GOOD HANDS

Understanding how muscles, bones, and tendons work together

Whether catching a quick pass or laying in a bucket, nimble hands are crucial in basketball. Let's investigate how they work.

HERE IS WHAT YOU WILL NEED:

- String
- Toilet Paper Roll
- Tape
- Scissors
- Cardstock of poster board
- Pencil
- Marker
- Journal
- Skewer (optional)
- Bendable Drinking Straws

WARM-UPS

Look closely at your hand. Move it around. Close your fingers and then slowly open them back up. Look at your thumb. How does it act the same as your other fingers? How does it act differently? Watch your wrist when you move your fingers.

With one hand, feel your other hand, concentrating on the bones that lay beneath the skin.

How many bones do you feel in each finger?
How many bones do you feel in your thumb?
How many bones do you think there are in your whole hand?

Let's construct a model to help us explore what is happening beneath our skin. It will help to have a partner.

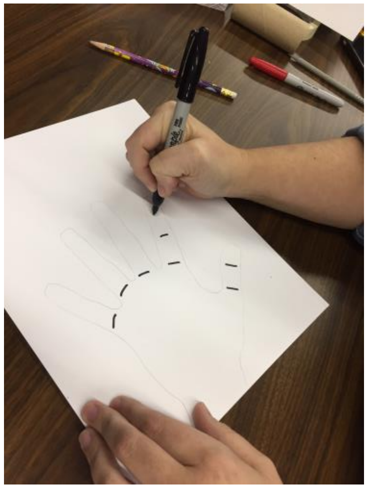
1. Lay your hand palm down, fingers spread apart on a sheet of cardstock or poster board.
2. Use a pencil to trace your entire hand including fingers and wrist. Stay as close to your skin as possible.
3. Using your own hand as a guide, sketch the position of bones you feel under your skin onto your drawing. Try to locate the joints, or places where the bones meet. Add these to your drawing, making it as accurate as you can.
4. Feel your wrist and include those bones in your drawing.

You may find that it is unclear how many bones there are in the area where your hand meets your wrist. That is okay. For this activity today we are primarily concerned with the longer bones of our hand and fingers.

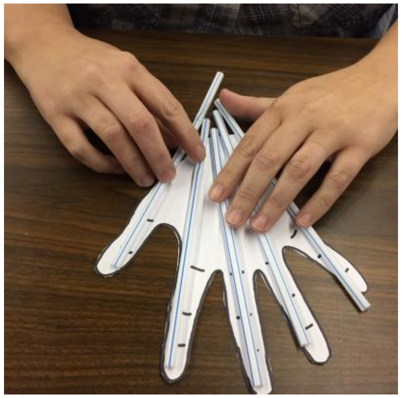
Lay your hand palm up next to your drawing. Does it seem accurate? Was it easier to differentiate bones in certain parts of the hands but more difficult in others? Record your observations in your journal.

Once your drawing accurately represents the shape of your hand, fingers, and wrist, as well as the location of bones underneath, you are ready to get started.

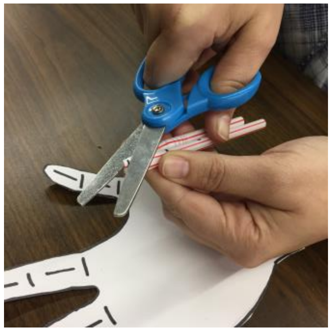
1. With scissors carefully cut out your hand shape. You should only cut around the shape of the hand. Do not cut around the drawings of bones.

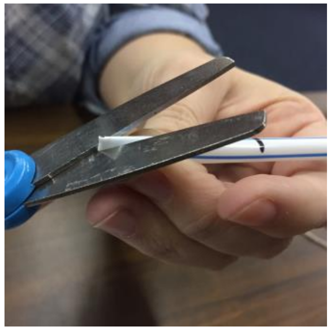


2. Use a marker and make lines over the joints on your hand model to make these locations more noticeable. You'll need them for the next step.
3. Lay straws on top of the hand model, one for each finger. Place the bendable part of the straw near the wrist and the other end extending over the fingertip. Hold the straws in place and use a marker to transfer the position of each joint onto each straw as shown.



4. If the straw extends past the end fingertip, mark the position of the fingertip and cut off the excess plastic. This will make all of the straws different lengths.





5. Complete the next step, one straw at a time. Pick up the first straw. Fold the straw over the joint mark. Use scissors to cut through one corner of the folded edge, removing a triangular piece about half the width of the straw. *See pictures above*. Cut each joint mark on the straw the same way. When finished, lay the straw back on the hand model with the cutout sections facing up. Pick up the next straw and continue until you've cut all the joint lines of each straw.
6. With each straw back in its correct place and the cut out sections facing up, secure the straws to the hand model with tape.
7. Cut five pieces of string approximately two-and-half times as long as your hand model.
8. Tie one pony bead to the end of each string.
9. Thread one string through each straw on your hand model so that the end with pony bead rests on the fingertip when the string is pulled tight. You can let the strings hang loose at the bottom, or, if you choose, you can tie additional pony beads to the ends near the wrist.

   HELPFUL HINT: If you find it difficult to thread the string through the straw, try taping the string to a wooden skewer and using it like a needle to pull the string through the straw.
10. Cut a toilet paper roll in half so that it makes two shorter cylinders. Make a wrist for your model by taping one of the cylinders to the bottom of your hand model and then running the strings through it. It will look like this:

GAME TIME

The model that you have built not only looks like your hand, but functions in similar ways.

- What happens when you pull a string?
- What happens when you pull several strings?
- Is it easier to pull one string or several strings at a time?

Think about different ways you use your hands every day. Test your model to see if you can use it to mimic tasks that your actual hands can do. What are some things you could try with your hand model? In your journal, record your observations of what your model can and cannot do.

- Try picking up things of different sizes and weights. What works best?
- Try holding a pen or a pencil. Will it grasp it? Will it grasp it well?
- Try using a keyboard. Can the hand type?
- Have a friend toss something light. Can the hand catch it?
- Try giving hand signals. Can you give thumbs up?
- What else can it do?

ANALYZE THE REPLAY

What happened?

Review all of the information you have collected through your tests and observations. Use it to compare the similarities and differences between the hand model and your actual hand.

- How were their movements similar?
- How did they move differently?
- Were there ways that your hand moved that the model could not mimic?

Thinking about a human hand, how are the working components of your model similar to the structures and tissues that make up your real hand?

- What makes up your hand? There are parts under the skin. What are they?
- What would you compare the paper shape of the hand model to in your real hand?
- What would you compare the straws to?
- What would you compare the strings to?
- How are the sections of the straw with the triangular piece removed like parts of your hands?
- What parts of your real hand are missing from this model?

OVERTIME
Let's take it a step further

As you have discovered, a lot of parts have to work together to allow the hand to function properly.

- What would happen if you removed one or more of the strings?
- What would happen if you attached the string at another location?
- What would happen if you removed one or more of the straws?
- What would happen if you removed a section of straw?
- What would happen if you removed the poster board?

Did you know that the muscles that make your fingers move are not found in your hand? They're actually located in your forearm! If you lay one arm flat on the upward facing palm of your other hand and move your fingers, you can feel those muscles moving in your arm. On your model, the toilet paper roll marks the location of the wrist and the strings that attach to the fingertips hang down past the bottom of it. These strings are like the tendons that connect your hand to your arm muscles. When you pull on the strings you become the arm muscles for your model, controlling the string tendons to make the fingers move.

- With this in mind, what could you change to make your model work better?
- If you could make this hand again from the beginning, what changes, if any, would you make?

DO YOU WANT TO LEARN MORE?
Research:
Biomechanics, Physiology, Tendon, Muscle, Bone

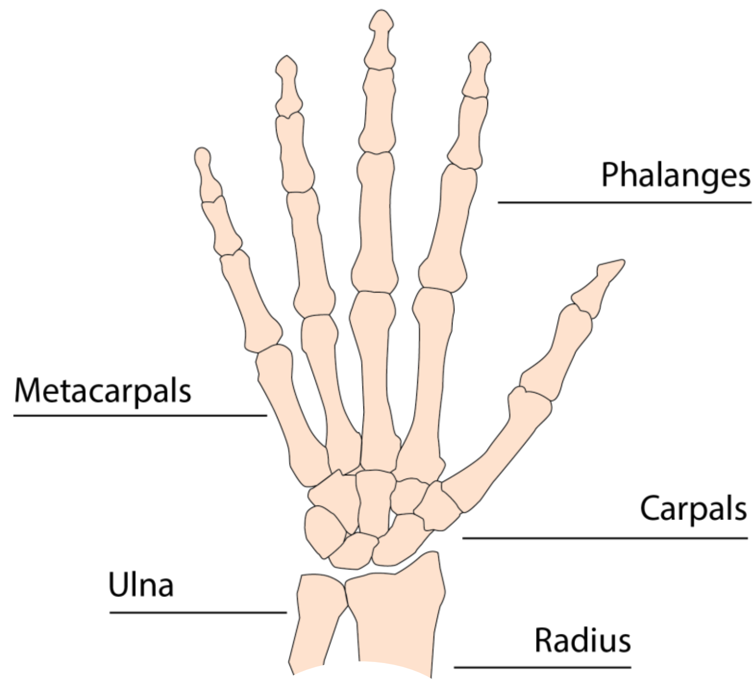
Having good hands is crucial to finding success on the basketball court.

- What could cause a player to injure his or hand during competition?
- How could a hand injury affect a player's performance?
- What hand injury would have the least effect on a player's performance?
- You may have seen some basketball players with a hand taped up. How do you think this would be of benefit to a basketball player?
- What basketball position do you think would be most likely to suffer a hand injury? Why?

COACH'S CORNER
Additional information and explanations for parents and educators

The model that we've made, while similar in some ways, is not nearly as complex as a human hand.

There are a lot of bones in a real hand. With twenty seven bones in each hand, nearly 25% of the body's skeleton is found here. There are three bones in each finger and two in the thumb. In addition, there are five bones in the main part or the palm of the hand. The long bones in the palm are called metacarpals, and those in the fingers and thumb are called phalanges. While it is relatively easy to feel the larger bones, it is difficult to distinguish the many individual small bones where the hand meets the wrists. There are actually eight of these bones, known as carpals. In the model, the straws serve as bones, providing the necessary support structure for the hand.



The sections of the straw with the cutout pieces removed act as joints. The joints, or the spaces between the bones, give a hand the wide range of motion and flexibility needed to manipulate objects. The ability to rotate our small and ring fingers across our palms to meet the thumb gives humans the dexterity that makes us unique in the animal kingdom. Known as ulnar opposition, it gives us a greater range of movement than any primate with opposable thumbs.

In the model, the poster board or cardstock is the skin that holds everything together. But, our model's "skin" can't replicate a living hand's exceptional sense of touch. The skin on our palm and fingertips lacks hair follicles, but in its place is an abundance of touch receptors and free nerve endings that pass on sensations of pressure, movement, temperature and pain to the brain.

The array of tasks our hands are able to achieve is truly remarkable. Hands are able to do all these things through the many parts working together, much like a team on the court.

It once was thought that the technology needed to create an artificial hand with the same capabilities as a human hand was decades in the future. Today that is changing.

Watch Dean Kamen, inventor of the Segway and holder of more than 400 U.S. and foreign patents, demonstrate the remarkable Luke prosthetic arm
http://www.bing.com/videos/search?q=Dean+Kamen+%2b+Luke&FORM=HDRSC3

OKLAHOMA STANDARDS				
Science		4th grade	5th grade	6th grade
PS 3.4	Energy	•		
LS1.1	From Molecules to Organisms	•		
MS.LS1.3	From Molecules to Organisms			•