

**Unit Overview: NGSS Alignment and 5E Instructional Summary**

| **UNIT TOPIC:**  **The Beetle Project: Response to Climate Change in Lady Beetles** | **Appropriate For:**  **High School Biology**  **(including Introductory Biology, Biotechnology, & AP Biology)** | **Developer:**  **Nikki Chambers**  **West High School, Torrance USD**  **chambers.nikki@tusd.org** |
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| **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) *(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> | | |
| **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. | | |
| Pacing guide (three to four 1-hour lessons) Extension activities suggested below can extend the sequence for up to an additional three lesson periods.  Suggested prerequisite knowledge:   * Basic understanding of the causes of global climate change * Basic graphing and foundational statistics (histograms, mean, standard error; middle-school level of understanding or better)   [**LESSON 1**](https://docs.google.com/document/d/1Sz3xHX-I2fQ8ILVgvy5TOaFn_mqoZjZL/edit?usp=sharing&ouid=111015151090405190057&rtpof=true&sd=true) (one 1-hour lesson period)   1. Short film + discussion 2. Learn about “Whiplash Weather” 3. Student research: “How do insects survive the winter?”   [**LESSON 2**](https://docs.google.com/document/d/1Zbqteqv2f1ACJHaHtnNnZwS0ELSknq25/edit?usp=sharing&ouid=111015151090405190057&rtpof=true&sd=true) (one 1-hour lesson period)   1. Introduction to lady beetles 2. Student design of experiment   [**LESSON 3**](https://docs.google.com/document/d/17Y9uV12zyjbvnwPFy0oLyLUHpU2JVAay/edit?usp=sharing&ouid=111015151090405190057&rtpof=true&sd=true)(one or two+ 1-hour lesson periods; note that at least two lesson periods are required in order to engage students with the live lady beetle experiment)   1. Guided inquiry lab with live organisms (two lesson periods) OR open inquiry lab with live organisms two+ lesson periods) OR Data Nugget data analysis activity only (one lesson period).   **Optional elaboration/extension lessons** (one to three 1-hour lesson periods, suggested placement: during or after Lesson 1)   1. [Introduction to phenotypic plasticity](https://docs.google.com/document/d/1EKXpb9v7lUf8cLeZhygfGZJmDlb0T3JXeSmt8bRP9mM/edit?usp=sharing) 2. Student activity: “Winners and Losers” (coming soon) | | |
| [**Lesson 1**](https://docs.google.com/document/d/1Sz3xHX-I2fQ8ILVgvy5TOaFn_mqoZjZL/edit?usp=sharing&ouid=111015151090405190057&rtpof=true&sd=true)**: How are organisms responding to rapid ecosystem change?** | | |
| **Teacher Will:**   1. **Engage** students by introducing some specific examples of the effects of climate change on different organisms. 2. Facilitate student **exploration** of selected organisms’ response to climate change. 3. If desired, **elaborate/extend** the lesson by facilitating student understanding of phenotypic variation. 4. If desired, **elaborate/extend** the lesson by facilitating student exploration of how different types of organisms do or do not benefit from environmental change. | **Students Will:**   * Use their findings to **construct preliminary explanations** about organisms’ response to climate change. * **Analyze and interpret data** about selected organisms’ response to climate change. * **Obtain/evaluate/communicate information** that demonstrates understanding of genotypic vs. phenotypic variation. * **Evaluate the evidence** supporting claims that environmental change can result in the increase or decrease of populations of different species over time. | |
| [**Lesson 2**](https://docs.google.com/document/d/1Zbqteqv2f1ACJHaHtnNnZwS0ELSknq25/edit?usp=sharing&ouid=111015151090405190057&rtpof=true&sd=true)**: 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**](https://docs.google.com/document/d/17Y9uV12zyjbvnwPFy0oLyLUHpU2JVAay/edit?usp=sharing&ouid=111015151090405190057&rtpof=true&sd=true)**: How can lady beetles’ response to temperature change be tested?**  ***Medium scaffolding****: Students analyze data collected from experiments conducted in class, following the Chill Coma Recovery Time experimental protocols provided by the Williams Lab.*  ***Low scaffolding (or extension to medium scaffolding)****: Students use the background knowledge developed in Lessons 1 and 2 to develop and conduct their own experimental protocols and analyze the resultant data. (Experimental protocol link, above, will give useful tips for success). Variables that could be tested include, but are not limited to:*   * *Comparison of CCRT in nourished vs. starved lady beetles* * *Comparison of CCRT in large vs. small lady beetles* * *Comparison of CCRT in lady beetles kept at refrigerator vs at ambient temperature before being placed in chill coma at 0C.*   ***High scaffolding (or extension to low or medium scaffolding)****: Students complete a Data Nugget (students analyze data provided from experiments done in the Williams Lab). This is also a lesson choice for classrooms that are unable to conduct beetle experiments, those that wish to compare another set of results to their own, or as a specific data analysis opportunity.* | | |
| **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. | |