Shapes of Bones Lab: NYSSLS Alignment

Teacher guide for the student worksheet at mrsajdak.com/boneshapes (two pages, 16 questions; a low-write version has the same numbers). Anatomy & Physiology, Shapes of Bones (AP.4.7.2). Hole's Essentials of Human Anatomy & Physiology 3e, Section 7.2, Bone Structure (pp. 228 to 232). The answer key is kept off the website; write to rsajdak@buffaloschools.org for it. © 2026 Ryan Sajdak. Free to use, share and change under CC BY-NC-SA 4.0 (creativecommons.org/licenses/by-nc-sa/4.0): give credit, do not sell it, share your version the same way. The bone model keeps its own CC BY-SA 4.0 license.

The model

Three tabs in one page, no login. The bones are the Z-Anatomy 3D skeleton (built on BodyParts3D, Database Center for Life Science, Japan; CC BY-SA 4.0): real surfaces from medical scans of one adult man, so sizes are true to life. The same file drives the Human Skeleton lab (/skeleton/). Students close an on-screen caliper on a bone. The lab reads the bone's own surface: L is the full length along the bone's longest direction; W and T are the wide and thin extents of a slice through the middle of that line (or near the wider end, for the plan check). Readings are rounded to whole millimeters, like a ruler. Every load gives the same numbers, so the key is exact.

The lab mirrors the lesson's hands-on Explore (a chicken leg bone, a turkey neck vertebra, a pork rib and a wrist bone measured with a ruler, the same two ratios, the same sorting rule, the kneecap test). Here the four bones are human: femur, scapula, capitate and the third lumbar vertebra. **What is real:** every bone and every size. **What is made or chosen:** the ratio cutoffs (flat when W ÷ T is 2 or more, long when L ÷ W is 3 or more, short when L ÷ W is under 2) are a classroom rule chosen to match the hands-on lab, not the book's; the tendon in the kneecap view is drawn in, because the scans hold bone only. Shape labels follow the usual five-way textbook sort (90 long, 30 short, 33 flat, 51 irregular, 2 sesamoid = 206); the sheets only ask about bones every book sorts the same way.

Objectives

The objective (AP.4.7.2): Students will be able to classify bones as long, short, flat, irregular, or sesamoid and relate shape to function.

I can	Questions
sort a bone as long, short, flat, irregular or sesamoid from its measurements and its look.	1 to 11, 13
explain how a bone's shape fits its job, with an example of each shape.	12 to 16

Performance expectations: building toward

HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. **HS-LS1-1** Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.

Worksheet link: students use a 3D model of one organ system, the skeleton, as 206 parts of five kinds, each shape doing its own job within the whole (Q12 to 15, HS-LS1-2). HS-LS1-1 is touched only through structure fitting function (Q14 to 16); DNA and proteins are not part of this lab. This is practice toward both, not a full assessment of either.

Practice or concept	Where students do it
SEP 3 Planning and carrying out investigations	Q1 and Q6: where to measure, and why the same spot on every bone keeps the test fair (52 mm near the femur's end against 30 mm at the middle).
SEP 5 Using mathematics and computational thinking	Q2, Q3, Q7: two ratios per bone, L ÷ W and W ÷ T, used as a sorting rule.
SEP 4 Analyzing and interpreting data	Q12 and 13: counts by shape and where each shape gathers.
SEP 2 Developing and using models	Q15: what the 3D bones show well and what they leave out.
SEP 6 Constructing explanations	Q16: the A&P three-part frame (what happened, the science idea, how the data shows it).
CCC 3 Scale, proportion and quantity	Q8 and Q11: shape, not size; a 19 mm fingertip bone is long and a 60 mm ankle bone is short.

CCC 4 Systems and system models	Q12: 206 parts of five shapes in one system.
CCC 6 Structure and function	Q9, Q14, Q16: the kneecap inside its tendon; each shape matched to its job.

Opening: pick a phenomenon

The slideshow opens with a menu. Pick one opener per class, or run two back to back. All three end at the same Observe, Wonder, Predict slide and the same driving question: *Every bone is made of the same tissue. Why does the body build bones in so many different shapes?* The revisit at the end works with any of them.

Option	What happens
A. Video Bones in Motion, 2 to 4 min	1. “X-ray Body in Motion - Yoga”, HybridMedical, 0:00 to 1:46 (youtube.com/watch?v=wCu14zMZ_1Y), an animation made to look like an X-ray; 2. “Finger Motion Xray - Fluoroscopy”, Pat McKee, 0:00 to 1:11 (youtube.com/watch?v=nctBBQSoZ18), real X-ray video; 3. “Wrist Motion Xray - Fluouroscopy”, Pat McKee, 0:00 to 0:54 (youtube.com/watch?v=MiuzJmqfPYc). Mute the sound. Watch for bones that swing like rods, the kneecap moving on its own, plates and little blocks. Do not name shapes yet. Clips 2 and 3 were checked by title and length only: preview them.
B. Try it A Pipe and a Plate, 3 min	A cooked, cleaned chicken leg bone and a pork rib piece under the document camera, turned slowly; look down each end. Ask which would make a better lever and which a better shield. The same bones as the hands-on lab; gloves on, nothing near a mouth. No names yet.
C. Photos Two Bones, Two Shapes, 3 min	A real femur and the top of a real skull (MAKY.OREL, CC0, Wikimedia Commons). A quiet minute to look, then Observe, Wonder, Predict.

Part by part

Part	Explore (data)	Learn It (the green box)	Apply, and the numbers
1. Measure four bones Tab 1, Q1 to 6	Q1 to 3	Long, short, flat, irregular; the ratio rule in order; why measure at the middle. Opens after L, W and T on all four bones and W near the femur's end.	Q4 to 6. Femur 456, 30, 28 (15.2, 1.1): long. Scapula 193, 94, 23 (2.1, 4.1): flat. Capitate 24, 17, 12 (1.4, 1.4): short. Vertebra 90, 64, 20 (1.4, 3.2): its numbers say flat, but it is irregular. Femur end 52 mm.
2. Test the rule Tab 2, Q7 to 11	Q7 to 9	Shape, not size; a tendon and a sesamoid bone (hand and knee X-rays); the full five-step rule. Opens after all three bones are measured and the kneecap is seen In the body.	Q10 and 11. Fingertip 19, 5, 4 (3.8, 1.3): long. Talus 60, 37, 27 (1.6, 1.4): short. Patella 43, 38, 18 (1.1, 2.1): numbers say flat; it sits in a tendon, so sesamoid.
3. Shape fits the job Tab 3, Q12 to 16	Q12 and 13	Long bones are levers, short bones pack and glide, flat bones protect and anchor, irregular bones do special jobs, sesamoid bones help a tendon; one system. Opens after each shape is lit up in the key.	Q14 to 16. Counts 90, 30, 33, 51, 2 = 206.

Inside the lab, after each Learn It opens, a **Sort it with the rule** card lets students check their sorting; a wrong pick is struck through with a hint that points back to the rule.

Running it

In the lesson the hands-on measuring of real bones is the Explore, and this lab is the **Elaborate**: Tab 2 (new bones, including the kneecap and a tiny long bone) and Tab 3 (all 206 by shape), about 8 minutes on one device per pair. Run the whole lab (about 35 minutes: openers 5, Tab 1 12, Tab 2 9, Tab 3 9) when the class has no real bones, for a student who was out, or for a make-up. The model is about 2.5 MB; open the page on every device before class. A link opens a tab directly: mrsajdak.com/boneshapes/#measure, #test or #jobs.

The misconception to plan for. "Short bones are the small ones and long bones are the big ones." Shape decides, not size: the 19 mm fingertip bone is long and the 60 mm talus is short (Q8, Q11). A second one: "flat means perfectly flat." Most flat bones are curved plates (the skull top in the Tab 3 Learn It photo). Students who round 5 ÷ 4 to 1.2 instead of 1.3 are fine.

Where students get stuck: Q1 (pick **Near an end** under "Where across the bone"); T (the bone turns on its side by itself; T is the thin way across the middle); Q9 (pick **In the body**; the pink band is the tendon); Q13 (light up one shape at a time and zoom with +).

District curriculum and additions

The BPS A&P unit doc puts Chapter 7 in Unit 2 (Support and Movement). Bone shape sits in the row for Section 7.2, Bone Structure (student edition pp. 228 to 232), with Vocabulary Support 1: Bone Structure and Classification and the Demonstration Activity: Use Your Noodle! (Teacher's Guide p. 151, pasta as models of bone types), which the lesson uses in Explain. The Teacher's Manual answer for 7.2 Practice question 1 names four shapes (long, short, flat, irregular); the objective adds sesamoid. **Additions beyond the district list:** this virtual lab, the measuring and the ratio rule, the cutoffs, and the kneecap test. Not checked here: whether the student edition, p. 228 to 229, names sesamoid bones.

Sources

Bones: Z-Anatomy (Gauthier Kervyn and Lluis Vinent), github.com/LluisV/Z-Anatomy, built on BodyParts3D, Database Center for Life Science (DBCLS), Japan; CC BY-SA 4.0. Photos and X-rays (Wikimedia Commons, CC0): “X-ray of normal hand by dorsoplantar projection” and “X-ray of a normal knee by lateral projection”, Mikael Häggström; “Femur - anterior, posterior”, “Vertebra - lumbales (superior view)”, “Cranium - neurocranium superior view”, “Scapula - anterior view” and “Patella - facies anterior et posterior patellae”, MAKY.OREL. Shape definitions: Hole's Essentials of Human Anatomy & Physiology 3e, Section 7.2, and its Teacher's Manual. The answer key is a separate file, kept off the public site.