

## Photo Description



This image shows a monarch butterfly caterpillar with bold yellow, black, and white stripes crawling on a concrete surface. Next to the caterpillar is an empty, clear chrysalis case that looks like a transparent shell. The striped caterpillar has small black antennae and appears to be moving away from where it completed its amazing transformation.

## Scientific Phenomena

The anchoring phenomenon shown here is complete metamorphosis - specifically the moment after a monarch butterfly has emerged from its chrysalis, leaving behind the empty pupal case. This represents one of nature's most dramatic transformations, where the caterpillar's body completely reorganizes inside the chrysalis over 8-10 days. Special groups of cells called imaginal discs, which were dormant during the larval stage, activate to form entirely new body parts like wings, reproductive organs, and different digestive systems suited for nectar feeding rather than leaf eating.

## Core Science Concepts

- 1. Life Cycles and Development:** Monarch butterflies undergo complete metamorphosis with four distinct stages - egg, larva (caterpillar), pupa (chrysalis), and adult butterfly, each with different body structures and functions.
- 2. Structure and Function:** The caterpillar's body is designed for eating and growing with strong jaws and a digestive system for processing milkweed leaves, while the adult butterfly has a completely different body structure with wings for flight and a proboscis for drinking nectar.
- 3. Inherited Traits and Survival:** The monarch's distinctive warning coloration (bright stripes on caterpillar, orange wings on adult) signals to predators that they are toxic from eating milkweed plants, helping them survive to reproduce.
- 4. Environmental Interactions:** Monarchs have co-evolved with milkweed plants in a specialized relationship where the plant provides food and chemical protection, while the butterfly serves as a pollinator.

### Pedagogical Tip:

Use real monarch caterpillars or chrysalises if available in your area during fall months, as hands-on observation dramatically increases student engagement and retention of metamorphosis concepts.

### UDL Suggestions:

Provide multiple ways for students to demonstrate their understanding of metamorphosis through drawing sequences, acting out the stages, creating digital presentations, or building 3D models to accommodate different learning preferences and abilities.

### Zoom In / Zoom Out

**Zoom In:** Inside the chrysalis, the caterpillar's tissues break down in a process called histolysis while imaginal discs use these recycled materials to build new organs through histogenesis. Hormones like ecdysone trigger these cellular changes that completely reorganize the insect's body plan.

**Zoom Out:** Monarch metamorphosis is part of a continental-scale migration system where multiple generations travel from Mexico to Canada and back, with the final generation undergoing physiological changes that allow them to live 6-8 months instead of the usual 6-8 weeks to complete the southern journey.

### Discussion Questions

1. What evidence can you observe that shows this butterfly recently completed metamorphosis? (Bloom's: Analyze | DOK: 2)
2. How might the monarch's life cycle strategy help the species survive environmental challenges that a simpler life cycle could not? (Bloom's: Evaluate | DOK: 3)
3. What patterns do you notice between the caterpillar's body design and its job of eating leaves compared to the butterfly's body design and its job of finding mates and laying eggs? (Bloom's: Analyze | DOK: 2)
4. If climate change affects the timing of milkweed plant growth, how might this impact monarch metamorphosis and migration? (Bloom's: Synthesize | DOK: 4)

### Potential Student Misconceptions

1. Misconception: The caterpillar just grows wings inside the chrysalis and comes out as a butterfly.  
Reality: The caterpillar's body almost completely dissolves and rebuilds using specialized cell clusters to create entirely new organs and body systems.
2. Misconception: All insects go through the same type of metamorphosis as butterflies.  
Reality: Some insects like grasshoppers undergo incomplete metamorphosis with only three stages (egg, nymph, adult) and no pupal stage.
3. Misconception: The chrysalis is like a cocoon that the caterpillar spins around itself.  
Reality: A chrysalis is the hardened skin of the caterpillar itself, while cocoons are silk structures spun by moth caterpillars.

### Cross-Curricular Ideas

1. Math - Data Collection and Graphing: Have students measure and track the length of monarch caterpillars over time, then create bar graphs or line graphs to show growth patterns. Students can compare growth rates across different caterpillars and calculate the percentage increase in size from caterpillar to chrysalis stage.
2. ELA - Sequencing and Narrative Writing: Students can write detailed sequential narratives describing each stage of the monarch's life cycle in order, using transition words like "first," "next," "then," and "finally." They could also write from the caterpillar's perspective as a creative first-person account of metamorphosis.
3. Art - Life Cycle Illustration and Design: Students create visual representations of the complete monarch life cycle using various media (colored pencils, watercolor, collage, or digital tools). They can focus on accurate coloring and patterns, then arrange illustrations in sequence to show the transformation stages.

4. Social Studies - Migration Patterns and Geography: Students research and map the monarch butterfly's annual migration route from Mexico to Canada, learning about the geographic challenges these insects face and how human activities (habitat loss, climate change) affect their journey across multiple countries and ecosystems.

### STEM Career Connection

1. Entomologist - An entomologist is a scientist who studies insects like monarch butterflies. They observe how insects live, grow, and interact with their environment. Entomologists might raise monarch caterpillars in labs, study how climate change affects their metamorphosis, or work to protect endangered insect species. Average Salary: \$65,000 per year
2. Environmental Scientist - Environmental scientists study how living things interact with nature and solve problems that hurt ecosystems. Someone in this career might investigate why monarch populations are declining, restore milkweed habitats that monarchs need to survive, or work on conservation projects to protect migration routes. Average Salary: \$73,000 per year
3. Science Educator or Museum Naturalist - These professionals teach visitors and students about nature and wildlife through hands-on activities, demonstrations, and exhibits. They might create displays about monarch metamorphosis at science museums, lead butterfly garden tours, or develop educational programs to help people understand why insects are important. Average Salary: \$52,000 per year

### NGSS Connections

- Performance Expectation: 5-LS2-1 - Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment
- Disciplinary Core Ideas: 5-LS1.B - Growth and Development of Organisms
- Disciplinary Core Ideas: 5-LS2.A - Interdependent Relationships in Ecosystems
- Crosscutting Concepts: Patterns - Observable patterns in nature guide organization and classification
- Crosscutting Concepts: Structure and Function - The way an object is shaped or structured determines many of its properties and functions

### Science Vocabulary

- \* Metamorphosis: The process where an animal's body changes completely from one form to another as it grows up.
- \* Chrysalis: The hard protective case where a caterpillar transforms into a butterfly.
- \* Larva: The caterpillar stage of a butterfly's life when it focuses on eating and growing.
- \* Pupa: The transformation stage when the caterpillar changes into a butterfly inside the chrysalis.
- \* Imaginal discs: Special groups of cells in caterpillars that stay inactive until they build the butterfly's new body parts.
- \* Histolysis: The breaking down of the caterpillar's old body parts during metamorphosis.

### External Resources

Children's Books:

- The Very Hungry Caterpillar by Eric Carle
- Waiting for Wings by Lois Ehlert
- An Extraordinary Life: The Story of a Monarch Butterfly by Laurence Pringle