Task 1: Introduction

LT: I can explore various resources in order to describe how a mystery fossil could be grouped with other fossils.

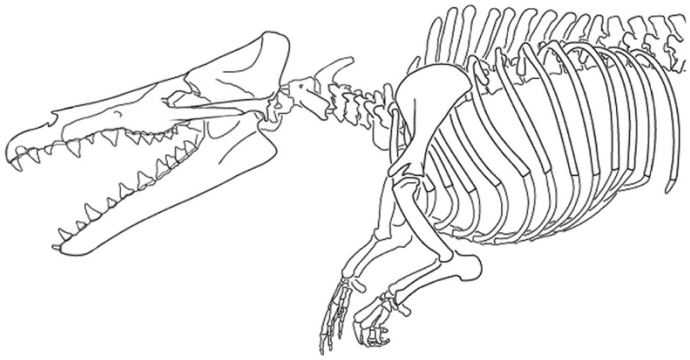
Watch the following video link that will explain your role in this unit.
https://sites.google.com/a/ps207tigers.org/207sci/amnh-fossils

To: Student Paleontologists
From: Andre Mosley, Natural History Museum Director
Subject: First Thoughts About Mystery Fossil

We want to make sure to place the Mystery Fossil in the museum with a group of other species that it makes the most sense for the fossil to be with. To make this decision, you will need to do the work of making careful observations and spending time comparing the bones of the Mystery Fossil to the bones and body structures of other organisms.

We asked our intern paleontologists at the museum to quickly examine the Mystery Fossil bones and give us some initial ideas about what species in the museum the Mystery Fossil might be most similar to. Their first examination of the Mystery Fossil tells us that there are three main types of organisms that the Mystery Fossil could be grouped with:

- whales
- wolves
- crocodiles

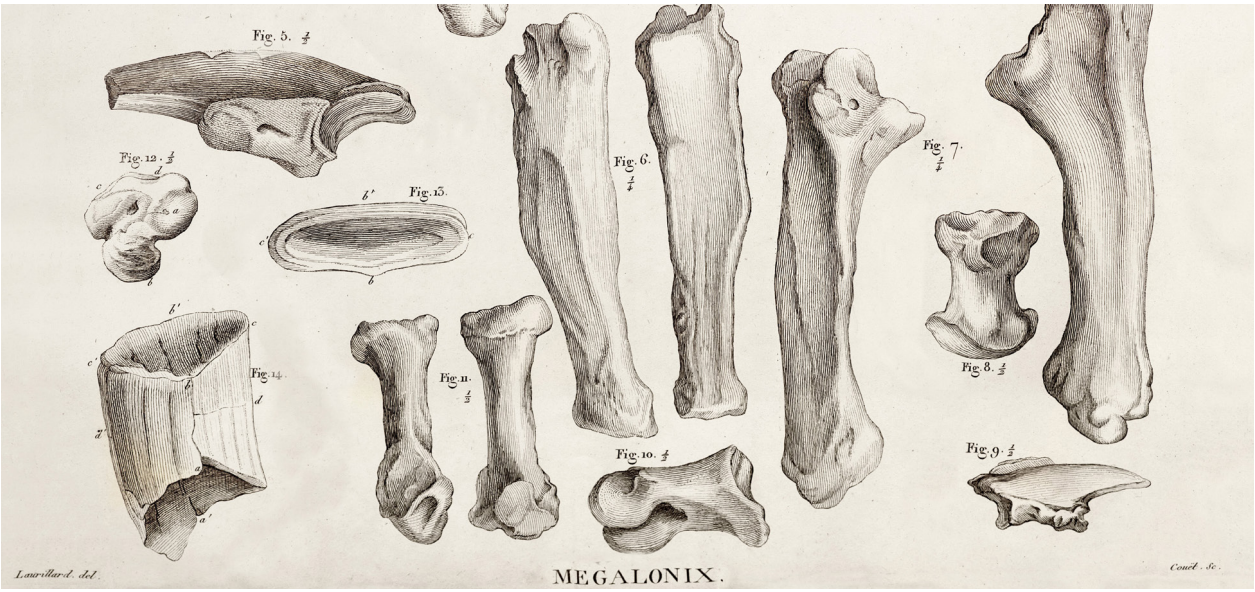


a. Where in the museum does this new fossil belong?

- Claim 1: The Mystery Fossil belongs with the whales, in the Whale (Cetacea) exhibit.
- Claim 2: The Mystery Fossil belongs with the wolves, in the Carnivore (Carnivora) exhibit.
- Claim 3: The Mystery Fossil belongs with the crocodiles, in the Reptile (Reptilia) exhibit.

To decide where to place the Mystery Fossil in the museum, you will need to learn how paleontologists think about and understand the history of life on Earth.

When paleontologists discover a new fossil, they compare it to other known fossils and living organisms. Paleontologists are interested in how fossils are similar to other extinct species and to species that are alive today.



This image is based on a drawing the scientist made of the fossilized bones.

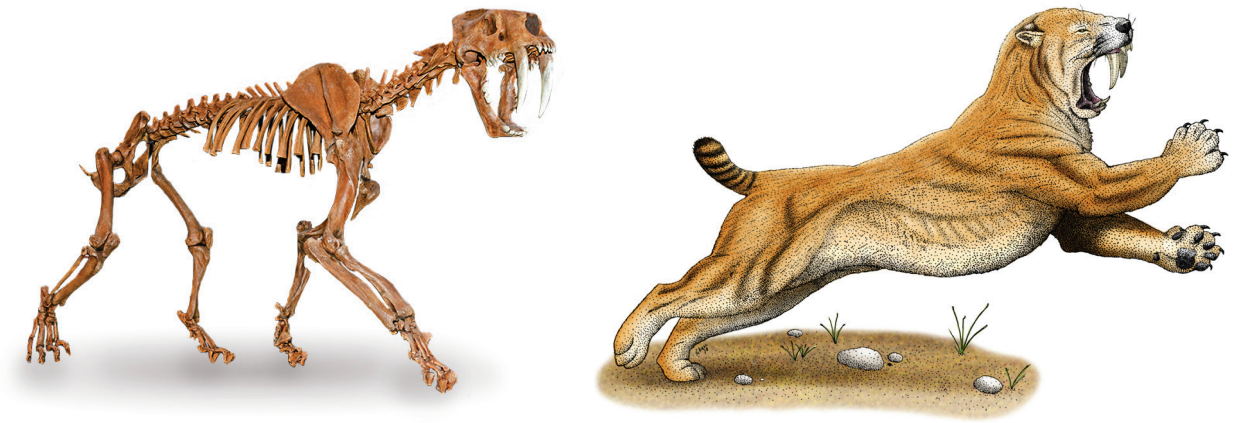
The Cat That Wasn't a Cat at All

When it comes to fossils, cases of mistaken identity are not uncommon. Paleontologists might think that they have found a fossil from one species, when it actually turns out to be from different species. Often, these mistakes are corrected as paleontologists make closer and more careful observations.

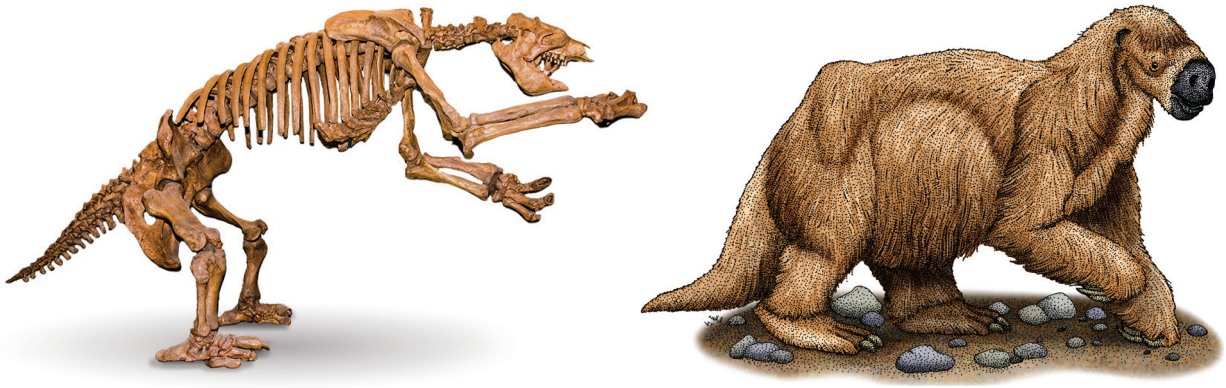
One interesting case of mistaken fossil identity happened in 1796, when workers dug up a pile of strange-looking fossilized bones. A scientist observed the fossils and noticed long limbs and big claws. Without making careful comparisons to other fossils, the scientist guessed that the bones belonged to a huge cat, much bigger than a lion. He named it *Megalonyx* ("giant claw"), and believed it might still exist in the western part of North America at the time.

Years later, another scientist studied the fossils and made more careful observations. After making close comparisons with fossils from other species, this scientist determined that the animal often walked on its hind legs. Cats do not walk on their hind legs, so this discovery probably meant that the fossil was not a cat.

The scientist discovered that the fossils actually belonged to a giant sloth. This species had been extinct for a long time— since the last Ice Age, more than 10,000 years earlier. Even though the mistake became clear with time, the name of the giant sloth was never changed. The *Megalonyx jeffersonii* (which isn't a cat at all!) is a reminder that it is important to make careful and precise observations in science.



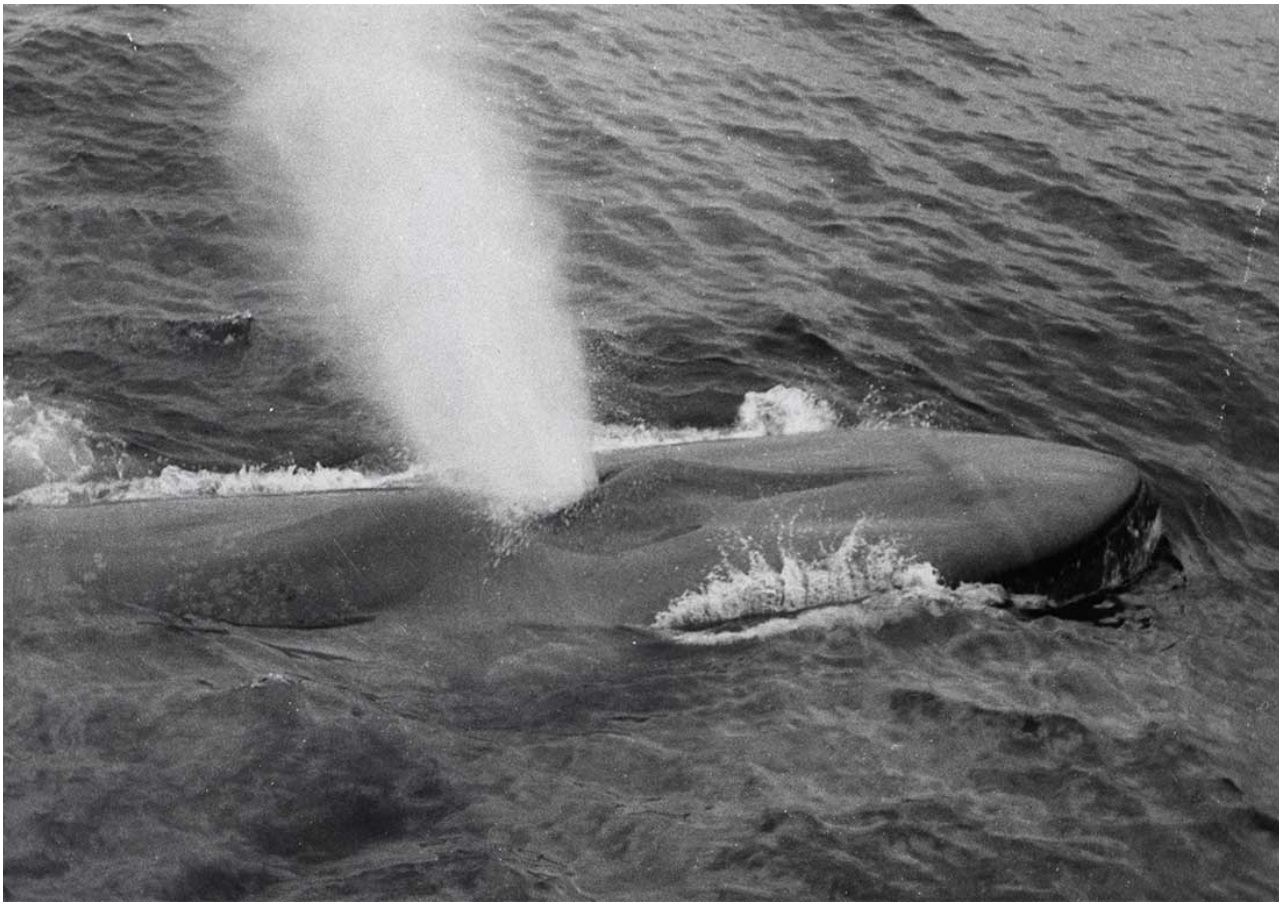
The scientist thought the fossilized bones he was studying came from a large cat, like this sabre-toothed cat.



Another scientist made more careful observations and realized that the bones actually came from a giant sloth.

b. The first scientist misidentified the fossil as that of a big cat. What body structure did he use to make his observations?

c. What body structure did the second scientist use to determine that the first scientist had misidentified the fossil?



Blue whales are mammals and must come to the ocean's surface to breathe.

How You Are Like a Blue Whale

If anybody tells you blue whales are the largest fish on Earth, they don't know what they're talking about. Blue whales may live in the ocean with fish, but they aren't fish at all. There are many important differences between the body structures of whales and fish. Fish are covered in shiny scales, while whales have smooth skin. Fish lay eggs, while whales give birth to live young. Fish fins are made of many tiny bones, but whale flippers are supported by just a few bones. In fact, whales are mammals, just like dogs, elephants, and humans. Blue whales share many more body structures with you than they do with fish!

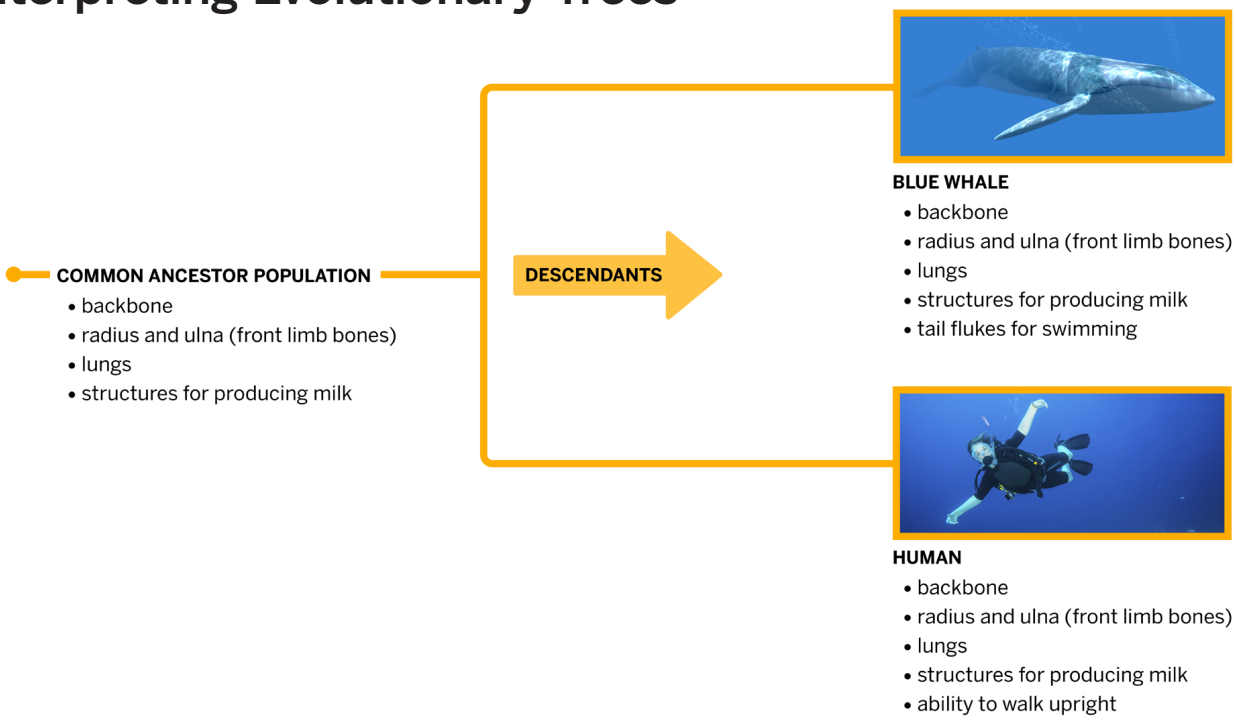
Just as whales and fish look similar but are actually very different, humans and blue whales look different but have a surprising amount in common. Mother whales produce milk for their babies, just as human mothers do. Like humans, whales have lungs instead of gills. Whales can't breathe underwater: they must come to the surface to breathe. And if you look at the bones in a human arm and the bones in a blue whale flipper, you can see that they fit together in similar ways. Blue whales even have leg bones, just like humans. However, in whales, these bones are so tiny that the skin, fat, and muscles of the whale's body hide them. You might not call them real legs, but they are leftovers from a time when whales' ancestors had legs and walked on land.

To figure out how two species are connected, scientists can study the skeletons of both species. Scientists studying present-day animals can use x-rays of living animals or sets of bones from animals that have died recently. Paleontologists studying species that are now extinct use fossils to compare species. Comparing skeletons tells us about how species are connected because organisms get their body structures the same way they get all their other traits. Body structures are determined by the code of DNA and are passed down from generation to generation over millions of years. By comparing the skeletons of different species, scientists can see patterns of how traits have been passed down. When two species' body structures are made from bones that are in the same pattern and roughly the same position in the body, scientists consider them to be shared body structures. Shared body structures in two very different species can be evidence that both species evolved from a common ancestor population that had those body structures long ago.

The shared body structures found in a common ancestor population didn't necessarily look very much like they do now. They may not even have been used for the same function! To see how two descendant species are connected, paleontologists examine the fossil record. In the case of whales and humans, they look for evidence of a species that had front limbs with the same pattern of bones, structures for producing milk, and lungs for breathing air. All of these things are true of both whales and humans today.

Paleontologists have used evidence from fossils, DNA, and other sources to conclude that the common ancestor of whales, humans, and all other mammals was a tiny animal that lived about 65 million years ago. Fossils from that time show evidence of mouse-like creatures that had four legs with claws, long tails, and long noses good for sniffing out insects. Similarities in body structures allow paleontologists to infer that whales,

Interpreting Evolutionary Trees



Humans and blue whales have many shared structures. Based on this information, paleontologists know that these species descended from a common ancestor population that also had those body structures.

Whales, humans, and other mammals alive today are all descendants of a common ancestor population that lived about 65 million years ago. Paleontological artists use what they know about the skeletons of these animals to make educated guesses and create drawings that show what they probably looked like.

humans, and all other mammals evolved from a common ancestor similar to this tiny animal, even though it looked very little like blue whales or humans do today.

Just as whales have lost the function of their back legs, but still have remnants of the bones, you also have old structures that have lost one or more of their functions. For example, our ancestors had tails, and we still have short tailbones in the place where tails would be. The bone structures and other traits we share with whales provide evidence of our shared evolutionary history: the ancestor population we have in common, from which we both evolved.

If you think about it, you can come up with structures that we share not only with whales, but with a lot of other animals, too. Can you think of all the animals that have a skull, eyes, teeth, and a backbone? All living things are related and share some basic traits like cell structure and DNA. By looking at evidence in the fossil record, scientists have learned that all living things inherited cell structure from the very first single-celled organisms on Earth. That population of single-celled organisms is a common ancestor we share with all other cellular life on the planet! Humans, whales, fish, and billions of different species all evolved from a common ancestor population that was made of just one tiny cell and lived about 4 billion years ago. The family of living things is much greater than we could have imagined, connecting us not only to close relatives such as whales and other mammals, but also to fish, worms, plants, bacteria, and all other life on Earth. We all share a common evolutionary history.

d. Which specific body structures do humans share with blue whales?

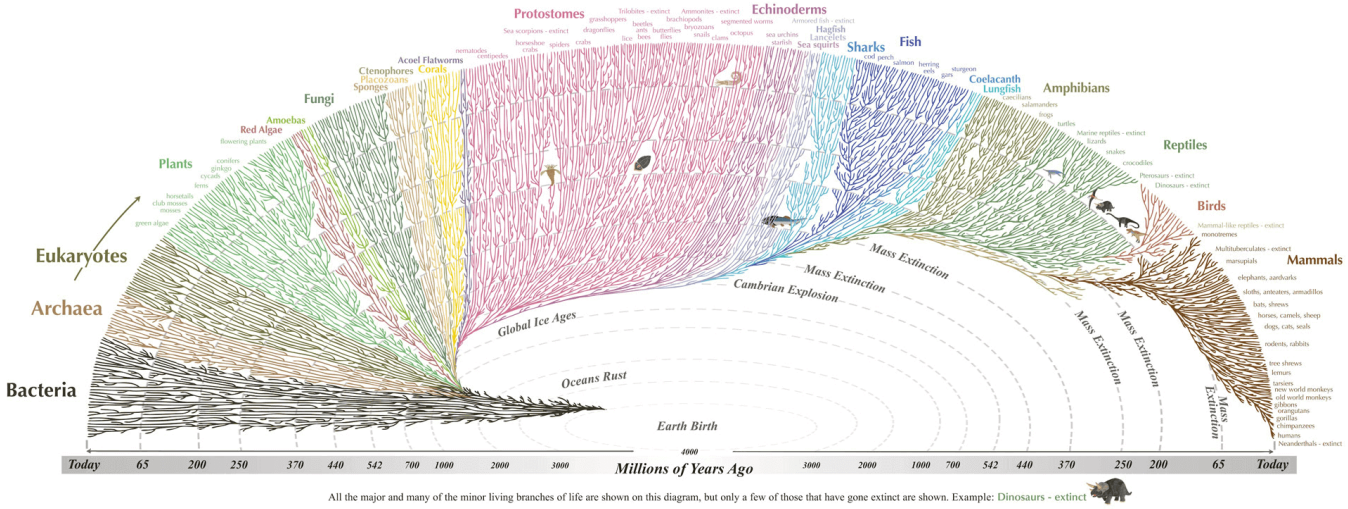
e. What did you learn from the reading that can help explain why humans and blue whales have shared body structures?

Task 2: Evolution SIM

LT: I can use a simulation to describe two different species with a shared body structure.

Paleontologists use evolutionary trees to make sense of the patterns of shared structures among species. Some of these visual representations are simple and some are more complex. Evolutionary trees can be even more complex when they try to incorporate the vast total of life on Earth.

The Great Tree of Life



This version of the tree shows you how complex a complete evolutionary tree would be to look at. Even this one is not entirely complete. Scientists often use simplified models to represent their ideas because they are easier to work with.

You will be finding living species that share a body structure of your choice.

1. vertebral column (Backbone)
2. jaws
3. limbs with digits (toes, for example)

Do:

1. Open the Sim: https://apps.learning.amplify.com/evolutionaryhistory/#/

2. Select Free Explore mode and press TREE to open Tree View.

3. Navigate through the evolutionary tree and press each of the "i" icons on the tree branches as you go.

4. Read the text from each icon until you find the "i" icon that has the body structure you are exploring.

5. Follow the tree branches to the right of this icon to find two living species that have this body structure.

6. Try to find species that are very different from one another by expanding branches of the evolutionary tree at the bottom of the screen.

Tips:

- The "i" icons are the orange and white circles with the letter "i" in the center.
- Navigate through the evolutionary tree by pressing on rows in the Tree Navigation window or by pressing the arrows in the main window.

a. Name the two species you found that share the body structure you explored.

b. Use the words in the word box to complete the following notes:

body structures	ancestors	descendants	a common ancestor population

Species inherit _____
from _____ .

If two living species have some of the same _____
this means that they are probably _____
of _____
that also had those _____ .

Task 3: Common Ancestors

LT: I can describe structural similarities among 3 species in order to consider what a common ancestor might have looked like.

From: Andre Mosley, Natural History Museum Director
To: Student Paleontologists
Subject: New Findings About the Mystery Fossil

We have finished putting the bones of the Mystery Fossil back together, and we found something amazing: The Mystery Fossil was pregnant when it died. A smaller fossil with structures just like the Mystery Fossil was found inside of the body of the Mystery Fossil.

I know you are working to decide where to place the Mystery Fossil in the museum and that you are using similar structures to help you decide where to place it. Maybe the fossil we found inside can help you decide what the Mystery Fossil is most similar to: whales, wolves, or crocodiles.

Whether a species gives live birth or lays eggs is something that is passed down from ancestor populations, just like body structures are passed down. In fact, special body structures are passed down to allow egg layers to lay eggs and to allow organisms that give live birth to do so.

These kinds of body structures are not always bone structures: As we've seen, there are many other kinds of body structures, too. For example, some body structures allow some organisms to produce milk, as we saw in the article "How You Are Like a Blue Whale."

The Mystery Fossil looks a lot like a crocodile, and it shares many similar body structures with crocodiles. It also shares many similar body structures with both whales and wolves.

However, it actually shares an important feature with whales and wolves that it does not share with crocodiles: The Mystery Fossil, the whale, and the wolf all have live births, while the crocodile does not. This suggests that the whale, the wolf, and the Mystery Fossil must have inherited live birth from the same ancestor population, which means that the Mystery Fossil shares an ancestor population with the whale and the wolf that is not shared by the crocodile.

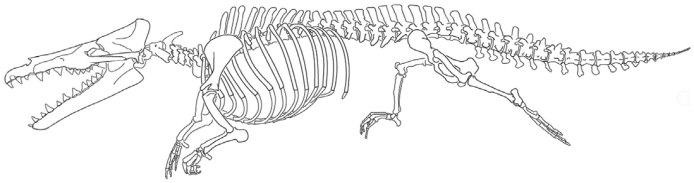
a.After this new finding, which claim can we refute?

- Claim 1: The Mystery Fossil belongs with the whales, in the Whale (Cetacea) exhibit.
- Claim 2: The Mystery Fossil belongs with the wolves, in the Carnivore (Carnivora) exhibit.
- Claim 3: The Mystery Fossil belongs with the crocodiles, in the Reptile (Reptilia) exhibit.

Name: _____ Date: _____

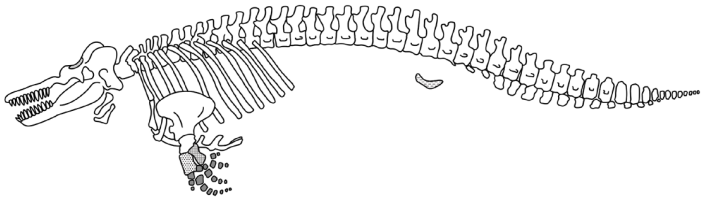
Comparing the Mystery Fossil to Whales and Wolves

Paleontologists look for shared body structures in different species. There are many different body structures and some of them can be difficult to find. Which of the body structures in the list can you find in each of the species below?



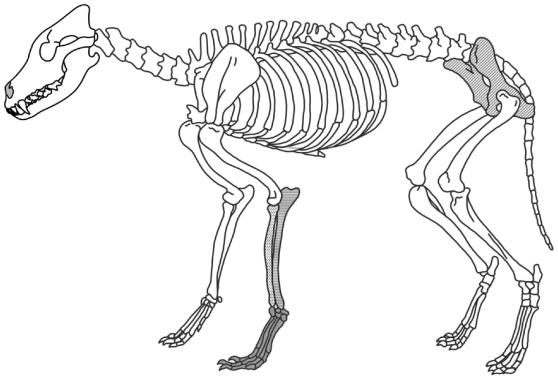
Select all the structures that the **Mystery Fossil** has:

- ☐ skull
- ☐ teeth
- ☐ neck bones
- ☐ "one, two, many" front limb structure
- ☐ rib bones
- ☐ backbone
- ☐ hip bone (pelvis)
- ☐ back limbs (legs)
- ☐ tail



Select all the structures that the **whale** has:

- ☐ skull
- ☐ teeth
- ☐ neck bones
- ☐ "one, two, many" front limb structure
- ☐ rib bones
- ☐ backbone
- ☐ hip bone (pelvis)
- ☐ back limbs (legs)
- ☐ tail



Select all the structures that the **wolf** has:

- ☐ skull
- ☐ teeth
- ☐ neck bones
- ☐ "one, two, many" front limb structure
- ☐ rib bones
- ☐ backbone
- ☐ hip bone (pelvis)
- ☐ back limbs (legs)
- ☐ tail

b. Which bone structures are similar between the Mystery Fossil, whale, and wolf?

c. How could two species that seem so different have so many shared structures?