

Science

Unit/Timeframe: Biology Unit 10: Evolution / Up to 4 weeks	Grade Level: 9, 10, 11, 12
Content Standards	2017 MA Literacy Framework
<u>Standard #1: HS-LS4-2: Natural Selection (REVISIT)</u> Construct an explanation based on evidence that Darwin’s theory of evolution by natural selection occurs in a population when the following conditions are met: (a) more offspring are produced than can be supported by the environment, (b) there is heritable variation among individuals, and (c) some of these variations lead to differential fitness among individuals as some individuals are better able to compete for limited resources than others. <u>State’s Clarification Statement:</u> Emphasis is on the overall result of an increase in the proportion of those individuals with advantageous heritable traits that are better able to survive and reproduce in the environment. <u>WPS Clarification Statement:</u> This was taught at the beginning of the year and has been integrated into the curriculum throughout, this is a good opportunity to revisit many of the examples of natural selection that have been explored throughout the year. <u>Standard #2: HS-LS4-1: Evidence for Evolution</u> Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence, including molecular, anatomical, and developmental similarities inherited from a common ancestor (homologies), seen through fossils and laboratory and field observations. <u>State’s Clarification Statement:</u> Examples of evidence can include the work of Margulis on endosymbiosis, examination of genomes, and analyses of vestigial or skeletal structures. <u>Standard #3: HS-LS4-5: Mechanisms of Evolution</u> Evaluate models that demonstrate how changes in an environment may result in the evolution of a population of a given species, the emergence of	RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. SL.11-12.4 - Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks. WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research. WHST.9-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

new species over generations, or the extinction of other species due to the processes of genetic drift, gene flow, mutation, and natural selection.	
Essential Questions	Skills/Knowledge
<u>Possible Phenomena:</u> • The laryngeal nerve of a giraffe • Tuskless elephants <u>Essential Questions:</u> • Under what conditions does natural selection occur? • What does evolutionary theory suggest about the unity and diversity of life? • What evidence suggests that species have changed over time? • How are genetics and evolution connected? • How do new species form?	<u>Students should be able to:</u> <u>State Provided Objectives:</u> • Use evidence of changing allele frequencies in a population to support a claim that evolution is occurring. • Construct an explanation for how each type of evidence (homologous structures, fossil structures, embryological similarities, vestigial structures, genome similarities, protein/polypeptide similarities) contributes to the theory of biological evolution and common ancestry among species. • Explain that the more similar the evidence is between two species, the more likely the species are related. • Analyze cladograms to determine the relatedness among species and recognize that evolutionary evidence was used to construct the cladograms. • Analyze models to explain how environmental selection pressures allow some species to have similar traits even though they are not closely related (convergent evolution) and some species are more closely related but have very different traits (divergent evolution). • Use changing traits and changing allele frequencies within a population as evidence that environmental factors (such as availability of resources, presence of predators, interspecies competition, climate change, disease) act as selection pressures on a population. • Explain how genetic variation is important to the survival of a species or the emergence of new species through the processes of genetic drift (geographic and reproductive isolation), gene flow (migration and emigration), mutations (beneficial and harmful), and natural selection. • Construct an explanation with evidence for how geographic or reproductive isolation can lead to a lack of gene flow between populations, and how different selection pressures in different environments can lead to speciation over time. <u>WPS Objectives:</u>

	• Describe a natural selection scenario using Darwin’s 4 points • Compare and contrast homologous and analogous structures, and relate them to convergent and divergent evolution • Explain the use of the word “theory” in the context of science, compared to its use in everyday speech • Explain why embryological similarities serve as evidence for evolution • Use DNA, RNA, or amino acid sequences to develop hypotheses about the evolutionary relatedness of organisms • Cite three pieces of evidence for evolution from prior units of study • Develop and test a model of natural selection • Explain how speciation occurs using the Biological Species Concept • Interpret a cladogram • Fill in a cladogram using data about the morphology or biochemistry of organisms
Common Resources	Common Assessments
HHMI Rock Pocket Mouse HHMI Tuskless Elephants Gene Frequency Bead Lab - After the initial procedure (described here) this lab can be extended and to model the founder effect, a genetic bottleneck, gene flow, and large vs. small population sizes.	Explain how characteristics of organisms that are inefficient or detrimental to their survival in their environments (such as the laryngeal nerve of the giraffe or the tail of a male peacock) serve as compelling evidence of natural selection.
Vocabulary	
Tier II: selection, frequency, survival of the fittest, population, variation, evidence, aerobic, anaerobic, structures, developmental, Tier III: evolution, adaptation, extinction, natural selection, fossil, species, artificial selection, theory, survival of the fittest, fitness, population, adaptation, allelic frequency, reproductive success, stabilizing selection, directional selection, disruptive selection, geologic time, era, periods, fossils, strata, relative dating, homologous structures, analogous structures, vestigial structures, embryology, paleontology, developmental biology, evolutionary change, DNA	
Additional Notes	
<u>Prior Knowledge:</u> In 6th grade students learned about the fossil record and extinctions, and used the anatomical evidence in fossils to relate ancient organisms to modern organisms. Students learned about natural and artificial selection in 8th grade.	

Practice	Description	Example for this Unit
<i>Practice #2: Developing and Using Models</i>	A model is an abstract representation of phenomena that is a tool used to predict or explain the world. Models can be represented as diagrams, 3-D objects, mathematical representations, analogies or computer simulations	Gene Frequency bead lab
<i>Practice #4: Analyzing and Interpreting Data</i>	Analyzing and interpreting data includes making sense of the data produced during investigations. Because patterns are not always obvious, this includes using a range of tools such as tables, graphs and other visualization techniques.	Gene Frequency bead lab
<i>Practice #5: Using Mathematics and Computational Thinking</i>	Mathematical and computational thinking involves using tools and mathematical concepts to address a scientific question.	Gene Frequency bead lab
<i>Practice #7: Engaging in Argument from Evidence</i>	Scientific argumentation is a process that occurs when there are multiple ideas or claims (e.g. explanations, models) to discuss and reconcile. An argument includes a claim supported by evidence and reasoning, and students engage in debates to evaluate and critique competing arguments	Make a claim about how the beak depths of Galapagos finches changed during the 1977 drought and support your claim with evidence and reasoning