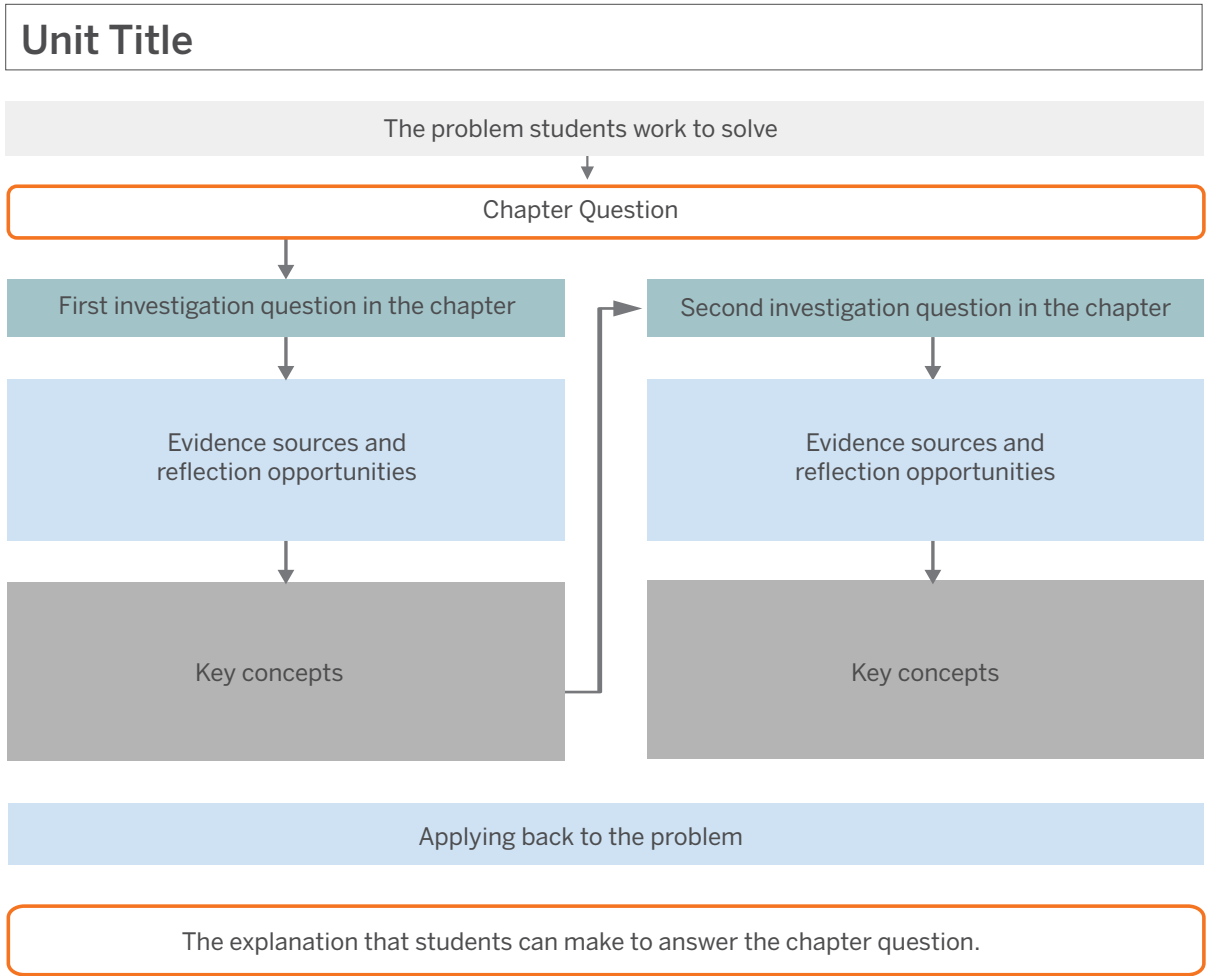
Evolutionary History Coherence Flowchart

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.

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Evolutionary History: Advising a Paleontology Museum

The problem students work to solve

Is this Mystery Fossil more closely related to wolves or to whales?

Chapter 1 Question

Where in the museum does this new fossil belong?

Investigation Question

Why do different species share similar structures? (1.3, 1.4, 1.5)

Evidence sources and reflection opportunities

- Examine body structures of different species and group species based on similarities (1.2)
- Read "How You are Like a Blue Whale" (1.3)
- Revisit "How You are Like a Blue Whale" (1.4)
- Use the Sim to find two species that share a common body structure on an evolutionary tree (1.4)

Key concepts

- Species inherit their body structures from their ancestor populations. (1.4)
- Body structures that are shared between two species are evidence that these two species inherited the shared structures from a common ancestor population. (1.4)

Application of key concepts to the problem

- Discuss claims about where in the museum the mystery fossil belongs based on new evidence (1.5)
- Analyze structural similarities among wolves, whales, and the mystery fossil and consider what a body structures a common ancestor might have had (1.5)
- Use the Modeling Tool to show a likely common ancestor based on structures shared between two model species (1.5)

Explanation that students can make to answer the Chapter 1 Question

The Mystery Fossil should be placed with either the whales in the Whale exhibit or the wolves in the Carnivore exhibit. This is because the fossil shares many similar structures with both wolves and whales. Traits, such as body structures, are passed down from parents to offspring. When two species have many similar structures, this is evidence that both species descended from a common ancestor population with those structures. The Mystery Fossil likely shares a common ancestor population with both wolves and whales.

Evolutionary History: Advising a Paleontology Museum

The problem students work to solve

Is this Mystery Fossil more closely related to wolves or to whales?

Chapter 2 Question

How did wolves, whales, and the Mystery Fossil become so different from their common ancestor population?

Investigation Questions

How does an ancestor population evolve into descendant species with differences in their shared structures? (2.1, 2.2, 2.3)

How did descendant species from a common ancestor become very different from one another? (2.4)

Evidence sources and reflection opportunities

- Analyze differences in the front limbs of three different organisms (2.1)
- Read "Where Do Species Come From?" (2.2)
- Read "Where Do Species Come From?" (2.2)
- Revisit "Where Do Species Come From?" (2.3)
- Use the Natural Selection Sim to model a population split into two different environments, and reflect on how one species can become two over time (2.3)

- Explore and discuss the timeline of Earth's evolutionary history (2.4)
- Sort cards depicting evolutionary changes based on how long they take to happen (2.4)
- Use the Sim to compare the scale of structural changes across different lengths of evolutionary time (2.4)

Key concepts

- In populations separated into different environments, natural selection causes different changes to happen to each population. This causes descendant species to end up with differences in their shared structures. (2.3)
- When the environment is mostly the same over time, body structures stay stable. When the environment changes over time, body structures may change due to natural selection. (2.3)

- Over many generations and very long periods of time, many small changes can build up to large differences in body structures. (2.4)

Application of key concepts to problem

- Use the Modeling Tool to show how the body structures of populations in different environments might change over time (2.5)
- Use unit vocabulary to explain how wolves, whales, and the Mystery Fossil became so different from their common ancestor population (2.5)

Explanation that students can make to answer the Chapter 2 Question

The differences between whales, wolves, and the Mystery Fossil may have evolved because the ancestors of each evolved in different environments. Populations can become separated into different environments. Due to natural selection, small changes that are helpful for survival in the different environments become more common over time. Over generations, two populations of the same species can become more and more different. Small changes add up to larger differences, like those observed among the different body structures of wolves, whales, and the Mystery Fossil.

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Evolutionary History: Advising a Paleontology Museum

The problem students work to solve

Is this Mystery Fossil more closely related to wolves or to whales?

Chapter 3 Question

How can we tell if the Mystery Fossil is more closely related to wolves or to whales?

Investigation Question

When you compare different species, how can you tell which species are more closely related than others? (3.1, 3.2, 3.3)

Evidence sources and reflection opportunities

- Explore evolutionary relationships with a physical model (3.1)
- Model shared structures in common ancestors using the Modeling Tool (3.1)
- Investigate the relatedness of extinct whales using the Sim (3.2)
- Use unit vocabulary to explain how you can tell which species are more closely related than others (3.2)

Key concepts

- Among any three species, the two species that separated most recently are the most closely related to each other. (3.1)
- When two species share a structure that is not shared with a third species, this can be evidence that the first two species are more closely related to each other than to the third species. (3.2)

Application of key concepts to the problem

- Compare whales and wolves to identify diagnostic structures (3.3)
- Analyze identified diagnostic structures of the Mystery Fossil, and then compare these structures to the structures of whales and wolves to draw a final conclusion about which species the Mystery Fossil is most closely related to (3.3)
- Place the Mystery Fossil on an evolutionary tree (3.3)

Explanation that students can make to answer the Chapter 3 Question

The Mystery Fossil probably shares a more recent common ancestor with whales and should be placed in the Whale exhibit. One way to tell which species the Mystery Fossil it more closely related to is by comparing the structures of all three species. For example, although all three species have a backbone and produce milk for their young, the Mystery Fossil and the whale share some diagnostic structures that the wolf doesn't share, like the shape of their jawbones and nostril placement.
*Students can also write a valid explanation saying the Mystery Fossil is closely related to wolves.

Evolutionary History: Advising a Paleontology Museum

Problem students work to solve and the Chapter 4 Question

Is the Tometti fossil more closely related to ostriches or to crocodiles?

Application of key concepts to new problem

- Analyze and sort evidence based on claims (4.1)
- Participate in the Science Seminar (4.2)
- Reason about evidence and claims (4.3)
- Write an argument to support one claim (4.3)

Explanation that students can make to answer the Chapter 4 Question

One possible explanation students can make:
The Tometti fossil is more closely related to crocodiles. Both the Tometti fossil and crocodiles have many pointy teeth while ostriches have no teeth. The Tometti fossil and crocodiles both have long tails with multiple bones, but ostriches only have one bone for their tail. The Tometti fossil shares more structures with crocodiles than it does with ostriches. This means the Tometti and crocodile were separated more recently and therefore share a more recent common ancestor.

There are some differences between the Tometti fossil and the crocodile, but that is because even though they are more closely related, they have been separated for a very long time, so they have changed to adapt to their environments. The Tometti skull has five holes in it, and crocodile skulls have three holes and crocodiles' ancestors had four holes. The common ancestor had four holes, so it could be that over the time the crocodile and the Tometti were separated the crocodile lost one hole and the Tometti gained one.

It is true that the Tometti fossil and ostriches walked on two limbs, which might make some think that the Tometti fossil is more closely related to ostriches. But in the past there were crocodiles that could walk on their back two limbs too. Overall, the Tometti shares more structures with the crocodile so the evidence supports the claim that the Tometti fossil is more closely related to crocodiles, not ostriches.