SCIENCE 3D

BATTLE DEEP: SPERM WHALES

SCIENCE PERFORMANCE EXPECTATIONS AND DISCIPLINARY CORE IDEAS

In the Middle School Mission, students will address the following general topics. Keep reading below to find the NGSS standards for each component of the mission. We will be adding Math and Language Arts standards to the document soon! *Note: Be sure to complete the **Mission Reader** and **Mission Research** before viewing the full **Mission Video**. Explore How to Use Science 3D to get suggestions on how to pace the mission and options for the order of activities.*

- In the **Mission Reader**, *Battle Deep: Sperm Whales*, students will start by exploring sperm whales and how energy and materials flow and cycle through their ecosystems. They will also learn about social behavior and organisms' roles in ecosystems. Students will see how genetic and morphological traits are used to understand relationships of current and fossil organisms and explore the physics of light, sound and pressure. Finally, they will read about threats to sperm whales and the technology scientists use to study them.
- During **Mission Research**, students will investigate evolutionary transitions in sperm whale ancestors and explore how ancient environments can be inferred from the fossil record. A second activity dives deeper into sperm whale ecology. A selection of these questions or activities can be completed to address specific standards (science or language arts) that you want to emphasize.
- In the **Science Mission**, students will enhance their math skills as they build a simple model to investigate the predator-prey interaction of sperm whales and giant squid. This model will also explore how population sizes change. Next, students will use the data they saw collected in the **Mission Video** to map where sperm whale prey are found and calculate how many sperm whales can be supported by the prey base. Then, students will explore how sperm whales might respond to changes in their environment and use what they have learned to make predictions and design next steps in the investigation.
- In the **STEM Project**, students will investigate the role of technology in science. They will define criteria and constraints required for sperm whale research and design solutions to help scientists put cameras on animals.
- In the **Explore Your Backyard** activity, students will reinforce their understanding of biotic and abiotic factors, as well as energy flow and the roles of organisms in ecosystems. They will also gain an understanding of how certain patterns are similar across different systems.

SCIENCE/ENGINEERING AND DESIGN DISCIPLINARY CORE IDEAS AND PERFORMANCE EXPECTATIONS

MISSION READER

MS-LS1-4	Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants: This discusses strategies sperm whales use for reproduction.
LS1.B	Growth and development of organisms: plant and animal reproduction and behavior: Explored for sperm whales.
MS-LS2-2	Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.
MS-LS1-6	Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.
PS3.D	Energy in chemical processes and everyday life: photosynthesis.
MS-LS2-1	Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
LS2.A	Interdependent relationships in ecosystems: competition.
LS2.A	Interdependent relationships in ecosystems: predation, mutualism, interactions similar across ecosystem types.
MS-LS2-3	Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
LS2.B	Cycles of matter and energy transfer: food web models.
MS2-LS2-4	Construct and argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

*ELA and Math standards to come

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.
LS4.A	Evidence of common ancestry and diversity: collection of fossils and placement is know from position and dating known as the fossil record; it documents existence, diversity, extinction.
MS-LS4-2	Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and modern and fossil organisms to infer evolutionary relationships.
LS4.A	Evidence of common ancestry and diversity: anatomical similarities and differences between fossils and modern taxa allow evolutionary history reconstruction.
PS1.B	Chemical reactions: some reactions release energy others store it.
MS-PS4-2	Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.
PS4.A	Wave properties: sound must travel through a medium.
PS4.B	Electromagnetic radiation: light.

MISSION RESEARCH

MS-LS1-6	Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.
MS-LS2-2	Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.
LS2.A	Interdependent relationships in ecosystems: predation, mutualism, interactions similar across ecosystem types.
LS2.A	Interdependent relationships in ecosystems: competition and resource limitation.
LS2.B	Cycles of matter and energy transfer: food web models.
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.
MS-LS4-2	Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and modern and fossil organisms to infer evolutionary relationships.
LS4.C	Adaptation.
MS-LS-1-4	Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants. Focus here is on animals. Plants are covered in other missions.
LS1.B	Growth and development of organisms: plant and animal reproduction and behavior. Focus here is on animals. Plants are covered in other missions.

SCIENCE MISSION

MS-LS2-1	Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
LS2.A	Interdependent relationships in ecosystems.
MS-LS2-3	Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
LS2.A	Interdependent relationships in ecosystems: competition and resource limitation.
LS2.B	Cycles of matter and energy transfer: food web models.
MS2-LS2-4	Construct and argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
MS-S4-4	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. Focus less on genetics in this lesson. **The Black Panther Mission** investigates genetic basis, but this activity provides a mathematical simulation of selection that is based on genetic variation influencing survival.
LS4.B	Natural selection: some traits common some rare.
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.
LS4.C	Adaptation.

STEM PROJECT

MS-ETS1-1	Define the criteria and constrains of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
MS-ETS2-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constrain.
ETS1.A	Defining and delimiting engineering problems: more precision in constraints and criteria is better.

*ELA and Math standards to come

ETS1.B	Developing possible solutions: systematic processes for evaluating solutions to make sure they meet criteria and constraints.
ETS1.C	Optimizing the design solution: interactive process leads to optimal solutions.

EXPLORE YOUR BACKYARD

MS-LS2-3	Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
LS2.B	Cycles of matter and energy transfer: food web models.

CROSS CUTTING CONCEPTS

Patterns: Mission Reader, Mission Research, Science Mission, Explore Your Backyard
Cause and Effect: Mechanisms and Predictions: Mission Reader, Science Mission
Scale Proportion and Quantity: Mission Reader, Science Mission
System and system models: All
Energy and matter: flows, cycles and conservation: Mission Reader, Mission Research, Science Mission, Explore Your Backyard
Structure and function: Mission Reader, Mission Research
Stability and change: Mission Reader, Mission Research, Science Mission

CONNECTION TO ENGINEERING, TECHNOLOGY AND APPLICATIONS OF SCIENCE

Interdependence of Science, Engineering and Technology: Mission Reader, Science Mission, STEM Project
Influence of Science, Engineering and Technology on Society and the Natural World: Mission Reader, Science Mission, STEM Project

CONNECTION TO NATURE OF SCIENCE

Scientific investigations use a variety of methods: Mission Reader, Science Mission, STEM Project
Scientific knowledge is based on empirical evidence: Mission Reader, Mission Research, STEM Project
Science models, laws, mechanisms and theories explain natural phenomena: Mission Reader, Science Mission, Mission Research, Explore Your Backyard
Science is a way of knowing: Mission Reader, Science Mission
Science is a human endeavor: Mission Reader, STEM Project
Science addresses questions about the natural and material world: All

SCIENCE AND ENGINEERING PRACTICES

Asking questions and defining problems: Mission Reader, Science Mission, STEM Project
Developing and using models: All
Planning and carrying out investigations: Science Mission
Analyzing and interpreting data: Science Mission
Using mathematics and computational thinking: Science Mission
Constructing explanations and designing solutions: Science Mission, STEM Project
Engaging in argument from evidence: Science Mission, STEM Project
Obtaining, evaluating and communicating information: Mission Reader, Mission Research, Science Mission, STEM Project

*ELA and Math standards to come