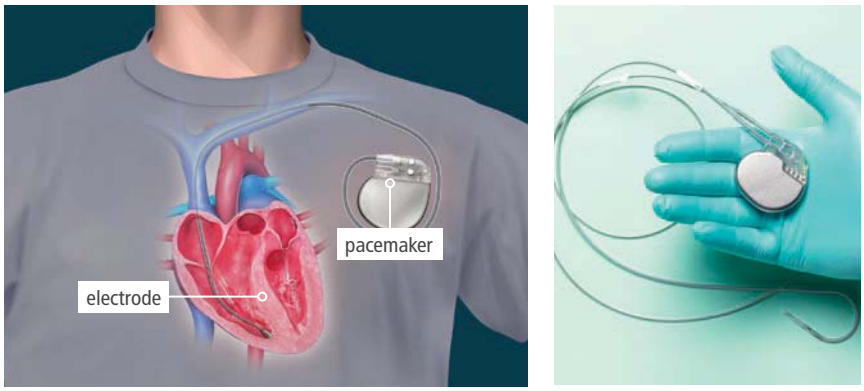
Lesson Self-Check

CAN YOU EXPLAIN IT?

FIGURE 14: A pacemaker is a nonliving system that functions inside a living system, the human heart.



Pacemakers generate electrical signals that stimulate the heart when cardiac activity is abnormal. The pacemaker has gone through many design changes based on improved technology and medical knowledge since its initial conception. As technologies improved, designs became smaller. As scientific understanding of anatomy, heart conditions, and biological systems progressed, so did the efficiency of pacemakers. Scientists and engineers continually work together to improve upon this design and many others in the medical field.

Explain The batteries in pacemakers eventually need to be recharged or replaced. What types of features would you consider when designing a better battery for a pacemaker?

When designing a new component for a device, engineers will still use the engineering design process. The process is iterative, so the steps may not be applied in the same order. For example, when designing a new battery for a pacemaker, engineers may start by testing pacemakers and existing batteries. The data gathered in these tests may help them brainstorm new ideas for how to improve the previous design.

The engineering team also will have different constraints when improving a design than when creating a new design. For example, engineers will only be able to develop batteries that fit inside the existing pacemaker and work with the components already in the design. They also may be working within a shorter timeframe and a smaller budget than if they were developing a new pacemaker design.

By working with patients, doctors, and manufacturers, engineers can identify the most important criteria to incorporate into their design. Perhaps patients would rather have a battery that is easier to recharge than one that lasts a few years longer and needs to be replaced. Once engineers understand the limitations in the current design, the constraints, and the important criteria, they can begin developing new designs.

CHECKPOINTS

Check Your Understanding

1. Imagine that you are an engineer who designed a prototype for a client. After testing the prototype, you discover it does not address the client's needs. What might be a possible next step in the process?

2. You and a partner have brainstormed a design for an implanted device to help keep insulin levels in check for a person who is diabetic. What should be the next step in the design process?
   - **a.** test on a patient
   - **b.** build a prototype
   - **c.** revise the design
   - **d.** evaluate the design

3. Which of the following technologies would likely involve a bioengineer to design and build? Select all correct answers.
   - **a.** artificial heart valve
   - **b.** tablet computer
   - **c.** artificial hip joint
   - **d.** global positioning system
   - **e.** automobile engine
   - **f.** surgical robot

4. A biomedical engineer is developing a portable medical imaging machine designed to be used in remote areas or in situations where a natural disaster has made access to local imaging facilities difficult. She made a list of criteria and constraints for the new device. Which of these should be classified as criteria? Select all correct answers.
   - **a.** transmits information wirelessly to base medical facility
   - **b.** one person can carry it without assistance
   - **c.** uses a rechargeable battery
   - **d.** case made of high-impact plastic
   - **e.** generates high-definition CT scans
   - **f.** completes scans rapidly

5. One of the ways in which society impacts technology is through government regulation. Describe how government regulation can have both positive and negative impacts on technology.

6. Make a decision matrix to compare three models of a device, perhaps personal tablet devices or phones. Use the following questions to build the matrix and evaluate the results:
   - **a.** What design criteria are most important?
   - **b.** How would you weight these criteria?
   - **c.** How would the competing designs score on each criterion?
   - **d.** Which design(s) should move to the next stage of the process and why?

MAKE YOUR OWN STUDY GUIDE

In your Evidence Notebook, design a study guide that supports the main ideas from this lesson:

Bioengineering is the application of engineering processes and practices to living things.

Engineering develops and modifies technological solutions for the needs of society.

Remember to include the following information in your study guide:

- Use examples that model main ideas.
- Record explanations for the phenomena you investigated.
- Use evidence to support your explanations. Your support can include drawings, data, graphs, laboratory conclusions, and other evidence recorded throughout the lesson.

Consider how bioengineering solutions influence the environment while addressing the wants of society.