

Robotic Hand

Overview: Your body moves with the muscles pull on the bones through ligaments and tendons. Ligaments attach the bones to other bones, and the tendons attach the bones to the muscles. If you place your relaxed arm on a table, palm-side up, you can get the fingers to move by pushing on the tendons below your wrist. We're going to make a real working model of your hand, complete with the tendons that move the fingers! Are you ready?

Materials

- flexible straws (5)
- scrap of cardboard (at least as big as your hand)
- rubber bands (5)
- string or thin rope (5 feet total, and a lighter with adult help if you're using nylon rope)
- hot glue with glue sticks
- scissors
- razor
- pen

Experiment

1. Using the pen, trace a grown-up's hand on the cardboard.
2. Cut out the hand shape with scissors, or a razor (with adult help). If using a razor, also round off the tips of the fingers using scissors.
3. Place your hand palm up beside the cardboard cutout. Use your hand as a guide to mark approximately where the segments of your hands are on the cardboard.
4. The lowest segment lines are probably below the cut portion of the cardboard, so use the scissors to cut the cardboard fingers apart down to the first segment line.
5. Be sure there is a segment line that indicates the mound where your thumb bends into the palm.
6. Open up the flexible part of the straws. Take the first straw and line it up with the bottom of the cardboard hand, making sure the bendy part is about halfway up the cardboard palm.
7. Make a stripe of hot glue down the cardboard. Then place the straw on the cardboard hand and reinforce it with an extra stripe of glue down either side of the straw. Do this for each finger. If you can't get to each side, it's fine to do only one.
8. For the thumb, place the flexible portion a little further down so that the straw overhangs the bottom of the hand. Flip over the hand to trim off this excess and also trim the excess straw from the top of each finger.
9. You will need adult help to notch the straws. Note the guidelines you drew for each finger segment. Holding the razor blade at a 45° angle, carefully pierce the straw and slice downwards. Do this on each side of the line and for each segment of each finger and thumb. Be sure to make a wide enough notch to allow for a good range of motion for your hand.
10. Noting the notch positions from the side of the hand, turn the hand over and score ONLY the top layer of cardboard. This allows the fingers to move, but keeps them attached. Do this for each segment on each finger and the thumb.

11. Cut your string into five equal pieces. If using nylon rope, have an adult help singe the ends to prevent fraying.
12. Cut open each of the rubber bands and tie each of them to one of the rope pieces. Make sure the knot is very secure and is as close to the end of the rope as possible. Pull on the rubber band to ensure it is secure.
13. Thread the rope end through the top of the straws so that the rubber band goes over the top of the hand to around to the front. Give a little bit of stretch to the rubber band, but not so much that the string is pulled out of the straw. The knot should stay at the top of the finger, but a little tension is needed to ensure the hand returns to this position after pulling on the strings. Hot glue down the rubber bands.
14. The rubber bands may not line up perfectly, depending on the portion used in each knot.
15. Now, the strings at the bottom of the cardboard hand will act as tendons. Try to pull them and see how your hand works. Adjust any rubber band that slips off by pulling it up, moving it over, and regluing it.

Reading

Voluntary muscles are one type of muscles in our body. They allow humans to walk, jump, carry things, and much more. These voluntary muscles are attached to our bones with small threadlike structures called tendons, which are a connective tissue. Ligaments and cartilage are other examples of connective tissues in our body. As their name suggests, connective tissue connects one part of the body to another and is also involved in structural support.

Ligaments are similar to tendons, but they join one bone to another bone. Tendons attach muscles to bone, helping the muscles to shorten (or contract) and move the bone. Without tendons, it would be impossible for our body to move as it does.

The wrist has two types of tendons. Flexor tendons curl the fingers and thumb, and allow the wrist to bend. Extensor tendons work to straighten and extend the fingers.

Exercises

1. What types of muscles are connected to our bones?
2. Which type of connective tissue connects our muscles to our bones?
3. What do extensor tendons in our wrist do?
4. What do flexor tendons do?

Answers to Exercises: Robotic Hand

1. What types of muscles are connected to our bones? (voluntary muscles)
2. Which type of connective tissue connects our muscles to our bones? (tendons)
3. What do extensor tendons in our wrist do? (allow us to straighten our fingers and thumb)
4. What do flexor tendons do? (curl the fingers and thumb, bend the wrist)