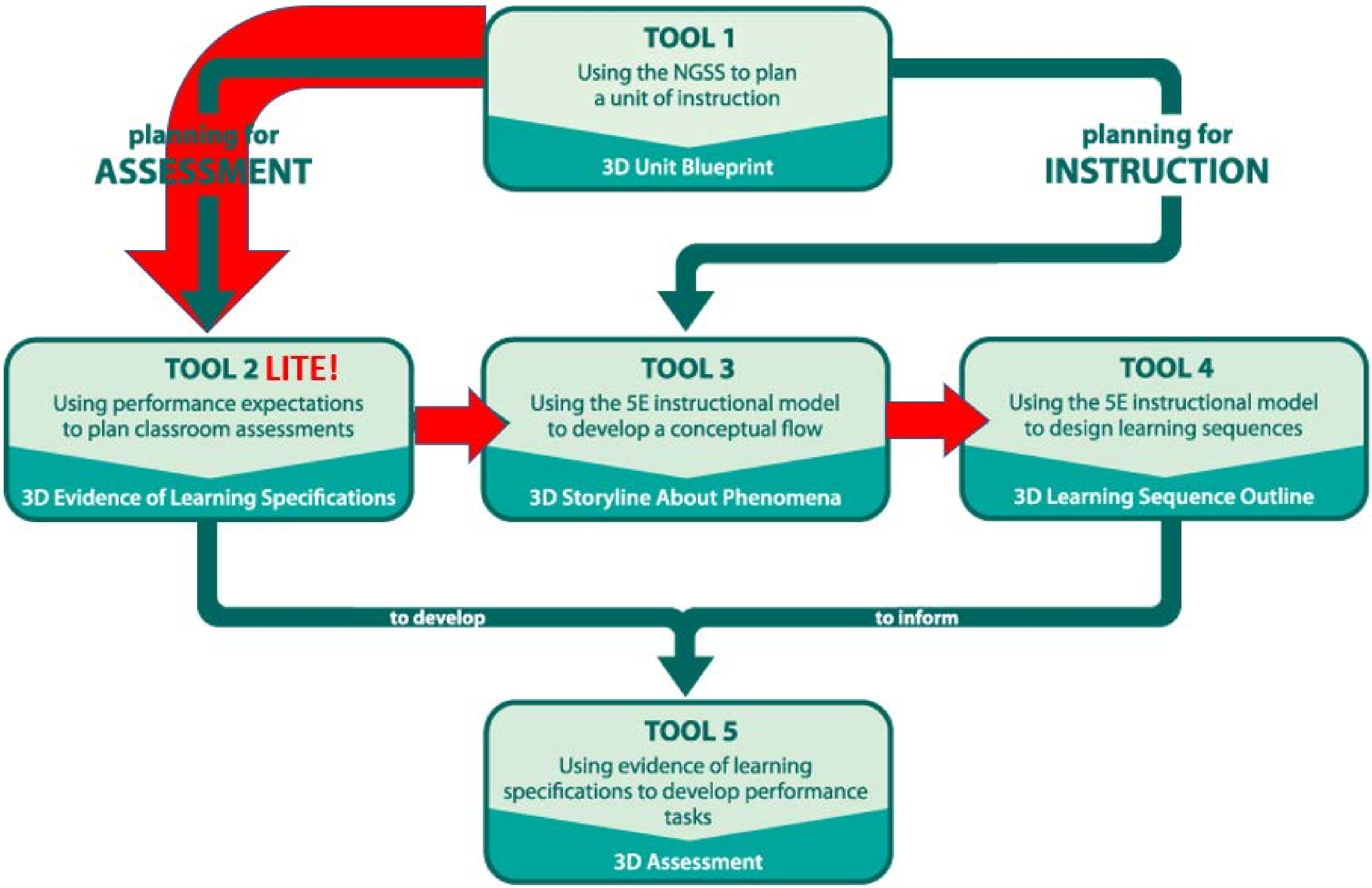
Advancing Tools and Processes for Next Generation Science

Model B: Planning for Instruction



NGSS Reading Guide

MS-LS2 Ecosystems: Interactions, Energy, and Dynamics

Reading Sources

A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (2012) by NRC
Next Generation Science Standards For States, By States Volume 1: The Standards (2013) by NGSS Lead States
Next Generation Science Standards For States, By States Volume 2: The Appendices (2013) by NGSS Lead States

Purpose	Number	Reading
Increasing understanding of the discipline	1	Framework ▪ Narrative on each core idea in Life Science p. 140 ▪ Box 6-1, p. 142 (Core and Component Ideas in the Life Sciences)
Increasing understanding of the core and component ideas	2	Framework Part 1 ▪ LS2 Ecosystems: Ecosystems: Interactions, Energy, and Dynamics p. 150 Part 2 (stop at Grade Band Endpoints, then read the Grade 8 Endpoint) ▪ LS2A. Interdependent Relationship and Ecosystems pp. 150-151; 152 ▪ LS2B. Cycles of Matter and Energy Transfer in Ecosystems pp. 152-153; 153-154 ▪ LS2C. Ecosystems, Dynamics, and Resilience pp. 154-155; 155
Becoming familiar with a standards page from the NGSS	3	NGSS Vol. 1: The Standards ▪ MS-LS2 Ecosystems: Interactions, Energy, and Dynamics pp. 70-71
Studying connections to other disciplinary core ideas (DCIs) in this grade band	4	NGSS Vol. 1: The Standards ▪ MS-LS2 connections to other DCIs in this grade band p. 149
Considering the progression of disciplinary core ideas (DCIs) across grade bands	5	NGSS Vol. 2: The Appendices ▪ Appendix E: Disciplinary Core Idea Progressions in the NGSS pp. 43-44

Purpose	Number	Reading
Studying the science and engineering practices (SEPs) associated with this topic and grade band	6	NGSS Vol. 2: The Appendices ▪ Appendix F Science and Engineering Practices in the NGSS ○ Introduction pp. 48-50 ▪ Appendix F Science and Engineering Practices in the NGSS (Note: These are the SEPs included in the standards page for MS-LS2) ○ SEP #2 Developing and Using Models pp. 52-53 ○ SEP #4 Analyzing and Interpreting Data pp. 56-57 ○ SEP # 6 Constructing Explanations and Designing Solutions pp. 60-61 ○ SEP #7 Engaging in Argument from Evidence pp. 62-63
Studying the crosscutting concepts (CCCs) associated with this topic and grade band	7	NGSS Vol. 2: The Appendices ▪ Appendix G: Crosscutting Concepts in the NGSS ○ Introduction p. 79 ○ Guiding Principles pp. 80-81 ▪ Appendix G: Crosscutting Concepts in the NGSS (Note: These are the CCCs included in the standards page for MS-LS2) ○ CCC #1 Patterns pp. 81-82 ○ CCC #2 Cause and Effect pp. 82-83 ○ CCC #5 Energy and Matter p. 86 ○ CCC #7 Stability and Change pp. 87-88
Studying the connections to the nature of science and engineering, technology, and applications of science associated with this topic and grade band	8	NGSS Vol. 2: The Appendices ▪ Appendix H: Understanding the Scientific Enterprise: The Nature of Science in the NGSS ○ Introduction p. 96 ○ The Nature of Science: A Perspective for the NGSS pp. 96-97 ○ A Rationale and Research p. 97 ○ The Nature of Science and the NGSS p. 97 ▪ Appendix H: Understanding the Scientific Enterprise: The Nature of Science in the NGSS ○ Nature of science understanding most closely associate with practices

Purpose	Number	Reading
		▪ Scientific knowledge is based on empirical evidence p. 98 o Nature of science understanding most closely associate with crosscutting concepts ▪ Scientific knowledge assumes an order and consistency in natural systems p. 100 ▪ Science addresses questions about the natural and material world p. 100 NGSS Vol. 2: The Appendices ▪ Appendix I: Engineering Design in the NGSS o Introduction p. 103 o Key Definitions p. 103 NGSS Vol. 2: The Appendices ▪ Appendix J: Science, Technology, Society, and the Environment o Introduction p. 108 o In the Framework p. 108 ▪ Appendix J: Science, Technology, Society, and the Environment o The Influence of Engineering, Technology, and Science on Society and the Natural World pp. 108-109 ▪ Appendix J: Science, Technology, Society, and the Environment o In the Next Generation Science Standards p. 110

Tool 1: Using the NGSS to plan a unit of instruction

Our ideas
- What do students need to know/understand about the topic?

DCIs
- How can we build from what we know and the disciplinary core ideas to ensure coherent instruction?

PEs
- What can we learn by studying the performance expectations?

SEPs & CCCs
- How can we build coherence using the science and engineering practices and crosscutting concepts?

Connections
- How do ideas about the nature of science, engineering, and common core influence our sequence?

Tool 1 Template Example – Unit Blueprint for MS-LS2 (Ecosystems: Interactions, Energy, and Dynamics)

Instructional Sequence 1	Instructional Sequence 2	Instructional Sequence 3	Instructional Sequence 4	Instructional Sequence 5
Performance Expectation 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.	**Performance Expectation MS-LS2-3** ***Develop a model to describe the cycling of matter and flow of energy among living and non-living 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.	**Performance Expectation MS-LS2-1** ***Analyze and interpret data to provide evidence for the effects of resources availability on organisms and populations of organisms in an ecosystem.*** *Clarification Statement:* Emphasis is on cause and effect relationships between resources and the growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.	**Performance Expectation 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.	**Performance Expectation MS-LS2-5** ***Evaluate competing design solutions for maintaining biodiversity and ecosystems 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. *This performance expectation integrates traditional science content with engineering through a practice or disciplinary core idea.
Performance Expectation MS-ESS3-4 ***Construct an argument supported by evidence for how increases in human population ~~and per-capita consumption of natural resources~~ impact Earth's systems.*** *Clarification Statement*: ~~Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change.~~ The consequences of increases in human populations ~~and consumption of natural resources~~ are described by science, but science does not make the decisions for the actions society takes.	**Performance Expectation MS-PS1-5** ***Develop and use a model to describe how ~~the total number of atoms does not change in a chemical reaction and thus~~ mass is conserved.*** *Clarification Statement*: Emphasis is on law of conservation of matter ~~and on physical models or drawings, including digital forms that represent atoms~~. *Assessment Boundary*: Assessment does not include the use of atomic masses, balancing symbolic equations, or intermolecular forces.	**Performance Expectation MS-ESS3-4** ***Construct an argument supported by evidence for how increases in human population ~~and per-capita consumption of natural resources~~ impact Earth's systems.*** *Clarification Statement*: ~~Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change.~~ The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.	**Performance Expectation MS-LS2-1** ***Analyze and interpret data to provide evidence for the effects of resources availability on organisms and populations of organisms in an ecosystem.*** *Clarification Statement:* Emphasis is on cause and effect relationships between resources and the growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.	**Performance Expectation MS-ESS3-3** ***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). *This performance expectation integrates traditional science content with engineering through a practice or disciplinary core idea.
	Performance Expectation MS-ESS2-1 ***Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.*** *Clarification Statement*: ~~Emphasis is on the processes of melting, crystallization, weathering, deformation, and sedimentation, which act together to form minerals and rocks through the~~ cycling of Earth's materials. *Assessment Boundary*: Assessment does not include the identification and naming of minerals.			**Performance Expectation MS-ESS3-4** ***Construct an argument supported by evidence for how increases in human population ~~and per-capita consumption of natural resources~~ impact Earth's systems.*** *Clarification Statement*: ~~Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change.~~ The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.

Instructional Sequence 1	Instructional Sequence 2	Instructional Sequence 3	Instructional Sequence 4	Instructional Sequence 5
MS LS2: Ecosystems: Interactions, Energy, and Dynamics LS2.A: Interdependent Relationships in Ecosystems *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)*	**MS LS2: Ecosystems: Interactions, Energy, and Dynamics** LS2.B: Cycle of Matter and Energy Transfer in Ecosystems *Food webs are models that demonstrate how matter and energy are 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 non-living parts of the ecosystem. (MS-LS2-3)*	**MS LS2: Ecosystems: Interactions, Energy, and Dynamics** LS2.A: Interdependent Relationships in Ecosystems *Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with non-living factors. (MS-LS2-1)*	**MS LS2: Ecosystems: Interactions, Energy, and Dynamics** 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)*	**MS LS2: Ecosystems: Interactions, Energy, and Dynamics** LS2.C: Ecosystem Dynamics, Functioning, and Resilience *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)*
MS ESS3: Earth and Human Activity ESS3.C: Human Impacts on Earth Systems *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. (connection DCI to MS-LS2-1, MS-LS2-4 and MS-LS2-5)*	**MS ESS2: Earth's Systems** ESS2.A: Earth's Materials and Systems *All Earth processes are the result of energy flowing and matter recycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. (connection DCI to MS-LS2-3 and MS-LS2-4)*	**MS LS2: Ecosystems: Interactions, Energy, and Dynamics** LS2.A: Interdependent Relationships in Ecosystems *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 constraints their growth and reproduction. (MS-LS2-1)*	**MS LS2: Ecosystems: Interactions, Energy, and Dynamics** LS2.A: Interdependent Relationships in Ecosystems *Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with non-living factors. (MS-LS2-1)*	**MS LS2: Ecosystems: Interactions, Energy, and Dynamics** LS4.D: Biodiversity and Humans *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. (MS-LS2-5)*
	MS PS1: Matter and Its Interactions PS1.B: Chemical Reactions *Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. The total number of each type of atom is conserved, and thus the mass does not change. (connection DCI to MS-PS1-5)*	**MS LS2: Ecosystems: Interactions, Energy, and Dynamics** LS2.A: Interdependent Relationships in Ecosystems *Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)*	**MS LS2: Ecosystems: Interactions, Energy, and Dynamics** LS2.A: Interdependent Relationships in Ecosystems *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 constraints their growth and reproduction. (MS-LS2-1)*	**MS ESS3: Earth and Human Activity** ESS3.C: Human Impacts on Earth Systems *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. (connection DCI to MS-LS2-1, MS-LS2-4 and MS-LS2-5)*
		MS ESS3: Earth and Human Activity ESS3.C: Human Impacts on Earth Systems *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. (connection DCI to MS-LS2-1)*	**MS LS2: Ecosystems: Interactions, Energy, and Dynamics** LS4.D: Ecosystem Dynamics, Functioning, and Resilience *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. (MS-LS2-5)*	**MS ESS3: Earth and Human Activity** 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. (connection DCI to MS-LS2-1 and MS-LS2-4)*

Instructional Sequence 1	Instructional Sequence 2	Instructional Sequence 3	Instructional Sequence 4	Instructional Sequence 5
				MS LS2: Ecosystems: Interactions, Energy, and Dynamics 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. (secondary to MS-LS2-5)*
Science and Engineering Practices 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 ideas, principles, and theories. ***Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena.*** *(MS-LS2-2)*	**Science and Engineering Practices** 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)*	**Science and Engineering Practices** 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)*	**Science and Engineering Practices** 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 worlds. ***Construct an oral or 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)*	**Science and Engineering Practices** 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 worlds. ***Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.*** *(MS-LS2-5)*
Science and Engineering Practices 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 worlds. ***Construct an oral or 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-ESS3-4)*	**Science and Engineering Practices** 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 a model to describe unobservable mechanisms.*** *(MS-PS1-5)*	**Science and Engineering Practices** 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-ESS3-4)*	**Science and Engineering Practices** 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)*	**Science and Engineering Practices** 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-ESS3-4)*
				Science and Engineering Practices 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 ideas, principles, and theories. ***Apply scientific principles to design an object, tool, process or system.*** *(MS-ESS3-3)*

Instructional Sequence 1	Instructional Sequence 2	Instructional Sequence 3	Instructional Sequence 4	Instructional Sequence 5
Crosscutting Concepts Patterns **Patterns can be used to identify cause and effect relationships.** *(MS-LS2-2)*	**Crosscutting Concepts** Energy and Matter ***The transfer of energy can be tracked as energy flows through a natural system.*** *(MS-LS2-3)*	**Crosscutting Concepts** Cause and Effect ***Cause and effect relationships may be used to predict phenomena in natural or designed systems.*** *(MS-LS2-1)*	**Crosscutting Concepts** Stability and Change **Small changes in one part of a system might cause large changes in another part.** *(MS-LS2-4)*	**Crosscutting Concepts** Stability and Change **Small changes in one part of a system might cause large changes in another part.** *(MS-LS2-5)*
Crosscutting Concepts Cause and Effect ***Cause and effect relationships may be used to predict phenomena in natural or designed systems.*** *(MS-ESS3-4)*	**Crosscutting Concepts** Energy and Matter ***Matter is conserved because atoms are conserved in physical and chemical processes.*** *(MS-PS1-5)*		**Crosscutting Concepts** Cause and Effect ***Cause and effect relationships may be used to predict phenomena in natural or designed systems.*** *(MS-LS2-1)*	**Crosscutting Concepts** Cause and Effect ***Cause and effect relationships may be used to predict phenomena in natural or designed systems.*** *(MS-ESS3-4)*
Connections of Nature of Science Science Addresses Questions About the Natural and Material World ***Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes.*** *(MS-ESS3-4)*	**Crosscutting Concepts** Stability and Change ***Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale.*** *(MS-ESS2-1)*	**Connections of Nature of Science** Science Addresses Questions About the Natural and Material World ***Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes.*** *(MS-ESS3-4)*	**Connections to Nature of Science** Scientific Knowledge Is Based on Empirical Evidence ***Science disciplines share common rules of obtaining and evaluating empirical evidence.*** *(MS-LS2-4)*	**Connections of Nature of Science** Science Addresses Questions About the Natural and Material World ***Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes.*** *(MS-LS2-5) (MS-ESS3-4)*
Connections to Engineering, Technology and Applications of Science 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.*** *(MS-ESS3-4)*	**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)*	**Connections to Engineering, Technology and Applications of Science** 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.*** *(MS-ESS3-4)*		**Connections to Engineering, Technology and Applications of Science** Influence of Science, Engineering, and Technology on Society and the Natural World ***The use of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; 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) (MS-ESS3-3)*
Big Ideas Sequence 1	**Big Ideas Sequence 2**	**Big Ideas Sequence 3**	**Big Ideas Sequence 4**	**Big Ideas Sequence 5**
Food webs show the patterns of interactions in ecosystems. Organisms in an ecosystem interact with each other in different ways, including predation, competition, and symbiosis. Humans impact ecosystems in both direct and indirect ways.	Ecosystem models can be used to describe the transfer of energy and cycling of matter.	Limited resources impact both organisms and populations. Humans impact ecosystems in both direct and indirect ways.	The introduction of a new species can affect many aspects of an ecosystem. Invasive species can have both positive and negative impacts on the stability of an ecosystem.	Human impact on ecosystems can be reduced, and solutions to environmental problems can be evaluated using criteria for sustainability.