

Lesson Plan

Rebuilding

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Science
Technology
Engineering
Arts
Mathematics

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Teacher Created Materials

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Answer Key: Rebuilding the Body

page 10—Problem Solving with Prostheses

- 1. **Problem:** Robotic arms were expensive and required dangerous surgery. **Solution:** Easton LaChappelle built a bionic hand that could be controlled with brainwaves.
- 2. **Problem:** Artificial legs did not provide the same power as human muscles. **Solution:** Hugh Herr created a bionic ankle with a spring and battery that moved people forward with each step.
- 3. **Problem:** To help people see, scientists needed to figure out how to record and send images to the brain. **Solution:** Scientists invented the Argus II, which records images with a video camera and uses a microchip to turn the video into electric signals to be sent to the brain.

page 11—Innovators in the Field

Responses will vary. Example:

- 1. DeLiang Wang
- 2. Professor of computer science and engineering

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References to digital components are included for educators who purchased the full kit: *Smithsonian STEAM Readers: Grade* 4. Please disregard digital component references if this lesson was purchased in a different product configuration.

- 3. Wang's mother started to lose her hearing when he was in college.
- 4. Wang made a hearing aid filter that separates voices from other noises.
- 5. Wang used a computer program that can tell whether a voice is louder or softer than background noise. To improve the program, he continues to add more sounds to help fine-tune his design.
- 6. The solution has already helped people with hearing loss greatly improve their hearing.

page 17—Rebuilding the Body Quiz

1. D 4. A

- 5. Responses may vary. Example: Paré invented
- **3.** B

2. C

- the first mechanical hand using metal gears
- and springs. A French captain wore it into battle, and it helped him hold the reins of his horse.

Rebuilding the Body

Materials

- Rebuilding the Body books
- copies of student activity sheets (pages 9–19)
- sticky notes
- index cards (optional)
- STEAM Challenge materials include but are not limited to the following:
 - ✓ 2 medium-sized bins
 - ✓ cardboard pieces
 - ✓ clothespins
 - ✓ construction pape
 - ✓ craft sticks
 - ✓ masking tape

Learning Objectives

- **Reading:** Describe the overall structure of events, ideas, concepts, or information in a text or part of a text.
- Writing: Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

- ✓ objects to pick up, such as number cubes, erasers, or coins
- ✓ scissors
- ✓ straws
- ✓ string or twine



- Speaking and Listening: Engage effectively in a range of collaborative discussions with diverse partners on grade-appropriate topics and texts, building on and expressing ideas clearly.
- Engineering: Define an engineering problem, design and evaluate solutions, and optimize a design based on test results.

Phenomena

Humans have internal and external structures that support survival

Lesson Timeline

Day I	Day 2	Day 3	Day 4	Day 5-10
Introductory and Before Reading Activities (page 4)	During Reading Activities (page 5)		After Reading Activities (page 5)	STEAM Challenge and Assessments (pages 6–8)
Define the STEAM Challenge, and practice identifying a problem and solution in the text.	Research prostheses, describe problems and solutions relating to the development of prostheses, and brainstorm design solutions.		Write an article featuring an innovator in the field of prostheses.	Design, build, test, improve, reflect on, and share a device that can act as a hand. Complete the assessments.

Rebuilding the Body(cont.)

STEAM Vocabulary

3-D printer prosthetic amplify amputees silicone

Introductory Activity

Define the Problem

- L Display the cover of the *Rebuilding the Body* book to students and read the title aloud. Ask students to look closely at the cover image and invite them to share their observations. Have students predict how the title, with a focus on the word *rebuilding*, may relate to the topic.
- Distribute the *Rebuilding the Body* books to students. Reveal the STEAM Challenge by reading aloud pages 28 and 29 of the book. As you read, explain each step of the engineering design process.
 - Display the Interactiv-eBook for a more digitally enhanced introduction to the challenge.
- **3.** Distribute *Make a Plan* (page 9) to students. Have them summarize the challenge. Summaries should include constraints and criteria. Provide the following sentence frame to help students summarize: *Make a* ______ *that can* _____.

Note: You may wish to distribute all student activity sheets as one packet. They will be used throughout the STEAM Challenge.

Before Reading

- I. Write the vocabulary words on the board and discuss their meanings. Write each vocabulary word on a sticky note. Place one sticky note on the back of each student. Have students walk around the room asking their classmates yes-or-no questions about the words on their backs. Have students sit down once they have guessed their word correctly.
- 2. Tell students that authors of nonfiction text use different text structures to organize and present information to readers. Explain that authors use a problem-and-solution text structure to present a problem to be solved, and will often include signal words and phrases, such as *one problem, solve the problem of, one solution,* and *one way.* Tell students that even when keywords or phrases are not used, authors will usually explain the problem first and then explain a solution or solutions.
 - Provide below-level learners with several index cards that describe either a problem or a solution. Have them work together to match the problems with the solutions.
- **3.** Invite students to take picture walks to preview the text. As they view each page, ask them to make predictions about what problems and solutions are presented in the text.

Rebuilding the Body(cont.)

During Reading

Research and Brainstorm

- L Distribute the *Rebuilding the Body* books to students. Read pages 4–9 aloud. Pause periodically to describe problem-solution relationships. For example, on page 6, point out how Paré helped solve the problem of missing limbs by creating artificial hands and legs.
 - Display the Interactiv-eBook for a more digitally enhanced reading experience. You may wish to have students annotate the PDFs as you read.
 - Play the audio recording as students follow along to model fluent reading. This may be done in small groups or at a listening station. The recording will/help
 English language learners practice fluency and aid in comprehension.
- 2. Distribute *Problem Solving with Prostheses* (page 10) to students. Have students read the book in pairs. Encourage them to identify and describe problems and solutions in the text as they read. Ask students to state the problems and describe the solutions for the three cases on their activity sheets.
- **3.** Have students record their ideas for designs on their *Make a Plan* activity sheets.

After Reading

- I. Write the vocabulary words on the board and review their definitions. Have groups of students write meaningful sentences for the words. Use the following sentence stems or create your own. Possible answers are provided.
 - Engineers often use *3-D printers* to _____. (print objects out of plastic)
 - (s) can be used to amplify sound. (hearing aids)
 - Amputees depend on engineers to _____. (design functional artificial limbs)
 - Prosthetic devices are used to ______.
 (replace body parts)
 - *Silicone* is a material that _____. (is water- and heat-resistant)
- 2. Tell students that journalists often write articles about the life and work of influential people, such as scientists and engineers. Explain that these articles inform readers about discoveries in various fields.
- **3.** Distribute the *Rebuilding the Body* books and *Innovators in the Field* (page 11) to students. Ask students to write articles as a journalist would to explain the contributions of innovators in the field of prosthetics. Have them use the activity sheets to plan their articles in pairs.
- **4.** Have students use their graphic organizers to write articles for the person they have chosen. Remind students to introduce that person, include details about how the person solved a problem, add relevant vocabulary words, and provide concluding statements. Invite students to include illustrations to accompany their articles.

Rebuilding the Body(cont.)

Prep

- Review all designs prior to building.
- Prepare all materials for the STEAM Challenge.

STEAM Challenge

Design and Build

- L Discuss the following questions as a class to connect the reading to the STEAM Challenge:
 - What are some solutions people have found to replace missing and injured body parts? Have students recall that people have found various ways to replace missing and injured body parts since ancient times, including replacing an eye with a round piece of tar and creating bionic legs that allow patients with missing legs to walk.
 - What is the goal of prosthetic devices? Guide the discussion to the idea that scientists and engineers aim to develop prosthetic devices that replicate the normal functions of a missing limb.
- Distribute previously completed activity sheets. Review the STEAM Challenge on pages 28 and 29. List materials on the board and show students the objects they will pick up and carry with their devices.
- **3.** Ask students to independently sketch and label two designs on their *Make a Plan* activity sheets.

- **4.** Organize students into teams. Distribute one copy of *Collaborative Design* (page 12) to each team. Ask teams to have members share their designs. Then, have groups choose, sketch, and label a team design. (Team designs must be submitted for approval before building.)
 - Challenge **above-level learners** by adding constraints or criteria (e.g., only three types of materials may be used).
- 5. Explain to students that when they build their models, they must follow their design plans. Reassure them they will have an opportunity to change and improve their designs after they present them. Review classroom expectations for working with materials. Give teams time to build models.
 - You may choose to digitally record students' processes to share at a later date with students and parents.
- **6.** Distribute *Think about It* (page 13) to students. Explain that reflection is an important part of the engineering design process. Read aloud questions 1 and 2 on the activity sheets and have students write their responses. Ask volunteers to share.



Rebuilding the Body(cont.)

Prep

- Review all designs prior to building.
- Prepare materials for the STEAM Challenge.
- Place two bins at opposite sides of the classroom.
 Set the objects inside one of the bins.

STEAM Challenge

Test and Improve

- L Discuss the following questions as a class to connect the reading to the STEAM Challenge:
 - What types of technology do engineers use in the field of prosthetics? Have students recall the types of technology that have contributed to the development of prosthetic devices, including 3-D printers, computer programs, and microchips.
 - What did Hugh Herr learn by trying to make his devices better? Make sure students mention how Hugh Herr learned how to make new artificial joints and batterypowered ankles by trying again and again to improve his devices.
- 2. Gather teams to test their devices. Invite teams to bring their devices to the bin with the number cube, eraser, and coin inside. Explain that teams will offer feedback after the test. Use *Friendly Feedback* (page 14) to review best practices for giving feedback.
- **3.** Distribute *Prosthetic Hand Test Results* (page 15) to students and ask them to record results for each team.
- **4.** Allow time for each team to test. Have teams select a student to use the device to lift one object from the bin, carry it across the room, and place it into the empty bin. Ask students to

repeat the procedure for the remaining two objects. A successful device will carry all three objects without dropping them.

- Challenge **above-level learners** and/or successful teams with additional constraints or criteria for the second design (e.g., the device must pick up multiple objects at once, the device must carry the objects a farther distance).
- **5.** Allow time for teams to brainstorm ways to improve their designs based on test results and feedback. Refer students back to their *Collaborative Design* activity sheets. Ask them to sketch their improved designs and explain any changes. Have students submit improved designs for approval before building.
- **6.** Have teams gather materials to improve their designs. Then, have them retest their devices.
- **7.** Have students answer questions 3 and 4 on their *Think about It* activity sheets.

Rebuilding the Body(cont.)

STEAM Challenge

Reflect and Share

- I. Guide students to reflect on ways that they offered and received help during the STEAM Challenge. Discuss with students various types of helpful actions and contributions that may have been exhibited during the challenge, including suggesting design ideas or improvements, listening to others while brainstorming, and working with others to build the devices.
- 2. Ask students to trace their hands on sheets of construction paper and have them cut out the shapes. On one side, ask students to write and draw ways that they contributed. On the other side, have students tell how other members of their team contributed to the success of their devices. Invite students to share their responses with the class or in small groups.
- **3.** Have students answer question 5 on their *Think about It* activity sheets.
- **4.** Distribute *Engineering Design Process* (page 16) and review how students used the steps to complete the challenge. Have them annotate the infographics with details specific to this challenge.
- **5.** Read "Career Advice" on page 32 of the book. Ask students to brainstorm other tips for a career in the field of prosthetics.

Assessment Activities

- **I.** Have students complete the short posttest, *Rebuilding the Body Quiz* (page 17), to assess the lesson's objectives.
- **2.** Students may complete the Interactiv-eBook activities in the Digital Resources for assessment purposes.
- **3.** Have students complete *Teamwork Rubric* (page 18) and *Engineering Design Process Checklist* (page 19) to reflect on and evaluate their work and collaboration skills.
- 4. Have students complete the Read and Respond questions from the book. Possible answers to the questions can be found in the Digital Resources (rebuildingbody_reproducibles.pdf).

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Make a Plan

Directions: Summarize the challenge. Brainstorm ideas and sketch two designs. Circle your favorite.

Challenge: _



Name:_____



Problem Solving with Prostheses

Directions: Describe the problems and solutions from the text.

I. "A Boy Wonder," pages 10–11



Name:	
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Innovators in the Field

Directions: Choose an innovator from the book. Answer the questions to plan an article about that person.

Name	
Profession or hobbies	
What inspired them to design and build prosthetics?	
What problem did they solve?	
How did they solve it? Did they make any improvements?	
How does the solution help people?	

Team Members:

Date:

Collaborative Design

Directions: Sketch your team's design in the first box. Sketch your team's improved design in the second box. Label each design with materials needed and the purpose of each part.



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Think about It

L What did your team struggle with? How did you deal with it? _____

2	
۷.	How did you contribute to your team?
3.	How did you use science, technology, engineering, the arts, and/or math in your
	designs?
4.	What was successful about your first design? How did you improve it?
_	
5.	What is the most important thing you learned? What questions do you still have?

Name: ____



Directions: Feedback can help people improve their work. Use these sentence stems to give feedback to your peers.

Clarify	
Can you explain?	
Why did you choose to?	
How did you?	
Warm Feedback	
I like because .	
It is interesting that	
is a sea of idea because	
Is a good idea because	
Cool Feedback	
Have you thought about	?
I wonder if	
You might want to the	-
	·



Prosthetic Hand Test Results

Directions: Write the materials each team used. Check boxes to record each team's test results. Then, answer the question.

Team	Materials	Test Results
		 picked up objects carried objects entire distance placed objects in bin
		 picked up objects carried objects entire distance placed objects in bin
		 picked up objects carried objects entire distance placed objects in bin
		 picked up objects carried objects entire distance placed objects in bin
		 picked up objects carried objects entire distance placed objects in bin
		 picked up objects carried objects entire distance placed objects in bin

Which design is most realistic? Why?

Name: _____



Engineering Design Process





Rebuilding the Body Quiz

Directions: Read each question. Choose the best answer. Fill in the bubble for the answer you have chosen. Answer the last question in complete sentences.

- I. Which technology is used in the Argus II?
 - a filter (\mathbf{A}) a 3-D printer
 - a microchip
- a surgical clamp

- **3.** How did LaChappelle make robotic arms more functional?
 - (\mathbf{A}) He used springs and batteries to add power.
 - B He built a hand that could be controlled by brainwaves.
 - C He used more expensive materials.
 - (**D**) He performed surgery to insert a microchip in the arm.
- **2.** What is the problem with hearing aids?
 - (A) They only hear background noises.
 - (B) They only hear voices.
 - (c) They amplify all sounds.
 - They filter sounds that aren't useful.

The utensil was made with so that it could be used to stir hot liquids.

- A silicone neurons
- B
- bionics C microchips
- - 5. How did Paré help injured soldiers in the French army in the 1530s?

4

Date:_____

Name:



Directions: Think about how you worked in your team. Score each item on a scale of 1 to 4.

4 = Always	3 = Often	2 = Sometim	es 1 = Neve	er	
I listened to people on my team.	4	3	2	1	
I helped people on my team.	4	3	2	1	
I shared ideas with people on my team.	A	3	2	1	
We made choices as a team.	4	3	2	1	
Total					
Comments:					



Engineering Design Process Checklist

Directions: Check the boxes to show that you completed each step.





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