SHRINKING SUTURES

Target Population:
Students, ages 9–11

STEM2D Topics:
Science, Technology, Mathematics
Shrinking Sutures is part of the STEM2D Student Activity Series. The content and layout were developed by the Smithsonian Science Education Center as part of Johnson & Johnson’s WiSTEM²D initiative (Women in Science, Technology, Engineering, Mathematics, Manufacturing, and Design), using a template provided by FHI 360 and JA Worldwide. This series includes a suite of interactive and fun, hands-on activities for girls (and boys), ages 5–18, globally.

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Model suture images & gummy bear image:Ryan Seymour, Smithsonian Science Education Center
Shrinking Sutures

Challenge
Design a suture model that has observable changes in its properties due to a chemical reaction.

Target Population
Students, ages 9–11

Activity Description
Students will design a suture model and observe how a chemical reaction can change the properties of their model. Using the example of the Johnson & Johnson suture Dynacord™, students will better understand how chemical reactions can change the properties of objects to improve the lives of people.

Materials for Each Student:
- 2 Gummy worms (5 cm, 2 inches long)
- 4 Pieces of milk carton cardboard cut into 2½-cm (1-inch) pieces
- Hole puncher or Scissors (shared)
- Ruler
- Student Sheet 1
- Student Sheet 2
- Pencil (shared)
- 2 Large bowls
- Warm to hot water
- Table salt
- Spoon
- Newspaper or paper towels

Safety
In science classrooms do not eat or taste any of the materials. Do not directly touch hot or boiling substances.

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Background Information

Sometimes humans and other animals get a cut or wound. Some wounds require nothing more than a Band-Aid and time to heal. Other wounds cannot heal on their own. Wounds that are deep, long, that have jagged edges, that gape open, or that continue to bleed after 15 minutes of applying pressure often will not heal on their own. Wounds that are in difficult locations, such as the face or near a joint (like a shoulder or knee), also may have trouble healing on their own. A wound that cannot heal on its own is a problem. It can lead to infection and make the person sick. Engineers and doctors have come up with solutions to this problem. The solutions are sutures and staples. Sutures are surgical threads that are used to repair cuts. They also are used to close wounds from surgery. Staples are small medical devices that can be used instead of sutures.

One special type of suture developed by Johnson & Johnson medical engineers is the Dynacord™. Dynacord™ is used to help a shoulder heal after surgery. Sometimes a surgeon might not be able to tie the suture as tight as it needs to be. If the suture is loose, the wound might not heal correctly. But with Dynacord™, the suture gets tighter while it’s inside the body, helping to repair a surgical wound. How does this suture get tighter by itself? The chemicals of the suture and the chemicals inside the body react with each other in a complex way, causing the overall length of the suture to decrease. This is an example of a chemical reaction.

Johnson & Johnson Dynacord™ illustration
DePuy Synthes Dynacord™ photograph

To see a Dynacord™ timelapse video go to: https://youtu.be/L1u2UrtpTbM
Meet a Suture Scientist Chloe Symes*

*Younger students may need an adult’s help reading this section.

**How did you get started in your career?**
I studied Biological sciences at university and loved it. However, I didn’t want to work in research, and a friend suggested working in medical devices as it combines science with business. I moved into the industry and haven’t looked back! I get a lot of satisfaction from my job as well as using my intellectual curiosity and interest in sciences.

**Can you provide a description of your work?**
I have been the suture product manager in the UK, so I was the person who supported our sales team with technical queries, support with surgeon meetings and advice on how best to interact with hospitals relating to sutures. I also set the strategic plan for sutures for the UK and was responsible for new product launches. Now I work in a role that covers all medical device products, not just sutures, but they still play an important part in my job.

**What is the best part of working in this field?**
Knowing that you work for a company that makes products that literally cut out cancer, sutures people’s bodies back together, helps remove blood clots in people’s brains when they have a stroke... I could go on. We make the products that help doctors do their jobs and the chances are if you know someone who has gone into hospital for an operation, they probably had a J&J suture holding them together at the end.

**How are chemicals and chemical reactions useful for healing?**
Synthetic sutures are absorbed through hydrolysis, which is the use of water molecules interacting with the atoms of the suture material to break them down. By using this method of breakdown, we can adjust the chemical composition of sutures to ensure they last different amounts of time in the body before dissolving. We can make sure the sutures used on the skin dissolve in the same amount of time it takes for skin to heal (about a week in a healthy person), whereas a suture used on the abdominal muscle needs to have a different chemical composition, so that it doesn’t dissolve for 6-8 weeks.
Meet a Suture Scientist Vivian Liang*

*Younger students may need an adult’s help reading this section.

How did you get started in your career?
Science and math were always interesting to me, so I went to college for engineering. I explored different careers through internships, lab research, and taking different classes to discover my passion. Eventually I joined Johnson & Johnson as a student intern, really enjoyed the work, and fortunately was able to start my career as a Research & Development Engineer.

Can you provide a description of your work?
My team works to develop new medical devices, including sutures. We all have different areas of expertise (Quality, Manufacturing, Research & Development, etc.), and together we design, create, test, and bring the product to market. Some suture-specific things we do include selecting the right materials, evaluating mechanical properties, and making sure the suture is safe and effective for a repair.

What is the best part of working in this field?
My favorite part about being an engineer is working with a diverse team to bring an idea to life. It’s awesome being able to harmonize creativity and science and technology to create something impactful.

How are chemicals and chemical reactions useful for healing?
All biologic functions, including healing, can be boiled down to chemical reactions. Certain materials can trigger cells to migrate to the repair site and promote healing response. Understanding the chemical reactions behind this can help with material selection during the design process. Some chemicals may elicit a healing response while others can be harmful if they are implanted.

How are chemicals and chemical reactions useful for healing?
The material selection for the suture is based on the application. Suture materials can be natural or synthetic, absorbable or non-absorbable. Some examples of materials are steel, silk, polyester, and collagen. Dynacord suture even uses salt!
Explaining the Problem Conversation Starters

- Has anyone ever had a cut? Has anyone ever had surgery? (Introduce phenomenon of wound closure.)
- Has anyone ever had sutures?
- What do you think is causing the Dynacord™ to get tighter? Why is it important for a suture to do this?
- Let’s look at these two images of gummy worms. Do you notice any differences between the two? Why do you think they are different?
- We will use gummy worms to model how sutures can use chemical reactions to help a patient heal.

Step-by-Step Instructions

- Divide the students into groups.
- Each student collects 2 gummy worms and 4 pieces of milk carton cardboard.
  - Explain how the gummy worm is like the Dynacord™ suture that reacts to the chemicals in its environment, bringing the two pieces of the body together (represented by the milk carton cardboard).
- Students use a hole puncher or scissors to make a small hole in the middle of each of the cardboard pieces.
- Students write their initials on one of the cardboard pieces and also mark that piece with the letter A.
- Students feed one of the gummy worms through the center holes in two of the cardboard pieces.
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- Using a ruler, have students measure the distance between the two cardboard pieces on either end of the gummy worm. Have students record the distance on Student Sheet 1.

- Students then repeat the previous steps with the second gummy worm and the remaining two pieces of cardboard. They initial and mark one piece of cardboard with the letter B. Students record the measurement between the two cardboard pieces on their Student Sheet 1.

- Prepare two bowls of water for the student’s suture models. One bowl contains warm to hot water with enough salt stirred in to cause salt crystals to form at the bottom of the bowl. The second bowl contains only warm tap water. Label one bowl “Saltwater” and the other bowl “Tap Water.”
• Place the gummy worm suture models marked with the letter A into the Saltwater bowl and those marked B into the Tap Water bowl.
• Set a timer for 30 to 45 minutes.
  o While you’re waiting, have students write their predictions for each of their suture models on Student Sheet 1. They should also describe what property changes they expect to observe when submerging their models in each bowl.
  o Have students share their predictions with the class. Then they work on Student Sheet 2, identifying various objects’ property changes after a chemical reaction.
  o After students complete Student Sheet 2, ask the following questions:
    • Have you ever seen any of these chemical reactions before? Can you tell us when?
    • Can you think of any chemical reactions that are like the ones on Student Sheet 2? What was the object like before the chemical reaction? What was it like after the chemical reaction?
  o When the timer is up, use a large spoon to remove the gummy worms from the bowls. Students collect their worms and remeasure the distance between the two cardboard pieces. They add those measurements to Student Sheet 1.
  o Ask the following questions:
    • Which gummy worm suture brought the two pieces of cardboard closer together? What do you think caused this change?
    • How are the two gummy worms different from each other? How are they different from a normal gummy worm?
Vocabulary

**Chemical Reaction:** when two substances react with each other, causing changes

**Length:** the measurement from end to end

**Property:** a characteristic of an object

**Stitch:** a single loop of thread or yarn

**Suture:** a thread used to sew together parts of the body

**Wound:** an injury to the body that usually breaks the skin
Student Sheet 1

Before the Chemical Reaction

Describe the gummy worms before the chemical reaction:

____________________________________________________________________

____________________________________________________________________

Gummy worm A distance       Gummy worm B distance

___________________________       ________________________________

After the Chemical Reaction

Gummy worm A distance       Gummy worm B distance

___________________________       ________________________________

Describe gummy worm A after the chemical reaction:

____________________________________________________________________

____________________________________________________________________

Describe gummy worm B after the chemical reaction:

____________________________________________________________________

____________________________________________________________________
Student Sheet 2

These objects have changed because of a chemical reaction. Observe and write down how they are different. There might be many answers.

1. An apple is cut in half and left out in the air for a full day. How does this change the apple?

   ________________________________________________________________
   ________________________________________________________________

2. A gummy bear is placed into a bowl of vinegar. How is the gummy bear changed?

   ________________________________________________________________
   ________________________________________________________________
3. A match is lit. How does this change the match?

3. Baking soda is mixed with vinegar. How does this change the baking soda?