The Bone Case Lab: NYSSLS Alignment

Teacher guide for the student worksheet at mrsajdak.com/bonecase (two pages, 15 questions; a low-write version has the same numbers). Anatomy & Physiology, Location of Major Human Bones (AP.4.7.3). Hole's Essentials 3e, Section 7.5 Skeletal Organization (pp. 238 to 243). 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

Four tabs in one page, no login. Every run gives the same numbers, so the key is exact. The lab mirrors the lesson's hands-on Explore (find bones by clues, measure the ulna, estimate a height) with the bones students cannot feel or measure on themselves.

What is real. Tab 1 is a real early medieval burial from West Hanney, Oxfordshire (Oxfordshire County Council, Anni Byard, Portable Antiquities Scheme, CC BY-SA 4.0). The four bones in Tabs 2 and 3 are from a 3D scan of a real adult man's skeleton (BodyParts3D, Database Center for Life Science, cleaned up by Z-Anatomy, CC BY-SA), the same model as mrsajdak.com/skeleton. Each bone is drawn at true size, and its maximum length was measured from the scan: femur 456.4 mm, tibia 360.2, humerus 320.2, ulna 264.1. The scan's whole skeleton measures 169.4 cm from the top of the skull to the bottom of the heel, which is why the four estimates (169.0 to 171.7 cm) can be checked. The crooked femur reading (443 mm) is the scan's femur measured along a line 15 degrees off its long axis. The height formulas are Trotter and Gleser's (1952), as tabled in Trotter (1970), stature in cm: men, femur 2.38F + 61.41 (±3.27), tibia 2.52T + 78.62 (±3.37), humerus 3.08H + 70.45 (±4.05), ulna 3.70U + 74.05 (±4.32); women, femur 2.47F + 54.10 (±3.72). Richard III: skeleton found in 2012 at the Greyfriars site in Leicester; a severe right-sided spiral scoliosis (Cobb angle 65 to 85 degrees) that began in late adolescence, a trunk short for his limbs, normal and symmetric leg bones, and a height of about 5 ft 8 in without the curve, appearing several inches shorter (Appleby and others, The Lancet 383:1944, 2014); the height came from his femur (University of Leicester). **What is simplified:** the tags in Tab 1 mark a region, not one exact bone; Tab 4 uses the scan's skeleton with a drawn red line for the idea of a curve, not Richard's real spine; his femur in Q14 is worked backward from the published height (46.9 cm), not his measured length. The formulas come from adults aged 18 to 30 in the United States and work best for people like them; forensic scientists choose formulas to fit the person and the population. This lab offers only the formulas we could check against the published table.

These are real people. The photos show human remains: a grave and a king's burial place. Treat them with respect.

Objectives

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

I can	Questions
locate and name the major bones of the human skeleton.	1 to 4, 13
measure a long bone and use it to estimate a person's height.	5 to 12, 14, 15

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 skeleton as one system of named parts, found region by region on a real burial (Q1 to 4, CCC 4 Systems and system models); structure and function in the bones themselves: one bone above the elbow and knee, two below, the radius that turns, and a straight femur that still records height when the spine is curved (Q4, Q15, CCC 6). HS-LS1-1 is touched only through structure and function, not DNA. **SEP 3** is the plan check on measuring (Q7, Q8); **SEP 5** is the formula and working it backward (Q9, Q14); **SEP 6** is Explain it (Q15); **SEP 2** is the model itself (a scanned skeleton and the bone board). **CCC 3** Scale, proportion and quantity is Q11. The plan book tags SEP 2, SEP 6, CCC 6 and CCC 4; all four are enacted. **DCI LS1.A:** Structure and Function.

Opening: pick a phenomenon

The slideshow opens with a menu. Pick one opener per class. All three end at the same Observe, Wonder, Predict slide and the same driving question, and the revisit at the end works with any of them. The lesson before this one opens on the Richard III dig video, so this deck does not replay it: Part 4 comes back to that king with two new questions, his height and his curved spine.

Option	What happens
A. Video Whose Bones Are These?, 2 to 4 min	1. "Whose Bones Are These? Investigating A Classroom Skeleton", NPR's Skunk Bear, 0:00 to 1:51 (youtube.com/watch?v=PJ7A6Nw0My4): a high school art room skeleton is real bone, and forensic scientists measure every bone. Stop at 1:51, before the results. Later the video says many school skeletons came from a trade in human remains from India; leave that out of the opener. 2. "How forensic anthropologists identify human remains", MLive, 0:00 to 2:00 (youtube.com/watch?v=eBovP1H4_qQ). 3. "Long Bone Measurement", ProfCahoon, 0:00 to 1:30 (youtube.com/watch?v=0lhVzYaDlFI): a real osteometric board. Save it for Part 2. The clips were checked by their captions and embed links, not watched end to end: preview first.
B. Try it Arms Wide, 4 min	Back to the wall, arms out level with the shoulders; a partner tapes the tip of each middle finger; measure tape to tape and compare with height on the wall strip. Arm span usually comes out close to height. Ask: "If a scientist found only a leg bone, what could it tell them?" Anyone may measure a partner instead of being measured. **You need:** masking tape, a meter stick or cloth tape in cm, a height strip.
C. Photos Bones in the Ground, 3 min	The West Hanney grave and Richard III's grave in Leicester. A quiet minute to look, then Observe, Wonder, Predict.

Part by part

Part	SEP	CCC	What students do
1. The dig Tab 1, Q1 to 4	SEP 2 Developing and using models	Systems and System Models	Explore Q1 and 2: the body region for each of ten tags on a real burial, with a close-up. Learn It (before Q3 and 4): the major bones region by region; radius and ulna, tibia and fibula. Apply: press 2. Name and name all ten; sort the two forearm and two lower-leg bones.
2. The bone board Tab 2, Q5 to 8	SEP 3 Planning and carrying out investigations	Scale, Proportion and Quantity	Explore Q5 and 6: slide the block to the femur, tibia, humerus and ulna (456, 360, 320, 264 mm), then the femur crooked (443 mm). Learn It (before Q7 and 8): the osteometric board, maximum length, the same method every time, mm to cm. Apply: plan check.
3. How tall? Tab 3, Q9 to 12	SEP 5 Using mathematics	Scale, Proportion and Quantity	Explore Q9 and 10: the four formulas by hand, checked in the lab (169.9, 169.3, 169.0, 171.7 cm); the scan's skeleton, 169.4 cm, falls inside all four ranges. Learn It (before Q11 and 12): formulas from many skeletons, the ± range, leg bones best, sex-specific formulas. Apply: narrowest range; men's 169.9 against women's 166.7 on the same femur.
4. The king Tab 4, Q13 to 15	SEP 6 Constructing explanations SEP 5	Structure and Function	Explore Q13 and 14: judge femur, spine, humerus and tibia from the case file; work the femur formula backward (46.9 cm). Learn It (before Q15): scoliosis, a short trunk and normal limbs, why the femur, what a forensic scientist does. Apply: Explain it in the A&P three-part frame.

Running it

A full lab is one 40-minute period, one device per student or pair, or on the board as the class follows along. In the lesson the hands-on Explore (find bones by touch, measure the ulna, height ÷ ulna) comes first; the lab is the Elaborate. With 9 minutes, run Part 3 (Q9 to 12), which carries the class's ulna ratio into the real forensic formulas, and Part 4 if time allows; Parts 1 and 2 then serve a student who was out, a make-up, or a student who will not touch or be measured. Suggested times for a full period: opener and predict (5 min) · Part 1 (9 min) · Part 2 (8 min) · Part 3 (10 min) · Part 4 (8 min). Calculators for Part 3.

A link can open a tab directly: mrsajdak.com/bonecase/#dig (also #board, #height, #king).

Explore, then explain, then apply. Each part starts with data questions (Q1 and 2, 5 and 6, 9 and 10, 13 and 14). A READ FIRST line then sends students to the green Learn It box under the lab drawing, which opens once they have the data. Step

2 of Tab 1 (naming) stays locked until its Learn It box opens. The slideshow has matching Learn It slides at each point.

The misconceptions to plan for. "The ulna is on the thumb side" and "both ankle bumps belong to the fibula" (Q4); "the funny bone is a bone" (it is the ulnar nerve). Also "a height from bones is one exact number" (Q11, the revisit) and "women's bones are just shorter" (Q12: the same femur gives two answers because the formulas differ).

Where students get stuck: Q1 (the person lies on their back, so their right side is on our left); Q5 (the block cannot pass through the bone, so it stops when it touches; the reading is shown only then); Q9 (multiply first, then add; keep the length in cm); Q14 (undo in reverse: take away 61.41 first, then divide by 2.38).

District curriculum and additions

The BPS A&P unit doc (Unit 2, Support and Movement) gives Section 7.5, Skeletal Organization, student edition pp. 238 to 243: distinguish the axial and appendicular skeletons and name the major parts of each. District items used: the Labeling Activity, Major Bones of the Skeleton, and the Teacher's Manual Additional Discussion Question listing the bones students should label (Q1 to 4 cover the regions; the full list is on the slides). Use the Practices 7.5 (Using Mathematics) is a percentage of axial bones and belongs to the earlier axial and appendicular lesson; this lab's mathematics is the height formulas instead. The chapter phenomenon is forensic anthropology ("What Bones Tell Us"), which this lab carries.
Additions beyond the district list: the West Hanney burial, the bone board, Trotter and Gleser's formulas, the scanned skeleton's lengths and height, and the Richard III height case.

Sources

Trotter M, Gleser GC (1952). Estimation of stature from long bones of American Whites and Negroes. American Journal of Physical Anthropology 10:463 to 514; equations as tabled in Trotter M (1970), Estimation of stature from intact long limb bones, in Stewart TD (ed.), Personal Identification in Mass Disasters, Smithsonian Institution. Appleby J, Mitchell PD, Robinson C, and others (2014). The scoliosis of Richard III, last Plantagenet King of England: diagnosis and clinical significance. The Lancet 383(9932):1944. University of Leicester, Richard III: Discovery and identification (le.ac.uk/richard-iii). BodyParts3D, The Database Center for Life Science, CC BY-SA 2.1 Japan; Z-Anatomy (github.com/LluisV/Z-Anatomy), CC BY-SA 4.0. Hole's Essentials of Human Anatomy & Physiology 3e, Section 7.5, and its Teacher's Manual. The answer key is a separate file, kept off the public site.