



U.S. Department of Commerce  
National Oceanic & Atmospheric Administration  
National Marine Fisheries Service

## Lesson 20: Vertebrates II

### Overview

Lesson 20 provides an overview of marine mammal taxonomy including cetaceans and pinnipeds. The lecture presents the characteristics of common mammalian orders and provides some examples of each. In the activity, students use a dichotomous key to identify nine marine mammals.

### Lesson Objectives

Students will:

1. Identify the defining characteristics of the class Mammalia
2. Describe the common characteristics of major mammalian orders
3. Use a dichotomous key to identify species

### Lesson Contents

1. Teaching Lesson 20
  - a. Introduction
  - b. Lecture Notes
  - c. Additional Resources
2. Teacher's Edition: Identifying Marine Mammals
3. Student Activity: Identifying Marine Mammals
4. Student Handout
5. Mock Bowl Quiz

## Standards Addressed

**National Science Education Standards, Grades 9-12**

*Life science*

*Science in personal and social perspectives*

**Ocean Literacy Principles**

*The ocean supports a great diversity of life and ecosystems*

**DCPS, High School Biology**

*B.7. As a result of the coordinated structures and functions of organ systems, the internal environment of the mammalian body remains relatively stable, despite changes in the outside environment*

## Lesson Outline<sup>1</sup>

### I. Introduction

This lesson focuses primarily on marine mammals. One important characteristic of mammals is their maintenance of constant conditions within their bodies even when ambient conditions change, a feature known as **homeostasis**.

Introduce this concept by asking students to think about ways that their bodies work to maintain constant conditions. Temperature may be one variable that students find relatable. Ask them to describe what happens when they are in a very cold or very hot environment. They may mention some common ways that their bodies regulate their internal temperature including shivering, getting goose bumps or sweating. All mammals, including those that live in the ocean, have functions within their bodies to maintain constant internal temperature, pH, blood pressure and all sorts of other variables. The lecture will present some of the ways that marine mammals are adapted to maintain homeostasis.

### II. Lecture Notes

Use the PowerPoint for Lesson 20 (File:Lesson 20 – Vertebrates II.ppt) to present the following information. Distribute the Student Handout before you begin for students to take notes on key information.

*Warm-blooded animals (slide 3)*

1. Mammals are warm-blooded, which means they maintain a constant body temperature through behavioral or physiological mechanisms.

*Heat loss is high in the ocean (slide 4)*

1. Heat loss in the water occurs faster than in the air.
2. Countercurrent heat exchange helps mammals maintain constant temperature.
3. Countercurrent heat exchange occurs when veins (the two smaller blue arrows on the slide) in the body run adjacent to an artery (the larger blue arrow). The artery carries warm blood from the core of the body, while the veins carry cool blood from the body's extremities. At the point where the veins and artery are adjacent to one another, heat from the artery transfers to the cooler veins (depicted by the small red arrows), helping marine mammals maintain warm body temperature.

### III. Additional Resources

1. NOAA marine mammal explorations  
<http://oceanexplorer.noaa.gov/explorations/03trench/mammals/mammals.html>

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<sup>1</sup> Unless otherwise indicated, all websites provided or referenced in this guide were last accessed in November 2010.

## Identifying Marine Mammals

### Overview

In this activity, students use a dichotomous key to identify nine marine mammals including seal, sea lion and whale species. NOAA's Office of Protected Resources offers information on marine mammal taxonomy that may be useful for you or your students as background to this exercise. Follow the link below to the main mammal taxonomy page. There, you can choose links for cetaceans (whales, dolphins and porpoises) or pinnipeds (seals and sea lions) to find more information on particular species:

<http://www.nmfs.noaa.gov/pr/species/mammals/>

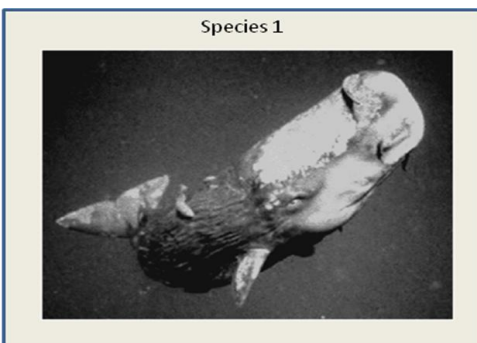
An excellent alternative activity on whale identification can also be found at the Smithsonian Education website below:

[http://www.smithsonianeducation.org/educators/lesson\\_plans/whale/index.html](http://www.smithsonianeducation.org/educators/lesson_plans/whale/index.html)

### Background

In this activity, your students play the role of marine biologists at NOAA. Students are presented with scenarios in which their friends and coworkers seek help identifying marine organisms they see. Students will read a list of scenarios below and answer the accompanying questions. To identify the marine mammals, students should use the dichotomous keys provided: one for cetaceans (whales, dolphins and porpoises) and one for pinnipeds (seals, sea lions and walruses). A dichotomous key is a systematic guide to species identification. First, students should read the two options under number one. Then, they should choose the option that best describes the marine mammal they are identifying and skip to the number indicated. They should continue until they have identified the organism. Students may also use information from the lesson's PowerPoint to answer the questions.

### Answer Key



1. Your colleague brings you a picture of a whale (Species 1) captured during a deep sea expedition. The whale was spotted at about 1,000m under the sea, far from the coast and was about 40ft long. She noticed that there was no baleen structure on the whale's mouth. Loud clicking noises were heard while the mammal was being observed. Use the dichotomous key for cetaceans to identify the whale, then answer the questions below<sup>2</sup>.

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<sup>2</sup> Photo: NOAA (F. Nicklin)

<http://swfsc.noaa.gov/textblock.aspx?ParentMenuId=230&id=1427>

1a. What type of whale is in the picture?

**Sperm whale as evidenced by its appearance (no baleen, jaw well below tip of snout), its location (deep and far off-shore) and its characteristic clicking noises.**

1b. Which Order and Suborder does it fall under?

**Order Cetacea and Suborder Odontoceti.**

1c. Your colleague tells you that she thinks krill is the main part of this whale's diet. Do you agree? Explain why or why not.

**Baleen whales eat krill and small fish. The sperm whale is a toothed whale, not a baleen whale. Like other toothed whales, the sperm whale is a predator and its diet probably consists mainly of squid, octopus and fish.**

1d. Is this animal more closely related to a bottlenose dolphin or a humpback whale?

**The sperm whale is more closely related to the bottlenose dolphin. They are both in the sub-order Odontoceti (toothed whales), whereas the humpback whale is in the suborder Mysticeti (baleen whales).**

2. A friend brings back some pictures of a whale that he took while boating. The picture on the left shows the whale breaching. In a close-up view, you could see bumps on its flippers and jaws and parallel grooves on its throat. The picture on the right shows a close-up of its mouth, which contains a bristle-like structure. Take a look at his pictures (Species 2a and 2b) and use the dichotomous key to identify the animal and answer the questions<sup>3</sup>.



<sup>3</sup> Photo (Species 2a): NOAA

[http://www.noaanews.noaa.gov/stories2008/20080128\\_sanctuary.html](http://www.noaanews.noaa.gov/stories2008/20080128_sanctuary.html)

Photo (Species 2b): NOAA

[http://www.aquariumofpacific.org/onlinelearningcenter/full\\_description/humpback\\_whale/P1/](http://www.aquariumofpacific.org/onlinelearningcenter/full_description/humpback_whale/P1/)

2a. What type of whale is this?

**It is a humpback whale. You can tell by the presence of baleen (the bristle-like structure in the mouth), the parallel grooves on its throat and its long flippers.**

2b. What is the function of the comb-like structure visible in the photo of Species 2b?

**The structure is called baleen. It acts as a filter that traps food like phytoplankton and small fish.**

3. Real Life Event: In 2006, a massive cargo ship struck and killed a rare whale and dragged it into Baltimore Harbor. Scientists from NOAA Fisheries Service, Baltimore Aquarium, Maryland Department of Natural Resources and several other organizations examined the whale. As a NOAA biologist, you are called to the scene to help identify the whale. Read the known information and examine the pictures below (Species 3a and 3b). Use your dichotomous key to identify the whale<sup>4</sup>.



Known information about the whale:

- Baleen whale
- Body was dark grey with white patches underneath closer to the mouth
- Dorsal fin present though small and considerably curved
- Flippers and flukes had dark undersides
- An analysis of stomach contents indicated it had eaten several types of zooplankton (microscopic marine animals), including shrimp and small fish

<sup>4</sup> Photos for Question 3 courtesy of NOAA's National Marine Fisheries Service



3a. What type of whale is this?

**The whale is a sei whale, which can be identified by the fact that it is a baleen whale, has a small dorsal fin and with small, curved pectoral fins that lacks white on its baleen (except for a white fringe) or fins.**

4. Your coworker recently returned from an expedition and shares with you the two photos below. He believes the mammals in both pictures are both dolphins and wants help identifying their species names. Look at the photos of Species 4 and Species 5 and answer the questions<sup>5</sup>.



4a. Do you think that your coworker is correct that both mammals he saw were dolphins? Explain your answer.

**He is incorrect. Species 4 is a dolphin, as evidenced by its curved dorsal fin and beak-shaped snout. Species 5 looks like a porpoise, with a smaller, triangular dorsal fin and blunt snout.**

4b. Use the dichotomous key for cetaceans to identify Species 4 and Species 5.

**Species 4 is a bottlenose dolphin and Species 5 is a harbor porpoise.**

<sup>5</sup> Photo(Species 4): NOAA, [http://www.noaaworld.noaa.gov/conservation/aug2008\\_conservation\\_5.html](http://www.noaaworld.noaa.gov/conservation/aug2008_conservation_5.html)  
Photo (Species 5): NOAA, [http://www.nero.noaa.gov/prot\\_res/porptrp/](http://www.nero.noaa.gov/prot_res/porptrp/)

5. On a trip to California, you and your friend spot the marine mammals pictured below, labeled Species 6, Species 7 and Species 8. (Note that pictures labeled Species 6a and 6b are two different pictures of the same species.)<sup>6</sup>



<sup>6</sup> Photo(Species 6a): NOAA, <http://www.swr.noaa.gov/psd/rookeryhaulouts/pinnipedinfo.htm>

Photo(Species 6b): NOAA, <http://www.nmfs.noaa.gov/pr/species/mammals/pinnipeds/stellersealion.htm>

Photo(Species 7): NOAA, [http://www.noaanews.noaa.gov/stories2008/20080131\\_sealpups.html](http://www.noaanews.noaa.gov/stories2008/20080131_sealpups.html)

Photo(Species 8): NOAA, <http://www.accessnoaa.noaa.gov/index122007.html>

5a. Your friend isn't sure if the mammals are seals or sea lions. Name at least two ways you can tell the difference between seals and sea lions. Without using your dichotomous key, can you tell if Species 6, 7 and 8 are seals or sea lions?

**Sea lions have ear flaps and flippers that rotate forward, whereas seals lack ear flaps and cannot rotate their flippers (and thus have reduced mobility on land compared to sea lions).**

5b. Use the dichotomous key for pinnipeds to identify each species.

**Species 6 is a Steller sea lion. Species 7 is a harbor seal. Species 8 is a California sea lion.**

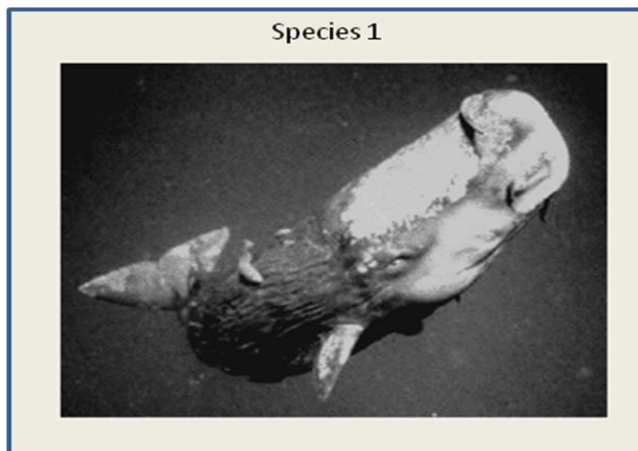


## Identifying Marine Mammals

Congratulations! You just started a job as a marine biologist at NOAA. Because you know so much about the taxonomy of marine organisms, your friends and coworkers often come to you for help identifying what they see. Can you help them out?

Read the scenarios below and answer the questions. To identify the marine mammals, use the dichotomous keys provided – one for cetaceans (whales, dolphins and porpoises) and one for pinnipeds (seals, sea lions and walruses). A dichotomous key is a systematic guide to species identification. Start by reading the two options under number one. Choose the option that best describes the marine mammal you are identifying and skip to the number indicated. Continue until you have identified the organism. You may also use information from today's PowerPoint to help you.

### Questions



1. Your colleague brings you a picture of a whale (Species 1) captured during a deep sea expedition. The whale was spotted at about 1,000m under the sea, far from the coast and was about 40ft long. She noticed that there was no baleen structure on the whale's mouth. Loud clicking noises were heard while the mammal was being observed. Use the dichotomous key for cetaceans to identify the whale, then answer the questions below<sup>7</sup>.

1a. What type of whale is in the picture?

1b. Which Order and Suborder does it fall under?

1c. Your colleague tells you that she thinks krill is the main part of this whale's diet. Do you agree? Explain why or why not.

1d. Is this animal more closely related to a bottlenose dolphin or a humpback whale?

<sup>7</sup> Photo: NOAA (F. Nicklin), <http://swfsc.noaa.gov/textblock.aspx?ParentMenuId=230&id=1427>

2. A friend brings back some pictures of a whale that he took while boating. The picture on the left shows the whale breaching. In a close-up view, you could see bumps on its flippers and jaws and parallel grooves on its throat. The picture on the right shows a close-up of its mouth, which contains a bristle-like structure. Take a look at his pictures (Species 2a and 2b) and use the dichotomous key to identify the animal and answer the questions<sup>8</sup>.



2a. What type of whale is this?

2b. What is the function of the comb-like structure visible in the photo of Species 2b?

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<sup>8</sup> Photo (Species 2a): NOAA

[http://www.noaanews.noaa.gov/stories2008/20080128\\_sanctuary.html](http://www.noaanews.noaa.gov/stories2008/20080128_sanctuary.html)

Photo (Species 2b): NOAA

[http://www.aquariumofpacific.org/onlinelearningcenter/full\\_description/humpback\\_whale/P1/](http://www.aquariumofpacific.org/onlinelearningcenter/full_description/humpback_whale/P1/)

3. Real Life Event: In 2006, a massive cargo ship struck and killed a rare whale and dragged it into Baltimore Harbor. Scientists from NOAA Fisheries Service, Baltimore Aquarium, Maryland Department of Natural Resources and several other organizations examined the whale. As a NOAA biologist, you are called to the scene to help identify the whale. Read the known information and examine the pictures below (Species 3a and 3b). Use your dichotomous key to identify the whale<sup>9</sup>.



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- An analysis of stomach contents indicated it had eaten several types of zooplankton (microscopic marine animals), including shrimp and small fish

3a. What type of whale is this?

<sup>9</sup> Photos for Question 3 courtesy of NOAA's National Marine Fisheries Service

4. Your coworker recently returned from an expedition and shares with you the two photos below. He believes the mammals in both pictures are both dolphins and wants help identifying their species names. Look at the photos of Species 4 and Species 5 and answer the questions<sup>10</sup>.



4a. Do you think that your coworker is correct that both mammals he saw were dolphins? Explain your answer.

4b. Use the dichotomous key for cetaceans to identify Species 4 and Species 5.

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<sup>10</sup> Photo(Species 4): NOAA, [http://www.noaaworld.noaa.gov/conservation/aug2008\\_conservation\\_5.html](http://www.noaaworld.noaa.gov/conservation/aug2008_conservation_5.html)  
Photo (Species 5): NOAA, [http://www.nero.noaa.gov/prot\\_res/porptrp/](http://www.nero.noaa.gov/prot_res/porptrp/)



5. On a trip to California, you and your friend spot the marine mammals pictured below, labeled Species 6, Species 7 and Species 8. (Note that pictures labeled Species 6a and 6b are two different pictures of the same species.)



5a. Your friend isn't sure if the mammals are seals or sea lions. Name at least two ways you can tell the difference between seals and sea lions. Without using your dichotomous key, can you tell if Species 6, 7 and 8 are seals or sea lions?

5b. Use the dichotomous key for pinnipeds to identify each species.

Species 6:

Species 7:

Species 8:



Dichotomous Key - Cetaceans<sup>11</sup>

1.	
Baleen present on palate. No teeth. Lower jaw very wide and arched in shape.	Go to 2
No baleen. Teeth present.	Go to 7
2. Baleen whales	
No grooves on throat. No dorsal fin. Mouth and upper border of lower lip very arched in shape. Long baleen plates up to 6-9ft high.	Northern right whale
Distinctive pectoral flippers. Numerous parallel grooves on throat.	Go to 3
3.	
Flippers very long (nearly 1/3 of animal's length) and often white with scalloped lower margin. Distinctive bumps or nodules on head.	Humpback whale
Flippers much less than one third of animal's length, not scalloped on lower margin.	Go to 4
4. Rorquals	
Baleen yellowish white or slate colored, or both.	Go to 5
Baleen black or nearly black. No white on baleen except for the hairy fringe.	Go to 6
5.	
Size up to 70ft +. Baleen yellow and slate colored except at front of right side of mouth where it is white.	Fin whale
Size up to 30ft. Baleen and its hairy fringes all white or yellowish. White band on outside of flipper.	Minke whale
6.	
Size up to 85ft +. Baleen very black with coarse black hairs.	Blue whale
Size up to 50ft +. Baleen mostly dark. No white on flippers.	Sei whale
7. Toothed Whales, Dolphins & Porpoises	
Tip of lower jaw well behind foremost limit of head.	Go to 8
Tip of lower jaw at same level as tip of snout.	Go to 9
8.	
Size of large whale, up to 60ft +.	Sperm whale
Size of large dolphin, up to 12ft.	Dwarf / pygmy sperm whale
9.	
No dorsal fin.	Go to 10
Dorsal fin present.	Go to 11

<sup>11</sup> Dichotomous Key created using information from the Cetacean Research & Rescue Unit:  
[http://www.crru.org.uk/cetaceans\\_identification.asp](http://www.crru.org.uk/cetaceans_identification.asp)

10.	
Head short. Prominent forehead. Color greyish with black mottling. Either no visible teeth (female) or a single, spirally twisted tusk, projecting from front of the upper jaw (male).	Narwhal
Color white all over (grey-brown in juveniles). 8 - 10 pairs of teeth in each jaw.	Beluga
11.	
Small, triangular beak with no sharp crease at base.	Harbor porpoise
Distinctive beak.	Go to 12
12.	
Beak creased at base.	Bottlenose dolphin
Small beak and small dorsal fin.	Fraser's dolphin

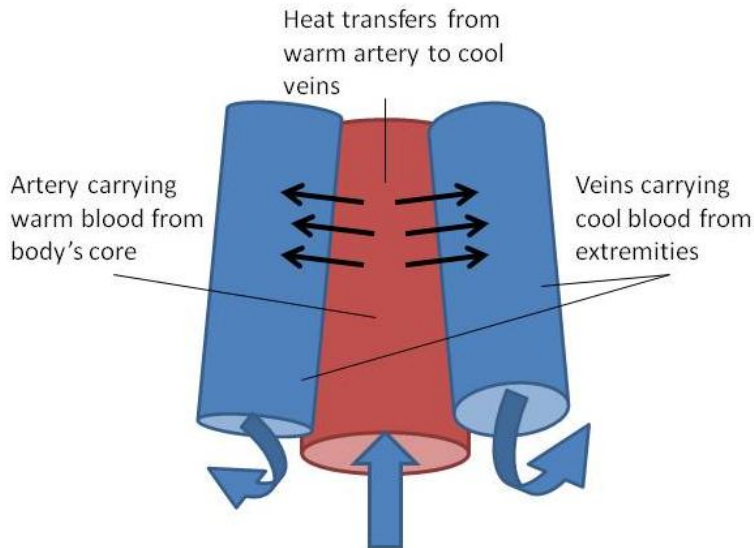
### Dichotomous Key - Pinnipeds

1.	
Ear flaps present.	Go to 2
Ear flaps absent.	Go to 3
2. Sea lions	
High brow ridge.	California sea lion
Rounded forehead.	Steller sea lion
3. Seals	
Short, concave snout.	Harbor seal
Small, flat head, narrow snout.	Harp seal

## What to Know for the Bowl - Vertebrates II

### Countercurrent Heat Exchange:

This refers to one of the mechanisms by which marine mammals maintain constant body temperature in the ocean, where heat loss occurs faster than on land. Arteries and veins run parallel to one another, allowing the heat from relatively warm blood carried by the artery to transfer to the relatively cool blood carried by the veins.



### Know the Differences:

Write down some differences between each set of two organisms listed below.

Organisms	
Baleen whales	Toothed whales
Seals	Sea lions
Porpoises	Dolphins

## Vertebrates II

1. Reminder Question: Which of the following organisms is NOT a bivalve:
  - w. Oyster
  - x. Mussel
  - y. Scallop
  - z. **Tube Worm**
2. What organism is not in the same sub-order as the others listed?
  - w. Orca (Killer whale)
  - x. **Blue whale**
  - y. Pacific white-sided dolphin
  - z. Bottlenose dolphin
3. Short answer: This structure is used by whales in the sub-order Mysticeti to strain small organisms from large gulps of water.  
**Answer: Baleen**
4. Mammals are warm-blooded organisms, which means
  - w. They rely on the external environment to regulate their internal body temperature
  - x. Their internal body temperature fluctuates throughout the day
  - y. **They maintain a constant internal body temperature**
  - z. They literally have warmer blood temperature than cold-blooded organisms
5. The California sea lion is most closely related to the:
  - w. Blue whale
  - x. **Spotted seal**
  - y. Bottlenose dolphin
  - z. Pacific white-sided dolphin
6. Which organism tends to dive deep to forage (find food) and eats squid as a main part of its diet?
  - w. **Sperm whale**
  - x. Humpback whale
  - y. California sea lion
  - z. Blue whale
7. Short answer: This term refers to a method used by some toothed whales involving sound for navigation or to hunt prey.  
**Answer: Echolocation**

8. Short answer: Porpoises and dolphins are in the same order, but dolphins belong to the family Delphinidae, while porpoises belong to which family?

**Answer: Phocoenidae**

9. These whales make the most diverse range of human-detected sounds of any whale:
- w. Sei whales
  - x. Sperm whales
  - y. Humpback whales**
  - z. Blue whales

10. Team Challenge Question

One mechanism that certain marine mammals use to maintain their body temperature is known as countercurrent heat exchange.

1. What class of marine vertebrates maintains constant body temperature? (1pt)

2. How does countercurrent heat exchange work? (4pt)

3. Name three other mechanisms that help marine mammals maintain constant body temperature. (3pt)



ANSWER

Team Challenge Question

One mechanism that certain marine mammals use to maintain their body temperature is known as countercurrent heat exchange.

1. What class of marine vertebrates maintains constant body temperature? (1pt)

**Mammalia**

2. How does countercurrent heat exchange work? (4pt)

**Arteries carrying blood from the mammal's body core (1pt) exchange heat with veins coming from the extremities (1pt) so that heat isn't lost to the environment (2pt).**

3. Name three other mechanisms that help marine animals maintain constant body temperature. (3pt)

**1pt each for three of the following: Increased metabolism, blubber, fur, warming behavior (coming to the surface to be warmed by the sun) or hair.**