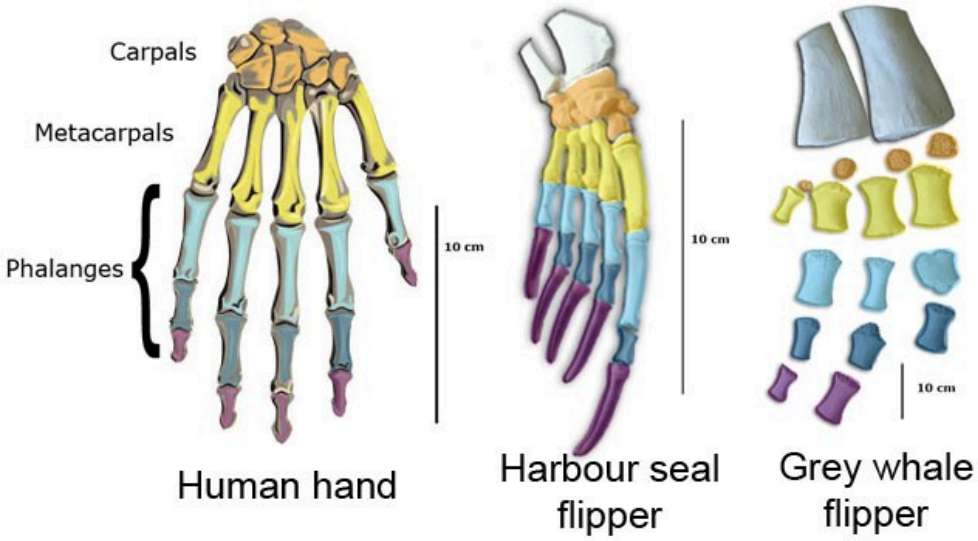
Lecture 18: Marine Mammals

Lecture 18: Marine Mammals

Mammals like you and I are a grouped with the fishes, in the Vertebrate phylum. Recall from the earlier lectures on Zoopolankton and Invertebrates, that vertebrates are the animals with bones. The marine mammals are all evolved from ancestors that lived on land, and they retain a number of characteristics that are evidence of the terrestrial origins. Even though they live in the ocean, they breathe air, give birth to live young and produce milk that they suckle their young with, and are warm-blooded.

Up to now we have talked a lot about the animals that live in the ocean, and with the exception of a few of the faster swimming fishes, all have been ectothermic – or cold-blooded. This means that their body temperature is controlled by their environment. When cold-blooded animals like invertebrates are in cold water, their body temperature is cold. This is important because their metabolism - the rate that their bodies convert food into energy to stay alive – remains low, and will increase as the water temperature around them increases. This strategy works well, until the water temperature gets too high and the heat starts to cause malfunctions – when that happens they can't keep their bodies at a suitable temperature and they suffer damage or even death. Marine mammals are different; they are endothermic or warm-blooded. This means that their internal body temperature is regulated to remain constant regardless of the environment. This is like the inside of your apartment on a cold day – your thermostat and heating keeps the inside at a constant temperature regardless of how the temperature outside changes through the day. This allows them to move among widely varying temperatures without risk of damage, but it comes at a cost. Like heating or air conditioning in your apartment, energetically costly to keep your body temperature constant.

Marine mammals are closely related to land mammals, but they have a number of amazing adaptations that allow them to live in the ocean. Life in water is very different than life in air, and the characteristics of water have lead to a number of very cool adaptations in marine mammals. The marine mammals all have streamlined bodies that are specialized for swimming. Water is much more viscous than air and so moving through this thick fluid takes more energy than moving through air. Streamlining to reduce drag helps them conserve energy when they are swimming. Many marine mammals have ears and limbs that are reduced or absent to reduce drag. They also have modified 'hands' (flippers) that are broad and effective at propulsion like the face of a canoe paddle. The bone structure of a seal flipper shows the evidence of it's similarity to land mammals like us. The diagram below shows the bones of a human hand on the left, and the bones in a seal flipper on the right. They are amazingly similar considering how differently they are used – in biology we call these 'homologous structures'.



Water also has a much higher heat capacity than air (this means it can take up more heat than air – recall this from the previous lecture on why water is so awesome). This is why you might feel cold in the ocean even when the water is room temperature. For warm-blooded mammals, this means that the water that they live in can take more of their internal body heat than if they lived on land. Marine mammals deal with this by being well-insulated by either a thick layer of fat or fur. The thick layer of fat is also known as blubber. Before there were kerosene lamps (or electric lights for that matter), whale blubber was used for lamp oil. Whale blubber was also used for making soaps before the invention of hydrogenation. The marine mammals all have large bodies which further helps reduce the heat lost by exchange with the water around them because larger bodies have lower surface area to volume ratios, meaning they have a lower area over with heat can exchange with the water than they had smaller body sizes like squirrels.

The density of water means that diving deeper in the water puts marine mammals under conditions of high pressure (pressure increases as you go deeper in the ocean). This can be very dangerous for air breathing mammals (like humans) because the pressure compresses the lungs and forces nitrogen into the blood. If the animal comes to the surface too quickly, the nitrogen gas can form deadly bubbles in the blood – a potentially fatal condition that scuba divers call 'the bends'. Deep diving marine mammals have amazing adaptations including collapsible and reduced lung volumes, slowed heart rates during dives, high blood volumes, lung bypass veins, high myoglobin levels in the blood – and more - that allow them to get to great depths chasing after prey without getting 'the bends'. Some whales can dive down to 1500 m – incredible!
Check out this video (https://youtu.be/Kr8SYy1fywc)

(https://youtu.be/Kr8SYy1fywc)
to see how one research team is using trained sea lions to learn more about diving physiology of mammals.

There are three groups of marine mammals. There are the *Cetaceans* – these are the porpoises, dolphins and whales. Sea lions, seals, walruses and sea otters are in a group called the *Carnivora*. And manatees and duogongs belong to a group called the *Sirenia*.

The Cetaceans – the porpoises, dolphins and whales – all have paddle-shaped forelimbs that function for steering, much like the wing of an airplane. Their hind legs are highly reduced and don't stick out from the body

at all. They swim using a big strong tail that generates thrust by moving up and down. They have specialized nostrils at the top of their heads (their blowhole) that have valves that ensure they don't take in water when they are submerged. They often build complex social groupings and use special vocalizations that allow them to communicate. Their vocalizations carry well in water and their songs can be heard hundreds of miles away. Some cetaceans have teeth and feed on fish and other mammals, while others feed on plankton using baleen. Baleen whales are larger than the toothed whales (the largest of all whales, the Blue whale is a baleen whale). They have keratin plates on their upper jaw that act like a big strainer for filtering zooplankton out of the seawater. They use their massive expandable mouth to gulp in huge volumes of water, then squeeze the water out through the baleen filter which keeps the tiny zooplankton inside their mouth.
Here is a video (https://youtu.be/1_BqC9lluKU)

(https://youtu.be/1_BqC9lluKU)
showing a humpback whale feeding on krill -recall from last lecture how important these zooplankton are to southern ocean food webs.

The Carnivora grouping includes the seals, sea lions, walruses and sea otters. These marine mammals are close relatives of other terrestrial predators (carnivores) like dogs, cats and bears. These animals are highly social and are able to be mobile on land, often leaving the ocean to mate and raise young. As a group, they have streamlined bodies with their four limbs modified into flippers. They are highly agile in the water, and have keen sight and smell. All of the group are fur-covered, except the mighty walrus. The seals, sea lions and sea otters are expressive, cute and very trainable. They make excellent attractions at zoos and aquariums – they can really draw a crowd. Who can resist
adorable otters (https://youtu.be/epUk3T2Kfno)

(https://youtu.be/epUk3T2Kfno)
snuggling and napping?

Dugongs and manatees (the sirenians), sometimes commonly called sea cows, are a small group of bulky, slow animals that feed on sea grasses and algae. Some are very large, they have modified front limbs that function like arms for steering. Their hind limbs are reduced and they swim with a tail that acts like a paddle. They live in relatively shallow coastal water and some species will rest floating vertically in the water. Misidentification of these animals by weary seamen are the likely source of legends about mermaids.

And here is your dose of 'weird marine biology' – the mammal edition. Ambergris are large waxy clumps that float around in the ocean and occasionally wash up on a beach. It is a rare, but highly valuable beachcomber's goldmine. It has a nice smooth aroma and has long been used in making expensive perfumes. But what makes this weird stuff? The answer is the sperm whale, and more specifically, sperm whale vomit. The sperm whale

eats all kinds of animals, but one of its favorite meals is squid. Squid are molluscs (more about molluscs next lecture) that have a very reduced and internalized shell that it uses as a beak (similar in shape to a bird beak). These beaks are indigestible, so when the sperm whale eats a squid, it packages up the beak in a waxy ball in it's intestine to protect the whale's organs from damage. Just like your beloved housecat Fluffy who has to barf up a furball every now and again, the sperm whale has to get rid of these balls from time to time. When it is first ejected (note that it was once believed to be 'burped' up by the whale, but new evidence shows that it actually comes out of the other end), the ambergris smells pretty bad, but after floating around in salt water for a few years, the smell changes to a pleasant odour, and the chemical properties make it an ideal perfume. It must be good to be sought after by the likes of Chanel N^{o}. 5 and Yves St Laurent, but I am not sure that I am all that keen on smearing whale poo on my neck.