|  |
| --- |
| Local Adaptation of Milkweed – *Evolutionary Principles* |
| Introduction |
| This lesson bridges basic evolutionary principles with the concept of local adaptation. Students will learn the general definitions of these principles as well as connect them to their milkweed lab where these principles have been applied. They will consider the implications of local adaptation for milkweed population management.  This lesson plan is a component of the *EXPLAIN* stage of the 5E Learning Model for the overall curriculum. |
| Objectives |
| After this lesson, students will be able to:   * define evolutionary principles such as local adaptation and gene flow * explain how each of these principles relate to the milkweed lab * predict how local adaptation will influence the impact of milkweed management practices |
| NGSS Performance Expectations Addressed |
| Standards  Middle School   * MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. [Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.] [Assessment Boundary: Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.] * MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. [Clarification Statement: Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial.] * 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. [Clarification Statement: Emphasis is on using simple probability statements and proportional reasoning to construct explanations.]   High School   * HS-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations. [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.]   Science and Engineering Practices   * Obtaining, Evaluating and Communicating Information   Disciplinary Core Ideas   * LS2.A: Interdependent Relationships in Ecosystems * LS3.A: Inheritance of Traits * LS3.B: Variation of Traits * LS4.B: Natural Selection * LS4.C: Adaptation   Crosscutting Concepts   * Systems and Systems Models |
| Information for Classroom Use |
| Approximate Duration for the Task  100 minutes or two class periods.  Assumptions  Students should know or be familiar with:   * Charles Darwin’s theory of evolution * Distributions and means   Teachers should know or be familiar with:   * Charles Darwin’s theory of evolution, and the finch example of adaptation * Evolution/local adaptation terms listed on the flashcards   Additional Materials Needed   * Computer with internet and projector capabilities * Scissors * Tape or glue   Supplementary Resources   * Data Analysis with Authentic Finch Data: <http://www.hhmi.org/biointeractive/evolution-action-data-analysis> * “Beaks as Tools” Experiment: <http://www.hhmi.org/biointeractive/beaks-tools-selective-advantage-changing-environments> * A brief editorial in by Ellstrand and Rieseberg in *Evolutionary Applications* in 2016 may help to describe the contexts when local adaptation and gene flow may be risky.   \*Note: both of these supplementary resources are meant to complement the “The Origin of Species: the Beak of the Finch” video available from HHMI. |
| Classroom Task |
| Context  Although students will work in small groups to match up each term with its definition, each student should receive their own set of flashcards. There are two pages of flashcards; the second page is supplementary. The “elaborate” portion of this lesson plan is where students will learn the full research question they are investigating.  Task Components  *ENGAGE*   1. Have students watch “The Origin of Species: the Beak of the Finch:” <http://www.hhmi.org/biointeractive/origin-species-beak-finch>. 2. Students should fill out the first half of the worksheet while watching the video.   *EXPLORE*   1. In small groups or individually, have students complete the second half of the worksheet. 2. Alternatively, the “engage” and “explore” portions can be given as homework for students to complete by today. 3. Discuss the answers to the worksheet, especially the second half, highlighting the value of different types of graphs for question 4, and the importance of reasoning in many of the answers.   *EXPLAIN*   1. Hand out the Lesson 3 Flashcards; have students cut out each individual card. 2. Students should work in small groups to match each term with its definition. Allow students to ask questions or consult other materials to match up the terms. 3. Go over the flashcard answers; allow students enough time to tape or glue their flashcard fronts and backs together. 4. Help students connect the ideas of local adaptation with the evolutionary principles discussed related to the finches. For example, question 4 in the worksheet relates to local adaptation, but considers different species. When we study local adaptation, we are often interested in the adaptation of populations of the same species to different environments. 5. Reframe the student’s research question in terms of the new vocabulary- they are researching local adaptation of milkweed by studying multiple ecotypes in a common garden. 6. In small groups, have students discuss their milkweed lab in the context of their new vocabulary.   *ELABORATE*   1. Distribute the “Risky or Not” Handout, and make sure students understand the directions. 2. Students should first work alone to evaluate the “risks” associated with each scenario. 3. Students should discuss each situation with a small group, attempting to come to a consensus about the riskiness of each scenario. 4. As a class, identify the range of answers. Students should understand that the biggest risks are posed when plants are locally adapted and a large number of individuals from a distant location are introduced into a small population, “swamping” the locally adapted individuals. Students should use reasoning that draws on the concepts of gene flow, natural selection, and genetic drift.   *EVALUATE*   1. In small groups or as a class, have students make predictions about their data. Will their home ecotype perform better at home, or away? Do local ecotypes grow better at this site, or foreign ones? Encourage students to use their new vocabulary in making their predictions. 2. Students will attempt to test these predictions in the following “Data Analysis” lesson. |
| Alignment and Connections of Task Components to NGSS Performance Expectations |
| Standards  Middle School   * MS-LS1-5. *This standard is addressed by having students discuss what causes adaptation and speciation in Darwin’s finches.* * MS-LS2-2. *This standard is addressed by discussing interactions and competition between different species of finches.* * MS-LS4-4. *This standard is addressed by analyzing how drought conditions shift the average beak size.*   High School   * HS-LS4-4. *This standard is addressed by having students use evidence in the video to explain adaptation.*   Science and Engineering Practices   * Obtaining, Evaluating and Communicating Information – *This standard is addressed by having students obtain facts about adaptation and evolution from the video, using that to evaluate the terms in the flashcards, then communicating that to their small group.*   Disciplinary Core Ideas   * LS2.A: Interdependent Relationships in Ecosystems – *This idea is addressed by discussing the importance of food sources to different finches.* * LS3.A: Inheritance of Traits – *This idea is addressed by discussing traits of finch offspring after a drought, and the shift in average beak size that followed.* * LS3.B: Variation of Traits – *This idea is addressed by discussing the different beak shapes among Darwin’s finches.* * LS4.B: Natural Selection – *This idea is addressed by discussing how natural selection caused speciation among Darwin’s finches.* * LS4.C: Adaptation – *This idea is addressed by discussing adaptation of finch beaks to environmental conditions.*   Crosscutting Concepts   * Systems and Systems Models – *This idea is addressed by having students explore the system of natural selection and adaptation as an isolated model- here, the finches on Daphne Major.* |