Title: "Will you find this humerus? Homology Lab"

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Abstract:
Students often struggle with the concept of homologous and analogous structures, especially in on-level Biology classes. This activity is designed to provide both virtual and hands-on options for teachers based on the needs and strengths of their students. Students will compare and contrast the morphology of vertebrate forelimbs, and will use this knowledge to draw conclusions about their common ancestor and descent with modification. Students will also consider adaptation and how structure is shaped by selection pressures to suit the necessary function of limbs.

Subject, Grade, Level:
Biology, 10th grade (high school), and on-level and honors Biology.

Learning objectives:
Students will explore concepts relating to the evolution unit, including common ancestry, phylogeny, adaptation, and homologous structures.

Timeframe:
Instructor preparation: 50 minutes.

Estimated class time: 50 minutes.

List of materials:
For physical activity: 3D printed limb puzzles (4 species per group, 8 lab groups per class), lab handout document.

For virtual lab: One laptop per student, one set of headphones/earbuds per student, virtual lab document (WISE).

Procedure and general instructions (for instructor):
For physical activity:

- For background and prep, make sure that your students have been introduced to the concept of phylogeny and how morphology can be used as evidence of evolution; they should be familiar with the terms "**descent with modification**", "**speciation**", "**common ancestor**", "**homologous structures**", "**vestigial structures**", and "**analogous structures**".
- You should have enough 3D printed puzzle models for the number of lab groups in the classroom (typically 8 groups of 3-4 students). Have the lab handout document printed and ready for each student.

- Begin the lab with the bellwork listed below under student procedure. Have your students form lab groups, and provide each lab group with a set of the puzzle models. The students will begin by answering the pre-lab questions, then sorting the color-coded bones of the forelimb and attempting to assemble the puzzles.
- Circulate the room to keep students on task, and to ensure that the puzzles have been correctly assembled. Students will then begin answering analysis questions on the lab handout, attempting to match each forelimb with its own outline, and considering their common ancestry. Students will discuss homologous structures, and the selection pressures that might have resulted in the adaptations of the different forelimbs. Answer questions as needed as the students answer higher-order analysis questions.

For virtual lab:

- For background and prep, use the Chrome browser to navigate to the WISE website (wise.berkeley.edu). Complete the teacher registration; under "Teacher Home" click "Browse WISE Units". You can search for the "Will you find this humerus?" unit; click on the unit icon. You may either use the pre-prepared virtual lab, or copy the lab to edit it as needed. Click "Use with class" to use the pre-prepared virtual lab, or click the three dots on the top right side to see more options, click "Copy", and edit the virtual lab for your own needs. An access code will be created for your students to be able to join the virtual lab.
- Students should already be trained with how to appropriately use laptops or other devices in your classroom. Begin the lab with the bellwork listed below under student procedure. Have your students select the laptop and headphones/earbuds that they will be using with the virtual lab, and log in to open the Chrome browser. (The WISE platform is optimized for Chrome; there may be technical difficulties with other browsers, such as Firefox!)
- Your students will need to register and create a student account, as listed below under student procedure. Project or write the access code on the board, and have your students begin the virtual lab. Circulate the room to keep students on task, and to ensure that they are answering the analysis questions by typing into the provided text boxes. Answer questions as needed as the students answer higher-order analysis questions.

Procedure and general instructions (for students):

For physical activity:

- Bellwork: What is a homologous structure? What does it tell you about two different species?
- Form lab groups of 3 to 4 students. Begin working on putting the 3D printed puzzles together, using the magnetic connections to hold them together.

For virtual lab:

- Homology Lab. Bellwork: What is a homologous structure? What does it tell you about two different species?
- Select the laptop that matches the number of your desk; log in and open the Chrome browser.
- wise.berkeley.edu/
- Click on "Register" and choose "Student Account". Fill in the form with your name and personal information, and click "Submit". Enter the access code below to get started!
- Access Code: [Access code that is generated for the teacher by the WISE program.]

WISE Virtual Activity:

wise.berkeley.edu

Access Code: Mako581