Coherence and Alignment Among Science Curriculum, Instruction, and Assessment (CASCIA) Project

Grade 8 Unit 3: Understanding Earth History and the Origin of Species

Interpretive Guidance and Instructional Strategies for Educators

May 2025

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Purpose

The purpose of this document is to help educators understand their students' performance on the Grade 8 Unit 3 Science Assessment and to provide instructional strategies and resources for planning and adjusting instruction to help students learn, whether it involves reteaching previously addressed concepts and skills from the prior instructional unit or planning additional learning opportunities or interventions in the next unit.

Image: Geologic Time Scale
Credit: Joseph Graham, William Newman, and John Stacy, US Geological Survey
Source: http://commons.wikimedia.org/wiki/File:Geological_time_spiral.png
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Unit Overview

By engaging in this unit, students deepen their knowledge of evidence of a common ancestor interpreted through fossil records, how differences in their structure help explain present-day organisms, and how rock strata help us explain the history of Earth. Students develop and use models, analyze and interpret data, and construct explanations to reveal patterns and cause/effect relationships in the inheritance of traits through natural selection and the adaptation and change in life and populations on Earth.

Instructions for Educators

1. Based on your analysis of student work from the assessment, in combination with additional assessment evidence gathered over the course of the instructional unit, consider themes or trends in your students' performance. Refer to your students' scores on the Classroom Roster Report to determine the degree to which students in your classroom require additional instructional support based on their instructional needs levels—red, yellow, or green—for each performance category.
2. For each performance category, use the provided interpretive guidance (i.e., *What These Results Mean*, *Next Instructional Steps*, and *Example Scored and Annotated Student Work* located in the Grade 8 Unit 3 EOU Assessment Scoring Guide) to understand what your students likely know and are able to do and to consider next instructional steps based on their instructional needs levels. Scored and annotated student work samples are provided for each performance category to demonstrate the evidence students might demonstrate in response to each prompt for each possible score point. The student responses represent the full range of score points possible for each prompt based on the scoring rubric.
3. For each performance category, use the *Instructional Strategies and Resources* organized by Universal Design for Learning (UDL) principle to support the design and delivery of accessible instruction and learning opportunities for all students based on their performance on the Grade 8 Unit 3 Assessment and their recommended instructional needs. These instructional recommendations can be selected and used to intentionally plan instruction and learning opportunities for students across the range of instructional needs levels (i.e., red, yellow, green).

Universal Design For Learning

The instructional strategies and resources provided in this document are organized by the Universal Design for Learning (UDL) principles. UDL is a framework to improve and optimize teaching and learning for all people based on scientific insights into how humans learn." (CAST, 2022). Taking time to reflect on prior instruction when planning for accessible, differentiated, and culturally responsive instruction for diverse learners and culturally diverse classrooms serves to identify ways to improve future instructional practices. The UDL Guidelines provide a framework for this reflection. The guidelines include three principles: Multiple Means of Engagement, Multiple Means of Representation, and Multiple Means of Action & Expression as ways to focus on variety and flexibility in instructional practices.

Multiple Means of Engagement	*The WHY of Learning* - provide options for recruiting student interest, sustaining effort, and promoting motivation.
Multiple Means of Representation	*The WHAT of Learning* - provide options for displaying information, including alternatives for auditory and visual information, use multi-media, clarify vocabulary and symbols, support comprehending text, and guide information processing and visualization.
Multiple Means of Action & Expression	*The HOW of Learning* – vary the methods for student responses and collection of evidence of their learning, optimize access to tools and technologies, use multiple tools for construction and composing responses, facilitate managing information and resources, and enhance student capacity for monitoring progress.

By examining instruction and instructional materials through the lens of each of these principles, we can identify and thus reduce or remove barriers to diverse learners to promote accessible and equitable teaching and learning opportunities. Application of UDL guidelines and principles allows all students to engage with and be provided with multiple means of representing instructional content and expressing what they know and can do, which is similarly the purpose of the use of accommodations for students receiving special education, students who have a 504 plan, and emerging Bilinguals.

Performance Category 1: Support Explanations About Organisms That Lived Long Ago

Interpretive Guidance for Performance Category 1: Support Explanations About Organisms That Lived Long Ago *Task 1 Prompt 1, Part B (3 points); Task 1 Prompt 2, Part C (3 points); Task 2 Prompt 2 (2 points); Task 2 Prompt 3 (3 points)*		
Red (0-5 score points earned) ➢ **Extensive** additional instruction and reteaching of these skills is recommended. ➢ The student needs significant opportunities to reinforce and apply these skills in future learning.	**Yellow (6-9 score points earned)** ➢ **Moderate** additional instruction on these skills is recommended. ➢ The student needs additional opportunities to strengthen these skills in future learning.	**Green (10-11 score points earned)** ➢ **Minimal to no** additional instruction on these skills is recommended. ➢ The student is ready to extend these skills in future learning.
What These Results Mean		
This student is likely able to: • **Incorrectly** describe how the relative age of fossils is determined. • **Attempt** to apply reasoning to **incompletely and/or inaccurately** support a provided claim by describing similarities **or** differences in anatomical features over time. • **Incompletely and/or incorrectly** recognize and use similarities and differences in visual representations of fossils to identify patterns of anatomical features over time. • **Attempt** to support a claim, based on evolutionary history, by providing an **inaccurate and/or incomplete** explanation of changes in the traits of a species over time and not including a cause-and-effect relationship.	**This student is likely able to:** • Use relative ordering of rock strata to **accurately** determine the relative ages of fossils. • **Correctly** support a claim with **some accurate** scientific reasoning **and/or** some evidence to describe **some** advantageous changes **and** similarities in anatomical features in a fossil sequence. • **Correctly** apply scientific reasoning and visual representations of fossils to identify **some** evidence of similarities **and** differences in patterns of anatomical features over time that support a conclusion about evolutionary relationships. • **Partially** support a claim based on evolutionary history, using **some** sources of information/data to provide an **incomplete**	**This student is likely able to:** • Use relative ordering of rock strata to explain the order of the procedure to **accurately** determine the relative ages of fossils. • **Correctly** support a claim with **accurate** scientific reasoning **and complete** evidence to describe **all** advantageous changes **and** similarities in anatomical features in a fossil sequence. • **Correctly** apply scientific reasoning and visual representations of fossils to identify **multiple pieces of evidence** of similarities **and** differences in patterns of anatomical features over time that support a conclusion about evolutionary relationships. • **Completely** support a claim based on evolutionary history, using **multiple** sources

Interpretive Guidance for Performance Category 1: Support Explanations About Organisms That Lived Long Ago *Task 1 Prompt 1, Part B (3 points); Task 1 Prompt 2, Part C (3 points); Task 2 Prompt 2 (2 points); Task 2 Prompt 3 (3 points)*		
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	explanation with **some accurate, partial** evidence **and does not include an accurate** cause-and-effect relationship related to changes in the environment and changes in traits of a species brought about by the process of natural selection and/or adaptations that improved chances of survival.	of information/data to provide a **valid and reliable** explanation that **includes** an **accurate** cause-and-effect relationship between the changes in the environment and changes in traits of a species brought about by the process of natural selection and/or adaptations that improved chances of survival.

Interpretive Guidance for Performance Category 1:
Support Explanations About Organisms That Lived Long Ago

Task 1, Prompt 1 Part B (3 points); Task 1, Prompt 2 Part C (3 points); Task 2, Prompt 2 (2 pts); Task 2, Prompt 3 (3 points)

Red (0-5 score points earned)	**Yellow (6-9 score points earned)**	**Green (10-11 score points earned)**
➢ Extensive additional instruction and reteaching of these skills is recommended. ➢ The student needs significant opportunities to reinforce and apply these skills in future learning.	➢ Moderate additional instruction on these skills is recommended. ➢ The student needs additional opportunities to strengthen these skills in future learning.	➢ **Minimal to no** additional instruction on these skills is recommended. ➢ The student is ready to extend these skills in future learning.
Next Instructional Steps		
Provide opportunities for the student to: • Identify similarities and differences in simple visual representations related to geologic columns/rock strata. • Match a description related to the relative ages of fossils or changes in anatomical features to a model(s) • Match a pattern of anatomical features to visual representations of those features over time • Collaboratively sort inaccurate or irrelevant evidence (e.g., data) from accurate or relevant evidence as presented in simple diagrams or charts to support a provided description of the relationship between changes in an environment and changes in anatomical features in animals • From a list, identify the correct explanation or correct an inaccurate explanation of a	**Provide opportunities for the student to:** • Use visual representations related to geologic columns/rock strata and similarities/differences in anatomical fossil features to identify a complete and accurate explanation of a phenomenon • Identify accurate or relevant evidence as presented in text, diagrams, and/or charts about the relationship between changes in an environment and changes in anatomical features in animals to match a provided claim about evolutionary relationships. • Evaluate the strength of provided evidence to support or refute a provided explanation or claim or to select an accurate cause-and-effect relationship related to changes in the environment and changes in traits of a species brought about by the process of natural selection and/or adaptations that improved chances of survival.	**Provide opportunities for the student to:** • Given the relative ages of fossils, create visual representations of geologic columns with correct ordering of rock strata • Identify and use patterns in large data sets to identify similarities and differences in patterns of a range of anatomical features in various species to develop a conclusion about evolutionary relationships. • Research various species to develop visual representations of various anatomical changes over time as they relate to changes in different environments • Research a novel phenomenon to determine cause-and-effect relationships related to changes in the environment and changes in traits of a species brought about by the process of natural selection and/or

phenomenon related to the changes in traits of a species over time.		adaptations that improved chances of survival.

Instructional Strategies and Resources for Performance Category 1: Support Explanations About Organisms That Lived Long Ago

Task 1, Prompt 1, Parts A & B (4 points); Task 1, Prompt 3, Parts A&B (3 points); Task 2, Prompt 2, Part A (3 points); Task 3, Prompt 3, Part A (3 points)

Instructional Strategies and Resources

	Teaching Strategies	***Resources***
	*Supporting Explanations through Discourse* Provide varied opportunities (stations, small groups, partners, whole class) for students to engage in interactive discourse where they build on others' ideas to explain relationships involving organisms that lived long ago. Opportunities for scientific discourse should be situated in authentic, interest-driven science investigations.	• Lines of Evidence: the Science of Evolution – This webpage links to multiple lines of evidence that can be used as topics to support group discourse about evolution. [https://evolution.berkeley.edu/lines-of-evidence/fossil-evidence/] • Promoting Discourse in Science Class – This article by *Carolina Knowledge Center* explains the difference between discourse and science discourse. It supports teachers in moving away from focusing on correct answers and toward the use of supporting evidence. [https://knowledge.carolina.com/professional-growth/promoting-discourse-in-science-class/] • Argumentation in Science Education – This article by *The Science Teacher* lists ways to include argumentation in the classroom and includes a [3:44] video that compares and contrasts scientific theories with the everyday use of the term theory. [https://thescienceteacher.co.uk/argumentation-in-science/] • Thinking Science – This PDF slideshow provides science questions that can be used in a variety of ways, including setting norms for discussion and practicing classroom or group discourse. [https://www.stem.org.uk/system/files/elibrary-resources/2018/11/THINKING%20SCIENCE.pdf] • Fostering Student-Driven Scientific Discourse – This short article by *Discovery Education* addresses the three purposes of classroom discussion and the norms to ensure a comfortable

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Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		environment conducive to discourse. There is a link to a virtual demonstration. [https://www.discoveryeducation.com/info/scientific-discourse/] • Science Talk – This article by *Exploratorium* explains how a discourse-rich classroom culture supports all students in expressing ideas, developing language, and acquiring new knowledge of scientific phenomena. [https://www.exploratorium.edu/education/ifi/inquiry-and-eld/educators-guide/science-talk]
	***Culturally Responsive Explanation*** Foster culturally responsive explanations, drawing from and respecting students' cultural resources, backgrounds, and personal experiences. Provide a range of ways for students to engage in cooperative learning (e.g., think-pair-share, jigsaw, round robin) with diverse groupings of students.	• STEM Teaching Tools – Practice Brief 55 – This article explains why it is crucial to make cultural diversity visible in STEM education. [https://stemteachingtools.org/brief/55] • STEM Teaching Tools – Practice Brief 48 – This article discusses how teachers can use tools to scaffold student science talk and includes *Talk Resource Tools* to foster shifts in science classroom talk. [https://stemteachingtools.org/brief/48] • 5 Tips to Make Your Science Classroom More Culturally Responsive – This article by *Edutopia* includes suggestions on how science teachers can encourage students to explore their individual cultural heritages. [https://www.edutopia.org/article/5-tips-creating-culturally-responsive-science-curriculum/]

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Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		• Ten Culturally Responsive Teaching Strategies for the Science Classroom – This article, *Education Week,* describes ten straightforward ways in which teachers can be culturally responsive while teaching science. [https://www.edweek.org/teaching-learning/opinion-ten-culturally-responsive-teaching-strategies-for-the-science-classroom/2021/02]
	***Critiquing Scientific Explanations*** Use spoken and written examples to encourage students to critique and challenge scientific explanations by identifying strengths and weaknesses in reasoning and evidence.	• What Can Fossils Tell Us About the Nervous System's Evolution – This PDF is a short, engaging lesson presented in research-article format. This can be used for group discourse and critiquing. [https://www.sciencejournalforkids.org/wp-content/uploads/2022/09/CNS_article.pdf] • Inquiry and Scientific Explanations – This article supports teachers in encouraging students to challenge explanations. A CER rubric is included. [https://dpi.wi.gov/sites/default/files/imce/science/Inquiry_and_Scientific_Explanations_McNeill-Krajcik.pdf]
	***Promoting Engagement through Interactive, Collaborative Games*** Use interactive games and collaborative formats to reinforce disciplinary core ideas demonstrating the role of rock strata and similarities/differences in anatomical fossil features to support explanations about organisms that lived long ago.	• Evolution Lab, Mission 2 – This interactive webpage by *Nova* includes a [2:08] video and an interactive graphic on relative dating, as well as a student worksheet that can be printed. [https://aptv.pbslearningmedia.org/resource/nvev-sci-mission2/nova-evolution-lab-interactive-lesson-mission-2/] • Layers of Time | AMNH – This single-page fossil game has interactive rock layers and three levels of difficulty. A brief

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Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		instructional video is included. [https://www.amnh.org/explore/ology/paleontology/layers-of-time2] • Fossilize Me – This webpage includes printable templates and instructions for a card sort game. The game will have students match the fossil to the type of fossilization and to a picture of the organism. [https://www.sciencefriday.com/wp-content/uploads/2017/11/Fossilize-Me-Card-Set.pdf] • The Fossil Record – This interactive review game by *Khan Academy* consists of two brief quizzes on fossils and relative dating. Questions include visual representations. [https://www.khanacademy.org/science/ms-biology/x0c5bb03129646fd6:evolution/x0c5bb03129646fd6:the-fossil-record/e/apply-the-fossil-record] • All in the Family – This interactive webpage by *PBS* offers practice with a simplistic (phylogenetic) tree using information about the physical features of organisms. [https://aptv.pbslearningmedia.org/resource/tdc02.sci.life.evo.allinthefamily/all-in-the-family/] • Similarities and Differences: Understanding Homologies and Convergent Evolution – This interactive website has an eight-page tutorial with interactive graphics. Although designed for high school, the content is appropriate for middle school.

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Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		[https://evolution.berkeley.edu/similarities-and-differences-understanding-homology-and-analogy-ms/]
	*Vocabulary* Provide varied opportunities for students to learn and apply vocabulary in diverse situations and contexts. Vocabulary retention improves when academic terminology is layered on conceptual understanding. To maximize vocabulary building, support students in building conceptual understanding and then apply the academic terminology using the strategies outlined below. • Build understanding of domain-specific vocabulary using a multi-sensory approach or having students participate in simulations. • Make connections between vocabulary and real-life or future opportunities. ○ Explain, describe, give real-world examples, or provide concrete representations of vocabulary words rather than formal definitions. Vocabulary.com (see Resources) provides explanations of words using real-world examples. Once signed in, an educator can create word lists for students.	• Science Word Walls: A Must Have in Your Classroom – This webpage offers tips for science word walls as well as editable templates and pre-made word cards. [https://beakersandink.com/word-wall/] • Text Project – Word Pictures – This site provides Word Pictures that are free for educators to use. Their site includes word pictures for core vocabulary and various content areas, including science and social studies. [https://textproject.org/archive/textproject-word-pictures/] • The Science Penguin – This website provides ideas to teach science vocabulary. The vocabulary demonstration activity uses real objects to teach vocabulary. [http://thesciencepenguin.com/2013/12/science-solutions-vocabulary.html] • Interactive Word Walls Enliven Vocab Learning – This article with teaching strategies supports students' use of a word wall to build an understanding of key vocabulary. [https://www.middleweb.com/37209/interactive-word-walls-enliven-vocab-learning/] • STEM Teaching Tools – Practice Brief 66 – This article discusses how to support emerging multilingual learners as they develop

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Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	○ Build a vocabulary word wall that students can add to and reference during instruction and self-guided activities or tasks. ○ Have students restate the vocabulary word in their own words. Take this opportunity to help students connect new vocabulary, especially general vocabulary, to prior knowledge. • Read books or watch videos related to vocabulary words and concepts. • Sort words, photographs, or concrete representations into categories. Text Project (see Resources) provides Word Pictures that are free for educators to use. It includes Word Pictures for core vocabulary and various content areas, including science and social studies. • Pre-teach vocabulary and symbols, especially in ways that promote connection to the learners' experience and prior knowledge. • Define domain-specific vocabulary using both domain-specific and common terms. • Embedded visual, non-linguistic supports for vocabulary clarification (pictures, videos, etc.). • Have students create their own glossary of terms.	language that interprets and explains phenomena. [https://stemteachingtools.org/brief/66] • Vocabulary.com – This site provides explanations of words using real-world examples. Once signed in, an educator can create word lists for students. [https://www.vocabulary.com/]

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Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	*Presenting Information in Different Modalities* Provide information using a variety of multimedia (e.g., videos, interactives, simulations), informational texts, and formats to teach and reinforce disciplinary core ideas related to a scientific phenomenon involving organisms that lived long ago.	• Comparative Anatomy – This webpage by *CK-12* offers practice with terms to challenge students. Includes videos and interactives to support instruction. [https://www.ck12.org/assessment/ui/?test/detail/practice/biology/comparative-anatomy-practice&collectionHandle=biology&collectionCreatorID=3&conceptCollectionHandle=biology-::-comparative-anatomy&isPageView=true] • Evidence for Evolution – This article by *Khan Academy* describes the different types of information biologists use to trace and reconstruct evolutionary histories of organisms. [https://www.khanacademy.org/science/ap-biology/natural-selection/common-ancestry-and-continuing-evolution/a/evidence-for-evolution] • Deep History of Life on Earth – This webpage by HHMI contains an interactive timeline of the history of life on Earth. [https://www.biointeractive.org/classroom-resources/deep-history-life-earth] • Teaching Activities on Evolution and Natural Selection – This website includes games, labs, and other lessons. There are more links under "That's not all." [https://www.sciencejournalforkids.org/articles/lesson-ideas/teaching-activities-evolution-natural-selection/]

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Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		• Jeopardy – Fossils, Age, Dating, and Geologic Time – This slideshow is a Jeopardy review game with 36 questions. [https://docs.google.com/presentation/d/1S_r4JX8nEnKewix3jRPkVolADbZTh02lD7Qauxs0s78/edit#slide=id.p] • Can Wildlife Adapt to Climate Change? – This video [4:46] by *TEDEd* describes evolutionary adaptations and gives examples of organisms that have recently adapted to climate change. [https://www.youtube.com/watch?v=ZCKRjP_DMII] • Earth & Home – This website by the *Paleontological Research Institution* includes many visually appealing and content-rich resources, including the topics of fossils, evolution, and extinction. An interactive map of the geological regions of the country links to photographs and information about fossils that are found there. [https://earthathome.org/?gclid=Cj0KCQiAnrOtBhDIARIsAFsSe51KWVwEPf-a2J6W49x4tH7kUrnWfqYzT0JpUFy0M15X3fk4YhWQijkaAggmEALw_wcB]

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Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	*Maximizing Transfer of Information* Provide information in a manner that guides learners and supports generalization and transfer of knowledge by employing explicit strategies such as accessing prior knowledge, embedding it in familiar contexts, using mnemonic devices, applying it to new situations, and using graphic organizers.	• Evidence of Evolution – This PDF of a slideshow organizes evidence of evolution by category. This may work as a review. [https://www.longbranch.k12.nj.us/cms/lib3/NJ01001766/Centricity/Domain/1327/Evidences%20of%20Evolution%20Notes.pdf] • STEMscopes Student Notebook for Life Science – Pages 575-728 of this PDF contain multiple graphic organizers, mnemonic devices, reading activities, writing activities, and explorations on topics relating to organisms that lived long ago. [https://acceleratelearning.com/blended-learning/print/] • Learning by Inquiry – This website offers methods to activate prior knowledge by using a constructivist mindset to help learners integrate new information. [https://www.learningbyinquiry.com/simple-strategies-to-activate-students-prior-knowledge/] • Increasing the Value of Graphic Organizers – This article by *Edutopia* explains the importance of allowing students to take ownership of learning by creating their own graphic organizers. [https://www.edutopia.org/article/increasing-value-graphic-organizers/] • 10 Strategies and Tools to Activate Knowledge – This article by *The Teaching Factor* offers ten strategies and modalities for accessing students' prior knowledge.

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Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		[https://theteachingfactor.wordpress.com/2021/08/24/10-strategies-and-tools-to-activate-knowledge/] • Using Phenomena in NGSS Lessons and Units – This STEM Teaching Tool describes the benefits of seating learning in phenomena. Phenomena-driven instruction helps increase students' ability to transfer learning to new scenarios. [https://stemteachingtools.org/brief/42]
	***Identifying Valuable Information to Support Explanations*** Use multiple examples to identify patterns, critical features, and relationships in the anatomical features of fossils to support an explanation about organisms that lived long ago.	• Adaptation by Natural Selection – This webpage by *The Science Teacher* contains links to examples and evidence for students to use to support explanations. "Thinking Deeper" questions are included. [https://thescienceteacher.co.uk/adaptation/] • In Pictures: Fossils – This webpage by *The American Museum of Natural History* provides evidence in pictures with captions that students can use to support an explanation of what Earth was like millions of years ago. [https://www.amnh.org/explore/ology/paleontology/in-pictures-fossils2] • Lines of Evidence –The Science of Evolution – This website offers an extensive explanation of the current scientific evidence supporting the theory of evolution. [https://evolution.berkeley.edu/lines-of-evidence/]

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Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	*Build Fluencies with Graduated Levels of Support for Practice and Performance* Provide differentiated practice as well as scaffolds, supported opportunities, and degrees of freedom for more independence to students of varying ability levels.	• Living Things Change-Crash Course Kids #41.1 – This video [4:36] explains how organisms adapt to environmental changes. This video is appropriate for elementary and middle school students. [https://www.youtube.com/watch?v=xDSFlRunlrU] • Homologous Structures vs Analogous Structures: Key Differences – Video [1:53] by *2-minute Classroom* uses a T-chart to compare homologous and analogous structures in simple terms. [https://www.youtube.com/watch?v=2N3OPRodRvk] • Evolution / Evidence for Evolution – This webpage provides a comprehensive overview of the topic at a moderate level of difficulty. Three videos are included. [https://www.pathwayz.org/Tree/Plain/EVIDENCE+FOR+EVOLUTION] • Comparing & Contrasting Fossil Record Data & Modern Organisms as Evidence for Evolution – This content-deep review offers more challenging review questions. [https://study.com/skill/practice/comparing-contrasting-fossil-record-data-modern-organisms-as-evidence-for-evolution-questions.html]
	*Scaffolds for Communicating through Explanation* Provide scaffolds for explaining phenomena (e.g., sentence frames, graphic organizers, norms for whole class discussion, roles for students during small group activities) to support	• Anatomical Evidence of Evolutionary Relationships – This lesson by *The Wonder of Science* provides the data and framework for students to write a claim, support with evidence, and give their reasoning about the anatomical evidence supporting evolution.

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Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	communicating in science-specific ways that may seem unnatural for students.	[https://docs.google.com/document/d/1yxBPLfH13Aj5YDWRDw3L-9_ALISr9x6OHFqBGiui0gM/template/preview?pli=1] • Misconceptions About Evolution – This website contains lists of misconceptions about evolution and includes links to supporting data that can be used as a teacher key. The items in the list can be used as research/essay topics to offer students an opportunity to use evidence to support an explanation. [https://evolution.berkeley.edu/teach-evolution/misconceptions-about-evolution/] • National Science Foundation – Tools for Ambitious Science Teaching – This website discusses a tool that provides scaffolds for writing that support learners in constructing explanations with evidence. These take the form of sentence frames, guides for how to help English learners practice final explanations, norms for whole-class discussion that are developed by students, roles that students can take in small group activities, and others. [https://ambitiousscienceteaching.org/orientation-ambitious-science-teaching/] • Model Teaching – CER Checklist and Graphic Organizer – This site provides an introduction to Claim-Evidence-Reasoning (CER), downloadable resources, and writing templates. [https://www.modelteaching.com/education-articles/writing-instruction/claim-evidence-reasoning-cer]

Instructional Strategies and Resources for Performance Category 1: Support Explanations About Organisms That Lived Long Ago

Task 1, Prompt 1, Parts A & B (4 points); Task 1, Prompt 3, Parts A&B (3 points); Task 2, Prompt 2, Part A (3 points); Task 3, Prompt 3, Part A (3 points)

Instructional Strategies and Resources

	Teaching Strategies	***Resources***
	*Expressing Learning in Multiple Modalities* Provide multiple, flexible options for students to support explanations about organisms that lived long ago. • Use technologies that facilitate student participation and communication, such as discussion boards, podcasts, or blogs. • Allow students to choose a multi-modal project they would like to complete to demonstrate their learning, such as a poster presentation, debate, short film, lab report, blog, infographic, drawing, poetry, writing and performing a song, creating a game, etc. • Provide a variety of ways in which students can "write" to respond to questions (e.g., traditional form of writing, with sentence starters, using pictures, etc.)	• 1001 Writing Prompts About Fossils – This webpage provides a list of creative writing prompts that may be used or adapted for use by students to demonstrate their understanding of the topic. [https://commaful.com/blog/prompts/1001-writing-prompts-about-fossils/] • 10 Great Ways for Students to Research and Present Information – This article includes a few unique methods of presentation, such as "wax museum" and "pyramids." [https://lovinglanguagearts.com/10-great-ways-for-students-to-research-and-present-information/] • Science Notebook Corner – This website offers a variety of topics relating to students using science notebooks for lab reports, journaling, drawing, planning, and creative writing. [https://aptv.pbslearningmedia.org/collection/science-notebook-corner/] • The Secret to Great Middle School Presentations – This article offers tips to make presentations less formal and more enjoyable to students. [https://www.edutopia.org/article/secret-great-middle-school-presentations/]

Performance Category 2: Analyze Data to Explain the Appearance of Specific Traits in Populations

Interpretive Guidance for Performance Category 2: Analyze Data to Explain the Appearance of Specific Traits in Populations *Task 2 Prompt 1 (4 points); Task 3 Prompt 1 (4 points); Task 3 Prompt 3 (3 points); Task 3 Prompt 2 (3 points)*		
Red (0-5 score points earned) ➢ **Extensive** additional instruction and reteaching of these skills is recommended. ➢ The student needs significant opportunities to reinforce and apply these skills in future learning.	**Yellow (6-9 score points earned)** ➢ **Moderate** additional instruction on these skills is recommended. ➢ The student needs additional opportunities to strengthen these skills in future learning.	**Green (10-14 score points earned)** ➢ **Minimal to no** additional instruction on these skills is recommended. ➢ The student is ready to extend these skills in future learning.
What These Results Mean		
This student is likely able to: • **Attempt to** plot and utilize data to develop an **incomplete and/or inaccurate** description of a change in an observable trait over time. • Use **some** data as evidence to support a **partial conclusion** about which trait is most adaptive to a specific environmental change. • Use information from a general codon table with **little or no accuracy** to explain the effects of a mutation on the resulting protein and traits of an organism. • **Attempt to** utilize information to identify a difference in the process of mutation and natural selection.	**This student is likely able to:** • **Plot** data **with minor inaccuracies** to develop a description of a change in an observable trait over time. • **Attempt with minor errors** to communicate information obtained from graphs to explain the cause-and-effect relationship between the patterns of change in anatomical structures and environmental factors. • Use information from a general codon table to explain the sequence of events leading to a mutation on a protein and the resulting traits of an organism with **minor** errors. • **Correctly** utilize information to develop a **partial** explanation of the differences between the mechanisms of mutations as compared to natural selection.	**This student is likely able to:** • **Accurately plot and interpret** data to identify and describe patterns of change in an observable trait over time. • **Correctly** utilize data to **develop complete and accurate** explanations of the specific selective pressure driving an observable change in traits over time. • **Accurately** use information from a general codon table to explain the sequence of events leading to a mutation on a protein and the resulting traits of an organism using correct scientific terms. • Utilize multiple sources of information to develop **an accurate and complete** explanation of the differences between the mechanisms resulting in mutations as related to natural selection.

Interpretive Guidance for Performance Category 2: Analyze Data to Explain the Appearance of Specific Traits in Populations *Task 2 Prompt 1 (4 points); Task 3 Prompt 1 (4 points); Task 3 Prompt 3 (3 points); Task 3 Prompt 2 (3 points)*		
Red (0-5 score points earned) ➢ **Extensive** additional instruction and reteaching of these skills is recommended. ➢ The student needs significant opportunities to reinforce and apply these skills in future learning.	**Yellow (6-9 score points earned)** ➢ **Moderate** additional instruction on these skills is recommended. ➢ The student needs additional opportunities to strengthen these skills in future learning.	**Green (10-14 score points earned)** ➢ **Minimal to no** additional instruction on these skills is recommended. ➢ The student is ready to extend these skills in future learning.
Next Instructional Steps		
Provide opportunities for the student to: • Match various graphical displays (line graphs, bar graphs, pictographs, and/or pie charts) to provided data sets to identify and, with support, describe patterns related to change in an observable trait of a species over time. • Plot a few data points on a line or bar graph on a provided labeled graph to show change in an observable trait over time (e.g., height, weight). • With guided support, practice how to use a general codon chart/wheel for a given codon to determine the amino acid used to code that codon. • Use a codon table to identify mutations for different codons that cause a changed amino acid sequence in the resulting protein.	**Provide opportunities for the student to:** • Analyze provided data sets and various graphical displays related to a given phenomenon using written or oral procedural supports as needed to describe patterns related to changes in observable traits in multiple species over time. • Plot multiple data points on a line graph or bar graph to show change in an observable trait over time (e.g., height, weight). • Use information from a general codon chart/wheel to identify and sequence correct statements from a list of statements written in grade-level academic terms to explain the sequence of events leading to a mutation on a protein and the resulting traits of an organism • Sort provided statements and examples of mutation and natural selection to write an explanation of the differences between the	**Provide opportunities for the student to:** • Use and/or create graphical displays (charts, graphs, and/or tables) of large data sets to describe multiple patterns related to changes in observable traits of multiple and varied populations over time. • Research scientific scenarios to explain how evidence can or cannot support a conclusion about genetic factors in a species. • Explain why the genetic code for protein synthesis can, with minor exceptions, be applied to all species • Research how the genetic code of life was discovered and identify resulting questions or wonderings related to the cells of humans, plants, and microbes and how other biological processes work to help them stay alive and function properly

• Collaboratively discuss the effects of a mutation on a resulting protein and traits of an organism. • Discuss and compare the concepts and examples of mutation (variation in an organism) and natural selection (favorable traits to survive and reproduce).	mechanisms of mutations as compared to natural selection.	

Interpretive Guidance for Performance Category 2:
Analyze Data to Explain the Appearance of Specific Traits in Populations

Task 2, Prompt 1 (4 points); Task 3, Prompt 1, (4 points); Task 3, Prompt 2 (3 points); Task 3, Prompt 3 (3 points)

Instructional Strategies and Resources

	Teaching Strategies	***Resources***
	*Data Analysis through Discourse* Provide varied opportunities (stations, small groups, partners, whole class) for students to engage in an interactive discourse where they build on ideas to optimize the use of a range of tools for tabulation, graphical representation, visualization, and statistical analysis to analyze and interpret data. Opportunities for scientific discourse should be situated in authentic, interest-driven science investigations.	Use any of the resources about generating scientific discourse with any of the resources about changes in traits over time to design a collaborative opportunity for students to engage with real data about changing populations. ***Discussion Tools:*** • The Dialog Toolkit – This toolkit provides self-facilitated ways for students to engage with stimuli. Students can use the strategies listed to start engaging with provided data. [https://pz.harvard.edu/sites/default/files/DigDil%20and%20OOEL%20Dialogue%20Toolkit.pdf] ***Data Sources:*** • The Evolution of Kangaroos – This video [3:43] by *PBS* presents information for students to discuss. The data is being used to explain the evolution of kangaroos in Australia. [https://wyoming.pbslearningmedia.org/resource/nvaus.sci.bio.kangaroos/the-evolution-of-kangaroos/] • Genetic Drift Lab – This lesson includes a *Genetic Drift* portion for students to complete. Ask students to explain how future populations would be different from the original if their small group of six candies was cut off from the rest of the population. [https://teaching.betterlesson.com/lesson/637446/genetic-drift-lab?from=mtp_lesson]

Interpretive Guidance for Performance Category 2: Analyze Data to Explain the Appearance of Specific Traits in Populations *Task 2, Prompt 1 (4 points); Task 3, Prompt 1, (4 points); Task 3, Prompt 2 (3 points); Task 3, Prompt 3 (3 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	*Critiquing and Refining Data Interpretation* Use spoken and written examples to model scientific interpretation of data, including significant features and observable patterns and/or relationships between variables by identifying strengths and weaknesses such as sources of error.	• Tuskless African Elephants – This task provides practice interpreting data from multiple sources about the changes in the African Elephant populations. [https://docs.google.com/document/d/1MgXpoAD8PUq25iDKkIIwfIBTAi5CNAVWZkqBDsSrYN8/template/preview] • Killer Microbe – This video [5:13] by *PBS* can be used to analyze the data collected about how the microbe developed antibiotic resistance. Identify sources of error that the scientist performing the study could have introduced. [https://nebraskapublicmedia.pbslearningmedia.org/resource/biot09.biotech.concpt.kmicrobe/killer-microbe/]
	*Determining Relevant Data Needed for Particular Conclusions* Foster data interpretation and inform inferences by highlighting the utility and relevance of learning and to demonstrate that relevance through authentic, meaningful activities.	• Evolution Lab – This interactive (continued in the "Expressing Conclusions" section) allows students to see the relationship between organisms and the traits that those organisms share through their evolutionary history. [https://www.pbs.org/wgbh/nova/labs//lab/evolution/research#/evo/deeptree] • Trouble at Grainly Farms – This interactive (continued in the "Highlighting Patterns in Data" section) allows students to draw conclusions about what is happening to the soybeans at Grainly Farms. [https://nebraskapublicmedia.pbslearningmedia.org/resource/trouble-at-grainly-farms/grainly-farms/]

Interpretive Guidance for Performance Category 2: Analyze Data to Explain the Appearance of Specific Traits in Populations *Task 2, Prompt 1 (4 points); Task 3, Prompt 1, (4 points); Task 3, Prompt 2 (3 points); Task 3, Prompt 3 (3 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	***Highlight Patterns in Data that Identify Critical Features*** Draw students' attention to patterns in provided data sets that support the identification of important features of the data over less important features of the data.	• Nebraska Deer Mouse – This PDF provides varying sources of data that can be used to determine the mechanism responsible for varying colors in Nebraska mice. [https://docs.google.com/document/d/1eVagnAIGqv9681Kn8qwnlBRbcELRrMqkmtsHWq8a2Ek/template/preview] • Trouble at Grainly Farms – This is the interactive (continued from the "Determining Relevant Data" section). As a student makes progress through the interactive, draw attention to data features that are relevant and not relevant to the solution. [https://nebraskapublicmedia.pbslearningmedia.org/resource/trouble-at-grainly-farms/grainly-farms/]
	***Maximize Transfer and Generalization by Scaffolding Data Analysis*** Use scaffolding to interpret data by highlighting patterns, critical features, big ideas, and relationships between objects that help connect new information to previously learned information.	• A Mutation Story – This video [4:49] about sickle cell anemia can be used to compare this mutation in the human population to mutations that have occurred in other species. [https://nebraskapublicmedia.pbslearningmedia.org/asset/tdc02_vid_mutatestory/] • Cause and Effect Data Tool – This graphic organizer can be used to help students explain the cause-and-effect relationships between the data that they see on evolution and natural selection. [https://static1.squarespace.com/static/59c3bad759cc68f757a465a3/t/5b50e006352f5381b3315075/1532026886593/Cause+Effect.pdf]

Interpretive Guidance for Performance Category 2: Analyze Data to Explain the Appearance of Specific Traits in Populations *Task 2, Prompt 1 (4 points); Task 3, Prompt 1, (4 points); Task 3, Prompt 2 (3 points); Task 3, Prompt 3 (3 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	*Activate Prior Knowledge* Ask questions and provide resources that connect current learning to learning that may or may not have taken place in 3rd grade. Provide relevant background information for students when prior learning does not exist.	• Heredity: Who Are You? – This video [5:54] reviews the basis of heredity and how traits are passed from parents to offspring. Stop playing the video at [4:57]. [https://nebraskapublicmedia.pbslearningmedia.org/resource/heredity-who-are-you-science-trek/heredity-who-are-you-science-trek/] • Reproduction: One Goal, Two Methods – This interactive can be used to review the pros and cons of two types of reproduction. Draw students' attention to how the genes and traits are passed between parents and offspring. [https://lsintspl3.wgbh.org/en-us/lesson/midlit10-sci-splrepro/1] • I Love My Traits – This video [3:25 but stop at 2:04] (will be continued in the Expressing Conclusions section) can be used to review traits and how traits are inherited throughout generations of a family. Although designed for elementary school, the content is appropriate for middle school. [https://nebraskapublicmedia.pbslearningmedia.org/resource/i-love-my-traits-video/rise-and-shine-science-time/]
	*Communicating Conclusions of Data Analysis* Provide scaffolds for analyzing and interpreting data to be used as evidence to support scientific conclusions to explain a phenomenon or support a design solution (e.g., sentence frames, graphic organizers, norms for whole class discussion, roles for students during small group activities) to support	• Analyzing and Interpreting Data Tool – This graphic organizer can be used to help students compile and organize data collected during an investigation and then analyze and interpret the data. [https://drive.google.com/file/d/1__JPpQ9VtWKbrFTAEHTslQABaQefuBNX/view]

Interpretive Guidance for Performance Category 2: Analyze Data to Explain the Appearance of Specific Traits in Populations *Task 2, Prompt 1 (4 points); Task 3, Prompt 1, (4 points); Task 3, Prompt 2 (3 points); Task 3, Prompt 3 (3 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	communicating in science-specific ways that may seem unnatural for students.	• Engaging in Argument from Evidence – This graphic organizer can be used to help students formulate an argument using evidence in the form of data that has been analyzed and interpreted. [https://drive.google.com/file/d/1vn_TCsdAm0dD7UmKKFHlSyOP99P1qPyn/view]
	*Expressing Conclusions from Data Analysis in Multiple Modalities* Provide multiple, flexible options for students to communicate their results and present data evidence to support their conclusions and learning in class. • Use technologies that facilitate student participation and communication, such as discussion boards, podcasts, or blogs. • Allow students to choose a multi-modal project they would like to complete to demonstrate their learning, such as a poster presentation, debate, short film, lab report, blog, infographic, drawing, poetry, writing and performing a song, creating a game, etc. • Provide a variety of ways in which students can "write" to respond to questions (e.g., traditional form of writing, with sentence starters, using pictures, etc.)	• Evolution Lab – Once students have explored the interactive (continued from the Determining Relevant Data section), have students choose two species and complete a multimedia project to communicate how those two organisms are related. Students should pay attention to the traits that the organisms share and traits that distinguish between the two species. [https://www.pbs.org/wgbh/nova/labs//lab/evolution/research#/evo/deeptree] • I Love My Traits – Watch this video [3:25 but start at 2:04], continue from the Activating Prior Knowledge section) to have students compare their traits with the traits of one of their family members. [https://nebraskapublicmedia.pbslearningmedia.org/resource/i-love-my-traits-video/rise-and-shine-science-time/]

Performance Category 3: Use Models to Describe Rock Formations and Fossils

Interpretive Guidance for Performance Category 3: Use Models to Describe Rock Formations and Fossils *Task 1 Prompt 1, Part A (2 points); Task 1, Prompt 2, Parts A & B (3 points)*		
Red (0-1 score points earned) ➢ **Extensive** additional instruction and reteaching of these skills is recommended. ➢ The student needs significant opportunities to reinforce and apply these skills in future learning.	**Yellow (2-3 score points earned)** ➢ **Moderate** additional instruction on these skills is recommended. ➢ The student needs additional opportunities to strengthen these skills in future learning.	**Green (4-5 score points earned)** ➢ **Minimal to no** additional instruction on these skills is recommended. ➢ The student is ready to extend these skills in future learning.
What These Results Mean		
This student is likely able to • Use a model to develop **an incomplete and/or inaccurate** conclusion related to Earth's history **and** ancient organisms. • Use a model to sequence and/or describe evolutionary relationships with **multiple** errors.	**This student is likely able to:** • Use a model to develop a **partial and accurate** conclusion related to Earth's history **and** ancient organisms. • Use information to sequence the components of a model **and/or** use the model to support a description related to organisms and their changes over time.	**This student is likely able to:** • Use a model to develop a **complete and accurate** conclusion related to Earth's history **and** ancient organisms. • Use information to **correctly** identify **and accurately** sequence the components of a model to support a **complete** description related to organisms and their changes over time.

Interpretive Guidance for Performance Category 3: Use Models to Describe Rock Formations and Fossils *Task 1 Prompt 1, Part A (2 points); Task 1, Prompt 2, Parts A & B (3 points)*		
Red (0-1 score points earned) ➢ **Extensive** additional instruction and reteaching of these skills is recommended. ➢ The student needs significant opportunities to reinforce and apply these skills in future learning.	**Yellow (2-3 score points earned)** ➢ **Moderate** additional instruction on these skills is recommended. ➢ The student needs additional opportunities to strengthen these skills in future learning.	**Green (4-5 score points earned)** ➢ **Minimal to no** additional instruction on these skills is recommended. ➢ The student is ready to extend these skills in future learning.
Next Instructional Steps		
Provide opportunities for the student to: • Collaboratively discuss and chart characteristics of fossils and their similarities to living species to select from a list of ecosystems in which each fossil was formed. • Pair representations of fossils to the type of ecosystem in which each fossil was formed. • Describe and compare features of groups of related fossils. • Order additional components of a partially completed model to correctly show the ancestral relationships between fossils. • Using a completed, simple model showing changes in an organism over time (fossil record to modern-day species), circle and describe similar anatomical features and select a correct statement indicating a pattern corresponding to the sequence.	**Provide opportunities for the student to:** • Compare models of ancient animal and plant fossils to modern-day animals and plant species to identify similarities and differences in their features. • Use features of ancient fossils to select an ecosystem in which a fossil would have lived. • Complete a partial conclusion related to Earth's history and ancient organisms using evidence from provided models of fossils. • Practice ordering additional components of a partially completed model to correctly represent the sequence of anatomical changes of extinct organisms over time. • Given a correctly sequenced model showing the changes in anatomical features of multiple fossils to a modern-day species, collaboratively discuss and identify at least	**Provide opportunities for the student to:** • Create models of geologic columns by forming and arranging rock layers from oldest to youngest using common materials for a particular environment. • Correlate fossil evidence in similar rock layers at different locations to describe changes through geologic time. • Research stratified rock in your local environment to describe how the environment has changed over time and consider what types of animals and plants may have lived during each layer. • Research how engineers use rock strata to design foundations for large structures and how rock strata influence the type and depth of the foundations.

	two statements indicating patterns corresponding to the sequence.	

Instructional Strategies and Resources for Performance Category 3: Use Models to Describe Rock Formations and Fossils *Task 1, Prompt 1, Part A (2 points); Task 1, Prompt 2 Parts A & B (points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	*Modeling through Discourse* Provide varied opportunities (stations, small groups, partners, whole class) for students to engage in interactive discourse where they build on others' ideas to optimize the use of a range of models to understand Earth's history through rock formation and fossil evidence. Opportunities for scientific discourse should be situated in authentic, interest-driven science investigations.	• Promoting Discourse in Science Class – An article that outlines the differences between discourse and science discourse in promoting the need for students to draw on their funds of knowledge to explain science. This article emphasizes the idea that there is more than just one right answer to a question, and making this shift puts students as active participants in their learning. [https://knowledge.carolina.com/professional-growth/promoting-discourse-in-science-class/] • Mass Extinctions Past...and Present! – This lesson plan and data set will get students talking and interacting with data to model relationships between fossil history and time scale. [https://about.dataclassroom.com/ready-to-teach/mass-extinctions-pastand-present] • STEM Teaching Tools – Practice Brief 48 – This article discusses how teachers can use tools to scaffold student science talk and includes "Talk Resource Tools" to foster shifts in science classroom talk. [https://stemteachingtools.org/brief/48] • Talk Activities Flowchart – This flowchart can help structure activities so that students' talk is more equitable, scientific, and focused on sensemaking in support of a classroom culture based on curiosity and learning. [https://stemteachingtools.org/sp/talk-flowchart]

Instructional Strategies and Resources for Performance Category 3: Use Models to Describe Rock Formations and Fossils *Task 1, Prompt 1, Part A (2 points); Task 1, Prompt 2 Parts A & B (points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	*Foster Community and Collaboration through Modeling* Increase support for engagement and structured collaboration when discussing using and developing models. • Create expectations for productive group work and discussion. • Encourage opportunities for synthesis and whole group consensus of models. • Provide support opportunities for peer interactions. • Construct clear responsibilities through scaffolds for inquiry of work with models.	• Talk Science Primer – This TERC article describes what elements are needed for a productive talk in the classroom and outlines goals that increase the student's ability to share, expand, and clarify their own thoughts, listen carefully to one another, deepen their reasoning, and help students engage with others during reasoning. [https://inquiryproject.terc.edu/shared/pd/TalkScience_Primer.pdf] • Introduction to Model-based Inquiry and Practical Work – This article examines lesson integration of scaffolds, small group discussion, and model-based inquiry. [https://www.nuffieldfoundation.org/sites/default/files/files/Introduction%20to%20model-based%20inquiry.pdf] • Tools - Face to Face – A family of tools to help students construct and revise evidence-based explanations and models for complex phenomena. [https://ambitiousscienceteaching.org/tools-face-to-face/] • Layers of Time | AMNH – This single-page fossil game has interactive rock layers and three levels of difficulty. A brief instructional video is included. [https://www.amnh.org/explore/ology/paleontology/layers-of-time2]

Instructional Strategies and Resources for Performance Category 3: Use Models to Describe Rock Formations and Fossils *Task 1, Prompt 1, Part A (2 points); Task 1, Prompt 2 Parts A & B (points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	*Modeling and Critiquing Scientific Models* Use spoken and written examples to model how to evaluate and refine models comparing predictions with the real world and encourage students to adjust and refine the model by identifying strengths and weaknesses in the model to explain Earth's history and fossils.	• Models: Bringing Real-World Phenomena to School – This article demonstrates how teachers can use real-world phenomena to highlight the importance and limits of scientific models. [https://smithsonianstc.com/models-bringing-real-world-phenomena-to-school-whitepaper/] • Models, Critique, and Descriptive Feedback – Build a culture that promotes agency by critiquing and giving descriptive feedback. Use this website to get ideas for examining models that make standards real and tangible and strategies for analyzing models and generating quality feedback. [https://pblife.edublogs.org/2016/03/20/68-models-critique-descriptive-feedback/] • How to Make a Good Scientific Model – This brief article offers a simple way to begin critiquing student models. It includes a "Good Model" checklist. [https://knowledge.carolina.com/discipline/earth-environmental/how-to-make-a-good-scientific-model/] • Practice Makes Progress: Critiques in the Science Classroom – A [6:32] video example of elementary students is used to explain the critique process of scientific models. In the video, students and teachers are taught to use student work to facilitate thinking for revisions and the importance of multiple drafts to get the results that are needed. [https://www.jessicafriesgaither.com/single-post/practice-makes-progress-critiques-in-the-science-classroom]

Instructional Strategies and Resources for Performance Category 3: Use Models to Describe Rock Formations and Fossils *Task 1, Prompt 1, Part A (2 points); Task 1, Prompt 2 Parts A & B (points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		• Modeling in Science Instruction – This NSTA article gives feedback stems for models when critiquing other students' work. It also gives guidance about the revision process and examples of how the teacher uses models during her unit of instruction. [https://www.nsta.org/blog/modeling-science-instruction]
	*Scaffolds, Feedback, and Strategies to Assist Learners Making Models* Students understanding modeling and how to model is a meta-cognitive processing activity that requires students to predict and depict information they have never seen. Use scaffolds and feedback to teach this meta-cognitive process. • Provide scaffolds and guidance to "chunk" information about how to model. • Give prompts for organization methods and feedback that support information processing in models. • Provide strategies for multiple entry points to modeling with optional pathways to explore how to express their conceptual understandings.	• Engaging Students in Scientific Practices: What does constructing and revising models look like in the science classroom? – This article provides an in-depth look at the scientific practice of developing, evaluating, and revising scientific models to explain and predict phenomena and what that means for classroom teaching. More importantly, it breaks down the steps in teaching modeling to "chunk" relevant parts of a model to help students depict what they imagine about things we cannot see. [https://static.nsta.org/ngss/resources/201203_Framework-KrajcikAndMerritt.pdf] • Developing and Using Models – This video explains the importance of modeling in science and engineering to explain phenomena. Here, students will be able to understand different models and what they are used for to assist them in choosing the right type of model. [https://www.bozemanscience.com/ngs-developing-using-models] • What is Meant by Engaging Youth in Scientific Modeling? – This STEM teaching tool explains how helping students develop and

Instructional Strategies and Resources for Performance Category 3: Use Models to Describe Rock Formations and Fossils *Task 1, Prompt 1, Part A (2 points); Task 1, Prompt 2 Parts A & B (points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		test models supports their learning and helps them understand important aspects of how science and engineering work. [https://stemteachingtools.org/brief/8] • Developing and Using Models – Mini Lesson – Level 1 – This mini-lesson introduces an example with practice slides and a student worksheet to help students understand how to create a model of a gear board. [https://thewonderofscience.com/mlsep21] • Developing and Using Models – Mini Lesson – Level 2 – This mini-lesson introduces an example with practice slides and a student worksheet to help students understand how to create a model of an oddly stable red block and then a colored cube sort. [https://thewonderofscience.com/mlsep22] • Developing and Using Models – Mini Lesson – Level 3 – This mini-lesson introduces an example with practice slides and a student worksheet to help students understand how to create a model of a complex gearbox and then a can opener opening a can. [https://thewonderofscience.com/mlsep23]
	***Presenting Information in Different Modalities*** Provide information using a variety of multimedia (e.g., videos, interactives, simulations), informational texts, and formats to teach and reinforce disciplinary core ideas related to a scientific phenomenon involving Earth history and fossils.	• Climate Change in the Fossil Records - Prehistoric Road Trip – This "Prehistoric Road Trip" allows students to examine evidence in rock layers of worlds of ecosystems of the past and the implications of our actions of today can impact our future by looking at how ancient ecosystems changed over time. [https://nebraskapublicmedia.pbslearningmedia.org/resource/video-climate-change-in-the-fossil-record/prehistoric-road-trip/]

Instructional Strategies and Resources for Performance Category 3: Use Models to Describe Rock Formations and Fossils *Task 1, Prompt 1, Part A (2 points); Task 1, Prompt 2 Parts A & B (points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		• Radioactive Dating Game - Dating Game – This Phet activity on the fourth tab allows students to explore different rock layers with a probe and investigate the half-lives of fossils or objects. Students are able to estimate the age of the fossils and evaluate a graph to help them solve problems. [https://phet.colorado.edu/en/simulations/radioactive-dating-game] • Fish Out of Water – This interactive simulation allows students to view the transitional fossils, which provide scientists with evidence to establish how major animal groups are related to one another in evolutionary terms. Students explore an ancient organism and recently discovered fossil named *Tiktaalik*. [https://rmpbs.pbslearningmedia.org/resource/midlit10.sci.spltransition/tiktaalik-a-fish-out-of-water/] • What Major Changes Mark Earth's Fossil Record? – This online text investigates what major events mark Earth's fossil record. It includes activities and questions. [https://grade8science.com/5-4-1-what-major-changes-mark-earths-fossil-record/] • Fossilization - How Fossils Form – This website provides various types of resources, including videos, lessons, activities, science articles, and subject guides related to how bones fossilize. [https://naturalhistory.si.edu/education/teaching-resources/paleontology/fossilization-how-fossils-form#lifescience]

Instructional Strategies and Resources for Performance Category 3: Use Models to Describe Rock Formations and Fossils *Task 1, Prompt 1, Part A (2 points); Task 1, Prompt 2 Parts A & B (points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	*Maximizing Transfer of Information* Provide information in a manner that guides learners and supports generalization and transfer of knowledge by employing explicit strategies such as accessing prior knowledge, embedding it in familiar contexts, using mnemonic devices, applying it to new situations, and using graphic organizers.	• Megafauna Extinction: Humans or Climate – This [3:38] video can be used to have the student apply their understanding to a new situation about megafauna with an engaging video. [https://thewonderofscience.com/phenomenon/2018/5/13/megafauna-extinction-humans-or-climate] • Rock and Fossil Patterns Graphic Organizer – This graphic organizer from *Wonder of Science* can be used with any rock layer graphic and have them analyze patterns. [https://static1.squarespace.com/static/59c3bad759cc68f757a465a3/t/5e1e7f7d48c1600b960a7054/1579057024053/4-ESS1-1+Rock+and+Fossil+Layers+%28Student+Version%29.pdf] • Activating Prior Knowledge – This website provides ideas and strategies to activate students' thinking about their prior knowledge about a topic before engaging in a conceptual model. [https://teaching.vt.edu/teachingresources/adjustinginstruction/priorknowledge.html] • 10 Strategies and Tools to Activate Knowledge – This article by *The Teaching Factor* offers ten strategies and modalities for accessing students' prior knowledge. [https://theteachingfactor.wordpress.com/2021/08/24/10-strategies-and-tools-to-activate-knowledge/] • Learning by Inquiry – This website offers methods to activate prior knowledge by using a constructivist mindset to help learners integrate new information.

Instructional Strategies and Resources for Performance Category 3: Use Models to Describe Rock Formations and Fossils *Task 1, Prompt 1, Part A (2 points); Task 1, Prompt 2 Parts A & B (points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		[https://www.learningbyinquiry.com/simple-strategies-to-activate-students-prior-knowledge/] • Increasing the Value of Graphic Organizers – This *Edutopia* article explains the importance of allowing students to take ownership of learning by creating their own graphic organizers. [https://www.edutopia.org/article/increasing-value-graphic-organizers/]
	***Build Fluencies with Graduated Levels of Support for Practice and Performance*** Provide differentiated models and investigations for rock formations and fossils as well as scaffolds, supported opportunities, and degrees of freedom for more independence to students of varying ability levels.	• Adventures at Dry Creek – This interactive webpage offers individual explorers the opportunity to embark on an exciting scientific adventure based upon ongoing research of UC paleontologists studying life in Montana 60-70 million years ago. (Click on the highlighted character in the scenario to learn and make progress.) [https://ucmp.berkeley.edu/education/explorations/tours/Trex/index.html] • Mission 2 - Fossils: Rocking the Earth – This webpage contains seven interactive activities with graphics, animations, clicks and space for students to explain their thinking about real world examples of fossils changing the way we think about ancient organisms. [https://lsintspl3.wgbh.org/en-us/lesson/nved-il-evolab-m2/?as_guest=True&next=https://nebraskapublicmedia.pbslearningmedia.org/resource/nvev-sci-mission2/nova-evolution-lab-interactive-lesson-mission-2/]

Instructional Strategies and Resources for Performance Category 3: Use Models to Describe Rock Formations and Fossils *Task 1, Prompt 1, Part A (2 points); Task 1, Prompt 2 Parts A & B (points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		• Earth History and Clues from Fossils – This brief online tutorial on the history of Earth includes two videos: a [5:23] *Science Show* video, "The Oldest Fossils Ever Found" with review questions and an EXPLORE MORE OPTION *Smithsonian Education* [5:06] video, "Clues to the End-Permian Extinction", also with a summary and questions. [https://flexbooks.ck12.org/cbook/ck-12-middle-school-earth-science-flexbook-2.0/section/15.3/primary/lesson/earth-history-and-clues-from-fossils-ms-es/?referrer=search]
	*Scaffolds for Communicating through Models* Provide scaffolds for developing models to explain phenomena (e.g., sentence frames, graphic organizers, norms for whole class discussion, roles for students during small group activities) to support communicating in science-specific ways that may seem unnatural for students.	• Grand Canyon Mystery – This graphic organizer provides the framework for students to make an argument from evidence in models of rock layers and fossil evidence. [https://docs.google.com/document/d/1WaQLmXsCkf9CN6EeHvBbgLUnnax0PAjaBr46X91JB3E/template/preview] • A Dinosaur Apocalypse – This graphic organizer provides the framework for students to make an argument from evidence in using models of rock layers and Earth's history. [https://docs.google.com/document/d/1RDUqmyz5D4t-DZZjqKIQuqS-CcKZUD9MsgtB4Ro3dAU/template/preview] • Developing and Using Models – This article from *MPRES Toolkit for Teachers Conceptual Change* includes a "Developing and Using Models" video from *Bozeman Science*, links to activities and guiding questions. [http://www.mtscienceeducation.org/toolkit-home/scientific-engineering-practices/developing-and-using-models/]

Instructional Strategies and Resources for Performance Category 3: Use Models to Describe Rock Formations and Fossils *Task 1, Prompt 1, Part A (2 points); Task 1, Prompt 2 Parts A & B (points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		• National Science Foundation – Tools for Ambitious Science Teaching – This website discusses a tool that provides scaffolds for writing that support learners in constructing explanations with evidence. These take the form of sentence frames, guides for how to help English learners practice final explanations, norms for whole-class discussion that are developed by students, roles that students can take in small group activities, and others. [https://ambitiousscienceteaching.org/orientation-ambitious-science-teaching/] • Model Teaching – CER Checklist and Graphic Organizer – This site provides an introduction to Claim-Evidence-Reasoning (CER), downloadable resources, and writing templates. [https://www.modelteaching.com/education-articles/writing-instruction/claim-evidence-reasoning-cer]
	*Expressing Learning in Multiple Modalities* Provide multiple, flexible options for students to communicate their models and learning in class. • Use technologies that facilitate student participation and communication, such as discussion boards, podcasts, or blogs. • Allow students to choose a multi-modal project they would like to complete to demonstrate their learning, such as a poster presentation, debate, short film, lab report, blog,	• Virtual Collection-Digital Atlas of Ancient Life – This webpage by *Paleontological Research Institution* provides models of over 635 fossils to help people learn more about their fossil discoveries and the history of life. [https://www.digitalatlasofancientlife.org/vc/] • BioRender - Building Scientific Models – This website allows students to build scientific models for presentation with tools that are meant for expressing scientific thinking. [https://www.biorender.com/features?utm_source=google&utm_medium=cpcsearch&utm_campaignname=23_Search_NA_NB_Design_Software&signup_referral=23_Search_NA_NB_Desig

Instructional Strategies and Resources for Performance Category 3: Use Models to Describe Rock Formations and Fossils *Task 1, Prompt 1, Part A (2 points); Task 1, Prompt 2 Parts A & B (points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	infographic, drawing, poetry, writing and performing a song, creating a game, etc. • Provide a variety of ways in which students can "write" to respond to questions (e.g., traditional form of writing, with sentence starters, using pictures, etc.)	n_Software&utm_content=nb=&utm_term=scientific%20presentation%20templates&gad_source=1&gclid=Cj0KCQiAwbitBhDIARIsABfFYIIHQ6EjrmsAxbJSpGWF4VnbxyTRM4ccsMdGUVFPr4-qwqBsQj19Zk8aAofFEALw_wcB] • Make a Model Fossil – An investigation activity where students gather materials from outdoors to create a model of a fossil. Students will discuss the differences between a "cast" model fossil and a "mold" to better understand rock formation and fossils. [https://serc.carleton.edu/sp/mnstep/activities/27092.html] • Science Notebook Corner – This website offers a variety of topics relating to students using science notebooks for lab reports, journaling, drawing, planning, and creative writing. [https://aptv.pbslearningmedia.org/collection/science-notebook-corner/] • Venngage Infographic Maker – This free, user-friendly infographic-building website allows students to create visually appealing displays to present their projects. [https://venngage.com/blog/infographics-maker?utm_source=google&utm_medium=cpc&utm_campaign=&utm_content=&utm_term=infographic%20maker&match=e&campaignid=19558960020&adgroupid=143879091486&gad=1&gclid=CjwKCAjws9ipBhB1EiwAccEi1HuNZdgWNz4MdFj26NlUeiZMHVMp994nWi-pG7DVaMZCbJxCgBjIOxoChWMQAvD_BwE]