Snapback!
Exploring Elasticity Lab
Activity 3B

Activity Objectives:
Using equipment, a set of weights, and elastic tubes, students will be able to:
- investigate the properties of elastic bodies
- measure how changes in force may affect the amount of extension (stretch) in an elastic body
- distinguish between extension (strain) and force of weight (stress)
- provide a definition of Hooke’s law
- apply the principle of elasticity to human blood vessels
- graph their data to find that strain is proportional to stress

Activity Description:
Students will investigate Hooke’s law by studying the elastic properties of various sized tubing, especially the relationship between a force that stretches an elastic body and the length the elastic body stretches. Students will apply a known force to several elastic tubes and measure resulting changes in the circumference and length. Once students acquire a basic understanding of elasticity, they will relate this concept to the cardiovascular system.

Activity Background:
A material that can resist stretching and return to its original size and shape when a force is applied and then removed is elastic. An object is more elastic if it returns more exactly to its original size and shape. For example, think of a ponytail holder and a guitar string. The guitar string resists stretching and returns to its original length even after continual usage. A ponytail holder will lose its shape much faster under continual usage and is thus less elastic than the guitar string. Using a spring as an example of an elastic object, a weight hanging on the end of the spring as shown in Figure 1, Spring Elasticity, applies a stress to the spring. When the weight pulls on the spring, the spring will pull back in an attempt to resist stretching, but will lengthen to some degree under the stress of the weight. The stretch of an elastic object due to an applied force is called strain. (See Figure 1, Spring Elasticity). The same principle applies to other elastic bodies such as the tubes used in this activity.
In an elastic material, strain is proportional to stress. This means that the larger the weight (stress) hanging on a spring (or other elastic material), the more it will stretch (strain). This principle of elasticity is called Hooke’s Law. The point at which elastic materials do not obey Hooke’s Law is known as the elastic limit. When the elastic limit of a material is not exceeded, the material will go back to its original length when the weight (stress) is removed. However, if too much weight is added, the material will stretch without going back to its original length when the weight is removed. A very large weight hanging on an elastic object, will cause the object will get longer and longer until it breaks.

How does elasticity relate to the human body? The cardiovascular system consists of the heart and blood vessels (arteries, veins, and capillaries) and elasticity is an important property that allows our blood vessels to function properly. Arteries receive blood that is pumped away from the heart under pressure – this stretches arterial walls. Elastic fibers in arterial walls ensure that the vessel returns to its original shape. Arterial Elasticity keeps pressure on the blood inside, smoothing out the flow of the blood even when the heart relaxes; this pressure keeps the blood moving. Elastic recoil keeps blood moving though the capillaries – without it, the heart would have to work much harder. The elastic properties of arteries change with age and with disease. Arteriosclerosis is a disease in which arteries lose elasticity as their walls became stiff and inflexible; often as a result of high blood pressure exerting excess force against arterial walls. Atherosclerosis is a disease that begins with inflammation and causes arteries to become blocked. Atherosclerosis used to be considered an old person’s disease; however, it begins in childhood and progresses through young adulthood to cause coronary heart disease (CHD). Fatty streaks and lesions have been found in youth as early as 15 years of age.

It is important to understand the elastic behavior of arteries in terms of force and motion. In an elastic tube, such as an artery, the blood inside exerts a force by pushing against the walls to create a stress. The greater the force on artery walls, the less elastic and more stiff they would be.
become. If an artery wall goes beyond its *elastic limit*, a rupture may cause bleeding which can result in irreparable damage or death. Maintaining higher elasticity in the arteries is necessary for managing vascular health. Blood vessel elasticity can be maintained by eating a low-fat, healthy diet, exercising, maintaining a healthy body weight, and keeping blood pressure within a healthy range. Teaching students about the elastic properties of arteries will encourage them to make positive changes that can affect their young lives.

**Activity Materials:** (per group)

- Ring stand
- Clamp
- Spring scale (compatible with range of weights)
- Metric measuring tape
- 4 large binder clips*
- 4 medium binder clips*
- (1) 10 cm and (1) 15 cm stretchy rubber tube with the same inside and outside circumference, labeled A and B**
- (2) 15 cm stretchy rubber tubes with different sized inside and outside circumferences, labeled C and D**
  
  * 4 large binder clips*
  * 4 medium binder clips*
  ** (1) 10 cm and (1) 15 cm stretchy rubber tube with the same inside and outside circumference, labeled A and B**
  ** (2) 15 cm stretchy rubber tubes with different sized inside and outside circumferences, labeled C and D**
  
  * Set of weights (100 gram increments)
  (available through science supply stores)
  * Safety goggles
  * 1 set of task cards per group (these can be laminated and reused from class to class)

* By pinching sides together, the silver clasps are removed from binder clips. Insert one clasp into each end of the tube as shown in Figure 2. Pinch the tip of the binder clip and push into the tube as far as possible, then use the tip of a small knife to make a very small hole that allows the end of the clip to protrude through the tubing. Teacher should prepare the tubes prior to doing activity.

**Activity Management Suggestions:**

**Modifications:**
This activity may be arranged as a center or as part of several lab stations around the classroom. The teacher can write up easy to follow instructional cards, which guide the student and limit teacher direction.

**Extensions:**
Inquiry activity to determine other materials that obey Hooke’s Law.
Activity References Used:


Special thanks to Mary Poarch and her students at Alamo Heights ISD for field testing this activity.