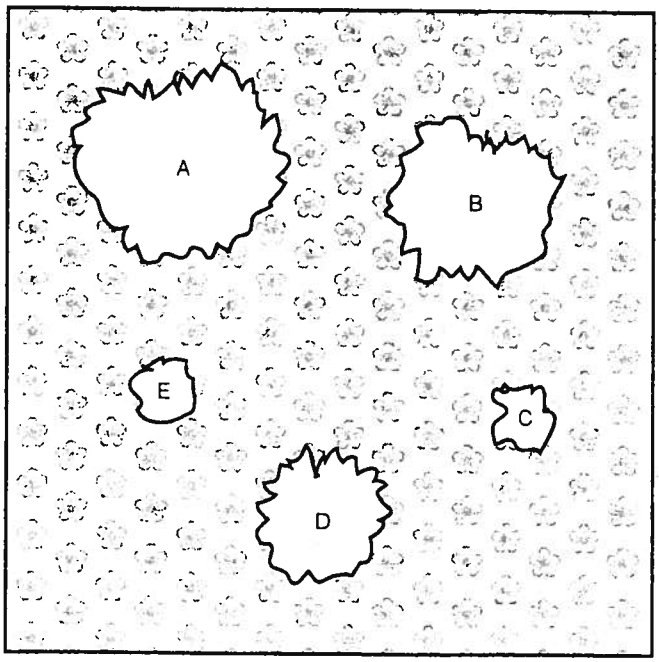


**Figure 1.3** The above figure shows a section of Hildy's parents' living room wall after her experiment. The table on the next page is a key containing her results.