LIVING BONES, STRONG BONES

Student Name _____

This lesson will help you identify ways to keep your bones healthy, and observe the effects of reduced gravity on bone models.

During this lesson you will:
- observe bones.
- design bone models using index cards.

Problem

How can I make a bone model that is strong and will hold weight?

Observation

Astronauts need to be able to walk long distances to explore the moon or Mars surface, especially if their rover breaks down. This long distance is called a 10 km walk-back (6.2 miles). Astronauts need to be in top condition to keep their bones strong and healthy, which is essential for performing tasks in space such as the walk-back.

Bone is a living organ in your body. Bone is broken down and built back up by special cells in the bones. It takes 10 years for your entire skeleton to be replaced with new bone!

There are two ways to keep your bones healthy – proper diet and resistive exercise. One without the other is not as effective as using both together.

First, a proper diet will ensure that bones stay healthy. You require calcium and vitamin D to build healthy bones. Where do calcium and vitamin D come from? Calcium is found in dairy products such as milk, cheese, and yogurt, and in leafy green vegetables. Vitamin D is called the “sunshine vitamin” because regular exposure to sunlight gives your body the vitamin D it needs. Vitamin D is added to foods such as milk and orange juice. Astronauts need proper amounts of calcium and vitamin D to keep their bones strong and healthy.

Second, gravity pulling on your body, or “loading” is essential to bone health. A type of exercise that “loads” your bones is called resistive exercise. When you do push ups, jump rope, or push against a surface, you are doing a resistive exercise, and that helps you build strong bones! Astronauts need resistive exercise to keep their bones strong and healthy.

Engineering Design

Materials

Per class:
- meter stick
- balance scale
- gram weights

Per group:
- one cooked, clean, dry chicken thigh or leg bone inside a snack size zipper-seal bag
- centimeter ruler
- five index cards (7.6 x 12.7 cm or 3 x 5 in)
- clear cellophane tape
- cardboard square (approx. 24 x 24 cm or 9.4 x 9.4 in)
- textbooks or reams of paper
- snack size zipper-seal bag 1/3 full of aquarium gravel

Per student:
- safety glasses or goggles
- red pen
- hand lens

Safety

Review your classroom and lab safety rules. You should wear eye protection during this activity. Do not remove the chicken bone from the zipper-seal bag.

Eating a proper diet rich in calcium and vitamin D and being physically active will keep your bones strong. If you go outside to play hopscotch on a sunny day, you are taking in vitamin D from the sun, and getting resistive exercise – two parts of having proper bone health. Doing these things will keep your bones strong, the same way the astronauts keep their bones healthy. Who knows? One day, if you keep your body well-conditioned you could become one of our next space explorers to travel to the moon, Mars, and beyond!

Brainstorm with your group about bones. Make observations about bone following your teacher's instructions.

Use the first column of this KWL chart to organize your observations about bones. Brainstorm with your group what you want to know about bones, and then record your list in the second column of the KWL chart.

KNOW	WANT TO KNOW	LEARNED

Hypothesis

Based on your observations, materials, and predictions, answer the problem question with your best guess. **Problem: How can I make a bone model that is strong and will hold weight?** Your hypothesis should be written as a statement.

My Hypothesis: _____

_____

Test Procedure

With your group:

1) Study the index card.
    - Discuss the shape, size, and thickness of bones.
    - Decide how you would like to design your group bone model from the index card.
        - Design a bone model making sure your bone model is:
            - made much like the chicken bone, and
            - sturdy enough to hold weight.
2) Complete your individual bone model design drawing on your own piece of graph paper.
3) Label the materials in your design on your graph paper.
4) Group members should agree on a title for your bone model design, and include it on your graph paper.
5) Use the index card to build a bone model according to your sketches, using the tape for fastening.

6) Place the bone model on the table in the same way your leg bone is in your body when you are standing up.

7) Record the materials you will use to construct your bone model on your Living Bones, Strong Bones Data Sheet.

8) Place the cardboard square on top of the bone model.

9) Predict how many textbooks you will be able to stack on the bone model.

   The textbooks represent the weight of your body.

10) Record your prediction on your Living Bones, Strong Bones Data Sheet using a red pen.

11) Place the textbooks, one at a time, on the cardboard square until you run out of textbooks or your bone model collapses.

12) ***Collect and record data*** by counting the number of books your bone model was able to hold and recording the number on your Living Bones, Strong Bones Data Sheet.

    The bone model you tested represents bones that are weak due to improper amounts of calcium and vitamin D, a lack of resistive exercise, or the force of gravity no longer pulling on them. Your bones need resistive exercise and a healthy diet including calcium and vitamin D to stay strong.

13) Redesign the bone model on your graph paper, making it stronger by increasing the thickness of the simulated bone. This strengthening of your bone represents increased resistive exercise and a diet rich in calcium and vitamin D. Make sure you label your drawing, including the new materials.

14) Record the materials you will use to construct your new bone model on your Living Bones, Strong Bones Data Sheet.

15) Rebuild the bone model using two index cards.

16) Predict how many textbooks you will be able to stack on the new bone model.

17) Record your prediction on your Living Bones, Strong Bones Data Sheet using a red pen.

18) Place the textbooks, one at a time, on the cardboard square until you run out of textbooks or your new bone model collapses.

19) ***Collect and record data*** by counting the number of books your new bone model was able to hold and recording the number on your Living Bones, Strong Bones Data Sheet.

    The bone model you tested represents bone that is somewhat weak due to less than sufficient amounts of calcium and Vitamin D and resistive exercise. In addition, the force of gravity has been reduced. Your bones need resistive exercise and a healthy diet including calcium and vitamin D to stay strong.

20) Redesign the bone model on your graph paper, making it stronger by placing material inside the bone model. This strengthening of bone is due to proper nutrition, including a diet rich in calcium and vitamin D and resistive exercise. Make sure you label your drawing, including the new materials.

21) Record the materials you will use to construct your new bone model on your Living Bones, Strong Bones Data Sheet.

22) Using your new bone model sketch, build a new bone model out of two index cards.

23) Place the zipper-seal bag containing aquarium gravel inside the bone model.

24) Predict how many textbooks you will be able to stack on the bone model.

25) Record your prediction on your Living Bones, Strong Bones Data Sheet using a red pen.

26) Place the textbooks, one at a time, on the cardboard square until you run out of textbooks or your bone model collapses.

27) ***Collect and record data*** by counting the number of books your bone model was able to hold and recording the number on your Living Bones, Strong Bones Data Sheet.

Record Data

Living Bones, Strong Bones Data Sheet

Bone Model	**Materials Used to Construct the Bone Model**	**PREDICT** How many textbooks will the bone model hold? **Use your red pen in this column.**	**ACTUAL** Record the number of textbooks the bone model held.
First Bone Model			
Second Bone Model			
Third Bone Model			

Study Data

After collecting all data, ***study data*** by answering the following questions.

1. Which bone model was the strongest? Explain why.

2. Compare the amount of weight the first bone model held to the weight the last bone model held. What is the difference? Did the amount of weight increase or decrease? Why did the amount change?

3. Were your predictions correct? Why or why not?

4. Does this data support your hypothesis? Why or why not?

5. How do your group results compare to class results?

Conclusion

- Fill in the LEARNED column in the KWL chart.
- Restate your hypothesis then explain what happened during testing, including your results.

Scientific Investigation Rubric

Experiment: Living Bones, Strong Bones

Student Name _____ Date _____

Performance Indicator	4	3	2	1	0
The student developed a clear and complete hypothesis.					
The student followed all lab safety rules and directions.					
The student followed the scientific method.					
The student recorded all data on the data sheet and drew a conclusion based on the data.					
The student asked engaging questions related to the study.					
The student designed a bone model that was strong and held weight.					
Point Total					

Point total from above: _____ (24 possible)

Grade for this investigation _____

Grading Scale:

A = 22 - 24 points

B = 19 - 21 points

C = 16 - 18 points

D = 13 - 15 points

F = 0 - 12 points

Bone Model 1: _____

Bone Model 2: _____

Bone Model 3: _____