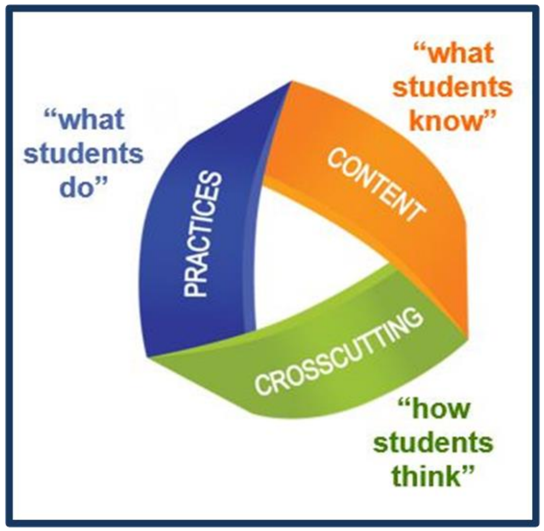
Ledyard Public Schools
Middle School NGSS Curriculum Course 1



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District Philosophy

Ledyard's vision for K-12 inquiry based science is to engage students in scientific and engineering practices as they apply crosscutting concepts to deepen their understanding of the core ideas in these fields.

A New Vision for Science Education

Implications of the Vision of the Framework for K-12 Science Education and the Next Generation Science Standards

SCIENCE EDUCATION WILL INVOLVE LESS:	SCIENCE EDUCATION WILL INVOLVE MORE:
Rote memorization of facts and terminology.	Facts and terminology learned as needed while developing explanations and designing solutions supported by evidence-based arguments and reasoning.
Learning of ideas disconnected from questions about phenomena.	Systems thinking and modeling to explain phenomena and to give a context for the ideas to be learned.
Teachers providing information to the whole class.	Students conducting investigations, solving problems, and engaging in discussions with teachers' guidance.
Teachers posing questions with only one right answer.	Students discussing open-ended questions that focus on the strength of the evidence used to generate claims.
Students reading textbooks and answering questions at the end of the chapter.	Students reading multiple sources, including science-related magazine and journal articles and web-based resources; students developing summaries of information.
Pre-planned outcome for "cookbook" laboratories or hands-on activities.	Multiple investigations driven by students' questions with a range of possible outcomes that collectively lead to a deep understanding of established core scientific ideas.
Worksheets.	Student writing of journals, reports, posters, and media presentations that explain and argue.
Oversimplification of activities for students who are perceived to be less able to do science and engineering	Provision of supports so that all students can engage in sophisticated science and engineering practices

Source: National Research Council. (2015). *Guide to Implementing the Next Generation Science Standards* (pp. 8-9). Washington, DC: National Academies Press. http://www.nap.edu/catalog/18802/guide-to-implementing-the-next-generation-science-standards

Three Dimensions of the *Next Generation Science Standards*:

SEP (appendix F), DCI (appendix E), CCC (appendix G)

Scientific and Engineering Practices Matrix

Asking Questions and Defining Problems

A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world works and which can be empirically tested.

Engineering questions clarify problems to determine criteria for successful solutions and identify constraints to solve problems about the designed world. Both scientists and engineers also ask questions to clarify the ideas of others.

Planning and Carrying Out Investigations

Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters. Engineering investigations identify the effectiveness, efficiency, and durability of designs under different conditions.

Analyzing and Interpreting Data

Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis.

Engineering investigations include analysis of data collected in the tests of designs. This allows comparison of different solutions and determines how well each meets specific design criteria—that is, which design best solves the problem within given constraints. Like scientists, engineers require a range of tools to identify patterns within data and interpret the results. Advances in science make analysis of proposed solutions more efficient and effective.

Developing and Using Models

A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations. Modeling tools are used to develop questions, predictions and explanations; analyze and identify flaws in systems; and communicate ideas. Models are used to build and revise scientific explanations and proposed engineered systems. Measurements and observations are used to revise models and designs.

Constructing Explanations and Designing Solutions

The products of science are explanations and the products of engineering are solutions. The goal of science is the construction of theories that provide explanatory accounts of the world. A theory becomes accepted when it has multiple lines of empirical evidence and greater explanatory power of phenomena than previous theories. The goal of engineering design is to find a systematic solution to problems that is based on scientific knowledge and models of the material world. Each proposed solution results from a process of balancing competing criteria of desired functions, technical feasibility, cost, safety, aesthetics, and compliance with legal requirements. The optimal choice depends on how well the proposed solutions meet criteria and constraints.

Engaging in Argument from Evidence

Argumentation is the process by which explanations and solutions are reached. In science and engineering, reasoning and argument based on evidence are essential to identifying the best explanation for a natural phenomenon or the best solution to a design problem. Scientists and engineers use argumentation to listen to, compare, and evaluate competing ideas and methods based on merits. Scientists and engineers engage in argumentation when investigating a phenomenon, testing a design solution, resolving questions about measurements, building data models, and using evidence to identify strengths and weaknesses of claims.

Using Mathematics and Computational Thinking

In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; statistically analyzing data; and recognizing, expressing, and applying quantitative relationships. Mathematical and computational approaches enable scientists and engineers to predict the behavior of systems and test the validity of such predictions. Statistical methods are frequently used to identify significant patterns and establish correlational relationships.

Obtaining, Evaluating, and Communicating Information

Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity. Communicating information and ideas can be done in multiple ways: using tables, diagrams, graphs, models, and equations as well as orally, in writing, and through extended discussions. Scientists and engineers employ multiple sources to acquire information that is used to evaluate the merit and validity of claims, methods, and designs.

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Developed by NSTA based on content from the *Framework for K-12 Science Education* and supporting documents for the *May 2012 Public Draft of the NGSS*

Disciplinary Core Ideas Matrix Course 1 Disciplinary Core Ideas are highlighted yellow			
Physical Science	**Life Science**	**Earth and Space Science**	**Engineering, Technology, and the Application of Science**
PS1: Matter and Its Interactions PS1.A: Structure and Properties of Matter PS1.B: Chemical Reactions PS1.C: Nuclear Processes **PS2: Motion and Stability: Forces and Interactions** PS2.A: Forces and Motion PS2.B: Types of Interactions **PS3: Energy** PS3.A: Definitions of Energy PS3.B: Conservation of Energy and Energy Transfer PS3.C: Relationship Between Energy and Forces PS3.D: Energy in Chemical Processes and Everyday Life **PS4: Waves and Their Applications in Technologies for Information Transfer** PS4.A: Wave Properties PS4.B: Electromagnetic Radiation PS4.C: Information Technologies and Instrumentation	**LS1: From Molecules to Organisms: Structures and Processes** LS1.A: Structure and Function LS1.B: Growth and Development of Organisms LS1.C: Organization for Matter and Energy Flow in Organisms LS1.D: Information Processing **LS2: Ecosystems: Interactions, Energy, and Dynamics** LS2.A: Interdependent Relationships in Ecosystems LS2.B: Cycles of Matter and Energy Transfer in Ecosystems LS2.C: Ecosystem Dynamics, Functioning, and Resilience LS2.D: Social Interactions and Group Behavior **LS3: Heredity: Inheritance and Variation of Traits** LS3.A: Inheritance of Traits LS3.B: Variation of Traits **LS4: Biological Evolution: Unity and Diversity** LS4.A: Evidence of Common Ancestry and Diversity LS4.B: Natural Selection LS4.C: Adaptation LS4.D: Biodiversity and Humans	**ESS1: Earth's Place in the Universe** ESS1.A: The Universe and Its Stars ESS1.B: Earth and the Solar System ESS1.C: The History of Planet Earth **ESS2: Earth's Systems** ESS2.A: Earth Materials and Systems ESS2.B: Plate Tectonics and Large-Scale Systems ESS2.C: The Role of Water in Earth's Surface Processes ESS2.D: Weather and Climate ESS2.E: Biogeology **ESS3: Earth and Human Activity** ESS3.A: Natural Resources ESS3.B: Natural Hazards ESS3.C: Human Impacts on Earth Systems ESS3.D: Global Climate Change	**ETS1: Engineering Design** ETS1.A: Defining and Delimiting an Engineering Problem ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution

Developed by NSTA based on content from the *Framework for K-12 Science Education* and supporting documents for the *May 2012 Public Draft of the NGSS*

Crosscutting Concepts Matrix		
Patterns Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them. Cause and Effect: Mechanism and Explanation Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.	Scale, Proportion, and Quantity In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance. Systems and System Models Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.	Energy and Matter: Flows, Cycles, and Conservation Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations. Structure and Function The way in which an object or living thing is shaped and its substructure determine many of its properties and functions. Stability and Change For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

Developed by NSTA based on content from the *Framework for K-12 Science Education* and supporting documents for the *May 2012 Public Draft of the NGSS*

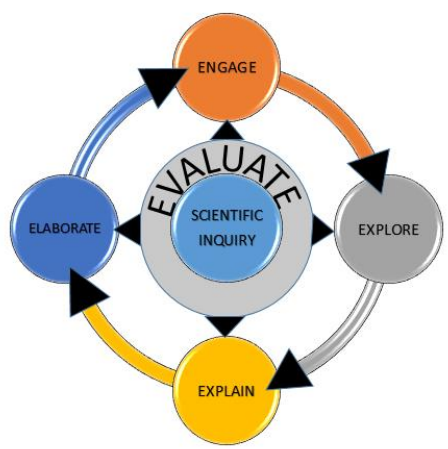
Connections to the Nature of Science

Nature of Science Practices	Nature of Science Crosscutting Concepts
These understandings about the nature of science are closely associated with the science and engineering practices, and are found in that section of the foundation box on a standards page. More information about the Connections to Engineering, Technology and Applications of Science can be found in Appendix H.	These understandings about the nature of science are closely associated with the crosscutting concepts, and are found in that section of the foundation box on a standards page. More information about the Connections to Engineering, Technology and Applications of Science can be found in Appendix H.
Scientific Investigations Use a Variety of Methods	Science is a Way of Knowing
Science Knowledge is Based on Empirical Evidence	Scientific Knowledge Assumes and Order and Consistency in Natural Systems
Scientific Knowledge is Open to Revision in Light of New Evidence	Science is a Human Endeavor
Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena.	Science Addresses Questions About the Natural and Material World

How does Ledyard Define Inquiry?

Inquiry is defined as a way of seeking information, knowledge, or truth through questioning. Inquiry is a way for a learner to acquire new information and data and turn it into useful knowledge. Inquiry involves asking good questions and developing robust investigations from them. Inquiry also involves considering possible solutions and consequences. A third component of inquiry is separating evidence based claims from common opinion, and communicating claims with others, and acting upon these claims when appropriate. Questions lead to gathering information through research, study, experimentation, observation, or interviews. During this time, the original question may be revised, a line of research refined, or an entirely new path may be pursued. As more information is gathered, it becomes possible to make connections and allows individuals to construct their own understanding to form new knowledge. Sharing this knowledge with others develops the relevance of the learning for both the student and a greater community. Sharing is followed by reflection and potentially more questions, bringing the inquiry process full circle.

Inquiry 5 Science Teaching Model



Engagement	Object, event or question used to engage students. Connections facilitated between what students know and can do.
Exploration	Objects and phenomena are explored. Hands-on activities, with guidance.
Explanation	Students explain their understanding of concepts and processes. New concepts and skills are introduced as conceptual clarity and cohesion are sought.
Elaboration	Activities allow students to apply concepts in contexts, and build on or extend understanding and skill.
Evaluation	Students assess their knowledge, skills and abilities. Activities permit evaluation of student development and lesson effectiveness.

Ledyard Next Generation Science Standards Grade 6

Unit 1: The Study of Energy and Energy Transfer

August-November

Anchoring Phenomenon	
Steam powered engine Geothermal energy	
Compelling Questions	**Supporting Questions**
How can we measure the flow of energy in a system?	• *How do tiny, moving particles in the atmosphere cause temperature changes all around our planet?* • *What is energy?* • *How does energy affect temperature?* • *How does heat affect matter?*
Storyline	**Possible Student Misconceptions:**
Students will investigate and understand the relationship between heat, temperature and molecules. By the end of the unit, student understanding of thermal energy will guide them in their construction of a device to maintain a specific temperature.	• *Heat is made up of 'heat' molecules* • *Only heat, not cold transfers* • *The mass of atoms or molecules increases with temperature increase, and decreases with temperature decrease*

Unit 1: The Study of Energy and Energy Transfer Overview

Performance Expectations	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• **MS-PS3-3** • **MS-PS3-4** • **MS-PS3-5** • **MS-ETS1-3** *Teacher Note: All the* ***Performance Expectations*** *above will be covered this unit and can be worked on concurrently. All* ***Science and Engineering Practices*** *and* ***Crosscutting Concepts*** *in bold are written in the Performance Expectations above. The italicized practices and crosscutting concepts, although not mentioned specifically, may be incorporated additionally in any science lesson at any time.*	• *1: Asking Questions and Defining Problems* • 2: Developing and Using Models • **3: Planning and Carrying Out Investigations** • *4: Analyzing and Interpreting Data* • *5: Using Mathematical Computational Thinking* • ***6: Constructing Explanations and Designing Solutions*** • ***7: Engaging in Argument from Evidence*** • *8: Obtaining, Evaluating, and Communicating Information*	**ENGINEERING, TECHNOLOGY AND THE APPLICATION OF SCIENCE** • **ETS1 Engineering Design** -ETS1.B Developing Possible Solutions -ETS1.C Optimizing the Design Solution **PHYSICAL SCIENCE** • **PS3 Energy** -PS3.A: Definitions of Energy -PS3.B: Conservation of Energy and Energy Transfer	• *1: Patterns* • 2: Cause and Effect • ***3: Scale, Proportion and Quantity*** • *4: Systems and System Models* • ***5: Energy and Matter*** • 6: Structure and Function • *7: Stability and Change*

Performance Expectation
MS-PS3-3 Energy

Students who demonstrate understanding can:

Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.

Assessment Boundary: *Assessment does not include calculating the total amount of thermal energy transferred.*

Lesson Level Phenomenon: Ice melts faster on some surfaces than others. Also use pictures of hot drink cups, cold drink cups, thermos, coolers.

note: all photo and video above links to suggested activities below

MS-PS3-3 Suggested Activities	MS-PS3-3 Recommended Formative Assessments
Taking Earth's Temperature (*TCI Weather and Climate: Unit 1 The Atmosphere and Energy, Lesson 2)* Students will be building a thermometer and examining the transfer of energy to design a device that will maintain a desired temperature. (5-6 class periods) Thermal Properties of Matter (*TCI Forces and Energy: Unit 4, Lesson 11)* Students will investigate thermal properties of matter, and energy changes during changes of state(s) in matter. (2-3 class periods)	• Gather data to support or refute a claim for the device. • Share a multi-media presentation of device.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions • Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system. **Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.**	**PS3.A: Definitions of Energy** • Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. **PS3.B: Conservation of Energy and Energy Transfer** • Energy is spontaneously transferred out of hotter regions or objects and into colder ones. **ETS1.A: Defining and Delimiting an Engineering Problem** • The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. *(secondary)* **ETS1.B: Developing Possible Solutions** • A solution needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. *(secondary)*	**Energy and Matter** • The transfer of energy can be tracked as energy flows through a designed or natural system.

Performance Expectation
MS-PS3-3 Energy

Connections to other DCIs in Middle School:
MS.PS1.B ; MS.ESS2.A ; MS.ESS2.C ; MS.ESS2.D

Articulation of DCIs across grade-levels:
4.PS3.B ; HS.PS3.B

Common Core State Standards Connections:

ELA/Literacy -

RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. *(MS-PS3-3)*

WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-PS3-3)

Mathematics -
N/A

Lesson Level Vocabulary: *kinetic energy, temperature, proportional, heat, conduction, radiation, convection, evaporation, condensation, thermal conductivity, thermal conductor, thermal insulator, heat capacity*

DCI Domain Vocabulary:

Domains are bold:

- **Energy→Definitions of Energy, Conservation of Energy and Energy Transfer (PS3)**
  average, chemical process, combination, conservation of energy, conserve, control (variable), conversion, convert, current, dependent variable, design task, electric current, electrical circuit, electrical energy, evolve, field, generator, heat convection, heat energy, heat radiation, heat retention, heat transfer, independent variable, insulate, kinetic energy, limited, macroscopic scale, magnitude, mass, mechanical motion, microscopic scale, motion energy, particle, passive, precise, precision, proportional, ratio, relative, renewable energy, solar heater, spontaneous, square root, store, stored energy, systematic, thermal, thermal energy, transfer, uniform, wind turbine

Performance Expectation
MS-PS3-4 Energy

Students who demonstrate understanding can:

Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

Clarification Statement: Examples of experiments could include comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass as they cool or heat in the environment, or the same material with different masses when a specific amount of energy is added

Assessment Boundary: *Assessment does not include calculating the total amount of thermal energy transferred*

Lesson Level Phenomenon: **Food coloring in hot and cold water.; Hot and cold water kinetic energy of molecules/heat transfer.**

note: all photo and video above links to suggested activities below

MS-PS3-4 Suggested Activities	MS-PS3-4 Recommended Formative Assessments
Taking Earth's Temperature (*TCI Weather and Climate: Unit 1, Lesson 2)* Students will be building a thermometer and examining the transfer of energy. (5-6 class periods) Thermal Energy and Heat (*TCI Forces and Energy: Unit 4, Lesson 10)* Students will construct and observe models of thermal equilibrium and three methods of heat transfer/energy flow (conduction, convection, and radiation). (3-4 class periods) Thermal Properties of Matter (*TCI Forces and Energy: Unit 4, Lesson 11)* Students will investigate thermal properties of matter, and energy changes during changes of state(s) in matter. (2-3 class periods)	• Write a claim about how energy flows, and will gather data to support or refute their claim for thermal energy transfer/energy flow. • Construct and revise a model identifying how heat is transferred.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations • Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. **Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.** --- ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** • Science knowledge is based upon logical and conceptual connections between evidence and explanations.	**PS3.A: Definitions of Energy** • Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. **PS3.B: Conservation of Energy and Energy Transfer** • The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment.	**Scale, Proportion, and Quantity** • Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes.

Performance Expectation
MS-PS3-4 Energy

Connections to other DCIs in Middle School:
MS.PS1.A ; MS.PS2.A ; MS.ESS2.C ; MS.ESS2.D ; MS.ESS3.D

Articulation of DCIs across grade-levels:
4.PS3.C ; HS.PS1.B ; HS.PS3.A ; HS.PS3.B

Common Core State Standards Connections:

ELA/Literacy -

RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS3-4)

WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. *(MS-PS3-4)*

Mathematics -

MP.2 Reason abstractly and quantitatively. (MS-PS3-4)

6.SP.B.5 Summarize numerical data sets in relation to their context. *(MS-PS3-4)*

Lesson Level Vocabulary: *kinetic energy, temperature, proportional, heat, conduction, radiation, convection, evaporation, condensation, thermal energy, thermal equilibrium, thermal conductivity, thermal conductor, thermal insulator, heat capacity*

DCI Domain Vocabulary:

Domains are bold:

- **Energy→Definitions of Energy, Conservation of Energy and Energy Transfer (PS3)**
  average, chemical process, combination, conservation of energy, conserve, control (variable), conversion, convert, current, dependent variable, design task, electric current, electrical circuit, electrical energy, evolve, field, generator, heat convection, heat energy, heat radiation, heat retention, heat transfer, independent variable, insulate, kinetic energy, limited, macroscopic scale, magnitude, mass, mechanical motion, microscopic scale, motion energy, particle, passive, precise, precision, proportional, ratio, relative, renewable energy, solar heater, spontaneous, square root, store, stored energy, systematic, thermal, thermal energy, transfer, uniform, wind turbine

Performance Expectation
MS-PS3-5 Energy

Students who demonstrate understanding can:
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.
Clarification Statement: Examples of empirical evidence used in arguments could include an inventory or other representation of the energy before and after the transfer in the form of temperature changes or motion of object.
Assessment Boundary: *Assessment does not include calculations of energy.*

Lesson Level Phenomenon: Roller Coaster, Playing Pool, Rube Goldberg
note: all photo and video above links to suggested activities below

MS-PS3-5 Suggested Activities	MS-PS3-5 Recommended Formative Assessments
Taking Earth's Temperature (*TCI Weather and Climate: Unit 1, Lesson 2)* Students will be building a thermometer and examining the transfer of energy to design a device that will maintain a desired temperature. (5-6 class periods) Forms of Energy (*TCI Forces and Energy: Unit 3, Lesson 7)* Students will trace energy transformation in a system. (3 class periods) Thermal Energy and Heat (*TCI Forces and Energy: Unit 4, Lesson 10)* Students will construct and observe models of thermal equilibrium and three methods of heat transfer/energy flow (conduction, convection, and radiation). (3-4 class periods)	• Write a claim about how energy flows, and will gather data to support or refute their claim for thermal energy transfer/energy flow. • Construct and revise a model identifying how heat is transferred. • Gather data to support or refute their claim for their device. • Present data in a multi-media shared presentation. • Create a trebuchet machine to illustrate energy transformation.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence • Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon. **Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed worlds.** --- ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** • Science knowledge is based upon logical and conceptual connections between evidence and explanations.	**PS3.B: Conservation of Energy and Energy Transfer** • When the motion energy of an object changes, there is inevitably some other change in energy at the same time.	**Energy and Matter** • Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion).

Performance Expectation
MS-PS3-5 Energy

Connections to other DCIs in Middle School:
MS.PS2.A

Articulation of DCIs across grade-levels:
4.PS3.C ; HS.PS3.A ; HS.PS3.B

Common Core State Standards Connections:
ELA/Literacy –

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. *(MS-PS3-5)*

WHST.6-8.1 Write arguments focused on discipline content. *(MS-PS3-5)*

Mathematics –

MP.2 Reason abstractly and quantitatively. (MS-PS3-5)

6.RP.A.1 Understand the concept of ratio and use ratio language to describe a ratio relationship between two quantities. *(MS-PS3-5)*

7.RP.A.2 Recognize and represent proportional relationships between quantities. *(MS-PS3-5)*

8.F.A.3 Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. *(MS-PS3-5)*

Lesson Level Vocabulary: *kinetic energy, temperature, proportional, heat, conduction, radiation, convection, evaporation, condensation, energy, potential energy, law of conservation of energy, temperature, thermal equilibrium, thermal energy*

DCI Domain Vocabulary:
Domains are bold:

- **Energy→Conservation of Energy and Energy Transfer (PS3)**
  average, chemical process, conservation, conservation of energy, control (variable), conversion, convert, current, dependent variable, design task, electric current, electrical circuit, electrical energy, evolve, field, heat convection, heat energy, heat radiation, heat retention, heat transfer, independent variable, insulate, kinetic energy, magnitude, mass, mechanical motion, motion energy, particle, passive, precise, precision, proportional, ratio, solar heater, spontaneous, stored energy, systematic, thermal, thermal energy, transfer, uniform,

Performance Expectation
MS-ETS1-3 Engineering Design

Students who demonstrate understanding can:
Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
Clarification Statement: N/A
Assessment Boundary: N/A

Lesson Level Photo Analysis: N/A

MS-ETS1-3 Suggested Activities	MS-ETS1-3 Recommended Formative Assessments
Minimizing and Maximizing the Rate of Heat Transfer (TCI Weather and Climate: Engineering Challenge) Students will build either a cooler (insulator) for use in Death Valley or a solar cooker (conductor) for use in Antarctica. (2-3 class periods)	• Gather data to support or refute their claim for their insulator/conductor. • Present design results/data in a multi-media shared presentation to an audience for a design contest.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data • Analyze and interpret data to determine similarities and differences in findings. **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.**	**ETS1.B: Developing Possible Solutions** There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. • Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. **ETS1.C: Optimizing the Design Solution** • Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design.	**N/A**

Performance Expectation
MS-ETS1-3 Engineering Design

Connections to MS-ETS1.B: Developing Possible Solutions Problems include:
Physical Science: MS-PS1-6, MS-PS3-3, Life Science: MS-LS2-5
Connections to MS-ETS1.C: Optimizing the Design Solution include:
Physical Science: MS-PS1-6

Articulation of DCIs across grade-bands:
3-5.ETS1.A ; 3-5.ETS1.B ; 3-5.ETS1.C ; HS.ETS1.B ; HS.ETS1.C

Common Core State Standards Connections:
ELA/Literacy –

RST.6-8.1	Cite specific textual evidence to support analysis of science and technical texts. *(MS-ETS1-3)*
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-ETS1-3)*
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-ETS1-3)

Mathematics –

MP.2	Reason abstractly and quantitatively. *(MS-ETS1-3)*
7.EE.3	Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. *(MS-ETS1-3)*

Lesson Level Vocabulary: *thermal conductivity, thermal conductor, thermal insulator, heat capacity*

DCI Domain Vocabulary:
Domains are bold:

- **Engineering→Developing Possible Solutions (ETS1)**
  abstract, agreed-upon, break down, concrete, consideration, convincing, criteria, jointly, mathematical model, physical replica, priority, real-world, representation, societal, systematic, theoretical model

Unit 2: The Study of Earth's Systems and Human Impact

November-March

<table>
<tr><th colspan="2">Anchoring Phenomenon</th></tr>
<tr><td colspan="2">Severe weather events can lead to loss of property and/or life.
Earth's average temperature is increasing.</td></tr>
<tr><th>Compelling Questions</th><th>Supporting Questions</th></tr>
<tr><td>What is contributing to the rise in global temperature?</td><td>• How is all of Earth's water recycled?
• How does water affect weather as it cycles through Earth's system?
• What is wind and what makes it blow?
• What are the effects of recent changes in Earth's climate, and how can we address them?</td></tr>
<tr><th>Storyline</th><th>Possible Student Misconceptions:</th></tr>
<tr><td>Students will build an understanding about the water cycle, regional climate weather patterns, the rise of global temperature, and the relationship between humans and the environment.</td><td>• Weather and climate are the same.
• Global rising temperatures mean less snow during the winter.
• Global changes in temperature happen quickly.
• Climate change does not exist or happen.</td></tr>
</table>

Unit 2: The Study of Earth's Systems and Human Impact Overview

Performance Expectations	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• **MS-ESS2-4** • **MS-ESS2-5** • **MS-ESS2-6** • **MS-ESS3-3** • **MS-ESS3-5** • **MS-ETS1-4** *Teacher Note: All the Performance Expectations above will be covered this unit and can be worked on concurrently. All Science and Engineering Practices and Crosscutting Concepts in bold are written in the Performance Expectations above. The italicized practices and crosscutting concepts, although not mentioned specifically, may be incorporated additionally in any science lesson at any time.*	• ***1: Asking Questions and Defining Problems*** • **2: Developing and Using Models** • **3: Planning and Carrying Out Investigations** • *4: Analyzing and Interpreting Data* • *5: Using Mathematical Computational Thinking* • ***6: Constructing Explanations and Designing Solutions*** • *7: Engaging in Argument from Evidence* • *8: Obtaining, Evaluating, and Communicating Information*	**ENGINEERING, TECHNOLOGY AND THE APPLICATION OF SCIENCE** • **ETS1 Engineering Design** -ETS1.B Developing Possible Solutions -EST1.C Optimizing the Design Solution **EARTH AND SPACE SCIENCE** • **ESS2 Earth's Systems** -ESS2.C: The Role of Water in Earth's Processes -ESS2.D: Weather and Climate • **ESS3 Earth and Human Activity** -ESS3.C: Human Impacts on Earth's Systems -ESS3.D: Global Climate Change	• *1: Patterns* • **2: Cause and Effect** • *3: Scale, Proportion and Quantity* • ***4: Systems and System Models*** • ***5: Energy and Matter*** • 6: Structure and Function • ***7: Stability and Change***

Performance Expectation
MS-ESS2-4 Earth's Systems

Students who demonstrate understanding can:
Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.
Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.
Assessment Boundary: *A quantitative understanding of the latent heats of vaporization and fusion is not assessed.*

Lesson Level Phenomenon: Warm air rises and then cools, clouds form.
note: all photo and video above links to suggested activities below

MS-ESS2-4 Suggested Activities	MS-ESS2-4 Recommended Formative Assessments
Water and the Weather (*TCI Weather and Climate: Unit 2 Weather, Lesson 5)* Students will design and construct a functioning psychrometer to measure relative humidity and dew point levels. Students will develop an understanding of why water is in the air (water cycle) due to the influences of the sun and gravity. (3-4 class periods) **The Water Cycle** (*TCI Planet Earth: Unit 2 Processes that Shape the Earth, Lesson 5)* Students will identify where water can be found on Earth, and discover ways water moves. (5-6 class periods)	• Develop and discuss aspects of the psychrometer design. • Create a physical model, children's book or drama to explain the water cycle, identifying three or more components of the water cycle and explaining three or more processes by which water transfers between the components of the water cycle.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Develop a model to describe unobservable mechanisms. **Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.**	**ESS2.C: The Roles of Water in Earth's Surface Processes** • Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. • Global movements of water and its changes in form are propelled by sunlight and gravity.	**Energy and Matter** • Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter.

Performance Expectation
MS-ESS2-4 Earth's Systems

Connections to other DCIs in Middle School:
MS.PS1.A ; MS.PS2.B ; MS.PS3.A ; MS.PS3.D

Articulation of DCIs across grade-levels:
3.PS2.A ; 4.PS3.B ; 5.PS2.B ; 5.ESS2.C ; HS.PS2.B ; HS.PS3.B ; HS.PS3.D ; HS.PS4.B ; HS.ESS2.A ; HS.ESS2.C ; HS.ESS2.D

Common Core State Standards Connections:
ELA/Literacy -
N/A

Mathematics -
N/A

Lesson Level Vocabulary: *water cycle, evaporation, transpiration, condensation, precipitation, runoff, infiltration, ground water, absolute humidity, relative humidity, dew, dew point, crystallization*

DCI Domain Vocabulary:
Domains are bold:

- **Earth's Systems→The Roles of Water in Earth's Surface Processes (ESS2)**
  alternative, chemical, condensation, content, crystal, deposition, dissolve, distribution, dynamic, evaporation, groundwater, hydrologic cycle, mechanical, melting point, mineral, molecular, percentage, percolation, polar ice caps, reservoir, rock cycle, store, transfer, transmit, transpiration, universal solvent, water cycle, wetland

Performance Expectation
MS-ESS2-5 Earth's Systems

Students who demonstrate understanding can:

Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions.

Clarification Statement: Emphasis is on how air masses flow from regions of high pressure to low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time, and how sudden changes in weather can result when different air masses collide. Emphasis is on how weather can be predicted within probabilistic ranges. Examples of data can be provided to students (such as weather maps, diagrams, and visualizations) or obtained through laboratory experiments (such as with condensation)

Assessment Boundary: *Assessment does not include recalling the names of cloud types or weather symbols used on weather maps or the reported diagrams from weather stations.*

Lesson Level Photo Analysis: Block Island Wind Farm

note: all photo and video above links to suggested activities below

MS-ESS2-5 Suggested Activities	MS-ESS2-5 Recommended Formative Assessments
Air Pressure and Wind *(TCI Weather and Climate: Unit 2 Weather, Lesson 4) Students will investigate atmospheric pressure and wind, how they are measured, and how they affect and determine changes in the weather. (4-5 class periods)*	• Collect Ledyard and regional (New England) atmospheric pressure using multiple resources (e.g weatherunderground.com), wind speed and temperature data and predict weather changes.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations • Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. **Planning and carrying out investigations in 6-8 builds on K-5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions.**	**ESS2.C: The Roles of Water in Earth's Surface Processes** • The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. **ESS2.D: Weather and Climate** • Because these patterns are so complex, weather can only be predicted probabilistically.	**Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Performance Expectation
MS-ESS2-5 Earth's Systems

Connections to other DCIs in Middle School:
MS.PS1.A ; MS.PS2.A ; MS.PS3.A ; MS.PS3.B

Articulation of DCIs across grade-levels:
3.ESS2.D ; 5.ESS2.A ; HS.ESS2.C ; HS.ESS2.D

Common Core State Standards Connections:

ELA/Literacy –

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS2-5)

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-ESS2-5)

WHST.6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. *(MS-ESS2-5)*

Mathematics –

MP.2 Reason abstractly and quantitatively. (MS-ESS2-5)

6.NS.C.5 Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. (MS-ESS2-5)

Lesson Level Vocabulary: *atmospheric pressure, density, sea level, barometer, wind, anemometer, convection cell, prototype*

DCI Domain Vocabulary:
Domains are bold:

- **Earth's Systems →The Roles of Water in Earth's Surface Processes; Weather and Climate (ESS2)**
  accuracy, air mass, air mass circulation, alternative, altitude, atmospheric, atmospheric circulation, average, biosphere, carbon dioxide, chemical, climate change, climatic pattern, condensation, constrain, content, convection cycle, Coriolis effect, crystal, cyclical, density, deposition, determinate, dissolve, distribution, dynamic, evaporation, geographic, geography, geological, gradual, groundwater, high pressure, human activity, humidity, hydrologic cycle, intensity, land distribution, latitude, latitudinal, longitude, longitudinal, low pressure, mass, mechanical, melting point, mineral, molecular, ocean circulation, oceanic, orbit, orientation, percentage, percolation, polar ice caps, pressure, probabilistic, redistribute, reservoir, rock cycle, salinity, solar, store, tectonic, tectonic cycle, tilt, time scale, transfer, transmit, transpiration, unequal heating of air, unequal heating of land masses, unequal heating of oceans, universal solvent, volcanic ash cloud, water cycle, weather map, wetland

Performance Expectation
MS-ESS2-6 Earth's Systems

Students who demonstrate understanding can:
Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.
Clarification Statement: Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. Examples of models can be diagrams, maps and globes, or digital representations.
Assessment Boundary: Assessment does not include the dynamics of the Coriolis effect

Lesson Level Photo Analysis: Connecticut temperatures (shoreline vs inland) (locate a map showing isotherms for the state of Connecticut)
Lesson Level Phenomenon Video: Some places are windy, some are not. Earth's surface is warmer at the equator than at its poles. The sooty shearwater's migration follows the same figure-eight pattern each time. The local climates on either side of a mountain are different.
note: all photo and video above links to suggested activities below

MS-ESS2-6 Suggested Activities	MS-ESS2-6 Recommended Formative Assessments
Air Pressure and Wind (*TCI Weather and Climate: Unit 2 Weather, Lesson 4)* Students will construct an anemometer investigate atmospheric pressure and wind, how they are measured, and how they affect and determine changes in the weather. (4-5 class periods) Supplemental BBC VIDEO (4 mintues) Severe Weather Action Plan (*TCI Weather and Climate: Unit 2 Weather, Performance Assessment)* Students will develop a weather action plan to mitigate the effects of severe weather in Ledyard (2-3 class periods) Climate Patterns (*TCI Weather and Climate: Unit 3, Lesson 8)* Students will explain why Earth's temperature differs at the poles and at the equator as they identify the difference between weather and climate and examine climographs. (4-5 class periods) Global Circulation of the Atmosphere (*TCI Weather and Climate: Unit 3, Lesson 9)* Students will create a classroom model of the Coriolis Effect and identify global wind patterns to plot routes for a shipping company. (3-4 class periods) How the Oceans Affect Climates (*TCI Weather and Climate: Unit 3 Climate, Lesson 10)* Students will make a plan to monitor ocean temperatures using buoys and create a model of the global circulation and flow of energy of the ocean. (5-6 class periods)	• Develop an inital model and revise the model depicting onshore and offshore breezes and their affect on land temperature. • Write a list of recommendations to the Town Council to alert Ledyard citizens of severe weather. • Design and test a microclimate for plants collaboratively, and present to the class.

MS-ESS2-6 Suggested Activities	**MS-ESS2-6 Recommended Formative Assessments**
Local Climate (*TCI Weather and Climate: Unit 3, Lesson 11)* Students will explore the effects of albedo, and use climographs to explain different climate differences in similar locations. (2-3 class periods) Designing a Microclimate (*TCI Weather and Climate: Unit 3 Climate, Engineering Challenge)* Students will design and develop a growth system that maintains its own microclimate for a plant not native to our local environment. (2-3 class periods)	*See above

Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models • Develop and use a model to describe phenomena. **Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.**	**ESS2.C: The Roles of Water in Earth's Surface Processes** • Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. **ESS2.D: Weather and Climate** • Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. • The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents.	**Systems and System Models** • Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems.

Performance Expectation
MS-ESS2-6 Earth's Systems

Connections to other DCIs in Middle School:
MS.PS2.A ; MS.PS3.B ; MS.PS4.B

Articulation of DCIs across grade-levels:
3.PS2.A ; 3.ESS2.D ; 5.ESS2.A ; HS.PS2.B ; HS.PS3.B ; HS.PS3.D ; HS.ESS1.B ; HS.ESS2.A ; HS.ESS2.D

Common Core State Standards Connections:

ELA/Literacy –

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. *(MS-ESS2-6)*

Mathematics –N/A

Lesson Level Vocabulary: *atmospheric pressure, density, sea level, barometer, wind, anemometer, convection cell, prototypes, surface winds, Coriolis effect, global winds, jet stream, climate, climate zone, polar, temperate, tropical, ocean current, surface current, Gulf Stream, California Current, density currents, global ocean convection, El Nino, local climate, albedo, topography, urban heat island, microclimate*

DCI Domain Vocabulary:
Domains are bold:

- **Earth's Systems →The Roles of Water in Earth's Surface Processes; Weather and Climate (ESS2)**
  accuracy, air mass, air mass circulation, alternative, altitude, atmospheric, atmospheric circulation, average, biosphere, carbon dioxide, chemical, climate change, climatic pattern, condensation, constrain, content, convection cycle, Coriolis effect, crystal, cyclical, density, deposition, determinate, dissolve, distribution, dynamic, evaporation, geographic, geography, geological, gradual, groundwater, high pressure, human activity, humidity, hydrologic cycle, intensity, land distribution, latitude, latitudinal, longitude, longitudinal, low pressure, mass, mechanical, melting point, mineral, molecular, ocean circulation, oceanic, orbit, orientation, percentage, percolation, polar ice caps, pressure, probabilistic, redistribute, reservoir, rock cycle, salinity, solar, store, tectonic, tectonic cycle, tilt, time scale, transfer, transmit, transpiration, unequal heating of air, unequal heating of land masses, unequal heating of oceans, universal solvent, volcanic ash cloud, water cycle, weather map, wetland

Performance Expectation
MS-ESS3-3 Earth and Human Activity

Students who demonstrate understanding can:
Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.*
Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).
Assessment Boundary: N/A

Lesson Level Photo Analysis: **What do the rings in this ice core sample from the past tell us about our human impact and how do they help us predict our future impact?**
Lesson Level Phenomenon Video: **The size of the polar ice caps is decreasing annually.**
note: all photo and video above links to suggested activities below

MS-ESS3-3 Suggested Activities	MS-ESS3-3 Recommended Formative Assessments
Climate Today and Tomorrow (*TCI Weather and Climate: Unit 3 Climate, Lesson 13*) *Students will investigate changing weather patterns and climate change and the affects to Earth's biosphere and hydrosphere. (3-4 class periods)* Also see: https://icecores.org/	• Research the Protect Long Island Sound project and present at least three things you can do to sustain and protect Long Island Sound.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions • Apply scientific principles to design an object, tool, process or system. **Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.**	**ESS3.C: Human Impacts on Earth Systems** • Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. • Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.	**Cause and Effect** • Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. - ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** • The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.

Performance Expectation
MS-ESS3-3 Earth and Human Activity

Connections to other DCIs in Middle School:
MS.LS2.A ; *MS.LS2.C* , *MS.LS4.D*

Articulation of DCIs across grade-levels:
3.LS2.C ; *3.LS4.D* ; *5.ESS3.C* ; *HS.LS2.C* ; *HS.LS4.C* ; *HS.LS4.D* ; *HS.ESS2.C* ; *HS.ESS2.D* ; *HS.ESS2.E* ; *HS.ESS3.C* ; *HS.ESS3.D*

Common Core State Standards Connections:

ELA/Literacy –

WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-ESS3-3)

WHST.6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-ESS3-3)

Mathematics –

6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. *(MS-ESS3-3)*

7.RP.A.2 Recognize and represent proportional relationships between quantities. *(MS-ESS3-3)*

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-ESS3-3)*

7.EE.B.4 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-ESS3-3)*

Lesson Level Vocabulary: *ice sheet, sea level rise, permafrost, climate change mitigation, sustainable, renewable energy, climate change adaptation*

DCI Domain Vocabulary:
Domains are bold:

- **Earth and Human Activity→Human Impacts on Earth Systems (ESS3)**
  agriculture, aquifer, biosphere, civilization, consumption, cultural, development, diversity, Earth system, economic, fertile, geologic, groundwater, human activity, human impact, impact, industry, interior, land usage, levee, mass wasting, material world, mineral, modern, negative, per-capita, positive, river delta, societal, urban development, water usage, wetland

Performance Expectation

MS-ESS3-5 Earth and Human Activity

Students who demonstrate understanding can:

Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.

Assessment Boundary: N/A

Lesson Level Phenomenon Video: Polar ice shield melting.

note: all photo and video above links to suggested activities below

MS-ESS3-5 Suggested Activities	MS-ESS3-5 Recommended Formative Assessments
Earth's Climate Over Time (*TCI Weather and Climate: Unit 3 Climate, Lesson 12*) Students will create a timeline of Earth's history, identifying climate change, and asking questions and finding answers concerning why these changes in climate occurred. (*3-4 class periods*) Climate Today and Tomorrow (*TCI Weather and Climate: Unit 3 Climate, Lesson 13)* Students will identify effects of climate change and work in groups discuss the potential effects on our region. *(3-4 class periods)* Mitigating and Adapting Climate Change (TCI Weather and Climate: Unit 3 Climate Performance Assessment) Students will write a plan for our regional climate to mitigate or adapt to potential climate change.(2 class periods)	• Research and identify a climate change and human involvement in climate change and write a plan to mitigate and adapt to the identified climate change. • Debate whether humans are playing a role in climate change

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems • Ask questions to identify and clarify evidence of an argument. **Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.**	**ESS3.D: Global Climate Change** • Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities.	**Stability and Change** • Stability might be disturbed either by sudden events or gradual changes that accumulate over time.

Performance Expectation
MS-ESS3-5 Earth and Human Activity

Connections to other DCIs in Middle School:
MS.PS3.A

Articulation of DCIs across grade-levels:
HS.PS3.B ; HS.PS4.B ; HS.ESS2.A ; HS.ESS2.D ; HS.ESS3.C ; HS.ESS3.D

Common Core State Standards Connections:

ELA/Literacy –

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS3-5)

Mathematics –

MP.2 Reason abstractly and quantitatively. *(MS-ESS3-5)*

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-ESS3-5)*

7.EE.B.4 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-ESS3-5)*

Lesson Level Vocabulary: *ice age, global warming, climate change, deforestation, enhanced greenhouse effect, ice sheet, sea level rise, permafrost, climate change mitigation, sustainable, renewable energy, climate change adaptation*

DCI Domain Vocabulary:
Domains are bold:

- **Earth and Human Activity→Global Climate Change (ESS3)**
  advance, agriculture, atmospheric, average, biosphere, capability, carbon dioxide, climate change, climate science, combustion, consistency, disturb, diverse, geoscience, geosphere, global climate change, global temperature, global warming, gradual, greenhouse gas, human activity, human behavior, hydrosphere, impact, marine, mean surface temperature, methane, natural process, photosynthetic, solar radiation, volcanic activity, vulnerability

Performance Expectation
MS-ETS1-4 Engineering Design

Students who demonstrate understanding can:
Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.
Clarification Statement: N/A
Assessment Boundary: N/A

Lesson Level Photo Analysis: **Warm air rises and then cools, clouds form.**
note: all photo and video above links to suggested activities below

MS-ETS1-4 Suggested Activities	MS-ETS1-4 Recommended Formative Assessments
Water and the Weather (*TCI Weather and Climate: Unit 2 Weather, Lesson 5)* Students will design and construct a functioning psychrometer to measure relative humidity and dew point levels. Students will develop an understanding of why water is in the air (water cycle) due to the influences of the sun and gravity. (3-4 class periods) Mitigating and Adapting Climate Change (TCI Weather and Climate: Unit 3 Climate Performance Assessment) Students will write a plan for our regional climate to mitigate or adapt to potential climate change.(2 class periods)	• Develop and discuss aspects of the psychrometer design. • Research and identify a climate change and human involvement in climate change and write a plan to mitigate and adapt to the identified climate change.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. **Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.**	**ETS1.B: Developing Possible Solutions** • A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. • Models of all kinds are important for testing solutions. **ETS1.C: Optimizing the Design Solution** • The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution.	**N/A**

Performance Expectation
MS-ETS1-4 Engineering Design

Connections to other DCIs in Middle School:
MS-ETS1.B: Developing Possible Solutions Problems include: **Physical Science: MS-PS1-6, MS-PS3-3, Life Science: MS-LS2-5**
Connections to MS-ETS1.C: Optimizing the Design Solution include: **Physical Science: MS-PS1-6**

Articulation of DCIs across grade-levels:
3-5.ETS1.B ; 3-5.ETS1.C ; HS.ETS1.B ; HS.ETS1.C

Common Core State Standards Connections:

ELA/Literacy –

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. *(MS-ETS1-4)*

Mathematics –

MP.2 Reason abstractly and quantitatively. *(MS-ETS1-4)*

7.SP Develop a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy. *(MS-ETS1-4)*

Lesson Level Vocabulary: *water cycle, evaporation, transpiration, condensation, precipitation, runoff, infiltration, ground water, absolute humidity, relative humidity, dew, dew point, crystallization*

DCI Domain Vocabulary:
Domains are bold:

- **Engineering Design→Developing Possible Solutions; Optimizing the Design Solution (ETS1)**
  abstract, agreed-upon, break down, collaboratively, computational, concrete, consideration, control of variables, controlled experiment, convincing, criteria, cultural, data analysis, data interpretation, data presentation, design system, element, impact, iterative process, jointly, linear, mathematical model, nonlinear, optimal, physical replica, priority, prototype, quantitative, real-world, redesign process, representation, societal, statistical, systematic, systematic, test results, theoretical model, trial

Ledyard Next Generation Science Standards Grade 6

Unit 3: The Study of Life: Structure and Function

March-April

Anchoring Phenomenon	
First Human Made Synthetic Cell	
Compelling Questions	**Supporting Questions**
How are structure and function related to living things? What does it mean to be 'living'? How do living organisms process information?	• *What is a cell?* • *What structures allow cells to function properly?* • *How do the parts of a cell function to keep the cell alive?* • *How do substances move in and out of cells?* • *What would you need to know about a cell to make a synthetic cell in a lab?* • *How do body systems work together?* • *How does your body change and respond to a constantly changing environment?*
Storyline	**Possible Student Misconceptions:**
Students will investigate and understand the significance of cells, cell structures and body systems in life's various functions, including information processing.	• *You can see cells with your naked eye* • *All cells are the same* • *Animal cells are not different than plant cells* • *Groups of cells make up body systems* • *Molecules, atoms and cells are the same thing*

Unit 3: The Study of Life: Structure and Function Overview

Performance Expectations	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• **MS-LS1-1** • **MS-LS1-2** • **MS-LS1-3** • **MS-LS1-8** • **MS-ETS1-1** *Teacher Note: All the <u>Performance Expectations</u> above will be covered this unit and can be worked on concurrently. All <u>Science and Engineering Practices</u> and <u>Crosscutting Concepts</u> in bold are written in the Performance Expectations above. The italicized practices and crosscutting concepts, although not mentioned specifically, may be incorporated additionally in any science lesson at any time.*	• *1: Asking Questions and Defining Problems* • **2: Developing and Using Models** • **3: Planning and Carrying Out Investigations** • 4: Analyzing and Interpreting Data • 5: Using Mathematical Computational Thinking • 6: Constructing Explanations and Designing Solutions • **7: Engaging in Argument from Evidence** • **8: Obtaining, Evaluating, and Communicating Information**	**<u>ENGINEERING, TECHNOLOGY AND THE APPLICATION OF SCIENCE</u>** • **ETS1 Engineering Design** -ETS1.C: Optimizing the Design Solution **<u>LIFE SCIENCE</u>** • **LS1: From Molecules to Organisms: Structures and Processes** -LS1.A: Structure and Function -LS1.D: Information Processing	• 1: Patterns • **2: Cause and Effect** • **3: Scale, Proportion and Quantity** • **4: Systems and System Models** • *5: Energy and Matter* • **6: Structure and Function** • *7: Stability and Change*

Performance Expectation
MS-LS1-1 From Molecules to Organisms: Structure and Processes

Students who demonstrate understanding can:
Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.
Clarification Statement: *Emphasis is on developing evidence that living things are made of cells, distinguishing between living and non-living things, and understanding that living things may be made of one cell or many and varied cells.*
Assessment Boundary: *N/A*

Lesson Level Phenomenon: **Spontaneous Generation analysis of claim mice created by recipe and claim fish form in the mud of dry river beds.**
note: all photo and video above links to suggested activities below

MS-LS1-2 Suggested Activities	MS-LS1-2 Recommended Formative Assessments
Cell Theory (*TCI Cells and Genetics: Unit 3 Cells, Lesson 6*) Students will investigate/differentiate between living and nonliving cells by collecting microscopic samples of unicellular and multicellular organisms. (8-9 class periods) *Teacher Note: Additional Resources in Appendix Science Scope: "Let's Talk Science" figure 5 and activity 1	• Write claims about the characteristics of cells in living and non-living things. Students will research cells by gathering evidence of cell presence and/or structure using onion (plant) cells and cheek (animal) cells and non-living things. Students will summarize their investigation in writing. Teacher note: recommend using elodea. • Provide examples of multicellular organisms in comparison to unicellular organisms through illustration/writing/multimedia or other format.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations • Conduct an investigation to produce data to serve as the basis for evidence that meet the goals of an investigation. **Planning and carrying out investigations in 6-8 builds on K-5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions.**	**LS1.A: Structure and Function** • All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular).	**Scale, Proportion, and Quantity** • Phenomena that can be observed at one scale may not be observable at another scale. --- ***Connections to Engineering, Technology and Applications of Science*** **Interdependence of Science, Engineering, and Technology** • Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems.

Performance Expectation
MS-LS1-1 From Molecules to Organisms: Structure and Processes

Connections to other DCIs in Middle School:
N/A

Articulation of DCIs across grade-levels:
HS.LS1.A

Common Core State Standards Connections:
ELA/Literacy

WHST.6-8.7	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-LS1-1)

Mathematics

6.EE.C.9	Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. *(MS-LS1-1)*

Lesson Level Vocabulary: *multicellular, unicellular, cell theory, virus*

DCI Domain Vocabulary:
Domains are bold:

- **From Molecules to Organisms: Structures and Processes→Structure and Function (LS1)**
  body plan, cell, circulatory system, conceptual, detect, digestive system, elastic, excretory system, external, external cue, external feature, function, functional, heart rate, intellectual, internal, internal cue, internal structure, invertebrate, life-sustaining functions, multicellular, muscular system, nervous system, nutrient, organ, organ system, organic matter, organism system failure, precision, reproductive system, respiratory system, response, skeletal, specialized, specialized organ, specialized tissue, stimulus, structural, subsystem, tolerance, vertebrate

Performance Expectation

MS-LS1-2 From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can:

Develop and use a model to describe the function of a cell as a whole and ways the parts of cells contribute to the function.

Clarification Statement: *Emphasis is on the cell functioning as a whole system and the primary role of identified parts of the cell, specifically the nucleus, chloroplasts, mitochondria, cell membrane, and cell wall.*

Assessment Boundary: *Assessment of organelle structure/function relationships is limited to the cell wall and cell membrane. Assessment of the function of the other organelles is limited to their relationship to the whole cell. Assessment does not include the biochemical function of cells or cell parts.*

Lesson Level Phenomenon Video: Paramecium video

note: all photo and video above links to suggested activities below

MS-LS1-2 Suggested Activities	MS-LS1-2 Recommended Formative Assessments
Parts of Cells (*TCI Cells and Genetics: Unit 3 Cells, Lesson 7*) Students will use visual models and analogies to explore parts of cells, their structure and functions. (4-5 class periods) Modeling Synthetic Cells (TCI Cells and Genetics: Unit 2 Cells, Performance Assessment) Students will create a 3-D or 2-D model of cell (illustrate or construct), the parts of a plant or animal cell with label, description and function of the cell parts. (2 class periods)	• Identify parts of a cell and write an explanation of their functions.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Develop and use a model to describe phenomena. **Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.**	**LS1.A: Structure and Function** • Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell.	**Structure and Function** • Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function.

Performance Expectation

MS-LS1-2 From Molecules to Organisms: Structures and Processes

Connections to other DCIs in Middle School:
MS.LS3.A

Articulation of DCIs across grade-levels:
4.LS1.A ; *HS.LS1.A*

Common Core State Standards Connections:
ELA/Literacy

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. *(MS-LS1-2)*

Mathematics

6.EE.C.9 Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. *(MS-LS1-2)*

Lesson Level Vocabulary: *cell membrane, DNA, ribosome, protein, cytoplasm, organelle, nucleus, mitochondria, chloroplast, cell wall*

DCI Domain Vocabulary:

Domains are bold:

- **From Molecules to Organisms: Structures and Processes→Structure and Function (LS1)**
  body plan, cell, circulatory system, conceptual, detect, digestive system, elastic, excretory system, external, external cue, external feature, function, functional, heart rate, intellectual, internal, internal cue, internal structure, invertebrate, life-sustaining functions, multicellular, muscular system, nervous system, nutrient, organ, organ system, organic matter, organism system failure, precision, reproductive system, respiratory system, response, skeletal, specialized, specialized organ, specialized tissue, stimulus, structural, subsystem, tolerance, vertebrate

Performance Expectation
MS-LS1-3 From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can:

Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.

Clarification Statement: *Emphasis is on the conceptual understanding that cells form tissues and tissues form organs specialized for particular body functions. Examples could include the interaction of subsystems within a system and the normal functioning of those systems.*

Assessment Boundary: *Assessment does not include the mechanism of one body system independent of others. Assessment is limited to the circulatory, excretory, digestive, respiratory, muscular, and nervous systems.*

Lesson Level Phenomenon Video: Paramecium video

note: all photo and video above links to suggested activities below

MS-LS1-3 Suggested Activities	MS-LS1-3 Recommended Formative Assessments
Interacting Body Systems (*TCI Cells and Genetics: Unit 2 Bodies, Lesson 3*) Students will identify internal organs and body systems by creating models to explain how body systems interact. Students will gather information from a variety of sources to assess and diagnose a patient explaining the cause of symptoms. (5-6 class periods) Designing a Prosthetic Hand (TCI Cells and Genetics: Engineering Challenge) Students will build, test, and modify a prosthetic hand to serve a specific function. (2-3 class periods)	• Compare and contrast a frog's anatomy to a human's by listing similarities and differences. • Record the observations and evidence about the human body systems and their functions. • Create and design a prosthetic hand collaboratively and share the design plan, procedure and product with the class.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence • Use an oral and written argument supported by evidence to support or refute an explanation or a model for a phenomenon. **Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).**	LS1.A: Structure and Function • In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions.	Systems and System Models • Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. -------------------- ***Connections to Nature of Science*** **Science is a Human Endeavor** • Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas.

Performance Expectation
MS-LS1-3 From Molecules to Organisms: Structures and Processes

Connections to other DCIs in Sixth Grade:
N/A

Articulation of DCIs across grade-levels:
HS.LS1.A

Common Core State Standards Connections:
ELA /Literacy –

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-LS1-3)

RI.6.8 Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not.(MS-LS1-3)

WHST.6-8.1 Write arguments focused on discipline content. (MS-LS1-3)

Mathematics —

6.EE.C.9 Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. *(MS-LS1-3)*

Lesson Level Vocabulary: *skeletal system, muscular system, organ, digestive system, respiratory system, circulatory system, excretory system, reproductive system*

DCI Domain Vocabulary:

Domains are bold:

- **From Molecules to Organisms: Structures and Processes→Structure and Function (LS1)**
  body plan, cell, circulatory system, conceptual, detect, digestive system, elastic, excretory system, external, external cue, external feature, function, functional, heart rate, intellectual, internal, internal cue, internal structure, invertebrate, life-sustaining functions, multicellular, muscular system, nervous system, nutrient, organ, organ system, organic matter, organism system failure, precision, reproductive system, respiratory system, response, skeletal, specialized, specialized organ, specialized tissue, stimulus, structural, subsystem, tolerance, vertebrate

Performance Expectation
LS1-8 From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can:
Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.
Clarification Statement: *N/A*
Assessment Boundary: *Assessment Boundary: Assessment does not include mechanisms for the transmission of this information.*

Lesson Level Phenomenon Video: Bat Echolocation; People become sick when body systems do not function properly.
note: all photo and video above links to suggested activities below

MS-LS1-8 Suggested Activities	MS-LS1-8 Recommended Formative Assessments
Controlling Body Systems (*TCI Cells and Genetics: Unit 2 Bodies, Lesson 5*) Students will investigate how the human body senses and responds to a changing environment. Students will identify the parts, structures and functions of the nervous system. Students will investigate information transmission from sensory receptors to the brain (processed as behaviors or memories). Lastly, students will gather information from multiple sources to diagnose a patient and explain the cause of symptoms. (5 class periods) Diagnosing JJ (TCI Cells and Genetics: Unit 2 Bodies, Performance Assessment) Students will use their body system knowledge as evidence to make a claim about JJ's diagnosis. (2 class periods)	• Pair sensory stimuli with appropriate physiological responses. Demonstrate (acting out, written, etc.) or illustrate (poster, google drawing, video, etc.) an understanding of the cause and effect relationship between sensory stimuli and physiological responses. • Collect, evaluate and communicate information to successfully diagnose JJ.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Obtaining, Evaluating, and Communicating Information • Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. **Obtaining, evaluating, and communicating information in 6-8 builds on K-5 experiences and progresses to evaluating the merit and validity of ideas and methods.**	**LS1.D: Information Processing** • Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories.	**Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural systems.

Performance Expectation
LS1-8 From Molecules to Organisms: Structures and Processes

Connections to other DCIs in Sixth Grade:
N/A

Articulation of DCIs across grade-levels:
4.LS1.D ; HS.LS1.A

Common Core State Standards Connections:
ELA /Literacy -
WHST.6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-LS1-8)

Mathematics —
N/A

Lesson Level Vocabulary: *nervous system, neuron, spinal cord, brain, nerve, stimulus, sense receptors*

DCI Domain Vocabulary:
Domains are bold:

- **Biological Evolution: Unity and Diversity→Biodiversity in Humans (LS4)**
  accuracy, behavioral response to stimuli, cell, chemical, electromagnetic, immediate, mechanical, memory, nerve, perception, process, receptor, sense receptor, sensory, stimulus, storage, transfer, transmit

Performance Expectation
MS-ETS1-1 Engineering Design

Students who demonstrate understanding can:
Define the criteria and constraints 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.
Clarification Statement: N/A
Assessment Boundary: *N/A*

Lesson Level Photo Analysis: **Prosthetic limbs help people achieve desired tasks.**
note: all photo and video above links to suggested activities below

MS-ETS1-1 Suggested Activities	MS-ETS1-1 Recommended Formative Assessments
Designing a Prosthetic Hand (TCI Cells and Genetics: Engineering Challenge) Students will build, test, and modify a prosthetic hand to serve a specific function. (2-3 class periods)	• Create and design a prosthetic hand collaboratively and share the design plan, procedure and product with the class.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems • Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. **Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.**	**ETS1.A: Defining and Delimiting Engineering Problems** • The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions.	**Influence of Science, Engineering, and Technology on Society and the Natural World** • All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. • The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions.

Performance Expectation
MS-ETS1-1 Engineering Design

Connections to MS-ETS1.A: Defining and Delimiting Engineering Problems include:
***Physical Science:* MS-PS3-3**

Articulation of DCIs across grade-levels:
3-5.ETS1.A ; 3-5.ETS1.C ; HS.ETS1.A ; HS.ETS1.B

Common Core State Standards Connections:
ELA /Literacy –

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ETS1-1)

WHST.6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-ETS1-1)

Mathematics —

MP.2 Reason abstractly and quantitatively. *(MS-ETS1-1)*

7.EE.3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. *(MS-ETS1-1)*

Lesson Level Vocabulary: *N/A*

DCI Domain Vocabulary:

Domains are bold:

- **Engineering Design→Defining and Delimiting Engineering Problems (ETS1)**
  consequence, consideration, criteria, design task,development,economic,humanity,impact,limitation,long-term,natural resource,negative,positive,potential,precise,qualitative,quantitative,real-world,requirement,short- term, societal, specification, supply, testable

Ledyard Next Generation Science Standards Grade 6

Unit 4: The Study of Genetics

May-June

Anchoring Phenomenon
Male peacock have beautiful plumage. A female praying mantis devours her mate. Organisms have unique physical and behavioral traits that help them survive.

Compelling Questions	Supporting Questions
What influences the growth, development and survival of an organism?	• *How are characteristics from one generation related to the previous generation?* • *Why do individuals from the same species vary in how they look, function and behave?*

Storyline	Possible Student Misconceptions:
Students will build an understanding of the conditions for successful reproduction, behaviors in terms of genetics and inherited traits.	• *All reproduction is sexual.* • *Traits do not help you reproduce.*

Unit 4: The Study of Genetics Overview

Performance Expectations	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• **MS-LS1-4** • **MS-LS1-5** • **MS-LS3-2** • **MS-ETS1-2** *Teacher Note: All the Performance Expectations above will be covered this unit and can be worked on concurrently. All Science and Engineering Practices and Crosscutting Concepts in bold are written in the Performance Expectations above. The italicized practices and crosscutting concepts, although not mentioned specifically, may be incorporated additionally in any science lesson at any time.*	• **1: Asking Questions and Defining Problems** • **2: Developing and Using Models** • *3: Planning and Carrying Out Investigations* • *4: Analyzing and Interpreting Data* • *5: Using Mathematical Computational Thinking* • **6: Constructing Explanations and Designing Solutions** • *7: Engaging in Argument from Evidence* • **8: Obtaining, Evaluating, and Communicating Information**	**ENGINEERING, TECHNOLOGY AND THE APPLICATION OF SCIENCE** • **ETS1 Engineering Design** -ETS1.A :Defining and Delimiting Engineering Problems **LIFE SCIENCE** • **LS1 From Molecules to Organisms: Structures and Processes** -LS1.B: Growth and Development of Organisms • **LS3: Heredity: Inheritance and Variation of Traits** -LS3.A: Inheritance of Traits -LS3.B: Variation of Traits	• **1: Patterns** • **2: Cause and Effect** • *3: Scale, Proportion and Quantity* • *4: Systems and System Models* • *5: Energy and Matter* • *6: Structure and Function* • **7: Stability and Change**

Performance Expectation

MS-LS1-4 Biological Evolution: Unity and Diversity

Students who demonstrate understanding can:

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 respectively.

Clarification Statement: Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, herding of animals to protect young from predators, and vocalization of animals and colorful plumage to attract mates for breeding. Examples of animal behaviors that affect the probability of plant reproduction could include transferring pollen or seeds, and creating conditions for seed germination and growth. Examples of plant structures could include bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.

Lesson Level Phenomenon Video: Blue-footed Booby Dance.

note: all photo and video above links to suggested activities below

MS-LS1-4 Suggested Activities	MS-LS1-4 Recommended Formative Assessments
Traits for Reproduction (TCI: Cells and Genetics Unit 1, Lesson 2) Students will observe and identify specialized reproductive traits. Students will conduct research and record their findings on data charts. Students will argue based on their evidence the reasons for the Elephant Bird's extinction. (2-3 class periods)	• Complete Trait Trek to Madagascar (TCI Performance Assessment) • Use Google Map Trek to create a digitally planned route with four stops identifying one or more organisms and their specialized survival/reproduction traits

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence • Use an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. **Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).**	**LS1.B: Growth and Development of Organisms** • Animals engage in characteristic behaviors that increase the odds of reproduction. • Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction.	**Cause and Effect** • Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

Performance Expectation
MS-LS1-4 Biological Evolution: Unity and Diversity

Connections to other DCIs in Middle School:
MS.LS2.A

Articulation of DCIs across grade-levels:
3.LS1.B ; HS.LS2.A ; HS.LS2.D

Common Core State Standards Connections:

ELA/Literacy -

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-LS1-4)

RI.6.8 Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not.(MS-LS1-4)

WHST.6-8.1 Write arguments focused on discipline content. (MS-LS1-4)

Mathematics -

6.SP.A.2 Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape. *(MS-LS1-4)*

6.SP.B.4 Summarize numerical data sets in relation to their context. *(MS-LS1-4)*

Lesson Level Vocabulary: *reproduction, courtship behavior, model, germinate*

DCI Domain Vocabulary:

Domains are bold:

- **From Molecules to Organisms: Structure and Processes→Growth and Development of Organisms (LS1)**
  breed, diverse, transfer, development, attract, characteristics of life, germination, plant structure, plumage, reproductive system, soil fertility, vocalization, fertilizer, genetic, specialized

Performance Expectation

MS-LS1-5 From Molecules to Organisms: Structure and Processes

Students who demonstrate understanding can:

Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds

Assessment Boundary: *Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.*

Lesson Level Phenomenon Video: Humans have opposable thumbs but turtles do not.

note: all photo and video above links to suggested activities below

MS-LS1-5 Suggested Activities	MS-LS1-5 Recommended Formative Assessments
Traits for Survival (TCI: Cells and Genetics Unit 1, Lesson 1) Students will observe and identify specialized survival traits. They will research plants and animal traits and compile their findings in a data chart. Students will research an organism of their choice, focusing on specialized survival traits. (4-5 class periods)	• Complete Trait Trek to Madagascar (TCI Performance Assessment) • Use Google Map Trek to create a digitally planned route with four stops identifying one or more organisms and their specialized survival/reproduction traits.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions • 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. **Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.**	LS1.B: Growth and Development of Organisms • Genetic factors as well as local conditions affect the growth of the adult plant.	Cause and Effect • Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

Performance Expectation
MS-LS1-5 From Molecules to Organisms: Structure and Processes

Connections to other DCIs in Middle School:
MS.LS2.A

Articulation of DCIs across grade-levels:
3.LS1.B ; 3.LS3.A ; HS.LS2.A

Common Core State Standards Connections:

ELA/Literacy –

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-LS1-5)

RST.6-8.2 Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. *(MS-LS1-5)*

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-LS1-5)*

WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (MS-LS1-5)

Mathematics -

6.SP.A.2 Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape. *(MS-LS1-5)*

6.SP.B.4 Summarize numerical data sets in relation to their context. *(MS-LS1-5)*

Lesson Level Vocabulary: *starvation, dehydration, suffocation, predation, physical trait, criteria, constraints, behavioral trait, species*

DCI Domain Vocabulary:

Domains are bold:

- **From Molecules to Organisms: Structure and Processes→Growth and Development of Organisms (LS1)**
  breed, diverse, transfer, development, attract, characteristics of life, germination, plant structure, plumage, reproductive system, soil fertility, vocalization, fertilizer, genetic, specialized

Performance Expectation
MS-LS3-2 Heredity: Inheritance and Variation of Traits

Students who demonstrate understanding can:
Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.
Clarification Statement: Clarification Statement: Emphasis is on using models such as Punnett squares, diagrams, and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.
Assessment Boundary: N/A

Lesson Level Photo Analysis: Some organisms like bacteria are identical to their parents, but some organisms like dogs are not.
note: all photo and video above links to suggested activities below

MS-LS3-2 Suggested Activities	MS-LS3-2 Recommended Formative Assessments
Inheriting Genes (TCI: Cells and Genetics Unit 4, Lesson 9) Students will determine if a species reproduces asexually or sexually, by predicting the traits resulting from inherited genes. Students will model how alleles determine traits. Students will model how alleles and traits are inherited. (3-4 class periods)	• Explain trait variation between the offspring of asexually or sexually reproducing families. • Label the boxes of a Punnett Square (given in TCI student notebook) using parent 1 alleles, parent 2 alleles, possible alleles of combinations of offspring.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Develop and use a model to describe phenomena. **Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.** .	**LS1.B: Growth and Development of Organisms** • Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. *(secondary)* **LS3.A: Inheritance of Traits** • Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. **LS3.B: Variation of Traits** • In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other.	**Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural systems.

Performance Expectation
MS-LS3-2 Heredity: Inheritance and Variation of Traits

Connections to other DCIs in Middle School:
N/A

Articulation of DCIs across grade-levels:
3.LS3.A ; 3.LS3.B ; HS.LS1.B ; HS.LS3.A ; HS.LS3.B

Common Core State Standards Connections:
ELA/Literacy -

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

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-LS3-2)*

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-LS3-2)

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.*(MS-LS3-2)*

Mathematics

MP.4 Model with mathematics. *(MS-LS3-2)*

6.SP.B.5 Summarize numerical data sets in relation to their context. *(MS-LS3-2)*

Lesson Level Vocabulary: *asexual reproduction, sexual reproduction, genetic variation, random, probability, dominant allele, recessive allele, Punnett square*

DCI Domain Vocabulary:

Domains are bold:

- **Heredity: Inheritance and Variation of Traits→Inheritance of traits, Variation of Traits (LS3)**
  allele, asexual reproduction, beneficial, breed, cell, chromosome, combination, contribute, development, distinct, distribution, formation, gene, genetic, genetic variation, hereditary information, human genetics, identical, instruction, microscopic, molecule, neutral, probability, production, progress, protein, Punnett square, random, recognizable, sexual reproduction, species diversity, structural, subset, transfer, transmission, variant, variation, version

Performance Expectation
MS-ETS1-2 Engineering Design

Students who demonstrate understanding can:
Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

Clarification Statement: N/A
Assessment Boundary: N/A

Lesson Level Video Analysis: **Seed dispersal** **(slides 3 and 8)**
note: all photo and video above links to suggested activities below

MS-ETS1-2 Suggested Activities	MS-ETS1-2 Recommended Formative Assessments
Designing a Seed Dispersal Device (TCI Cells and Genetis, Unit 1: Engineering Challenge) Students will design build and test a structure for dispersing seeds that mimics the traits of plants dispersing seeds in nature.	• Present the seed dispersing prototype to the class, including the design process, materials used, and how design constraints were addressed.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence • Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. **Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world.**	ETS1.B: Developing Possible Solutions • There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.	N/A

Performance Expectation
MS-ETS1-2 Engineering Design

Connections to other DCIs in Middle School:
MS-ETS1.B: Developing Possible Solutions Problems include: **Physical Science: MS-PS1-6, MS-PS3-3, Life Science: MS-LS2-5**

Articulation of DCIs across grade-levels:
3-5.ETS1.A ; 3-5.ETS1.B ; 3-5.ETS1.C ; HS.ETS1.A ; HS.ETS1.B

Common Core State Standards Connections:

ELA/Literacy –

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. *(MS-ETS1-2)*

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-ETS1-2)

WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-ETS1-2)

WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. *(MS-ETS1-2)*

Mathematics –

MP.2 Reason abstractly and quantitatively. *(MS-ETS1-2)*

7.EE.3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. *(MS-ETS1-2)*

Lesson Level Vocabulary: *N/A*

DCI Domain Vocabulary:
Domains are bold:

- **Engineering Design→Developing Possible Solutions (ETS1)**
  abstract, agreed-upon, break down, concrete, consideration, convincing, criteria, jointly, mathematical model, physical replica, priority, real-world, representation, societal, theoretical model