Evolutionary Structures

Unit	Utah SEEd Standard / NGSS Performance Expectation	Estimated Lesson Time:
Utah SEEd Standard Biology 4.1	Obtain, evaluate, and communicate information to identify the patterns in the evidence that support biological evolution. Examples of evidence could include DNA sequences, amino acid sequences, anatomical structures, the fossil record, or the order of appearance of structures during embryological development. (LS4.A)	**Two 70-minute Class Periods**

LESSON OVERVIEW

Learning Objective

Students will obtain, evaluate, and communicate evidence from anatomical structures, fossils, embryology, DNA, and amino acid sequences to explain patterns that support biological evolution.

Anchor Phenomenon

Similarities between human, dog, bird, and whale homologous structures.

Driving Question(s)

How do patterns in anatomical fossils, embryological, and molecular evidence support common ancestry among organisms?

Lesson Level Performance Expectations

- Use of obtain, evaluate, and communicate information to show that patterns can be used to explain the evolutionary evidence.
- Patterns show data in evolutionary evidence using information they gathered.

3D-RST is supported by the NSF under grant number #DRL-2101383

LESSON SNAPSHOT

LESSON SUMMARY:

	Estimated Time	Section Overview	How are students answering the driving question or meeting the learning objectives? (Highlight SEPs, DCIs, and CCCs)
Experience the Phenomenon	10 min	Homologous structures serve as evidence of evolution.	Students explore homologous structures and use anatomical evidence to infer evolutionary relationships. The lesson builds on prior knowledge of the fossil record and anatomical comparisons to understand patterns of descent.
Investigate the Phenomenon	50 min	Students will gather and assess evidence of common ancestry and diversity.	Students observe, discuss, and evaluate visual evidence, engaging in discussions to synthesize information and assess the credibility and relevance of anatomical similarities. Students identify patterns in anatomical structures across species, which provide evidence of evolutionary relationships.
Communicate and Synthesize Evidence	30 min	Gallery walk to explore all the different evidence found by classmates.	Evidence suggests that similar structures across species indicate a shared evolutionary history, even if those structures serve different functions. Students should recognize that patterns in the fossil record reveal cause-and-effect relationships in biological systems and support explanations.

DISCIPLINARY CORE IDEAS	SCIENCE & ENGINEERING PRACTICES	CROSSCUTTING CONCEPTS
NGSS Appendix E **LS4.A: Evidence of common ancestry and diversity** The ongoing branching that produces multiple lines of descent can be inferred by comparing DNA, amino acid, and anatomical and embryological evidence across different organisms.	NGSS Appendix F **Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.** • Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.	NGSS Appendix G In grades 9-12, students observe **patterns** in systems at different scales and cite patterns as empirical evidence for causality in supporting their explanations of phenomena. They recognize classifications or explanations used at one scale may not be useful or need revision using a different scale; thus, requiring improved investigations and experiments. They use mathematical representations to identify certain patterns and analyze patterns of performance in order to reengineer and improve a designed system.
Related knowledge and skills from prior grades		

3D-RST is supported by the NSF under grant number #DRL-2101383

Disciplinary Core Idea: NGSS Appendix E The fossil record documents the existence, diversity, extinction, and change of many life forms and their environments through Earth's history. The fossil record and comparisons of anatomical similarities between organisms enable the inference of lines of evolutionary descent.	Science and Engineering Practices NGSS Appendix F Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and the methods used, and describe how they are supported or not supported by evidence.	Crosscutting Concept: NGSS Appendix G In grades 6-8, students recognize that macroscopic patterns are related to the nature of microscopic and atomic-level structure. They identify patterns in rates of change and other numerical relationships that provide information about natural and human-designed systems. They use patterns to identify cause-and-effect relationships and graphs and charts to identify patterns in data.

Materials

Link to all materials on the 3DRST website (3drst.byu.edu): https://3drst.byu.edu/bio-4-1-evolution
Link to all materials on Canvas Commons: https://tinyurl.com/3DRSTbiology

Student Materials	Teacher Materials	Lab Materials/Other Resources
Student Handout Gallery Walk Handout (works well if printed two pages per sheet)	Teacher Slides Evolutionary Patterns Rubric	Physical Poster: - Poster Paper - Markers/ Color Pencils/ Crayons - Pens/ Pencils Virtual poster: Access to Canva, Adobe, PowerPoint, Google Slides, etc. Student device (laptop, iPad) Gemini and Notebook LM also make good posters if your students have access to those.

Lesson Preparation

Material Preparation:
Poster Paper
Markers or colored pencils

Required Previous Knowledge:
This lesson builds on students' prior understanding of the following DCIs developed in previous units associated with evolution.

Vocabulary Definitions:
DNA sequences, amino acid sequences, anatomical structures (homologous and analogous), the fossil record, or the order of appearance of structures during embryological development.

3D-RST is supported by the NSF under grant number #DRL-2101383

EXPERIENCE THE PHENOMENON/PROBLEM (ENGAGE)	
What Students Are Doing	**Teacher Tips**
Students will view the pictures on **slide 3**. They will make observations using the "see-think-wonder" model. In doing this, they should focus their observations on the similarities among these animals. Students will recognize that these organisms breathe, eat, undergo mitosis, and so on. Think-pair-share the similarities and differences between the organisms. **Students should recognize **slides 4-6** from 7th-grade lessons **Slides 7-8**: Students will observe and comment on the homologous structures each animal has in common. **Slide 9** helps students understand where most homologous structures are found.	Print out the student handout or have them make a see-think-wonder table on whiteboards **The lesson referred to is the BYU 3D-RST lesson: 7.5.2 Patterns in the Fossil Record
What Teachers Are Doing	**Teacher Tips**
Introduce the lesson by displaying **slides 1-2.** Read the lesson objective together. Show students **slide 3**—instruct students to do a think-pair-share and describe similarities between the organisms in the images. The teacher will show **slides 4-6** to the students and discuss the similarities and differences as a class. The teacher will discuss and explain the homologous structures displayed and their functions (this is not an explanation of their origin, but rather how they appear similar yet have different actions). The teacher will display **slides 7-9** to stimulate student curiosity. Teachers will ask what structures are homologous between the animals shown on the slides. Possible student prompts: • What pattern do you observe across organisms? • What evidence suggests common ancestry? • How is this evidence stronger or weaker than other evidence? • Why might similar structures evolve differently over time? **Slide 9** helps students understand where most homologous structures are found.	Helpful Prompting questions: Where does each organism live? What do you notice about how each organism moves? Which organism seems most different from the others? Which organisms seem most similar? If you have whiteboards for groups or journals, you could have the students write their ideas on those.

3D-RST is supported by the NSF under grant number #DRL-2101383

INVESTIGATE THE PHENOMENON (EXPLORE)

What Students Are Doing	Teacher Tips
Students will fill out the worksheet for their section of the poster. They will use the internet to research the assigned evidence for evolution. Once they have learned what their evidence is and can answer their questions, have students create a poster to communicate to their classmates what they have learned.	Have each group select a spokesperson to communicate what they learned to their classmates during the gallery walk. Suggested reliable sources • Khan Academy: Evidence for evolution • HHMI BioInteractive • Smithsonian Human Origins • UC Berkeley Understanding Evolution • NIH genetics resources • PBS Evolution
What Teachers Are Doing	**Teacher Tips**
***Split into groups of 3-4 The teacher will assign one of the 5 evidence of evolution (found on **slide 11**) for the poster. Use **Slides 12-16** to introduce the different topics. If you want to print the slides, you could give them to the individual groups to use as a reference to help them. **Slide 17** shows the criteria for the posters. Leave this up for the duration of poster creation. Students will refer to this for the remainder of the class to determine what is required on their posters. Teachers will move around the classroom to ensure that students are researching the assigned topic. Help students remember they are looking for patterns of evolution, not just researching their topic for "cool things." Teachers should also evaluate information to ensure it is accurate and from reliable sources. Ensure that students are guided to reliable sources and corrected for misinformation.	*** We found this amount to be appropriate per group, but feel free to adjust it to what works best for your class. If you would like more groups, another possible jigsaw group to add is vestigial structures, then homologous structures, and analogous structures (instead of anatomical structures), etc. Posters can be physical, virtual slides, or created using Canva, etc. Because the background information provides an introduction to the topic and its anatomical structures, you might want to assign this topic to the group that needs an easier one.

3D-RST is supported by the NSF under grant number #DRL-2101383

COMMUNICATE AND SYNTHESIZE EVIDENCE (EXPLAIN)

What Students Are Doing	Teacher Tips
Students will participate in a gallery walk to learn about the other four pieces of evidence prepared by their peers. Each student should be looking for patterns of evolution. Gallery Walk Setup: • Have one student stay behind with a poster to present their evidence to their classmates. • Other members of the group move to other groups, moving around the room so they can view each group's evidence. • While in each new group, students will fill out their handout with the corresponding group they are in. • Students will wait for the teacher to have them move to the following group. • Upon completion of their handouts and each rotation, the returning members will communicate the newly found information to the one member left behind. Students will participate in a gallery walk to learn about the various evidence of evolution. As students walk around, they will fill out their worksheets on all the evidence of evolution. After the students finish the gallery walk, have them write a one-paragraph summary of their reflection on the various types of evidence and how they connect to support the theory of biological evolution.	Give the students 1 class period to make posters, and 1 Day to do the gallery walk.
What Teachers Are Doing	**Teacher Tips**
Teachers should have already made sure the evidence was reliable while students were creating posters. In this section, teachers should only provide clarifying information when requested by the groups. Teachers will monitor the students and ensure they have time to visit all the posters. *Set a timer for 5-8 minutes and rotate to the next station every 5-8 minutes to keep students flowing. Final Prompt: Which type of evolutionary evidence do you think provides the strongest support for common ancestry, and why?	*You can determine the length of time you want to give to each group. We found 5-8 minutes was plenty of time. You will have some groups that communicate more quickly and others that require a little more time.

This lesson was created by Jens Andreasen, Ray Davis, and Bryan Holder.

3D-RST is supported by the NSF under grant number #DRL-2101383