Levers in the Body:  
They Are Not What You Might Think!

Introduction:
Movement is all around us all the time! Just think how boring things would be if we couldn’t move and if things around us stayed the same. You have studied about movement and have learned about levers, but you may not know as much about how levers work in your body. In this activity, you will be able to use a model of the human arm to explore movement of your elbow joint by a lever system. Before you go any further, take a minute to move your elbow joint; flex and extend the joint. What observations can you make about the way your elbow works?

Background:
Actually your muscles, bones, ligaments and tendons come together to form complex joints. Joints in your body are places where two or more bones come together and are held together by tough connective tissue called ligaments. Muscles are attached to the bones with tough connective tissue called tendons. The muscles, tendons, ligaments and the shapes of the bones themselves allow movement of joints in specific ways and help prevent undesirable slipping and sliding.

Remember from the previous activity, “Just a Little Bit of Effort: Exploring Levers”, there are three classes of levers; first, second and third class. The classification of levers is based upon the relative position of the Fulcrum (F), Effort (E) and Resistance (R). *(Resistance is often called load (L)). Lever systems are important to human movement and are found throughout the human body. The field of study that applies the principles of mechanics and anatomy to human movement is called kinesiology (ki’ neesee’ âlujee). Before moving on, a cautionary statement is necessary. There is a significant amount of disagreement among experts about the classification of lever systems in the body. Human joints are complex, often including many muscle connections and ligaments that allow a joint to function in several ways and creating complex sets of forces in the joint lever system. This complexity makes it difficult to classify joints as one type of lever or another. All forces involved in moving a joint must be carefully defined and even experts in the field cannot always agree.

Just as the levers you already studied, levers in the human body consist of a rigid bar (bone), a fulcrum (joint), an effort force (pull of muscle on bone) and a resistance (load) force (weight of the body part being moved – this may include weight being held). An example is the elbow joint, operated by the biceps and triceps muscles; see Figure 1, Lever System in the Body.
An example of a first class lever in the body includes the muscles acting to balance head on neck joint. This lever allows us to tilt our head back. See Figure 2, First Class Lever in the Body. It is important to note that there are few first class levers in the human body.

Very few, if any, second class levers are found in the body - rising on the toe is identified and often disputed as a second class lever. The human body is not designed to apply a large force in a lever system, as occurs in a second class lever. Please note that many materials designed for students state that rising on the toe is a second class lever – not all experts agree on this point!!

Third Class levers are the most common type of lever in the body – almost all movable joints function as third class levers. Examples include the biceps muscle moving forearm; see Figure 3, Third Class Lever in the Body.
Activity Materials: (per group)

- Pattern for arm model
- Stiff cardboard for arm model (note: more permanent models can be made with wood*)
- 1 1 N (100g) hanging weight
- 1 1/4" X 3/4" bolt with wing nut (if using wooden models)
- 1" diameter plastic pulley
- Heavy brads (if using cardboard models)
- Rubber Cement or Craft Spray Adhesive (Liquid Nails® for attaching laminated pattern to wood)
- Ring Stand
- 10 N Spring scale
- Single hole punch
- String (2 colors)
- 6 #216 screw eyes used to attach string to wooden models (reduces friction)
- Protractor
- Ruler
- Student Activity Page packet for each group
- Student Data Page packet for each student

* 1 2’ X 4’ piece of 1/4” thick wood makes about 18 models

Instructions: (Read each instruction and check off each step as it is completed.)

☐ 1. For wooden models, trace the pattern pieces found in Figure 5 Arm Model Pattern Pieces (page 10) onto 1/4” plywood and cut out using a jig saw. Smooth the cut edges with sandpaper. Using Liquid Nails® adhesive, glue laminated and trimmed pattern pieces to the wooden cut-outs.

☐ 2. For cardboard models, glue the page with the pattern pieces, Figure 5 Arm Model Pattern Pieces to rigid cardboard or tag board. There is a pattern piece for the scapula (shoulder blade) and humerus (upper arm) and a pattern piece for the radius and ulna (bones of the forearm).

☐ 3. Cut out each pattern piece. Since you are working in a group, have each student cut out a different pattern piece – this is good time management!

☐ 4. The pattern pieces include large, solid dots which should be punched out on cardboard models or drilled out on wooden models (use a 1/8” drill bit). The elbow joint circle of cardboard models can be punched for the brad to be inserted. For wooden models, the hole marking the elbow joint must be drilled using the 1/8” bit to make a pilot hole and then with a 1/4” drill bit to finish the hole. Also on the pattern pieces are smaller, open circles which mark the locations for #216 screw eyes to be inserted. Find these locations and carefully insert the screw eyes. Refer to Figure 5 Arm Model Pattern Pieces for an abbreviated legend of these markings.
5. Attach the pattern pieces at the elbow joint using heavy brads for cardboard models or bolts with wing nuts for wooden models. The elbow joint should move freely after being assembled. The scapula and the shoulder joint will be immovable in this model to better isolate the elbow joint.

6. The protractor being used to measure the joint angle can be used separately or can be attached to the model. To attach the protractor to the model, find the center of the protractor straight edge and drill a 1/4” inch hole. Open the elbow joint brad on cardboard models or remove the wing nut from wooden models and place the newly drilled protractor hole over the brad or bolt. Close the brad or reattach the wing nut, depending upon which type of model you are making.

7. Attach a supporting piece of cardboard or wood to the scapula. This supporting piece will be attached to the ring stand; see Figure 4 Setting up the Model. For wooden models, attach the arm model to a 2” x 2” piece of wood that is 12” long and is center drilled to fit your ring stand.

8. From this point forward, follow the instructions on your Student Data Page, filling in measurements and observations as you complete the activity.

Figure 4 Setting Up the Model