MIDDLE SCHOOL LIFE SCIENCE: POPULATION GENETICS

Standards Bundle

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

MS-LS1-4 Construct an argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. (SEP: 7; DCI: LS1.B; CCC: Cause/Effect) [Clarification Statement: Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, herding of animals to protect young from predators, and vocalization of animals and colorful plumage to attract mates for breeding. Examples of animal behaviors that affect the probability of plant reproduction could include transferring pollen or seeds, and creating conditions for seed germination and growth. Examples of plant structures could include bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.]

MS-LS4-4 Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment. (SEP: 6; DCI: LS4.B; CCC: Cause/Effect) [Clarification Statement: Emphasis is on using simple probability statements and proportional reasoning to construct explanations.]

MS-LS4-5 Obtain, evaluate, and communicate information about how technological advances have changed the way humans influence the inheritance of desired traits in organisms. (SEP: 8; DCI: LS4.B; CCC: Cause/Effect) [Clarification Statement: Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, gene therapy); and, on the impacts these technologies have on society as well as the technologies leading to these scientific discoveries.]

MS-LS4-6 Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. (SEP: 5; DCI: LS4.C; CCC: Cause/Effect) [Clarification Statement: Emphasis is on using mathematical models, probability statements, and proportional reasoning to support explanations of trends in changes to populations over time.] *[Assessment Boundary: Assessment does not include Hardy Weinberg calculations.]*

Content Overview

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

Within every population (a group of organisms of the same species living in the same area), organisms display a range of variations. Some of these variations include traits and behaviors that are favorable and thus increase the organism's likelihood to survive. Other variations are unfavorable and decrease the organism's likelihood to survive. Organisms that survive have a greater chance to reproduce and pass their genetics on to their offspring. Through technology, humans have found ways to increase the rate at which some desirable traits occur in some organisms.

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.

- Many birds, such as tree swallows, add linings of hair and feathers to their nests.
- Buffalo will move their young to the middle of the herd when lions are near.
- In New Guinea, male birds of paradise not only are vividly colored, but also orchestrate elaborate dances to attract a mate.
- After your dog runs through the field, his fur is full of cockleburs.
- Hummingbirds are found near flowers that are bright red in color with a long, tubular shape.
- The corpse flower emits a strong odor similar to rotting flesh.
- Peppered moths come in two color variations: a black form and a pale form. After the industrial revolution, the black form outnumbered the pale form.
- Producers utilize artificial insemination to select desired genetics for their herds and flocks.
- Roundup ready crops are resistant to the herbicide Roundup.

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 ● Use an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. **Constructing Explanations and Designing Solutions** ● Construct an explanation that includes qualitative or quantitative relationships between variables that describe phenomena. **Obtaining, Evaluating, and Communicating Information** ● Gather, read, and synthesize information from multipl	**LS1.C: Growth and Development of Organisms** ● Animals engage in characteristic behaviors that increase the odds of reproduction. Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. **LS4.B: Natural Selection** ● Natural selection leads to the predominance of certain traits in a population, and the suppression of others. **LS4.B: Natural Selection** ● In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed onto	**Cause and Effect** ● Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. **Using Mathematics and Computational Thinking** ● Use mathematical representations to support scientific conclusions and design solutions.	offspring. **LS4.C: Adaptation** ● Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes.	

All species have characteristics that assist individuals within the species to survive in their environments. These characteristics include both traits (visible features) and behaviors. Favorable traits and behaviors that help organisms to survive in a particular environment are called adaptations. Examples of behavioral adaptations include the following: prey animals travel in herds for protection from predators, predators hunt in packs or prides to increase hunting success, some organisms build nests to protect their young, and some organisms perform elaborate displays to attract a mate. Examples of visible adaptations include the following: some animals in cold climates have fur and layers of insulating fat, some organisms are brightly colored to warn predators they are poisonous, some organisms are brightly colored to attract a mate, some plants have brightly colored flowers to attract pollinators, some plants have flowers that emit an odor to attract pollinators, and some plants have thorns for protection.

Traits and behaviors displayed by organisms of a species are a result of variations in their DNA (genetics). Though the organism's genes are not visible, the traits and behaviors resulting from genetic code can be observed. These observable characteristics result in changes of a population of a specific species. As environmental conditions change over time, the distribution of traits in a population will also change. These changes can be explained by using mathematical representations, such as simple probability statements and proportional reasoning. According to natural selection, traits and/or behaviors that help organisms of a species to survive and reproduce will increase in frequency in the population over time, and less favorable traits and/or behaviors will decrease in frequency in the population over time. Natural selection is the mechanism for how species change over time. Individuals within populations that contain favorable traits will survive, reproduce, and pass on the favorable adaptations at a higher rate than those without favorable adaptations. For example, peppered moths come in two color variations, a black form and a pale form. During the Industrial Revolution, the color of tree bark changed to a darker color due to soot from pollution. Moths of the black form were more effectively camouflaged against the darker bark and moths of the pale form were more easily seen and eaten by birds.

Humans can purposefully influence traits in a species through artificial selection (selective breeding). Artificial selection is the breeding of plants and animals with desirable traits to produce offspring with those desirable traits. Humans may select the parents with the desired phenotypic (visible) traits to breed to get a more desirable offspring. One example is raising animals such as horses, dogs, or cattle for a specific purpose. Some horses are bred to be racehorses. Breeders will select the fastest horses to produce offspring that are faster for competition. Humans that raise dogs for showing will select dogs to breed that have the most desirable traits, according to a breed standard, to produce offspring that will more closely match the ideal characteristics of the breed. Ranchers that raise cattle for beef will select bulls that produce offspring with low birth weights, but will gain weight quickly once born. These technologies may include concepts such as genetic modification, animal husbandry, and gene therapy.

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 Engaging in Argument from Evidence

- Write an argument based on evidence that similarities in embryological development show relationships not evident in the fully formed anatomy.
- Provide a representation of evidence that some animal behaviors play a role in the likelihood of successful reproduction in plants.

SEP Constructing Explanations and Designing Solutions

- The rare Addax antelope survive in a harsh desert environment. Using data collected to explain how certain traits affect their probability of survival and if the traits have something to do with the rarity of the species.

SEP Obtaining, Evaluating, and Communicating Information

- Complete an analysis of an article on gene therapy.
- Have students research a dog breed from within the American Kennel Club. Using reliable data, each student should produce a poster explaining how artificial selection has affected the breed and its standards currently in effect.

SEP Using Mathematics and Computational Thinking

- Using data collected from an investigation, calculate the frequency of physical traits (phenotypes) within a population under changing environmental conditions.

CCC Cause & Effect

- What do you predict would happen if all of the bees died? Provide evidence to support your prediction.
- Wolves live in packs with complicated social structures. What is the benefit to living in a pack? Explain what could happen if a wolf is not part of a pack.
- How could the use of antibiotics affect their effectiveness to treat bacterial infections over time?
- Draw a diagram that shows how changes to one component of the system affects components that are not directly connected to that component.

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.

- **Engage in argument from evidence** that certain characteristic behaviors of animals can increase the odds of reproduction.
- **Engage in argument from evidence**, using *cause and effect relationships* to explain that plants sometimes depend on animal behavior for reproduction.
- **Develop and use models** to show how genetic factors *affect* the growth of plants and animals.
- **Analyze and interpret data** to show how local conditions can *affect* the growth of a plant or animal.
- **Construct an explanation using mathematical evidence** to show that natural selection leads to the predominance or suppression of certain traits in a population over time.
- **Gather and synthesize information** to determine that humans have the capacity to *influence* certain characteristics of organisms through artificial selection by selective breeding, animal husbandry, genetic modification, and/or gene therapy.
- **Develop a model** to explain that through selective breeding, humans can choose desired parental traits of organisms, determined by the genes, which are then passed onto offspring.
- **Use mathematical representations to support explanations** that an adaptation by natural selection acts over many generations.
- **Engage in arguments from evidence** that species change over time in *response* to changes in environmental conditions.
- **Construct explanations** that traits which are less successful for survival and reproduction become less common over time, *resulting* in a change in the distribution of traits in a population.
- **Analyze graphs, charts, and images** to make a *comparison* of the embryological development of different species.
- **Engage in argument from evidence** that similarities in embryological development show *relationships* not evident in the fully formed anatomy.