

## Content Option 4: Ocean Mini-Lab

A Whale of a Tale activity from the MBARI EARTH lesson plans

Topics: Genetics and Marine Mammals

I used this lesson plan with my college preparatory students during our genetics unit. We had already explored the structure and function of DNA in the nucleus as well as genes, traits, and alleles. 53 students participated in the activity, although, many students failed to turn in completed packets. My students struggled with remaining on task and completing the assignment successfully. The intent of the project was to look at the Ocean literacy Fundamental Concept 6.G: Everyone is responsible for caring for the ocean. The ocean sustains life on Earth and humans must live in ways that sustain the ocean. Individual and collective actions are needed to collectively manage ocean resources for all as well as use mitochondrial DNA data to identify the whale involved in one of the three scenarios. I'll complete a modified version of this next year with more detailed instructions. Over the year, I have tried multiple group projects with similar outcomes. This year's students struggle with collaboration and remaining on tasks even with checklists. IN the future, I need to delegate tasks in the form of jobs for each student of a group. In this way each participant has their task to complete and an individual score as well as a group score. As written, this lesson needs more guided activities with gradual release of responsibility throughout the year to prepare them for this type of research and analysis.

I began the lesson with the WebQuest introducing the students to mitochondrial DNA. The students were able to complete Parts I and II of the WebQuest but could not complete Part III due to the New York Times article being blocked by our system and not approved as a resource by our school board. For part III, I substituted in the TEDED video: *The Genes You Don't Get from Your Parents (but Can't Live without)*. The WebQuest was completed independently by each student. The students were given notebook paper or the choice to use a word document on their iPads for completion. Many squished their answers onto the handout or didn't submit the WebQuest at all with multiple prompts. Those students who did complete the assignment. Were able to successfully answer the Level 1 and 2 low level questions. When it came to the How and explain your reasoning questions, the students struggled. Those who completed the TEDED substitution, which was more guided, were more successful. I had to laugh at some of the answers for What are mitochondria? For example: one student wrote: structures within cells that convert NRG. For question 2: Describe the structure of

mitochondrial DNA, one student wrote: about 16,500 base pairs which was only a fragment from the 2 paragraphs in Part 1.

Part 2: had 3 paragraphs to read and a really good diagram. Students answered half of several of the questions providing evidence in fragments that did not answer the questions fully.

Student samples Webquest

Available at <https://www.youtube.com/watch?v=H2158LLUCQ> or just youtube google TED-Ed Can't Live Without

True or false (circle one): Inside our cells, each of us has a second set of genes completely separate from the 23 pairs of chromosomes we inherited from our parents.

a. This second genome belongs to our mitochondria an organelle inside our cells.

i. Approximately 15 billion years ago scientists think a single-celled organism engulfed the mitochondria's ancestor, creating the predecessor of all multicellular organisms.

ii. What is the role of mitochondria? Explain.  
generate oxygen

iii. In mammals, mitochondria usually have 37 genes. In some plants, like cucumbers, mitochondria have up to 65 genes, and some fungal mitochondria have only 1.

1. This variety exists because mitochondria are still evolving, both in tandem with the organisms that contain them, and separately, on their own timeline.

2. In almost all species, mitochondrial DNA is passed down from only one parent; in humans and most animals, that parent is the mother.

3. How is the mitochondria replication process separate from our cells? Explain.  
Mitochondria replicate on its own separate process while cells do their own process.

4. The random selection of your mother's mitochondrial DNA you inherit at birth can change throughout your life and throughout your body.

5. What was the most interesting element regarding mitochondrial DNA that you learned from this TED-Ed video? Explain why.  
that the mitochondria's ancestor was originally a single cell organism which became separate.

### Part I: What is Mitochondrial DNA?

Go to the National Institute of Health's Genetics Home Reference Page on Mitochondrial DNA at: <https://ghr.nlm.nih.gov/mitochondrial-dna>

1. What are mitochondria?  
structures within cells that convert the energy from food into a form that cells can use
2. Describe the structure of mitochondrial DNA (mtDNA).  
DNA packaged in chromosomes
3. What types of genes are located on mtDNA, and how do these genes allow mitochondria to function?  
mitochondrial DNA they allow mitochondria to build proteins

### Part II: Why do Mitochondria have DNA?

Go to the Genetic Science Learning Center's Evolution of the Cell page at:

<http://learn.genetics.utah.edu/content/cells/organelles/>

4. How does the Endosymbiotic Theory explain the origin of mitochondria?  
When host cell and ingested bacteria could easily become dependent one on another for survival
5. How did the Endosymbiotic Theory get its name?  
because people when they talk benefit from things and works together
6. Explain how the meaning of the word "theory" in science is different from that in every day language.  
every day means opinion in science theory is a well established explanation supported by extensive experimentation and observations
7. What scientific evidence is there to support the Endosymbiotic Theory?  
A double membrane surrounds both mitochondria and chloroplast each was inherited by a primitive host

### Part III: Why Do We Inherit Mitochondrial DNA only from our Mothers?

Go to the New York Times article titled "Why Do We Inherit Mitochondrial DNA only from our Mothers?" at <http://www.nytimes.com/2016/06/24/science/mitochondrial-dna-mothers.html>

8. Both the unfertilized egg and sperm contain mitochondria, but the fertilized egg only contains the egg's mitochondria. What do scientists think happen to the sperm's mitochondria, based on their research in roundworms?
9. What is the role of the cps-6 gene in sperm cells?
10. Explain the hypothesis presented in the article for why mitochondria are consistently inherited from mothers, and not fathers, across so many animals.

Part 1

1. Mitochondria are structures within the cell that converts NA into food.
2. The Mitochondria is composed of a inner and outer membrane which is very similar to DNA but not the same.
3. Disease

Part 2

4. There is compelling evidence that the Mitochondria and Chloroplast were once primitive bacterial cell.
5. When one organism actually lives inside the other it's called endosymbiosis.
6. Theory is a well established explanation based on extensive experimentation and observation.
7. A double membrane surrounds both mitochondria and chloroplast, further evidence that each was ingested by a primitive host.

1. structures within cells that convert the energy from food into a form that cells can use
2. packaged in chromosomes within the nucleus, mitochondria also have a small amount of their own DNA. spans about 16600 DNA and 37 genes
3. Oxidative phosphorylation, they use oxygen and simple sugars, main energy source
4. There is compelling evidence that mitochondria and chloroplast were once bacteria cells
5. symbiosis occurs when a different species benefit from living and working together.
6. Theory is an opinion or idea someone has but doesn't have facts
7. the evidence is that the cell exist

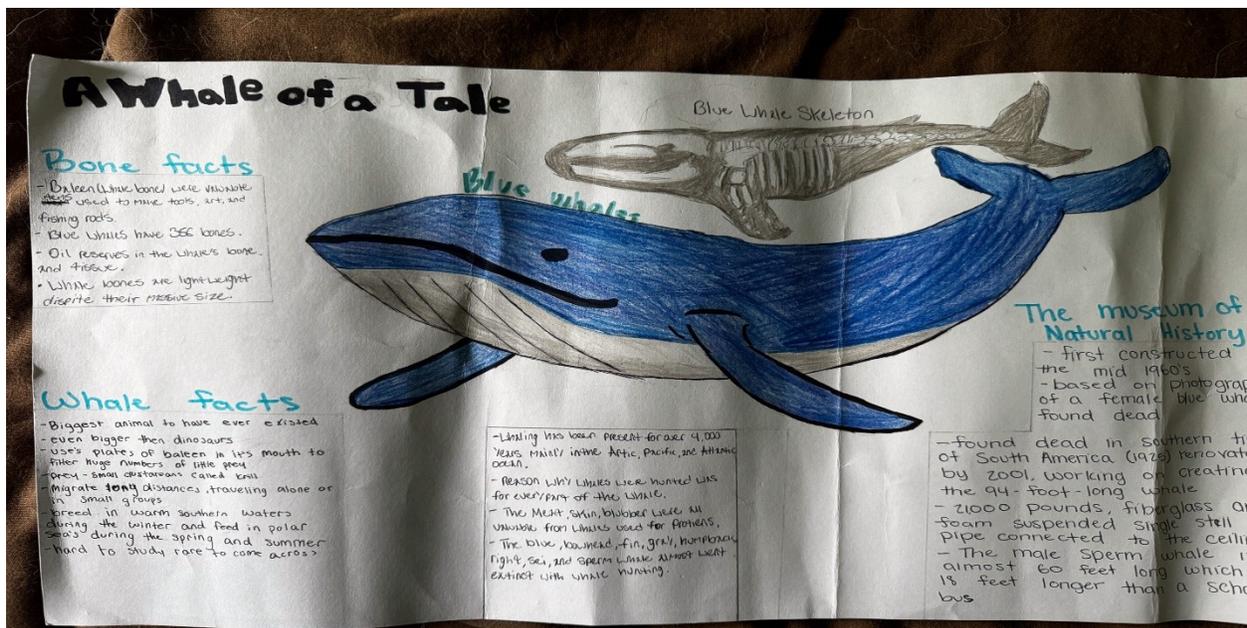
The following two days were our B/C days with double periods. The students were divided into groups of 3 or 4 students to complete this part of the lesson. When I worked through the lesson, I decided to add in an infographic about the scenarios instead of just having the students identify the mtDNA sequences and write a summary. One of my roles as a teacher is to know my students. Out of the 53 college preparatory students 2 will write a summary of more than 3 to 5 sentences. The rest struggle to write and support with evidence from their research. Once students were in their groups, I handed out the mtDNA sequences and instructed the students on how to use BLAST

to find the genus and species of the 4 whales. This was the easy part of the lesson and all but three students correctly identified the four whales. After the whales were identified, I went over the expectations for the research phase for the students to make a group infographic and also write their individual summaries. Each group was given one of the three scenarios. We went over OLFC 6.G. and discussed what it meant. Students watched the video clip from UNESCO about principle 6. Students were given guidelines for their infographics and told to divide the research amongst them to be able to complete the task in the allotted time frame of this double period and one more period on the next A Day, a 40 minute period. The infographic was to contain the following information:

- OLFC 6.G
- A summary of the scenario
- The whale that fit their scenario
- Details about their whale and why it fit their scenario.
- Graphs and tables about populations of their whale in and around the location of the scenario which included range maps.
- Any laws that were violated by their scenario, if applicable
- Why did the whale need to be correctly identified?
- Colored diagrams or images

Individual summaries needed a written summary of the above including why the other whales did not match their scenario.

Student samples of summaries and infographics:

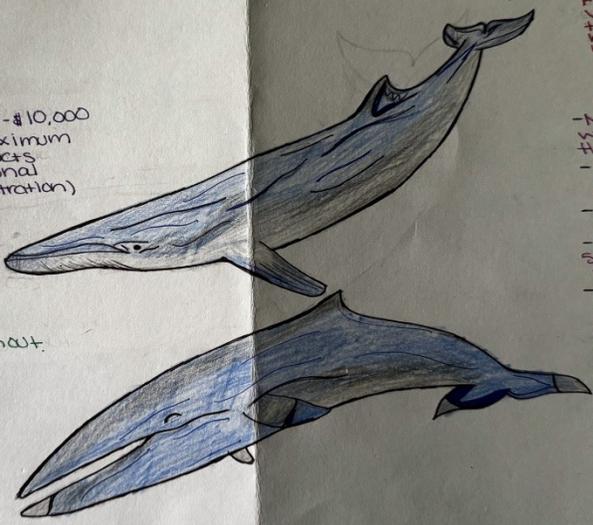


**Human Impacted:**  
 "The restaurant claims they were deceiving customers by passing off the much less expensive deer meat as whale meat which people say has a similar flavor."

**Laws Addressed:**  
 The Marine Mammal Protection Act of 1972 States:  
 Killing - \$3,500 - \$13,000  
 Wound / Injure / Hunt / Capture - \$2,000 - \$10,000  
 Import or Export - \$500 - Statutory Maximum  
 Import Marine Mammals or products made from them into U.S. NOAA (National Oceanic and Atmospheric Administration) Law.

**How You Can Help Marine Mammals**  
 - Report marine life in distress  
 - Keep your distance  
 - Report any violation  
 - Reduce speed and be on the lookout.

# MINKE WHALE



**Characteristics:**  
 In the picture its somewhat clear that it couldn't be a minke because of the big on of meat being displayed. It is in container labeled "whale". The meat apparently taste like venison (deer meat). From some sample of all whales it could still be a minke. To figure out which whale meat it could be sold at restaurant.

**Evidence:**  
 - Minke whales have a widespread distribution in the North Hemisphere.  
 - Found mostly in North Atlantic and Pacific Oceans.  
 - Whalers exploited Minke since 1930's.  
 - Commercial whaling started targeting Minke whales.  
 - Several thousand Minke whales have been hunted in the Northern Hemisphere.  
 - Today, whaling countries such as Greenland and Norway still take Minke whales for commercial and scientific research.

## Whale of a Tale

### Blue Whale

- Blue whales are endangered.
- Only 10,000-25,000 remaining.
- Size from 82-105 ft. long, weigh up to 200 tons.
- Largest animals ever known to live on Earth.
- Their brains alone can weigh as much as an elephant.
- Their hearts can weigh as much as a car.
- A single blue whale consumes about 4 tons of food a day.
- Blue whales have flippers that are suspended like wings attached to their upper jaw.
- They emit a series of pulses, clicks, and moans, and it's thought that blue whales can hear each other up to 1,000 miles away.

### Humpback Whale

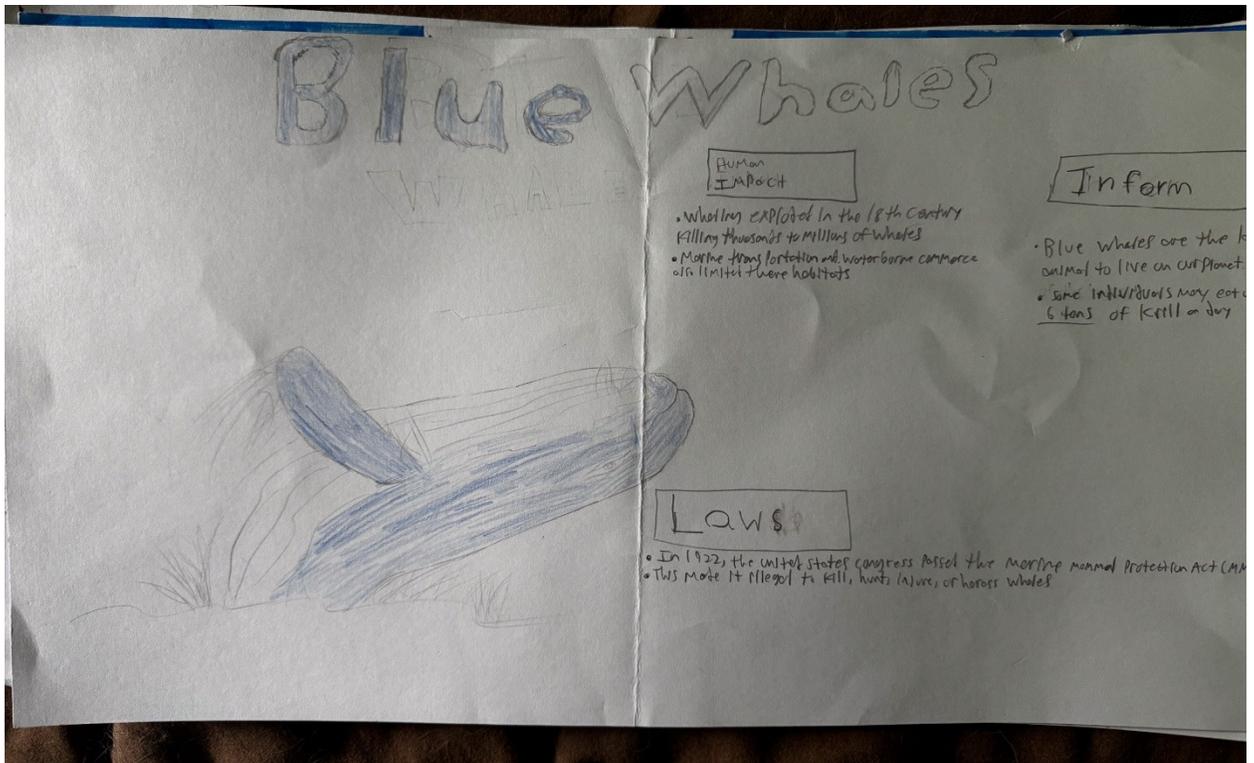
- Humpback whales are endangered.
- Only 85,000-120,000 remaining.
- Grow from 45-62.5 ft. long, weigh up to 40 tons.
- Their pectoral fins can grow up to 16 ft. long.
- Dark backs, light bellies, pleats on their throats, and a small hump in front of their dorsal fins.
- Known for their songs.
- Sequences of moans, howls, cries, and other noises continue for hours on end.
- Humpback whales are found along coastlines, feeding on krill, plankton, and small fish.
- First found along the coast of New England.

### Fin Whale

- Fin whales are endangered.
- Only 50,000-90,000 remaining.
- Grow up to 20 ft. and weigh up to 80 tons.
- Distinct ridge along their back, which gives them the nickname "razorback".
- Lower right jaw is white and the lower left jaw is black.
- Circles fish with the white side showing to frighten the prey into denser schools which makes it easier to catch.
- The fin whale shows its food from the water through baleen plates.
- The majority of their meat ends up in Japanese markets, which it then could be sold to the US.

| Scientific Name               | Common Name    |
|-------------------------------|----------------|
| <i>Balaenoptera musculus</i>  | Blue Whale     |
| <i>Megaptera bovine</i>       | Humpback Whale |
| <i>Balaenoptera physalus</i>  | Fin Whale      |
| <i>Balaenoptera acronotus</i> | Minke Whale    |

**Summary**  
 The reason we picked these 3 whales is because they are all endangered and all could be transported to the US. Another reason is because they all eat krill when the restaurant labeled the container as to maybe cover it up.



### Conclusion:

Write a paragraph explaining the significance of your findings in relation to your scenario.

The significance of our findings is that we are able to identify the types of whale bones found in the area. Through the amounts of whales dropping, we found that that is similar to the whale populations dropping in the scenario. We even found some of the same whales in our research that we did in the scenario. It shows that the whales we found in our research of the DMT are the types of whale bones found in the graveyard and it was highly possible that the surrounding area could have been used as a stop for whale hunters before the Marine Mammal Act was passed.

**Conclusion:**

Write a paragraph explaining the significance of your findings in relation to your scenario.

Each of the sequences relates to some sea mammal mainly whale. It revolves around the devastating impact and overall lasting effect whaling had on our ecosystem. Whaling began its popularity in the mid 1700s and continued to the 1900s. Which led to various advancements to continue the hunt for more whales. Until the late 1900s the International Whaling Commission (IWC) was established making a law to stop whaling. Due to 8 species of whale becoming endangered causing the US to outlaw the sport. It took too many years for people to give hunting whales so it's our job to secure their safety.

**Conclusion:**

Write a paragraph explaining the significance of your findings in relation to your scenario.

Whale population plummeted while hunting was permitted. However, after it was banned, they've steadily been increasing.