Unit 8.6 Natural Selection & Common Ancestry

Content Area: **Science**
Course(s): **Science 8**
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Essential Questions

How could things living today be connected to the things that lived long ago?

Lesson 1 How are we connected to the patterns we see in the sky?

Lesson 2 What patterns are happening in the sky that I have experienced and can observe (through models and tools)?

Lesson 3 How can we explain the Sun's path change over time?

Lesson 4 How do these changes in sunlight impact us here on Earth?

Lesson 5 How can we explain phenomena like Manhattanhenge?

Lesson 6 Why do we see the shape of the Moon change?

Lesson 7 Why do we see eclipses and when do we see them?

Lesson 8 What does a lunar eclipse look like and how can we explain it?

Lesson 9 Why do the Moon and Sun appear to change color near the horizon?

Lesson 10 How does light interact with matter in the atmosphere?

Lesson 11 How does the shape of a water droplet or an ice crystal cause sunlight to form into a rainbow?

Lesson 12 Why does the Moon always change color during a lunar eclipse?

Lesson 13 What new patterns do we see when we look more closely at other objects in the sky?

Lesson 14 Why do some solar system objects orbit planets and others orbit the Sun?

Lesson 15 How did the solar system get to be the way it is today?

Lesson 16 What patterns and phenomena are beyond our solar system that we cannot see with just our eyes?

Lesson 17 How are we connected to all of the systems in space beyond the planet we live on?

Big Ideas

At the beginning of this unit, students hear about the surprising fossil of an ancient penguin (nicknamed

"Pedro") in a podcast from the researchers who found and identified the fossil. Students analyze data about modern penguins and Pedro to develop initial explanations for how these penguins could be connected. They brainstorm about 1) Where did all the ancient penguins go? 2) Where did all the different species of modern penguins come from? and 3) What other organisms alive today might also be connected to organisms that lived long ago?

After exploring variations in body structures and behaviors in modern penguins and ancient penguins, they also analyze data from ancient and modern species of horses, whales, and horseshoe crabs to see whether these organisms have similar patterns. Then, to figure out the cause of the changes they have observed in populations, students explore more recent cases of changing heritable trait distribution in populations and explain them by developing a model for natural selection.

In the last part of the unit, students use their model for natural selection to explain how some body structure variations in different species of modern penguins could result from natural selection and how they could descend from a common ancient ancestor penguin population. They analyze embryological data to their argument supporting how different species may be connected. Finally, students take stock of all the questions they answered in this unit and previous OpenSciEd units and identify questions they look forward to figuring out in high school.

Enduring Understandings

NGSS Performance Expectations

- MS-PS2-3: Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.
- MS-PS2-5: Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.
- MS-PS3-2: Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.
- MS-PS2-2*: Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
- MS-PS3-1*: Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.
- MS-PS3-5*: Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object (p. 61).

Disciplinary Core Ideas

The unit expands students' understanding of forces and energy transfer, which include these grades 6-8 DCI elements:

PS2.B: Types of Interactions

- Electrical and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. (MS-PS2-3)
- Forces that act at a distance (electrical, magnetic, and gravitational) can be explained by fields that

extend through space and can be mapped by their effect on a test object (a charged object, a magnet, or a ball, respectively). (MS-PS2-5)

PS3.A: Definitions of Energy

- A system of objects may also contain stored (potential) energy, depending on their relative positions. (MS-PS3-2)
- When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (MS-PS3-2)

The parts of the DCI elements that are not developed in this unit are crossed out. In the OpenSciEd Scope and Sequence, students will develop an understanding of gravity in OpenSciEd Unit 8.4. Electricity is treated as an extension opportunity within this unit. The placement of this OpenSciEd Unit 8.3 and associated units within the OpenSciEd Middle School Scope and Sequence.

Crosscutting Concepts

- Cause and Effect: This unit intentionally develops this crosscutting concept through the application of cause-effect sentence frames. Students routinely identify, test, and use relationships to explain change throughout.
- Systems and System Models: This crosscutting concept is key to the sensemaking in this unit.Students spend the unit breaking down and modeling the speaker system, describing and explaining the system in terms of its components and interactions
- Energy and Matter: This crosscutting concept is key to the sensemaking in this unit. Students figure out and apply the idea that energy can be transferred in various ways and between objects in order to explain how the speaker system works.
- The following crosscutting concepts are also key to the sensemaking in this unit:
    - Patterns
    - Scale, Proportion, and Quantity

CRLLKS- Career Education

Lab

Investigating Natural Selection

Objective:

Students will explore the concept of natural selection by simulating how environmental changes

can affect a population of species over time.

Reflection Questions

- Which color paper clip was most often picked up? Why?
- How did changing the background affect which paper clips were picked up?
- How does this simulation represent natural selection?

Assessment:

- Have students write a brief paragraph explaining how natural selection can lead to changes in species over generations.
- Discuss how this lab relates to real-world examples of natural selection.

MS-LS4-1 Standards Addressed:

1. Analyze and interpret data to provide evidence for the effects of natural selection on the traits of populations.
2. Use simulations to understand how changes in environmental conditions can lead to natural selection.

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Lab: Comparative Embryology

Objective: Students will compare and contrast different species of animal embryos to understand evolutionary relationships.

Reflection Questions:

- What do the similarities in embryos suggest about the relationship between species?
- How do the differences in embryos help us understand evolutionary changes?

Assessment:

Worksheet Completion: Ensure all students have filled out their worksheets with detailed observations.
- Group Discussion Feedback: Evaluate student participation and understanding through their contributions to group and class discussions.

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Lab: Exploring Technologies that Influence Inheritance of Traits

Objective:

Students will explore and understand the technologies that have changed the way humans influence the inheritance of desired traits in organisms.

Reflection Questions:

1. How have technologies like CRISPR changed our approach to influencing inheritance compared to traditional methods like selective breeding?
2. What ethical considerations should be taken into account when using genetic engineering?

Assessment:

Observe group discussions and concept map presentations to assess understanding.
● Collect completed concept maps for evaluation.

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Cross-Curricular Integration

Mathematics & Data Analysis

Analyzing Large Data Sets: Students analyze data sets containing heritable external structures and behaviors of 18 different modern penguin species to identify patterns and infer connections.

Measurement & Variation: Students look at measured physical structure variations, such as wing lengths and bone structures, to understand differences between populations.

Statistical Shifts: In Lesson 7, students analyze shifts in trait distribution over generations for five different populations, including cliff swallows and peppered moths.

Probability & Simulations: Students use computer simulations to understand how competitive advantages affect the probability of individual outcomes and lead to natural selection.

Geography & Environmental Studies

Mapping & Location Analysis: Students analyze maps to see where fossils formed and where modern penguins currently live.

Environmental Impact: Investigations include how local and global environments—such as food distribution or the presence of predators—influenced the survival of specific ancient organisms.

Case Studies: Students explore real-world geographic scenarios, such as the introduction of brown anole lizards to islands and its effect on the native green lizard population.

English-Language Arts

Argumentation: Students construct and revise explanations based on evidence, engaging in peer feedback sessions to refine their scientific arguments.

Jigsaw Strategy: A "jigsaw" reading and analysis strategy is used in Lesson 7 to have students specialize in one case study and then teach their peers.

Technical Reading: The unit requires students to analyze scientific readings and descriptions of fossil sites to gather evidence for their models.

History

Timeline Development: Students develop and update a "Penguin Timeline" representing millions of years of history to visualize how organisms changed relative to one another over deep time.

Science and Engineering Practices

Analyzing and Interpreting Data: This unit intentionally develops this practice as students investigate large data sets for variations in animals' body structures and changes over time. Although students have had prior experience with this practice, the data sets they use in this unit are the largest and most complex that they have worked with in OpenSciEd. Throughout the unit, students analyze and interpret data from photos, sketches, modern and ancient world maps, organism size comparison charts, timelines, tables displaying multiple categories of body structures, environmental and behavioral information, linear models, histograms, and box-and-whisker plots. Students consider the role of randomness in the simulations they use to describe the shifts in distribution and central tendency of trait variations in populations. The work of this unit requires students to synthesize these data sets in more-complex ways than they did in past units. Students combine evidence from their analyses and interpretation of data about multiple organisms to support the models they develop throughout the unit. The unit provides several different opportunities to assess students' work in this practice.

Constructing Explanations and Designing Solutions: This practice is intentionally developed in this unit. Students construct explanations throughout the unit as they gather evidence for the mechanism in their General Model for Natural Selection in efforts to explain "Where did all the ancient penguins go?" and "Where did all the different species of modern penguins come from?"

Students have experience with this SEP from prior units, including with long time scales and small changes accumulating over time, but now they are building that kind of explanation in living systems. There are multiple opportunities to assess students' independent use of this practice throughout the unit, including a peer feedback activity in Lesson 11 during which students respectfully provide critiques about each other's explanations and respond by adding more elaboration and detail.

Engaging in Argument from Evidence: This practice is key to the sensemaking students do in this unit. Arguing from evidence they have collected from multiple investigations is deeply embedded into students' work supporting their scientific explanations for how populations of organisms can change over time and how they are connected to those long ago. A key goal of the unit is for students to be able to say not only what they think happened in these cases of natural selection but also how the evidence supports that explanation. Students specifically engage in this practice in Lessons 5, 6, 8, and 14, at which points they can also be assessed.

The following practices are also key to the sensemaking in the unit:

- Asking questions and defining problems
- Developing and using models
- Planning and carrying out investigations
- Obtaining, evaluating, and communicating information

Science and Society

CSDT Technology Integration

8.2.8.NT.4: Explain how a product designed for a specific demand was modified to meet a new demand and led to a new product
Action: Students will identify, compare, and contrast the evolution of the microscope. Students will work with the compound light microscope, identify the parts, and explain how it works.

Digital Driving Question Boards (DQB)

Lessons 1, 4, and 15 to guide the entire investigation. Transitioning this to a digital platform like Padlet or Canva Whiteboards allows students to contribute "Notice and Wonder" post-its from their own devices, which can then be easily categorized and saved throughout the 31-day unit. A digital DQB is particularly effective for Lesson 15's "Putting the Pieces Together" phase, as teachers can instantly pull up questions from the first day of class to show students exactly how much they have figured out about the connection between ancient and modern organisms.

Interactive Fossil Timelines and Maps

Using Google Earth or HHMI BioInteractive's EarthViewer, students can manipulate a global timeline to see how plate tectonics moved continents over millions of years. This helps explain why the "Pedro" fossil was discovered in Peru and how the local environment changed from an ancient coastline to its current state. By using virtual tours of natural history museums, students can also perform "virtual observations" of whale and horse fossil structures, bridging the gap between the classroom and real-world paleontological evidence.

Collaborative Data Analysis

Students can use a shared Google Sheet where each group enters their population data. This tech integration allows the class to generate live, side-by-side bar graphs of trait distributions. Instead of spending time manually drawing graphs on posters, students can spend more time on the high-level analysis of why certain traits became more common, using the collective data of the entire class to validate their General Model for

Natural Selection.

Service Learning

Community Issue: Students will choose between one of these issues to research, create a presentation on how they can help with this issue in Milltown, and then make a pamphlet to be posted.

Focus Areas:

- **Mosquito Pathogens:** Investigate the diseases and viruses mosquitoes carry. Determine the most prevalent pathogens as well as their effects on humans and other organisms. Using the internet, library, and other resources, students can create a PowerPoint or brochure to share with the community.
- **Mosquito Population Control:** Learn about the breeding grounds of mosquitoes and how to reduce their population. Using the internet, library, and other resources, students can create a PowerPoint or brochure to share with the community.
- **Natural Predators:** Use the internet and other resources to gather information about mosquito preditors and the predator's ideal environments. Students will research the cost, the materials needed, and the placement of these objects in the environment. The information can be shared with the public.
- **Natural Pest Control:** Learn alternative methods of pest control and the different impacts that these methods have on the environment. Create a brochure to demonstrate how everyone in town can do this and not use harmful pesticides.

Activity:

- **Pre-Reflection:**
  - Students in their groups, will look over the list of types of projects they can do their project on.
  - They will talk about what they already know about mosquitos, their breeding seasons, and what they can do to share their information with the community in the most effective way. Using their previous knowledge, they will choose the best project for their group.
- **Research:**
  - Students will research their topic. They will brainstorm and come up with a concept map of how they want to create their presentation Google Slides and their pamphlet in Google Docs.
- **Presentation & Pamphlet:**
  - Students will take all of their research on their chosen topic and create a presentation in Google Slides. This presentation will be presented to the class.
  - Students will also come up with a pamphlet summarizing their presentations that can be shared on Parent Square to help bring awareness to the Milltown Community.
- **Reflection:**
  - Students will then reflect (in a Google Doc) on how they think their project went, and how they will use the suggestions they provided to help the environment.

Resources

Scientific Inquiry

MS-LS1-1 Plant, Animal, Bacteria Lab
MS-LS1-2 Cell Organelle Project - Inner Life of a Cell Multiple Project Choice, 2D Cell Project, 3D Cell Project
MS-LS3-1 Strawberry DNA Lab
MS-LS4-5 Technologies that Influence Inheritance of Traits
MS-LS4-1 Investigating Natural Selection
MS-LS4-3 Comparative Embryology