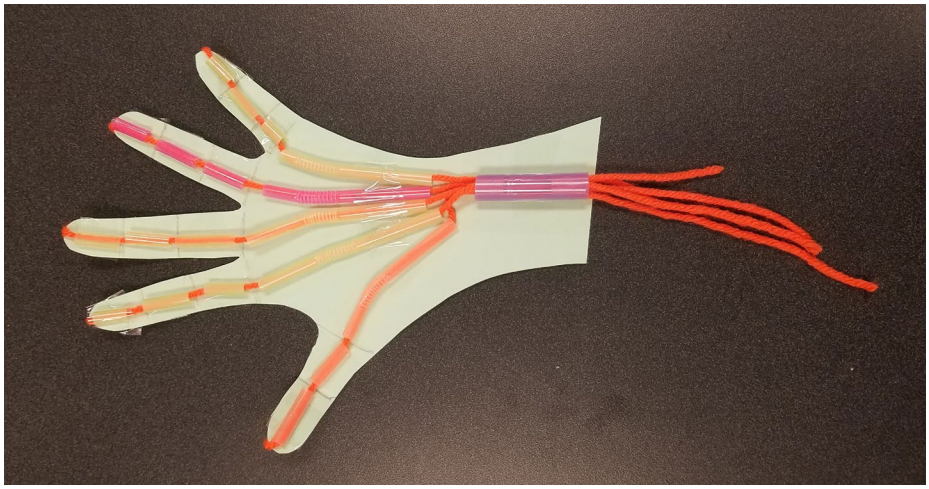
# STEM ON A DIME

## ROBO HAND

*Activity from 4-H at Home: Low Cost Robotic Hand*

*Activity Updated August 2021*



## SKILL LEVEL

Age 8-18

## KEY TERMS

Bones, Muscles, Joints, Skeletal System

## EDUCATION STANDARDS

South Dakota Science:

- 4-LS1-1
- MS-LS1-2

## TIME NEEDED

20 minutes

## MATERIAL LIST

*Materials needed per robo hand:*

- Five Straws with Bend
- One Straw Preferably Larger in Diameter
- Five 24-inch Pieces of String
- Construction Paper

*Materials to be shared by group:*

- Scissors
- Tape
- Glue

## EXPECTED LEARNER OUTCOMES

**OBJECTIVE 1** – Youth will be able to identify what makes up the structure of their hand.

**OBJECTIVE 2** – Youth will create a robot that models the function of their hand.

**OBJECTIVE 3** – Youth will be able to discover how the bones and muscles work together to allow it to move.

## BACKGROUND

The human body is a fascinating and complex thing to explore. There are a variety of systems that allow it to function and complete various tasks from breathing to walking. In this lesson, we will specifically be looking at the skeletal and muscular systems and how they work together.

Here are some fun facts about our bones and muscles:

- There are 206 bones in the human body.
- The longest bone in your body is called the femur and it is located in the thigh.
- Bones need calcium to keep healthy.
- There are 640 muscles in the human body. The most important one is the heart. Muscles are attached to bones with tendons.

## CAREER CONNECTIONS

When most of us think about careers related to the skeletal and muscular system, we think about doctors, physical therapists, chiropractors and athletes. However, engineers also have an interest in understanding how the skeletal and muscular system works. Engineers utilize this knowledge to create robots that can replicate natural functions and movements. These robots can be used to complete various tasks including serving as prosthetic limbs.

## VOCABULARY

**Phalanges** – The bones that make up the fingers.

**Metacarpals** – The five bones that extend from wrist to fingers.

**Carpals** – The bones that make up the wrist.

**Muscles** – The fibrous tissue in the body that has the ability to contract and produce movement. There are three types of muscles: skeletal, smooth and cardiac. In this activity we will be talking about skeletal.

**Bones** – Provide support and shape for the body.

## ACTIVITY PREPARATION

1. Gather the following materials for each youth:
   a. Five Straws with Bend
   b. Five 24-inch Pieces of String
   c. One Piece of Construction Paper
2. Gather the following materials:
   a. Scissors - Be sure that they are appropriate for the age, development and needs of your youth (i.e. safety scissors or left-handed scissors).
   b. Tape – This can be used to make it easier for youth to thread the straw onto the yarn.
   c. Glue - School glue, glue sticks or hot glue could be used. When selecting your glue source make sure to consider dry time and safety. Tape may also be used as an alternative if dry time is limited.

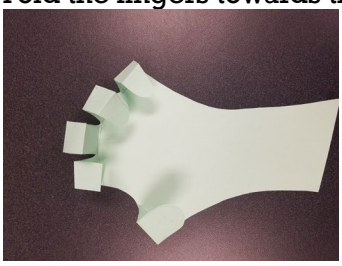
## ACTIVITY INSTRUCTIONS

1. Have youth examine their hands.
   a. What can they see?
   b. What can they feel? Can they identify both hard (bones) and softer (muscular) structures?
   c. How do they move? Where do they bend (joints)?
   d. What challenges might they have if they didn't have their hands?
      i. Various injuries and illnesses can lead to the loss of limbs like the hand. Biomedical engineers work to create prosthetics that can aid these individuals in regaining some of their abilities.
   e. Ask youth if they can identify other things that operate similarly to their hand (like a grapple fork).
   f. The mechanics of the human body are often replicated within robots to complete tasks that are too dangerous for humans or too repetitive.

2. Create your own prosthetic hand or robotic hand model
   a. Trace your hand and wrist on a piece of paper. Be sure to have your fingers spread out. For youth with smaller hands, have them make their tracing larger than their actual hand. You may also consider providing them the tracing of an adult hand. The smaller the hand is, the more difficult it will be to make a functional robot hand.
   b. Cut out the traced hand.

c. On the paper hand, mark the locations of your knuckles.

d. Fold the fingers towards the palm, creating a crease at each of the marked knuckles.

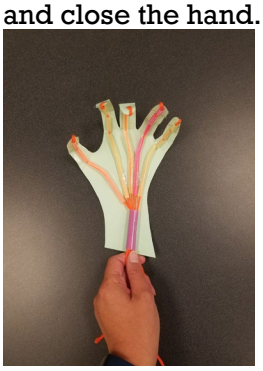


e. Flatten the hand back out.
f. Have the youth lift up their paper hands. What do they notice? Are they floppy and unstable, unlike their own hand? What is in their hand that keeps their muscles and skin from being floppy like the paper? (bones)

g. Let's add some bones (straws) to provide structure for our paper hand.
h. Flatten the hand out again and lay out a straw on each of the fingers. The bendable part of the straw should be in the palm of the hand.
i. Cut each straw into four portions, one for each of the three portion of the phalanges (fingers) and one (the bendable segment) for the metacarpals and carpals (palm). For smaller hands, you may want to cut each straw into three portions, combining the top two segments of each finger. Make sure to leave space between straw portions.
j. Tape or glue the straw pieces onto the paper hand.
k. Have the youth lift their paper hands again. What do they notice? Is there more stability and structure? Does that model hand work like their own? What else does it need to make it more like their own hand? (control/muscles)

l. Let's add some muscles (yarn) to provide some control of our paper hand.

m. Tape or glue the larger straw to the wrist area of the model.
n. Thread each of the strings through the straws, taping it on the back of each finger and leaving the ends hang below the straw on the wrist. To thread the string easier tape the end of the string and then thread through the straws.
o. By pulling on an individual string or all the strings at the same time, youth should be able to open and close the hand.



## REFLECTION

How can we use this model of our hand to figure out how other parts of our bodies work, like our feet?

Would you hand work the same if you had only muscles? What would be different?

We are able to bend our fingers by using joints, what would happen if we didn't have joints or they were injured?