HS-LS1-3

Students who demonstrate understanding can:

Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

[Clarification Statement: Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, and root development in response to water levels.] *[Assessment Boundary: Assessment does not include the cellular processes involved in the feedback mechanism.]*

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
Planning and Carrying Out Investigations Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. • 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. -------------------------------- ***Connections to Nature of Science*** **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.	**LS1.A: Structure and Function** 9. 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.	**Stability and Change** • Feedback (negative or positive) can stabilize or destabilize a system.

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.

3.1 Ability to clarify the goal of the investigation and identify the evidence needed to address the purpose of the investigation

3.2 Ability to develop, evaluate, and refine a plan for the investigation

3.3 Ability to collect the data for the investigation

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.

3.1.1 Ability to describe the purpose of the investigation or formulate a question that can be investigated

3.1.2 Ability to identify relevant independent and dependent variables and to consider possible confounding variables or effects

3.1.3 Ability to describe what and how much data need to be collected to provide sufficient evidence to the purpose of the investigation

3.1.4 Ability to describe how the observations and/or collected data can be used as evidence for the phenomenon under investigation

3.2.1 Ability to decide how to measure and observe relevant variables, including considering the level of accuracy and precision required, and the kinds of instrumentation and techniques best suited to making such measurements to reduce both random and systematic error

3.2.2 Ability to describe detailed experimental procedure, including how the data will be collected, the number of trials, the experimental setup, and the equipment and tools required

3.2.3 Ability to compare and evaluate alternative methods to determine which design provides the evidence necessary to address the purpose of the investigation

3.3.1 Ability to use appropriate tools for accurate and precise measurements

3.3.2 Ability to make observations according to the investigation plan

3.3.3 Ability to evaluate the quality of data to determine if the evidence meets the goals of the investigation

Disciplinary Core Idea Assessment Targets

LS1.A.9a Identify feedback mechanisms and their effects on living systems

LS1.A.9b Describe the evidence needed to document the effect of feedback mechanisms on living system

LS1.A.9c Develop an investigation plan (including how environmental changes and the living system’s response to them will be measured) to demonstrate the effect of feedback mechanisms on living systems

LS1.A.9d Implement a data collection strategy to provide evidence that feedback mechanisms maintain homeostasis

LS1.A.9e Evaluate investigation into feedback mechanisms that maintain homeostasis including an assessment of accuracy and precision of data, limitation, and ability to provide the evidence required to draw conclusions

Crosscutting Concept Assessment Target(s)

CCC7 Identify feedback, both positive and negative, that can stabilize or destabilize a system

Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides student with a list of materials/tools for planning an investigation based on feedback mechanisms:

- Identifies/describes a feedback mechanism that can be investigated with the provided list of materials/tools (3.1.1, LS1.A.9, and CCC7)

- Formulates an investigable question based on the selected feedback mechanism (3.1.1, LS1.A.9, and CCC7)

- Describes the data that would need to be collected as evidence to address the purpose of the investigation (3.1.1, LS1.A.9, and CCC7)

Task provides student with an experimental question based on how living things maintain homeostasis via feedback loops:

- Identify factors that might affect the result of the investigation (3.1.2, LS1.A.9, and CCC7)

- Identify the dependent and independent variables (3.1.2, LS1.A.9, and CCC7)

Task provides student with an experimental protocol for measuring homeostatic response based on feedback mechanisms:

- Identifies what is to be recorded as useful data (3.1.3, LS1.A.9, and CCC7)

- Decides how relevant variables will be measured and collects data for analysis (3.1.3, LS1.A.9, and CCC7)

Task provides student with data from a simulation based on an experimental investigation of homeostasis based on feedback mechanisms:

- Evaluates the quality of data to determine if the evidence meets the goal of the investigation (3.1.4, LS1.A.9, and CCC7)

- Develops a procedure with explicit scientific rationales to support the goal of the investigation (3.1.4, LS1.A.9, and CCC7)

- Identifies which trials of data from a simulation can be used as evidence for the goal of the investigation (3.1.4, LS1.A.9, and CCC7)

Task provides student with a list of materials/tools for planning an investigation based on feedback mechanisms:

- Evaluates a provided list of materials/tools for an investigation and identifies gaps (3.1.2, LS1.A.9, and CCC7)

- Selects relevant measuring tools and instrumentations that can help obtain sufficient and precise data (3.1.2, LS1.A.9, and CCC7)

Task provides student with an experimental question based on how living things maintain homeostasis via feedback loops:

- Selects/describes experimental procedures appropriate to the target feedback mechanism under investigation (3.2.2, LS1.A.9, and CCC7)

- Describes what and how to measure, observe, and sample the feedback mechanism under investigation (3.2.2, LS1.A.9, and CCC7)

Task provides student with alternative experimental protocols for measuring homeostatic response based on feedback mechanisms:

- Compares and evaluates alternative methods to determine which design provides the evidence necessary to address the purpose of the investigation (3.2.3, LS1.A.9, and CCC7)

Task provides a lab simulation in conjunction with an experimental procedure for investigating homeostasis based on feedback mechanisms:

- Uses tools and techniques to collect data useful for investigating the feedback mechanism (3.3.1, LS1.A.9, and CCC7)

Task provides a video or simulated model of an investigation of homeostasis based on feedback mechanisms:

- Describes and identifies observations relevant to the feedback mechanism under investigation (3.3.2, LS1.A.9, and CCC7)
- Records observations from a video or simulated models (3.3.2, LS1.A.9, and CCC7)
- Uses the observations to evaluate the investigation plan and identify gaps (3.3.2, LS1.A.9, and CCC7)

Task provides student with data from an investigation into the role of a feedback mechanism in maintaining homeostasis:

- Evaluates the quality of data to determine if the evidence meets the goal of the investigation (3.3.3, LS1.A.9, and CCC7)
- Evaluates the amount of data to determine if the data is sufficient to answer the scientific question about the feedback mechanism under investigation (3.3.3, LS1.A.9, and CCC7)

Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

- Thermoregulation of endotherms
- Effect of exercise on heart rate/breathing rate
- Fruit ripening

- Stomata response to moisture/temperature
- Root development in response to water levels
- Plant growth in response to changing light conditions

Common Misconceptions

Note that the list in this section is not exhaustive.

- Animals, but not plants, need to maintain homeostasis to survive.
- Living things cannot maintain constant internal conditions when external conditions change.
- When organisms experience changes in their external environment, they die.

Additional Assessment Boundaries

None listed at this time.

Additional References

HS-LS1-3 Evidence Statement (PDF)

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 (PDF)
https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix1.pdf

HS-LS1-5

Students who demonstrate understanding can:

Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.

[Clarification Statement: Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. Examples of models could include diagrams, chemical equations, and conceptual models.] *[Assessment Boundary: Assessment does not include specific biochemical steps.]*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Use a model based on evidence to illustrate the relationships between systems or between components of a system.	**LS1.C: Organization for Matter and Energy Flow in Organisms** 6. The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.	**Energy and Matter** • Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

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.

2.2 Ability to use models

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.

2.2.1 Ability to use the model to collect evidence to reason qualitatively or quantitatively about concepts and relationships represented in the model

2.2.2 Ability to use the model to generate explanations and predictions about the behavior of a scientific phenomenon

Disciplinary Core Idea Assessment Targets

LS1.C.6a Describe that photosynthesis transforms light energy into stored chemical energy by converting carbon dioxide and water into sugars and oxygen

LS1.C.6b Describe that in chemical reactions including photosynthesis the breaking of bonds requires energy and the forming of bonds releases energy

LS1.C.6c Describe that the chemical energy stored in organic compounds produced by photosynthesis is a result of the difference in the total bond energies of the inputs (carbon dioxide and water) and outputs (sugars and oxygen)

LS1.C.6d Describe the role of photosynthesis in the transfer of matter and flow of energy between organisms and the environment

LS1.C.6e Identify relationships between the components of a model illustrating the process of photosynthesis

Crosscutting Concept Assessment Target(s)

CCC5 Describe changes of energy and matter in a system in terms of the flow of energy and matter into, out of, and within that system

Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides an interactive model and a question/hypothesis about energy and matter in photosynthesis:

- Uses the data/evidence generated by the model to answer the question (2.2.1, LS1.C.6, and CCC5)
- Uses the data/evidence generated by the model to support or refute the hypothesis (2.2.1, LS1.C.6, and CCC5)

Task provides data/evidence from a model of energy and matter in photosynthesis:

- Identifies the mechanisms and relationships among the inputs and outputs of photosynthesis (2.2.1, LS1.C.6, and CCC5)

Task provides a model of energy and matter in photosynthesis:

- Uses the model to explain an aspect of photosynthesis (2.2.2, LS1.C.6, and CCC5)
- Uses the model to make a prediction about photosynthesis (2.2.2, LS1.C.6, and CCC5)

Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

- An interactive model of photosynthesis in which inputs can be varied to generate data
- An energy diagram of the overall reaction of photosynthesis that shows the relative energy levels of reactants and products
- A matter diagram showing the transfer of matter between organisms and the environment during photosynthesis
- A model comparing relative efficiency of C3 and C4 photosynthesis in different environments
- An interactive model comparing light-absorbing ability of different pigment combinations
- A model of CAM photosynthesis stressing its adaptive advantage in a desert environment

Common Misconceptions

Note that the list in this section is not exhaustive.

- Photosynthesis is a one-step process, as represented by the overall chemical equation.
- Glucose is the major end product of photosynthesis.
- Breaking bonds releases energy and forming bonds requires energy.
- Matter is created through photosynthesis.

Additional Assessment Boundaries

None listed at this time.

Additional References

Photosynthesis Misconceptions http://abt.ucpress.edu/content/57/4/198.2

HS-LS1-5 Evidence Statement

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

HS-LS2-2

Students who demonstrate understanding can:

Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

[Clarification Statement: Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.] *[Assessment Boundary: Assessment is limited to provided data.]*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Using Mathematics and Computational Thinking Mathematical 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 and revise explanations. ------------------------------ ***Connections to Nature of Science*** **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.	**LS2.A: Interdependent Relationships in Ecosystems** 8. 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. **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** 4. 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.	**Scale, Proportion, and Quantity** • Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale.

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

5.2 Ability to conduct mathematical and/or computational analyses

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 measurement and representations to describe characteristics and patterns of a scientific phenomenon and/or a design solution

5.2.1 Ability to use the results of computational models (e.g., graphical representation in a simulation) to identify the mathematical and/or computational representations to support a scientific explanation or a design solution

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

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

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

5.2.5 Ability to use mathematical and statistical tools to analyze trends and patterns in data from scientific investigations

Disciplinary Core Idea Assessment Targets

LS2.A.8a Define carrying capacity as it relates to a population, a community, and/or an ecosystem

LS2.A.8b Explain the factors that affect carrying capacity

LS2.A.8c Describe the impact of a change in environmental conditions on carrying capacity

LS2.A.8d Use mathematical comparisons to explain how carrying capacity is affected by a change in one or more factors in an ecosystem

LS2.A.8e Use mathematical representations to support claims about factors impacting carrying capacity in an ecosystem

LS2.A.8f Explain how population size fluctuates around carrying capacity due to physical and biological dynamics of the ecosystem

LS2.C.5a Explain that under stable conditions, numbers and types of organisms remain relatively constant over time

LS2.C.5b Explain that certain disturbances to an ecosystem do not have a lasting effect; the ecosystem is resilient

LS2.C.5c Explain that extreme changes to conditions can cause large-scale changes to the ecosystem

Crosscutting Concept Assessment Target(s)

CCC3 Use the concept of orders of magnitude to understand how a model at one scale relates to a model at another scale

Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides data on the population size of one or more species in a particular habitat over time:

- Provides or identifies a correct graph of the data (5.1.1, LS2.A.8/LS2.C.4, and CCC3)
- Describes patterns in the data (5.2.1, LS2.A.8/LS2.C.4, and CCC3)
- Provides a correct numerical description of data patterns (5.2.4, LS2.A.8/LS2.C.4, and CCC3)
- Analyzes patterns in the data using mathematical tools, such as mean populations, change over time (5.2.5, LS2.A.8/LS2.C.4, and CCC3)

Task provides a claim that a population has reached carrying capacity and provides data on the population size of a given species in a particular habitat over time:

- Uses the data to correctly support or refute the claim that the population has reached carrying capacity (5.2.1, LS2.A.8, and CCC3)

Task provides a claim about the ability of a particular ecosystem to support a population of organisms at carrying capacity:

- Predicts how carrying capacity would change with changes in environmental conditions (5.2.2, LS2.A.8, and CCC3)

Task provides a simulation in which population numbers of various species can be manipulated based on available resources/changes in environmental conditions:

- Identifies patterns generated by the results of the simulation (5.2.3, LS2.A.8/LS2.C.4, and CCC3)
- Applies the data from the simulation to correctly predict the impact of changes in resources or environmental conditions on actual populations (5.2.3, LS2.A.8/LS2.C.4, and CCC3)
- Uses the results of the simulation to correctly predict which changes to the ecosystem can be overcome over time and which can lead to permanent changes (5.2.3, LS2.C.4, and CCC3)

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.

- Carrying capacity affected by:
    - Resource availability
    - Competition
    - Abiotic factors

- Extent of change to an ecosystem

- Carrying capacity presented as a mathematical representation that includes trends, averages, and impact of environmental change
- Mathematical representations that present changes over time in the numbers and types of organisms in a given ecosystem
- Mathematical representations of boom and bust cycles
- Interactive model to explore factors of an ecosystem (richness, complexity, resource availability) that determine the resilience of the ecosystem in the face of disturbances
- Interactive models that explore the effect of a predator-prey relationship on population stability

Common Misconceptions

Note that the list in this section is not exhaustive.

- Carrying capacity is a fixed number.
- Ecosystems do not change.
- Change in an ecosystem will always decrease the number of individuals who can survive in a population.

Additional Assessment Boundaries

None listed at this time.

Additional References

HS-LS2-2 Evidence Statement
https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/HS-LS2-2%20Evidence%20Statements%20June%202015%20asterisks.pdf
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

HS-LS4-3

Students who demonstrate understanding can:

> **Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.**
>
> [Clarification Statement: Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations.] *[Assessment Boundary: Assessment is limited to basic statistical and graphical analysis. Assessment does not include allele frequency calculations.]*

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
Analyzing and Interpreting Data Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. • Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.	**LS4.B: Natural Selection** 4. Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information — that is, trait variation — that leads to differences in performance among individuals. 5. The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. **LS4.C: Adaptation** 4. Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. 5. Adaptation also means that the distribution of traits in a population can change when conditions change.	**Patterns** • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

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.

4.1 Ability to record and organize data

4.2 Ability to analyze data to identify relationships

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.

4.1.3 Ability to organize data in a way that facilitates analysis and interpretation

4.2.1 Ability to use observational and/or empirical data to describe patterns and relationships

4.2.2 Ability to identify patterns (qualitative or quantitative) among variables represented in data

4.2.3 Ability to apply concepts of statistics and probability to data

4.2.4 Ability to consider limitations of data analysis

Disciplinary Core Idea Assessment Targets

LS4.B.4a Describe heritable phenotypic variation among individuals in a population as a result of mutations and sexual reproduction

LS4.B.4b Describe that genetic variation can lead to a variation of expressed traits in individuals in a population

LS4.B.4c Describe that the variation of the expressed traits may lead to differences in performance in individuals

LS4.B.5a Describe that traits that positively affect survival are more likely to be passed on to offspring and become more common in a population

LS4.C.4a Describe that the differential survival and reproduction of organisms with advantageous heritable traits leads to an increase in the proportion of individuals in a population over time

LS4.C.4b Identify heritable traits (anatomical, behavioral, and physiological) that provide an advantage in a particular environment

LS4.C.3a Describe that the distribution of adaptive traits in a population may change in response to changes in the environment

LS4.C.3b Identify conditions of a particular environment that act as a selective pressure on a population

Crosscutting Concept Assessment Target(s)

CCC1 Identify different patterns at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena

Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task describes a description of an advantageous heritable trait and a description of data that have been collected or are expected to be collected:

- Identifies the appropriate way to organize the data to facilitate analysis that supports an explanation about the distribution of the trait in a population (4.1.3, LS4.C.4, LS4.C.3, and CCC1)

Task provides a scenario about an advantageous heritable trait and a data set in the form of a table showing the distribution of the trait over time or varying habitats:

- Describes patterns or relationships in a data set and its corresponding scientific concept, such as natural selection (4.2.1, LS4.C.4, LS4.C.3, and CCC1)

Task provides a description of an advantageous heritable trait and a data set in the form of a graph showing the distribution of the trait over time or varying habitats:

- Connects patterns in the data set and its corresponding scientific concept relevant to the trait (4.2.2, LS4.C.4, LS4.C.3, and CCC1)

Task provides a description of an advantageous heritable trait and a data set related to the frequency of the trait among the population:

- Analyzes data using reasoning, mathematics, or statistics and probability (including mean, median, mode, and variability) to answer a scientific question about the distribution of the trait in a population (4.2.3, LS4.C.4, LS4.C.3, and CCC1)

Task provides a description of an advantageous heritable trait, a data set, and a scientific question being investigated:

- Identifies limitations of data sets or an analysis of the data set, with respect to their ability to answer the scientific question (4.2.4, LS4.C.4,LS4.C.3, and CCC1)

Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

- A specific variation of a trait is observed to increase over time in a given population in a given environment.
- Two populations of the same species are in two different habitats. Each habitat has a different variation of an advantageous trait.
- Gene frequency data is used to determine if a change in frequency is a function of natural selection or a random major event.
- Gene frequency data is used to predict whether a specific trait would be adaptive or maladaptive in a new environment.
- Gene frequency data and quantitative environmental changes are analyzed for correlation.
- A heterozygote advantage is observed within a population.

Common Misconceptions

Note that the list in this section is not exhaustive.

- Statistics don't really mean anything important.
- Patterns always indicate cause and effect.
- Changes are due to the conscious efforts of organisms.
- Adaptations develop in a single organism over its lifetime.

Additional Assessment Boundaries

None listed at this time.

Additional References

HS-LS4-3 Evidence Statement

https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/HS-LS4-3%20Evidence%20Statements%20June%202015%20asterisks.pdf

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

HS-LS4-5

Students who demonstrate understanding can:

Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

[Clarification Statement: Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, fishing, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current or historical episodes in science. • Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments.	**LS4.C: Adaptation** 6. Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline — and sometimes the extinction — of some species. 7. Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost.	**Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

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.

7.2 Ability to compare, evaluate and critique competing arguments

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.

7.2.1 Ability to evaluate arguments about a natural phenomenon based on scientific concepts, principles, and big ideas

7.2.2 Ability to respond to critiques from others by probing reasoning and evidence, and revising the argument

7.2.3 Ability to evaluate competing perspectives/claims using reasoning and evidence

Disciplinary Core Idea Assessment Targets

LS4.C.6a Identify changes in environmental conditions that could potentially result in an increase in the number of some species, lead to the emergence of new species over time, and/or lead to the extinction of other species

LS4.C.6b Identify the evidence supporting a claim that changes in environmental conditions can affect species both positively and/or negatively

LS4.C.6c Evaluate the evidence supporting a claim that changes in environmental conditions affected a species positively/negatively

LS4.C.6d Evaluate evidence supporting that environmental factors can determine the ability of individuals in a species to survive and reproduce

LS4.C.7a Explain why a change in an environment may cause extinction of a species

LS4.C.7b Explain why an inability to reproduce can lead to extinction

Crosscutting Concept Assessment Target(s)

CCC2 Identify empirical evidence to differentiate between cause and correlation and make claims about specific causes and effects

Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides a claim stating that changing environmental conditions affect a species:

- Identifies evidence that could be used to support the claim (7.2.1, LS4.C.6, and CCC2)
- Describes the conditions under which the claim can be supported (7.2.1, LS4.C.6, and CCC2)

Task provides a claim and supporting data on how changing environmental conditions affect a species:

- Evaluates whether the claim is supported by the data (7.2.1, LS4.C.6, and CCC2)
- Critiques the claim with supporting reasoning and/or evidence (7.2.1, LS4.C.6, and CCC2)

Task provides a claim and supporting data on how changing environmental conditions lead to species extinction:

- Evaluates whether the claim is supported by the data (7.2.1, LS4.C.7, and CCC2)
- Critiques the claim with supporting reasoning and/or evidence (7.2.1, LS4.C.7, and CCC2)

Task provides a claim and supporting data on how changing environmental conditions can lead to species extinction:

- Revises the claim based on an adequate critique (7.2.2, LS4.C.7, and CCC2)

Task provides competing claims about how changing environmental conditions affect a species:

- Identifies possible evidence and reasoning that can be used to justify the different claims (7.2.3, LS4.C.6, and CCC2)
- Student can evaluate the competing claims using reasoning and evidence (7.2.3, LS4.C.6, and CCC2)

Environmental Principles and Concepts

- EP1: The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services.
- EP2: The long-term functioning and health of terrestrial, freshwater, coastal, and marine ecosystems are influenced by their relationships with human societies.

Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

- Natural disasters (e.g., storms, mudslides, etc.)
- Human activities (e.g., overhunting, pollution, etc.)
- Extinction
- Rapid evolution
- Change in species composition
- Range expansion/contraction
- Increases in the number of individuals of some species

Common Misconceptions

Note that the list in this section is not exhaustive.

- Environmental changes are always bad for organisms.
- Naturally occurring events are better for species survival than are human-caused ones.
- All species are equally affected by environmental changes.

Additional Assessment Boundaries

None listed at this time.

Additional References

HS-LS4-5 Evidence Statement https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/HS-LS4-5%20Evidence%20Statements%20June%202015%20asterisks.pdf

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