

**Lesson 2: How MIGHT lady betles respond to temperature change ?**

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| **Unit: Adaptation and Evolution: Phenotypic/Genotypic Response to Climate Change in Lady Beetles** | **Essential Question: How can lady beetles be used as a model organism to examine responses to temperature change?** |  **Duration:** 1-2 one-hour periods, depending on scaffolding level selected for design of experiment |
| **Foundational Concept for this Lesson:**A useful, quantifiable trait in lady beetles (otherwise known as lady bugs or ladybird beetles) and their relatives is their natural ability to enter Chill Coma. (Students will learn about this trait in the “Explore” section of this lesson.) Chill coma is a reversible total paralysis; emergence from chill coma can be timed. This measurable parameter is known as Chill Coma Recovery Time (CCRT). The effect of different variables on CCRT can be tested. |
| **Performance Expectation(s):** *This lesson builds foundational knowledge in support of:*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. *The lesson also focuses on developing Science and Engineering Practices, including:** Asking questions/defining problems
* Planning & carrying out investigations
* Obtaining, evaluating, and communicating information
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| **Learning Targets (Students will be able to…):** * Develop a baseline understanding of lady beetles as a model organism
* Brainstorm ideas in response to teacher questions
* Propose additional questions about lady beetles’ response to temperature change
* Propose ways of their testing ideas
* Predict outcomes of proposed tests
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| **Student Evidence:** * Completed handout (HO 2.1)
* Poster (or other student product) with proposed tests and predicted outcomes
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| **Materials (handout follows this lesson plan):*** Student Handout #1: Essential Facts and Vocabulary Worksheet, (HO #2.1)
* Access to the following online resources:
* [YouTube: Top 5 Unusual Facts about Ladybugs](https://www.youtube.com/watch?v=95N9AMJa2LY), https://www.youtube.com/watch?v=95N9AMJa2LY
* [YouTube: Time Lapse of Lady Beetle Life Cycle](https://www.youtube.com/watch?v=wqddneGYkc4), https://www.youtube.com/watch?v=wqddneGYkc4
* [Article: "Ladybug"](http://animals.sandiegozoo.org/animals/ladybug), http://animals.sandiegozoo.org/animals/ladybug
* Poster materials for “Explore” portion of this lesson, as needed
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| **Re-Engage: What have you learned about ways that different organisms respond to climate change?** |
| Re-engage students by briefly revisiting and summarizing the Lesson 1 Learning Targets, using interactive technique of choice:* Distinguish between genotypic and phenotypic variation
* Explain the concept of phenotypic plasticity
* Demonstrate understanding that climate change involves not only global warming, but also increased weather extremes and seasonal shifts.
* “Identify particular species that may be better suited to survive extreme climate change events.”
* “Propose why organisms that display greater phenotypic plasticity would be better suited to survive climate change events.”
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| **Engage/Explain: What are lady beetles, and how do they survive cold winters?** |
| Introduce lady beetles and direct students to complete today’s Essential Facts and Vocabulary Worksheet, (HO #2.1), using the following resources:* [YouTube: Top 5 Unusual Facts about Ladybugs](https://www.youtube.com/watch?v=95N9AMJa2LY), https://www.youtube.com/watch?v=95N9AMJa2LY
* [YouTube: Time Lapse of Lady Beetle Life Cycle](https://www.youtube.com/watch?v=wqddneGYkc4), https://www.youtube.com/watch?v=wqddneGYkc4
* [Article: "Ladybug"](http://animals.sandiegozoo.org/animals/ladybug), http://animals.sandiegozoo.org/animals/ladybug

Direct students to do additional research to complete the Worksheet. |
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| **Explore: How could you test lady beetle’s response to temperature shifts?** |
| Using an interactive technique of choice, invite students to brainstorm answers to the following questions: * Why might we be using ladybugs as a model organism?
* What kind of temperature changes might ladybugs be exposed to, and why?
* How might ladybugs respond to temperature shifts?
* How would we know if the response is due to phenotypic plasticity or genotypic variation?
* What might be the selective advantage of the suggested responses?

Based on their discussion and foundational learning, direct students (individually, in pairs, or in small groups) to work individually or in small groups to begin **planning investigations** of lady beetle responses to temperature change (design of experiment and predicted outcome). Students can create a poster (or other product) in response to the following two questions:* how might lady beetles’ responses to temperature change be tested?
* what do you predict will happen?
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| **Explain/Evaluate: Which test(s) will we conduct? What does the data tell us?** |
| Compile proposed experiments.  Honor all suggestions, but narrow them down as appropriate, depending on the degree of inquiry that is planned for Lesson 3.  Options include:* *High scaffolding/dry lab*:  fully directed analysis of provided data.
* *Medium scaffolding/wet lab:*  teacher-directed experimental protocol; analysis of wet lab data.
* *Low scaffolding/wet lab:* student-planned and conducted experimental protocol(s); analysis of wet lab data.
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**Lady Beetles and Temperature Change:**

**Essential Facts and Vocabulary**

Video: Top 5 Unusual Facts About Ladybugs

1. During what seasons are lady beetles rarely seen, and why?

Video: Time Lapse of Lady Beetle Life Cycle

1. What is the first stage of a lady beetle’s life cycle?
2. Describe the hatchlings.
3. The hatchlings are known as larvae; what do they eat?
4. Why do larvae shed their skin? How often does this happen?
5. The last time a larva sheds its skin, what emerges?
6. How much time goes by before an adult lady beetle emerges from its pupa?
7. What happens next?

Article: “Ladybug”

1. Why are lady beetles classified as insects?
2. What is the purpose of diapause?
3. How long can lady beetles survive on “stored resources” (in other words, without eating)?
4. What triggers lady beetles to emerge from diapause?
5. What is the purpose of lady beetles’ bright red and black coloration?
6. How many species of lady beetles can be found in California? Are they all native?

Bonus questions: Use the Internet to research some additional facts About ladybugs

1. Ladybugs are not actually bugs; to what family do they belong?
2. How many species of lady beetles are there?
3. Do lady beetles bite?
4. What do lady beetles emit when threatened?
5. Is the emitted substance toxic?
6. What do lady beetles eat?
7. Why do gardeners and farmers appreciate lady beetles?
8. Are all lady beetle species carnivorous? Explain.
9. What can you feed captive lady beetles?