# "HOLLOW STRENGTH"

**Background:**

When we think about what a bone is made of, we usually imagine it to be a dry and hard substance that doesn't appear to be 'living' in any way. In fact, the bones in our bodies are filled with living material. There are blood vessels which run near the surface of the bone, and two layers of bone types, compact bone and spongy bone. Often there is a jelly-like area in the center of the bone, which is called the bone marrow. Bone marrow produces the body's blood cells. Red blood cells carry oxygen around the body and white blood cells fight infection within the body.

Our long bones are hollow, and their cross sectional shape is a circle. Engineers agree that this structure is difficult to bend or twist. When we walk, run or lift objects, our bones do flex a little, but their basic shape helps to prevent them from grossly deforming or collapsing. If the central cavity of long bones were solid, bones would be considerably heavier, requiring much larger muscles to create movement. The added weight of extra muscle would make it difficult to move.

**Materials**

- Computer Paper (8 1/2 X 11)
- Tape
- Paper Plates
- Weights (wooden blocks - all the same size and shape)
- Scale
- Student Worksheet

**Activity Procedure Part 1:**

1. Students will roll up a sheet of paper into a cylinder with a diameter of 1 inch. Students will make a total of 4 cylinders/ paper bones.
2. Students will stand the paper bones up on their ends, placing a paper plate on top of the bones.
3. The teacher will ask the students to explain what is happening. (The hollow rolls are supporting the plate.)
4. The students will begin to add weights (wooden blocks) to the plate.
5. The students will count how many blocks the plate can hold before it collapses the bones.
6. The student will chart their results on the Student Worksheet.

**Activity Procedure Part 2:**

7. Students will roll up 4 more sheets of paper as tightly as possible, so there is little to no hollow section.
8. The students will stand these "paper bones" just as before and place the same paper plate on top of them.
9. The students will begin to place weights on the top pf the plate until it collapses.
10. The students will conclude what happened and chart their results on the Student Worksheet.
11. The teacher will explain that hollow bones were able to support more weight. Having a hollow center gives the bones a better design and makes them stronger. The large bones in our body are also hollow, which makes them strong so they can support more weight , but light, so it takes less energy to move them.

# Hollow Strength Student Worksheet

**Directions Part 1:**

1. Take one sheet of paper and roll it up into a cylinder with a diameter of 1 inch. Make a total of 4 cylinders which will be your hollow paper bones.
2. Stand the paper bones up on their ends.
3. Take one paper plate and weight it. Mark the weight on the chart below.
4. Place the paper plate on top of the hollow bones.
5. Take one block and weigh it on the scale. Mark the weight on the chart below.
6. Add weights (wooden blocks) to the plate.
7. Count how many blocks the plate can hold before it collapses the bones. Mark your results on the chart below and find the total weight o the Paper Bones.

## Hollow Bones

| | Weight of Paper Plate | Number of Blocks | Weight of one block | Total Weight on the Paper Bones |
|---|---|---|---|---|
| Experiment 1 | | | | |
| Experiment 2 | | | | |
| Experiment 3 | | | | |

**Directions Part 2:**

6. Roll up 4 more sheets of paper as tightly as possible, so there is little to no hollow section.
7. Stand the paper bones up on their ends.
8. Take one paper plate and weight it. Mark the weight on the chart below.
9. Place the paper plate on top of the solid bones.
10. Take one block and weigh it on the scale. Mark the weight on the chart below.
11. Add weights (wooden blocks) to the plate.
12. Count how many blocks the plate can hold before it collapses the bones.
13. Mark your results on the chart below and find the total weight of the Paper Bones.

## Solid Bones

| | Weight of Paper Plate | Number of Blocks | Weight of one block | Total Weight on the Paper Bones |
|---|---|---|---|---|
| Experiment 1 | | | | |
| Experiment 2 | | | | |
| Experiment 3 | | | | |

What is the difference between the hollow bones and the solid bones? _____

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