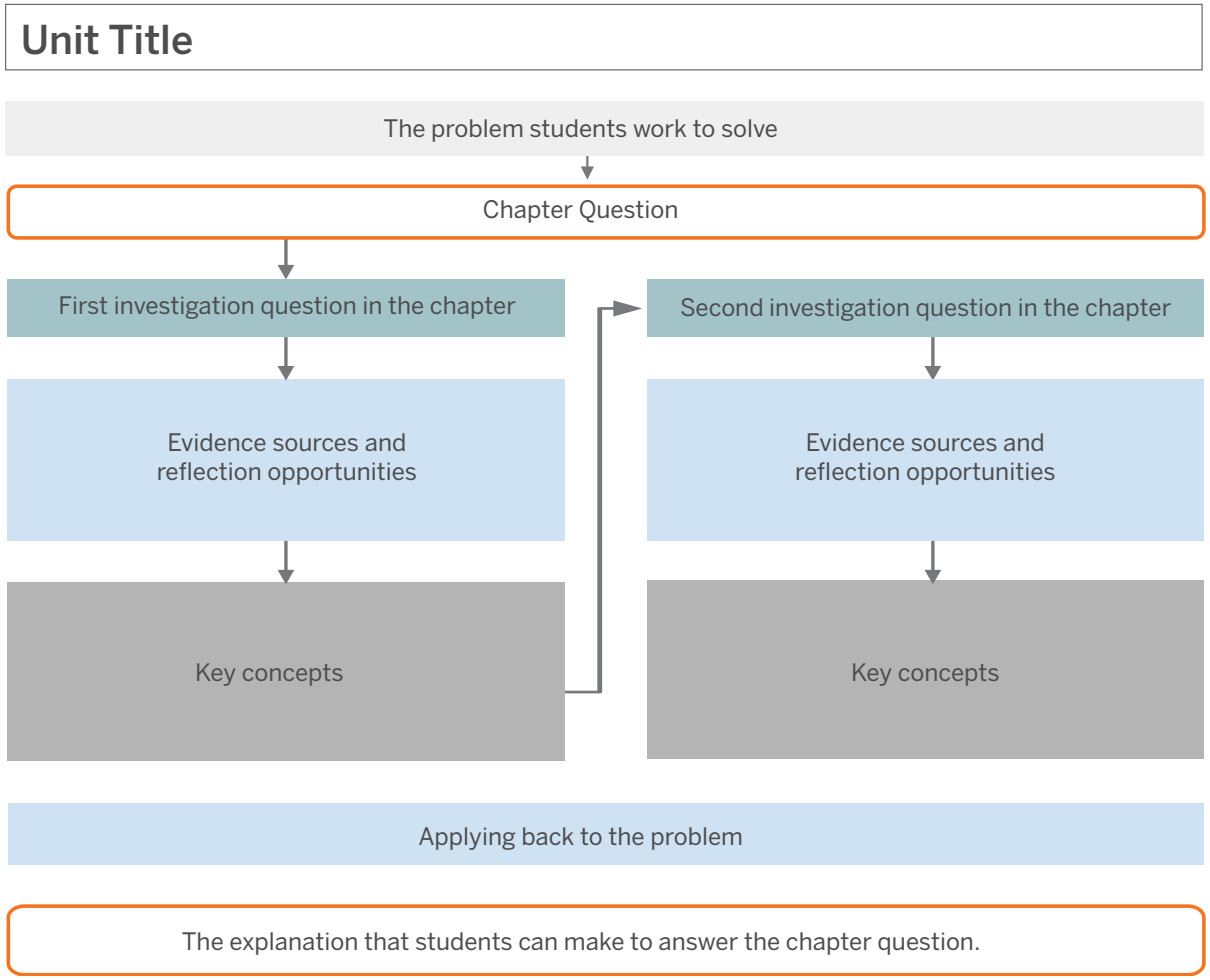
Natural Selection Coherence Flowchart

The storyline of the unit

In each Amplify Science unit, students figure out a phenomenon by asking questions, gathering evidence, and coming up with an explanation of how the phenomenon works. The Coherence Flowchart visually represents the storyline of the unit, showing the coherent flow of questions, evidence, and ideas that support students as they build complex explanations of the unit's anchor phenomenon. The Coherence Flowchart on the following pages (one chapter per page) can be used to see the connections between the questions that drive students' experiences, the evidence they gather, the ideas they figure out, and the new questions that those ideas generate. The diagram to the right explains the structure of a chapter in the Coherence Flowchart.

Note: The Coherence Flowchart is a tool for teachers and is not meant to be distributed to students.

Typical structure of one chapter in a Coherence Flowchart



Instruction is framed by questions about the unit's anchor phenomenon and the related problem students are solving. Chapter Questions then guide students in figuring out the phenomenon, piece by piece. Within each chapter, Investigation Questions focus students on a manageable piece of content that will help them figure out the Chapter Question. Each question motivates activities, and each activity provides specific evidence related to the Investigation Question. Students synthesize the understanding constructed over multiple activities, and this understanding is formalized through key concepts. Often a key concept leads students to an additional Investigation Question students need to pursue to answer the Chapter Question. At the end of the chapter, students' new understanding is applied back to the unit's anchor phenomenon and leads students to a new Chapter Question or a final explanation.

AmplifyScience

Natural Selection: Poisonous Newts

The problem students work to solve

What caused the newt population in Oregon State Park to become more poisonous?

Chapter 1 Question

What caused this newt population to become more poisonous?

Investigation Questions

How can we describe a population? (1.2, 1.3)

What makes the distribution of traits in a population change? (1.4, 1.5, 1,6)

Evidence sources and reflection opportunities

- Observe the different traits in a population of butterflies (1.2)
- Use the Sim to observe trait variation and distribution in populations (1.3)
- Use cubes to build histograms showing the variation and distribution of traits in a population (1.3)

- Observe how the distribution of fur traits in a population changes over time in the Sim (1.4)
- Use the paper Modeling Tool to show predictions of how the distribution of fur traits in a population will change in a cooling environment, and test predictions in the Sim (1.4)
- Use the Sim to investigate whether a trait is adaptive in different environments (1.5)
- Use the paper Modeling Tool to show how and why a trait can become more common in a population over time (1.5)
- Write and share to explain why the distribution of traits changed in a population (1.6)

Key concepts

- A population can be described by the traits present and by the number of individuals who have each trait. (1.3)
- The number of individuals with each trait in a population can change over time. (1.4)

- Over many generations, individuals with adaptive traits become more common in a population, while individuals with non- adaptive traits become less common. (1.4)
- The traits that exist in a population determine which traits can become more common over many generations. (1.4)
- Whether or not a trait is adaptive depends on the environment. (1.5)
- Biologists analyze data about environmental conditions (the causes) to explain changes in the distribution of traits in populations (the effects). (1.6)

Application of key concepts to the problem

- Examine histograms of the newt population and explain why the newts in the population became more poisonous over time (1.6)

Explanation that students can make to answer the Chapter 1 Question

The newt population became more poisonous because the snakes in this environment caused poison to be an adaptive trait. When snakes became part of the environment, the newts with high-poison level were more likely to survive. Over time, newts with a high-poison level became more common in the population because they were more likely to survive after the environment changed.

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Natural Selection: Poisonous Newts

The problem students work to solve

What caused the newt population in Oregon State Park to become more poisonous?

Chapter 2 Question

How did the trait for increased poison level become more common in the newt population?

Investigation Questions

How do individuals in a population get their traits? (2.1)

How do some traits become more common over many generations while others become less common? (2.2, 2.3, 2.4)

Evidence sources and reflection opportunities

- Use the Sim to investigate whether reproduction always results in offspring with adaptive traits (2.1)
- Use a color cube model to investigate how reproduction in a population results in traits being passed from one generation to the next (2.1)
- Read "Glowing Jellies" (2.1)

- Observe how genes are passed from parent to offspring, which result in trait inheritance using the Traits and Reproduction Sim (2.2)
- Use the Sim to investigate whether individuals with adaptive traits have more offspring than individuals with non-adaptive traits (2.2)
- Use the paper Modeling Tool to explain how survival and reproduction can change the distribution of traits over time (2.2)
- Read "The Deadly Dare"(2.3)
- Revisit "The Deadly Dare"(2.4)

Key concepts

- Genes are instructions for making protein molecules and protein molecules determine an organism's traits. (2.2)
- Individuals inherit their genes from their parents. Genes, and therefore traits, in a population are passed down from generation to generation. (2.2)

- Individuals with adaptive traits are more likely to live longer and have offspring; individuals with non-adaptive traits are more likely to die without having offspring. (2.4)

Application of key concepts to the problem

- Use the Reasoning tool to construct a scientific argument that explains the changes in the newt population (2.4)

Explanation that students can make to answer the Chapter 2 Question

Since snakes were present in the environment, the more poisonous traits were adaptive in the newt population. Over time, the high-poison levels became more common in the newt population because newts with higher levels of poison were more likely to survive longer than newts without them. Surviving longer means the newts had more chances to reproduce and pass their genes, and therefore their traits, to their offspring.

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Natural Selection: Poisonous Newts

The problem students work to solve

What caused the newt population in Oregon State Park to become more poisonous?

Chapter 3 Question

How did a poison-level trait that wasn't always present in the newt population become the most common trait?

Investigation Questions

How do new traits appear in populations? (3.1)

What determines whether a new trait will become more common in the population? (3.2, 3.3)

Evidence sources and reflection opportunities

- Read Mutations: Not Just for Superheroes (3.1)
- Use the Sim to predict and test what happens to a population with mutations when the environment changes. (3.1)

- Revisit Mutations: Not Just for Superheroes (3.2)
- Use the Sim to investigate whether traits created through mutations are always adaptive (3.2)
- Write and share to compare how the distribution of traits changes in populations when different mutations are introduced (3.3)

Key concepts

- Mutations are changes to genes that can lead to changes to protein molecules, which can result in changes to traits. (3.2)
- Mutations to genes can sometimes introduce new traits into a population. (3.2)

- A new trait will only become more common in a population if it is adaptive. (3.3)

Application of key concepts to the problem

- Use the paper Modeling Tool to show how the distribution of poison traits in the newt population changed over time and write an accompanying explanation (3.3)

Explanation that students can make to answer the Chapter 3 Question

A mutation happened that introduced the trait for high poison-level in the newt population. When snakes became part of the environment, this trait became adaptive. Therefore, newts with the high-poison trait were more likely to survive and reproduce, passing on their genes to their offspring. Over time, this trait became more and more common.

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Natural Selection: Poisonous Newts

Problem students work to solve and the Chapter 4 Question

What caused the stickleback population to have less armor and become faster?

Application of key concepts to new problem

- Analyze and sort evidence based on claims (4.1)
- Participate in the Science Seminar (4.2)
- Use the Reasoning Tool to connect the evidence to the claims (4.3)
- Write an argument to support a claim (4.3)

Explanation that students can make to answer the Chapter 4 Question

One possible explanation students can make:

In their current environment, sticklebacks with low armor are faster and live longer and reproduce more than sticklebacks with more armor. Individuals with adaptive traits are more likely to live longer and have offspring so low armor and faster speed must be an adaptive trait in the current environment. This makes sense because when the sticklebacks' environment changed, the new environment included a much faster predator: the dragonfly nymph. A speed that is fast enough to escape a predator was not necessary in the sticklebacks' old environment. In the new environment, the sticklebacks most likely to live long enough to reproduce and pass their genes to their offspring are the sticklebacks with the trait for less armor. Therefore, faster predators caused the change to trait distribution in the stickleback population.