Bones of the Foot Lab: NYSSLS Alignment

Teacher guide for the student worksheet at mrsajdak.com/foot (two pages, 16 questions; a low-write version has the same numbers). Anatomy & Physiology, Location of Major Human Bones (AP.4.7.3), the foot. Hole's Essentials 3e, Section 7.12 Lower Limb (pp. 264 to 269). 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 model

Three tabs in one page, no login. Every run gives the same numbers, so the key is exact. Students click real bones on high-detail renders of a CT-scanned foot; each render carries a hidden bone map, so the lab knows exactly which bone was clicked.

What is real. The bones are the right foot of a 26-year-old man (case 024) from the Virtual Skeleton Database lower-extremity CT segmentations (SMIR, via the BoneHub set on Hugging Face, CC BY-NC-SA 4.0), with the bottom 14 cm of his tibia and fibula. They are about six times more detailed than the Z-Anatomy skeleton used in mrsajdak.com/skeleton. Every number in the lab was measured from those meshes in Blender: volume (cm^3), length, the lowest point of each bone above the floor, and the closest gap between each pair of bones. Key values: calcaneus 101.9 cm^3, talus 53.3, navicular 15.3; the tibia's only foot contact is the talus (0.5 mm gap); lowest points: calcaneus 1.9 mm, talus 46.5, navicular 39.7, medial cuneiform 24.4, metatarsal 1 1.9, cuboid 15.3. The X-ray is a normal right foot, dorsoplantar view (Mikael Häggström, CC0), turned a quarter turn to match the render. The footprints are real inked prints labelled normal, flat, advanced flat and hollow (pes cavus) by their author (Juan Carlos Fonseca Mata, CC BY-SA 4.0).

What is changed or left out. The CT was taken lying down with the foot pointed and rolled in; the bones were turned about the subtalar and ankle axes to stand on a floor, and the floor was fitted under the heel and metatarsal heads. "The floor" is where the bones would rest; a living foot has a heel fat pad and skin beneath them, so real bone heights above the ground are larger. "Touches" means a gap of 2 mm or less; in life that space is joint cartilage. Two pairs read 0.0 mm where the posed bones meet. The model has no cartilage, ligaments, plantar fascia, muscles or sesamoids, and it is one man's foot.

Objectives

The plan book objective (AP.4.7.3): Students will be able to locate and name the major bones of the human skeleton. This lab takes that objective into the foot.

I can	Questions
locate and name the bones of the foot.	1 to 6, 9
explain how the shape of the foot's bones fits their job of holding up the body.	7, 8, 10 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: the foot as a system of 26 named parts in three groups, on the same plan as the hand (Q1 to 5, CCC 4 Systems and system models); structure and function in the talus that takes all the weight, the big calcaneus that takes the impact and anchors the Achilles tendon, and the arch that spreads the load (Q8, Q10, Q16, CCC 6). HS-LS1-1 is touched only through structure and function, not DNA. **SEP 5** is the percent and the volume ratio (Q3, Q7); **SEP 4** is reading the contact and height data (Q6, Q11, Q12); **SEP 2** is the model check (Q15); **SEP 6** is Explain it (Q16). **DCI LS1.A:** Structure and Function.

Opening: pick a phenomenon

Students first do the Do Now on the lab page and the worksheet: four real footprints, "Which part left no ink?" The slideshow then opens with a menu. Pick one opener per class. All three end at the same Observe, Wonder, Predict slide and the same driving question ("Your feet carry your whole body all day. How can 26 small bones hold up so much weight?"), and the revisit works with any of them.

Option	What happens

A. Video Feet at Work, 2 to 4 min	1. "Ballet Anatomy: Feet", The Australian Ballet, 0:00 to 1:30 (youtube.com/watch?v=FYwntsUota0): a dancer's feet at work. 2. "Flouroscan Video X-ray of the Foot and Ankle", Arbor Foot Health Center, 0:00 to 1:07 (youtube.com/watch?v=upVf5LOGj_M): the talus moving under the tibia, and the sesamoids under the big toe. 3. "MatScan Barefoot Screening Device", Tekscan Medical, first minute (youtube.com/watch?v=R_WTQ89Lbjs): a pressure mat shows heel and ball pressing, the arch blank; it is a product video, so stop before the sales talk. All three embed; they were picked by title, description and length, not watched end to end: preview first.
B. Try it The Paper Arch, 5 min	A flat sheet of paper across a gap between book stacks, then a sheet bent into an arch with its ends wedged against the books; add coins one at a time to each. The arch usually holds several times more, as long as its ends cannot slide. **You need:** two sheets of paper per group, four books, about 40 coins or washers.
C. Photos Four Footprints, 3 min	The four inked footprints beside a real X-ray of a foot from above. A quiet minute to look, then Observe, Wonder, Predict.

Part by part

Part	SEP	CCC	What students do
1. Name the 26 Tab 1, Q1 to 5	SEP 2 Developing and using models SEP 5	Systems and System Models	Explore Q1 and 2: click every bone on the top view; the lab names it and counts it by group (7, 5, 14). Learn It (before Q3 to 5): tarsals, metatarsals numbered from the big toe, phalanges and the hallux, the hand's 27, sesamoids. Apply: the percent of the body's bones in two feet; naming by place; five letters on a real X-ray (Real X-ray unlocks with the Learn It box).
2. The ankle and heel Tab 2, Q6 to 10	SEP 4 Analyzing and interpreting data SEP 5	Structure and Function	Explore Q6 and 7: turn the foot (inside, outside, back, front) and click the tibia, fibula, talus, calcaneus and navicular for their volumes and contacts; calcaneus ÷ navicular. Learn It (before Q8 to 10): joints and cartilage, the ankle joint on the talus, the malleoli, the weight path, the calcaneus and the Achilles tendon. Apply: which bone takes the weight, the two ankle bumps, a job for a big heel bone. "Show the weight path" unlocks with the Learn It box.
3. The arch Tab 3, Q11 to 16	SEP 2 Developing and using models SEP 6 Constructing explanations	Structure and Function	Explore Q11 and 12: click five inside bones and the cuboid for their heights above the floor and graph them; show which bones touch the floor (the heel and metatarsal heads). Learn It (before Q13 to 16): the medial longitudinal arch, why an arch, ligaments and the plantar fascia, flat feet and high arches. Apply: name the arch; judge the footprints (unlocked with the Learn It box); model check; Explain it in the A&P three-part frame.

Running it

One 40-minute period, one device per student or pair, or on the board as the class follows along. Suggested times: Do Now and opener (7 min) · Part 1 (11 min) · Part 2 (10 min) · Part 3 (12 min). A link can open a tab directly: mrsajdak.com/foot/#name (also #ankle, #arch).

Explore, then explain, then apply. Each part starts with data questions (Q1 and 2, 6 and 7, 11 and 12). A READ FIRST line then sends students to the green Learn It box under the photo, which opens once they have the data. The slideshow has matching Learn It slides at each point.

The misconceptions to plan for. "Both ankle bumps are one bone" (Q9); "the shin sits on the heel bone" (Q8: it sits on the talus); "every toe has three bones" (Q2); "the arch is held up by the bones alone" (Q15); "flat feet are always a problem" (they are common and often painless; keep it matter-of-fact and do not ask students about their own feet).

Where students get stuck: Q1 (the middle phalanges of the fourth and fifth toes are about 1 cm long; a student on 24 or 25 of 26 is usually missing one); Q6 (the fibula is hidden in the Inside view: use Outside or Back); Q12 (plot the heel on the

left even though the Inside view shows the heel on the right).

District curriculum and additions

The BPS A&P unit doc (Unit 2, Support and Movement) gives Section 7.12, Lower Limb, student edition pp. 264 to 269: locate and identify the bones and the major features of the bones that compose the lower limb. The district lists the APR dissections Ankle and Foot and the animations Talocrural (Ankle) Joint and Intertarsal Joints; this lab covers the same ground with real scanned bones, and the APR animations make a good follow-up. The plan book has no separate foot objective, so this lab serves AP.4.7.3 (locate and name the major bones). **Additions beyond the district list:** this lab itself, the CT-scanned foot and its measurements, the real X-ray, the footprints and the arch. The femur, patella and the rest of the lower limb are not in this lab; mrsajdak.com/skeleton and mrsajdak.com/bonecase cover them.

Sources

Kistler M, Bonaretti S, Pfahrer M, Niklaus R, Büchler P (2013). The Virtual Skeleton Database: an open access repository for biomedical research and collaboration. Journal of Medical Internet Research 15(11):e245. Lower-extremity CT segmentations, case 024, via BoneHub/vsd-lower-extremities-seg (Hugging Face), CC BY-NC-SA 4.0. Häggström M, X-ray of normal right foot by dorsoplantar projection, Wikimedia Commons, CC0. Fonseca Mata JC, Huellas plantares, Wikimedia Commons, CC BY-SA 4.0. Hole's Essentials of Human Anatomy & Physiology 3e, Section 7.12, and its Teacher's Manual. The answer key is a separate file, kept off the public site.