



Bendable Bones

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Grade Level:

High School

Bendable Bones

Purpose:

Engage students in exploring bone as living tissue.

Grade level: High School Biology

Objectives:

Students will be able to:

- identify different parts of bone.
- recognize how strong bones are.
- compare the shape of the bone to its strength.
- gain a basic understanding of the composition of bone.
- assess different substances that may affect the strength and rigidity of bones.

Materials:

- cross section cow leg bone (femur)
- microscope
- microscope slides and cover slips
- spoon (not plastic)
- ruler (metric)
- chicken bones
- paper cups
- paper/plastic wrap to cover cups
- vinegar, Apple Juice, Cola, Water

The students will work together in pairs.

Each pair of students will receive:

- two cross sections of cow leg bone (one frozen, one boiled)
- one spoon
- one ruler
- four chicken bones
- four paper cups
- four rubber bands
- four pieces of paper/plastic to cover cups
- one pair of rubber/latex gloves
- 150mL vinegar (½ cup)
- 150mL apple juice
- 150mL Cola
- 150mL Water

The cross section of cow bone can be found at your local butcher. There may be a nominal charge for the bone.

Cow bones should be boiled for a maximum of five minutes to kill any bacteria or kept frozen until ready to use. (Note: you shouldn't boil the bones any more than five minutes because it will destroy the consistency of the marrow.)

Rubber/latex gloves can be found at a local beauty shop or drug store.

Chicken bones should be cleaned of all meat. Boil the chicken until the meat falls off or call your local butcher to see if he/she has any discarded chicken bones.

General Information:

Prior to the lab activity discuss bone as a living tissue.

The skeleton performs several necessary functions. It supports and protects the softer tissues; it provides an attachment surface for the muscles, tendons and ligaments, which in turn provide the mechanical foundation that allows us to move our bodies. Bones also act as a storehouse for essential mineral salts, like calcium, and many bones produce our blood cells in their inner marrow cavities.

Adult humans typically have 206 bones, although extra bones in the hands, feet and tailbone are common. The number of bones in a child's body varies with age, since many bones begin to mineralize (ossify) in two or more locations and later they form one bone.

In life, bones are not dry and inflexible, but rather adaptable, living organs. Living bone cells make up about 20 percent of bone. The rest consists mainly of long fibers of collagen (the protein that makes up our connective tissue), where mineral salts have been deposited like scales. Blood vessels and nerves run throughout bone within tiny canals. Bones are not static, like rocks, but are constantly changing as old cells are reabsorbed and new cells are formed. This active remodeling is the basis for the healing process in broken bones.

Bone marrow is a soft, netlike mass of connective tissue in the middle of the compact bone. It is made up of blood and fat cells. In certain bones, red blood cells are manufactured (thigh and arm bones), in childhood. Later in life, the red marrow becomes yellow, fatty marrow.

About 1.5 percent of our body weight is calcium, a mineral that plays an essential role in cardiac and skeletal muscle contraction, nerve function, and blood coagulation.

Phosphorus, a mineral vital to the production of cell membranes and genetic material (DNA, RNA), is also stored in the bones. Too few minerals in the diet can lead to serious health problems. Osteoporosis, for example, occurs when there is either too little calcium in the diet or when not enough calcium is being absorbed. Eating a healthy diet that includes calcium-rich foods, as well as performing regular weight bearing exercise, will help to maintain a strong skeletal system for a lifetime.

The bones that are exposed to acid become flexible and the texture changes. This is due to the organic salts being removed from the bone.

Joints link our bones together and allow our bodies to move. Joints can act in a number of ways:

- The hinge, like on a door, e.g., our knees, elbows and fingers.
- A ball and socket, e.g., our upper leg [femur-pelvis] and upper arm [humerus-scapula joints].
- The pivotal joint, e.g., the radius of the forearm.
- The plane joint, e.g. wrist bones, or carpal, or like saddles base of thumb where it joins the wrist

Safety:

After the lab, make sure the students wash their hands with soap. Even though you have boiled the bones and they should be safe, washing the hands just insures that if there is any bacteria it gets washed away.

Questions to ask:

1. Are bones living?
2. What does real bone look like inside?
3. What makes bones so strong?
4. Is the outside of bone hard or soft?
5. Is the inside of bone hard or soft?
6. Do you think that the outside or inside of the bone is stronger? Why?
7. What other things do you notice?
8. Do you think that any of these liquids will have an effect on the bones, change them in any way?

Suggestions for Assessment:

- Class presentation of experiments, results and conclusions.
- Develop a rubric for evaluation of group activity.

Where to go from here:

- Explore in more detail how bones grow and repair.
- Investigate bones as levers.
- Compare the skeleton of other animals to humans.
- Assemble a model of the human skeleton and learn the names of the bones.
- Investigate organisms with skeletons on the outside (size, shape, mass, and function).
- Examine bone cells under the microscope.

Extracurricular activities:

- Take a hammer and try to smash the bone. (Note: Keep the bone inside a heavy paper or plastic bag and use safety goggles.)
- Interview a Doctor of Orthopedics

- Build different geometric shapes to see which ones can withstand the same forces as bones.

Reference and Resources:

1. Raven, H., Peter (1996). *Understanding Biology*. Iowa: Wm. C. Brown Publishers.
2. Johnson, B., George (1997). *The Living World*. Massachusetts: WCB McGraw-Hill.
3. Websites:
 - <http://www.scicentral.com>
 - <http://www.utexas.edu/world/lecture>
 - <http://www.mhhe.com/biosci/genbio/tlw/world.html>
 - <http://www.gened.emc.maricopa.edu/bio/bio181/BIOBK/BioBookTOC.html>

Student Activity Sheet 1

What is Inside and Outside a Bone?

Materials

- cross section of cow bone (femur), one frozen, one boiled
- spoon
- ruler
- microscope
- clean slides
- cover slips

Procedure:

1. Collect materials from the instructor.
2. Pick up both bones.
3. Examine the inside and the outside of the bones.
4. Touch the outside of each bone.
5. Touch the inside of each bone.
6. Compare and contrast the feel and look of the boiled bone to the frozen bone.
7. Are the bones stronger on the inside or the outside?
8. Why do you think the inside of the bone is soft?
9. Why do you think the bone is hard on the outside?
10. What other things do you notice about the bones?
11. Scrape the hard part of the bone and place the sample on the slide with the cover slip over it.
12. Look at it under the microscope using all three powers.
13. Describe and draw what you observe.
14. Can you tell what bone is made of?
15. Write up a lab report, using the scientific method, of your observations and conclusions.

Be sure to include the following in your lab report:

- Your question (purpose).
- Your hypothesis (what you think will happen).
- Materials.
- Methods (how you will do the experiment).
- Chart to record your data.
- Results.
- Conclusions.
- Additional questions you would like to explore (where would you go from here?).

Student Activity Sheet 2

Strong Bones, Weak Bones

Materials

- four chicken bones
- four rubber bands
- four cups
- paper/plastic to cover cups
- solutions: Vinegar. Apple juice, cola and water

Procedure:

1. Label four cups (water, apple juice, cola and vinegar).
2. Label the date and time on each cup of when you started the experiment.
3. Observe each chicken bone (length, width, shape, mass, color, rigidity, etc.).
4. Make a chart with the written observations made from question 3.
5. Place a chicken bone in each cup.
6. Cover the bone with liquid (make sure the liquid you pour matches the cup you are pouring it in).
7. Cover each cup with paper or plastic and secure it with a rubber band.
8. Allow bones to sit four days in the liquid solution.
9. Write all observations on a chart.
10. Conclusion should include the comparison and the contrast of the observations before and after the experiment.
11. The experimental design has been provided to test the strength of bones.

You should develop:

- Purpose
- Hypothesis
- Predict what you think will happen
- Run experiment
- Chart to record data
- Results
- Conclusions
- Additional questions that you would like to explore.