HIGH SCHOOL LIFE SCIENCE: NATURAL SELECTION

Standards Bundle:

Standards are listed within the bundle. Bundles are created with potential instructional use in mind, based upon the potential for related phenomena that can be used throughout a unit.

HS-LS2-8 Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce. (SEP: 7; DCI: LS2.D; CCC: Cause/Effect) [Clarification Statement: Emphasis is on (1) distinguishing between group and individual behavior, (2) identifying evidence supporting the outcomes of group behavior, and (3) developing logical and reasonable arguments based on evidence. Examples of group behaviors could include flocking, schooling, herding, and cooperative behaviors such as hunting, migrating, and swarming.]

HS-LS4-2 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. (SEP: 6; DCI: LS4.B, LS4.C; CCC: Cause/Effect) [Clarification Statement: Emphasis is on using evidence to explain the influence each of the four factors has on the number of organisms, behaviors, morphology, or physiology in terms of ability to compete for limited resources and subsequent survival of individuals and adaptation of species. Examples of evidence could include mathematical models such as simple distribution graphs and proportional reasoning.] [Assessment Boundary: Assessment does not include other mechanisms of evolution, such as genetic drift, gene flow through migration, and co-evolution.]

HS-LS4-3 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. (SEP: 4; DCI: LS4.B, LS4.C; CCC: Patterns) [Clarification Statement: Emphasis is on analyzing shifts in the 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.]

HS-LS4-4 Construct an explanation based on evidence for how natural selection leads to adaptation of populations. (SEP: 6; DCI: LS4.C; CCC: Cause/Effect) [Clarification Statement: Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations.]

Content Overview
This section provides a generic overview of the content or disciplinary core ideas as an entry point to the standards.

Over time, species with traits or characteristics that are better suited for them to survive in a habitat are likely to have more success than those that have traits or characteristics that are less suited to a habitat. When an organism has a trait that makes it better suited to the environment, it is called an adaptation. An adaptation is a mutation or genetic change, that helps an organism, such as a plant or animal, survive in its environment. Due to the helpful nature of the mutation, it is passed

down from one generation to the next. As more and more organisms inherit the mutation, the mutation becomes more prevalent in the population. The mutation has become an adaptation. Adaptive traits can be physical or behavioral. Social or group behaviors often develop in populations as a way to overcome limiting factors. For example, herding behavior has developed in many prey species. Herding increases the chance of the individual animal to survive a predator's attack and has thus developed as an adaptation to predators in their environment.

Phenomena

Phenomena can be used at varying levels of instruction. One could be used to anchor an entire unit, while another might be more supplemental for anchoring just a unit. Please remember that phenomena should allow students to engage in the SEP and use the CCC/DCI to understand and explain the phenomenon.

- Photographs of herding animals showing the distribution of size and age as well as locations of females and their young.
- Video clips of predator/prey interactions.
- In some spider species, the mother spider is consumed by her babies when they hatch.
- Rare albino members within species (i.e., white buffalo, white alligators, etc.)
- Show two distribution maps for humans - one map shows the distribution of humans with hemoglobin disorders (sickle cell disease) and another map shows the distribution of malaria infection.
- Data of a particular population of mice based on fur color before and after a volcanic event caused surface changes in a region.
- Picture of a human or animal family
- Show animals or humans with mutations.
- Population graphs for humans or different species and compare to populations of organisms living in the same habitats.
- Show a picture or video of organisms competing for resources (food, water, space, and/or mate).
- Compare population data for a species that remains constant versus one that is changing.
- Present behaviors between buffalo and mountain lions (herding vs isolated).

Storyline

This section aims to decode not only the DCI connections but also the SEP and CCC in a detailed account of how they possibly fit together in a progression for student learning, including both rationale and context for the bundle.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts

Engaging in Argument from evidence	Social Interactions and Group Behavior	Cause and Effect
• Evaluate the evidence behind currently accepted explanations to determine the merits of arguments. **Constructing Explanations and Designing Solutions** • Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' investigations, models, theories, simulations, and 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. **Analyzing and Interpreting 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.	• Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. • 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. • 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. • 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. • The traits that positively affect survival are more likely to be reproduced and thus are more common in the population. • 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. • Adaptation also means that the distribution of traits in a population can change when conditions change. • 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.	• Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. **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.

Adaptation is the primary mechanism by which changes in biodiversity occur. In this bundle of performance expectations, students can engage in investigations and generate evidence to defend and critique claims for how changes in genetic diversity can affect the size of populations and the emergence or extinction of species. Using simulations, data sets, and/or case studies, students can construct explanations about how different environmental conditions affect populations. Those organisms that are anatomically, behaviorally, and physiologically well suited to a specific environment will survive and reproduce.

Through synthesis of this information, students can engage in arguments from evidence about the origins of adaptations and predict their effects on survival and reproduction. To truly understand adaptations, students must first understand the cause-and-effect relationship between changes in genetic frequency and overall reproduction or survival success in a population.

Through analyzing evidence, students can understand how the selection of beneficial traits (natural selection) causes adaptations in the population. Because these adaptations have the effect of increasing an individual's ability to survive and reproduce, the gene for the beneficial trait may increase and alter the genetic frequency of that trait in the population. Students can investigate examples of grouping behaviors and cooperative behaviors and their effect on survival and reproduction.

Students can also use evidence to engage in argumentation, predicting how changes in environmental conditions (such as habitat destruction, invasive species, etc.) can affect the fitness of the population, which can lead to changes in biodiversity. Students can evaluate the connections between selection pressures, adaptations, and populations to analyze and communicate the changes in biodiversity on Earth.

Formative Assessment

Formative assessment is crucial because all learners benefit from timely and focused feedback from others. It promotes self-reflection, self-explanation, and social learning. It can also make learning more relevant. Each of the questions below might be used throughout the formative assessment process. Specific prompts may focus on individual practices, core ideas, or crosscutting concepts, but, together, the components need to support inferences about students' three-dimensional science learning as described in a given bundle, standard, or lesson-level performance expectation.

SEP Defining Problems
- Using evidence, explain what problems can arise due to the introduction of an invasive organism into an ecosystem.
- Identify possible effects on other native species as a result of the introduction of an invasive species into a population.
- define the criteria and constraints for proper management of forests with respect to the health of the trees and animals in terms of selective and non-managed forest ecosystems in the Black Hills.

SEP Analyzing and Interpreting Data
- Using the given data set, determine whether the deer population is stabilizing or evolving due to the selective pressures of hunting.
- Using pheasant population data, justify hunting limits.

CCC Stability and Change
- Provided with evidence of changing populations of animals in Yellowstone National Park, identify the appropriate graphs that would best depict what is happening in a population at different times in its described history.

- Discuss the effects of reintroducing wolves and elk into Yellowstone National Park.

CCC Cause and Effect
- Provided with gene frequency data for a given population, research possible causes for the changes in gene frequencies in that population.

Performance Outcomes

These are statements of how students use knowledge and are similar to the standards in how they blend DCI, SEP, and CCC, but at a smaller grain size. These are potential outcomes for instruction as it plays out in lessons and activities in the classroom. It is important to also think of these as smaller outcomes that build toward the larger goal of mastering the standards.

- **Synthesize, communicate, and evaluate claims** that changes in environmental conditions of pheasants will affect survival strategies and numbers.
- **Construct an explanation** based on evidence for how an ear size or fur density in jackrabbits is an *adaptation* that leads to differential survival and reproduction of organisms.
- Using a computer simulation such as Phet or peppered moth to **analyze evidence to predict** how changes in gene frequency within a population can alter its survival and reproduction.
- **Analyze evidence** to predict how changes in environmental conditions such as climate warming will affect the *fitness of a species*.
- **Synthesize, evaluate, and communicate** how *selection pressures and adaptations* can affect *biodiversity* on Earth.
- **Evaluate evidence to analyze** the role of group behaviors in the *ability of a species to survive and reproduce*.
- **Explain, giving evidence,** how the group behavior of a herding animal such as buffalo or elk increases their chances of survival and reproduction.
- Identify additional evidence (data, information) needed but not initially provided that would help to explain the reasons for limits (environmental pressures) on walleye or some other sport fish or game animal related to the health of the population and reproductive capacity.
- **Assess the validity, reliability, strengths, and weaknesses** of the given evidence along with its ability to **support logical and reasonable arguments** about the outcomes of *group behavior of bees or wasps on their survival and reproduction*.
- **Evaluate evidence** on population size for a given animal (deer, pheasant, crappie) and its relationship it supports *cause and effect relationships* of group behavior on individual survival rates.
- **Construct an explanation** for how having a large number of offspring contributes to *enhanced survival and reproduction*.
- **Engage in argumentation** on how individuals can have specific traits that give them a competitive advantage relative *to other individuals* in the species.
- **Explain** the *difference* between natural selection and biological evolution (natural selection is a process, and biological evolution can result from that process).