Applications: Activity 2

Bone Regrowth

Cast Away

We're Kobel and Nathan. Our friend, Adam, took a skateboarding spill and is stuck with a cast on his leg for weeks. At the **Oregon Museum of Science and Industry**, we learned that scientists are using nanotechnology to help regenerate nerves and bones. We caught up with a scientist from **Brown University** who is working on a solution of nanotubes and minerals that could be injected into a fractured bone and heal it almost instantly! The nanomaterial keeps the bone together (without a cast) and slowly disappears as new bone grows and takes its place.

Our question:

What's the best nanomixture to make the strongest bone repair?

We experimented with different mixtures and put our model (sponge) bones to the test in our bone buster to find out which mix made the strongest repair!

Nano Matters

The field of nanomedicine is an area in which nanotechnology has the potential to make a big impact in the near future. Since scientists are now able to manipulate materials as small as (and even smaller than) individual cells, novel ways to treat a variety of diseases and ailments are being researched. In this episode, we explore a mixture of nanotubes and minerals that mimic the naturally occurring collagen and minerals present in bone. These nanotubes are not made of carbon, but of bases of DNA, making them completely biocompatible. Scientists in the field of nanomedicine are mending bones, regenerating nerves and even targeting cancer cells without harming other cells of the body.

Icebreaker

Learn some bone basics with this simple activity.

25 minutes for investigation; 24–48 hour wait period

DragonflyTV Skill: Experimenting

Guide your kids as they

1) Clean 3 chicken bones and place one in each jar.
2) Label the jars and add water to one, vinegar to another and bleach to the third. Make sure the liquid covers the entire bone. Seal the jar lids.
3) Wait 24 hours. Remove the bones and rinse with water. (Avoid direct contact with bleach by removing the bone with tweezers.)
4) Examine the appearance of each bone and test its flexibility. Can you cut it with a pair of scissors?
5) Place the bones back in their respective jars and leave them for 24 additional hours. Rinse and repeat the observations and tests.

You'll need:

- 3 chicken bones
- 3 jars with lids
- bleach
- vinegar
- water
- tweezers
- scissors
- permanent makers or labels for the jars

Are you a nano-bit curious?

Two of the main components that make up bone are collagen (a protein) and minerals (such as calcium). Collagen is a really small, nanosized protein molecule that gives bone flexibility. The minerals give bone its strength. Vinegar is a mild acid that reacts with the calcium carbonate in the bone to produce three products: carbon dioxide gas (the bubbles you saw), water and a calcium salt. The bone is now flexible, since the vinegar reacted with and broke down the mineral strengthener. Bleach is a strong base that causes the protein (collagen) to denature or lose its three dimensional structure. Without collagen, bone is very brittle. Can you imagine your bones without one ingredient or the other? Nanoscientists are trying to produce artificial analogs of these components to help heal broken bones by mimicking the natural balance of strength and flexibility.

For other ideas of Icebreaker activities on this topic, visit: pbskids.org/dragonflytv/superdoit/eggcellent_idea.html and pbskids.org/dragonflytv/superdoit/dissolvetheeggshell.html.

Investigation
No bones about it!

3 hours plus drying time

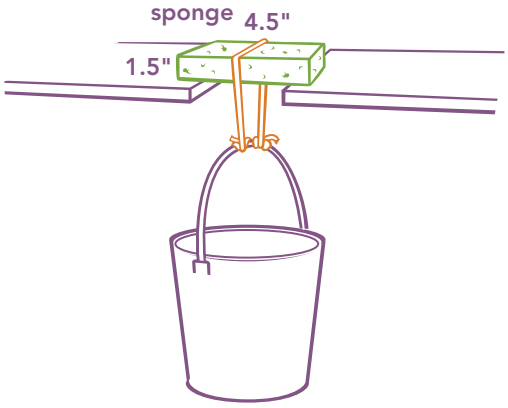
Guide your kids as they

1) Divide into groups. You may want to line your table with a tablecloth or old newspaper for easy clean-up.
2) Cut the sponge in half lengthwise so you have 2 pieces about 4.5" x 1.5". The sponges will represent the spongy matrix of bones.
3) Imagine that you are a nanoscientist in the lab. You are looking for new ways to repair broken bones and your goal is to find the best mixture that makes the strongest bone. Each group should use a different amount of plaster of Paris. Plaster of Paris is made of calcium sulfate and will represent the calcium and minerals that give bones their strength.
4) Grab disposable containers and add 1 cup of water to each. Add plaster of Paris in various amounts such as 1, 2, 4 and 6 tablespoons. Use Popsicle sticks to mix the plaster of Paris and water. (Note: it may not completely dissolve.)
5) Each group will dunk the sponge "bone" into one mixture and let it set for 15 seconds before flipping it over and repeating to completely cover the sponge. Keep mixing as you do this so the plaster of Paris does not settle. Prepare 3 sponge bones to test for each mixture.
6) Place the sponge bones on wax paper to dry for about 48 hours, flipping half-way through. Speed up drying time by placing the sponges in the oven. Be sure to choose a low temperature (300˚F or less) and do not leave them unattended.
7) Allow the remaining mixture to dry and dispose of it in the trash. DO NOT POUR PLASTER OF PARIS DOWN THE DRAIN!
8) Predict which bone will support the most weight. Then test it by placing 2 desks or tables of equal height about 2" apart. Lay the bone across as a bridge between the two desks.
9) Tie a string around the handle of a bucket and wrap it around the center of the sponge bone. Add weights slowly until the bone breaks or cracks. Record the weight at which it broke.

You'll need:

- newspaper or tablecloth
- kitchen sponges (4.5" x 2.75")
- plaster of Paris
- water
- bucket
- scale
- string
- 2 desks or tables of equal height
- tablespoon
- disposable containers
- Popsicle sticks
- wax paper

Adapted from: Bone Up on Bones Teacher's Guide; Oregon Museum of Science and Industry 2004.

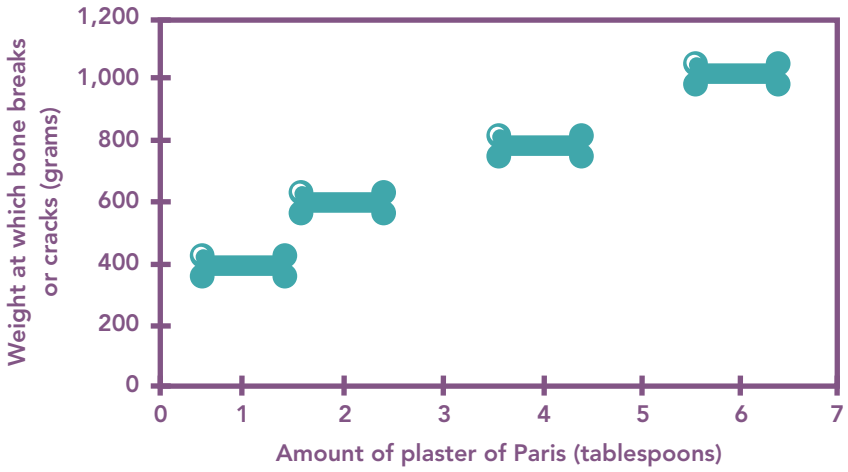


Don't have weights? No problem. Add water to the bucket little by little until the bone breaks or cracks. Then weigh the bucket on a bathroom scale. Alternatively, you can measure the amount in cups, quarts or milliliters!

Are you a nano-bit curious?

Strengthening minerals, like calcium, are deposited in a spongy matrix that prevents our bones from becoming too heavy. In this activity, you discovered why individuals with insufficient calcium often have fragile bones. While showcasing the importance of calcium, this exercise also reinforces the importance of the scientific process in any field of science, including nanoscience and nanomedicine. It serves as an excellent model of how nanoscientists must test and retest their formulations to create the desired result. Only one variable—the amount of plaster of Paris—was changed, while the rest of the experiment was kept constant. It also provided an opportunity to discuss the importance of multiple replicates. Some of your replicates may have varied quite a bit. Why? What could have been done to better control the conditions?

DFTV Kids Synthesize
Data and Analysis



Keep Exploring!

Brainstorm other ways you would like to see nanomedicine make your trip to the doctor a little more pleasant. Besides broken bones that heal almost instantly, what nanovention would you like to see?