Biology Unit 1 - Ecology: Using Matter & Energy

Content Area:	**Science**
Course(s):	**Biology**
Time Period:	**MP1**
Length:	**40 days**
Status:	**Published**

NJSLS - Science

SCI.HS-PS1	Matter and Its Interactions
SCI.HS-PS2	Motion and Stability: Forces and Interactions
SCI.HS-LS1-3	Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
SCI.HS-LS2-1	Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
SCI.HS-LS2-2	Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
SCI.HS-LS2-4	Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
SCI.HS-LS2-6	Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
SCI.HS-LS2-8	Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.
SCI.HS-ETS1-3	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Science and Engineering Practices

Planning and Carrying Out Investigations

Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-LS1-3)

Using Mathematics and Computational Thinking

Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (HS-LS2-1)

Use mathematical representations of phenomena or design solutions to support and revise explanations. (HS-LS2-2)

Use mathematical representations of phenomena or design solutions to support claims. (HS-LS2-4)

Scientific Investigations Use a Variety of Methods

Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. (HS-LS1-3)

Engaging in Argument from Evidence

Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-6)

Evaluate the evidence behind currently accepted explanations to determine the merits of arguments. (HS-LS2-8)

Scientific Knowledge is Open to Revision in Light of New Evidence

Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-2)

Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation. (HS-LS2-6, HS-LS2-8)

Constructing Explanations and Designing Solutions

Evaluate a solution to a complex real-world problem, based on scientific knowledge, student generated sources of evidence, prioritized criteria, and trade off considerations. (HS-ETS1-3)

Disciplinary Core Ideas

LS1.A: Structure and Function

Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3)

LS2.A: Interdependent Relationships in Ecosystems

Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (HS-LS2-1), (HS-LS2-2)

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

Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (HS-LS2-4)

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2), (HS-LS2-6)

LS2.D: Social Interactions and Group Behavior

Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HS-LS2-8)

ETS1.B: Developing Possible Solutions

When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)

Crosscutting Concepts

Cause and Effect

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS2-8)

Scale, Proportion, and Quantity

The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-LS2-1)

Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (HS-LS2-2)

Energy and Matter

Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS2-4)

Stability and Change

Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6))

Feedback (negative or positive) can stabilize or destabilize a system. (HS-LS1-3)

Connections to Nature of Science Scientific Knowledge is Open to Revision in Light of New Evidence

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Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation. (HS-LS2-6), (HS-LS2-8)

Scientific Investigations Use a Variety of Methods

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LS1-3)

Influence of Science, Engineering, and Technology on Society and the Natural World

New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology

Rationale and Transfer Goals

In this unit of study, students construct explanations for the role of energy in the cycling of matter in organisms and ecosystems. They apply mathematical concepts to develop evidence to support explanations of the interactions of photosynthesis and cellular respiration, and they will develop models to communicate these explanations. Students also understand organisms' interactions with each other and their physical environment and how organisms obtain resources. Students utilize the crosscutting concept of scale , proportion and quantity to make sense of ecosystem dynamics. Students are expected to apply energy and matter to explain the role of energy in the cycling of matter in organisms and ecosystems. They apply mathematical concepts to develop evidence to support explanations as they demonstrate their understanding of the disciplinary core ideas.

Enduring Understandings

- How do organisms respond to their environment?
- Model energy and matter cycling through ecosystems.
- Populations change based on biotic and abiotic environmental factors.

Essential Questions

How can humans and dolphins mutually benefit from each other? https://thewonderofscience.com/phenomenon/2018/5/3/dolphins-and-humans-fishing-together

Why do we sweat? How is sweating essential to maintain homeostasis? https://ed.ted.com/lessons/why-do-we-sweat-john-murnan

Content - What will students know?

- Characteristics of life
- Levels of organization in ecology (biosphere → organism)
- Food chains & food webs
- Energy pyramids
- Species interactions: predation, competition, Symbiosis
- Changes in populations: immigration, emigration, mortality, natality.
- Growth curves/carrying capacity

Skills - What will students be able to do?

- Students will observe and analyze how organisms respond to stimuli and attempt to maintain homeostasis.
- Students will contrast the size and complexity differences among the levels of organization.
- Compare and contrast food chains with food webs. They will be able to explain why food chains are not a realistic representation of a community of organisms.
- Students will analyze changes in quantities of matter and energy that exist in an ecological energy pyramid.
- Students will differentiate the interactions of predation, competition, and symbiosis.
- Contrast changes in populations when positive increases happen due to immigration and birth with decreases caused by emigration and mortality.
- Students will compare and contrast population changes in logistic and exponential growth curves.

Activities - How will we teach the content and skills?

- Students will participate in the mealworm lab to test hypotheses and observe how invertebrates can respond to changes in their environment.
- Students will create graphic organizers, making their own labels and examples, to develop a deeper

understanding of how each level is unique.

- Students will participate in lab exercises and/or small group projects to study food webs in various ecosystems.
- Students will create energy pyramids to reflect multiple populations, accurately estimating decreases in matter and energy.
- Students will complete data tables and analyze varying symbiotic relationships between organisms.
- Analyze graphic representations (data tables, charts, graphs) of population dynamics.
- Students will use data tables and textual information to make graphs they can study and discuss the results with their peers.

Evidence/Assessments - How will we know what students have learned?

- **Assessments can be reviewed for each course inthis folder.**
- Chapter tests
- Biology Unit 1 Benchmark
- Lab assignments
- Small group projects
- Mealworm lab
- Symbiosis Lab
- Food web project

Spiraling for Mastery

Content or Skill for this Unit	Spiral Focus from Previous Unit	Instructional Activity
• HS-LS1-3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. • HS-LS2-1 Use mathematical and/or computational	• MS-LS1-3 Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells. • MS-LS2-1 Analyze and interpret data to provide	• Review parts of a eukaryotic cell when focusing on chloroplasts and mitochondria to explain photosynthesis and respiration. • Review mathematical practices to estimate

representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. • HS-LS2-2 Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. • HS-LS2-4 Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.	evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. • MS-LS2-2 Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. • MS-LS2-4 Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.	energy transfer in a pyramid of numbers. • Practice interpreting ecological data from tables, energy pyramids, and food webs. • Conduct simulations to determine how a variety of factors impact population growth.

Key Resources

Mealworm behavior virtual lab

Food Web project

Simply Symbiosis Lab

21st Century Life and Careers

WRK.9.2.12.CAP.2	Develop college and career readiness skills by participating in opportunities such as structured learning experiences, apprenticeships, and dual enrollment programs.
WRK.9.2.12.CAP.3	Investigate how continuing education contributes to one's career and personal growth.
WRK.9.2.12.CAP.4	Evaluate different careers and develop various plans (e.g., costs of public, private, training

	schools) and timetables for achieving them, including educational/training requirements, costs, loans, and debt repayment.

Career Readiness, Life Literacies, & Key Skills

TECH.9.4.12.CT.3	Enlist input from a variety of stakeholders (e.g., community members, experts in the field) to design a service learning activity that addresses a local or global issue (e.g., environmental justice).
TECH.9.4.12.CT.4	Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
TECH.9.4.12.GCA.1	Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1, 7.1.IH.IPERS.6, 7.1.IL.IPERS.7, 8.2.12.ETW.3).
TECH.9.4.12.IML.2	Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources.
TECH.9.4.12.IML.3	Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8).
TECH.9.4.12.IML.4	Assess and critique the appropriateness and impact of existing data visualizations for an intended audience (e.g., S-ID.B.6b, HS-LS2-4).
TECH.9.4.12.IML.5	Evaluate, synthesize, and apply information on climate change from various sources appropriately (e.g., 2.1.12.CHSS.6, S.IC.B.4, S.IC.B.6, 8.1.12.DA.1, 6.1.12.GeoHE.14.a, 7.1.AL.PRSNT.2).
TECH.9.4.12.IML.6	Use various types of media to produce and store information on climate change for different purposes and audiences with sensitivity to cultural, gender, and age diversity (e.g., NJSLSA.SL5).
TECH.9.4.12.IML.7	Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change (e.g., NJSLSA.W1, 7.1.AL.PRSNT.4).

Interdisciplinary Connections

RL.CR.9–10.1. Cite a range of thorough textual evidence and make relevant connections to strongly support analysis of multiple aspects of what a literary text says explicitly and inferentially, as well as including determining where the text leaves matters uncertain.

RI.CR.9–10.1. cite a range and thorough textual evidence and make clear and relevant connections, to strongly support an analysis of multiple aspects of what an informational text says explicitly and inferentially, as well as interpretations of the text.

W.AW.9–10.1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient textual and non-textual evidence.

W.IW.9–10.2. Write informative/explanatory texts (including the narration of historical events, scientific procedures/ experiments, or technical processes) to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

S.ID.A. Summarize, represent, and interpret data on a single count or measurement variable

- Represent data with plots on the real number line (dot plots, histograms, and box plots).
- Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.
- Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).
- Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages.
- Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.