# As We Are "Jointed" Together*



## Purpose

To construct an arm model

To discover the relationship between muscles and bones

To learn about the different kinds of body joints and how they move

## Materials

2 rulers with holes for a 3-ring binder
1 paper clip
50-cm string
1 brad
clear tape
protractor
metric ruler
marker
Arm Model Chart (p. 30)
large construction paper
tennis ball cut in half
foam ball slightly smaller than a tennis ball
pencil
science journal

## Background

There are three main body parts responsible for moving bones: ligaments, tendons, and muscles. Ligaments are strong, elastic bands of tissue that connect bones together. Tendons are special cords made of tough tissue that attach muscles to bones. Muscles move the bones. These muscles are either attached directly to the bones or by tendons to the bones. Muscles make the joints move by contracting or becoming shorter and pulling two bones closer together. Muscles can only move in one direction. They can only pull, not push. For this reason, muscles must work in pairs. One muscle or group of muscles will bend one part of a joint while a different muscle or muscle group will pull it back to its original position. The place where the muscle is attached to the bone affects the amount of movement the bone can make. There are many muscles for every bone. The movement of a muscle and joint is comparable to a simple machine; for example, the arm is like a lever.

The place where two bones meet is called a joint. Some joints can move, while others do not. Joints that do not move are called fixed joints. Your skull has fixed joints. Moving joints allow you to move your body to walk, eat, and play a video game. Some joints move a lot while other joints move very little. Joints in your spine have very minimal movement. Joints in your arms and legs have a broader range of motion. There are two basic moving joints in the human body: the hinge joint and the ball and socket joint. The hinge joints are in your elbows and knees and allow you to bend and to straighten your arms and legs. The joints are similar to the hinges on a door. Most doors can only open in one direction. It is the same with your arms and legs. They can only move in one direction. There are smaller hinge joints in your fingers and toes. The ball and socket joint is in your shoulders and hips and is made up of a round end of bone that fits into a small, cup-shaped area of another bone. Ball and socket joints allow you to move in more than one direction.

**Teacher Prep:** Cut a tennis ball in half and remove inside material.

## Procedure

1. Place the rulers so that the smooth sides are together.
2. Using the brad, fasten the end holes on both rulers together.
3. Fold the ends of the brad flat against one ruler.
4. Tape only the ends of the brad in place. See diagram 1.

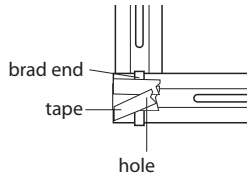


**Diagram 1**

5. The attached rulers represent the upper and lower arm. The brad represents the joint, or in this case, the elbow.
6. Open the paper clip into the shape of an "S" to make a hook.
7. Place the string on a flat surface.
8. Smooth out one end of the string and measure 5 cm from the end. Mark the distance with a colored marker.

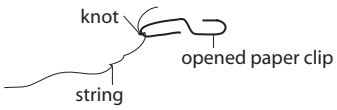


**Diagram 2**

9. Tie the unmarked end of the string to one end of the paper clip. The paper clip represents a tendon connecting muscle to bone. The string represents a muscle. See diagram 2.
10. Position the arm model into an "L" shape.
11. Place the model on a flat surface, such as a table, so that one ruler lies horizontally and the other ruler is vertical. The joint should rest off the edge of the flat surface to allow the rulers to move freely.
12. Hook the paper clip through the farthest hole from the joint in the ruler resting on the table.



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13. Thread the marked end of the string through the top hole of the vertical ruler. See diagram 3.
14. Slowly pull the string through the hole in the vertical ruler, stopping at the 5-cm mark. Be sure to hold the elbow joint to keep the rulers steady. The horizontal ruler should rise up off the flat surface.
15. Measure the distance between the tip of the bottom ruler and the flat surface.
16. Record your measurement on the Arm Model Chart.
17. Ask a friend to place a protractor on the table, lining up the center of the protractor with the hinge joint (brad).
18. Measure the angle of the lifted arm and record this measurement.
19. Return the arm model to the "L" position.
20. Move the paper clip into the middle hole of the horizontal ruler.
21. Predict what will happen when you move the string. Record your prediction in your science journal.

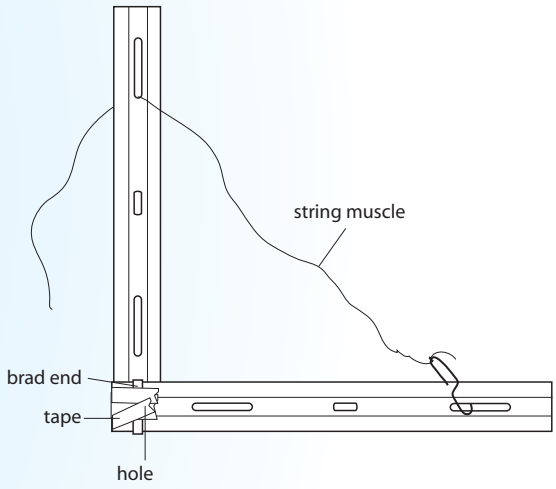


**Diagram 3**

22. Repeat steps 15–19.
23. Move the paper clip into the hole closest to the joint on the horizontal ruler.
24. Predict what will happen when you move the string. Record your prediction in your science journal.
25. Repeat steps 15–19.
26. In your science journal, draw a picture of the arm model. Use arrows to show the range of motion for a hinge joint.
27. To demonstrate a ball and socket joint, carefully stick the sharp end of a pencil into the foam ball. The pencil and foam ball represent the rounded end of a bone that fits into the socket.
28. Place the foam ball (round bone) into one half of a tennis ball (socket).
29. Practice moving the bone around in the socket.
30. In your science journal, draw a picture of the bone movement. Use arrows to show the range of motion for the ball and socket joint.

## Discussion

1. Based on your observations of the arm model, how does the placement of the muscle affect the movement of the bone?
2. Where would you expect the ends of a muscle to be attached if the objective was to achieve the most movement for the least amount of effort? Why?
3. Which joint gives you the greatest range of motion?
4. What are the advantages/disadvantages of a hinge type joint?
5. What are the advantages/disadvantages of a ball and socket joint?
6. Describe the role joints have in physical activity.

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## Extension

1. Devise a way to connect another string muscle to the ruler arm model that would straighten the arm back out. Remember that muscles can only pull, not push.
2. Learn about other joints in the body, such as fixed or unmovable joints and pivot joints. Make models of the different joints and explain how they work.
3. Imagine if your body had only one type of movable joint. What would you be able to do if you only had hinge joints in your body? What would you be unable to do? What could you do if you had only ball and socket joints in your body? What would you be unable to do?

**ARM MODEL CHART**

| Ruler Position | Distance ruler is raised from table (cm) | Angle ruler is raised from table (number of degrees) |
|---|---|---|
| Position 1: farthest hole from "joint" | | |
| Position 2: middle hole | | |
| Position 3: closest hole to the "joint" | | |