

1  
40- to 50-minute session



## ACTIVITY OVERVIEW

In this activity, students read about the history of heart surgery. They explore the challenges in developing new treatments and discuss the ethics of using new treatments on people.

## KEY CONCEPTS AND PROCESS SKILLS

*(with correlation to NSE 5–8 Content Standards)*

1. Cardiovascular disease is the leading cause of death in the United States. (LIFE SCIENCE: 1)
2. Perfectly designed solutions do not exist. Technological designs have constraints. (SCIENCE AND TECHNOLOGY: 2)
3. Important personal and social decisions are made based on perceptions of benefits and risks. (PERSPECTIVES: 4)
4. Scientists and engineers have ethical codes for human subjects involved with research (PERSPECTIVES: 5)
5. Many individuals have contributed to the traditions of science and to the development of modern scientific ideas. Their contributions have had numerous effects on society and human health. (HISTORY AND NATURE OF SCIENCE: 3)

## KEY VOCABULARY

ethics

## MATERIALS AND ADVANCE PREPARATION



For each student

- 1 Student Sheet 25.1, “Heart Surgery Timeline”
- 1 Student Sheet 25.2, “Three-Level Reading Guide: Healing the Heart”

\*Not supplied in kit

## TEACHING SUMMARY

### Getting Started

1. Discuss the risks of heart surgery.

### Doing the Activity

2. Students read about the history of heart surgery and complete a timeline.

### Follow-Up

3. (LITERACY) Students complete Student Sheet 25.2, “Three-Level Reading Guide: Healing the Heart”
4. The class discusses the challenges and ethics of using new procedures on heart patients.



### Extension

Students use the *Science and Life Issues* page of the SEPUP website to link to sites with more information on the history of heart surgery.

## BACKGROUND INFORMATION

Daniel Hale Williams is credited as being the first doctor to operate successfully on the heart. Graduating from medical school in 1883 in Chicago, he became one of only four African-American doctors in the Chicago area. He soon became so well known for his sterile and antiseptic hospital and medical procedures that in 1889, he was appointed to the Illinois Board of Health.

By the time he performed the first heart surgery, he had opened Provident Hospital to provide a place for doctors and nurses of all races to train. When stabbing victim James Cornish was brought in, Dr. Williams did not have the benefit of X-rays or blood transfusions to help him operate. After opening Cornish’s chest, Dr. Williams found that the heart itself had not been damaged, only the pericardium—the sac that surrounds the heart. He was able to repair it, and the patient recovered, even without the benefit of antibiotics.

Few doctors were willing to operate on the heart under these conditions, however, and it was not until sophisticated antibiotics were developed during World War II that doctors were willing to perform heart surgery regularly. Without these drugs, patients

would usually die of shock or infection. Even with these advances, surgeons did not know how to operate on a beating heart that was full of blood. It was only through the desperate attempts to save lives of seriously wounded soldiers that heart surgeries were performed regularly—and with far less testing than is currently required before the adoption of new surgical techniques. Since the early 1960s, new surgical techniques have had to undergo greater scrutiny by the medical profession. While doctors today still have some latitude in developing innovative procedures, generally new innovations are minor adaptations of accepted medical procedures. At every medical institution there is an institutional review board that oversees human subject research. Any doctor using an experimental procedure on a patient has to answer to this board.

With new technology for less invasive surgery, doctors rely on the heart-lung machine much less frequently than they did a couple of decades ago. For example, with angioplasty they can thread tiny probes into the heart and coronary arteries from a small opening in the leg to clear out clots and widen narrowed arteries without surgery. (Angioplasty is explored in more detail in Activity 28, “Heart Problems.”) Endoscopic technology allows surgeons to insert tiny instruments, fiber optics, and video cameras through small incisions between the ribs to repair defects that used to require cracking the sternum. In some cases even simpler bypass surgery can be performed in this manner. Operations on outer sections of the heart can be done by immobilizing only the area of the heart that will be operated on, while the rest of the heart can continue to beat. Some operations, such as valve repair, still require the heart to be stopped and emptied of blood, in which case heart bypass machines are used in conjunction with hypothermia (lowering of the body temperature) for short periods. Anesthesiologists and surgeons still use hypothermia to reduce oxygen requirements of organs, especially the brain, and to protect the organs from damage during surgery.

## REFERENCES

The Black Inventor Online Museum

<http://www.blackinventor.com/pages/danielwilliams.html>


Public Broadcasting Service (PBS). *A Science Odyssey: “Matters of Life and Death”* (video). United States, 1998.

## TEACHING SUGGESTIONS

### ■ GETTING STARTED

Ask, *Do you know anyone who has had successful heart surgery?* Before accepting responses, encourage students to respect the privacy of friends or relatives and not mention names. Students will most likely not only mention the person but also the purpose of the surgery. You may wish to make a list of these conditions on the board or a piece of chart paper that the class may refer to later. Use students' responses to build the idea that cardiovascular disease is common and that modern surgical methods can sometimes improve the quality and length of patients' lives.

### ■ DOING THE ACTIVITY

2.  **Students read about the history of heart surgery and complete a timeline.**

After students read the introduction, have them discuss in their groups how doctors have overcome the challenge of operating on a beating heart. This is an opportunity to informally assess how much students know about heart surgery and if they appreciate the difficulty of operating on the heart.

Distribute Student Sheet 25.1, "Heart Surgery Timeline," and have students fill in the information from the reading for each date that is listed. This will help them organize their thinking about the history of heart surgery. A key to the timeline is on the next page.

Costs are not addressed in the reading but you can ask students to consider both the financial expense and the personal cost of suffering. Health maintenance organizations have controlled costs somewhat, but medical costs are still rising faster than the cost of living. Students may be interested to know that surgeons on average charge around \$5,000 per bypass operation and anesthesiologists about \$2,500. In some parts of the country, surgeons' fees may be as high as \$10,000. Total costs for coronary bypass surgery average \$30,000–

\$50,000; and a heart transplant is likely to cost at least \$225,000. The bulk of these costs are not usually paid directly by the patient, but by the patient's health insurance company or by a government health care program.

### ■ FOLLOW-UP

3. (LITERACY) **Students complete Student Sheet 25.2, "Three-Level Reading Guide: Healing the Heart"**

During the reading, students are provided an opportunity to improve their performance in reading comprehension, particularly of informational text. Student Sheet 25.2, "Three-Level Reading Guide: Healing the Heart," guides students through the text and through three levels of understanding: literal, interpretive, and applied. Students look at a list of statements and determine which ones are supported by the text. For more information on Three-Level Reading Guides, see the Literacy section of Teacher Resources II: Diverse Learners.

Possible responses to the reading guide are shown on page B-172. Note that Statements 3a, 3b, and 3c (applied level of understanding) do not have a single correct response. Students may interpret information differently and agree or disagree with each statement. Whatever their perspective, it is important that they explain and support their positions.

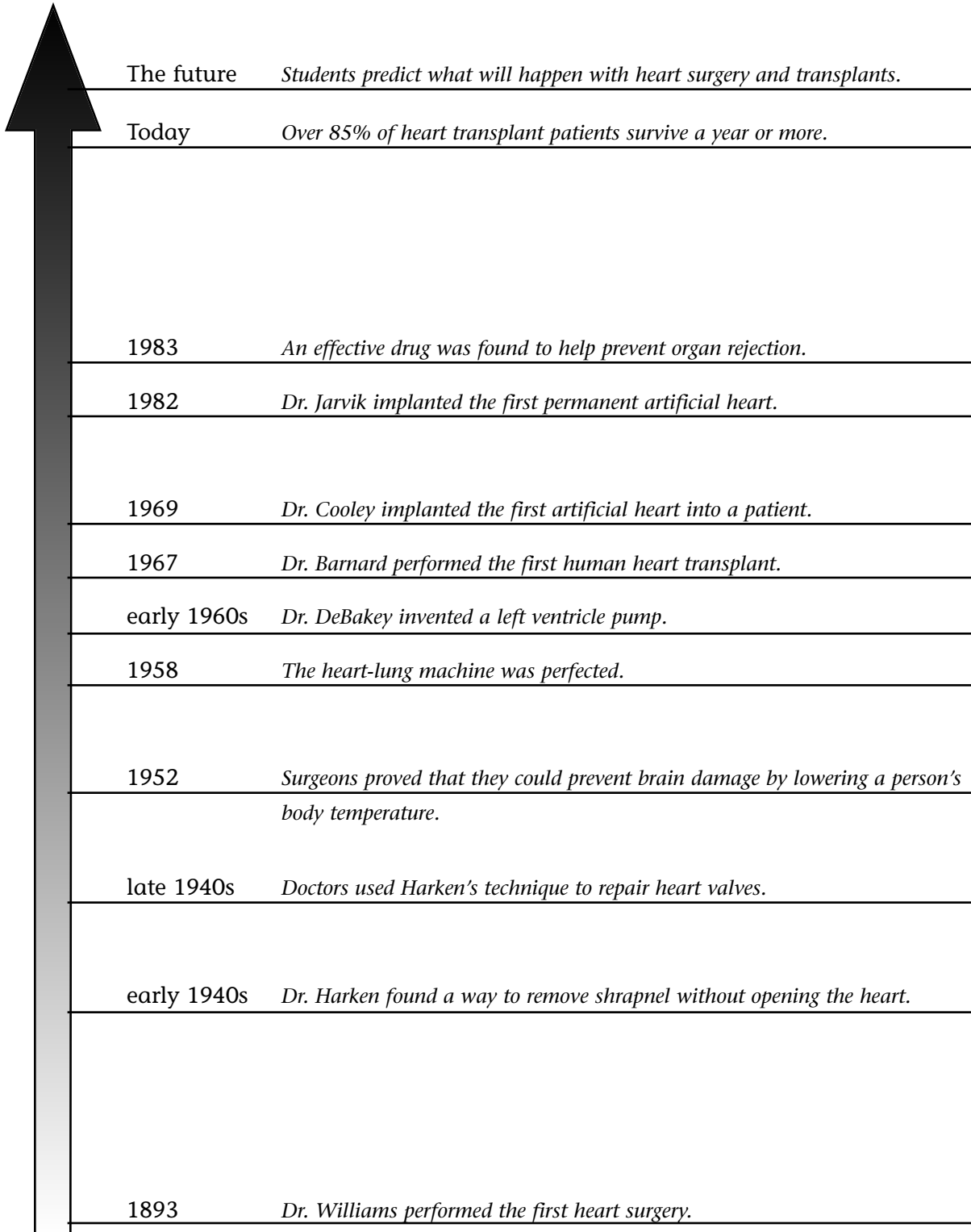
4. **The class discusses the challenges and ethics of using new procedures on heart patients.**

Ask students, *What observations can you make about the timeline?* Students may notice that there was a lot of time between Dr. Williams's surgery and the next major advance in heart surgery. Elicit ideas as to the reasons for this long time span. Students may say that antibiotics helped the patients survive heart surgery and between the 1890s and 1940s they were not yet available.

Students may also notice that a lot of things happened between the early 1950s and the late 1980s. This was a time of great growth for the biomedical and biochemical industries, and so a lot of people

KEY to Student Sheet 25.1 Heart Surgery Timeline

List the discovery or development in heart surgery that occurred at each date on the timeline.



Sample Student Response to Student Sheet 25.2, “Three-Level Reading Guide: Healing the Heart”

1. Check the statements below that you believe agree with what the reading says. Sometimes, the exact words found in the reading are used. At other times, other words may be used to communicate the same meaning.

- a. Throughout history heart surgery has been considered complicated because the heart is constantly moving as it beats.
- b. When a person’s body temperature is lowered, the brain needs less oxygen.
- c. The primary cause of death for early heart transplant patients was infection.
- d. The biggest obstacle to successful heart transplants today is rejection by the immune system.

2. Check the statements below that you believe represent the intended meaning of the reading.

- a. A transplanted organ is a foreign object in the human body, and the immune system tries to destroy it.
- b. An artificial heart is a good alternative for a patient if a human heart is not available.
- c. The major reason for the increased survival rate for heart transplant patients today compared to the first transplant patients is improved surgical technique.
- d. A person who receives a transplanted heart always runs the risk of organ rejection.

3. Check the statements below that you agree with, and be ready to support your choices with ideas from the reading and from your own knowledge and experience.

- a. Heart surgery is the only way to take care of heart problems.

*Students who support this statement may be considering only the information that was presented in the reading. Or, they may be considering people with congenital heart problems. Other students may recall some of the information presented in Activity 20, “Great-aunt Lilly’s Will.” In that activity, the characters discussed the possibility of spending money to support public education to prevent heart disease.*

- b. Dr. Cooley’s first transplant of an artificial heart into a patient was not ethical.

*Students who support this statement may argue that Dr. Cooley did it to save the patient’s life, and it worked! The patient survived to receive a human heart transplant several days later. Other students may say that it was not ethical because there was a doubt that Dr. Cooley invented the heart and it had not been adequately tested—at least by today’s standards.*

- c. Everyone over 18 should sign up to be an organ donor.

*Students who support this statement may say that it would decrease the number of patients who die while waiting for a heart. Students who disagree may cite personal or religious issues about donating organs, or may be concerned that hearts from those with certain diseases could be dangerous.*

were working on surgical problems.


You might refer to the list of heart conditions, or recall some that were discussed earlier (under “Getting Started”). Ask if those conditions could have been surgically treated in Dr. Williams’s time, or even in Dr. DeBakey’s and Dr. Cooley’s time. For those conditions that students do not think could have been treated, ask, **Why couldn’t they have been treated?** Students should relate past medical advances to successful surgeries today. You may wish to discuss whether or not Dr. Cooley could have used an untested product, such as the artificial heart, on a human today? What would the ethical concerns be?

Discuss Analysis Question 4 with the class. Have them think about what they would have done had they been in the position of Dr. Williams, Dr. Cooley, or one of their patients. Ask, **How would you have felt about the risks of the pioneering, risky heart surgery described in the reading? Do you think the doctor’s decisions were unethical or inappropriate when they decided to perform untested procedures?** Emphasize that today there are specific guidelines for how treatments must be tested before they are used. An individual’s willingness to accept risk depends on his or her assessment of the potential benefits. Individuals who volunteer for high-risk experimental treatments are often those with few or no other options, as with the early heart transplant patients discussed in this question.

If you introduced the costs of heart surgery earlier, you may ask students to think about the potential advantage, in terms of human quality of life and health care costs, of measures to prevent cardiovascular disease. Not only can the costs of health care be reduced with preventive care, but the quality and length of peoples’ lives may be enhanced. Ask, **How do you think heart disease can be prevented?** Based on their work in Activity 20, “Great-aunt Lilly’s Will,” students may suggest education. They are less likely to suggest regular visits to a doctor. If a doctor can diagnose high blood pressure and high cholesterol levels early, he or she can suggest preventive measures, such as diet, exercise, and med-

ication that could reduce the person’s risk of serious heart disease.

### SUGGESTED ANSWERS TO QUESTIONS


1. *What is the age range of most transplant patients?*  
The age of most transplant patients is 50–64 years old.
2. *What is a heart transplant patient’s chance of survival after:*
  - *one year?*  
Men: 87% Women: 86%
  - *three years?*  
Men: 79% Women: 76%
  - *five years?*  
Men: 72% Women: 68%
3.  *Compare the percentages of male and female transplant patients. Why do you think there is a difference? Explain.*

Almost 75% of heart transplant patients are male. Students may have many ideas about the reasons for this. Some of them are included below, along with additional information about heart disease and its effects in men and women:


- More men smoke, which leads to heart disease.
- Men are less likely to see a doctor on a regular basis.
- During a woman’s reproductive years, the hormone estrogen may protect a woman from high cholesterol, lessening her chances of having heart disease. Since only young to middle-age people are considered candidates for transplants (although that is changing), there are more men having heart transplants.
- A woman’s heart attack symptoms are more likely than a man’s to be misdiagnosed, which leads to a higher initial death rate.
- Women tend to wait longer than men to go to the emergency room when having a heart attack, leading to a higher initial death rate.
- More women’s heart attacks are fatal, as compared to men’s.

## Activity 25 • Healing the Heart

- Even if the attack is not fatal, more women than men die within one year of having their first heart attack.

4.  *Why did the early heart transplant patients agree to a transplant when it was so risky?*

There was no other hope for their survival without a heart transplant. In many cases they were days away from dying. Their risk of death from the transplant was less than their risk if they did not agree.

5.  *What are the challenges that had to be overcome to develop new surgeries for heart problems?*

- It was difficult to operate on a beating heart, so doctors had to figure out how to safely stop and restart it.
- The brain only lives four minutes without oxygen, so doctors had to figure out how to extend that time.

6. **Reflection:** *A person can sign up to be an organ donor when he or she receives a driver's license. Would you be willing to sign up to be an organ donor? Explain.*

Students' answers will vary. Students who say yes may cite the desire to help other people. Students who say no may do so due to personal or religious grounds of not wanting to desecrate the body, even in death.



# Heart Surgery Timeline

List the discovery or development in heart surgery that occurred at each date on the timeline.

The future

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Today

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1983

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1982

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1969

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1967

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early 1960s

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1958

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1952

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late 1940s

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early 1940s

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1893

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## Three-Level Reading Guide: Healing the Heart

1. Check the statements below that you believe agree with what the reading says. Sometimes, the exact words found in the reading are used. At other times, other words may be used to communicate the same meaning.

- \_\_\_\_\_ **a.** Throughout history, heart surgery has been considered complicated because the heart is constantly moving as it beats.
- \_\_\_\_\_ **b.** When a person's body temperature is lowered, the brain needs less oxygen.
- \_\_\_\_\_ **c.** The primary cause of death for early heart transplant patients was infection.
- \_\_\_\_\_ **d.** The biggest obstacle to successful heart transplants today is rejection by the immune system.

2. Check the statements below that you believe represent the intended meaning of the reading.

- \_\_\_\_\_ **a.** A transplanted organ is a foreign object in the human body, and the immune system tries to destroy it.
- \_\_\_\_\_ **b.** An artificial heart is a good alternative for a patient if a human heart is not available.
- \_\_\_\_\_ **c.** The major reason for the increased survival rate for heart transplant patients today compared to the first transplant patients is improved surgical technique.
- \_\_\_\_\_ **d.** A person who receives a transplanted heart always runs the risk of organ rejection.

3. Check the statements below that you agree with, and be ready to support your choices with ideas from the reading and from your own knowledge and experience.

- \_\_\_\_\_ **a.** Heart surgery is the only way to take care of heart problems.
- \_\_\_\_\_ **b.** Dr. Cooley's first transplant of an artificial heart into a patient was not ethical.
- \_\_\_\_\_ **c.** Everyone over 18 should sign up to be an organ donor.

