

Middle School Life Sciences

Students in middle school develop understanding of key concepts to help them make sense of the life sciences. These ideas build upon students' science understanding from earlier grades and from the disciplinary core ideas, science and engineering practices, and crosscutting concepts of other experiences with physical and earth sciences. There are five life science topics in middle school: 1) Structure, Function, and Information Processing, 2) Growth, Development, and Reproduction of Organisms, 3) Matter and Energy in Organisms and Ecosystems, 4) Interdependent Relationships in Ecosystems, and 5) Natural Selection and Adaptations. The performance expectations in middle school blend core ideas with scientific and engineering practices and crosscutting concepts to support students in developing useable knowledge across the science disciplines. While the performance expectations in middle school life science couple particular practices with specific disciplinary core ideas, instructional decisions should include use of many science and engineering practices integrated in the performance expectations. The concepts and practices in the performance expectations are based on the grade-band endpoints described in A Framework for K-12 Science Education (NRC, 2012).

The National Wildlife Federation's Eco-Schools USA programs has aligned two of the five middle school life science topics that meet our learning objectives and outcomes, **Matter and Energy in Organisms and Ecosystems** and **Interdependent Relationships in Ecosystems**.

The Performance Expectations in **Matter and Energy in Organisms and Ecosystems** help students formulate answers to the questions: "How do organisms obtain and use matter and energy? How do matter and energy move through an ecosystem?" Middle school students can use conceptual and physical models to explain the transfer of energy and cycling of matter as they construct explanations for the role of photosynthesis in cycling matter in ecosystems. They can construct explanations for the cycling of matter in organisms and the interactions of organisms to obtain the matter and energy from the ecosystem to survive and grow. Students have a grade-appropriate understanding and use of the practices of investigations, constructing arguments based on evidence, and oral and written communication. They understand that sustaining life requires substantial energy and matter inputs and the structure and functions of organisms contribute to the capture, transformation, transport, release, and elimination of matter and energy. Adding to these crosscutting concepts is a deeper understanding of systems and system models that ties the performances expectations in this topic together.

The Performance Expectations in **Interdependent Relationships in Ecosystems** help students formulate an answer to the question, "How do organisms interact with other organisms in the physical environment to obtain matter and energy? To answer the question, middle school students construct explanations for the interactions in ecosystems and the scientific, economic, political, and social justifications used in making decisions about maintaining biodiversity in ecosystems. Students can use models, construct evidence-based explanations, and use argumentation from evidence. Students understand that organisms and populations of organisms are dependent on their environmental interactions both with other organisms and with nonliving factors. They also understand the limits of resources influence the growth of organisms and populations, which may result in competition for those limited resources. Crosscutting concepts of matter and energy, systems and system models, and cause and effect are used by students to support understanding the phenomena they study.

The National Wildlife Federation’s Eco-Schools USA program has aligned their program pathways of sustainability to the Next Generation Science Standards, NGSS. **As a part of the Eco-Schools 7-Step Framework, linking to the curriculum, is a priority.** This alignment is designed to highlight the natural connections between the NGSS and the Eco-Schools USA program.

Our program icons are used to denote pathway connections to the NGSS Performance Expectations. **Not every topic, with its set of Performance Expectations are a fit with the Eco-Schools USA program** and in that case an alignment will not be present.

Also present within this alignment document are connections to the Common Core State Standards, CCSS, English Language Arts, ELA, and Mathematics, 21st Century Skills, Environmental Ladder of Responsibility, and Connections to Music, Physical Education, and Art.

Green STEM is an initiative of the National Wildlife Federation’s Eco-Schools USA program and is focused on identifying best practice in the STEM fields as it relates to environment-based learning. These elements include:

- Problem-based learning
- Utilizing the school, both inside and out, as a learning laboratory
- The incorporation of two or more STEM disciplines within a single lesson, whole curricula, a set of standards, etc.
- A Maker mentality – design/create/solve
- A commitment to service learning
- An inclusive culture – where all students can learn and all students can participate



MS. Matter and Energy in Organisms and Ecosystems

MS.Matter and Energy in Organisms and Ecosystems

Students who demonstrate understanding can:

- MS-LS1-6. Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.** [Clarification Statement: Emphasis is on tracing movement of matter and flow of energy.]
[Assessment Boundary: Assessment does not include the biochemical mechanisms of photosynthesis.]
- MS-LS1-7. Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.** [Clarification Statement: Emphasis is on describing that molecules are broken apart and put back together and that in this process, energy is released.] [Assessment Boundary: Assessment does not include details of the chemical reactions for photosynthesis or respiration.]
- MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.** [Clarification Statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.]
- MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.** [Clarification Statement: Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.] [Assessment Boundary: Assessment does not include the use of chemical reactions to describe the processes.]
- MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.** [Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]

Developing and Using Models

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.

- Develop a model to describe phenomena. (MS-LS2-3)
- Develop a model to describe unobservable mechanisms. (MS-LS1-7)

Analyzing and Interpreting Data

Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

- Analyze and interpret data to provide evidence for phenomena. (MS-LS2-1)

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.

- Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-LS1-6)

Engaging in Argument from Evidence

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).

- Construct 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. (MS-LS2-4)

Connections to Nature of Science

Scientific Knowledge is Based on Empirical Evidence

- Science knowledge is based upon logical connections between evidence and explanations. (MS-LS1-6)
- Science disciplines share common rules of obtaining and evaluating empirical evidence. (MS-LS2-4)

LS1.C: Organization for Matter and Energy Flow in Organisms

- Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (MS-LS1-6)
- Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy. (MS-LS1-7)

LS2.A: Interdependent Relationships in Ecosystems

- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)
- In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)
 - Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)

LS2.B: Cycle of Matter and Energy Transfer in Ecosystems

- Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (MS-LS2-3)

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4)

PS3.D: Energy in Chemical Processes and Everyday Life

- The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen. (secondary to MS-LS1-6)
- Cellular respiration in plants and animals involve chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials. (secondary to MS-LS1-7)

Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-LS2-1)

Energy and Matter

- Matter is conserved because atoms are conserved in physical and chemical processes. (MS-LS1-7)
- Within a natural system, the transfer of energy drives the motion and/or cycling of matter. (MS-LS1-6)
 - The transfer of energy can be tracked as energy flows through a natural system. (MS-LS2-3)

Stability and Change

- Small changes in one part of a system might cause large changes in another part. (MS-LS2-4)

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-LS2-3)

Science and Engineering Practices

Disciplinary Core Ideas

Crosscutting Concepts

The section entitled "Disciplinary Core Ideas" is reproduced verbatim from A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas. Integrated and reprinted with permission from the National Academy of Sciences.

Connections to other DCIs in this grade-band: **MS.PS1.B** (MS-LS1-6),(MS-LS1-7),(MS-LS2-3); **MS.LS4.C** (MS-LS2-4); **MS.LS4.D** (MS-LS2-4); **MS.ESS2.A** (MS-LS1-6),(MS-LS2-3),(MS-LS2-4); **MS.ESS3.A** (MS-LS2-1),(MS-LS2-4); **MS.ESS3.C** (MS-LS2-1),(MS-LS2-4)

Articulation across grade-bands: **3.LS2.C** (MS-LS2-1),(MS-LS2-4); **3.LS4.D** (MS-LS2-1),(MS-LS2-4); **5.PS3.D** (MS-LS1-6),(MS-LS1-7); **5.LS1.C** (MS-LS1-6),(MS-LS1-7); **5.LS2.A** (MS-LS1-6),(MS-LS2-1),(MS-LS2-3); **5.LS2.B** (MS-LS1-6),(MS-LS1-7),(MS-LS2-3); **HS.PS1.B** (MS-LS1-6),(MS-LS1-7); **HS.PS3.B** (MS-LS2-3); **HS.LS1.C** (MS-LS1-6),(MS-LS1-7),(MS-LS2-3); **HS.LS2.A** (MS-LS2-1); **HS.LS2.B** (MS-LS1-6),(MS-LS1-7),(MS-LS2-3); **HS.LS2.C** (MS-LS2-4); **HS.LS4.C** (MS-LS2-1),(MS-LS2-4); **HS.LS4.D** (MS-LS2-1),(MS-LS2-4); **HS.ESS2.C** (MS-LS2-3); **HS.ESS2.D** (MS-LS1-6); **HS.ESS2.E** (MS-LS2-4); **HS.ESS3.A** (MS-LS2-1); **HS.ESS3.B** (MS-LS2-4); **HS.ESS3.C** (MS-LS2-4)

COMMON CORE STATE STANDARDS

Connections: ELA/Literacy–

- RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts. (MS-LS1-6),(MS-LS2-1)
- 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-LS1-6)
- 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-LS2-1)
- RI.8.8** Trace and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient to support the claims. (MS-LS-4)
- WHST.6-8.1** Write arguments to support claims with clear reasons and relevant evidence. (MS-LS2-4)
- 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-LS1-6)
- WHST.6-8.9** Draw evidence from informational texts to support analysis, reflection, and research. (MS-LS1-6),(MS-LS2-4)
- SL.8.5** Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-LS1-7),(MS-LS2-3)

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-LS1-6),(MS-LS2-3)



ECO-SCHOOLS USA PATHWAYS ALIGNMENT

MS-LS1-6, MS-LS1-7

Each Performance Expectation is more successfully accomplished by students who have spent significant time outdoors in the natural world. Using the schoolyard as a learning laboratory, provides students with countless experiential opportunities using inquiry based methods during field investigations. Students will be able to develop and use models with greater precision and understanding and have the ability to communicate understanding with fact-based evidence.

Students who have played an integral role in the creation and care of a Schoolyard Habitat, sustainable food project, or biodiversity studies, have the conceptual understanding needed to build new learning around these performance expectation's overarching concepts, cause and effect relationships, cycling of matter and the flow of energy into and out of systems and stability and change.

LADDER OF RESPONSIBILITY

Connecting to Home

- Share gardening and habitat building at home on a smaller scale. Potted plants, square foot gardens, hydroponic and/or vertical gardens, insect houses, frog habitats, bird feeders, butterfly habitats
- Discuss as a family basic needs of all living things. For chemical processes associated with photosynthesis to occur what environment should be provided?
- Volunteer at your local community garden, nature center, local, state, national park.
- Consider how changes (big and small) and commitments made at the family level can impact the local environment; discuss local, state, national and global environmental issues.
- Environmental and scientific literacy are important no matter your age or profession.

Using Tools Outside

- Demonstrate and teach proper use and safety when using equipment – lab safety applies outside as well as inside. Never assume students know how to use the tool for its intended purpose.
- Proper care and maintenance of tools used to design, create, and maintain gardens and wildlife habitats – i.e. carpentry, electric, and battery powered tools, shovels, rakes, sheers, etc.
- Needs analysis – what tools are required to complete a project or task? i.e. microscopes, saws, drills, soil testing kits, etc.
- Applied use of tools as a way to design, create, and maintain gardens and habitats
- An understanding that tools are technology too. Innovation is born from necessity to make a project or task easier.

The Four R's

- **Reduce:** Using less and investing in long-lasting products that can be re-used means less waste.
- **Refuse:** You have the right as a consumer to refuse products like Styrofoam cups and take out containers, plastic dinnerware, straws, etc. If you need a to-go container, bring one from home. Straws are not necessary when enjoying your favorite drink. Plastic water bottle – no thank you, I brought my own reusable bottle.
- **Reuse:** Cut back on disposable and single serve items. Buy a big bag of veggie straws and bring them to school or work in a reusable eco-friendly container. Use both sides of the paper, better yet try going completely digital!
- **Recycle: This is the last step in the cycle.** Once you have exhausted the other 3 R's then it's time to properly dispose of the item. Make sure you understand the recycling policies in your community. Where can you dispose of hazardous waste? Have you started a compost bin?

Wildlife and Habitat Stewardship

Wildlife depend on us to speak on their behalf; to protect and conserve the natural resources they depend on. Being a wildlife and habitat steward requires us to care for the planet and those who call it home.

Learn to use various outdoor spaces as the backdrop for mindful practices that holistically benefit students.

- Reading and writing outside
- Listening to sounds in nature
- Relieving stress through outside physical activity (running, organized sports, gardening, walking, hiking, swimming, climbing, playing, etc.)
- Fostering an appreciation for nature as a space to be cherished, conserved, and protected.

21st CENTURY SKILLS

Learning and Innovation

- Creativity and Innovation
- Critical Thinking and Problem Solving
- Communication and Collaboration

Information, Media, and Technology

- Information Literacy
- ICT Literacy (Information, Communications, Technology)

Life and Career

- Flexibility and Adaptability
- Initiative and Self-Direction
- Productivity and Accountability
- Leadership and Responsibility

Music/PE/Art

Work with teachers on campus that have the ability and expertise to extend student learning beyond their core academic classes, ELA, science, math, and the social studies.

Examples include:

- Playing period pieces inspired by nature or taking music class outside.
- Advocate for more unstructured natural physical education – free choice.
- Make art inspired by nature or modeled after artists inspired by the natural world, such as Monet or Cezanne.

MS. Interdependent Relationships in Ecosystems

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<p>Students who demonstrate understanding can:</p> <p>MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. [Clarification Statement: Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial.]</p> <p>MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.* [Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.]</p>		
<p>Constructing Explanations and Designing Solutions</p> <p>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.</p> <ul style="list-style-type: none"> • Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. (MS-LS2-2) <p>Engaging in Argument from Evidence</p> <p>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).</p> <ul style="list-style-type: none"> • Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-LS2-5) 	<p>LS2.A: Interdependent Relationships in Ecosystems</p> <ul style="list-style-type: none"> • Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (MS-LS2-2) <p>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</p> <ul style="list-style-type: none"> • Biodiversity describes the variety of species found in Earth’s terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem’s biodiversity is often used as a measure of its health. (MS-LS2-5) <p>LS4.D: Biodiversity and Humans</p> <ul style="list-style-type: none"> • Changes in biodiversity can influence humans’ resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. (secondary to MS-LS2-5) <p>ETS1.B: Developing Possible Solutions</p> <ul style="list-style-type: none"> • There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (secondary to MS-LS2-5) 	<p>Patterns</p> <ul style="list-style-type: none"> • Patterns can be used to identify cause and effect relationships. (MS-LS2-2) <p>Stability and Change</p> <ul style="list-style-type: none"> • Small changes in one part of a system might cause large changes in another part. (MS-LS2-5) <p>-----</p> <p style="text-align: center;">Connections to Engineering, Technology, and Applications of Science</p> <p>Influence of Science, Engineering, and Technology on Society and the Natural World</p> <ul style="list-style-type: none"> • The use 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. (MS-LS2-5) <p>-----</p> <p style="text-align: center;">Connections to Nature of Science</p> <p>Science Addresses Questions About the Natural and Material World</p> <p>Scientific knowledge can describe consequence of actions but does not make the decisions that society takes. (MS-LS2-5)</p>
<p>Science and Engineering Practices</p>	<p>Disciplinary Core Ideas</p>	<p>Crosscutting Concepts</p>
<p>Connections to other DCIs in this grade-band: MS.LS1.B (MS-LS2-2); MS.ESS3.C (MS-LS2-5)</p>		
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<p>COMMON CORE STATE STANDARDS</p> <p>Connections: ELA/Literacy –</p> <p>RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-LS2-2)</p> <p>RST.6-8.8 Distinguish among facts, reasoned judgment based on research findings, and speculation in a text. (MS-LS2-5)</p> <p>RI.8.8 Trace and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient to support the claims. (MS-LS2-5)</p> <p>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-LS2-2)</p> <p>WHST.6-8.9 Draw evidence from literary or informational texts to support analysis, reflection, and research. (MS-LS-2)</p> <p>SL.8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others’ ideas and expressing their own clearly. (MS-LS2-2)</p> <p>SL.8.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. (MS-LS2-2)</p> <p>Mathematics –</p> <p>MP.4 Model with mathematics. (MS-LS2-5)</p> <p>6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems. (MS-LS2-5)</p> <p>6.SP.B.5 Summarize numerical data sets in relation to their context. (MS-LS2-2)</p>		

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ECO-SCHOOLS USA PATHWAYS ALIGNMENT: INTERDEPENDENT RELATIONSHIPS IN ECOSYSTEMS

MS-LS2-2, MS-LS2-5

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