Stackable Instructionally-embedded Portable Science (SIPS) Assessments Project

Grade 8 Science

Unit 3 Instructional Framework

Understanding Earth History and the Origin of Species

June 2023

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Unit 3 Overview

Storyline Synopsis:

This unit has four segments that engage students in multiple science and engineering practices and crosscutting concepts as students make sense of the key disciplinary ideas of natural selection, adaptation, evidence of common ancestry and diversity, inheritance and variation of traits, and history of planet Earth.

- **Instructional Segment 1:** By engaging in the practices of developing and using models, obtaining, evaluating, and communicating information, constructing explanations, and the use of mathematical and computational thinking, students learn about the importance of fossil records and understanding the geological timescale in relation to rock strata and existence of modern life forms as seen from evidence obtained from Earth's history. Students begin the unit by exploring an anchor phenomenon based on choosing a particular organism from an online database of fossil records around the world. Possible driving questions include: "How can we investigate the ancestors of our organism? How did these organisms get here?" This phenomenon is revisited in the segment as students learn more about the origin of their fossil of choice. The segment culminates with students placing various events from Earth's history on a geological time scale.

- **Instructional Segment 2**: By engaging in the practices of analyzing and interpreting data, obtaining, evaluating, and communicating information, and constructing explanations, students look for patterns in various fossil records and relate them to modern life forms. Using cladograms and major events from Earth's history and nearby fossil records of other organisms, students look back and forward in time to gather information about how the world changed and identify how those changes impacted the ancestors and descendants of their organisms. They also reconstruct fossil pieces of an organism to get an idea of how the organism looked. At the end of the segment, students collect and organize the evidence they have gathered related to their own fossil record into a single document that explains how anatomical similarities and differences act as evidence to support evolutionary relationships.

- **Instructional Segment 3:** By engaging in the practices of obtaining, evaluating, and communicating information and developing and using models, students learn how traits are inherited, the relationships among cells, chromosomes, genes, alleles, and protein structure and function, and how they are affected by gene mutations. They also explore the human impact of mutations and how they may be linked to genetic diseases. At the end of the segment, students develop an explanatory model that shows how mutations may have impacted traits and changes in structure and function of various anatomical features that were passed on from ancestors of modern-day organisms.

- **Instructional Segment 4:** By engaging in the practices of analyzing and interpreting data, developing and using models, and the use of mathematical and computational thinking, students learn about the role of the environment in changing the proportion of a species across a generation and how its survival depends on an advantageous trait. At the end of the segment, students add to their explanatory model to show the role of adaptation as seen in an advantageous trait that was necessary for the survival of their species to which their fossil belonged across many generations.

Unit Storyline Framing: Students review a large data set of fossil records to choose a fossil they find interesting and relevant. They develop a series of questions, such as: *What do you notice about the*

organism? What do you wonder? Are we family to the organism? How can we investigate the ancestors of our organism? How can we investigate its descendants? Why are some organisms not found clearly in the fossil record? How does this relate to human family trees? Did they disappear or did they change? What caused them to disappear or change?

Stage 1 – Desired Results

Overview of Student Learning Outcomes

The Grade 8 Unit 3 Topic Bundle, "**Understanding Earth History and the Origin of Species**," organizes performance expectations with a focus on helping students deepen their knowledge about evidence of a common ancestor interpreted through fossil records and how differences in their structure help explain present-day organisms. They will also learn how rock strata help us explain the history of the Earth. In this unit, there is significant overlap and synergy between the DCI and CCC dimensions, where patterns of different scales and proportions are traced throughout the multiple components of a system represented in a model. Similarly, the SEPs allow students to analyze and interpret data and consider other evidence to develop models and explanations about the history of life on Earth. By building familiarity with previous Unit 2 ideas related to gravity and motion of objects in the solar system, Unit 3 allows students to use and extend this knowledge to the history of Earth found within the solar system and the origin of its species. Unit 3 focuses on Earth's history and how its fossil structures are genetically related to present-day life forms.

Unit 3 Big Ideas:

LS4.B: Natural Selection + LS4.C: Adaptation	1. Adaptation results from natural selection acting over generations in response to environmental conditions and changes the distributions of traits in a population. (MS-LS4-4; MS-LS4-6)
LS4.A: Evidence of Common Ancestry and Diversity	2. Similarities and differences between current and fossilized organisms help us make inferences about the origin of species. (MS-LS4-2; MS-LS4-1)
LS3.A: Inheritance of Traits + LS3.B: Variation of Traits	3. Mutations can affect an organism's genetic information, and genetic information affects an organism's traits. (MS-LS3-1)
ESS1.C: The History of Planet Earth + LS4.A: Evidence of Common Ancestry and Diversity	4. Rock strata and the fossil record provide evidence for changes in life and landforms over Earth's history. (MS-LS4-1; MS-ESS1-4; MS-LS4-2)

The [SIPS Unit 3 Student Profile](#) describes what students should know and be able to demonstrate prior to and at the culmination of three-dimensional science instruction in Unit 3 to prepare for new and increasingly sophisticated learning opportunities in Unit 4.

Next Generation Science Standards (NGSS) Performance Expectations & Foundation Boxes

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

MS-LS4-4. Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment. [Clarification Statement: Emphasis is on using simple probability statements and proportional reasoning to construct explanations.]

MS-LS4-6. Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. [Clarification Statement: Emphasis is on using mathematical models, probability statements, and proportional reasoning to support explanations of trends in changes to populations over time.] [Assessment Boundary: Assessment does not include Hardy Weinberg calculations.]

MS-LS3-1. Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism. [Clarification Statement: Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins.] [Assessment Boundary: Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.]

MS-LS4-1. Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past. [Clarification Statement: Emphasis is on finding patterns of changes in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in the rock layers.] [Assessment Boundary: Assessment does not include the names of individual species or geological eras in the fossil record.]

MS-ESS1-4. Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6 billion-year-old history. [Clarification Statement: Emphasis is on how analyses of rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history. Examples of Earth's major events could range from being very recent (such as the last Ice Age or the earliest fossils of homo sapiens) to very old (such as the formation of Earth or the earliest evidence of life). Examples can include the formation of mountain chains and ocean basins, the evolution or extinction of particular living organisms, or significant volcanic eruptions.] [Assessment Boundary: Assessment does not include recalling the names of specific periods or epochs and events within them.]

Targeted Scientific Practices	Targeted Disciplinary Core Ideas	Targeted Cross-Cutting Concepts
[SEP-6] Constructing Explanations and Designing Solutions • Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and	**[LS4.A] Evidence of Common Ancestry and Diversity** • Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record, enable the	**[CCC-1] Patterns** • Patterns can be used to identify cause-and-effect relationships. **(MS-LS4-2)** • Graphs, charts, and images can be used to identify patterns in data. **(MS-LS4-1)**

designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

- Apply scientific ideas to construct an explanation for real-world phenomena, examples, or events. **(MS-LS4-2)**

- Construct an explanation that includes qualitative or quantitative relationships between variables that describe phenomena. **(MS-LS4-4)**

- Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. **(MS-ESS1-4)**

[SEP-5] Using Mathematics and Computational Thinking

- Mathematical and computational thinking in 6–8 builds on K–5 experiences and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.

- Use mathematical representations to support scientific conclusions and design solutions. **(MS-LS4-6)**

[SEP-2] Developing and Using Models

- Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising

reconstruction of evolutionary history and the inference of lines of evolutionary descent. **(MS-LS4-2)**

- The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth.**(MS-LS4-1)**

[LS4.B] Natural Selection

- Natural selection leads to the predominance of certain traits in a population, and the suppression of others. **(MS-LS4-4)**

[LS4.C] Adaptation

- Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits changes in a population. **(MS-LS4-6)**

[LS3.A] Inheritance of Traits

- Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes.

[CCC-2] Cause and Effect

- Phenomena may have more than one cause, and some cause-and-effect relationships in systems can only be described using probability. **(MS-LS4-4) (MS-LS4-6)**

[CCC-6] Structure and Function

- Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function. **(MS-LS3-1)**

[CCC-3] Scale, Proportion, and Quantity

- Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. **(MS-ESS1-4)**

models to describe, test, and predict more abstract phenomena and design systems.	Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. **(MS-LS3-1)**	
• Develop and use a model to describe phenomena. (MS-LS3-1)		
[SEP-4] Analyzing and Interpreting Data		
• Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.	**[ESS1.C] The History of Planet Earth**	
• Analyze and interpret data to determine similarities and differences in findings. **(MS-ESS1-4)**	• The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale.	

Acquisition Goals

Acquisition Goals are multi-dimensional knowledge-in-use statements that integrate aspects of the NGSS dimensions (SEP & DCI or SEP & DCI & CCC) but are smaller in breadth than a performance expectation. Acquisition Goals describe the essential concepts and key skills a student must acquire to obtain mastery of the unit's objectives and emphasize student understanding as rooted in engagement with the science and engineering practices and not in memorization of science facts. The acquisition goals intentionally include SEP and CCC from outside of the unit's PE bundle.

Students will know and be able to . . .

A1. Critically read scientific text(s) to obtain scientific information about the geological time scale used to represent Earth's history and the timing of important events during this history.

A2. Use mathematical representations of time that are appropriate for representing events and time scale(s) necessary to support conclusions about events that occurred during Earth's history.

A3. Develop and/or use a model of the process of rock strata formation to describe how it allows us to collect evidence about the relative age of rocks and/or landforms.

A4. Construct an explanation based on evidence obtained from scientific sources about how rock strata form in the present to explain how rock strata formed earlier in Earth's history.

A5. Analyze and interpret data in the fossil record to make determinations about evolutionary changes that occurred in the past.

A6. Compare, integrate, and evaluate sources of information from print resources and articles to solve a problem related to patterns presented in fossil records.

A7. Determine similarities and differences between organisms today and fossilized organisms using patterns found in fossil records.

A8. Use similarities and differences between structures of organisms today and fossilized organisms to find patterns that help draw conclusions about the origin of organisms.

A9. Develop an explanation about what caused the similarities and differences between organisms today and organisms from fossil records.

A10. Obtain information from other sources that show related species of modern-day organisms evolved due to changes in the environment or mutations.

A11. Develop and/or use a model that shows sexual reproduction and/or genetic mutations can affect an organism's traits.

A12. Critically read scientific text(s) to obtain and make sense of information about genes, alleles, and chromosomes (and the relationships between them) to describe patterns in traits across organisms.

A13. Develop and/or use a model that shows the relationships between genes, alleles, chromosomes, and cells in order to describe why organisms have different traits.

A14. Critically read scientific text(s) to obtain and make sense of information about genes, proteins, and traits (and the relationships between their structures and functions) to provide evidence that genes can affect an organism's traits.

A15. Develop and/or use a model that shows the relationships between genes, mutations, proteins, structures, and functions.

A16. Determine similarities and differences using patterns in findings related to the proportions of a species in a population across generations.

A17. Use mathematical representations to support scientific conclusions about how environmental conditions caused species to change over time.

A18. Use a model to explain how the environment causes a change in the proportion of a species across generations.

A19. Construct an explanation about how a species' survival rate is due to the presence of an advantageous trait.

Cross-curricular Integration

Students deepen their knowledge about evidence of a common ancestor interpreted through fossil records and how differences in their structure help explain present-day organisms. They also learn how rock strata help us explain the history of the Earth. Students develop these understandings by using models, building and revising scientific explanations, and analyzing and interpreting various forms of data and information to construct and support explanations related to patterns in the change of lifeforms in the history of Earth, similarities and differences among organisms, patterns in the cause and effect relationships related to the inheritance of traits through natural selection, and changes in populations over time. Students use reading and research skills to **acquire new information** and to **draw on** and **integrate information** from **multiple sources**. Students also use mathematical practices such as **reasoning and modeling** and mathematical concepts related to **measurement and data** to explain phenomena or create solutions to design problems.

Common Core State Standards for Literacy	Common Core State Standards for Mathematics
Speaking and Listening	*Mathematical Practice*
SL.8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups,	**MP.4** Model with mathematics. **(MS-LS4-6)**

teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly. **(MS-LS4-2) (MS-LS4-4)**

SL.8.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. **(MS-LS4-2) (MS-LS4-4)**

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. **(MS-LS3-1)**

Reading Science and Technical Subjects

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. **(MS-LS4-2) (MS-LS4-4) (MS-LS3-1) (MS-LS4-1) (MS-ESS1-4)**

RST.6-8.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics. **(MS-LS3-1)**

RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). **(MS-LS3-1) (MS-LS4-1)**

RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. **(MS-LS4-4)**

Writing Science and Technical Subjects

WHST.6-8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. **(MS-LS4-2) (MS-LS4-4) (MS-ESS1-4)**

WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. **(MS-LS4-2) (MS-LS4-4)**

Ratios and Proportional Relationships

6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. **(MS-LS4-4) (MS-LS4-6)**

7.RP.A.2 Recognize and represent proportional relationships between quantities. **(MS-LS4-4) (MS-LS4-6)**

Statistics & Probability

6.SP.B.5 Summarize numerical data sets in relation to their context. **(MS-LS4-4) (MS-LS4-6)**

Expressions and Equations

6.EE.B.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or depending on the purpose at hand, any number in a specified set. **(MS-LS4-2) (MS-LS4-1) (MS-ESS1-4)**

7.EE.B.6 Use variables to represent quantities in a real-world or mathematical problem and construct simple equations and inequalities to solve problems by reasoning about the quantities. **(MS-ESS1-4)**

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Enduring Understandings	Essential Questions
Students will understand that . . .	
EU1. Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Also, changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits.	**EQ1.** How and why do individual species change over generations?
	EQ2. How can patterns in natural systems support inferences about lines of evolutionary descent?
EU2. The history of changes in life forms and an understanding of Earth's history along with the geologic time scale provides evidence for how natural selection is related to evolutionary relationships among living things.	**EQ3.** How can we use knowledge of events in Earth's past to shape or predict how natural laws affect all life on Earth?
	EQ4. How do scientists explain complex or less easily observable changes in biological and physical systems over geological time periods?
EU3. The history of mutations and survival of a species is supported by extensive scientific evidence ranging from the fossil record to genetic relationships among species. We can use this evidence, including our knowledge of patterns and cause/effect relationships, to understand and address the effects of current and future happenings on Earth (e.g., extinction, diversity, change).	
EU4. Scientists identify patterns in data, use mathematical representations, and visualize and create various models to analyze and explain how complex natural structures and systems function.	

Vocabulary		
• Eon	• Chromosome	• Superposition
• Epoch	• Protein	• Intrusion
• Predominance	• Allele	• Adaptation
• Suppression	• Mutation	• Cladogram
• Natural selection	• Rock strata	• Homologous structure
• Gene	• Relative frequency	• Analogous structure
• Geological time	• Index fossil	• Vestigial structure
• Evolution	• Trait	• Extinction
• Fossil records	• Species	

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Stage 2 – Assessment Evidence

Assessment Overview

For each acquisition goal listed in the Stage 1 - Desired Results, evidence statements were developed. These statements provide information on what we would want to see students do in order to determine the degree to which students have met the acquisition goals. These acquisition goals and evidence statements were then sequenced into instructional segments. Evidence statements and acquisition goals that were deemed critical were identified and assessment opportunities were developed. For this unit, four segments were identified. An overview of each segment is provided below.

Instructional Segment 1 focuses on Big Idea 4 and students' abilities to obtain, evaluate, and communicate information, develop and use models, analyze and interpret data, use mathematical and computational thinking, and construct explanations about Earth's geologic history and the fossil record. Students use science texts to produce a representation of some of the most important events in Earth's geologic history. Students investigate how rock strata form today to gather evidence for an explanation describing how rock strata formed in the past. Using this information, they produce a model demonstrating how rock strata are formed so they can determine the relative ages of rocks and landforms in a provided scenario. The fossil record is explored with students gathering data to determine events that occurred in the past. Finally, students produce a scale model of Earth's geologic history, coordinating the events from the beginning of the lesson with an analysis of the fossil record onto one artifact. Students are formally assessed on these concepts and are informally assessed on their interpretation of important geological events in Earth's history.

Instructional Segment 2 focuses on Big Idea 2 and students' abilities to obtain, evaluate, and communicate information, analyze and interpret data, and construct explanations about patterns in fossil records through identification of gross anatomical similarities and differences. Several times during this segment, students complete specific steps related to the investigation of their individual research project that are addressed in each lesson. At the end of the segment, students apply the methods they have learned to support inferences about evolutionary relationships related to their individual research topic. Students are both formally and informally assessed on identifying patterns in fossil records to make inferences about evolutionary relationships.

Instructional Segment 3 focuses on Big Idea 3 and students' abilities to obtain, evaluate, and communicate information and develop and use models to describe how variations in traits occur through sexual reproduction and genetic mutations. Students use and develop models to show the relationships between alleles, genes, chromosomes, protein structure and function, cells, and mutations. Students are both formally and informally assessed on how genetic information affects an organism's traits.

Instructional Segment 4 focuses on Big Idea 1 and students' abilities to develop and use models, analyze and interpret data, construct explanations, and use mathematical representations and models to examine changes to a population over time. Students represent and describe patterns in changes to the presence of traits in a population over time. Students provide explanations for how environmental conditions can cause change and use models to support this explanation. Finally, students explain how the environment caused changes in ancient populations that led to their chosen organism and how further changes led to their organism going extinct, as other organisms had greater

advantages. Students are both formally and informally assessed on the role of the environment in bringing about change in the proportion of a species across generations.

End-of-Unit Stackable, Instructionally-embedded, Portable Science (SIPS) Assessment:

For the end-of-unit SIPS assessment, students engage in three scenario-based assessment tasks. The tasks focus on the PEs: MS-LS4-2, MS-LS4-4, MS-LS4-6, MS-LS3-1, MS-LS4-1, and MS-ESS1-4.

Instructionally-Embedded Assessments

For each instructional segment, descriptions of *informal* and *formal* instructionally embedded assessments are included based on the acquisition goals and evidence statements deemed critical to assess along an instructional plan. Informal assessments defined as "in the moment" assessment opportunities identify student challenges and lack of knowledge or misconceptions and could include class check-ins such as discussion prompts, exit tickets, or graphic organizers. Formal assessments measure how well students perform when engaging with more complex tasks that require integration of the dimensions (SEPs, DCIs, CCCs) in the service of sense-making. They are administered at specific, intentional points in time along an instructional plan before or after a lesson or a series of lessons. Examples include performance tasks, concept maps, research projects, or hands-on tasks.

Instructionally-embedded Assessments for Use during Instructional Segment 1

Informal Assessment: Utilizing Informational Texts for Learning

As students read, watch, and explore informational text, the teacher utilizes question strategies to check for student understanding of concepts and encourages students to check the validity of their sources while supporting students in documenting their learning. Students explore several scientific texts to identify and describe important events in Earth's geologic history, understand geologic time scales, and explain rock formations.

Assessment Purpose and Use

- These informal assessments are typically used for formative purposes. The goal is to gauge where students are in their learning, identify what challenges students are facing, and determine the next steps for the class and/or individual students. This assessment provides information that can be used either at the class level or the group level to help determine what instructional activities will best support the students when gathering information from informational texts.

Administration Time: 10-15 minutes

Scoring Time: 1-5 minutes

Assessment Type(s)

Informal - Classroom Check-In

Assessment Sub-Type(s)

In-the-moment Questions

Graphic Organizers

Discussion prompts

These assessments will assess students' ability to:

- Identify information from scientific texts about geological time scales that can be used to represent Earth's history and the timing of important events during history.

- Describe the timing of important events in history based on information about the geological time scale found in scientific text(s).

- Describe the effects of important events in history based on information about the geological time scale found in scientific text(s).

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Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):	NGSS PEs:	CCSS:	EUs/EQs:	AGs:
• Fossils Around Us	MS-ESS1-4	RST.6-8.1	EU2/EQ2	A1
• Earth's History	MS-LS4-1	RST.6-8.4		A4*
• What was First, Second, Third…	MS-LS4-2	RST.6-8.9		
• Plotting Events to Scale		WHST.6-8.2		

Formal Assessment: Major Events in Earth's History

Students research major events in the Earth's history and identify 5 important events that they consider interesting and relevant, with at least one connecting with their selected fossil from the anchoring phenomenon. For each event, students include a description of the event, approximately when the event occurred, what the Earth was like before, a description of the cause of the event (if possible, not all events are clearly understood), and what life on Earth was like afterward.

Assessment Purpose and Use	**Administration Time:** 90 minutes
• Students are provided with (or pick out) a specific research topic and asked to explore this topic. The purpose of the project is to provide an opportunity for the students to apply their knowledge to a particular question or to demonstrate their ability to research a specific topic. It allows them to demonstrate how they would apply concepts over an extended period of time.	**Scoring Time:** 10-15 minutes **Assessment Type(s)** Formal - Extended Performance Task **Assessment Sub-Type(s)** Extended Project

These assessments will assess students' ability to:

• Identify information from scientific texts about geological time scales that can be used to represent Earth's history and the timing of important events during history.

• Describe the timing of important events in history based on information about the geological time scale found in scientific text(s).

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):	NGSS PEs:	CCSS:	EUs/EQs:	AGs:
• Earth's History	MS-ESS1-4	RST.6-8.1	EU2/EQ2	A1
		RST.6-8.4		
		RST.6-8.9		
		WHST.6-8.2		

Formal Assessment: What Was First, Second, Third…

The teacher provides students with an image of a road cut or rock outcrop to analyze and explain. First, students analyze the image, create a drawing of the road cut, and label each feature indicating the oldest to the newest. Students use this drawing to create a multimodal explanatory model, which they use to explain how the rock strata were deposited and altered to create the observed patterns and characteristics of the road cut or rock outcrop. Their model should include labels, arrows, drawings, and text.

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Assessment Purpose and Use

- While classroom check-ins do not require students to engage in 3-dimensional thinking, performance tasks generally do provide opportunities for students to engage with the practices of the discipline along with the content. These tasks are used to measure how well students perform when provided with more complex tasks and are opportunities to engage in a meaningful way with the content in the curriculum.

- Students are presented with materials to work with to address a problem or question. These tasks can be similar to short labs but do not require students to engage with all elements of the experimental process. The purpose of the assessment is to obtain information related to how well students are able to engage with modeling.

Administration Time: 90 minutes

Scoring Time: 5-10 minutes

Assessment Type(s)

Formal - Short Performance Task

Assessment Sub-Type(s)

Research Report

These assessments will assess students' ability to:

- Describe how a model provides evidence about the relative age of rocks and/or landforms.

- Use a model of the process of rock strata formation to describe the relative age of rocks and/or landforms.

- Develop a model about the process of rock strata formations to provide evidence about the relative age of rocks and/or landforms.

- Identify information related to how rock strata form in the present and explain how rock strata formed earlier in Earth's history.

- Explain how rock strata formed earlier in Earth's history based on information about rock strata forms found from scientific forces.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):	NGSS PEs:	CCSS:	EUs/EQs:	AGs:
- What Was First, Second, Third…	MS-ESS1-4	RST.6-8.7	EU2/ EQ2	A3
			EU4/ EQ4	A4

Formal Assessment: The Present Can Reveal the Past

After reading and viewing various media sources for information, students generate a concept map that they use to explain how processes in the ancient past can be inferred from processes we observe today. The concept map should be based on a scaffold provided that guides the students to organize today's observations first, and then explain how these can be used to infer how past scenarios may have played out similarly.

Assessment Purpose and Use

- While classroom check-ins do not require students to engage in 3-dimensional thinking, performance tasks generally do provide opportunities for students to engage with the practices of the discipline along with the content. These tasks are used to measure how well students perform

Administration Time: 45 minutes

Scoring Time: 5 minutes

Assessment Type(s)

Formal - Short Performance Task

Assessment Sub-Type(s)

when provided with more complex tasks and are opportunities to engage in a meaningful way with the content in the curriculum.

Scenario/Phenomena-based Assessment Task

Concept Map

- Teachers can use this task to obtain information on how well students are able to gather and organize information related to rock strata.

These assessments will assess students' ability to:

- Identify information related to how rock strata form in the present and explain how rock strata formed earlier in Earth's history.

- Explain how rock strata formed earlier in Earth's history based on information about rock strata forms found from scientific forces.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):	NGSS PEs:	CCSS:	EUs/EQs:	AGs:
• Earth's History	MS-ESS1-4	RST.6-8.1	EU2/ EQ2	A4
• What Was First, Second, Third…		RST.6-8.9	EU4/ EQ4	

Formal Assessment: Plotting Events to Scale

Students create a scale representation of a timeline of Earth's geological history. Students decide on a scale (teachers may need to assist with setting reasonable parameters) and then create a physical representation to be shared with others. Students could create physical models, utilizing resources such as register tape, masking tape, or digital resources such as a video with narration. Students highlight important events on the geologic timeline with a focus on events and not eras. Eras, epochs, and other divisions may be included but the focus should be on the major events.

Assessment Purpose and Use

- While classroom check-ins do not require students to engage in 3-dimensional thinking, performance tasks generally do provide opportunities for students to engage with the practices of the discipline along with the content. These tasks are used to measure how well students perform when provided with more complex tasks and are opportunities to engage in a meaningful way with the content in the curriculum.

- Students are presented with materials to work with to address a problem or question. These tasks can be similar to short labs but do not require students to engage with all elements of the experimental process.

Administration Time: 60 minutes

Scoring Time: 10 minutes

Assessment Type

Formal - Short Performance Task

Assessment Sub-Type(s)

Hands-on Task

This assessment will assess students' ability to:

- Identify information from scientific texts about geological time scales that can be used to represent Earth's history and the timing of important events during history.

- Describe the effects of important events in history based on information about the geological time scale found in scientific text(s).

- Develop a mathematical representation of time that supports conclusions about events that occurred during Earth's history.

- Describe how a mathematical representation of time supports conclusions about events that occurred during Earth's history.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):	NGSS PEs:	CCSS:	EUs/EQs:	AGs:
• Plotting Events to Scale	MS-ESS1-4	RST.6-8.7	EU2/EQ2	A1
		WHST.6-8.2		A2
		RST.6-8.9		
		6.RP.A.2		
		7.RP.A.2		

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Instructionally-embedded Assessments for Use during Instructional Segment 2

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Informal Assessment: Analyzing Fossils: Using Data and Patterns to Connect the Past and Present

In this segment, students analyze the fossil record of their species, mixed fossils pieces, and compare and contrast fossils with organisms today to create an evidence-based explanation of how species evolved over time. While students are working, the teacher uses in-the-moment questions to check for student understanding of core concepts, encourages students to consider the validity of sources, and supports students in discovering patterns within the data on their own.

Assessment Purpose and Use

- The goal is to gauge where students are in their learning, identify what challenges students are facing, and determine next steps for the class and/or individual students. The assessments provide information that can be used either at the class level or the individual student level to help determine what instructional activities will best support the students.

- Determine whether students can identify and use information related to patterns in fossil records to solve a problem.

- Evaluate student ideas as they analyze and interpret data in the fossil record.

Administration Time: 10-15 minutes

Scoring Time: 3-5 minutes

Assessment Type(s)

Informal - Classroom Check-In

Assessment Sub-Type(s)

In-the-moment Questions

Exit Tickets

Graphic Organizers

These assessments will assess students' ability to:

- Identify information from media sources that relate to patterns in fossil records.

- Draw a conclusion about events that occurred in the past based on data from fossil records.

- Accurately identify patterns found in fossil records.

- Accurately describe similarities and differences between organisms today and fossilized organisms based on patterns found in fossil records.

- Describe appropriate conclusions about the origin of organisms based on patterns in the structure of organisms today and fossilized organisms.

- Identify information in fossil records that relate to the similarities and differences between organisms today and fossilized organisms.

- Explain what caused similarities and differences between organisms today and fossilized organisms based on fossil records.
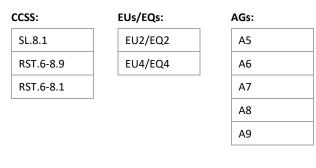
Stage 3 Connection(s):	**NGSS PEs:**	**CCSS:**	**EUs/EQs:**	**AGs:**

- Ancestors and Decedents: Where Did They Come From? What Became of Them?

- Building A Tree of Life

- What Was Their Life Like?

- The Leg Bone Connects To…

- What Was Their Past, Present, and Future?

NGSS PEs	CCSS	EUs/EQs	AGs
MS-LS4-1	SL.8.1	EU2/EQ2	A5
MS-LS4-2	RST.6-8.9	EU4/EQ4	A6
	RST.6-8.1		A7
			A8
			A9

Informal Assessment: Organizing Our Thinking: Documenting and Sorting Our Ideas to Find Patterns

Students document their thinking as they explore content and record their ideas in scientific notebooks using notes, graphic organizers, annotated drawings, and other methods that make sense to them. These artifacts provide the teacher with additional information to check for student understanding, as the students document evidence to support their explanations based on patterns in fossil records that they use to make inferences about evolutionary relationships.

Assessment Purpose and Use

- The goal is to gauge where students are in their learning, identify what challenges students are facing, and determine next steps for the class and/or individual students. The assessments provide information that can be used either at the class level or the individual student level to help determine what instructional activities will best support the students.

- Support students as they identify patterns in the fossil records and gross anatomical similarities and differences between organisms.

- Provide data to determine if students need more instruction with identifying patterns based on similarities/differences in gross anatomical structures.

These assessments will assess students' ability to:

- Identify patterns found in fossil records.

- Describe similarities and differences between organisms today and fossilized organisms based on patterns found in fossil records.

Administration Time: On-going during lessons.

Scoring Time: 10-15 minutes
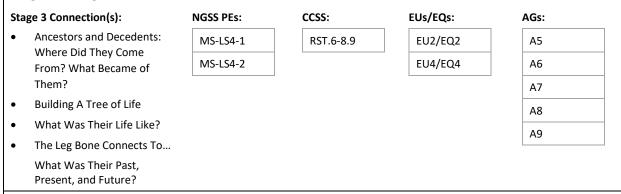
Assessment Type(s)

Informal - Classroom Check-In

Assessment Sub-Type(s)

Graphic Organizers

Concept Map

- Identify information from media sources that relate to patterns in fossil records.

- Draw a conclusion about events that occurred in the past based on data from fossil records.

- Describe appropriate conclusions about the origin of organisms based on patterns in the structure of organisms today and fossilized organisms.

- Identify information in fossil records that relate to the similarities and differences between organisms today and fossilized organisms.

- Explain what caused similarities and differences between organisms today and fossilized organisms based on fossil records.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):	NGSS PEs:	CCSS:	EUs/EQs:	AGs:
• Ancestors and Decedents: Where Did They Come From? What Became of Them?	MS-LS4-1 MS-LS4-2	RST.6-8.9	EU2/EQ2 EU4/EQ4	A5 A6 A7 A8 A9
• Building A Tree of Life				
• What Was Their Life Like?				
• The Leg Bone Connects To…				
What Was Their Past, Present, and Future?				

Formal Assessment: The Leg Bone Connects To…

Students work in small groups to gather fossils from a "dig site" and attempt to assemble those fossils into skeletons by working across groups. Students create and present a 5-minute report and display of the skeleton they created, explaining how each bone fits within the skeleton, why certain bones that were discovered were left out of the skeleton, how their thinking changed over each "day", and identify what information they still need to verify their thinking.

Assessment Purpose and Use	
• While classroom check-ins do not require students to engage in 3-dimensional thinking, performance tasks generally do provide opportunities for students to engage with the practices of the discipline along with the content. These tasks are used to measure how well students perform when provided with more complex tasks and are opportunities to engage in a meaningful way with the content in the curriculum.	**Administration Time:** 50 minutes **Scoring Time:** 10 minutes **Assessment Type(s)** Formal - Short Performance Task **Assessment Sub-Type(s)** Discussion prompts Scenario/Phenomena-based Assessment Task
• This assessment should be used to determine whether students can use information related to patterns in fossil records to solve a problem.	
• Teachers use this information to determine whether students need more instruction about problem-solving methods or identifying patterns.	

These assessments will assess students' ability to:

- Describe how to solve a problem based on information about patterns presented in fossil records.
- Identify information from newspaper articles that relate to patterns in fossil records.
- Identify characteristics of skeletal structures and group fossil pieces by characteristics.
- Justify their choices and recognize changes in thinking.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):	NGSS PEs:	CCSS:	EUs/EQs:	AGs:
• The Leg Bone Connects To…	MS-LS4-1	WHST.6-8.2	EU2/EQ2	A6
	MS-LS4-2	RST.6-8.1	EU4/EQ4	
		SL.8.1		

Formal Assessment: Building A Tree of Life

Students examine both living and extinct relatives of their identified fossil organisms to find evidence of evolution and group their organisms into in/out groups based on different characteristics. An example of a characteristic they could use is the presence or absence of analogous, homologous, and vestigial structures. Using these groupings and information gathered from resources related to their fossil organism, students create a visual representation through a cladogram with clear labels and a scientific explanation that justifies their choices using evidence and reasoning.

Assessment Purpose and Use

- While classroom check-ins do not require students to engage in 3-dimensional thinking, performance tasks generally do provide opportunities for students to engage with the practices of the discipline along with the content. These tasks are used to measure how well students perform when provided with more complex tasks and are opportunities to engage in a meaningful way with the content in the curriculum.

- Support students in making connections between living and extinct organisms based on shared traits.

- Engage students in creating representations that show species evolving over time.

Administration Time: 5 minutes

Scoring Time: 10 minutes

Assessment Type(s)

Formal - Short Performance Task

Assessment Sub-Type(s)

Scenario/Phenomena-based Assessment Task

Graphic Organizers

Sample Instructionally-embedded Assessment Task: "Building a Tree of Life"

These assessments will assess students' ability to:

- Identify and describe evidence in fossil records that relate to the similarities and differences between organisms today and fossilized organisms.

- Develop an explanation about what caused the similarities and differences between organisms today and organisms from fossil records.

- Explain how organisms that share anatomical features are likely closely related while recognizing that structures can be used for the same purpose, but structural differences show they are not closely related (wings of birds vs. insects).

- Use changes over time in the fossil record to infer lines of descent based on shared features.

Science
Grade: 8   Unit: 3
51 days of instruction

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):	NGSS PEs:	CCSS:	EUs/EQs:	AGs:
• Building A Tree of Life	MS-LS4-1	RST.6-8.1	EU2/EQ2	A6
	MS-LS4-2		EU4/EQ4	A9

Formal Assessment: Changes in the Fossil Record

Students conduct research into their identified fossil from the anchoring activity to create a piece of media that shares the characteristics and descriptions of the fossil's ancestors and descendants. Students include images of fossils, drawings/representations/pictures of the organisms, the approximate times they were alive, major adaptations that separate them from each other, any major events from Earth's timeline that had an impact, and interesting information that they would like to share.

Assessment Purpose and Use

- Students are provided with (or pick out) a specific research topic and asked to explore this topic. The purpose is to provide an opportunity for the students to apply their knowledge to a particular question, or to demonstrate their ability to research a specific topic. It allows them to demonstrate how they would apply concepts over an extended period of time.

- This type of project is one that students engage in over an extended period of time. It could be a combination of other research projects (e.g., having a report and an experiment) or could focus on one type. Students may be asked to add to their project after they have learned additional topics in the course.

Administration Time: 90 minutes

Scoring Time: 10 minutes

Assessment Type(s)

Formal - Research Project

Assessment Sub-Type(s)

Extended Project

These assessments will assess students' ability to:

- Identify information related to how life and/or landforms changed over the course of Earth's history.
- Explain how life and/or landforms changed over the course of Earth's history based on fossil records.
- Draw a conclusion about events that occurred in the past based on data from fossil records.
- Describe how data support conclusions about events that occurred in the past.
- Accurately identify patterns found in fossil records.
- Accurately describe similarities and differences between organisms today and fossilized organisms based on patterns found in fossil records.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):	NGSS PEs:	CCSS:	EUs/EQs:	AGs:
• Ancestors and Descendants: Where Did They Come	MS-LS4-1	RST.6-8.1	EU2/EQ2	A5
				A7

From? What Became of
Them?

Formal Assessment: What Was Their Past, Present, and Future?

In this assessment, students compile evidence they have gathered about a fossil they selected in the anchoring activity. Students look at a large data set to identify patterns between species found within the same rock layers, periods/eras/epochs, and patterns between rock layers and periods/eras/epochs. Students organize their information into an explanation of what life was like for their fossil, how related species changed over time, when mass extinctions occurred that impacted related species, and how the descendants of the species increased in diversity and complexity over time. Students present their information in a way that makes sense for them, including, but not limited to a video recording, animation, oral presentation, written report, children's book, informative booklet, or others.

Assessment Purpose and Use

- Students are provided with (or pick out) a specific research topic and asked to explore this topic. The purpose is to provide an opportunity for the students to apply their knowledge to a particular question, or to demonstrate their ability to research a specific topic. It allows them to demonstrate how they would apply concepts over an extended period of time.

- The purpose of this assessment is to determine whether students are able to apply their knowledge about patterns in fossil records and use evidence of anatomical similarities and differences to support inferences about evolutionary relationships.

- Teachers use this to determine how much support students might need in future assignments.

Administration Time: 120 minutes

Scoring Time: 15 minutes

Assessment Type(s)

Formal - Research Project

Assessment Sub-Type(s)

Research Report

Extended Project

These assessments will assess students' ability to:

- Draw conclusions about organisms based on patterns in the structure of organisms today and fossilized organisms.

- Analyze and interpret data to determine evidence for the existence, diversity, extinction, and change in life forms through the history of Earth.

- Describe similarities and differences between organisms today and fossilized organisms based on patterns found in fossil records.

- Identify information in fossil records that relate to the similarities and differences between organisms today and fossilized organisms.

- Explain what caused similarities and differences between organisms today and fossilized organisms based on fossil records.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):	NGSS PEs:	CCSS:	EUs/EQs:	AGs:
• What Was Their Past, Present, and Future?	MS-LS4-2	RST.6-8.1	EU2/EQ2	A8
		WHST.6-8.2	EU4/EQ4	A9
		SL.8.4		

Formal Assessment: What Was Their Life Like?

Students add to their explanatory model and create annotated drawings for three species (one ancestor of their organism, their organism, and one descendant of the organisms). The annotated drawings include other species the organisms would have interacted with in their environment, a drawing of their surrounding environment (fern forest, shallow sea, etc.), clear labels, and a representation of any major events, such as mass extinction, to show what facilitated a dramatic change.

Assessment Purpose and Use	**Administration Time:** 45 minutes
• While classroom check-ins do not require students to engage in 3-dimensional thinking, performance tasks generally do provide opportunities for students to engage with the practices of the discipline along with the content. These tasks are used to measure how well students perform when provided with more complex tasks and are opportunities to engage in a meaningful way with the content in the curriculum.	**Scoring Time:** 15 minutes
	Assessment Type(s)
	Formal - Short Performance Task
	Assessment Sub-Type(s)
	Scenario/Phenomena-based Assessment Task

These assessments will assess students' ability to:

- Identify information in fossil records that relate to the similarities and differences between organisms today and fossilized organisms.
- Explain what caused similarities and differences between organisms today and fossilized organisms based on fossil records.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):	NGSS PEs:	CCSS:	EUs/EQs:	AGs:
• What Was Their Life Like?	MS-LS4-2	RST.6-8.1	EU2/EQ2	A9
		WHST.6-8.2	EU4/EQ4	
		SL.8.4		

Instructionally-embedded Assessments for Use during Instructional Segment 3

Informal Assessments: Scientific Notebooks

As students explore content, they record key ideas and evidence in their scientific notebooks utilizing graphic organizers, concept maps, annotated drawings, and note-taking schema that works for them. Students document their thinking on the role of chromosomes, genes, and proteins in gene expression, potential causes of mutations, the effect of mutations, and examples of positive, negative,

and neutral mutations. Students utilize these notes and documents to provide evidence and reasoning when they create explanations later in the segment.

Assessment Purpose and Use

- These informal assessments are typically used for formative purposes. The goal is to gauge where students are in their learning, identify what challenges students are facing, and determine next steps for the class and/or individual students. The assessments provide information that can be used either at the class level or the individual student level to help determine what instructional activities will best support the students.

- These informal assessments should be given throughout the instruction to help inform future instruction and the need for remediation.

Administration Time: 5-10 minutes

Scoring Time: 3-5 minutes

Assessment Type(s)

Informal - Classroom Check-In

Assessment Sub-Type(s)

Research Report

Concept Map

Graphic Organizers

These assessments will assess students' ability to:

- Obtain, evaluate, and communicate to
  - describe how variations of traits occur through patterns of inheritance or genetic mutation.
  - describe how genes, alleles, and chromosomes are related to describing patterns in traits across organisms.
  - describe evidence that genes can affect an organism's trait(s).
  - identify information found in scientific text(s) that provide evidence that genes can affect an organism's trait(s).

- Use a model to
  - provide evidence that sexual reproduction and/or genetic mutations can affect an organism's traits.
  - describe how a model shows the relationship between genes, alleles, chromosomes, and cells.
  - provide evidence for why organisms have different traits.
  - provide evidence about the relationship between genes, mutations, proteins, structures, and functions.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):	NGSS PEs:	CCSS:	EUs/EQs:	AGs:
• Can You Taste It?	MS-LS3-1	SL.8.5	EQ3/EQ3	A10*
• From Gene to Protein to Person		RST.6-8.1	EU4/EQ4	A11
• Mutations and Change in Infectious Diseases		RST.6-8.7		A12
• Human Impacts of Mutations		WHST.6-8.2		A13
• Mutations and Changing Populations				A14
				A15

Science
Grade: 8   Unit: 3
51 days of instruction

Formal Assessment: From Gene to Protein to Person

With the help of other resources, students develop an explanatory model that shows how alleles, genes, chromosomes, and cells are related and the role each of those has in expressing different traits. Students use their model to describe why different individuals of the same species (e.g., kittens from the same litter) have different traits, making explicit connections between alleles and genes, genes being on chromosomes, and chromosomes being in cells. Students provide evidence that gene instructions result in proteins, proteins have functions, and those functions result in observable traits.

Assessment Purpose and Use

- While classroom check-ins do not require students to engage in 3-dimensional thinking, performance tasks generally do provide opportunities for students to engage with the practices of the discipline along with the content. These tasks are used to measure how well students perform when provided with more complex tasks and are opportunities to engage in a meaningful way with the content in the curriculum.

- This task is used to determine how much support students would need for developing a model in future instruction or tasks.

Administration Time: 15 minutes

Scoring Time: 60 minutes

Assessment Type(s)

Formal - Short Performance Task

Assessment Sub-Type(s)

Scenario/Phenomena-based Assessment Task

These assessments will assess students' ability to:

- Develop a model that shows the relationship between genes, alleles, chromosomes, and cells.

- Apply their model to a different, related phenomenon to explain the phenomenon.

- Describe how a model supports the idea that genetic mutations can affect an organism's traits.

- Use a model to provide evidence that \ genetic mutations can affect an organism's traits.

- Develop a model to show how sexual reproduction and/or genetic mutations can affect an organism's traits.

- Identify information found in scientific text(s) that relates to patterns in traits across organisms.

- Describe patterns in traits across organisms based on information found in scientific text(s).

- Describe evidence that genes can affect an organism's trait(s) based on information found in scientific text(s).

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):	NGSS PEs:	CCSS:	EUs/EQs:	AGs:
• From Gene to Protein to Person	MS-LS3-1	SL.8.5	EU3/EQ3	A10
		RST.6-8.1	EU4/EQ4	A11
		RST.6-8.4		A12
		WHST.6-8.2		A14

Formal Assessment: Causes and Impacts of Mutations

Students create a graphic organizer which uses multiple means of representation while they are exploring resources on the causes of genetic mutations and how they impact protein function,

observable traits, and how those changes in traits impact the organism. Students identify multiple causes of mutations and for each cause provide potential effects. For example, a mutation caused by radiation exposure in skin cells can lead to uncontrolled reproduction which leads to the development of a tumor.

Assessment Purpose and Use

- While classroom check-ins do not require students to engage in 3-dimensional thinking, performance tasks generally do provide opportunities for students to engage with the practices of the discipline along with the content. These tasks are used to measure how well students perform when provided with more complex tasks and are opportunities to engage in a meaningful way with the content in the curriculum.

Administration Time: 60 minutes

Scoring Time: 15 minutes

Assessment Type(s)
Formal - Short Performance Task

Assessment Sub-Type(s)
Graphic Organizers

These assessments will assess students' ability to:

- Identify information found in scientific text(s) that provide evidence that genes can affect an organism's trait(s).

- Describe evidence that genes can affect an organism's trait(s) based on information found in scientific text(s).

- Describe how a model shows the relationships between genes, mutation, proteins, structures, and functions.

- Develop and use a model to provide evidence about the relationship between genes, mutations, proteins, structures, and functions.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):	NGSS PEs:	CCSS:	EUs/EQs:	AGs:
• Mutations and Change in Infectious Diseases	MS-LS3-1	SL.8.5	EU 3/EQ3	A14
• Human Impacts of Mutations		RST.6-8.1	EU /EQ4	A15
• Mutations and Changing Populations		RST.6-8.4		

Formal Assessment: Explaining How a Mutation Impacts an Organism

After obtaining, evaluating, and communicating information and using models to describe how an organism's traits can be affected by mutations, students are presented with several scenarios involving genetic mutations and their impacts. Students select one scenario and provide a multimodal explanation of how the genetic mutation resulted in the observed traits based on the relationship between genes, mutations, proteins, and functions. They discuss if the mutation is a beneficial, harmful, or neutral change and provide reasoning to support their thinking. The explanation includes both drawings, labels, arrows, and text to explain the connections while using evidence from learning experiences.

Assessment Purpose and Use

- While classroom check-ins do not require students to engage in 3-dimensional thinking, performance tasks

Administration Time: 30 minutes

Scoring Time: 15 minutes

Assessment Type(s)

generally do provide opportunities for students to engage with the practices of the discipline along with the content. These tasks are used to measure how well students perform when provided with more complex tasks and are opportunities to engage in a meaningful way with the content in the curriculum.

Formal - Quiz

Assessment Sub-Type(s)

Scenario/Phenomena-based Assessment Task

These assessments will assess students' ability to:

- Obtain, evaluate, and communicate to
  - describe how variations of traits occur through patterns of inheritance or genetic mutation.
  - describe how genes, alleles, and chromosomes are related to describing patterns in traits across organisms.
  - describe evidence that genes can affect an organism's trait(s).
  - Identify information found in scientific text(s) that provide evidence that genes can affect an organism's trait(s).

- Use a model to
  - provide evidence that sexual reproduction and/or genetic mutations can affect an organism's traits.
  - Describe how a model shows the relationship between genes, alleles, chromosomes, and cells.
  - provide evidence for why organisms have different traits.
  - provide evidence about the relationship between genes, mutations, proteins, structures, and functions.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):	NGSS PEs:	CCSS:	EUs/EQs:	AGs:
• Human Impacts of Mutations.	MS-LS3-1	SL.8.5	EU 1/EQ1	A11
• Mutations and Changing Populations		RST.6-8.1	EU 43/EU3	A12
		RST.6-8.4	EU4/EQ4	A13
				A14
				A15

Instructionally embedded Assessments for Use during Instructional Segment 4

Informal Assessment: Analyzing Population Data

Students explore a variety of simulations across the segment to identify patterns that arise when new traits or limiting factors are introduced into populations. Students may be provided with a graphic organizer or other scaffolds to support their data analysis if necessary. Students utilize a data analysis tool such as CODAP (https://codap.concord.org) or spreadsheet software. As students are working, the teacher uses in-the-moment questions to encourage students to think deeply and try different approaches. The teacher can encourage students to engage in productive discourse around the data by posing relevant discussion prompts for both whole-group and small-group discussions.

Science
Grade: 8   Unit: 3
51 days of instruction

Assessment Purpose and Use

- These informal assessments are typically used for formative purposes. The goal is to gauge where students are in their learning, identify what challenges students are facing, and determine next steps for the class and/or individual students. The assessments provide information that can be used either at the class level or the individual student level to help determine what instructional activities will best support the students.

Administration Time: 60 minutes

Scoring Time: 5 minutes

Assessment Type(s)

Informal - Classroom Check-In

Assessment Sub-Type(s)

Discussion prompts

In-the-moment Questions

Lab/Experiment

These assessments will assess students' ability to:

- Accurately identify patterns related to the proportions of a species with a particular trait or traits across generations.

- Accurately describe similarities and differences in the proportions of a species with a given trait(s) across generations of a population.

- Describe how a model shows the relationships between genes, mutation, proteins, structures, and functions.

- Use a model to provide evidence about the relationship between genes, mutations, proteins, structures, and functions.

- Develop a model that shows the relationships between genes, mutations, proteins, structures, and functions.

- Generate mathematical representations of the relationships between environmental conditions and changes in traits of species over time.

- Describe how mathematical representations support conclusions about how environmental conditions caused species to change over time.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):	NGSS PEs:	CCSS:	EUs/EQs:	AGs:
• Looking At Today to Understand the Past	MS-LS4-4	MP.4	EU1/EQ1	A15
• Environmental and Physical Factors Impact Traits in Populations	MS-LS4-6	6.RP.A.1	EU4/EQ4	A16
		7.RP.A.2		A17
• Populations Change Over Time		6.EE.8.6		
		7.EE.8.6		

Formal Assessment: Environmental and Physical Factors Impact Traits in Populations

After informally exploring simulations, students analyze data to examine how environmental conditions impact traits displayed in a population. Students are presented with one or more studies that provide a real-world/citizen science data set for students to analyze. Students conduct a comparative analysis of the data sets to find patterns related to how traits expressed in populations respond to different conditions.

Assessment Purpose and Use

Administration Time: 30-50 minutes

- While classroom check-ins do not require students to engage in 3-dimensional thinking, performance tasks generally do provide opportunities for students to engage with the practices of the discipline along with the content. These tasks are used to measure how well students perform when provided with more complex tasks and are opportunities to engage in a meaningful way with the content in the curriculum.

- This task is used to determine how much support students may need with mathematical representations in future instruction.

Scoring Time: 5-20 minutes

Assessment Type(s)

Formal - Short Performance Task

Assessment Sub-Type(s)

Scenario/Phenomena-based Assessment Task

Sample Instructionally-embedded Assessment Task: "Environmental and Physical Factors Impact Traits in Populations"

These assessments will assess students' ability to:

- Generate mathematical representations of the relationship between environmental conditions and changes in traits of species over time.

- Describe how mathematical representations support conclusions about how environmental conditions caused species to change over time.

- Accurately identify patterns related to the proportions of a species with a particular trait or traits across generations.

- Construct an accurate explanation that describes how an advantageous trait in a population led to an increase in the population of a species.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):	NGSS PEs:	CCSS:	EUs/EQs:	AGs:
• Environmental and Physical Factors Impact Traits in Populations	MS-LS4-6	MP.4	EU1/EQ1	A15
		6.RP.A.1	EU4/EQ4	A16
		7.RP.A.2		A17
		6.SP.B.5		A19

Formal Assessment: Modeling How Populations Can Change

Throughout Segment Four, students explore a variety of multimodal resources on the process of natural selection. Students document key ideas in their science notebooks through structured notes, concept maps, graphic organizers, and annotated drawings. Students use these notes and learning to develop an explanatory model that explains how environmental factors result in certain traits being an advantage and these advantages result in changes to the population. Over time these population changes add up and result in the evolution of species.

Assessment Purpose and Use

- While classroom check-ins do not require students to engage in 3-dimensional thinking, performance tasks generally do provide opportunities for students to engage with the practices of the discipline along with the content. These tasks are used to measure how well students perform when provided with more complex tasks and are

Administration Time: 90 minutes

Scoring Time: 5 minutes

Assessment Type(s)

Formal - Extended Performance Task

Assessment Sub-Type(s)

opportunities to engage in a meaningful way with the content in the curriculum.

Scenario/Phenomena-based Assessment Task

These assessments will assess students' ability to:

- Accurately describe how a model supports the idea that the environment causes a change in the proportion of a species with a given trait across generations.

- Accurately describe the relationships shown in a model between the environment and the change in the proportion of a species with a particular trait across generations

- Describe how a model shows the relationships between genes, mutation, proteins, structures, and functions.

- Use a model to provide evidence about the relationship between genes, mutations, proteins, structures, and functions.

- Develop a model that shows the relationships between genes, mutations, proteins, structures, and functions.

- Generate mathematical representations of the relationships between environmental conditions and changes in traits of species over time.

- Describe how mathematical representations support conclusions about how environmental conditions caused species to change over time

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):	NGSS PEs:	CCSS:	EUs/EQs:	AGs:
• Environmental and Physical Factors Impact Traits in Populations	MS-LS4-6	RST.6-8.7	EU1/EQ1	A15
		RST.6-8.9		A17
• Populations Change Over Time				A18
• Modeling How Populations Change Because of Natural Selection				

Formal Assessment: Beneficial Traits Enhance Survival

Students utilize notes, models, and learning from the four segments to help them explain how mutations and environmental conditions led to certain traits being advantageous, giving rise to ancient ancestor species over time. They explain how major earth events occurred and caused changes to the environment, changing which traits are advantageous which results in extinctions and new species evolving over time, and new mutations occurred eventually resulting in their chosen fossil. Students explain how major Earth events and additional mutations resulted in new conditions that changed which traits were advantageous and resulted in new species, like those evolving today, and their chosen fossils going extinct. Students are asked to identify and explain different advantageous traits using information they have about major Earth events from Segment 1, the species-environment from Segment 2, the processes of genetic change from Segment 3, and how natural selection facilitated evolution from Segment 4.

Assessment Purpose and Use

- While classroom check-ins do not require students to engage in 3-dimensional thinking, performance tasks

Administration Time: 45 minutes

Scoring Time: 5-10 minutes

generally do provide opportunities for students to engage with the practices of the discipline along with the content. These tasks are used to measure how well students perform when provided with more complex tasks and are opportunities to engage in a meaningful way with the content in the curriculum.

Assessment Type(s)

Formal - Extended Performance Task

Assessment Sub-Type(s)

Scenario/Phenomena-based Assessment Task

Extended Project

These assessments will assess students' ability to:

- Develop a model about the process of rock strata formations to provide evidence about the relative age of rocks and/or landforms.
- Identify information in fossil records that relate to the similarities and differences between organisms today and fossilized organisms.
- Explain what caused similarities and differences between organisms today and fossilized organisms based on fossil records.
- Develop and use a model to show how sexual reproduction and/or genetic mutations can affect an organism's traits.
- Accurately identify the evidence that supports a claim about how a trait in a population led to an increase in the population of a species.
- Construct an accurate explanation that describes how an advantageous trait in a population led to an increase in the population of a species.

Stage 1 & Stage 3 Associations:

Stage 3 Connection(s):	NGSS PEs:	CCSS:	EUs/EQs:	AGs:
• Beneficial Traits Enhance Survival	MS-LS4-6	RST.6-8.7	EU1/EQ1	A3
		WHST.6-8.2	EU3/EQ3	A9
				A11
				A18

Guidance for Equitable Assessments for Diverse Learners

How do we optimize accessibility for diverse learners and why is this important? Designing Equitable Assessments for Diverse Learners provides steps to planning and developing equitable assessments that incorporate the principles of Universal Design for Learning (UDL) and the elements of Universally Designed Assessments (UDA). Both UDL and UDA are designed to provide access to instruction and/or assessment to the widest range of students. This includes, but is not limited to, students with varying abilities, cultures, primary languages, background knowledge, and interests. For more information about equitable assessment design and use, and why it is important, view _Chapter 4: Fairness and Accessibility_ of the Strengthening Claims-based Interpretations and Uses of Local and Large-scale Science Assessment Scores (SCILLSS) Digital Workbook on Educational Assessment Design and Evaluation: Creating and Evaluating Effective Educational Assessments.

Stage 3 – Learning Plan

Learning Plan Rationale

The learning plan is based on an articulation of learning goals (i.e., NGSS PEs, CCSS, EUs/EQs, and acquisition goals (defined in Stage 1) distributed over 4 instructional segments. These learning goals are used in Stage 2 to identify and describe the assessments that will be used to assess (to collect evidence of) students' learning throughout the course of the unit and instruction. The lessons in instructional segments 1 through 4 are designed to ensure students have opportunities to acquire and apply the learning goals in Stage 1. The instructional segments in both Stage 2 and Stage 3 are similar in terms of the learning goals they represent. Assessments listed in Stage 2 for a segment might use (assess) fewer learning goals than are present in the respective Stage 3 but will not use additional learning goals (unless they were taught in a prior segment).

Unit Entrance

The unit opening focuses on students experiencing and discussing a phenomenon that sparks their interest and curiosity. To do so, the class engages with an "anchor phenomenon" and generates questions based on that phenomenon, posting their questions to the "driving question board." Some of the questions added to the driving question board can be used by the teacher to transition into Instructional Segment 1, by framing the lessons (and segment) as a means by which to investigate and answer some of the questions that students generate based on the anchor phenomenon.

Throughout the unit (e.g., after each instructional segment) the teacher returns to the driving question board and students reflect on their recent learning and which questions they can answer based on their learning in the prior segment. Following this reflection, the teacher uses the driving question board again, this time identifying remaining unanswered (or partially answered) questions that can motivate the activities and investigations that are the focus of the next instructional segment.

Anchor Phenomenon

In this unit, the anchor phenomenon is based on the shared experience the class will have of selecting from an online database of fossils found in their area (https://paleobiodb.org/navigator/). Students select a particular organism to think about throughout the unit by zooming into a region/state on the map of interest and selecting an interesting organism. The teacher can problematize this for students by setting up the general questions, "What do you notice about these organisms? What do you wonder about them?" Details for this anchor phenomenon activity appear in *Fossils Around Us* in Segment 1.

Unit Framing

Framing for SIPS Instructional Framework

Students select a focus fossil that is interesting and relevant to them. Where appropriate a whale is suggested as an example species for teachers to utilize. Teachers may want to select a different fossil that is locally relevant instead (e.g., mammoth, archaeopteryx, megalodon).

Example Driving Questions

Potential/example driving questions that students might generate include:

- How did these organisms get here?

- How can we investigate the ancestors of our organisms?

- How can we investigate what happened to our organisms?

- Why are some organisms not found clearly in the fossil record?
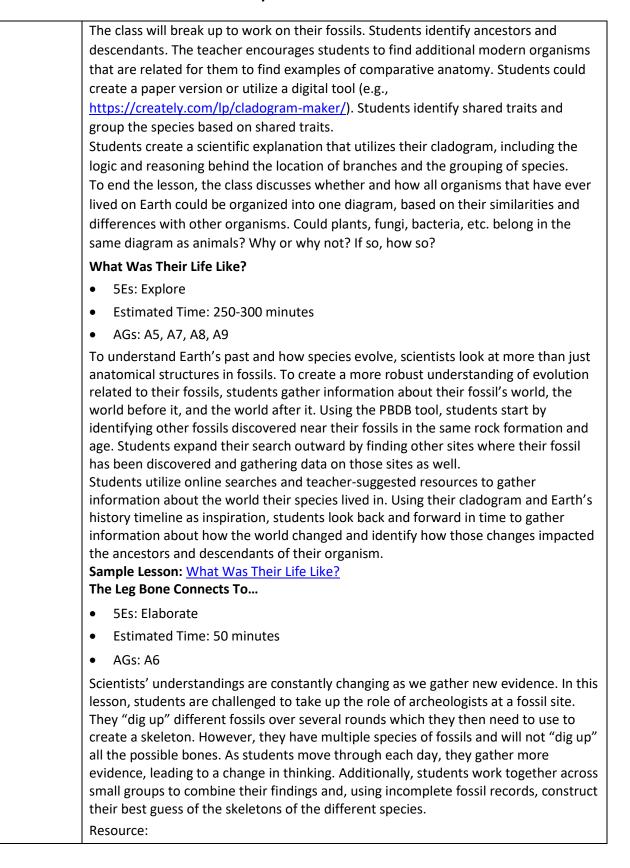
- How does this relate to human family trees?

Potential Investigative Phenomena (Scaffolded by Having a Common Point of Exploration)

If we want to understand our organism of choice, we need to research its origin through fossil records. We need to understand why some of the species are now extinct from the variation in the current species and fossil records. What was it about their environment that caused them to change? What might have enabled them to survive better than other organisms? We would also need to investigate the expression of genes within the organism. Were there possible mutations that might have occurred that enhanced their survival?

Instructional Segment 1
Learning Investigations and Sample Lessons

Stage 1 Associations	**Estimated Classroom Time: 450 minutes**
NGSS PEs:	**Fossils Around Us**
MS-LS4-2	- 5Es: Engage
MS-LS4-1	- Estimated Time: 100 minutes
MS-ESS1-4	- AGs: A1*
CCSS:	To introduce the lesson, students utilize a big data tool, the PBDB navigator, to identify fossils that have been found in their home, state, or region of interest to answer the question "How do species evolve?". As a class, students work together on the creation of a driving question board.
SL.8.1	
SL.8.4	The teacher begins class with the zoomed-out world view of the PBDB navigator open on screen. Then, the teacher asks students to share what they notice about the tool. The teacher provides students with an explanation of the data set and then walks them through zooming in and finding fossils that have been found in their home state. There is a walkthrough to reference here: https://youtu.be/n_FkX4Vf_8I. Students explore the navigator and identify a species they are interested in. Students may need support in understanding the species found as they are listed by their scientific names. The teacher encourages students to utilize search engines to find pictures/drawings/representations of their species. Note, students can also filter the fossils by different eras and taxonomies if there is a type of organism they are interested in instead.
RST.6-8.1	
RST.6-8.4	
RST.6-8.7	
RST.6-8.9	
WHST.6-8.2	
MP.4	
6.RP.A.1	
7.RP.A.2	
EUs/EQs:	After students have identified a species, the teacher brings the class back together and works to identify key questions to answer to understand the evolutionary ancestors and descendants of the species they have selected. The teacher uses those questions to create the driving question board for the storyline.
EU2/EQ2	
EU4/EQ4	
AGs:	The teacher may want to select an example species to utilize throughout the lesson to guide students. This unit will refer to whales for this, but the teacher could opt for a different species if they feel it is more appropriate/relevant for their students (e.g., mammoth, archaeopteryx, megalodon).
A1	
A2	

A3
A4

Earth's History

- 5Es: Explore
- Estimated Time: 150 minutes
- AGs: A1

Using a geologic timeline such as the bottom of the PBDB navigator, the teacher asks students what they notice about the timeline and the class discusses why there are different segments. (Note: the focus is not on the names, just the fact that there are different groupings.) The teacher asks students to predict why there are different breakups of the timeline and why they are different lengths of time.

To understand these breakups, students research the major events in Earth's history. The class watches the video: 'A Brief History of Geologic Time' as an introduction: https://youtu.be/rWp5ZpJAIA*E*.

Students read available textbooks or online source material related to Earth's geologic history to develop a list of 10-12 important events. Students decide what they think are five important events in Earth's geologic history, including at least one that relates to their selected fossil, then research and create a summary of each.

What Was First, Second, Third…

- 5Es: Explore
- Estimated Time: 150 minutes
- AGs: A3, A4

Students view an image of a rock outcrop, road cut, or other slices into a large formation and are asked to come up with a prediction of how this came to be. After students share their thinking, they explore media, text, and online interactive resources to learn about the process of rock formation development and relative dating through the principles of superposition, horizontality, cross-cutting relationships, weathering and erosion, intrusions, and index fossils. After learning about these topics, students revisit the original image and check their predictions.

Finally, students individually (or in small groups) create a multimodal explanation of the relative dating of different rock features. They could be assigned this feature or be tasked with finding a feature on their own. If there is a feature nearby, students could go out and photograph it themselves or the teacher could provide images.

Plotting Events to Scale

- 5Es: Evaluate
- Estimated Time: 50 minutes
- AGs: A2

Students are challenged to create a scale representation of the Earth's history timeline. Examples include plotting all of Earth's geologic history in one year, or one day, or making a physical timeline using register tape or masking tape. Students plot the five events they researched in the lesson *Earth's History* and plot them on their timeline. In the next lesson, *Ancestors and Descendants: Where Did They Come*

	From? What Became of Them? they return and add all the fossils/organisms researched on the same scale model. The teacher may also encourage students to add specific developments, events, extinctions, or organisms to the task.

Instructional Segment 2
Learning Investigations and Sample Lessons

Stage 1 Associations	**Estimated Classroom Time: 800-850 minutes**
NGSS PEs:	**Ancestors and Descendants: Where Did They Come From? What Became of Them?**
MS-LS4-1	• 5Es: Engage
MS-LS4-2	• Estimated Time: 100 minutes
CCSS:	• AGs: A5, A7
SL.8.1	In this lesson, the anchor phenomenon is revisited, and students identify related species to their fossils or organisms. Students conduct research online to identify reputable sources with information about ancestors and descendants of their fossils. Students gather images of fossils, drawings/representations/pictures of the organisms, approximate timeframe for the species, adaptations, and variations between ancestors, and make note of any major events that would have had an impact. Students are encouraged to include information that they find especially interesting. Students add these "relatives" to their timeline from *Plotting Events to Scale*.
WHST.6-8.2	
RST.6-8.1	
RST.6-8.4	
RST.6-8.7	
RST.6-8.9	
EUs/EQs:	**Building A Tree of Life**
EU2/EQ2	• 5Es: Explore/Explain
EU4/EQ4	• Estimated Time: 200 minutes
AGs:	• AGs: A5, A7, A8
A5	In this lesson, students are introduced to cladograms, then conduct and review research to build a cladogram relating to the organisms they have chosen to research for their projects. To support student understanding, the teacher begins by sharing examples such as Cladogram V.1 or Cladogram V.2, which are some modern and fossil ancestors of whales (or other teacher-selected fossils from earlier in the unit). Students look for similarities and differences between the species represented on the cladograms and develop a class definition of what a cladogram is and what should be included in it.
A6	
A7	
A8	
A9	
	Next, the class uses a modern descendant of the teacher's fossil to compare its skeleton to other organisms in the past and present (e.g., elephant, sparrow, hammerhead shark). Students suggest existing organisms that they think the modern species will be related to and find images of skeletons to put into the outline. The teacher introduces the concepts of homologous, analogous, and vestigial structures. The class discusses the similarities and differences between these organisms, and have students add their thinking to the class document. The teacher asks student groups to make a prediction based on their analysis of similarities and differences as to which organisms are most closely related.

The class will break up to work on their fossils. Students identify ancestors and descendants. The teacher encourages students to find additional modern organisms that are related for them to find examples of comparative anatomy. Students could create a paper version or utilize a digital tool (e.g., https://creately.com/lp/cladogram-maker/). Students identify shared traits and group the species based on shared traits.

Students create a scientific explanation that utilizes their cladogram, including the logic and reasoning behind the location of branches and the grouping of species.

To end the lesson, the class discusses whether and how all organisms that have ever lived on Earth could be organized into one diagram, based on their similarities and differences with other organisms. Could plants, fungi, bacteria, etc. belong in the same diagram as animals? Why or why not? If so, how so?

What Was Their Life Like?

- 5Es: Explore
- Estimated Time: 250-300 minutes
- AGs: A5, A7, A8, A9

To understand Earth's past and how species evolve, scientists look at more than just anatomical structures in fossils. To create a more robust understanding of evolution related to their fossils, students gather information about their fossil's world, the world before it, and the world after it. Using the PBDB tool, students start by identifying other fossils discovered near their fossils in the same rock formation and age. Students expand their search outward by finding other sites where their fossil has been discovered and gathering data on those sites as well.

Students utilize online searches and teacher-suggested resources to gather information about the world their species lived in. Using their cladogram and Earth's history timeline as inspiration, students look back and forward in time to gather information about how the world changed and identify how those changes impacted the ancestors and descendants of their organism.

Sample Lesson: What Was Their Life Like?

The Leg Bone Connects To…

- 5Es: Elaborate
- Estimated Time: 50 minutes
- AGs: A6

Scientists' understandings are constantly changing as we gather new evidence. In this lesson, students are challenged to take up the role of archeologists at a fossil site. They "dig up" different fossils over several rounds which they then need to use to create a skeleton. However, they have multiple species of fossils and will not "dig up" all the possible bones. As students move through each day, they gather more evidence, leading to a change in thinking. Additionally, students work together across small groups to combine their findings and, using incomplete fossil records, construct their best guess of the skeletons of the different species.

Resource:

	• [Lesson Plan Fossils: University of Texas Environmental Science Institute](https://www.esi.utexas.edu/files/066-Lesson-Plan-Fossils.pdf) [https://www.esi.utexas.edu/files/066-Lesson-Plan-Fossils.pdf] **What Was Their Past, Present, and Future?** • 5Es: Evaluate • Estimated Time: 200-250 minutes • AGs: A8, A9 Students use this lesson to collect the evidence they have gathered in this segment related to their project organism into a single report. They organize their information into an explanation of the evolution of species related to their local fossil. Students use evidence gathered about major events, other species alive at the time, the environment in which they lived, and other information to explain why species evolved and how these new species led to an increase in diversity and complexity. Students create their reports using a format that makes sense for them and then share their reports with the class.
	Instructional Segment 3
	Learning Investigations and Sample Lessons
Stage 1 Associations **NGSS PEs:** MS-LS3-1 **CCSS:** SL.8.5 RST.6-8.1 RST.6-8.4 RST.6-8.7 WHST.6-8.2 **EUs/EQs:** EU 1/EQ1 EU3/EQ3 EU4/EQ4 **AGs:** A10* A11 A12 A13 A14 A15	**Estimated Classroom Time: 600 minutes** **Can You Taste It?** • 5Es: Engage, Explore • Estimated Time: 100 minutes • AGs: A10*, A12 In Segments 1 and 2, students learn about the history of Earth and that species change over time. The teacher asks students the question, "How do these changes happen?" The teacher encourages students to share their ideas and the class develops a driving question board around the question. Next, to introduce the ideas of genetic mutations and refresh their recollection of Mendelian genetics, students learn about a genetic mutation that some humans have that impacts their taste of phenylthiocarbamide (PTC). Students collect class data of students' reactions to PTC test strips and then discuss what they think might cause this difference. Students conduct a guided exploration that reviews phenotypes, genotypes, and introduces mutations. The lesson resource below provides a guide for the activity with links to supplemental resources for students. The resource asks students to explore the genetic code related to PTC; the teacher may want to remove this section or have students who are above grade level explore the topic. Resource: • [How Gene Mutations Change Your Ability to Taste	Lesson Plan (sciencebuddies.org)](https://www.sciencebuddies.org/teacher-resources/lesson-plans/genetic-mutation-PTC-test#) [https://www.sciencebuddies.org/teacher-resources/lesson-plans/genetic-mutation-PTC-test#]

From Gene to Protein to Person

- 5Es: Explore
- Estimated Time: 150 minutes
- AGs: A11, A12, A14, A15

In *Can You Taste It?* students are introduced to the idea that genes are connected to proteins and that is what leads to differences between organisms. In this lesson, students explore multimodal resources to better understand how that happens. Students gather information and record key ideas and evidence in their science notebooks as annotated drawings, graphic organizers, concept maps, and other notes that make sense to the students. Students read, view, and explore resources that review genes, alleles, and chromosomes and provide key information and details on the creation of proteins, their functions, and how they lead to gene expression and patterns across organisms. The teacher encourages students to explore the internet to find valid resources or provides curated resources. Some suggested resources are listed at the end of the instructional framework.

Mutations and Change in Infectious Diseases

- 5Es: Explore, Explain
- Estimated Time: 150 minutes
- AGs: A10*, A11

Working in pairs, students utilize interactives to simulate the impact of mutations on viruses and bacteria, and then see how the changes impact the human population through several activities.

To start, the teacher introduces students to the concept of advantageous mutations in bacteria and superbugs by utilizing resources and simulations and by talking with the students about what they know about being sick and fighting infection. Potential questions include: "What are bacteria? What can we do to fight bacteria? What is a 'superbug'?"

Next, students utilize the simulation [Antibacterial Resistance](#) to simulate a bacteria colony. Students make observations of the simulation and then document what they notice. As a class, discuss what occurred and why they think it occurred. Students explore resources on bacterial changes such as [bacterial resistance](#) and [mutations](#) if they need additional information.

Next, students compare different strains of the COVID-19 virus using data from an online simulator. Students gather data and compare the infection rates utilizing resources from [Comparing COVID-19 Variants: Science Buddies](#). This lesson plan has several resources and handouts for teachers to utilize as they see fit. Students explore the impacts of viral mutations.

Students write a reflection in their scientific notebooks about the impacts of mutations on populations. The teacher encourages students to consider and write about mutations that are harmful, helpful, or have no impact at all.

Human Impacts of Mutations

- 5Es: Elaborate
- Estimated Time: 100 minutes
- AGs: A11, A12, A13, A14, A15

Using a variety of resources, students obtain information and develop simple explanatory models to show how mutations in genes affect protein structure and function and how they lead to different traits in organisms. Students learn about inherited mutations, new mutations early in development, and mutations later in development for humans. Students examine images of chromosomes to identify differences, and then learn about the different impacts of genetic diseases. Students act as genetic counselors and provide information for individuals based on their genomes.

Resource:

- [Genetic Counselor Lesson](http://racheliufer.com/wp-content/uploads/2014/02/Genetic-Diseases-Case-Studies-Middle-School.pdf)

  [http://racheliufer.com/wp-content/uploads/2014/02/Genetic-Diseases-Case-Studies-Middle-School.pdf]

Mutations and Changing Populations

- 5Es: Explain, Evaluate
- Estimated Time: 100 minutes
- AGs: A13, A15

Students return to their organism from the anchoring activity and consider how mutations may have led to changes from species to species as the ancestors evolved into the anchoring species and then on into its descendants. The teacher encourages students to make predictions about mutations and how those mutations provided advantages during major Earth events.

To wrap up the segment, students are presented with several scenarios involving genetic mutations and their impacts. Students select one scenario and create a multimodal scientific explanation using evidence from their learning experiences so far.

Instructional Segment 4
Learning Investigations and Sample Lessons

Stage 1 Associations

NGSS Pes:

MS-LS4-6

CCSS:

MP.4

6.RP.A.1

Estimated Classroom Time: 550 – 650 minutes

Looking At Today to Understand the Past

- 5Es: Engage
- Estimated Time: 100 minutes
- AGs: A17, A18*, A19*

The teacher begins the unit by reminding students how the processes we see today have been happening all along. For example, the teacher can say, "To better

7.RP.A.2	understand how the process by which our species changed, we are going to look at one species alive today."
6.SP.B.5	
6.EE.8.6	The teacher introduces the students to the species they will look at, the Deer Mouse, utilizing Lesson 1.1 of the Deer Mouse Fur Color curriculum from ConnectedBio. Students are introduced to the deer mouse, its range, habitat, behaviors, and the CODAP data analysis tool by analyzing some provided data. Note: the teacher can also have students consider a locally relevant species or other data sources that may be more relevant to students and use the resource as a guide instead.
7.EE.8.6	
RST.6-8.7	
WHST.6-8.2	
EUs/EQs:	After learning about the deer mouse, the teacher revisits the driving question board from Segment 3 and asks students to consider if any of the questions have been answered and what new questions should be added.
EU1/EQ1	
EU3/EQ3	**Environmental and Physical Factors Impact Traits in Populations**
EU4/EQ4	• 5Es: Explore
AGs:	• Estimated Time: 100-150 minutes
A3	• AGs: A13, A15, A18
A9	Students explore resources and information about the deer mouse at a variety of ecological levels to better understand the factors that impact the genetics of a deer mouse. Utilizing resources from Lesson 1.2 of Deer Mouse Fur Color, students learn the basics about the deer mouse and its environment and observe the impact of predators on mice in different environments.
A11	
A13	
A15	
A16	Next, students explore the biological processes that give the mouse its color to better understand why different mice have different fur in different habitats in Lesson 2.1 and Lesson 2.2. This content connects to *From Gene to Protein to Person* by providing a simulation and visuals of cells creating proteins and the impact of those proteins on the expressed genes of deer mice. Lesson 2.1 begins with brown deer mice, and lesson 2.2 explores beach mice. Students review cell anatomy before they explore an individual hair cell. There are sections of the simulation that go into protein development and the functions of individual parts of the cellular membrane. Students who need a higher challenge may be encouraged to explore these additional sections; otherwise, the teacher can skip the above-grade-level content.
A17	
A18	
A19	
	Populations Change Over Time
	• 5Es: Explore, Explain
	• Estimated Time: 100-150 minutes
	• AGs: A16, A17
	Having learned about the environmental factors and cellular factors that impact the deer mouse, students zoom out to look at how the population changes because of these factors using resources from Lesson 5.1 of the deer mouse curriculum. Students are introduced to relative frequency and then use simulation data to see how the relative frequency of alleles changes over generations. In addition, students can adjust the setting and decide to introduce additional mutations into the population. Students write a procedure, conduct their experiment, gather, and analyze their data, and then create a report with conclusions to share with peers.

Students share their conclusions with the class and gather feedback. Then, as a class, students examine the data sets to find overall patterns. The class revisits the driving question board to determine if there are any additional questions that they need to answer.

Sample Lesson: Populations Change Over Time

Modeling How Populations Change Because of Natural Selection

- 5Es: Explain, Elaborate

- Estimated Time: 100 minutes

- AGs: A18, A19

After reviewing the unanswered questions from the driving board, students conduct additional research and tests to find the answers to their remaining questions about the field mouse so they can finalize their explanatory model explaining how populations change over time due to natural selection. Students could conduct their research using valid resources or the teacher could provide curated resources. Students who are above grade level may want to explore advanced resources such as those offered by the Howard Hughes Medical Institute's BioInteractive and more advanced simulations from ConnectedBio.

Beneficial Traits Enhance Survival

- 5Es: Evaluate

- Estimated Time: 150 minutes

- AGs: A3, A9, A11, A18

Students finalize the explanatory model that they have been working on over the four segments about their chosen fossil. They gather feedback from peers about their model and consider additions and revisions based on reviewing peer models. Then, students create their final explanatory model about their chosen fossil and present their information by creating a piece of media, oral presentation, written report, or another format that makes sense for the student. Students present their reports to an audience and receive additional feedback.

Accessibility and Differentiation for Diverse Learners

"Universal Design for Learning (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. 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.

Providing Multiple Means of Engagement (e.g., allowing choices, authentic scenarios, varying demands, clear goals), broadens the opportunities of gaining and sustaining students' interest and cognitive engagement in learning the content. Providing Multiple Means of Representation (e.g., variety of presentation modes, clarifying vocabulary, activate background knowledge) allows for

students to receive and comprehend the content. Providing Multiple Means of Action & Expression (e.g., variety of methods to respond to instruction, variety of ways to interact with the instructional materials) helps students to use their strengths and abilities to access the instructional materials and express what they understand. Accommodations are typically reserved for students receiving special education, students who have a 504 plan, and English Learners can be made available to all students using the UDL principles, thus allowing all students to benefit from the accommodations.

The SIPS Grade 8 Unit 3 Instructional Framework Differentiation Strategies and Resources support educators' intentional planning of accessible, differentiated, and culturally responsive instruction for all students aligned to the specific performance expectations in focus for this unit.

Core Text Connections

- Relative Dating / Rock Formation
  - Relative Dating: Brain Pop YouTube
    [https://youtu.be/bXDys3G4d6s]
  - Relative Dating: Science Learning Hub Pokapu Akoranga Putaiao
    [https://www.sciencelearn.org.nz/resources/1485-relative-dating]
  - Determining Relative Ages: CK-12 Flexbooks 2.0
    [https://flexbooks.ck12.org/cbook/ck-12-middle-school-earth-science-flexbook-2.0/section/15.5/primary/lesson/determining-relative-ages-ms-es/]
  - Relative Rock Layers Interactive: Science Learning Hub Pokapu Akoranga Putaiao
    [https://www.sciencelearn.org.nz/labelling_interactives/4-relative-rock-layers]
  - Stratum Making Simulation: Java Lab
    [https://javalab.org/en/stratum_making_en/]
  - Sedimentary rock - formation under the sea: LSGScience
    [https://www.youtube.com/watch?v=04a_32NuYqs]
  - GCSE Science Revision - Formation of Sedimentary Rock layers - YouTube
    [https://www.youtube.com/watch?v=Yf4YtDlA1oQ]
  - PBS *Eons*
    [https://www.youtube.com/channel/UCzR-rom72PHN9Zg7RML9EbA]
  - Law of Superposition - YouTube
    [https://www.youtube.com/watch?v=EadTLGMu3LI]
  - Geochronology - Superposition Principle, Rock Strata, and Neptunist Theory | Britannica
    [https://www.britannica.com/science/geochronology/The-principle-of-superposition-of-rock-strata]
  - 1. Relative age dating - Digital Atlas of Ancient Life
    [https://www.digitalatlasofancientlife.org/learn/geological-time/relative-age-dating/]
- Major Earth Events
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General Resources:

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