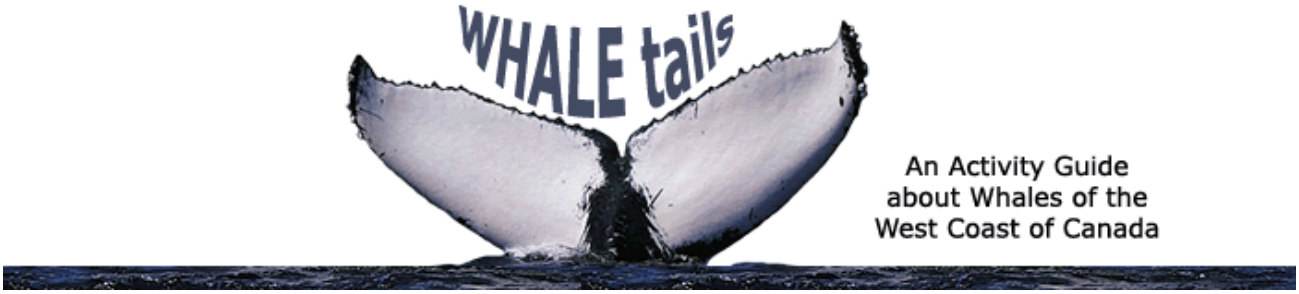


TEACHER'S ACTIVITY GUIDE

This guide integrates aspects of the **Science Curriculum** for levels kindergarten through grade seven as outlined by the British Columbia Ministry of Education. Through these activities, students will learn about the natural history of the whales, dolphins and porpoises found off the coast of British Columbia.

GIANTS OF THE OCEAN

1. Weights and Measures K-3, 4-7
Students get to see how large whales really are.

EVOLUTION OF WHALES

2. Why is it a whale? K-3, 4-7
Students compare whales and fish.
3. Evolution 4-7
Students compare whales with their land-mammal ancestors.

SWIMMING AND DIVING

4. Blowhole K-3
Students will act out how a whale breathes.
5. Oh, the pressure! 4-7
Students will understand the pressures that whales are under when diving.

FEEDING

6. Fine-toothed comb K-3
Students find out what it's like to eat like a baleen whale.
7. Fast food 4-7
Students will discover the feeding habits of whales and humans through simple calculations.

ECHOLOCATION AND COMMUNICATION

8. Predator Prey K-3
Students get to be sound waves to understand echolocation.
9. Sound Waves 4-7
Students examine how sound waves travel through different media.
10. Body Language Charades K-3
Students get to communicate like whales.
11. Human Impact 4-7
Students learn how human actions affect whale communication.

ANATOMY AND PHYSIOLOGY

12. Bag of Blubber K-3
Students will feel how blubber works.
13. Cetacean Creations K-3, 4-7
Students create a new species of whale.
14. Keeping the heat in K-3, 4-7
Students will see how the shape of a whale helps it survive in the cold ocean.

15. Go with the flow 4-7

Students will demonstrate how whales can change their temperature so they don't get too hot or cold.

CLASSIFICATION OF ORGANISMS

16. Linnaeus's Latin Lingo 4-7

Students decipher scientific names and learn what they really mean.

SENSES

17. Cetacean Sensations K-3, 4-7

Students will fine tune their senses, and understand how whales sense things differently than humans.

RITUAL, MYTH, AND LEGEND

18. Tale of a Whale K-3, 4-7

Students explore the different myths and stories from different cultures about whales.

GIANTS OF THE OCEAN

1. **Weights and measures**
Objective: To appreciate the different sizes of whales.

Level: K-3, 4-7
Background: Of the 78 species of cetaceans (whales, dolphins and porpoises), 23 live in or swim through British Columbia waters. The Blue Whale is the largest, growing to about 30 metres long, but several other species exceed 15 metres.

Many people confuse dolphins and porpoises, but they are two distinct families of marine mammals. Dolphins are larger, ranging in length from 2.4 to 3.7 metres, while porpoises range from 1.4 to 2.5 metres long. Dolphins are usually beaked and have a larger, moveable dorsal fin. Dolphins have sharp, pointed, conical teeth, and porpoises have small, spade-shaped teeth. Killer Whales (Orcas) are the largest members of the dolphin family.

Species	Max. Length	Max. Weight
Harbour Porpoise	2 metres	45 kg
Pacific White-Sided Dolphin	2.25 metres	135 kg
Killer Whale (Orca)	9 metres	7 tonnes
Minke Whale	10.5 metres	9 tonnes
Grey Whale	15 metres	32 tonnes
Sperm Whale	18.5 metres	45 tonnes
Humpback Whale	19 metres	48 tonnes
Blue Whale	30 metres	135 tonnes

Level: K-3
Materials: rope (approx. 30 m long), flagging tape.
Procedure:

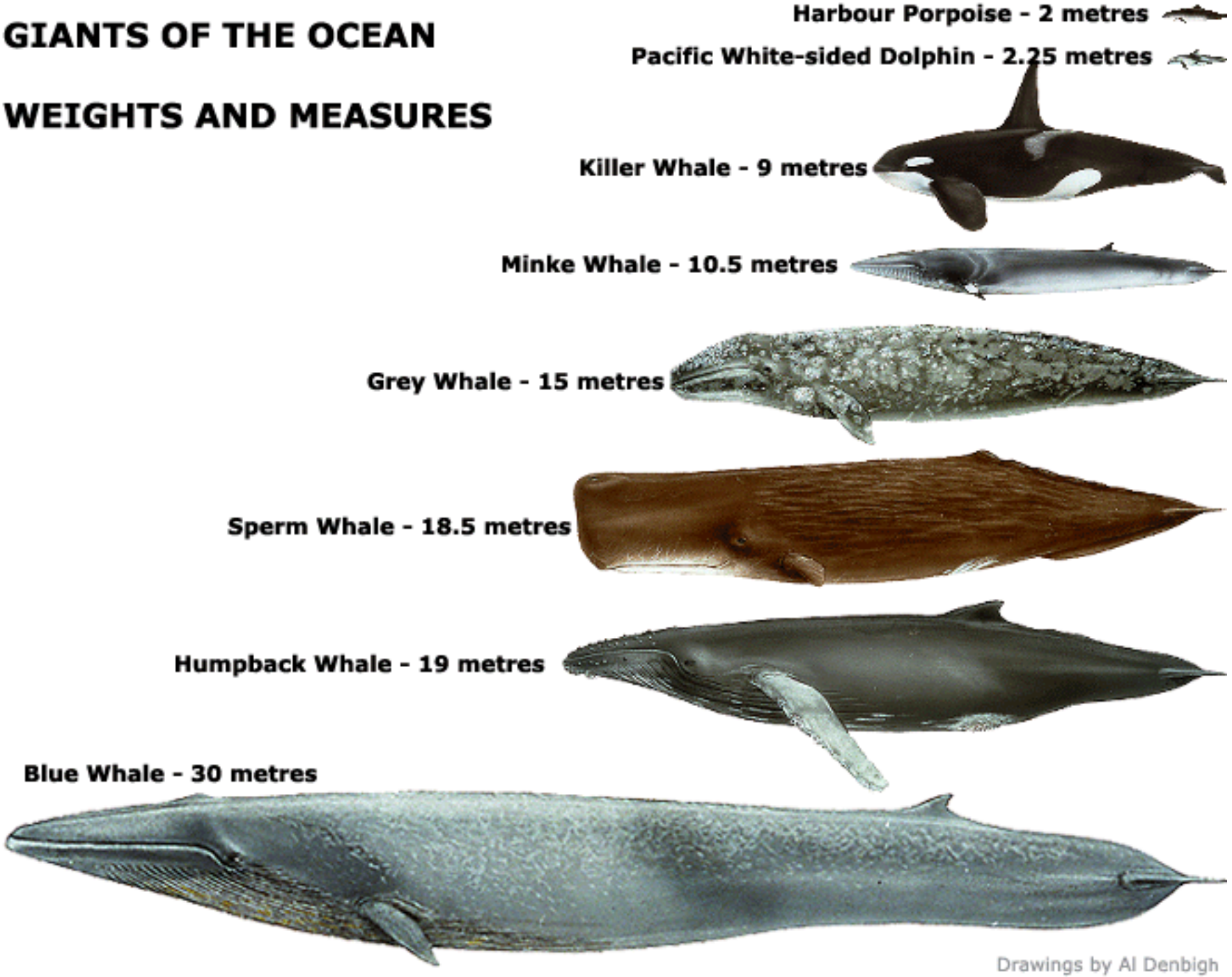
1) Cut lengths of rope to equal the lengths of different whales.
2) As a class, students hold different lengths of rope, which are marked every metre with flagging tape. Have each student hold a mark.
3) Count the number of students it takes to equal the length of one whale. Count each student as one metre, two metres, etc.

Level: 4-7
Materials: metre stick or measuring tape, bathroom weight scale, calculators.
Procedure:

1) Have students measure each other's height and calculate the average height of students in the class, then determine how many students it takes to equal the maximum length of a species of whale.
2) Have students weigh themselves and calculate the average weight of students in the class, then find out how many of them it takes to equal the maximum weight of the same species of whale.

GIANTS OF THE OCEAN

WEIGHTS AND MEASURES



Drawings by Al Denbigh

675 Belleville Street
Victoria, British Columbia
CANADA

1-250-356-7226
www.royalbcmuseum.bc.ca

EVOLUTION OF WHALES

2. **Why is it a whale?**

Objective: Students will understand the differences between cetaceans and other ocean-dwelling creatures.

Level: K-3, 4-7

Background: A whale has a smooth, rounded, streamlined body that moves quickly and easily through the water. Instead of arms, it has flippers that help it balance and steer in the water. A whale also has two pointed flukes that make up its large, horizontal tail. This tail propels the whale forward with an up-and-down motion rather than a side-to-side motion as a fish's tail does. The dorsal fin on the back helps keep the whale balanced, although some whales manage quite well without one.

Whales are mammals. Like other mammals, they breathe air, are warm-blooded, nurse their young with milk and, at some point in their lives, have hair. Whales evolved from land-dwelling, flesh-eating mammals that lived about 70 million years ago. Between 70 and 50 million years ago these ancestors gradually ventured back into the ocean and evolved into the superbly adapted animals we know today. In order to make this transition to a marine lifestyle, cetaceans had to overcome problems of buoyancy, thermoregulation, streamlining, underwater vision, respiration, feeding and communication.

Level: K-3

Materials: paper, crayons.

Procedure:

1) Have students draw a picture of a whale and a fish. What position is the tail in for each animal? (Vertical for the fish and horizontal for the whale.)
2) Discuss how each tail is used for swimming. (A sideways motion for the fish and an up-and-down motion for the whale.)

Level: 4-7

Materials: large sheet of paper, felt pens.

Procedure: The complexity of this activity can vary with the grade level.

1) Divide a sheet of paper into four columns. In the first column list general characteristics of animals that live in the sea; i.e., body covering, source of oxygen, tail, tail position, warm or cold-blooded, method of birth (live/eggs), etc. Label the other columns "Cetaceans", "Fish", "Other Sea Mammals".
2) Discuss for each column of animals how each relates to the category of characteristics listed in column one. Write down these findings and discuss the similarities and differences found.

EVOLUTION OF WHALES

3. **Evolution**

Objective: Students compare whales and their land-mammal ancestors.

Level: 4-7

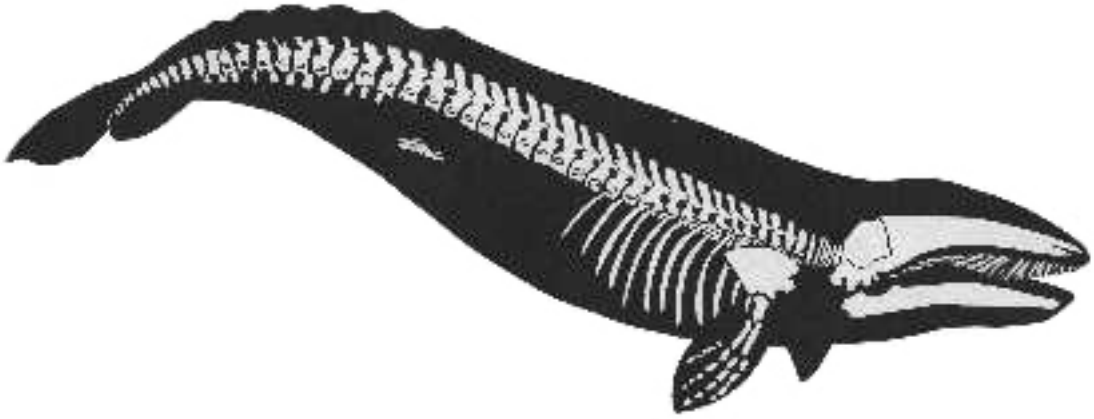
Background: No one is certain how whales came to exist, but there is fascinating evidence for the evolutionary link between whales and other mammals. Fossils of early whales possess some clear, whale-like characteristics: elongated bodies, reduced hind legs, long snouts and a trend to the placement of nostrils on the upper rear part of the snout. Scientists now believe that whales evolved from carnivorous land mammals called mesonychids. The huge, furred, wolf-like Andrewsarchus was a mesonychid that lived from 42 to 40 million years ago in the Eocene epoch. At a length of 3.7 metres Andrewsarchus was the largest carnivorous land mammal that ever lived. Although Andrewsarchus appeared too late to be an ancestor to whales, the best available evidence suggests that one of its small relatives gave rise to the whales about 50 million years ago. The form and number (44) of Andrewsarchus's teeth are very similar to those characteristics of the earliest whales. The body form of whale ancestors clearly underwent a major alteration during the transition to aquatic life. Front limbs became flippers, hind limbs eventually disappeared, the hair was all but lost, and the body took on a streamlined shape.

One of the early whales, Basilosaurus, flourished about 40 million years ago. Perhaps this best-known species of the early whales was an intermediate form between land mammals and the modern whales. It had small but functional hind limbs, its nostrils were situated on the top of the snout and its ears had adapted only partially to hearing in the aquatic environment. Other early whales show the intermediate or transitional features that one would expect to find. Today, whales have a non-functional and totally isolated pelvic structure as the only skeletal trace of hind limbs. The forelimbs have evolved into flippers but the bones inside the flipper are like those in a human hand and arm. Most contain five fingerlike bone arrangements (although some have only four) and the limb bones of cetaceans connect to the shoulder blade, as ours do.

Materials: pictures of animals, paper, felt pens.

Procedure:

1) Examine *Andrewsarchus* and *Basilosaurus* and compare their characteristics to those of modern-day whales. Make a list of similarities and differences.
2) Discuss what characteristics the whale had to develop in order to survive in an aquatic environment.



675 Belleville Street
Victoria, British Columbia
CANADA

1-250-356-7226
www.royalbcmuseum.bc.ca

SWIMMING AND DIVING

4. **Blowhole**

Objective: To demonstrate how whales breathe.

Level: K-3

Background: Like all other mammals, whales have lungs and breathe air, and so must come to the surface to breathe. Instead of a nose, a whale has either one or two blowholes on the top of its head that serve as nostrils. The dorsal location of the blowhole allows the whale to breathe without having to lift its head out of the water. The blowhole is surrounded by a set of powerful muscles that close off the hole and prevent water from entering when the whale dives. A system of nerves and muscles automatically keeps the blowhole from opening under water. The toothed whales have only one blowhole while baleen whales have two.

Breathing frequencies vary depending on species, physical activity and family groupings. Right, Blue and Humpback whales surface every four to seven minutes. Most species take a series of breaths separated by 10 to 30 seconds before diving again. When baleen whales feed, they generally go down for 10 to 15 minutes, then resurface and breathe or "blow" about once a minute. Their limit under water is about 40 minutes. At rest, whales do not to breathe as quickly as they do immediately after returning from a dive. Family relationships can also influence breathing: Killer Whale pods tend to breathe in the same rhythm, with all animals surfacing at approximately the same time.

When whales surface they let out their breath and spout a column of air and water vapour several metres into the air. This is called *blow*. Whales do not exhale water although it sometimes looks that way. Blow is created primarily through three mechanisms:

-water resting in the cup of the blowhole is vaporized as the whale exhales;
-the whale's warm breath condenses in a cooler ambient temperature;
-air released under pressure condenses.

When swimming fast, many cetaceans will jump clear of the water to breathe. If a fast-moving whale were to raise just its blowhole to the surface, it would meet maximum water turbulence and drag, and so expend a great amount of energy. Jumping out of the water allows the whale to maintain speed without expending too much energy.

The four-metre-wide tail flukes of the Fin Whale can generate up to 200 horsepower. With this kind of power and a streamlined body it is easy to understand how whales can swim so fast. A 20-metre Blue Whale is able to keep up a speed of 37 km/hr (20 knots) for 10 minutes and 26 to 28 km/hr (14 to 15 knots) for over two hours. Killer Whales can travel at speeds up to 45 km/hr (24 knots) and the Dall's Porpoise, the fastest of all cetaceans, can reach 50 km/hr (27 knots).

Procedure:

1) Have the students close their eyes, take a deep breath and imagine they are underwater. What is the first thing they do when they surface to breathe, inhale or exhale?
2) Have them make a large blowhole with both hands over their head, take a deep breath and close their hands tight. Have them hold their breath for 10 to 15 seconds, open their hands and exhale, then inhale quickly and close their hands tightly, and repeat.
3) Notice the different sounds they make as they inhale and exhale. Most whales make a tremendous sound as they surface and breathe. They must inhale quickly because their blowhole is only out of the water for a short time.

SWIMMING AND DIVING

5. **Oh, the pressure!**

Objective: Students will understand the pressures that whales are under when diving.

Level: 4-7

Background: The deeper down you go into the water, the greater the pressure. Whales have developed adaptations that allow them to survive in this environment. Some cetaceans can dive to incredible depths. The Sperm Whale (a toothed whale) is the champion diver of all whale species - it can dive deeper than 2000 metres and stay underwater for over 90 minutes. Sperm Whales have a unique adaptation for diving called the spermaceti organ. It is a large oil-filled sac in the head of the whale. As the whale descends into cooler water, its nasal passages, which are surrounded by the spermaceti organ, are filled with water. The cold water changes the density of the spermaceti and thus the buoyancy of the whale. By controlling the amount and temperature of the water the whale can control its buoyancy and remain neutrally buoyant at various depths. Baleen whales do not usually dive deeper than 90 metres, since their food is generally found in greatest concentration in the top 20 metres of water. But they can dive much deeper if they have to - up to 460 metres.

Whales have evolved other adaptations for diving in order to cope with the pressures of extreme depths. Research indicates that whales can take in about twice as much oxygen as other animals from a given volume of air. Whales have more red blood cells per unit of blood (almost twice that of humans) and the cells are larger than those in humans and other animals. These two factors allow for a speedy exchange of oxygen from the lungs to the haemoglobin -- the pigment in the red blood cells that carries oxygen. This oxygen supply is then transported throughout the body. Where whales differ from humans and other terrestrial animals is in their myoglobin content -- the oxygen-carrying pigment in the muscle. Whales show two to eight times as much myoglobin as terrestrial mammals; that's why cetacean muscle is much darker than beef and other animal meats. Since there is more oxygen circulating in the blood and muscles, a whale can have a continuous supply of oxygen to the heart and brain throughout the dive.

It is the oxygen-holding capacity of the muscle and blood that is the secret behind the whale's ability to perform long dives. It is not a factor of held breath as it is with humans. According to one estimate, total oxygen storage in a human diver is 34% in the lungs, 41% in the blood, 13% in the muscles, and 12% in other tissues. In the whale, the proportionately smaller and compressed lungs hold only 9% of the oxygen, with 41% in the blood, 41% in the muscles, and 9% in tissues.

When humans come up from a deep dive too quickly, they get what is known as the bends, or decompression sickness. If the diver doesn't decompress during the dive and expel some of the nitrogen s/he has taken in with the air, the expanding nitrogen can bubble into the tissues and cause dangerous, and possibly fatal, consequences upon surfacing. Whales don't get the bends like humans do, even though they make relatively deep dives with quick returns to the surface. One whale was recorded as routinely diving to 300 metres. Two factors protect whales from getting the bends. At depth, the air is compressed to a very small volume. As water pressure increases, the ribs, most of which are not strongly connected to the breast-

bone, collapse inward compressing the lungs and forcing air into nonabsorptive portions of the lung. Lung compression also reduces blood flow to the lungs. Both processes, and perhaps others, minimize absorption of air into the blood, preventing excessive quantities of nitrogen from dissolving in the blood. As the whale ascends, the compressed air expands again, refills the lungs, and blood flow and gas exchange resume. Also, the air the whale begins with is the air it comes up with, unlike SCUBA divers who are taking in compressed air (and compressed nitrogen) during the dive.

Whales also have other adaptations for diving. The heartbeat slows to about a tenth of its natural rhythm, and the temperature and metabolic rate of the whale decrease.

Materials: large can or carton, shallow bin, water.
Procedure:

1) Take a large can or carton and punch three or four holes in a vertical row from bottom to top, starting at least one-third of the way up the can.
2) Place the container in a shallow basin. Plug the holes and fill the container with water.
3) Unplug the holes and observe the differences in water streams from the top and bottom of the container. You will see that the greater pressure at the bottom of the container forces the water stream out farther from the wall of the container and that the top hole has a weaker stream.

FEEDING

6. **Fine toothed comb**

Objective: Students will understand the differences between feeding in toothed whales and baleen whales.

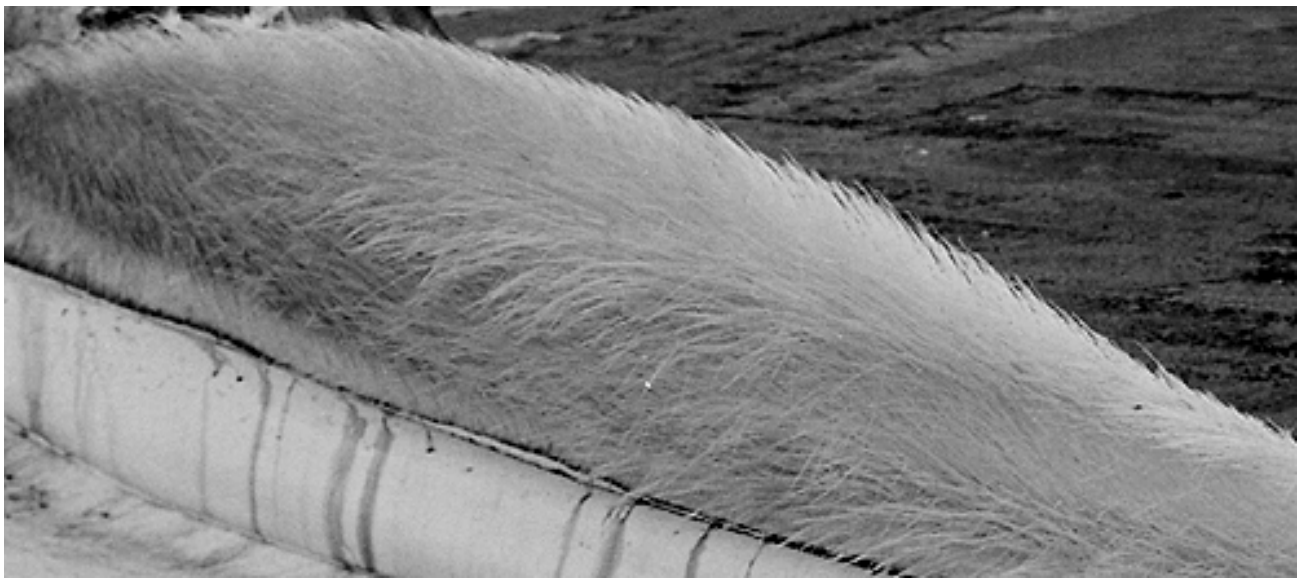
Level: K-3

Background: Different species of whales use different techniques to hunt and eat different types of prey. There are two basic types of feeding strategies:

-Toothed whales such as Killer and Sperm Whales hunt large prey such as fish and squid, which they seize with their teeth. Of the 78 species of cetaceans in the world, 67 have teeth.

-Baleen whales have no teeth. They feed on small organisms in the water such as crustaceans (krill and copepods) or small fish such as herring and sardines which they filter out of the water with sieve-like baleen plates. Only 11 species of cetaceans are baleen whales, including Humpbacks, Greys and Blues.

Baleen whales have two feeding strategies: gulping and skimming. A gulper (called a rorqual), feeds by gulping a huge amount of water containing plankton or small fish into its pleated throat, which bulges out to hold an incredible volume. After taking in this great mouthful - or throatful - the whale raises its tongue and forces the water out through sieve-like baleen plates that hang down from its upper jaw. The food is caught in the baleen and, once the water is removed, the whale licks the baleen clean and swallows the food. Some whales may also raise their heads out of the water and let gravity do the work of straining the water through the baleen. Other baleen whales are skimmers. They swim close to the surface with their mouths open and sift plankton from the water that enters their mouth with their baleen.



The Grey Whale feeds on the bottom and is not considered a gulper or a skimmer. Pressing one side of its head (usually the right side) against the bottom, a Grey Whale sucks up a large

amount of mud and sand. Using its tongue, it pushes the mud, water and food through its baleen plates. The mud and water pass through, and the food, mostly small crustaceans, is trapped in the baleen. Grey Whales leave characteristic pits in the bottom of the ocean where they have been feeding. They tend to feed closer to shore and in shallower water than other baleen whales.

Toothed whales hunt larger animals, such as fish and squid, which they capture with their teeth. Sperm Whales will dive deeper than two kilometres below the surface for up to 90 minutes to catch their favourite food, giant squid. Sailors have told many stories of battles between Sperm Whales and giant squid. These "battles" are usually just the writhing of the squid in a vain attempt to escape the jaws of the whale.

There are three types of Killer Whales in British Columbia: residents, transients and offshore. Residents tend to stay in the same general area; transients travel more widely, moving up and down the coast and passing through areas inhabited by resident pods; and offshore Killer Whales inhabit the open ocean, far from shore. Residents live in pods of 6 to 50, while transients form smaller pods of up to 5 whales. Resident Killer Whales eat fish, while transients feed on marine mammals such as seals, sea lions and even other whales.

Materials: tub of water, carrot slices, parsley flakes, combs, tongs, cups, water, sprinkles.
Procedure:

1) Using the background information above, introduce the two types of whales.
2) Divide class into groups.
3) Give each group a container, a comb, and a pair of tongs. Explain that the comb represents baleen and the tongs represent teeth.
4) Fill containers halfway with water.
5) Sprinkle parsley flakes in each container. The parsley flakes represent krill. Ask students to experiment with the tongs and comb. Which collects parsley flakes better?
6) Next, drop a few carrot pieces into the container. The carrot represents fish and other larger animals. Killer whales use teeth to catch fish and other prey. Have students experiment with the comb and tongs. Which collects carrots better?
7) Have students pretend they are whales. Give each student a cup with a small amount of water. Add "krill" (cake decoration sprinkles). Tell them to strain the "krill" from the water, just like a whale. Fill your mouth with water, close your teeth together, and squirt the water through your teeth into the cup (back into the ocean). The "krill" will remain on the back of your teeth. Students can use their tongues to lick off the "krill" from their teeth and swallow it.
8) Use the following food items and have students determine if they would need baleen or teeth to eat them: cake sprinkles, vegetables, spaghetti, alphabet soup, bread, noodles, peanut butter sandwich, hot dogs, whole fruit, sunflower seeds.

FEEDING

7. **Fast Food**

Objective: Students will calculate rates of feeding for the average baleen whale, and compare the energy requirements of whales with humans.

Level: 6-7

Background: Whales consume great quantities of food, which they need to power their enormous bodies and to maintain body heat. All mammals must expend energy to maintain a stable body temperature, but this is especially difficult for whales who would lose a considerable amount of body heat to cold ocean water were it not for their blubber. The larger whales must consume 500,000 to a million calories per day. To get these calories, an average-sized baleen whale consumes 2,000 kg (4,400 pounds) of food per day during the summer. About 25% of the food is stored as fat, called blubber, which serves as both insulation and an energy reserve necessary for surviving the winter when less food is available. A typical human weighs 67.5 kg (150 pounds) and takes in 2,500 calories per day. A whale weighing about 45 tonnes needs at least 395,000 calories per day. A whale of this size may spend 15 hours a day feeding in the summer months.

Materials: pencils, paper and calculators.

Procedure:

Have the students calculate the following:

1) If a whale's mouth opening is 1.5 m2, and the average density of copepods is 9500 per m2, how many copepods can a whale ingest in one mouthful?

2) If a whale ingests 500,000 calories per day, how many calories is it ingesting per minute?

3) Investigate your own consumption figures:

a. Estimate the number of minutes you spend per day feeding.

b. If you ingested 2,500 calories in one day, how many calories would you ingest per minute? (*Hint:* don't forget your answer to question 3a.)

4) Compare your caloric intake per minute with that of a whale. What factors account for the difference in intake? How does food availability differ for baleen whales and humans?

ECHOLOCATION AND COMMUNICATION

8. **Predator - prey**

Objective: Students will understand how whales use echolocation to find their food.

Level: K-3

Background: Although many whales have good underwater vision, the water of the North Pacific is often murky and dark, especially at depths below 20 metres. Whales compensate for this inability to see underwater by using another method of *seeing* called echolocation, or sonar. Sound travels four times faster in water than in air, and much farther. Whales send out powerful clicks or pings that they produce in air sacs in their foreheads. Many species have a fat deposit in the forehead called the melon. These whales change the shape of their melon to direct or focus the outgoing sonar waves. The melon transmits these sound waves while their oil-filled lower jaws receive and carry the returning sounds to the inner ear. As the whale approaches its target, it sweeps its head back and forth and saturates the area with clicks. When the signal returns to the whale, it computes the location, distance, direction of movement, speed, shape and texture of the object. Many of the sounds used in echolocation are high-pitched and inaudible to the human ear.

Sound travels through a medium in the form of waves. The number of wavelengths (the distance from one wave crest to the next) that pass a given point in one second (frequency) is measured in Hertz (Hz), or cycles per second. Dolphins generally do not send out signals much below 0.5 kHz. In echolocation, higher frequencies are sent out to gain information about nearby smaller objects. A low frequency signal is used for distant or large objects; in water, lower frequencies travel farther than high frequencies.

Toothed whales (Odontocetes) use a highly sophisticated form of sonar. The sound waves travel through the water and bounce off surrounding objects. A Sperm Whale's sonar consists of a series of clicks that sound like loose change banging in an empty clothes dryer. A single click is made up of one to nine separate pulses, each pulse lasting slightly more than 24 thousandths of a second. Baleen whales (Mysticetes) have a primitive echolocation system and scientists still debate whether they use it to sense their surroundings.

Materials: blindfolds

Procedure:

1) Divide the class into two groups. The students in each group hold hands to form a circle and the boundary of the game.
2) Select one student from each group to be the whale, and two students to be the fishes, and have them stand in the middle of the circle.
3) Blindfold the whale. The whale calls "whale" to locate the fish. Each time the student that is the whale calls "whale", the fish must respond with "fish" to imitate the returning echo of the whale's sonar. If the whale calls "whale, whale, whale" the fish must reply "fish, fish, fish". The object of the game is for the whale to find the two fish by following the sound of their voices. The students in the middle can move only within the boundaries of the circle.
4) When the whale touches a fish, the fish is considered eaten. When both fish are eaten, select a new whale and two new fish. Try to involve each member of the class. (It is important that the fish always respond to the whale's call).

ECHOLOCATION AND COMMUNICATION

9. **Sound waves**

Objective: Students will understand how sound waves travel through different media.

Level: 4-7

Background: Whales produce sound for communicating among themselves. Sounds may communicate the location of the caller, the state of excitement or physical condition, who the caller is or what group it belongs to. These vocalizations are different from the sounds used in echolocation.

Scientists use microphones called hydrophones to record sounds underwater. Using hydrophones, whale researchers have recorded vocalizations of a number of species of whales. Killer Whale researchers have discovered that certain vocalizations occur most often during playful activities, while other calls dominate during foraging or birth.

Of all baleen whale vocalizations, those of the Humpback have been studied the most. The Humpback Whale produces many different types of sounds including, moans, groans, squeals, chirps and clicks. During breeding season some of these sounds are arranged into complex sequences called songs. It was found that a solitary male Humpback song can travel several hundred kilometres under ideal conditions. Humpback songs have a number of themes, usually six, that are sung in order and repeated monotonously for long periods of time. Distinct dialects with subtle differences occur in different ocean basins and songs change annually within each population. There are several theories about the function of these songs but the predominant thought is that they are sung by mature males on the breeding grounds.

Materials: tuning forks, wood, metal, cloth, water, etc.

Procedure:

1) Set a tuning fork in motion and place it on different surfaces such as wood, metal and cloth, or in water. If you have more than one tuning fork you can test several materials simultaneously.
2) Have the students explain why sounds are different on different surfaces. (They will not hear sounds in the water, but they will see waves).
3) Have students determine how far from its place of origin they can hear the sound.
4) Suggest that the next time students are in a swimming pool they hold their breath under water and listen to the noises they hear. If your class has swimming lessons, this could be done as a group activity with some people making sounds under water while others listen. Surface noises will be muted, but sounds in the water will be more distinct.

ECHOLOCATION AND COMMUNICATION

10. **Body language charades**

Objective: Students will demonstrate an understanding of how bodies can be used to communicate.

Level: K-3

Background: Sound is not a whale's only mode of communication. Like all other animals, body language plays a role in general communication, dominance displays and signs of affection. Flippers and flukes are used for touching, signalling and play in courtship. Male Humpbacks compete to escort females in heat by combating one another with head butts and sweeps of their five-metre-long flippers. Breaching activity is also believed to be a form of communication.

Procedure:

1) Discuss how whales use their bodies to communicate feelings and ideas (stroking, hitting, etc.). Discuss body language in humans. A large part of human body language is communicated through facial expression. Whales do not have this ability.
2) Have the students communicate various feelings, emotions, or ideas without using speech or facial expressions. Some ideas are: "Come with me", "Go away", "I'm tired", etc.
3) Have other students try to guess what each student is saying.

ECHOLOCATION AND COMMUNICATION

11. **Human impact**

Objective: Students will learn the impact humans may have on whale communications.

Level: 4-7

Background: Whales have well-developed hearing, and have been observed to respond to sounds such as cameras clicking underwater and boat-engine noise. Grey Whales have shown avoidance behaviours at sound levels of 120 decibels.

An example of an unknown human impact on whales is a set of experiments that a group of scientists want to conduct to measure global warming. They have proposed using loud sounds to precisely measure the temperature of the world's oceans. Sound travels in sea water about 1445 metres per second at zero degrees Celsius. For each degree above zero, sound travels about five metres per second faster. Scientists can calculate the average temperature of the oceans by timing how long it takes sound to travel long distances. In order to get a sound to travel great distances, it has to be very loud. Even though the sounds made in this experiment will be well below the frequencies heard by humans, they can be easily heard by whales. Some scientists are concerned about the effect these sounds will have on marine mammals. Loud, frequent sounds may alter fertility and growth rates, disrupt feeding behaviour or muffle communication. More research is needed discover the effects of human-made sounds on whales.

Level: K-3

Materials: noise makers (optional)

Procedure:

1) Have two students stand three metres apart and talk to each other.
2) Next, have another student make a motorboat noise.
3) Gradually add more students talking and making noise.
4) After a few minutes, gather all the students and discuss the activity. How easy was it for students to communicate? Would they like this amount of noise around them all the time?

Level: 4-7

Materials: flip chart paper, felt pens

Procedure:

1) Have the students discuss the impact of human technology on whale communication.
2) Discuss the problems that the noise from power boats, hydroelectric power stations, commercial ships, etc. can cause to communication. What impact does whale watching have on whales, especially during breeding season? Whale watching can be a valuable way to learn about whales and increase respect for whales, but if not done carefully it can disturb them. Discuss the importance of keeping a respectful distance from whales in the wild.

ANATOMY AND PHYSIOLOGY

12. **Bag of Blubber**

Objective: students will learn the insulating properties of blubber.

Level: K-3

Background: Because whales are warm-blooded, they require a thick layer of insulation to maintain their body temperature in water. Water drains heat from a warm body 25 times faster than air does. Whales have a thick layer of fat, called blubber, that serves as an insulator and body temperature regulator, a reserve energy source, and a flotation device. Depending on the species, blubber can make up 21 to 45 per cent of a whale's body weight and can reach a thickness of 50 cm.

Although ocean water is cold, a whale that is exerting itself to swim fast produces a great deal of heat. Because whales cannot sweat or pant to cool off, their blubber may cause them to overheat. To maintain a constant body temperature, blood vessels leading to the flippers, tail flukes, and dorsal fin expand to dissipate excess heat into water.

Materials: a sink or bucket full of cold water, ice cubes, Ziploc bags, lard or vegetable shortening, elastic bands.

Procedure:

1) Fill the sink or bucket with water and add ice cubes.
2) Have students smear a 1-2 cm layer of lard evenly over the inside of a Ziploc bag.
3) Then turn another Ziploc bag inside out and place it inside the lard-filled bag. The tops of each side should close, forming a seal and trapping the lard between two layers of plastic, and leaving an opening for your hand.
4) Have students put the "bag of blubber" on one hand, and smooth out the layer of lard so it is spread evenly. An elastic band or some string may be helpful to keep the bags from sliding off their hands.
5) Instruct the students to immerse both hands into the cold water, being careful not to get water inside the bag.
6) See how long students can comfortably keep each hand in the water. Which hand gets colder more quickly? Why? If you were to spend your whole life in cold water, what would be a good way to keep warm?

ANATOMY AND PHYSIOLOGY
13. **Cetacean Creations**

Level: K-3, 4-7
Objective: Students will design and construct a whale out of household items and relate structure and behaviour of whales to their survival in the world's oceans.
Background:
There's a new group of whales in the world, Family Inventidae! This wondrous new whale family has been reported living in oceans all over the world. They are a variety of shapes, sizes and colours. In fact, the shape and size of their body, head, fins, flippers and flukes are all up to the imagination of the designer. But, before the students begin, there are a few things to keep in mind:

1) All of the materials they use must be found around the house and school. Have the students make sure they are allowed to use all the materials they have.
2) Students must be able to explain how all the materials they chose help the whale survive in a specific environment. For example, a Pin-nosed Bottle Whale has a mouth made of a clothes pin so it can pinch its prey from the water. It's sleek, bottle body gives it a streamlined shape, and it's transparent colour helps to camouflage it from ocean predators. This whale also has spoon shaped flippers to help it swim.
3) In order to be classified as a whale, these creatures must have a torpedo-shaped body, breathe air and have a horizontal tail.

Whales occupy a variety of habitats around the world: the Atlantic, Pacific and Indian oceans, in temperate and tropical climates, as well as the Arctic Ocean and Antarctic Sea. Whales can inhabit nearshore or offshore environments. Most whales span a variety of habitats depending on the time of year.

Materials: anything that can be found around the house (e.g. paper bags, bottles, screws, strainers, nuts, bolts, aluminum foil, utensils and cardboard).
Procedure:

1) Students choose a specific habitat, then design and construct, using household items, an imaginary whale that can survive in that particular environment.
2) Students name the whale and give an oral presentation to explain why the whale looks the way it does. Encourage the students to be creative and discuss all aspects of a whale's life. This includes how it eats, where it eats, where it lives, behavioural displays and other field marks; students can even invent and perform the songs of their whale.

ANATOMY AND PHYSIOLOGY

14. **Keeping the Heat In**

Objective: Students will compare heat loss in objects with different surface area to volume ratios, and relate the physical characteristics of whales to the environment in which they live.

Level: K-3, 4-7

Background: Whales have a very small body surface compared to their massive volume. That's why they look the way they do - a torpedo-shaped body with small limbs. Evolution has decreased the amount of surface area exposed to the external environment while increasing volume. Although they spend a lot of time in cold water, whales' bodies are well adapted to the cold and for preventing heat loss. Whale adaptations include heavy, round bodies, short, stubby limbs, and a thick layer of blubber.

Materials: hot and cold water, two plastic sandwich bags, a disposable plastic glove, a Styrofoam cup, three thermometers (optional), a dishpan, bucket or similar container.

Procedure:

1) Fill the container half full with cold water. This represents the cold ocean.
2) Put equal amounts of hot water into the glove and each sandwich bag (use enough water so the fingers of the glove are filled out). Tie or tape the bags and glove shut.
3) Feel each bag and the glove and remember how hot each felt. They should all feel the same.
4) Put one of the bags of hot water in the Styrofoam cup. Bend the tops of the cup in like a lid to seal the bag tightly inside.
5) Place the glove, hot bag, and closed cup into a bucket of cold water. Leave them in for about five minutes.
6) Remove the glove, bag and Styrofoam cup from the water. Remove the bag from the cup. Feel each again. They will now feel quite different. The glove will feel the coolest and the bag from the cup will be the warmest.
7) Optional: Do the experiment again but use a thermometer to record the actual before and after temperatures of the bucket, bags and glove, or monitor the temperature of each example throughout the experiment.
8) Discuss the results. The glove is like an animal with long legs. It has a lot of surface area and very little volume. If a whale had long legs, its body would cool quickly in the cold ocean. The plain sandwich bag shows how having no legs helps a sea animal. It remains warmer than the glove. But by far the warmest bag is the one from within the cup, showing the advantage of insulation, much like the blubber in a real whale.

ANATOMY AND PHYSIOLOGY

15. **Go with the flow!**

Objective: Students will demonstrate heat transfer in a countercurrent system, and explain the importance of conduction in heat-energy transfer.

Level: 4-7

Background: Thermodynamics is the science of energy, and its basic principles are that heat flows and that cold is an absence of heat. Heat energy can be transferred in a variety of ways, including conduction, convection and radiation. The countercurrent flow in the blood vessels in whale flippers and flukes is an example of conduction. Warm blood in arteries passes by the veins where heat is transferred and returned to the central core of the body. This activity will duplicate the whale's countercurrent heat exchange system.

Materials: two sections of thin plastic tubing - each approximately 1.5 metres long, two funnels, hot and cold water in containers, two buckets, two thermometers.

Procedure:

1) Get two four-litre (one-gallon) containers. Fill one with hot water and one with cold water. Measure the temperature of each.
2) Keeping the tubes separate, use the funnel to pour the water from each container through its own tube. Make sure that the end of the tube is placed in its respective bucket.
3) Measure the temperature of the hot water as it exits the tube. There should be a minimal amount of change in temperature from start to finish for both the hot and the cold water (heat loss or gain from the environment).
4) Twist the two tubes together. Make sure the respective ends are placed in the correct bucket - cold tube in cold bucket, hot tube in hot bucket.
5) Repeat steps 1 and 2.
6) Measure the temperature of the water as it exits. The cold water should have gained some heat from the hot water. This is an example of how the whale can bring heat back into its core. The hot water will have cooled off significantly. This demonstrates how heat can be dissipated to cool off an animal.
7) Optional: Try the experiment with tubes of different thicknesses. A thicker tube provides more insulation and less heat transfer.

CLASSIFICATION OF ORGANISMS

16. **Linnaeus' Latin Lingo**

Objective: students will understand the use of scientific names by using Latin and Greek words to decipher species names of whales.

Level: 4-7

Background: Every different type of plant and animal has a unique scientific name. The purpose of a scientific name is to ensure that scientists all over the world are talking about the same organism. Although common names may seem easier to remember, they can lead to confusion because there is often more than one common name for the same species. The scientific name consists of genus and species, used together like a person's first and last name. For example, the scientific name of the Sei Whale is *Balaenoptera borealis*; the genus name is *Balaenoptera* and the species name is *borealis*. The scientific name is also referred to as the Latin name, because most of the word origins are derived from Latin. These names may sound complicated, but the translations often make sense, describing a characteristic of the organism, such as colour, shape or behaviour. Others are named after a person, either the first to describe the species or in honour of someone. The Latin name for the Humpback Whale is *Megaptera novaengliae*, which means "Big-winged New Englander"; the name refers to the whale's great flippers and the waters off the New England coast where the whale was hunted. The Swedish scientist Carl von Linn (better known by the Latinized name, Carlus Linnaeus) invented this method of naming organisms, which is referred to as binomial nomenclature.

Materials: names of whales, key of root words, pencils

Procedure:

Root Words

acutus - sharp or pointed
albus - white
australis - southern
balaena - whale
borealis - northern
coeruleus - sky blue
cephale - head
crassus - thick
crucis - cross
dens - tooth
delphis - dolphin
eu - right, true
gero - bear, carry
glacialis - icy
globus - globe, ball
grampus - type of whale
griseus - grey
lagenos - bottle, flask
lisso - smooth
macros - long, large
melanus - black
obliquus - slanting
obscurus - dark
orca - a kind of whale
ops - face
physeter - blower
pseudos - false
pteron - wing or fin
rostris - beak, snout
rhynchos - beak, snout
stenos - narrow
truncare - cut off
tursio - dolphin

1) Have students decode the following species, using the root words above.

example: *Tursiops truncatus* (Bottlenose Dolphin) = dolphin with a cut-off face

Grampus griseus (Risso's Dolphin)
Lissodelphin borealis (Northern Right-Whale Dolphin)
Balaena glacialis (Northern Right Whale)
Balaenoptera borealis (Sei Whale)
Globicephala macrorhynchus (Short-finned Pilot Whale)
Stenella coeruleoalba (Striped Dolphin)
Pseudorca crassidens (False Killer Whale)
Physeter catodon (Sperm Whale)
Lagenorhynchus obliquidens (Pacific White-sided Dolphin)
Delphinus delphis (Saddle-backed Dolphin)
Balaenoptera acutorostrata (Minke Whale)
Lagenorhynchus albirostris (White-beaked Dolphin)
Globicephala melaena (Long-finned Pilot Whale)
Lagenorhynchus obscurus (Dusky Dolphin)
Balaena australis (Southern Right Whale)
Lagenorhynchus actus (Atlantic White-sided Dolphin)
Lagenorhynchus cruciger (Hourglass Dolphin)
Lagenorhynchus australis (Peale's Dolphin)

2) Use the root words listed above to create a name for an imaginary species of dolphin, and draw a picture of it. Or name the whales that were created in the Cetacean Creations activity.

SENSES

17. **Cetacean Sensations**

Objective: To learn the differences between how whales and humans perceive their environment.

Level: K-3, 4-7

Background:

Hearing

Whales have excellent hearing, which is helpful in the low light environment of the ocean where vision is less dependable. Whales are thought to hear very well at low-frequency ranges, but some whales may lack the ability to hear higher frequency sounds. They have been observed to respond to sounds such as cameras clicking underwater and boat-engine noise.

Baleen whales have a small external ear opening on each side of the head. These openings lead to an auditory canal that is completely closed by a waxy plug. It is not known how effective sound reception is through this ear canal. Toothed whales do not have a waxy ear plug, and the ear bones are not directly connected to the skull, as they are in baleen whales and other mammals. The middle and inner ear follow the basic mammalian structure. Surrounding the ear bones is a foamy liquid that contains air. The air is responsible for stopping the sound waves travelling through water and living tissues. This layer of air may acoustically isolate the whale's ear, enabling the whale to detect which direction the sound is coming from. In water, it is difficult to determine the direction of sound if the ear bones are attached to the skull, because of the disturbing vibrations coming from the skull.

Both toothed whales and baleen whales have the ability to emit sounds, although toothed whales are more developed in this skill. Baleen whales broadcast sounds widely, whereas toothed whales emit sounds in a directional manner. Baleen whales emit primarily low frequency sounds, whereas toothed whales emit a wide range of frequencies, from below 20 to 200,000 Hertz. Humans have the ability to detect sounds in the range of 20-2000 Hertz.

Vision

The sun's light cannot penetrate very far below the ocean waves, especially when it is blocked by abundant plankton near the surface. Like many fishes, whales have adapted to seeing in the dim light. First, the eye of the baleen whale is flatter than that of land mammals and the cornea is less curved. This allows better vision in low-light conditions. But a whale is nearsighted in air. A whale's eye also has a reflective layer behind its retina, called the *tapetum lucidum*, which reflects light back to the retina a second time. This takes advantage of the scarce light at ocean depths. A cat also has this adaptation, and it is this *tapetum lucidum* that causes the eye to reflect yellow when light is shined on it. A whale's retinas contain mostly rods, cells that gather more low-intensity light. Cone cells, which are responsible for colour vision, are much less abundant. The Sperm Whale has very small eyes relative to its size, which is associated with its feeding at great depths in the darkness of the sea. Whales also have no tear ducts, as their eyes are constantly bathed in water, but glands at the outer cornea and eyelids secrete an oily substance that cleans and lubricates the eye.

Smell
During the foetal stage, baleen whales have olfactory nerves and bulbs, but they are greatly reduced in the adult brain. Scientists have not yet discovered whether these structures are functional. Toothed whales have none, so they likely have no sense of smell.

Touch
Toothed whales have the sense of touch over the entire surface of the body, but they are most sensitive around the head, flippers, belly and genitals. A whale's skin is thin, sensitive and well supplied with nerves and blood vessels. Whales do not have hair, but they do have vibrissae, which are similar to the whiskers found on the upper lip of a domestic cat. In whales, however, the vibrissae are much smaller and shorter than those found on terrestrial mammals. In some species, vibrissae are present as a juvenile, and then fall out; some are retained for life; and some are present only in the embryo. Baleen whales have a well developed sense of touch. Vibrissae are usually located at the end and sides of the lower jaw and on the top of the head. They range from just a few to as many as 250 (on the head of the Northern Right Whale). Baleen whales also have dermal sensors that look like small lumps scattered over the head and snout, as well as a few distributed over the body.

Taste
The sense of taste has not been well studied. Whales have taste buds on their tongues, though not many, and those present have atrophied or degenerated. It could be that whales have no need for refined tasting ability because the constant flow of water through the mouth makes everything taste the same, like briny water. It could also be that because whales eat basically the same kinds of food, taste discrimination is not important.

Materials: blindfolds, objects for students to taste, touch, smell, and listen to.
Procedure:

1) Divide the class into small groups, and ask the students to take turns wearing the blindfold. Have each blindfolded student use one sense at a time to identify various objects:
2) Taste - have one student feed the blindfolded student an unknown piece of fruit. (check with students for allergies first).
3) Hearing - play a recorded sound, or blow up a balloon and have students guess what made the sound.
4) Touch - present each blindfolded student with an unknown object, and have them guess what it is by using only their hands.
5) Smell - have each student smell a well known scent, such as peppermint or freshly cut grass, and have them guess what it is.
6) Once every student has had a turn to use his/her senses, put away the blindfolds and discuss the activity. Which objects were the easiest/hardest to guess? Which senses were the easiest/hardest to use? Why?
7) Using the background information above, make a list of differences and similarities between whale senses and human senses. Discuss the reasons for the differences.

RITUALS, MYTHS AND LEGENDS

18. **Tale of a whale**

Objective: Students will gain an awareness of the different myths and legends surrounding whales from different cultures.

Level: K-3, 4-7

Background: The relationship between humans and whales is constantly changing. Legends, myths and rituals associated with whales have originated from many cultures throughout the world, and whales are a part of the folklore of virtually every seafaring civilization. The Greeks believed that dolphins were the friends and helpers of humans; to them, killing a dolphin was as morally wrong as killing a human.

In Scandinavian countries, people believed that there were good whales and evil whales. It was considered very dangerous to mention the names of evil whales while at sea, so they were referred to as *Great Fish*. Sailors thought that if an evil whale's name was mentioned, the whale would appear and try to destroy the boat; anyone who used the name of an evil whale was deprived of his food.

Vietnamese fishermen believed that whales were sent by the God of the Waters to protect sailors and to carry shipwrecked mariners on their backs to safety. They believed that every time a whale died, the rain would pour and the winds would howl for three days. River dolphins in the Amazon are considered sacred and thought of as the protectors of people. A person would never attempt to capture a dolphin or eat its flesh.

During the Middle Ages, most stories and pictures of whales were not based on visual observations but on second-hand descriptions of creatures that took on monstrous proportions. Many people believed that whales had huge teeth and that their blowholes were like chimneys that expelled torrents of water. Artists moved the baleen from the mouth of the whale to the side of its neck, where it formed a bristly fringe or mane. Many also believed that cetaceans enjoyed the sound of music, especially the pipes. There are numerous drawings and stories of sailors attempting to calm fierce whales with musical instruments.

The oral histories of northwest coast First Peoples tell of magic ancestors, some of whom were once whales. Magic whales travelled effortlessly through the oceans, often in the form of canoes, until they came ashore at a favoured spot. There they transformed into humans and founded villages. The human descendants of these magic whales pay tribute to them by depicting them in story, song, dance and art.

Though coastal aboriginal people of British Columbia hunted some species of whales, they always revered and respected the spirit and majesty of the whale.
British Columbia's First People never hunted Killer Whales, believing that the souls of departed noble chiefs and great hunters resided in them. But some mythic Killer Whales were malicious - they were changed into reefs and their dorsal fins, now hardened to rock, continue to threaten sea-faring folk.

On the northwest coast of North America, Thunderbird, the most powerful of the supernatural

animal beings, killed whales for food. Under the wings of Thunderbird were lightning-snakes that flashed out to kill a whale, which the Thunderbird then carried away and ate. A few people have seen Thunderbird's lofty eyrie, surrounded by piles of whale bones.

The Nuxalk (Bella Coola) people have a story of a giant Killer Whale saving people from a great flood. When the world was young the Nuxalk people were driven from their houses by a great flood. Some of the people fled to high ground on a hilltop near Bella Coola village to escape the flood, but the water kept rising and was soon threatening to overtake them. As the waters rose to the place where the people had taken refuge, a giant Killer Whale appeared. The people climbed inside the Killer Whale, which was as big as a house inside, and were cared for until the waters subsided. When the waters retreated, the Killer Whale returned the people to their homes.

Level: K-3
Materials: various whale myths and legends.
Procedure:

1) Read some myths and legends about whales.
2) Students may then draw a picture based on their favourite story and explain why they liked it.

Level: 4-7
Materials: various whale myths and legends.
Procedure:

1) Students select different First Nations legends about whales to read in class.
2) The students then write their own legends about whales, complete with illustrations. A story board or other type of visual aid could be used.