

**Unit Overview**

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| **UNIT OVERVIEW:**  **Adaptation and Evolution: Phenotypic/Genotypic Response to Climate Change in Lady Beetles** | **Subject:**  **Biology (including Introductory Biology, Biotechnology, & AP Biology)** | **Teacher:**  **Nikki Chambers**  **West High School, Torrance USD**  **chambers.nikki@tusd.org** |
| **CA NGSS-aligned Three-Course Model - suggested curriculum placement possibilities:**  *While selection of an NGSS-aligned high school course and curriculum map is done at the District level, many high school districts in California are choosing to employ the Three-Course Model. As explained in the Three Course Model Introduction in the* [*2016 California Framework*](https://www.cde.ca.gov/ci/sc/cf/scifwprepubversion.asp), https://www.cde.ca.gov/ci/sc/cf/cascienceframework2016.asp *(see Chapter 7):*  *“The three-course model combines all high school performance expectations (PEs) into three courses. ...each of the three courses present an integration of ESS and one of the other high school disciplines. ...The three courses have been explicitly titled to emphasize this synergy:*  *· Living Earth: Integrating Biology and Earth Science*  *· Chemistry in the Earth System: Integrating Chemistry and Earth Science*  *· Physics of the Universe: Integrating Physics and Earth & Space Science”*  *The Instructional Unit presented here is topically appropriate for inclusion in the storyline of any of the following instructional segments of The Living Earth course model.*  The Living Earth Instructional Segment 1: Ecosystem Interactions and Energy Instructional Segment 3: Evidence of Evolution Instructional Segment 4: Inheritance of Traits Instructional Segment 5: Structure, Function, and Growth (from Cells to Organisms) Instructional Segment 6: Ecosystem Stability and the Response to Climate Change  *For further information on the Three Course Model or The Living Earth course, including an informative introductory video series, please visit:*  <https://sites.google.com/site/csunngssguide/high-school-model---3-course-model/three-course-model/the-living-earth>  Access all lessons below through the project website: https://evolution.berkeley.edu/evolibrary/teach/lessons/beetle-project-overview.php | | |
| **NGSS Performance Expectations:**  *By completing the lessons and investigations in this Unit, students will have the opportunity to work towards mastery in the following NGSS Performance Expectations:*  HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.  HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.  HS-LS3-1. Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.  HS-LS3-2. Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors. [Clarification Statement: Emphasis is on using data to support arguments for the way variation occurs.]  HS-LS3-3. Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.  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.  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.  HS-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations.  HS-LS4-5. 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. | | |
| [**Lesson**](https://docs.google.com/document/d/1WtFLAr7mraEiaTWGmMt_sIxPvWDvcAvuf0_IWFC7ic8/edit?usp=sharinghttps://docs.google.com/document/d/1XBZ0oP2vYVZkGU7OFIqHVBlEdyZNFvHmGk1yGWJb_QA/edit?usp=sharing) **1: How are organisms responding to rapid ecosystem change?** | | |
| **Teacher Will:**   1. **Engage** students by introducing the concepts of genotypic vs. phenotypic variation. 2. Facilitate student **exploration** of the concept of phenotypic plasticity. 3. Facilitate student **exploration** of selected organisms’ response to climate change.\* 4. **Elaborate** by facilitating student investigation of how insects survive winter. 5. If desired, **elaborate/extend** the lesson by facilitating student completion of a phenology Data Nugget.   \* *These portions of the lesson will be done by using the following lesson from the Univ. of Florida:* [**LESSON 1: The Winners and Losers of Climate Change**](https://www.cpet.ufl.edu/resources/curricula/created-by-fellows/evolution/), https://www.cpet.ufl.edu/resources/curricula/created-by-fellows/evolution/ | **Students Will:**   * **Obtain/evaluate/communicate information** that demonstrates understanding of genotypic vs. phenotypic variation. * **Analyze and interpret data** about selected organisms’ responses to climate change. * Use their findings to **construct preliminary explanations** about organisms’ response to climate change. | |
| **Lesson 2: How MIGHT lady beetles respond to temperature change?** | | |
| **Teacher Will:**   1. **Re-engage** students by providing a concept/content bridge between lessons 1 and 2. 2. **Engage** students by introducing and **explaining** essential facts and vocabulary about lady beetles as a model organism. 3. Facilitate student **exploration** of ideas related to lady beetle response to temperature change. 4. Facilitate student **explanation** of how response to temperature change might be tested. 5. If desired, **elaborate on** student testing proposals to develop student-generated experiments (Low-scaffolding option, see Lesson 3.) | **Students Will:**   * **Obtain information:** Develop a baseline understanding of lady beetles as a model organism * **Construct explanations/communicate information:** Brainstorm answers to teacher questions * **Ask** additional **questions** * **Plan investigations:** Propose ways of testing ideas; predict testing outcomes | |
| **Lesson 3: How can lady beetles’ response to temperature change be tested?**  **Scaffolding Options:**   1. **Medium scaffolding (guided inquiry option):** Students place beetles in chill coma and measure their recovery time; population data is compared to data provided from other populations. 2. **Low scaffolding (stand-alone, open inquiry option, or this may be used as an extension to medium scaffolding):** Students use the background knowledge developed in Lessons 1 and 2 to conduct the experiments they designed at the end of Lesson 2. 3. **High scaffolding (data analysis option; may be used if lab testing is not feasible, or as an extension to low or medium scaffolding):** Students complete the “Beetle, It’s Cold Outside!” Data Nuggets, Parts 1 and 2. | | |
| **Teacher Will:**   * Select the scaffolding level appropriate to classroom needs (see above); facilitate activity. | **Students Will:**   * **Plan and conduct investigations, analyze and interpret data, argue from evidence:** Complete the selected lab activity as directed. | |