

9-12 Marine Mammals Activity

Overview

Focus Question

How can we distinguish between marine mammal species?

Activity Synopsis

Students will use a dichotomous key to distinguish between marine mammal species based on external characteristics. They will also research and learn about the unique adaptations marine mammals have to help them survive.

Time Frame

One 60 minute session

Objectives

The learner will be able to:

- Use a dichotomous key to determine marine mammal species
- List the three orders of marine mammals and provide a species from each order
- Describe the difference between suborder Mysticeti & suborder Odontoceti
- Explain two unique adaptations of marine mammals that allow them to live in the water

Student Key Terms

- Adaptation
- Baleen
- Blubber
- Brackish water
- Dorsal
- Echolocation
- Endothermic
- Extinct
- Marine mammal
- Melon
- Upwelling
- Vertebrate

Teacher Key Terms

- Callosities
- Carnivora
- Cetacea
- Critically endangered species
- Fissipeds
- Mysticeti
- Odontoceti
- Pinnipeds
- Sirenia
- Thermoregulation
- Tributaries

Standards

South Carolina College- and Career-Ready Science Standards 2021

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Biology: B-LS1-3, B-LS4-1, B-LS4-3, B-LS4-4

* **Bold standards are the main standards addressed in this activity**

Biology Performance Expectations

B-LS1-3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

B-LS4-1 Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.

B-LS4-3 Apply concepts of statistics and probability to support the explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.

B-LS4-4 Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

Cross Curricular Standards

South Carolina College and Career Standards for ELA

Inquiry (I) – 2.1

Communications (C) – 1.1

Background

Key Points

Key Points will give you the main information you should know to teach the activity.

- Marine mammals are **endothermic** (warm blooded) **vertebrate** animals that give live birth, breath through lungs, have hair and feed young with milk.
- **Marine mammals** include animals from the
 - Order **Cetacea**: suborder **Mysticeti** (baleen whales: humpback whale) & suborder **Odontoceti** (toothed whales: orca)
 - Order **Sirenia** (sea cows: manatee)
 - Order **Carnivora**: suborder **Pinnipedia** (flipper-footed: seals/sea lions) & suborder **Fissipedia** (paw-footed: sea otters/polar bears)
- There are over 100 species of marine mammals found throughout the world. The list is constantly changing as new species are discovered or species become **extinct**.
- Marine mammals are found in every type of water (salt water, fresh water and **brackish water**) and all around the world.
- Marine mammals have many unique **adaptations** that help them to survive in their environment.
- Protecting these animals involves understanding their worldly distribution and feeding.

Detailed Information

Detailed Information gives more in-depth background to increase your knowledge, in case you want to expand the activity or you are asked detailed questions by students.

Marine mammals, like all mammals, are **vertebrates** (have a backbone) with the following characteristics:

- Warm-blooded
- Breathe air
- Give live birth
- Nurse young with milk
- Have hair

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What separates marine mammals from other mammals is that they live in or by the ocean.

Marine mammals are **endothermic** or warm-blooded. This means that their body temperature is kept at a constant and not controlled by their environment. They are air breathers, using lungs to breathe. Some species of marine mammals have a blow hole/s, an adaptation that allows them to breathe more efficiently at the surface of the water. Marine mammals have internal fertilization, resulting in a baby through live birth that was nourished by a placenta while in the womb. Mother marine mammals will nurse their young and take care of them for up to a few years, depending on the species. All marine mammals live in the ocean with a few exceptions, such as the river dolphins. Some species, like the bottlenose dolphin, also have the ability to live in **brackish water**, where salt and fresh water mix. Some marine mammals like those within the order Carnivora have hair for their entire life, while others like order Cetacea may only have hair as a newborn that quickly falls out.

Taxonomy

Taxonomy is the division of biology that systematically classifies organisms. The levels, or taxa, of taxonomy are Kingdom, Phylum, Class, Order, Family, Genus and Species. Marine mammals are found in the Kingdom Animalia, Phylum Chordata and Class Mammalia. There are over 5000 species with 26 orders in the Class Mammalia. Marine mammals are mammals that spend their lives in saltwater (a few species are found in rivers). There are over 100 species of marine mammals within three orders. Not all taxonomists agree on the exact placement of these animals within the taxonomic structure, so it can get quite confusing. Marine mammals also don't all have a common ancestor. What unites them is their reliance on saltwater for food and shelter. We are going to use the following taxonomic structure to explain marine mammals. You may find this information organized differently or with slightly different names in other resources.

Marine mammals include animals from three orders: **Cetacea**, **Carnivora**, **Sirenia**. The order Cetacea, the whales, dolphins and porpoises, includes about 89 living species. This order is divided into two suborders: **Mysticeti** and **Odontoceti**. Mysticeti are **baleen** whales such as humpback and North Atlantic right whales. Odontoceti are toothed whales such as dolphins and orcas. Order Carnivora is divided into many suborders, including over 280 placental mammal species. Two of the Carnivora suborders have marine mammals including about 35 species. Those are **Pinnipedia** or 'flipper-footed' that includes seals and sea lions and **Fissipedia** or 'paw/pad-footed' including polar bears and sea otters. The order Sirenia or 'sea cows' comprises two aquatic, herbivorous families, the Dugongs and Manatees, and there are only four living species.

Order Cetacea (89 species)

- Suborder Mysticeti (baleen whales: humpback whales)
- Suborder Odontoceti (toothed whales: dolphins)

Order Carnivora (280 total, 35 marine mammal species)

- Suborder Pinnipedia (flipper-footed: seals/sea lions/walrus)
- Suborder Fissipedia (paw-footed: sea otters/polar bears)

Order Sirenia (4 species)

- Manatees
- Dugongs

There are around 100 species of marine mammals found throughout the world. The list is constantly changing as new species are discovered, reclassified or become **extinct**. Marine mammals can be found in all of the world's oceans and in all types of water, but the vast majority live in saltwater.

Adaptations

Marine mammals are well adapted to life in the ocean. They have many behavioral and physical adaptations (body parts) that allow them to successfully live in the ocean. These physical adaptations help them live in cold water, hold their breath for long periods of time, **thermoregulation**, swim fast, conserve water and hunt successfully in cold, dark or turbid (murky) waters. Some behavioral adaptations include **echolocation**, site specific feeding behaviors and adapted ways to sleep, or rest, while staying active.

Thermoregulation - One way that most marine mammals maintain their body temperature is through a thick layer of **blubber**. Blubber is a unique, thick layer of connective tissue found right below the skin and contains lipids (fats) and collagen (proteins). Blood vessels within blubber constrict in cold water, which helps conserve heat. Another way all marine mammals stay warm is through countercurrent heat exchange, where heat from the arteries is transferred to the veins. The arteries and veins are close together so heat can be transferred. Finding an equilibrium is a goal of nature so heat travels from high to low zones; therefore, heat from a warm artery will be transferred to a cool vein that is close-by. Arteries bring warm oxygen-rich blood from the heart to the rest of the body whereas veins bring cooler blood back to the heart to receive more oxygen.

Breathing adaptations - One would think marine mammals would have large lungs to hold more air, but in reality most marine mammals have small lungs that work more efficiently. When humans breathe we exchange 10-20% of the oxygen in our lungs in a single breath. Compare this to bottlenose dolphins who exchange 80% of their oxygen in a single breath. Additionally, marine mammals have high blood volume and more red blood cells, which increases their oxygen carrying capacity. Deep diving marine mammals have an amazing adaptation that allows them to survive under immense pressure for example the Sperm Whale can dive up to 2,250 meters where its ribs and lungs actually collapse under pressure.

Swimming adaptations - Another breathing adaptation that creates efficient swimming is the blowhole found on cetaceans. This allows cetaceans to exchange gases at the surface of the water quickly and efficiently when swimming. The blowhole is located on the **dorsal** (back) side of the animal. When their dorsal side breaks the water they can breathe while keeping most of their body underwater. Odontoceti species have one blowhole while Mysticeti species have two blowholes. All marine mammals also have a hydrodynamic body plan with modified appendages that reduce drag and increase propulsion within the water.

Water conservation - Most marine mammals do not drink water as other animals do. Instead they receive freshwater from the food they eat as well as from their blubber supply. Another adaptation that reduces the amount of freshwater needed are their kidneys. Marine mammal kidneys are adapted to make very salty urine, it is saltier than the saltwater they live in.

Sensory adaptation - Suborder Odontoceti, or toothed whales, communicate and locate their prey in a unique way. They use echolocation to speak to each other and also to hunt. In echolocation, these marine mammals send out sound waves which hit and come back to the marine mammal. This echo of the original sound wave is how they can tell how far away a prey item may be. Marine mammals use their **melon**, a part of their forehead, to focus the outgoing sound waves towards a specific area while their lower jaw acts as the receiving dish for returning sound waves. Pinnipeds use their very sensitive whiskers for exploring and hunting. The whiskers pick up on small vibrations in the water that helps the pinniped find its food.

External Anatomy

Marine mammals have unique external anatomy that help researchers to identify different species and individuals. External anatomical features on cetaceans include the beak/rostrum, blowhole, dorsal fin, and fluke. The rostrum is the upper jaw of the cetacean and is shaped differently depending on how the animal feeds. If the animal is in the Suborder Mysticeti, the rostrum is large and shaped like an arch to support the baleen they use for food capture. If the animal is in the Suborder Odontoceti, the rostrum is crescent shaped and designed to help them catch food with their teeth. The blowhole can be found on the dorsal (back) side of the animal and is used to exchange gases. Odontoceti species have one blowhole while Mysticeti species have two blowholes. The dorsal fin has different functions and prominence in different species. For dolphins, orcas, and porpoises their dorsal fin helps them to stay hydrodynamic. In blue whales and sperm whales, their dorsal fins have been highly reduced and in some cases have fully disappeared. In belugas, the dorsal fin has become a dorsal crest which is used to help them break through the ice in their habitat. Each dorsal fin has a unique blend of markings, scars, notches, and other characteristics that make easier to identify an individual. Scientists use these unique patterns to identify individuals through the noninvasive Photo Identification technique. Photo identification is when a high quality photo is taken of an animal and it is cataloged into a database. The last external anatomical feature is the fluke or tail. The cetacean fluke is set horizontally on the body, unlike a fish tail, and is used for propulsion through the water. The size and shape of the fluke can be used to identify different species of cetaceans. It can also be used to identify individuals through photo identification studies.

Notable anatomical features on pinnipeds (seals, sea lions, and walruses) include the ears and flippers. Pinnipeds are can be divided into three groups the Phocids, earless seals, the Otariids, eared seals, and the Odobenids, walruses. All three have streamlined bodies that allow them to move quickly through the water. However, unlike the cetaceans their flippers are also designed to bring them up on a land. Phocids, have ear holes along their head, but no external ear flaps. They are more graceful in the water using their rear flippers like a fish tail to propel themselves. On land, they move by flopping around on their bellies. The Otariids, which include the fur seals and sea lions, have external ear flaps giving them their name of eared seals. On land, they can pull all four flippers underneath their bodies and walk on them. The Odobenids have large tusks, no external ear flaps, and can pull their flippers underneath their body to walk on land.

Procedure

Materials

- [Activity Presentation](#)
- [Adaptations Web Search](#)
- [Adaptations Web Search Answer Key](#) (Teacher Only)
- [Marine Mammal Dichotomous Key](#)
- [Species Identification Cards](#)
- [Species Identification Answer Key](#) (Teacher Only)
- Journals/Notebooks/Piece of paper
- Writing utensils
- Computer/tablet
- Internet connection

Procedure

1. Start by using the Activity Presentation to go over general information.
2. Make sure all students understand the characteristics of a mammal (vertebrates, air breathers, warm-blooded, live birth, fur and milk for young).
3. Go a step further to explain to them that marine mammals are mammals that live in saltwater (a few live in freshwater) and are divided into three Orders (Cetacea, Carnivora and Sirenia) and explain the ways in which the three orders differ from one another.
4. Introduce the concept of adaptations (physical or behavioral trait that helps an animal survive) and explain that they will be learning more about marine mammal adaptations by completing a web search.
5. Give each student or student pair an Adaptations Web Search worksheet to complete.
6. After they complete the web search, ask students to explain a few of the adaptations they learned about. Then return to the Activity Presentation to introduce a few more unique adaptations of marine mammals.
 - Ask the students why marine mammals have so many varied adaptations and which one is the most important. Have them answer these journal prompts in their journal/notebooks/piece of paper.
7. After they complete the journal prompts, review the external anatomy of marine mammals. Let the students know that each species is different and this can be seen by looking at the external features of the marine mammal.
8. Give each student one marine mammal species from the list on slide 15 (bottlenose dolphin, orca, harbor seal, sea lion, North Atlantic right whale) and draw it in their journal, labeling its physical features and their corresponding adaptations

(for

example - melon for echolocation). Students should pick physical features and adaptations from a word bank on slide 15.

9. Briefly go over a few of your student's drawings, picking a different marine mammals each time and emphasize the physical traits and adaptations. Explain that the physical traits help distinguish between species. Pictures can be found on slide 16.

10. Let the students know that they are going to use pictures of marine mammals to distinguish between species using a dichotomous key. Give each student a Marine Mammal Dichotomous Key.

11. Go over how to use a dichotomous key with the students (this should be a review from middle school). Tell them it's like a choose your own adventure book, where they will be offered 2 options and by picking the right answer it will take them to another 2 options and so forth until they get to the final answer (the correct species).

12. To practice using a dichotomous key read the script below about a marine mammal sighting (told by a fisherman).

"Well, here is what I can tell you about the sighting. It was a sunny, brisk day out there on the Atlantic Ocean. We were out fishing for some grouper when out of nowhere a massive figure came up to the surface. It was very odd because it didn't have teeth, at least teeth you would see on a dolphin. And another thing that was strange was the animal didn't have a fin on the back- it didn't have a dorsal fin! It was a very odd animal and we couldn't figure it out."

This would be a way for student to use the dichotomous key to figure out that the fishermen saw a North Atlantic Right Whale. (1. Does your mammal have teeth? If No- go to 10; 10. Does your mammal have a dorsal fin? If no, you have a marine mammal J = North Atlantic Right Whale)

13. Now that your students have an idea on how to use the dichotomous key. Give each student (or a small group of students) a set of Species Identification Cards. When they figure out the marine mammal species, have them label it by letter.

- You could set this up as a lab by cutting the cards apart, laminating them and setting them around the classroom making 10 stations (each with a Dichotomous Key). Then students could rotate through and record their answers on a piece of paper numbered 1-10.
- You could also reinforce knowledge with a game by splitting class into two teams and one team will hold up the species identification card and the other team will have 30 seconds to work together to identify it. A bonus point can be given if a unique, un-used adaptation (behavioral or physical) can be given.

14. Once they are done, check their answers as a class using the answer key.

Follow-up Questions

- What marine mammal adaptations have inspired human technological advances? Could introduce biomimicry (echolocation – sonar).
- How do scientists create dichotomous keys? How long does it take?

At-home Learning and Virtual Modifications

At-home Learning: Have students explore our marine mammal wakelet: <https://wke.lt/w/s/mUsu3N>

This wakelet includes an introduction to marine mammals by Palomar College, the introductory powerpoint, and two worksheets. The first, will have students complete web search to learn more about marine mammal adaptations. The second will have them use a dichotomous key to identify different species of marine mammals. Have students send you the completed worksheets.

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- [Marine Mammals Adaptation Web Search](#)
- [Marine Mammals Adaptation Web Search Answer Key](#)
- [Marine Mammals Identification Worksheet](#)
- [Marine Mammals Identification Worksheet Answer Key](#)

Virtual: Use the following nearpod information to choose how to teach this activity. Activity will cover the unique adaptations marine mammals have and allow them to identify marine mammals using a dichotomous key.

[Teacher led lesson without student interaction](#)

Teacher led lesson with student interaction - directions

1. Create a free nearpod account (<https://nearpod.com/>)
2. Ask Aquarium to send you Marine Mammals nearpod link (email education@scaquarium.org)
3. After you receive Aquarium link, add lesson to your nearpod activities by clicking "Add to My Library"
4. Send to students using Live Participation
5. You'll be able to see their answers and interactions

Assessment

Give students the [Marine Mammal Assessment Worksheet](#) and the [Marine Mammal Dichotomous Key](#). They should be able to describe two marine mammal adaptations and determine the two species using the dichotomous key. Use this [Marine Mammal Assessment Worksheet Answer Key](#) to grade.

Scoring rubric out of 100 points

Correctly describe 3 characteristics of marine mammals:	10 points each (30 total)
Correctly name 1 swimming adaptation and its importance:	10 points
Correctly name 1 sensory adaptation and its importance:	10 points
Correctly identifies marine mammal for #4 and #5:	10 points each (20 total)
Correctly explains why they chose the answers for #4 and #5:	10 points each (20 total)
Correctly describes why scientists need to identify:	10 points

Cross-Curricular Extensions

STEAM Extension

Have students design (draw/collage/paint/etc.) a new marine mammal. In their design, they should include 5 adaptations and descriptions of how the adaptations help the animal to survive. Students can then present their animals to others on a gallery wall and students can vote for the best animal.

STEAM Extension

Have groups create models of marine mammal adaptations using common items.

Resources

Teacher and Student Reference Books

Gubbins, Cara M. *The Dolphins of Hilton Head: Their Natural History*. University of South Carolina Press, Columbia, SC, 2002.

Jefferson, Thomas A., Marc A. Webber, Robert L. Pitman and Uko Gorter. *Marine Mammals of the World: A Comprehensive Guide to Their Identification*. Academic Press, Amsterdam, 2015.

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Leatherwood, Stephen and Randall R. Reeves. *The Bottlenose Dolphin*. Academic Press, San Diego, CA, 1990.

Mann, Janet, Richard C. Connor, Peter L. Tyack, and Hal Whitehead. *Cetacean Societies: Field Studies of Dolphins and Whales*. University of Chicago Press. Chicago, IL, 2000.

Pearce, Agustin G. and Lucia M. Correa. *Dolphins: Anatomy, Behavior, and Threats*. Nova Science Publishers, Inc., Hauppauge, NY, 2010.

Pryor, Karen and Kenneth S. Norris. *Dolphin Societies: Discoveries and Puzzles*. University of California Press, Berkeley, CA, 1998.

Reynolds III, John E., Randall S. Wells and Samantha D. Eide. *The Bottlenose Dolphin: Biology and Conservation*. University Press of Florida, Gainesville, FL, 2000.

Reynolds III, John E. and Sentiel A. Rommel. *Biology of Marine mammals*. Smithsonian Institution, Washington, D.C., 1999.

Ridgway, Sam H. and Richard Harrison. *Handbook of Marine Mammals, Vol. 6, the Second Book of Dolphins and Porpoises*. Academic Press. San Diego, CA, 1999.

Samuels, Joshua B. *Dolphins: Ecology, Behavior, and Conservation Strategies*. Nova Science Publishers, Inc., Hauppauge, NY, 2014.

Teacher and Student Reference Websites

Animal Diversity Web: Mammals

<https://animaldiversity.org/accounts/Mammalia/>

This site gives a great background on the Class Mammalia.

The Marine Mammal Center

<http://www.marinemammalcenter.org/education/marine-mammal-information/>

A great place to read over the taxonomic structure of marine mammals.

Voices in the Sea

http://cetus.ucsd.edu/voicesinthesea_org/index.html

Great site for species information, sounds/calls, videos, games and more. Their distribution maps are amazing and referenced within this activity.

The Marine Bio Conservation Society

<http://marinebio.org/oceans/marine-mammals/>

Lots of background information on marine mammals.

Sea Grant Alaska

<https://seagrant.uaf.edu/marine-ed/mm/fieldguide/adaptations.html>

List of marine mammals adaptations.

Online Curricula

Dolphin Research Center

https://dolphins.org/groups_curriculum

Exploring Our Fluid Earth, University of Hawaii

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<https://manoa.hawaii.edu/exploringourfluidearth/biological/mammals/introduction-mammals>

Project Aquatic WILD

<https://www.fishwildlife.org/projectwild/aquatic-wild/activity-resources-aw>

Wild Animal Watch: Dolphins Teacher's Guide

<https://www.scholastic.com/teachers/lesson-plans/teaching-content/wild-animal-watch-dolphins-teachers-guide/>

Videos

Wildlife Survivors: A Tale of Two Turtles/Dolphins in Danger

National Geographic: Dolphins Even Smarter Than You Thought

<https://video.nationalgeographic.com/video/0000014c-1541-d376-a97f-d569098a0000>

Nature: Whales & Dolphins

<https://www.pbs.org/wnet/nature/group/mammals/whales-dolphins/>

Virtual Learning Opportunities

Pacific Marine Mammal Center

<https://www.pacificmmc.org/distance-learning/>

Alaska SeaLife Center

https://www.alaskasealife.org/distance_learning