HS. Natural Selection and Evolution

A Performance Expectations HS.LS4.NSE

1 Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. HS.LS4.1

2 Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment. HS.LS4.2

3 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. HS.LS4.3

4 Construct an explanation based on evidence for how natural selection leads to adaptation of populations. HS.LS4.4

5 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. HS.LS4.5

B Science and Engineering Practices HS.NSE.SEP

1 Analyzing and Interpreting Data HS.NSE.SEP.1

a 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. (HS-LS4-3) HS.NSE.SEP.1A

2 Constructing Explanations and Designing Solutions HS.NSE.SEP.2

a Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS4-2),(HS-LS4-4) HS.NSE.SEP.2A

3 Engaging in Argument from Evidence HS.NSE.SEP.3

a Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS4-5) HS.NSE.SEP.3A

4 Obtaining, Evaluating, and Communicating HS.NSE.SEP.4

a Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-LS4-1) HS.NSE.SEP.4A

5 Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena HS.NSE.SEP.5

a A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HS-LS4-1) HS.NSE.SEP.5A

C Disciplinary Core Ideas HS.NSE.DCI

1. LS4.A: Evidence of Common Ancestry and Diversity HS.NSE.DCI.LS4.A
   - a. Genetic information provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence. (HS-LS4-1) HS.NSE.DCI.LS4.A.1
2. LS4.B: Natural Selection HS.NSE.DCI.LS4.B
   - a. 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. (HS-LS4-2),(HS-LS4-3) HS.NSE.DCI.LS4.B.1
   - b. The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (HS-LS4-3) HS.NSE.DCI.LS4.B.2
3. LS4.C: Adaptation HS.NSE.DCI.LS4.C
   - a. Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. (HS-LS4-2) HS.NSE.DCI.LS4.C.1
   - b. 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. (HS-LS4-3),(HS-LS4-4) HS.NSE.DCI.LS4.C.2
   - c. Adaptation also means that the distribution of traits in a population can change when conditions change. (HS-LS4-3) HS.NSE.DCI.LS4.C.3
   - d. 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. (HS-LS4-5) HS.NSE.DCI.LS4.C.4
   - e. 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. (HS-LS4-5) HS.NSE.DCI.LS4.C.5

D Crosscutting Concepts HS.NSE.CC

1. Patterns HS.NSE.CC.1
   a. 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. (HSLS4-1),(HS-LS4-3) HS.NSE.CC.1A
2. Cause and Effect HS.NSE.CC.2
   a. Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HSLS4-2),(HS-LS4-4),(HS-LS4-5) HS.NSE.CC.2A
3. Scientific Knowledge Assumes an Order and Consistency in Natural Systems HS.NSE.CC.3
   a. Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. (HS-LS4-1),(HSLS4-4) HS.NSE.CC.3A