THE FRANKLIN INSTITUTE

Be a **Health Scientist!**

Be an **Orthopedic Doctor**

Educator Guide

Big Question: How do orthopedic doctors fix broken bones and protect them while they heal?

GSK Science in the Summer™

In collaboration with GSK

Table of Contents

Be a Health Scientist! Big Ideas

These are the themes you'll find running through all five *Be a Health Scientist!* activities.

Health Science is all about finding ways to keep people healthy and helping them get better when they are sick.

- *What are some ways people can stay healthy?*
- *How can we learn more about the spread of germs and diseases?*
- *What are some ways to help people get better when they are sick?*

The human body is complex. There are many parts that work together to protect us from sickness and work to keep us healthy. When those parts are unable to do their job, health scientists can help in a variety of ways:

- *Finding the cause of the problem through tests and identifying ways to fix it.*
- *Using specially designed equipment to help our body work.*
- *Making sure our body has what it needs to stay healthy.*

Core Four Strategies

Use the Core Four Strategies as you guide your learners through this activity.

- **Ask questions** to spark curiosity and encourage new ideas
- **Encourage scientific thinking** with chances to observe, make predictions, and test ideas
- **Cultivate rich dialogue** with chances to talk together, share ideas, and use science words
- **Make connections** between learners' experiences, science careers, and this activity

Ask Questions

Encourage Scientific Thinking

Cultivate Rich Dialogue

Make Connections

Be an Orthopedic Doctor

Big Question: How do orthopedic doctors fix broken bones and protect them while they heal?

MATERIALS:

Per pair of learners:

- Styrofoam rod
- Tray

Per class:

- Building materials:
  - Wooden craft sticks
  - Skewers
  - Toothpicks
  - Foam sheets
  - Rubber bands
  - Brass paper fasteners
  - Heavy-duty aluminum foil
  - String
  - Scissors
- Be an Orthopedic Doctor career card
- Lab notebooks
- Pencils
- Science skills stickers

Prepare

1. To represent the broken "bones," cut or break each Styrofoam rod in half and place the pieces on a separate tray. You can create different types of "injuries" by breaking cleanly, twisting, cutting on a diagonal, etc. As a challenge for older learners, you could break it in multiple locations.
2. Create materials stations where learners can easily access and choose from materials as they decide how to repair the model "bone."

Engage (~10min)

1. Introduce the orthopedic doctor career by showing the group the career card and asking questions to encourage learners to think about what an orthopedic doctor might do:
   - *What do you notice about this picture? What do you think this person is doing?*
   - *What does the name "orthopedic doctor" make you think of? What do you think they might do or study?*
2. Explain that orthopedic doctors specialize in the **musculoskeletal system**—peoples' bones, muscles, joints, and how they all connect to each other. They can treat injuries like broken bones or torn muscles.
3. Introduce the storyline:
   - We are orthopedic doctors at a hospital. We have a new patient who was injured during a hockey game and broke a bone in their lower leg called the tibia. **Our job is to find the best way to realign the bone and repair the injury.**
     - *Have you or someone you know ever broken a bone before?*
     - *What are some ways you think orthopedic doctors can repair bones?*

Explore (~40min)

Part 1: Research

1. Ask the group to think about how doctors can examine bones and muscles. Point out that those parts are on the inside of the body, so we can't just look at them with our eyes.
   - *What are some ways doctors could find out about problems with bones or muscles?*
2. Explain that **X-ray** is one way to look at our bones without going inside our body. Direct learners to observe the X-ray images of broken bones on different parts of the body in their lab notebooks on page 21.
   - *Has anyone you know had an X-ray before? What was it like?*
   - *What do you see in these X-rays? How are they similar and different?*
   - *Can you figure out what part of the body each X-ray is from?*
   - *Do our body parts look the same or different on the inside and outside? What is the same? What is different?*
3. Direct learners to look at the images of bone repairs in their lab notebooks on page 22.
   - *What types of repairs do you see here?*
   - *Why do you think an orthopedic doctor may use one type or the other?*
4. Explain that there are two types of repairs that orthopedists can use to prevent the bone from shifting as it heals.
   - Inside repairs: Putting rods, metal plates, nails or screws into the bone to hold it in place.
   - Outside repairs: Using a cast or splint to keep bone parts lined up as they heal.
   - *How do you think orthopedists decide which kind of repair is best for their patient?*
   - *What kind of repair might be best for our hockey player with the broken tibia?*

Part 2: Repairs

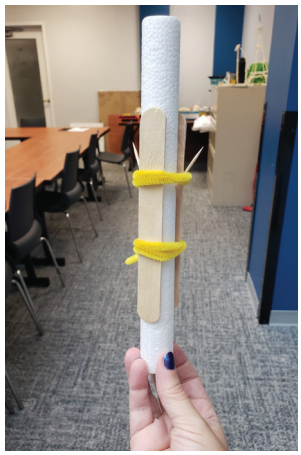
1. Divide the group into pairs at their work area. Explain that they are going to be repairing a **model** of a broken bone—an easier version that helps us learn about the real thing so we can solve our problem.
2. Distribute the broken Styrofoam rods that will represent the broken tibia. Explain that they will need to decide on a type of repair and use the materials they have available to fit the pieces of the bone together properly, like puzzle pieces! **It is important for the pieces to fit back together correctly, so they can heal properly**, or the patient will have problems later.
3. Direct learners to study the broken "bone" and show them the available tools they will have for their repair.
   - *What do you notice about the "bone"?*
   - *How do you think you can repair it using the tools we have available here?*
4. Ask learners to discuss a repair plan with their partners and draw a sketch of their idea in their lab notebook on page 22. They should also decide what materials they will use before they begin choosing their materials from the station.
   - *Will you use an inside or an outside repair? Why?*
   - *What materials are you thinking of using?*

5. Once they have a plan, invite pairs to visit the materials station and select the materials they listed for their repair. They should return to their workspaces and work on repairing their bone.
6. Once pairs have repaired their bones, explain that they will need to test the success of their repair.
7. Pairs should carry their repaired bone upright from one side of the room to the other. If the pieces do not separate and no pieces fall off they have repaired their bone successfully! If their bone separates or breaks, encourage them to return to workstations and revise their repair.

> *For younger learners, skip Part 3 and go straight to the Reflect section.*

Part 3: Walking support

1. If time allows, invite pairs to think about a second part of the patient's treatment. Once the bone has partly healed, the patient can start putting some weight on it, but the bone still needs support to keep it in place.
2. Challenge pairs **to design a splint or brace for the repaired bone that will keep it from wobbling or re-breaking when the patient puts weight on the leg.**
3. Demonstrate how to test the stability of their model by standing one end of their repaired bone on a tabletop or other hard surface and gently pressing down on the top end of the bone (as if the patient was putting weight on the leg.)
   - *Does the repaired part wobble or slip?*
   - *What kind of support would make it stronger?*
4. Encourage groups to think about what else the patient might need or want the device to do beyond supporting the bone.
   - *Which parts need to be strong and hard, and which parts might need to be soft or flexible?*
   - *If the patient has to wear this all the time for several weeks, what else might you need to think about?*
   - *How can you find the right balance between what the bone needs to heal and what is comfortable for the patient?*



Reflect (~10min)

1. Gather the whole group together. Invite learners to share their solutions for repairing the patient's broken bone.
   - *Which of our solutions are similar? What are some differences between them?*
   - *How do our solutions help keep the bone parts in the right place so they can heal?*
   - *Using what we learned from this model, what treatments should we suggest for our patient?*
2. Ask them to think about the design process of creating their solution.
   - *How did you decide what materials to use?*
   - *How did your ideas change? What did you try that didn't work?*
3. Encourage the group to reflect on how they were like orthopedic doctors during the activity. Refer to the career card and the science skills stickers:
   - *What are some of the things we did today as an orthopedic doctor?*
   - *How did we think like scientists? What science skills did we use?*
   - *What did you do today that made you feel like a scientist?*
4. Allow time for learners to draw or write their reflections on page 23 of their lab notebooks. Invite them to choose a science skills sticker that reflects a skill they used and add it to their notebooks.

Background

- Orthopedic doctors specialize in the musculoskeletal system. This system includes the repairing of bones, joints, ligaments, tendons, and muscles. Orthopedic surgeons train longer to be qualified to perform surgery.
- There are 206 bones in the adult human body. The tibia is one of two bones in the lower leg, at the front of the shin, and is the second longest bone in the body (after the femur, or thigh bone).
- Internal repairs like plates or screws are used for complicated breaks, where the bone is in multiple pieces or needs extra stability to keep the parts in place.
- Casts and splints support and protect a broken bone or injured tissue by keeping the injured part of the body still. Some splints are flexible and some are rigid. They are most often used for more minor injuries, like hairline fractures (cracks in the bone, rather than fully broken pieces).
- Some types of cast or brace can be used to support a partially healed bone as the patient begins using the body part again.

Acknowledgments

Authors: Tiffany Allen, Rachel Castro-Diephouse

Designers: Madeleine Bennett and Madelyn Lobb

Sponsor: This program is made possible with the generous support of GSK and the contributions of their dedicated team.

Host Organizations: Thank you to the many organizations who host and support GSK Science in the Summer™ programs across the country. GSK Science in the Summer™ reaches thousands of children each summer thanks to your ongoing commitment and invaluable contributions.

Photo Credits:

p. 4 © Anna Shvets / pexels.com

Be an Orthopedic Doctor Quick Guide

EDUCATORS DO:	EDUCATORS ASK:	LEARNERS DO:
ENGAGE		
Introduce Career • Use career card • Ask discussion questions • Explain what orthopedic doctors do	*What do you notice about this picture?* *What do you think this person is doing?* *What do you think an orthopedic doctor might do or study?*	• Make observations about the image • Make connections to their own experience • Share their ideas
Introduce Story • We are orthopedic doctors at a hospital and we got an emergency call • The patient broke their tibia and we need to repair it	*Have you or someone you know ever broken a bone before?* *What are some ways you think orthopedic surgeons can repair bones?*	• Imagine being an orthopedic doctor • Discuss why it is important to repair broken bones

***Quick Guide continues on the following page.*

Be an Orthopedic Doctor Quick Guide

EDUCATORS DO:	EDUCATORS ASK:	LEARNERS DO:
EXPLORE		
Part 1: Research • Show learners X-rays of broken and repaired bones • Discuss different techniques to repair broken bones	*Have you or anyone you know had an X-ray?* *What parts of our body are visible in X-rays? What parts are not visible?* *What materials are used to repair broken bones? Why are they effective?*	• Look at X-rays to make observations • Look at different techniques used to put bones back together
Part 2: Repair • Give learners models of broken bones • Ask questions to support learners' planning • Encourage testing and re-design	*What do you notice about the "bone"?* *How do you think you can repair it using the tools we have available here?* *What is the best technique to repair your bone?*	• Create a plan for repairing the bone model • Build and test their solution • Revise the design and retest
Part 3: Walking Support • Introduce the weight-bearing support challenge • Demonstrate the stability test • Support testing and re-design	*Does the repaired part wobble or slip?* *What kind of support would make it stronger?*	• Design a brace to support the bone while bearing weight • Build and test their solution • Revise the design and retest
REFLECT		
Share Group Results	*How are our solutions similar or different?* *Using what we learned from this model, what treatments should we suggest for our patient?*	• Compare solutions • Reflect on design process • Make recommendations
Make Career Connections	*What did you do today that made you feel like an orthopedic doctor?* *How did we think like scientists?* *What science skills did we use?*	• Use skills stickers • Draw/write reflections

Notes

Notes

Notes