

Osteo- Operation

Allie Connelly

AANT 311

Spring 2023

Game Instructions

This is the osteology-focused version of Operation. The rules of the game are the same as the original: use the tweezers to pick up each piece from its basket without setting off the buzzer.

These pieces are representations of real bones found throughout the body, and they demonstrate important features of each bone. The following manual explains how to identify each of the five pieces correctly and describes the various important features that are visible on each bone.

To successfully understand how each piece is identified, you must be familiar with anatomical terminology, most notably the following terms:

Anterior: towards the front of the body (ex. the heart is anterior to the spine)

Posterior: toward the back of the body (ex. the brain is posterior to the eye)

Superior: above (ex. the lungs are superior to the stomach)

Inferior: below (ex. the femur is inferior to the clavicle)

Dorsal: synonymous to posterior (mostly used to discuss vertebrae)

Ventral: synonymous to anterior (mostly used to discuss vertebrae)

Proximal: close to the point of origin (used for limbs, ex. the humerus is proximal to the radius)

Distal: far from the point of origin (used for limbs, ex. the phalanges are distal to the carpals)

Medial: towards the middle of the body (ex. the sternum is medial to the clavicle)

Lateral: towards the side of the body (ex. the scapula is lateral to the spine)

Piece One

Locate the first piece of the game, which should be found in the right upper corner of the board. This piece is a left metacarpal V. This means the bone would articulate with the hamate at the proximal end and proximal phalanx V of the left hand at the distal end. There are a few different identifying features that tell you exactly which bone this is:

1. First, you want to look at its location within the body. You can see just from looking at the board that this bone is found in the hand. This tells us it could be a carpal, metacarpal or phalanx.
2. You can quickly rule out carpals, because this is a long bone and carpals are sesamoid bones.
3. You can also rule out distal phalanges, based on the size of the bone. Distal phalanges are very small and do not have a long shaft like Piece One.
4. To decide if the piece is a metacarpal or a phalanx, you must look at the proximal and distal ends of the bone. First, look at the rounded end of the bone that looks like a bulb. This is the distal end. This should be very distinct and easy to see. Next, look at the end that is irregularly shaped and does not have any distinctly convex or concave features. This is the proximal end.
5. Based on the features of the distal and proximal ends of the bone, you can conclude this is a metacarpal. You know this because proximal phalanges would have a concave proximal portion and a spooled distal end, of which Piece One has neither. If it were an intermediate phalanx you would observe a biconcave proximal end and would also be spooled distally. So, you know you have a metacarpal.
6. To correctly identify this piece as an MC5, take note of its shaft. The slim, delicate shaft tells you that this is either an MC4 or an MC5.
7. The oval, relatively unfeatured proximal end tells you definitively that this is an MC5. An MC4, while it also has a gracile shaft, is much more angular in a proximal view.

Piece Two

Now find the second piece of the game, which should be in the upper center of the board. This piece is a left upper first molar (LM¹). Because it is an upper tooth, it would articulate with the maxilla. To determine which tooth it is, we must take into account its root number, cusp number, and feature profile.

- 1.) First, examine the general shape and composition of the tooth. Take note of the large tooth size and the rhomboid shape of the crown. This, along with the presence of four cusps, lets you know that this is a molar and not a canine, incisor, or premolar.
- 2.) To determine if this is an upper or lower molar, examine the root number and crown outline. You should be able to easily identify three distinct roots. This feature, along with the asymmetrical placement of the 4 cusps, indicates that this is an upper molar.
- 3.) Now that this has been successfully identified as an upper molar, use the same features to determine if this is an M¹, M² or an M³. The three long roots and clear positioning of four cusps indicates that this is an M¹. If it were an M² or M³, the crowns would be smaller and less visible, and the roots would be more fused.
- 4.) Given the fact that this piece is an upper M¹, the final step in identification is to side the tooth. To do this, examine the size of each cusp. The largest cusp, or the protocone, should be in the mesiolingual corner. The smallest cusp, called the hypocone, should be in the distolingual corner. The most prominent (highest raised) cusps should be located buccally and the roots should point distally. After examining these features, you should be able to identify this as a left upper M¹.

Piece Three

Next, locate the third piece. You should be able to find this located medially within the body, in the center of the playing board. This is the sternum. The sternum serves as an anchoring point for the the ribs to protect the lungs and is a part of the thoracic cage. This bone is easily identifiable because of its distinct shape. It is composed of three parts: the manubrium, the body, and the xiphoid process.

To find the manubrium, look for the wide, flat piece located at the superior end of the region. This is the thickest and widest portion of the sternum. The manubrium articulates with the clavicle in the superior, lateral regions. This articulation should be easily identifiable by locating the clavicular notches, found in the aforementioned region. The manubrium also articulates with ribs 1-2. The area of this articulation can be located by finding the costal notches on the lateral, inferior portions of the manubrium.

The body is the portion of the sternum located immediately inferior to the manubrium. This area can be distinguished based on its long, thin composition and its distinct ridges on the lateral portions of the bone. These ridges are more costal notches and are where the sternum articulates with ribs 2-7. You should be able to locate six costal notches on each side of the body. To determine the anterior versus posterior portions of the sternum, take note of the bone's curvature. The body should bow anteriorly.

The most inferior portion of the sternum is called the xiphoid process. This is by far the smallest region of the sternum and articulates with the 7th rib along with the body. The xiphoid process is clearly illustrated within piece three, however it is often ossified in older bones and may come in various shapes.

Piece Four

Piece four is a lumbar vertebra. Lumbar vertebrae are found in the most inferior portion of the spine and there are five total. They follow seven cervical vertebrae and twelve thoracic vertebrae. The lumbar vertebrae articulate with each other superiorly and inferiorly, and with the ribs laterally.

You should be able to locate where the vertebrae articulate with each other by finding the articulating facets. These are located on the superior and inferior dorsal sides of the vertebrae. In lumbar vertebrae, the superior facets face medially and the inferior facets face laterally.

There are several features to take note of within Piece Four. First, orient yourself with the bone. The body is the largest and thickest portion, and should be positioned ventral relative to the rest of the bone. Next, locate the previously discussed articulating facets. This should help you figure out the superior versus inferior portions of the bone, since you know that the superior facets turn medially. Another noticeable feature of the vertebra is the spinous process. This should be easy to identify; look for a long, thin process in between the articulating facets that points dorsally. This is a very important feature as it serves as a point of attachment for several important muscles and ligaments.

You should also find the transverse processes. These are also long, thin processes that are found on the lateral portions of the vertebra and angle dorsally. Like the spinous process, these serve as muscle attachments.

The final feature to take note of is the foramen located between the vertebral body and the articulating facets. This is the vertebral foramen and houses the spinal cord as it runs through the vertebrae. This is an incredibly important feature as the spinal cord is what allows for nerve signals to be sent between different parts of your body and your brain. The delicate nerves within the spinal cord rely on the sturdy protection of the vertebrae. This feature is why vertebral injuries can be so devastating to an individual's functionality- if the foramen is no longer protecting the spinal cord, the nerves within it can no longer work properly. Spinal injuries often result in partial or complete paralysis for this reason.

Piece Five

Piece Five is a right patella. You should be able to find this piece in the bottom right portion of the board. As you can see from a quick look at the board, the patella is located within the leg. This is the bone that makes up your kneecap. Note the distinct and unusual shape of the patella- it is a sesamoid bone and therefore does not have a shaft, head, or many of the other typical features of a bone.

To orient yourself with the bone you first must locate the base and the apex. The base is the broader, thicker portion of the bone while the apex, located at the opposite side, narrows into a dull point. Somewhat counterintuitively, the base is the superior portion of the patella while the apex is the inferior portion.

To figure out which is the anterior versus posterior side of the bone, locate the articulating facets. These are indentations running along the superior-inferior axis of the bone. You should be able to find two of these facets running parallel to each other. These facets are found on the posterior side of the bone. These facets articulate with the femur and help to create the knee joint. You should also be able to identify the anterior side by finding the convex surface of the patella.

Now that you are familiar with each surface of the bone, you can side the patella. For this you will again use the articulating facets. Note that one of the facets is much deeper and more visible than the other. The larger facet is on the lateral side of the bone, while the smaller facet is on the medial side. After examining these features, you should be able to identify this as a right patella.

Sources

JB. (2014, August 11). *Identifying Human Teeth: Human Dentition Cheat Sheet*.

Bone Broke.

<https://bonebroke.org/2014/08/11/identifying-human-teeth-human-dentition-cheat-sheet/>

Saladin, K. S., Sullivan, S. J., & Gan, C. A. (2021). *Anatomy & physiology : the unity of form and function*. McGraw-Hill Education.

White, T. D., Black, M. T., & Folkens, P. A. (2012). *Human osteology* (3rd ed.).

Elsevier, Academic Press.