

- 1 Class Mammalia
 - Marine Mammals:*
 - Cetaceans, Sirenians, Pinnipeds, Carnivores*
- 2 Compare marine mammals to terrestrial mammals
- 3 Compare marine mammals to terrestrial mammals
 - ▲ *No pelvic appendages*
 - ▲ *Little body hair*
 - ▲ *Streamlined*
 - ▲ *Breathe through dorsal blowhole*
 - ▲ *Propel themselves w broad, horizontal tail flukes*
- 4 Describe some of the adaptations of marine mammals to their environment.
- 5 Describe some of the adaptations of marine mammals to their environment.
 - ▲ *Homeotherms but live in cold water (streamlined bodies reduce surface area and rates of heat loss)*
 - ▲ *Body fluids are hypertonic to seawater (osmoregulators) get all water from food they eat*
 - ▲ *Air breathers: surface to breathe*
 - ▲ *Cannot see in water effectively; no sense of smell (have echolocation)*
- 6 Part 1:
 - Cetaceans*
- 7 List the three size categories of cetaceans.
 - ▲ *80 species of cetaceans; few in fresh water*
 - ▲ *Great whales > 9 m (29') includes all baleen whales and largest of Odontoceti, sperm whale*
 - ▲ *Smaller whales 4-9 m (13-29') killer whales, pilot whales, beluga whales*
 - ▲ *Smallest whales 1.5-4m (5-13') dolphins and porpoises*
- 8 Describe features of cetacean morphology that contribute to their fusiform shape.

- 9 Describe the functions of blubber.
- ▲ *Insulation body from cold*
 - ▲ *Streamline body for easy mobility in water*
 - ▲ *Provide buoyancy*
 - ▲ *Provide reserve source of energy*
- 10 Explain buoyancy in cetaceans.
- 11 Explain swimming power of cetaceans.
- ▲ *All power comes from fluke which moves up and down, NOT back and forth*
 - ▲ *Muscles connect to the posterior third of the body*
 - ▲ *Speed of cetaceans are similar to that of fast fish-tuna, salmon and swordfish*
 - ▲ *Tail of whale is like 500 horse power engine*
 - ▲ *Whales swim smoothly, rhythmically*
 - ▲ *Sharks throw forward like a rocket propel by a twist of its whole muscular body*
- 12 Whale Swimming Speeds
- ▲ *Sperm whales 3-4 knots at rest, disturbed 10-12 knots and can swim up to 20 knots*
 - ▲ *Blue whale 14-15 knots for 2 hours at a time, sustain 20 knots for 10 minutes*
 - ▲ *Finback whales 18 knots*
 - ▲ *Sei whales 35 knots*
 - ▲ *Humpback whales 4 knots, disturbed 10 knots*
 - ▲ *Grey whale 4-5 knots, if disturbed 10 knots*
- 13 Describe the morphology that contributes to the diving abilities of some cetaceans.
- ▲ *Migration of nostrils from tip of snout to top of head*
 - ▲ *Blowhole permits air exchange by rolling in an arc at the surface and exposing only the dorsal surface of the body*
 - ▲ *Seal off blowhole when diving*
- 14 Describe the physiology that contributes to the diving abilities of some cetaceans.
- ▲ *Air exchange is rapid and efficient*
 - ▲ *Remove 90% of air in lungs in less than a second*
 - ▲ *Use oxygen in air of lungs more efficiently than land animals*
 - ▲ *Blood has more red blood cells*
 - ▲ *Heart rate slows and circulation to muscle mass decreases (100 beats/min to 10 beats/min)*
 - ▲ *No air in lungs, no nitrogen in blood, no "bends" or narcosis*
 - ▲ *9x more myoglobin in muscles compared to land animals*
 - ▲ *Anaerobic metabolism to provide a continual energy source-higher tolerance for lactic acid*
 - ▲ *No autonomic breathing - Higher tolerance to CO₂*

- 15 **Diving Records**
- ▲ *Porpoises retrieve objects at 330 m*
 - ▲ *Baleen whales regularly dive to 350 m*
 - ▲ *Sperm whale feeds at 1000+ m (found at 2,200 m)*
 - ▲ *Most whales remain submerged for 5-15 minutes, many can stay for 50 minutes*
 - ▲ *Sperm whales can stay submerged for 90 minutes*
- 16 **Distinguish between dolphins and porpoises.**
- 17 **Porpoise or dolphin?**
- 18 **Porpoise or dolphin?**
- 19 **Dolphin or porpoise?**
- 20 **Dolphin or porpoise?**
- 21 **Dolphin and porpoise teeth**
- 22 **Mysceti vs Odontoceti**
- ▲ *Mysceti are baleen whales *Mysceti and Odonotoceti are orders)*
 - ▲ *Odonotoceti are toothed whales*
- 23 **Baleen Whales**
- ▲ *Filter feeders, carnivorous*
 - ▲ *Feed mostly on small zooplankton*
 - ▲ *Baleen is a series of plates that hang down from the gum region of the upperjaw*
 - ▲ *Plates are not teeth but are outgrowths of the palate*
 - ▲ *Baleen is made of keratin-like hair and fingernails or claws*
 - ▲ *Plates number between 150-400 on each side of the mouth*
 - ▲ *Inner edges are frayed into threads that intertwine to produce the filter*
- 24 **Baleen**
- 25 **3 methods of baleen feeding**
- ▲ *Straightforward*
 - ▲ *gulping*
 - ▲ *Feed by side scrape*
- 26 **Straightforward**
- ▲ *bowhead and right whales use this method*

- ▲ Longest baleen (bowhead plates are 10', 3+m long)
- ▲ Mouth closed, baleen folds inward
- ▲ When mouth opens, the baleen plates spring forward
- ▲ Swim slowly through water seiving small zooplankters from water
- ▲ Feed on copepods also euphausiids, sea butterflies, mysids, and amphipods
- ▲ Head is 1/3 of body length
- ▲ Body not well streamlined
- ▲ Slow swimmers
- ▲ Most effective speed for filter is 2 knots

27 Bowhead Whale

- 18-20 m (60-65') & weigh as much as 120 tons
- ▲ Based on analyses of amino acids in whale eyes, researchers now estimate that some of the bowhead whales harvested by the Inupiat were well past a century in age. One male specimen was estimated to be 211 years old.

28 Right Whale

29 Right Whales

- ▲ Right whales' heads and lips are marked by unique patterns of callosities covered with crustaceans. These bumps are the key to identifying individuals.
- ▲ grow up to 53 feet (16.2 meters) long
- ▲

30 Gulping

- ▲ Blue, sei, minke, humpback, and bryde's
- ▲ Smaller heads more streamlined bodies
- ▲ Faster swimmers
- ▲ Series of pleated folds runs vertically from snout to almost the naval
- ▲ Cavity is connected to throat
- ▲ Expands to 6x volume of body volume
- ▲ Mouth closes inhaled water sieved through baleen
- ▲ Small schooling fish
- ▲ Bubble netting

31 Sideways scrape

- ▲ Gray whale
- ▲ Short baleen plates
- ▲ Dives, swimming on side scrapes bottom
- ▲ Sediment sieved through baleen
- ▲ Feed on right side
- ▲ Amphipods, polychaetes, holothurians, tunicates
- ▲ Also schooling fish

32 Odontocete Food Sources

- ▲ *All actively pursue prey and generally eat individual animals*
- ▲ *Main food are fish & squid, killer whales feed on marine mammals*
- ▲ *Most swallow prey whole*

33 Sperm Whales

- ▲ *Largest of the toothed whales*
- ▲ *Has two parallel rows of teeth in lower jaw only (each tooth weighs 1 kg)*
- ▲ *11-20 m in length & 20 – 50 tonnes*
- ▲ *Family group is about 10-20 individuals mostly females and calves; young males are found in pods; older males are solitary*
- ▲ *All are solitary feeders of squid (giant squid can be 20 m and 4000 Kg, octopi, fish including sharks)*
- ▲ *Some feed at depths of a mile or more*
- ▲ *Killed for oil in blubber, spermaceti in head, and ambergris for perfumes*

34 Beaked Whales (large)

35 Beaked Whales

- ▲ *Feed almost exclusively on squid and have only a few pair of teeth in jaws*
- ▲ *Dolphins and porpoises are mostly fish eaters, will eat squid if available*

36 Killer Whale

- ▲ *Only species that uses teeth to bite chunks of flesh*
- ▲ *Has 10-14 pairs of teeth in both jaws*
- ▲ *Wide range of food types*
- ▲ *In one study, a killer whale consumed 20 seals in a week*
- ▲ *Specific food depends on where whales are feeding ice pack-seals, penguins, farther from ice pack preferred food is minke whales*
- ▲ *Farther from Antarctica prefer dolphins and fish*
- ▲ *Puget sound only eat fish*
- ▲ *Will attack baleen whales-sick, injured, pregnant, or calves*
- ▲ *Gray whales circle to prevent any individual from being singled out*

37 Dolphin Feeding Behaviors

- ▲ *Aquarium dolphins eat about 15 lbs of fish/day*
- ▲ *Wild dolphins eat 45 lbs of fish/day*
- ▲ *Chase fish into narrow slippery mud banks, then grab prey and slide back on their right side*
- ▲ *Position themselves into the tides so fish will swim right to them*
- ▲ *“corralling” a group encircles a clump of fish and each dolphin feeds*
- ▲ *Fish kicking-makes huge splash fish fly upwards*

38 Dolphin Feeding Behaviors cont.

- ▲ *Swim behind shrimp boats to eat what the shrimpers miss or leave behind*
- ▲ *Follow larger animals for their leftovers*
- ▲ *Vertical circle feeding-have nose at surface of water, wait for minnows to swim by*

and eat them

▲ *Herd fish into fisherman's nets or other walls/barriers to trap fish then eat*

▲ *Hear sounds of nets hitting water and herd schools of mullets into nets*

39 **Social Behaviors of Dolphins**

▲ *Strong social bonds*

▲ *If there are more than 100 dolphins = Community*

▲ *Captive dolphins will starve themselves after the death of their tank companions*

▲ *Mother dolphins will carry stillborn babies with them for weeks after the birth*

▲ *Mother and calves will copulate as a form of bonding once the calf is a few weeks old*

40 **Social Behaviors of Dolphins** cont

▲ *Only 15% of dolphin sightings were solitary dolphins*

▲ *Can potentially use echolocation to communicate with each other about surroundings, food, or just fun*

▲ *Groups of close friends*

▲ *Females live to 44, Males live to 28*

▲ *Stick within own "community", don't mingle with the other communities nearby*

▲ *Stay in same area for years; females stay together in one place while males roam*

41 **Social Behaviors of Dolphins** cont

▲ *Pods-->Same sex or same age; calves will stay with mothers in pods of other mother-calve relationships*

▲ *Pregnant females will associate with all females; most females will have groups of close friends, although they do mingle with the other females in the pod*

▲ *calf association can last up to 4 years; in captivity, less time together*

▲ *Have babysitters--usually related females*

42 **Social Behaviors of Dolphins** cont

▲ *Promiscuous--have sex frequently with multiple partners (for fun as well as reproductive necessity)*

▲ *Young males associate with many young males in the pod*

▲ *Adult males will associate selectively, with fewer "friends"*

▲ *Females mature between 5 to 7 years; Males mature 10 to 12*

▲ *Babies swim nestled by mother's side*

43 **Social Behaviors of Dolphins** cont

- ▲ *Have one "best friend" for life*
- ▲ *Travel around during the day with the "friend" and feed as often as they want*
- ▲ *Mother will teach calf feeding techniques and the pods will teach them to each other*
- ▲ *Like to play and roughhouse*
- ▲ *12-month gestation period*
- ▲ *Nurse for 18 months (**bottlenose dolphin**)*

44 **Social Behaviors of Dolphins** cont

- ▲ *Genetic variety = no inbreeding due to variation*
- ▲ *Calve year round (**bottlenose dolphin**)*

45 **Research methods**

- ▲ *Tagging (tracking)*
- ▲ *-Observe in wild*
- ▲ *-Chromosome analysis*
- ▲ *-Autopsies*
- ▲ *-Transects*
- ▲ *-Long-term studies for intervals*

46 **Lifestyles which contribute to migration patterns**

- ▲ *Larger whales, including most of the baleen whales, and the sperm whale have well defined migration routes*
- ▲ *Migratory movements are related to patterns of feeding and reproduction*
- ▲ *Prefer to have young in warmer waters-poor food supplies, go back north*

47 **Whale Migration Patterns**

- ▲ *Many whales have large home range through which individuals continually move*
- ▲ *Sometimes there are seasonal migrations*
- ▲ *Smaller dolphins and porpoises, including killer whales, do not have set migration routes*

48 **Life History of Whales: Calves**

- ▲ *Give birth at sea*
- ▲ *May have reproductive season or it may be all year*
- ▲ *Have to get calf to surface to breathe*
- ▲ *Milk jet streams 6-7'*
- ▲ *Whale milk 35% fat, cow's milk 3-5%*
- ▲ *Calf grows 230 lbs/day about 10 lbs an hour*
- ▲ *Infancy until about 7 months*

49 Life History of Whales

- ▲ *Adolescence at about 18 months*
- ▲ *29 months may be sexually mature*
- ▲ *Dolphins are later 5-7 years for females and 10-11 years for males*

50 Cetacean senses: smell, taste, touch

- ▲ *Odontoceti-no sense of smell, but can taste*
- ▲ *Mysticeti-no sense of taste, but can smell*
- ▲ *Touch generally restricted to face and mouth*
- ▲ *Touch sensitive tubercles and bristles are common on lower and upper lips of many whales*

51 Vision

- ▲ *More important to Odontoceti than Mysticeti*
- ▲ *Whales have blind spots and do not have binocular vision*

52 Sound

- ▲ *Sound is the single most important sense of cetaceans*
- ▲ *They have reduced ears and no sound producing vocal cords*
- ▲ *All cetaceans can whistle and click*
- ▲ *Use sound for social communication, these sounds are in range of human hearing*

53 Social Communication

- ▲ *Baleen and toothed whales use different sounds for social communication*
- ▲ *Baleen whales: low-pitched sounds (20-30 KHz), moans, groans, rumbles, grunts and squeaks*
- ▲ *Odontoceti: whistles and screams*
- ▲ *Sound signatures for a number of baleen whales and sperm whales, killer whales, and dolphins*

54 Social Communication (cont)

- ▲ *Whales can recognize the sounds of other species*
- ▲ *Distress signals bring help in sperm whales and bottlenose dolphins but common dolphins and others avoid distress calls*
- ▲ *Gray whales will turn and flee from screaming sound of killer whale and beluga whales avoid areas where killer whales sounds are present*

55 Humpback Whale Songs

- ▲ *Humpback whale has "song" important in courtship used by males to communicate with each other*
- ▲ *Have complex phrases or sounds between 15-180KHz (human range)*
- ▲ *Melodious, repeated for between 7-36 minutes*

- ▲ *specific to individual whale*
- ▲ *Gradually change over the year*
- ▲ *Each year still has basic song with small differences*

56 Identify and give significance of SOFAR.

- ▲ *SOFAR: sound fixing and ranging channel*
- ▲ *At the base of the thermocline, there is a zone of low velocity sound transmission*
- ▲ *Sound waves get trapped in this layer due to the bending (refraction) of the sound waves*
- ▲ *Sound waves can travel long distances in this channel-100 to 1000s of Km*
- ▲ *Marine animals use it as long distance communication*

57 Explain the process of echolocation.

- ▲ *Echolocation used by cetaceans like radar*
- ▲ *High-pitched sounds sent out*
- ▲ *Echoes that bounce off solid objects are used to estimate distance and identify the object*
- ▲ *At blowhole, there is a pair of valves, nasal plugs with associated air sacs branching from the nasal passage*
- ▲ *This is the site of click production*

58 Click Production and Focusing

- ▲ *Sound production generated in vestibular sac as indicated by Big intensities of the clicks have been measured over surface of head centered above margins of upper jaw*
- ▲ *Clicks are directed forward by concave front of skull focused by the fatty lens-shaped melon to concentrate clicks into narrow, directional beam*
- ▲ *shape of the melon is altered by muscles to focus sound*

59 Sound Interpretation

- ▲ *Clicks are received by external ears consisting of tubes connecting the inner ear to the exterior, often plugged with wax*
- ▲ *Jawbone that abuts ear is apparently used for long wavelength sound reception*
- ▲ *Long distance, loud low-frequency sounds with poor resolution are used*
- ▲ *Short distances, high-pitched short sounds are used for resolution;*

60 Sensitivity of Echolocation

- ▲ *Dolphins can locate 1 cm long gelatin capsule or small piece of fish from a distance of 6-7m; echolocation can be focused*
- ▲ *dolphins in aquariums can distinguish between objects that are the size of a B-B pellet and a kernel of corn (each less than 1/2 an inch (1.27 centimeters) in diameter) at about 50 feet (15.2 meters) away*

61

▲ *All cetaceans produce these sounds although echolocation has not been verified in baleen whales or sperm whales*

▲ *Sperm whales are thought to have echolocation due to their feeding behaviors, but it has not been verified*

62 **Diagram of echolocation**