

HS-LS2-4 Ecosystems: Interactions, Energy, and Dynamics

 California Science Test—Item Content Specifications

HS-LS2-4 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.

[Clarification Statement: Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem.] [*Assessment Boundary: Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.*]

Continue to the next page for the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts.

| Science and Engineering Practices | Disciplinary Core Ideas | Crosscutting Concepts |
| --- | --- | --- |
| Using Mathematical and Computational ThinkingMathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis; a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms; and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.Use mathematical representations of phenomena or design solutions to support claims. | LS2.B: Cycles of Matter and Energy Transfer in Ecosystems4. 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. | Energy and MatterEnergy cannot be created or destroyed; it only moves between one place and another place, between objects and/or fields, or between systems. |

## Assessment Targets

Assessment targets describe the focal knowledge, skills, and abilities for a given three-dimensional Performance Expectation. Please refer to the Introduction for a complete description of assessment targets.

### Science and Engineering Subpractice(s)

Please refer to appendix A for a complete list of Science and Engineering Practices (SEP) subpractices. Note that the list in this section is not exhaustive.

5.1 Ability to develop mathematical and/or computational models (e.g., graphical representation in a simulation)

5.2 Ability to conduct mathematical and/or computational analysis

### Science and Engineering Subpractice Assessment Targets

Please refer to appendix A for a complete list of SEP subpractice assessment targets. Note that the list in this section is not exhaustive.

5.1.1 Ability to generate mathematical representations to describe characteristics and patterns of a scientific phenomenon and/or a design solution

5.1.2 Ability to use units of measurement, diagrams, and graphs to record and organize data gathered directly or provided from scientific investigations

5.1.3 Ability to create, evaluate, and/or revise a computational model or simulation of a scientific phenomenon, a design solution, or both

5.1.4 Ability to recognize that computational models such as simulations are built on mathematical models that incorporate the underlying science principles being studied

5.2.1 Ability to use the results of computational models (e.g., simulations) to identify patterns in natural and/or design worlds

5.2.2 Ability to use the results of computational models to identify the mathematical and/or computational representations that support a scientific explanation or a design solution

5.2.3 Ability to use computational models (e.g., simulations) to make predictions for a scientific phenomenon

5.2.4 Ability to use critical mathematical skills to compare simulated effects in computational models to real-world observations to identify limitations of computational models

### Disciplinary Core Idea Assessment Targets

#### LS2.B.4

* Explain that only a small fraction of the energy available at lower trophic levels is available to organisms at higher trophic levels in an ecosystem
* Explain why there are typically fewer organisms at high trophic levels than at lower trophic levels in an ecosystem
* Describe how chemical elements used by organisms are combined and recombined in different organisms
* Explain how biogeochemical cycles facilitate the recycling of the elements required by organisms
* Describe the energy capture and transfer processes in ecosystems, including photosynthesis and cellular respiration

### Crosscutting Concept Assessment Target(s)

CCC5 Identify that energy cannot be created or destroyed; it only moves between one place and another place, between objects and/or fields, or between systems

## Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides incomplete models of a biogeochemical cycle:

* Generates a mathematical representation based on simple proportions or ratios to show how the transfer of energy and/or matter can be determined (5.1.1, LS2.B.4, and CCC5)

Task provides data on the energy available at different trophic levels:

* Uses the appropriate units, diagrams, and graphs to organize the data (5.1.2, LS2.B.4, and CCC5)
* Calculates the amount of energy lost or transferred between trophic levels using simple proportions or ratios (5.2.2, LS2.B.4, and CCC5)

Task provides a pyramid of biomass and selected organisms representing different trophic levels:

* Completes the model (5.1.3, LS2.B.4, and CCC5)
* Places the organisms into the correct trophic level (5.1.3, LS2.B.4 and CCC5)

Task provides a pyramid of biomass and selected organisms representing different trophic levels:

* Identifies the processes involved (5.1.4, LS2.B.4, and CCC5)
* Describes the transfer of energy and/or matter between the organisms (5.1.4, LS2.B.4, and CCC5)

Task provides one or more simulations showing the transfer of materials in a food web:

* Identifies the mathematical and/or computational representations (5.2.1, LS2.B.4, and CCC5)
* Uses the simulations to make predictions about material transfer (5.2.3, LS2.B.4, and CCC5)

## California Environmental Principles and Concepts

* EP2: The long-term functioning and health of terrestrial, freshwater, coastal, and marine ecosystems are influenced by their relationships with human societies.
* EP4: The exchange of matter between natural systems and human societies affects the long-term functioning of both.

## Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

* The flow of energy or cycling of matter through a food web or ecosystem (terrestrial or oceanic)
* The high percentage of biomass found in producers in terrestrial ecosystems or the low standing biomass (i.e., low total biomass within a given area at a given time) of primary producers in aquatic ecosystems
* The numbers of organisms found at each trophic level
* The inefficient transfer of energy between trophic levels

## Common Misconceptions

Note that the list in this section is not exhaustive.

* Food webs only have linear relationships.
* Water is an energy source for producers.
* Energy can be recycled.

## Additional Assessment Boundaries

None listed at this time.

## Additional References

HS-LS2-4 Evidence Statement [https://www.nextgenscience.org/sites/default/files/evidence\_statement/black\_white/HS-LS2-4 Evidence Statements June 2015 asterisks.pdf](https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/HS-LS2-4%20Evidence%20Statements%20June%202015%20asterisks.pdf)

California Environmental Principles and Concepts <http://californiaeei.org/abouteei/epc/>

California Education and the Environment Initiative <http://californiaeei.org/>

The *2016 Science Framework for California Public Schools Kindergarten through Grade 12*

Appendix 1: Progression of the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts in Kindergarten through Grade 12 <https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix1.pdf>

Appendix 2: Connections to Environmental Principles and Concepts <https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix2.pdf>

Posted by the California Department of Education, March 2021 (updated February 2024)