IS2

Grade Three Instructional Segment 2: Life Cycles for Survival

In kindergarten and grade two, students identified and investigated specific needs of plants and animals. In IS2 for grade three, students observe specific organisms to see different aspects of their growth and development, traits, and behaviors that help them survive. While this instructional segment introduces three seemingly unrelated concepts (organisms have life cycles, they inherit traits from parents, and they often live in groups), the central theme is that these features are all ways that help animals meet their needs for surviving, finding mates, and reproducing.

GRADE THREE INSTRUCTIONAL SEGMENT 2: LIFE CYCLES FOR SURVIVAL

Guiding Questions

- What is the advantage of having a complicated life cycle of growth and development?
- How do animals' life cycles help them survive?
- How similar are animals and plants to their siblings and their parents?
- How does being similar to parents help an animal survive?
- Why do some animals live alone while others live in large groups?

Performance Expectations

Students who demonstrate understanding can do the following:

3-LS1-1 Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death. [Clarification Statement: Changes organisms go through during their life form a pattern.] [*Assessment Boundary: Assessment of plant life cycles is limited to those of flowering plants. Assessment does not include details of human reproduction.*]

3-LS3-1. Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms. [Clarification Statement: Patterns are the similarities and differences in traits shared between offspring and their parents or among siblings. Emphasis is on organisms other than humans.] [*Assessment Boundary: Assessment does not include genetic mechanisms of inheritance and prediction of traits. Assessment is limited to non-human examples.*]

3-LS4-2. Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing. [Clarification Statement: Examples of cause and effect relationships could be plants that have larger thorns than other plants may be less likely to be eaten by predators and animals that have better camouflage coloration than other animals may be more likely to survive and therefore more likely to leave offspring.]

3-LS2-1. Construct an argument that some animals form groups that help members survive.

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The bundle of performance expectations above focuses on the following elements from the NRC document *A Framework for K–12 Science Education*:		
Highlighted Science and Engineering Practices	**Highlighted Disciplinary Core Ideas**	**Highlighted Crosscutting Concepts**
[SEP-1] Asking Questions and Defining Problems [SEP-2] Developing and Using Models [SEP-3] Planning and Carrying Out Investigations [SEP-4] Analyzing and Interpreting Data [SEP-5] Using Mathematics and Computational Thinking [SEP-7] Engaging in Argument from Evidence [SEP-8] Obtaining, Evaluating, and Communicating Information	LS1.B: Growth and Development of Organisms LS2.D: Social Interactions and Group Behavior LS3.A: Inheritance of Traits LS3.B: Variation of Traits	[CCC-1] Patterns [CCC-2] Cause and Effect: Mechanism and Explanation [CCC-6] Structure and Function [CCC-7] Stability and Change
Highlighted California Environmental Principles and Concepts: **Principle I** The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services. **Principle II** The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies. **Principle III** Natural systems proceed through cycles that humans depend upon, benefit from and can alter. **Principle IV** The exchange of matter between natural systems and human societies affects the long-term functioning of both.		
CA CCSS Math Connections: 3.MD.4		
CA CCSS for ELA/Literacy Connections: RI.3.7; SL.3.1, 2, 3		
CA ELD Standards Connections: ELD.3.PI.9		

Human babies have all the same body parts as adults but are just smaller and cuter. Tiny baby spiders emerge from spider eggs and the babies look like miniature versions of their parents. Butterfly eggs, however, do not contain tiny butterflies but instead contain caterpillars that look almost nothing like their parents until they undergo major changes later in life. Most flowering plants do not directly grow tiny little plants with tiny roots, leaves, and stems that pop out like babies. They produce seeds instead. Why are there differences? Why doesn't a caterpillar just stay a caterpillar and lay eggs? Why do plants produce so many seeds (most of which will never grow) when they could just grow a few tiny plants instead? Students will not learn enough to fully answer many of these questions in grade three, but they can make observations and recognize patterns that build toward answers in later grades.

Students begin with direct observations of different organisms' life cycles. They can grow seeds (including vegetables in a garden or fast growing plants such as *Brassica rapa* in the classroom), hatch insect eggs (such as milkweed bug, butterfly, or ladybug) or raise frogs from tadpole eggs. As they observe and carefully notice the changes in the organism, students **develop a model [SEP 2]** for the growth and development of the organism's life cycle (3-LS1-1). This model will likely take the form of a pictorial model (a diagram) that illustrates each stage of the life cycle. Note the performance expectation requires that *students* be able to develop their own model, not simply be given a model and correlate their observations to the model. An example that does not meet this goal comes from a lesson plan packaged with a manufacturer's live eggs: it recommends that teachers read an informational text to introduce the eggs to students on day 1, and the text has a complete pictorial model of the animal's life cycle right on the cover and then walks students through every stage of the animal's life. Instead, students can sketch the organism at regular intervals in science notebooks, describe in words the **changes [CCC-7]** they notice since the previous observation, and **ask questions [SEP-1]** about what they see. After they have seen an entire life cycle, they should be the ones to decide how many stages the organism underwent and how to describe each stage.

While it is ideal that students observe at least one organism directly throughout its full life cycle in their classroom, 3-LS1-1 also requires that students observe **patterns [CCC-1]** common in the life cycles of different organisms (all organisms are born, grow and develop, reproduce, and die). To explore a wide range of organisms, students can use images from informational texts or videos. Ideally, these images are presented as a sequence of regular snapshots of the animal (daily, weekly, etc.) so that the exercise is a virtual **investigation [SEP 3]** during which students **analyze the image data [SEP-4]** to **develop a model [SEP-2]** rather than simply **obtain information [SEP-8]** about the organism's life cycle by reading about someone else's synthesis of the ideas. By having students work in groups to investigate different organisms, students can come together to **communicate [SEP-8]** their life cycle models and make **claims [SEP-7]** that different organisms share common stages in their life cycles that serve similar purposes.

While it is true that all species of plants and animals undergo birth, growth, reproduction, and death, the timing and details can be very different between species. Some weedy plants take only a few weeks to transition from germination to flowering while others, like fruit trees, take 10 years or more to begin reproduction. Why are there such big differences in the timing of life cycle events? Teachers can help guide students to think about how an organism's life cycle relates to its needs. Plants need space to grow, so a weed that reproduces quickly can be the first to occupy bare or disturbed soil before other plants (after a fire, at the edge of a construction site, etc.). Plants need water and sunlight, so large fruit trees may need years to develop the extensive **structures [CCC-6]** (deep roots and leaves) to gather enough of these resources to produce juicy and sugary fruits.

Organisms have life cycles with different stages because life cycles help them meet their needs. Butterflies and moths lay their eggs on plants that their babies can eat. Caterpillars can therefore spend all their time eating and growing and do not have to worry about finding food. As adults with wings, the focus shifts and butterflies and moths travel great distances to find a mate and locate another food source for their offspring to eat. In some species (including the largest moths from the family *Saturniidae*), the division of labor is so extreme that the adults do not eat anything at all before they die. Plants have life cycles with a similar **pattern [CCC-1]**. They stay in one place where they build up enough energy to reproduce, and then have evolved strategies to mate (pollination by wind or insect) and disperse their offspring to new locations (seed dispersal by wind or animal). Grade three students are not expected to be able to fully explain the relationship between life cycles and animal needs, but they should be able to use their knowledge from grades K–2 to **ask questions [SEP 1]** about how life cycles might help organisms meet their needs.

Sample Integration of Science and ELD Standards in the Classroom

Students have been studying the concept that organisms have unique and diverse life cycles but all have birth, growth, reproduction, and death in common (3-LS1-1). Their study has included research, investigations, and looking for patterns in various examples of life cycles. Students are ready to plan and deliver an oral presentation of their findings, using pictures or realia for a dramatic representation of assigned organisms as evidence to explain how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing (e.g., plants with thorns versus without; camouflage) (3-LS4-2). The teacher has modeled, with one example, some of the characteristics, and has built, with student input, a word wall with illustrations for student reference. The teacher lists clear goals for the presentations and discusses them with the students. As students work in their groups, they identify, in their text and visual resources, the patterns for the life cycle of their group's organism and use materials provided (e.g., cotton, yarn, colors, tape, cardboard, chart paper) to build, refine, and prepare their models of the life cycle to share with their peers. They compare their information with groups studying a similar organism, to discuss patterns that they find (e.g., birds have eggs ➔ chicks ➔ adult bird, and moth and butterfly [or all insects] have eggs ➔ larva [caterpillar stage] ➔ pupa ➔ adult insect). With teacher facilitation, students chart the emergent patterns and discuss which organisms have better chances of living, growing, and surviving.

Once the model of the life cycle is drawn/built, each group is ready to give its oral presentation. Peers listen and get insight on their peers' presentations and gain teacher and student feedback to refine their own.

CA ELD Standards: ELD.3.PI.9

Source: Lagunoff et al. 2015, 261–262

EP&C Connection: After each presentation, the teacher asks the class to identify a way that human activities might influence the survival reproduction of each organism (EP&C II).

In grade one, students made observations to support the claim that young plants and animals look similar (but not identical) to their parents (1-LS3-1). In grade three, they revisit the exact same task but must analyze and interpret specific data to support their claim (3-LS3-1). They also place the slight differences between parent and child into the larger context of variation between all the organisms of the same species.

Students can explore this variation in their classrooms by growing plants or insects under controlled conditions and comparing traits. For example, teachers can purchase seed stock from exceptionally tall and short plants (such as fast growing *Brassica rapa*), grow one generation and have students collect seeds from them. Students that plant seeds from the tall plant find that their plant is also tall and vice-versa. As students analyze their data, they should also ask questions about how these differences could help plants and animals meet their needs. Students should be able to apply their knowledge of plant needs to explain how different traits can help plants survive or reproduce (3-LS4-2). A taller plant can reach the sunlight above its neighbors, but a shorter plant is less likely to be blown over by the wind or broken by a passing animal. Plants with larger flowers might attract more pollinators and therefore reproduce more effectively. A jackrabbit, elephant, desert fox, or dog with larger ears might be able to stay cooler than one with smaller ears. Students will return to this concept in IS3.

Students can also collect data about one or two features within a family from pictures (e.g., appearance of multiple individuals) and tables or graphs (e.g., height of seedlings at a given age). Students could describe the colors and patterns in families of guinea pigs, the shape and size of ears in dogs or cats, or the variation of color on maize samples (corn on the cob). For animals, students should ideally see offspring pictured with both parents to emphasize that offspring include a mix of traits from both their biological parents. Each individual is a slightly different mix of traits, which explains why siblings can look different or why different plants from a single seed source grow to slightly different heights even when grown in identical conditions. The word *mix* is an age-appropriate term from everyday language that students will replace in later years; in the middle grades, students will be able to explain the mixing in terms of genetics. The CA NGSS are filled with situations like this where students use **patterns [CCC-1]** to uncover evidence of a **cause and effect relationship [CCC-2]** in elementary school but do not develop an explanation or model that accounts for these patterns until later grades. Teachers that might be concerned about teaching their students a nontechnical term can consider how this progression in vocabulary reflects the nature of science where ideas are subject to refinement and revision. The introduction of more precise terminology occurs in parallel with enhanced conceptual understanding. To explicitly emphasize the nature of science, teachers explicitly identify such nontechnical terms as placeholders that will be refined in later grades.

The clarification statement for PE 3-LS3-1 emphasizes organisms other than humans. If students bring up human traits, teachers must recognize that many of their students may not live with both biological parents or may not even know who both biological parents are. While only the biological parents contribute physical traits to a child, the adults who chose to be part of that child's life will heavily influence that child's personality and disposition.

Grade Three Snapshot 4.2: Graphing Variation

Anchoring phenomenon: Different caterpillars grow at different rates.

Ms. P's class observed the life cycle of the hornworm caterpillar (*Manduca sexta*). Pairs of students ensured that their caterpillar's needs were met by providing food, water, and keeping the plastic enclosure clean. Every few days, they **measured the length [SEP-5]** of their caterpillar. Ms. P called up each pair to mark the length of their caterpillar on the line plot for the day so that students could visualize this variation (CA CCSSM 3.MD.4). She posted the daily plots on the wall so that students could track how the caterpillars had grown over time. Even though the animals had access to the same food and lived in the same environment, some individuals grew bigger than others.

Investigative phenomenon: Caterpillars of the same type share many features in common but other features differ.

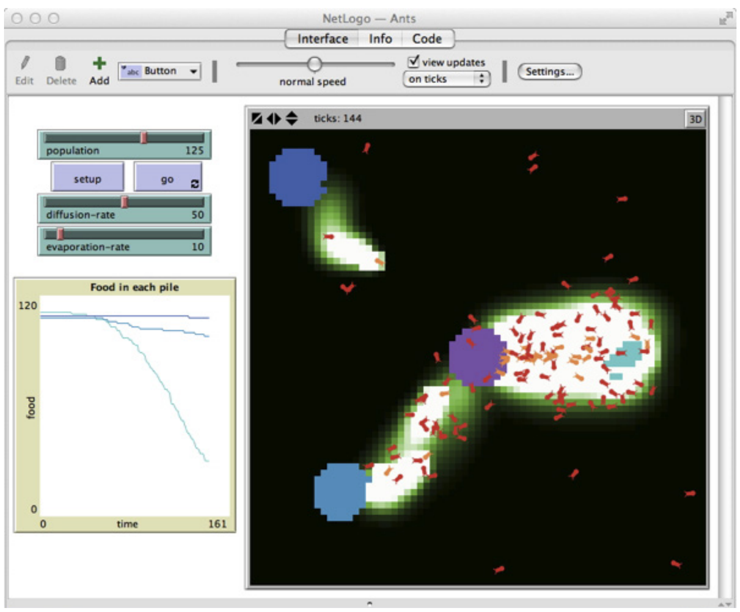
Ms. P focused student attention on the variation between caterpillars and had students **compare [SEP-4]** two caterpillars side-by-side, making a list of all the similarities and differences ("They both have seven stripes and nine spots. The spot sizes and shapes are slightly different"). Ms. P then showed students a picture of two caterpillars (including a ruler that reveals their lengths). She asked students which they think was more likely to be a baby picture of the mother of their caterpillar and what observations **support their claim [SEP-7]**.

Group Behaviors for Survival

Why do some animal families stick together in large groups while other animals live alone? In each case, animals behave the way they do to meet their needs, survive, and reproduce. When parents live separately from their young (or when the parent dies shortly after reproducing), children do not have to compete with their parents for resources. When animals live in groups, they can assist one another. Science experiences for third graders can include activities and games where teams complete tasks that highlight the potential individual benefits of cooperative behavior. It is often difficult to directly observe the benefits of group behavior of animals in the classroom, so students can investigate specific animal groups through informational literature and media such as groups of penguins in the arctic, zebras in Africa, schools of fish, or bird flocks. Humpback whales are particularly interesting California animals that are largely solitary, but travel in small groups during migration and occasionally cooperate in something called *bubble net feeding* when a group converges at a single location and comes to the surface in perfect unison to feast on schools of small fish (National Geographic 2014). With such clear demonstrations of their ability to collaborate, why do they usually live alone? How does that enable them to meet their needs and survive better?

Students can also indirectly observe group behavior through computer simulations like NetLogo (Wilensky 1999). These programs allow students to track individual organisms to see how they interact with others to meet their needs. In a simulation of an ant colony (figure 4.4), students can explore how the size of the ant colony affects the amount of food collected (including the success of a single ant) or what would happen if the colony were unable to communicate using pheromones. Students use this evidence to support an argument that the colony helps the ants survive (3-LS2-1).

Figure 4.4. Computer Simulation of Group Behavior in Ants



In this NetLogo computer simulation, ants (red) leave a trail of pheromones (white) that helps other ants find food (blue) around their nest (purple). *Source:* Wilensky 1999; Wilensky 1997
Long description of Figure 4.4.