



College of Education
UNIVERSITY of FLORIDA



FLORIDA
MUSEUM

Engaging K-12 Students in Integrated STEM via 3D Digitization, 3D Printing and Paleontology



AUTHOR (S)

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LESSON TITLE

What Do They Have in Common?

GRADE LEVEL

8th grade

TIME FRAME

60 minutes or 2- 40 minute periods

DRIVING QUESTION

What evidence and explanation can you give to determine how homologous structures show common ancestry?

LEARNING GOALS

Students will be able to identify and explain homologous structures and how the similar structures contribute to common ancestry with a hands-on approach using 3D printed bones for comparison.

ANCHORING EVENT

Show 2 Minute Classroom Video “Homologous Structures vs Analogous Structures”

<https://youtu.be/2N3OPRodRvk>

COLLABORATIONS

- Groups of 4 with assigned jobs
- Discussion among groups which lead to group decision and evidence to back up their decision
- Groups share their decision and evidence with another group in the class
- Students will share with whole class their decisions using evidence that they can back up their decisions with
- Video tape 1 to 2 groups to share with the other class(s)

STEM INTEGRATION

Students will be able to analyze and describe a homologous structure. They can compare and contrast comparative anatomy using 3D technology. They will also be able to defend arguments based on evidence that they have observed with the 3D structures.

ASSESSMENT

Formative Assessment

- Observations - Listen while students are discussing their ideas when investigating the bone structures
- Questioning - Prompt students with questions. Example questions might be:
 - Why do you think that bone belongs there?
 - Explain what you are thinking when you placed the bones in that order?
 - What patterns do you see in the structures that we are observing?
- Discussion - Monitor student discussion within their groups and also discussion with another group in their class
- Exit Slip - Make a statement on how homologous structures support the idea that evolution has occurred. Support your statement with 3 pieces of evidence. Write a “why” or “how” question related to this activity that you may still wonder about

Summative Assessment

- End of Unit Test
- OCCT State Test

PROCEDURE

Essential Question: What is a Homologous Structure?

Engage

- 2 Minute Classroom Video <https://youtu.be/2N3OPRodRvk>

Explore

- Place students in groups of 4 with assigned jobs (facilitator, timer, recorder, speaker)
- Hand each group of students a set of 3D printed bones.
- Ask them to discuss the answer the following (6-8 minutes):
 - Observe, analyze and determine the placement of the bones in the body.
 - What organisms do you think it belongs to?
 - What is the function of each bone?
 - Do all the bones have the same function?
- Remind students that the bones do not have to come from the same organism.

Explain

- Have each group share their decisions with one other group in the class using evidence to back up their decision.
- Students will return to their original groups and may change their answers to the above questions after conferring with that group if they choose to do so.
- Again, have each group share their decisions with an additional group in the class using evidence to back up their decision.
- Have each group return to their original table groups.
- Ask each group to share their findings with the whole class using evidence to back up their decisions.
- After sharing out, show your class the picture of the bones on the document titled Homologous Structures. (*See Homologous Structures PDF)
- Whole Class Discussion - Discuss and compare what they thought about their 3D printed bones in comparison with the Homologous Structures picture. Give your class time to compare their claims with the new evidence presented.

Elaborate

- EdPuzzle <https://youtu.be/MacfZPA95Ig> 11.2.2 Homologous Structures - Instruct each student to complete the edpuzzle and answer the questions. If you have a classroom account, they can answer the questions and turn in their completed answers through your classroom. If you do not, you may want to have your students write the answers down as they work through the EdPuzzle.

Evaluate

- Coloring Worksheet: This worksheet is a comparative anatomy worksheet showing the images of the skeletal structures of the front limbs of 6 animals - human, crocodile, whale, cat, bird, and bat. Each animal has a similar set of bones. Color code each of the bones according to the directions.
- Exit Slip - State a claim about how homologous structures support the idea that evolution has occurred. Support your statement with 3 pieces of evidence. Provides the justification for why this evidence is important to **this** claim. Write one “why” or “how” question related to this activity that you may still wonder about.

STANDARDS

NEXT GENERATION SCIENCE STANDARDS (NGSS)

MS-LS4-2 Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships. Clarification Statement: Emphasis is on explanations of the evolutionary relationships among organisms in terms of similarity or differences of the gross appearance of anatomical structures.

Oklahoma Academic Science Standards: Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer ancestral relationships.

Science Practices	Connection to the Lesson
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. <ul style="list-style-type: none">• Apply scientific ideas to construct an explanation for real-world phenomena, examples, or events.	Students will investigate 3D printed bones to determine relationships and provide evidence for forming an explanation for their determinations.
Disciplinary Core Ideas	Connection to the Lesson
LS4.A: Evidence of Common Ancestry and Diversity <ul style="list-style-type: none">• Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record, enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent.	Students will compare 3D printed bones to determine anatomical similarities of organisms living today based on observations of the 3D printed bones and peer group discussion.
Crosscutting Concepts	Connection to the Lesson
Patterns <ul style="list-style-type: none">• Patterns can be used to identify cause and effect relationships.	Analyzing and comparing the structure of each 3D printed bone will show patterns in position, structure and evolutionary origin. However, these patterns will not necessarily exhibit that the function will always be the same.

CCSS STANDARDS

List relevant CCSS state standards for the intended grade level for math and/or language arts.

<http://www.corestandards.org/Math/>

<http://www.corestandards.org/ELA-Literacy/>

OTHER STANDARDS

Oklahoma Academic Science Standards (OASS)

MS-LS4-2 Students will be able to apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer ancestral relationships. Emphasis is on explanations of the ancestral relationships among organisms in terms of similarity or differences of the gross appearance of anatomical structures. Students will be able to use patterns to identify cause and effect relationships.

RESOURCES & MATERIALS

Comparative Anatomy of the Domestic Chicken by HHMI.org, Labeled anatomical diagrams of fauna (cat, bat, whale and human) for comparison, Homologous Structures Coloring Sheet (see below at end of documents), and CER worksheet (see below at end of document).

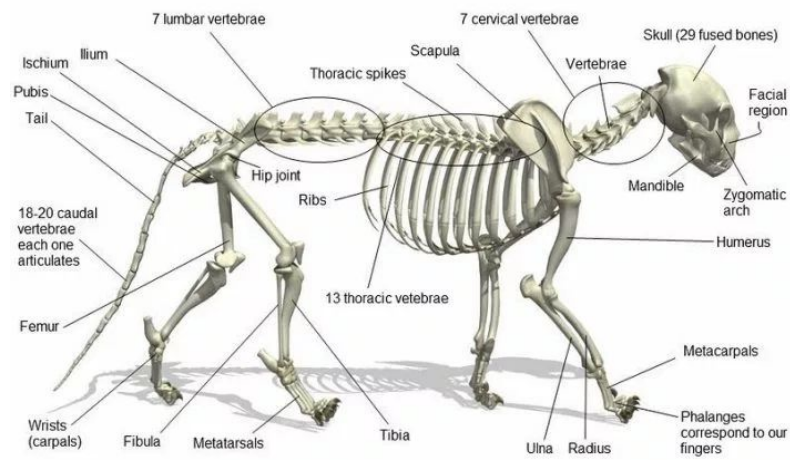
KEY ACADEMIC AND/OR SCIENTIFIC LANGUAGE

List the terms used in the lesson and definitions

1. Paleontology
2. Homologous Structures
3. Analogous Structures
4. Comparative Anatomy
5. Common Ancestor
6. Anatomical (Anatomically)
7. Structure
8. Function
9. Divergent Evolution

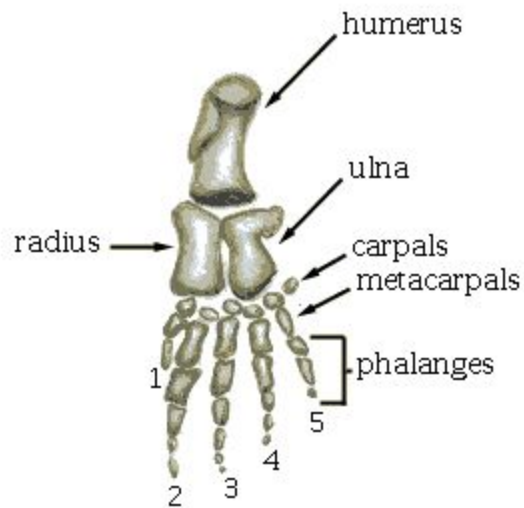
PRIOR KNOWLEDGE

Students begin this lesson with thorough knowledge of the different responsibilities of a Paleontologist. They should have a working knowledge of basic bone structures in present day animals and should understand how to read and/or construct a cladogram with knowledge of common ancestry. In addition, the students should be able to make a claim based on evidence and back up their claim with reasoning (CER).

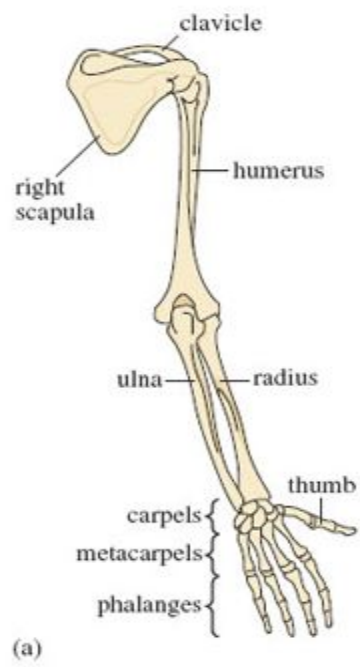


Cat Skeleton

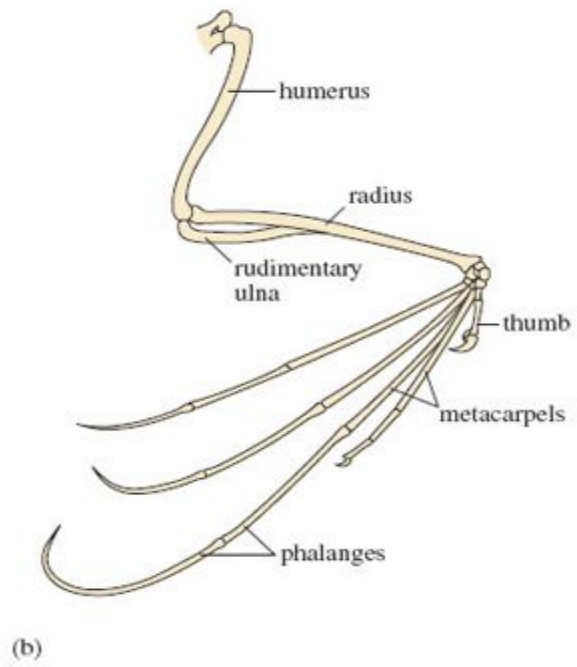
Bones of the left flipper



Orca Whale Humerus



Human Humerus



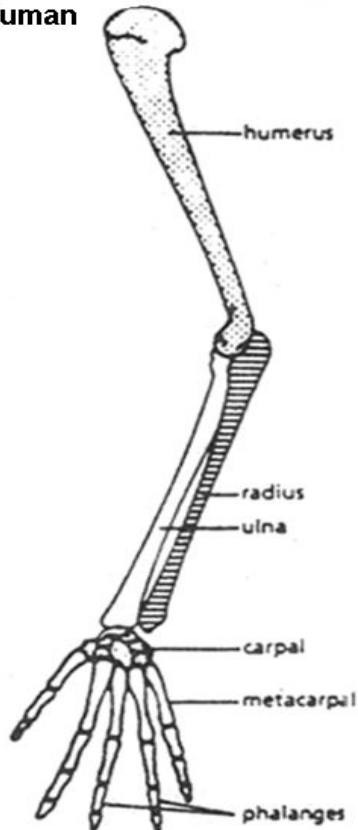
Bat Humerus

Homologous Structures Coloring Sheet

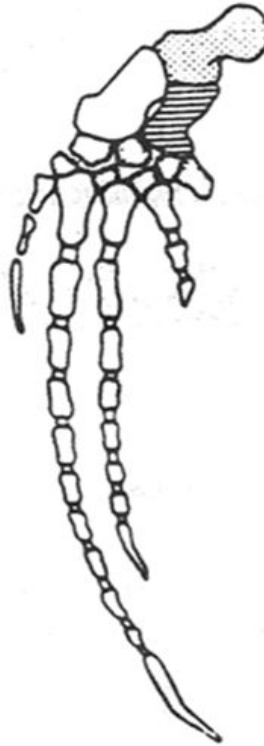
These structures are formed in similar ways during embryonic development and share like arrangements; however they have somewhat different forms and functions. They are called homologous structures.

Carefully examine the drawings of the bones shown in Figure 1. Look for similarities among the various animals. Next, color each part of the human arm a different color. Then color the corresponding bone in each of the other animals the same color as the human bone.

Human



Whale



Crocodile



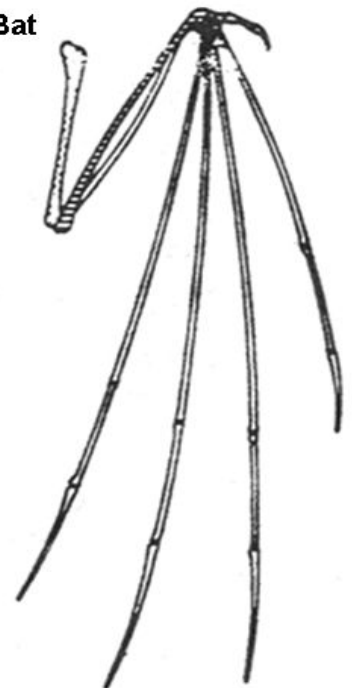
Cat



Bird



Bat



CER

Question: How have homologous structures supported the idea that evolution has occurred?	Claim:
Evidence: 1. 2. 3.	Reasoning
**Write one "why" or "how" question related to this activity that you may wonder about.	

CER

Question: How have homologous structures supported the idea that evolution has occurred?	Claim:
Evidence: 1. 2. 3.	Reasoning
**Write one "why" or "how" question related to this activity that you may wonder about.	