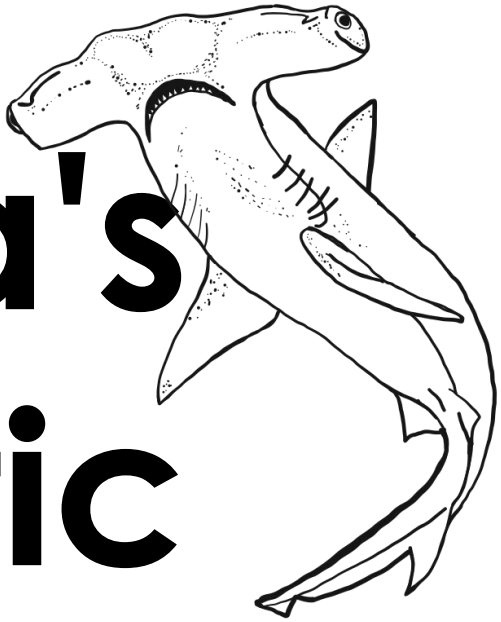
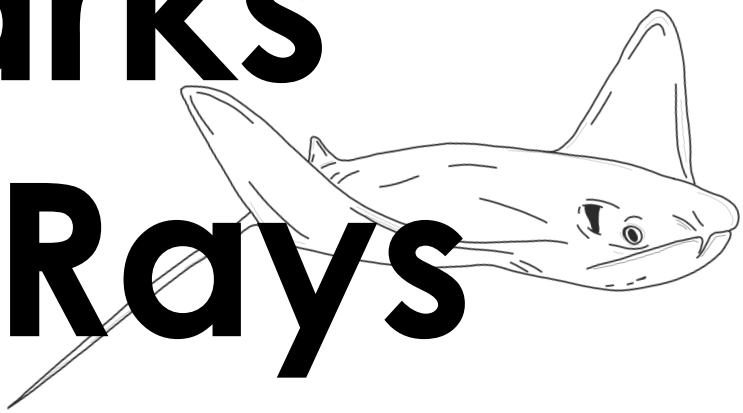
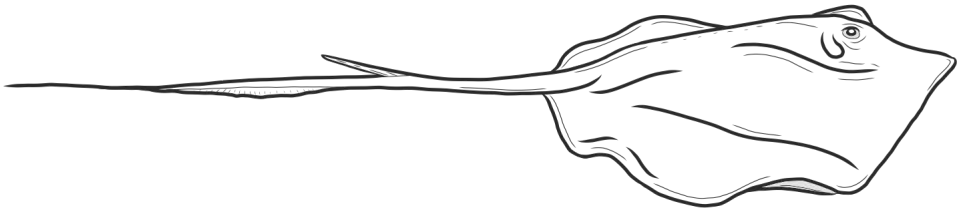


Florida's Fintastic Sharks and Rays



An at-home lesson for grades 6-8

Produced by: Florida Oceanographic Society

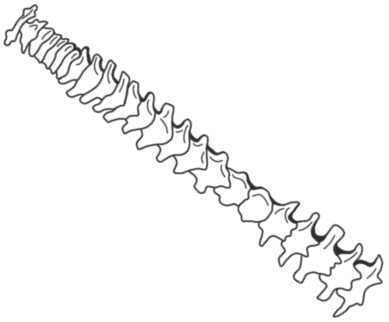


What are sharks and rays?

Believe it or not, they're a type of fish! When you think "fish", you probably picture a trout or tuna—something you'd commonly see on the end of a hook or on a plate. But fishes come in all shapes and sizes, some with saxophone shaped bodies (seahorses!) or elongated like a snake (eels!). No matter the look, all fishes share the following key characteristics that classify them into this **vertebrate** group. So before we get into sharks and rays, let's start with a more general overview that applies all types of fishes.

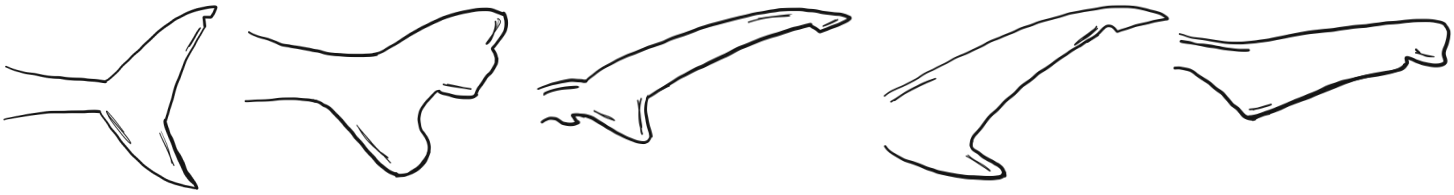
While we're at it, what is the correct **plural** version of the word "fish"? Well, it depends. If you are talking about more than one individual fish, the correct plural form is "fish" (I caught a bunch of fish today.). However, when scientists talk about multiple different types or groups of fish, the plural is "fishes" (My research focuses on coral reef fishes.)

Fishes have the simplest of **vertebrate** hearts with only two chambers- one atrium and one ventricle. The atrium brings in de-oxygenated blood from the body, pumps it to the ventricle which sends blood to the Gills. Blood is oxygenated through the vessels in the gills and circulated throughout the body.

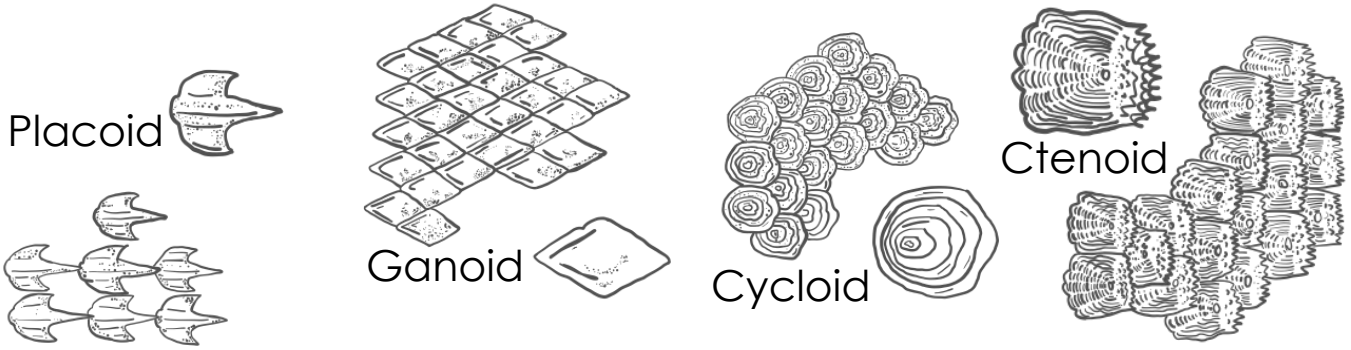


The vertebral column in a fish runs down the middle of its back in a similar manner to humans. Not all fishes have bony vertebrae.

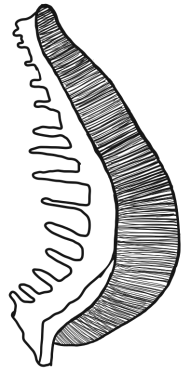
Fishes are cold-blooded, or **ectothermic**. Cold-blooded animals use their environment to warm up or cool down. The temperature of their surroundings directly affects their internal body temperature.



Fins serve a basic purpose in fish—locomotion. Fins are either paired, like pectoral and pelvic fins, or singular, like caudal or anal fins. Later in this packet we will look at the different types of fins on a fish and some of the unique ways they are used.



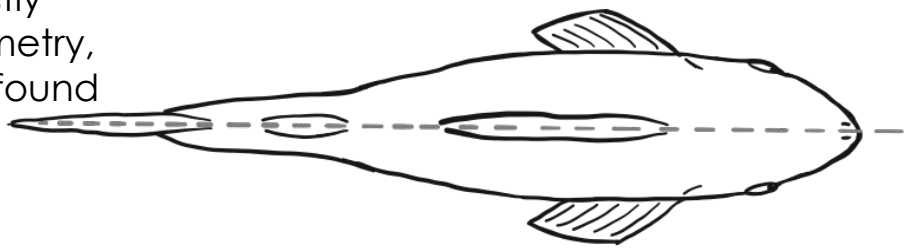
Hard protective **scales** cover the skin of many fish species. In addition to protection, scales act as "fingerprints" to help identify some fish species. They also allow fishes to become more **hydrodynamic**. In the same way a sports car has a lower profile and smoother curves to cut through the airstream (called aerodynamics), better hydrodynamics in fishes allow them to swim faster while using less energy. There are several different scale types in bony fishes, including **cycloid** (round), **ganoid** (rectangular or diamond), **ctenoid** (scalloped). Cartilaginous fishes have **placoid** scales which resemble tiny teeth on their skin.

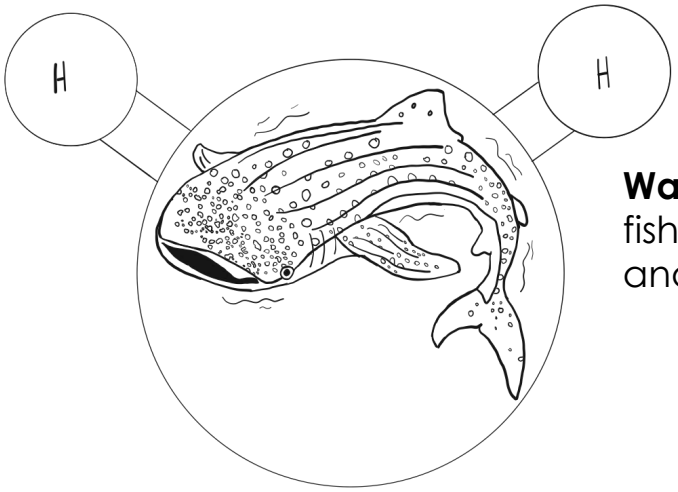


In the same way lungs extract oxygen from the air and provide it to the body, fishes use **gills** to extract oxygen from the water. A secondary function of the gills involves feeding. Some fishes use gill rakers, thin bony extensions on the front of the gill arch, to strain food out of the water.

Fishes require both male and female **gametes** in order to reproduce. Some fish species spawn using external fertilization by expelling their gametes into the water. Other species use internal fertilization. In these species, the fertilized eggs can be laid into the water, or they can be carried internally until they hatch, resulting in live birth.

Draw a line down the center of a fish, and you'll have two mostly equal sides. This form of symmetry, called **bilateral symmetry**, is found in all vertebrates.





Water provides everything needed for a fish to live. Even walking catfish and lungfish still need water to survive.

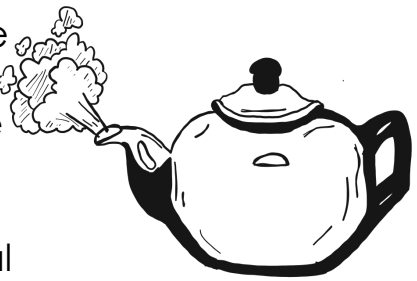
Water as a Habitat

Animals that live in the water—including sharks and rays—have to deal with some unique chemical and physical properties of H2O. Water is known as the 'universal solvent'. **Solvents** are liquids that dissolve other substances, called **solutes**, to make a solution. Salt and other minerals are dissolved in ocean water to create a healthy ecosystem in the same way sugar is dissolved into tea or coffee to make a better tasting beverage

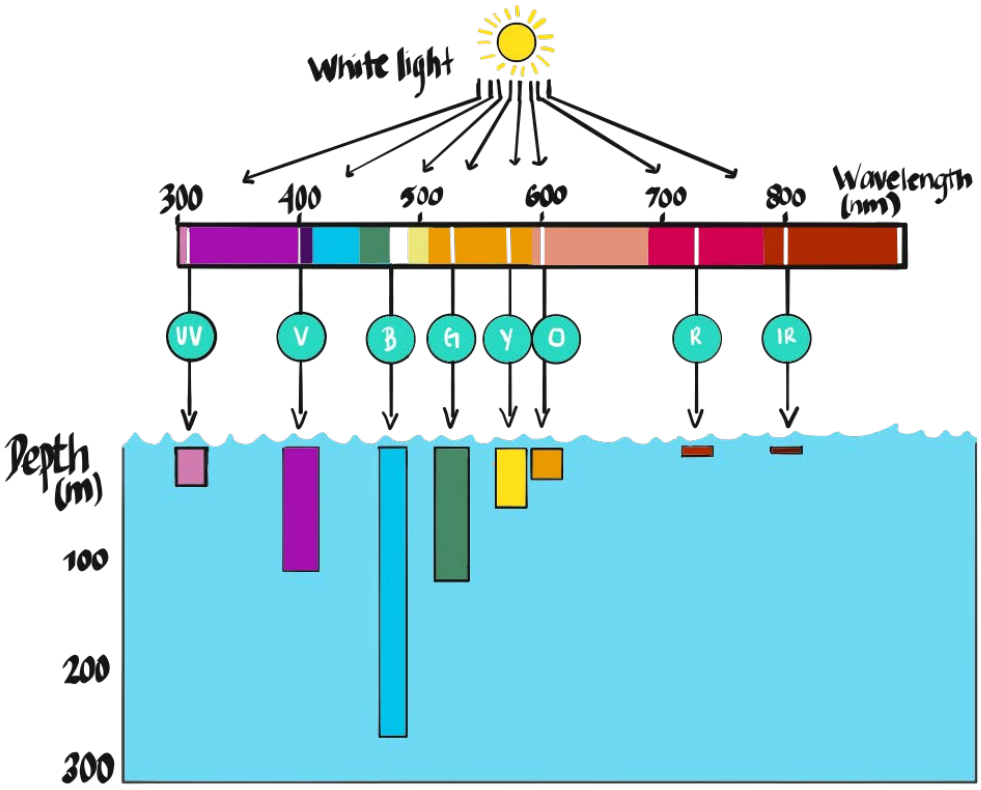
Salt water, like we find in the ocean, is defined as having a salt concentration of 30 or more parts per thousand (ppt). A higher number means more salt in the solution. For instance, fresh water is defined as 0 ppt of salt, and estuarine, or **brackish**, water ranges from 0.5 to 30 ppt. The **density** of water increases as it becomes more salty, allowing it to support larger and heavier body forms. This is why it's easier for a person to float in the ocean than in a pool.

Many aquatic animals rely on the support of water, which decreases the pull of gravity on their bodies. Saltwater animals benefit from the extra density and support of salty water. In some cases, this allows marine animals to survive without bones or a shell for support (like a jellyfish, for example). It also allows them to grow HUGE (like the blue whale), since they don't have to support their entire weight against the pull of gravity. Some of the largest animals in Earth's history have lived in the ocean.

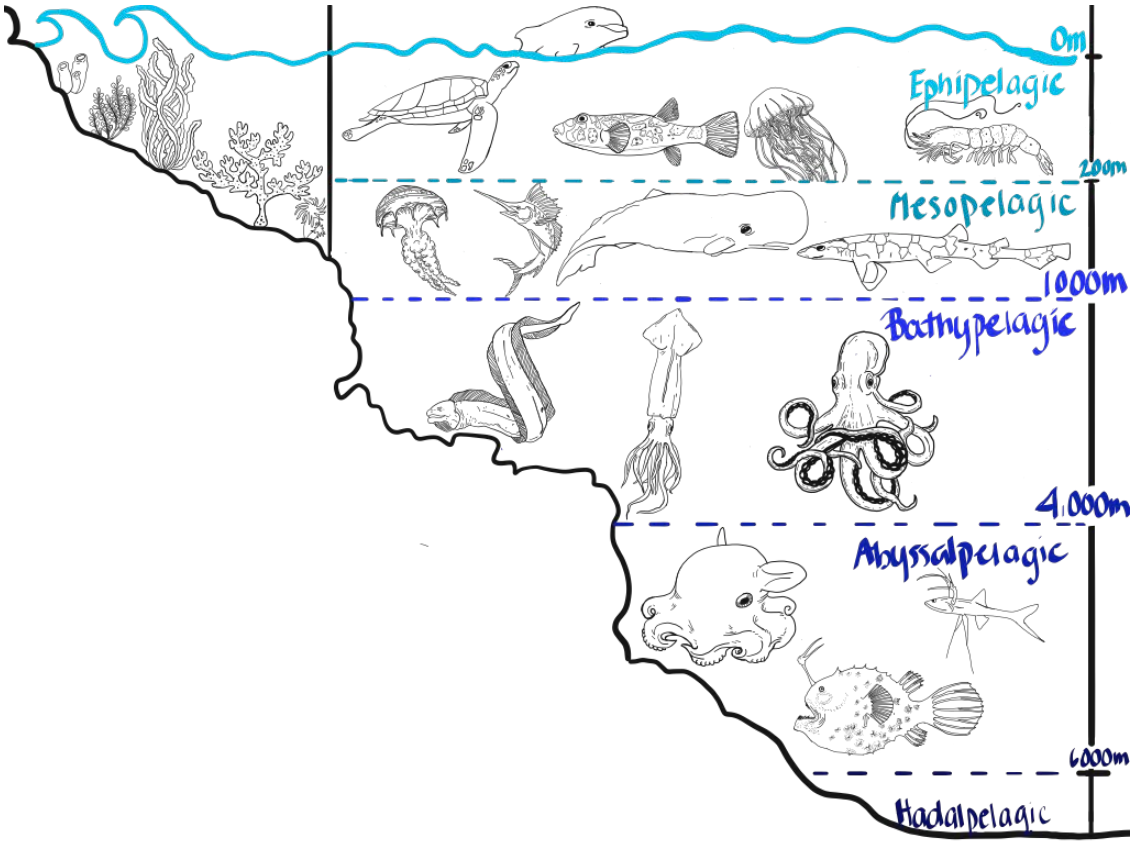
Ectothermic, or cold-blooded, animals rely on environmental temperatures to cool or warm their insides. Water naturally absorbs heat from organisms more quickly than air. For animals that are not adapted to living in the water, this can cause body temperatures to get too cold. Many **endothermic** (warm-blooded) aquatic animals have tricks to stay warm in chilly water, like thick fur, feathers, or an insulating layer of blubber (fat). Fishes don't have these options. Instead, most fishes are adapted to survive at a specific range of temperatures. As long as they don't get too hot or cold, they will remain healthy. Some very special fishes, including great white and mako sharks, can actually create their own body heat, allowing them to stay a little bit warmer than the water they are swimming in.



Animals that live in the water see things differently than animals that live on land. The deeper an animal dives, the darker it gets. This is because light does not penetrate water as easily as air. Different **wavelengths of light** disappear at different depths, so not only are the ocean's depths darker, there are fewer visible colors. Blue penetrates the deepest, which is why clear, deep water appears blue. Many plant and animal species rely on certain wavelengths, or colors, of light and can only be found in shallower depths.



Scientists divide the ocean up into different depth zones based on how far sunlight penetrates through the water. The epipelagic zone, where sunlight is still present, stretches from the surface down to 100-200 meters (328-565 feet). The mesopelagic zone starts at the bottom of the epipelagic zone, and goes down to about 1,000 meters (3,281 feet). Because only a tiny bit of sunlight is present in this area, it is sometimes called the twilight zone. The bathypelagic zone is found at depths of 1,000 to 4,000 meters (3281-13,123 feet). This is the first ocean zone where light from the sun completely disappears.



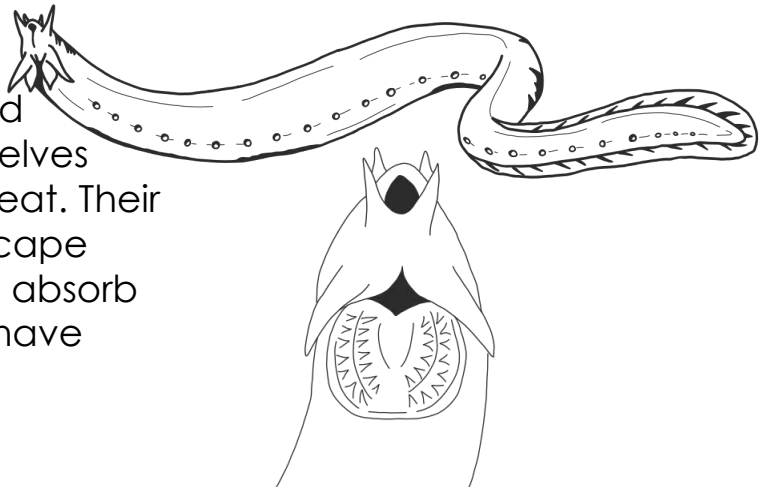
Many species of animals **migrate** between depths for feeding, reproduction, or protection. **Zooplankton** (animal-like plankton that eat things to gain energy) migrate towards the surface to feed on **phytoplankton** (plant-like plankton that use sunlight to create food) every night to eat their fill while avoiding daytime predators. During the day, they stay deep underwater, where it is easier to hide. This nightly up-and-down movement of plankton is one of the largest migrations on earth. Sperm whales and leatherback sea turtles dive into the bathypelagic zone to hunt for food, all while holding their breath.

Types of Fishes

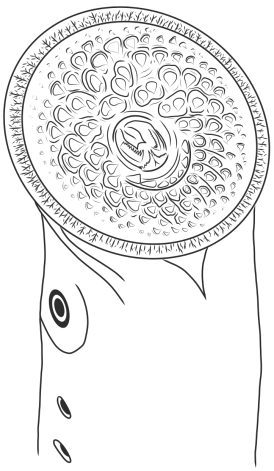
Now that we have some background on what makes a fish a fish, and how fishes deal with life in an aquatic environment, it's time to start thinking about specific types of fishes.

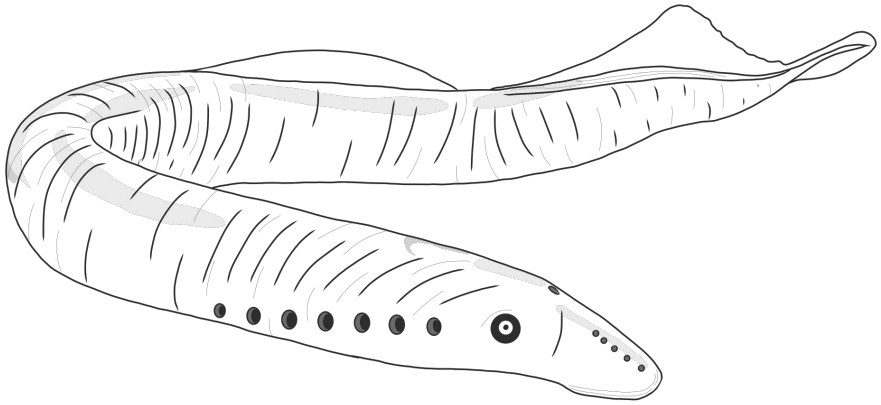
Fishes come in many different shapes and sizes. Most fishes have a jaw, just like we do. But some very primitive fishes are completely jawless! Two separate species of jawless fishes are still alive today in the group called **Agnatha**. In Latin, an 'a-' prefix means the organism is "without" the following word. Agnatha translates to "without jaws" or **jawless**. Hagfish and lampreys use suction, razor sharp teeth, and specialized maneuvers to feed

Hagfish primarily scavenge off dead carcasses. They twist and tie themselves into knots to help pull off bites of meat. Their super slimey exterior helps them escape from would-be predators as well as absorb any extra nutrients from food they have burrowed into.

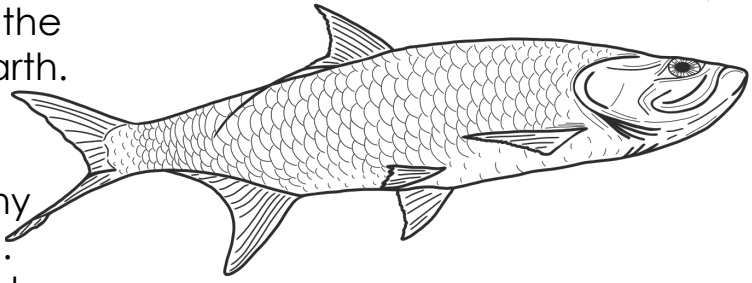


Lampreys are active predators that use their teeth to rasp away skin and flesh to connect to their host like a toothy suction cup. They suck on the host's blood and body fluid until it perishes.

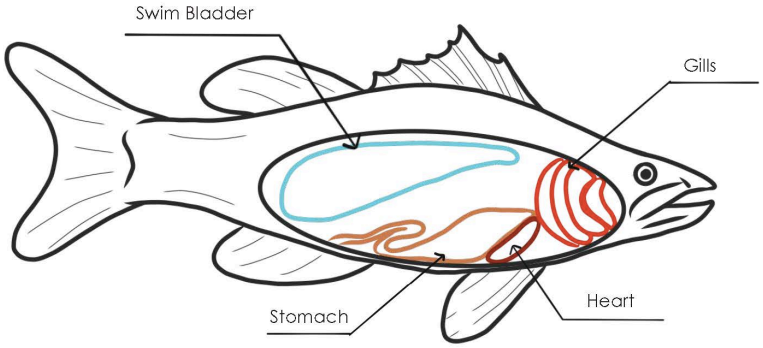




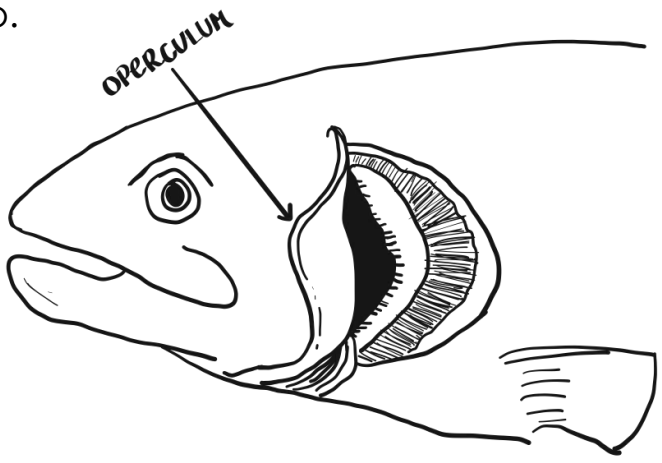
Jawed fishes in the Infraphylum **Gnathostomata** break down into two main groupings: those with bones and those without. **Osteichthyes**, or bony fishes, are the most common and numerous fishes on Earth. We can classify bony fishes even further based on the characteristics of their fins: either **ray-finned** or l**obe-finned** (with fleshy fins). Fishes with fleshier fins are prehistoric. Only eight representative species exist today. Coelacanths, a prehistoric lobe-finned fish, were once considered extinct, until rediscovered by accident in 1938.



There are over 29,000 species of **bony fishes**, superclass **Osteichthyes**, found on the planet. These fishes have bones, paired pelvic and pectoral fins, and unpaired dorsal, anal, and caudal fins. These fishes use a **swim bladder**, a gas-filled chamber, to control their buoyancy. The swim bladder is inflated either by the fish coming to the surface and taking a gulp of air or by diffusion of gas from the bloodstream into the bladder. Since air is less **dense** than water, an air-filled swim bladder allows a fish to remain neutrally buoyant (neither floating nor sinking).



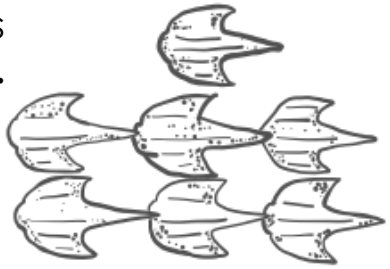
They also have bony-plated gill coverings called **operculums**. These bony plates protect the delicate gills and help the fish to breathe when motionless or hovering by acting like a pump.



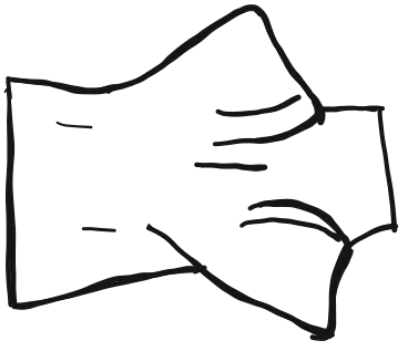
Cartilaginous fishes: Chondrichthyes

The class Chrondrichthyes is made up of two subclasses: Holocephali (chimaeras) and Elasmobranchii (sharks, skates, and rays).

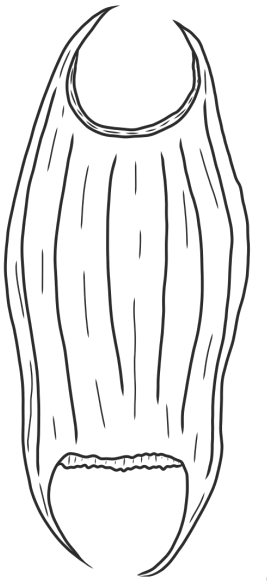
Cartilaginous fishes have **gills** that are located just inside of narrow openings, or gill slits. They are not covered by the **operculum** that bony fishes have. The number of gill slits varies depending on the species. In addition to gill slits, some cartilaginous fishes breathe through the use of **spiracles**. These openings, which are found on all rays and skates, as well as some shark species, are located on top of the body, directly behind the eyes. Spiracles act as water pumps, drawing oxygenated water in through the top of the animal and pushing the water through the body, over the gills, and out through the gill slits underneath. This helps bottom-dwelling sharks and rays from sucking in sand as they breathe. Another characteristic of animals within the class Chondrichthyes is that they have **placoid scales.**

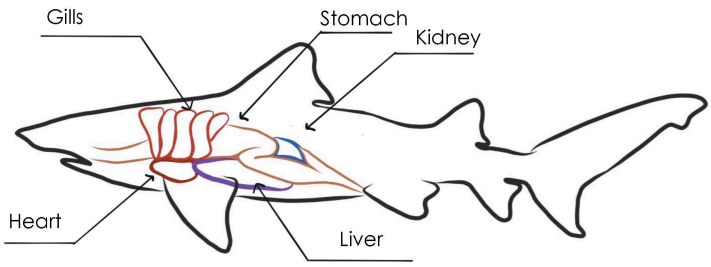


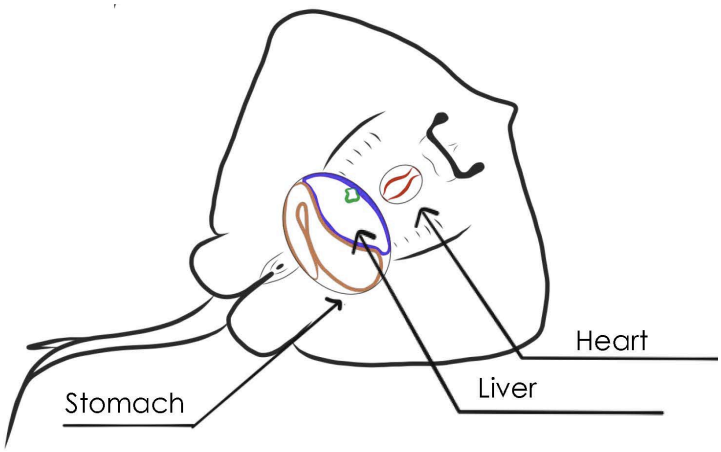
Cartilaginous fishes all use **internal fertilization** to reproduce. Males use **claspers**, a pair of special tube-shaped fins, to mate with females. In many species, males use their mouth to grasp females by one of their fins. Once positioned correctly, the male will release sperm through a clasper into the female's body to fertilize her eggs.



After mating, some cartilaginous fishes lay eggs, while others give birth to live young. All rays and many shark species give birth to live young (**vivipary**), which develop within the mother. Depending on the species, the developing sharks and rays receive nutrition from the mother either through a placenta, a yolk sac, by eating unfertilized eggs, or by feeding on siblings within the uterus. Skates and some shark species will actually lay eggs (**ovipary**) instead of giving live birth. The developing embryo gets energy and nutrition from a yolk sac inside of the egg casing. Empty skate egg cases, which are called **mermaid's purses** are sometimes found washed up on the beach.



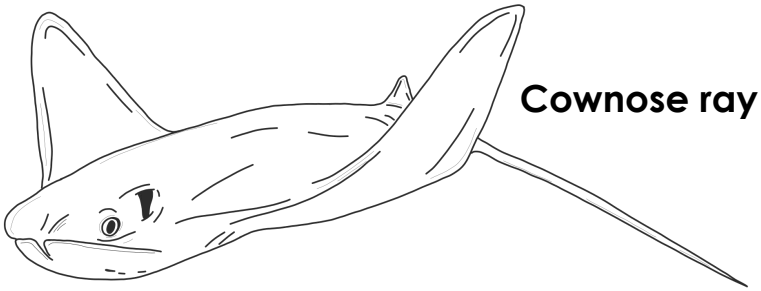




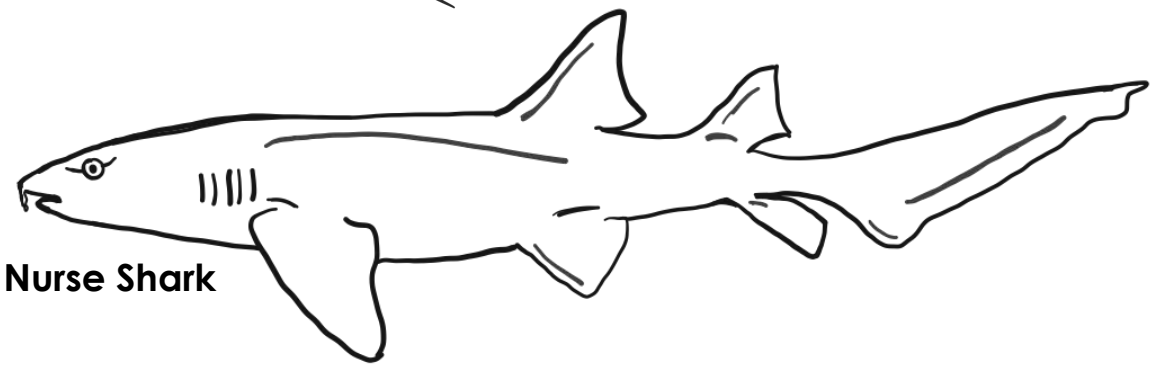
Another defining feature of the **cartilaginous** fishes is that they do not have a **swim bladder** to help control their buoyancy. Instead, these animals have a very **oily liver**.

The liver of cartilaginous fishes takes up a lot of space within their body. In some species, it can account for 30% of the internal body cavity. This organ aids in food digestion, filtering waste, and the storage of fat deposits for energy reserves. The reason the organ is described as "oily" is because of the oil, **squalene**, that it produces. This oil is lighter, or less dense, than water. Although the body of the fish may be heavy, it is able to swim through the water without sinking to the bottom thanks to the less-dense oil in its liver. The larger the liver, the more oil that is produced. Without it, these animals would use up a lot of energy while trying to swim.

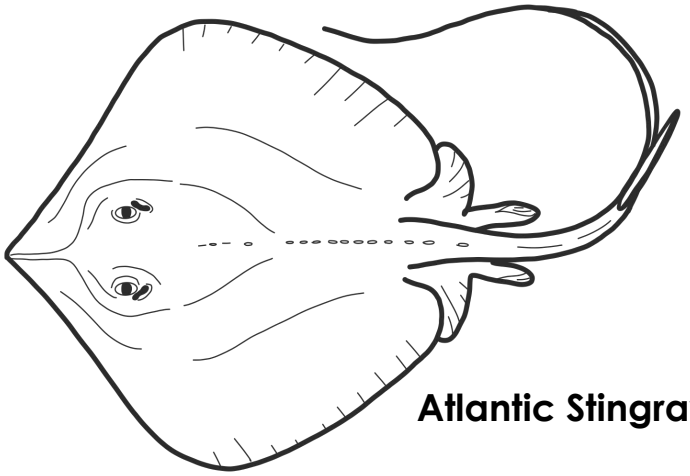
At **Florida Oceanographic Society**, we have 4 species of cartilaginous fishes: nurse sharks, cownose stingrays, southern stingrays, and atlantic stingrays.



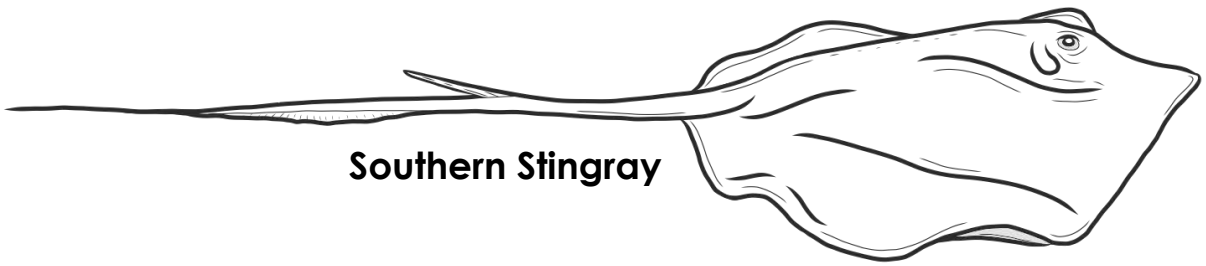
Cownose ray



Nurse Shark



Atlantic Stingray

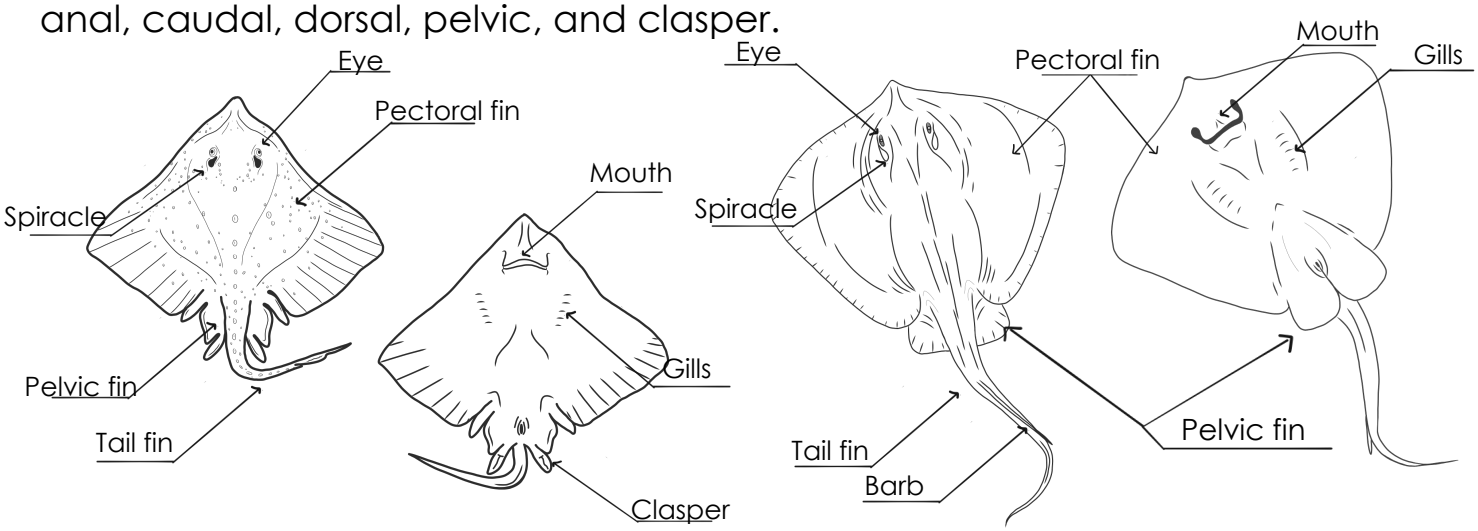


Southern Stingray

Anatomy

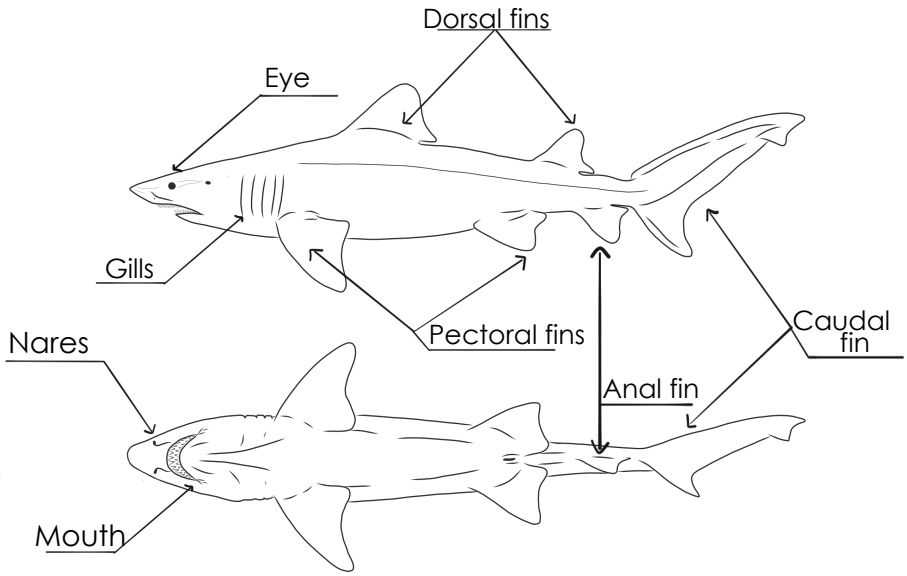
The anatomy of cartilaginous fishes does not vary too much from that of bony fishes, with which you may already be familiar. When viewing the anatomical diagrams of the shark, stingray and skate, it is useful to read each diagram like a true Marine Biologist. The three ways that you can view a diagram of a fish are **dorsally** (from above), **ventrally** (from below), and **laterally** (from the side). When describing where you would find the mouth of one of these fishes, you would direct people towards the **anterior** (front) end of the body. If you wanted to discuss the location of the caudal (tail) fin, you would have them look at the **posterior** (back) end.

Important structures to note on these diagrams are the mouth, eyes, gills, spiracles, barbs, and nares. We will discuss the use of these body parts in the section about senses. The **fins** to note on these diagrams are the pectoral, anal, caudal, dorsal, pelvic, and clasper.



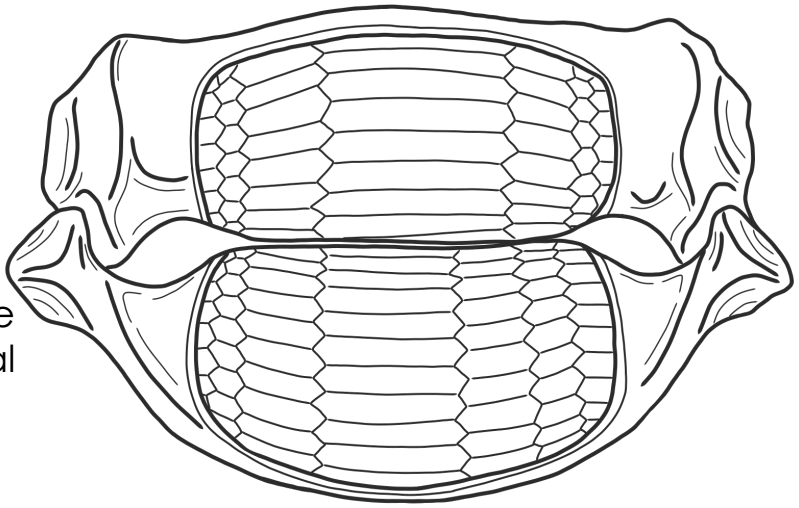
Rays and skates have a flattened body which is connected to their pectoral fins. Depending on the species, rays have different ways of swimming. Some rays flap the pectoral fins similar to a flying bird, and others ripple them.

Sharks use the caudal fin to propel or swim through the water. The shape of the caudal fin will differ among shark species. The dorsal fins help stabilize sharks while they swim, and the pectoral fins are used as rudders to help with steering.



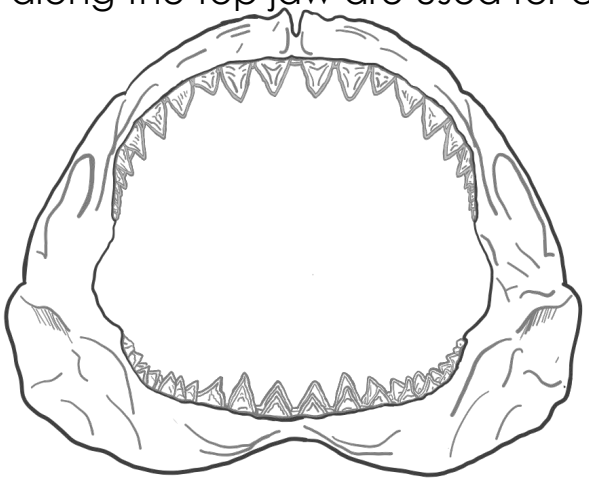
Diet

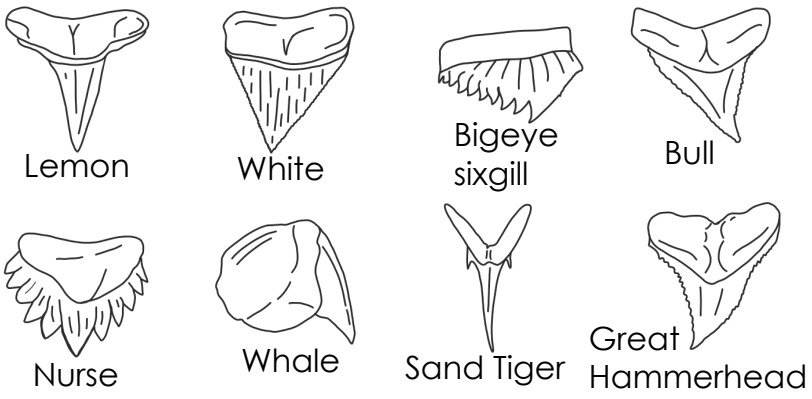
Humans only have 32 teeth and we only replace most of them once (our baby teeth), but cartilaginous fishes can have over 30,000 in their lifetime! As the teeth of these fishes wear down or fall out over time, a tooth from behind moves forward to take its place- just like a conveyor belt, constantly rotating through teeth.



Some species have teeth that are tiny or flattened—specialized for grinding or crushing their prey. Other species have teeth that aren't even designed to help with chewing. The shape of the teeth differs based on what the animal mainly feeds upon.

There are many species that have flat plate-like teeth to help them capture, crush, and ingest hard prey such as mollusks and crustaceans. Species that feed upon larger prey such as fishes, marine mammals, marine reptiles and other sharks have teeth that are very pointed and serrated. The teeth along the bottom jaw of these species are used to hold food into place and the teeth along the top jaw are used for cutting.

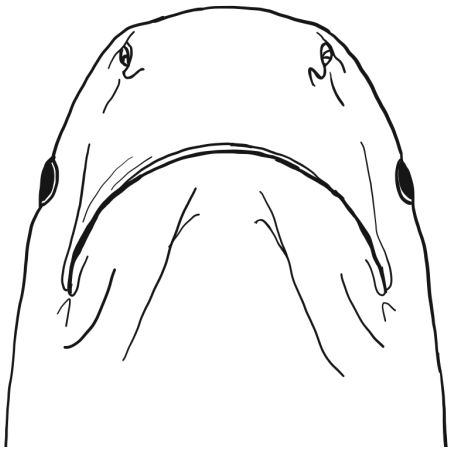


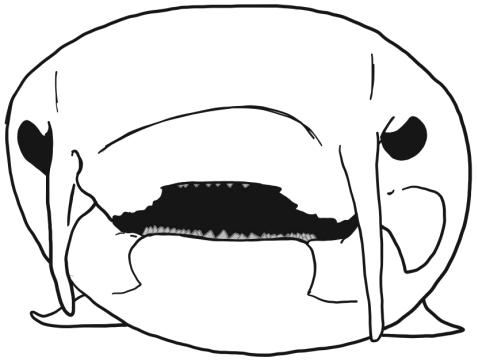


When it comes to feeding, sharks serve a very important purpose in the wild. Many shark species feed on sick, old, and injured prey because these animals are easier to catch. In turn, this helps to curb growing populations and slow the spread of disease and infection among a population.

Sensory

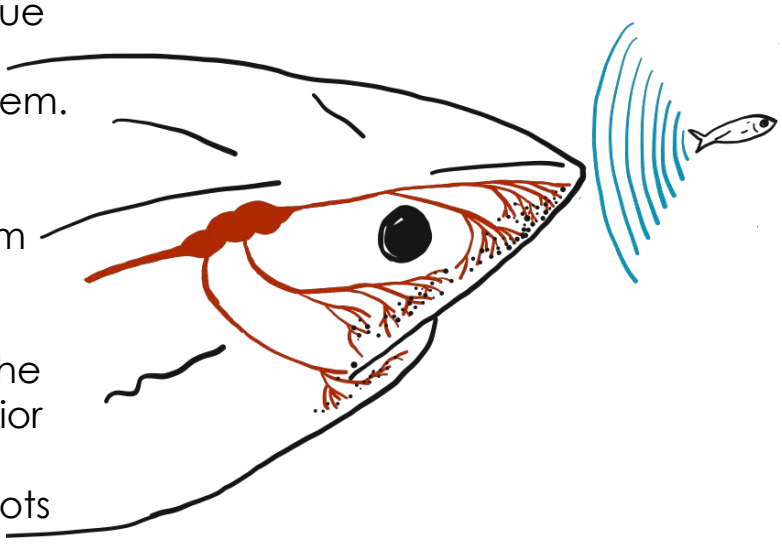
The **nares**, nasal cavities of sharks, rays, and skates, are found at the anterior end of the animal, on the ventral surface. There are two nares which can be found below the snout of the animal. Each nare has two openings for water to pass in and out of, aiding in the shark's ability to **smell** what is around its environment. Not only can these animals use their powerful sense of smell to figure out where their prey is located, they can also smell food from hundreds of meters away.



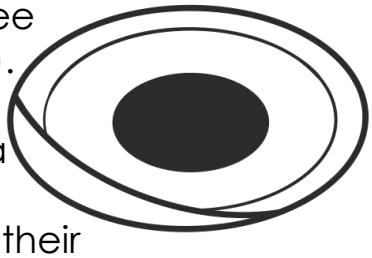


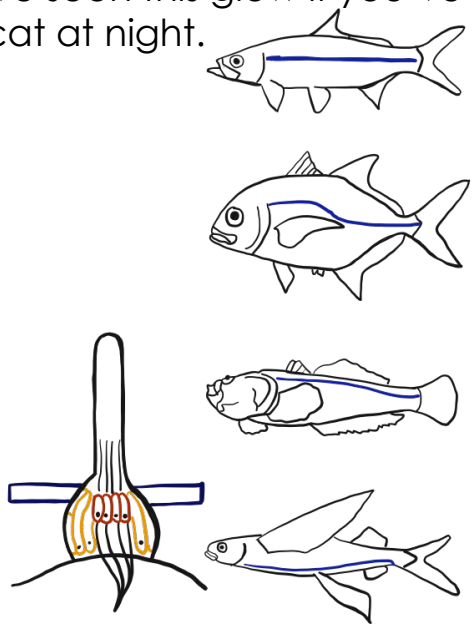
One way that some cartilaginous fishes interact with the world around them is through their **beard** or **barbels**. They **feel** and "**taste**" around on the seafloor with these sensitive appendages, which helps them to locate prey that is beneath the sand.

Cartilaginous fishes possess a very unique ability—they can **sense** the changes in electric and magnetic fields around them. These changes are produced by the muscle movement of prey and other animals. The tiny organs that allow them to sense electrical fields are called the **ampullae of Lorenzini**. These jelly-filled **electroreceptors** are apparent along the dorsal and ventral surface at the anterior end of the animal. To the human eye, they resemble clusters of small, dark spots or pores.



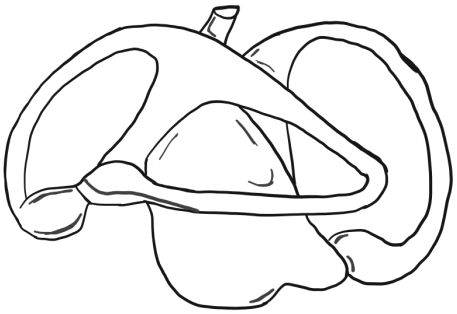
Most cartilaginous fishes have a set of **eyes** which help them to **see** any threats or prey within their habitat. For species that have eyes on opposite sides of the head, their field of vision is almost 360 degrees, meaning they can see in just about every direction except the area right in front of the snout and right behind the head. When it comes to finding prey, the **sense of sight** is not as helpful as the other senses because sharks are only able to see through the water for a distance of about 15 meters (50 feet). Once a shark gets closer to its prey, vision becomes more important. Some species of shark have a third eyelid called a **nictitating membrane,** which helps to protect the eye during feeding. For species that do not have this specialized eyelid, their eyes roll back into their head in order to ensure they are not damaged. This leaves just the whites of their eyes showing. Another interesting feature associated with eyesight is the ability of sharks to see in dark, murky waters. The **tapetum lucidum**, located behind the retina (the part of the eye that captures light and sends an image to the brain), reflects light back onto the retina to help them see better in low-light conditions. The eyes of an animal with a tapetum lucidum seem to glow when struck by a bright light. You may have seen this glow if you've ever aimed a flashlight at your dog or cat at night.





Another sensory organ, the **lateral line**, is used to detect **vibrations and pressure changes**. The lateral line runs the length of the body of the fish and is composed of many small pores that water is able to flow through. From the information gathered in those pores, the fish is able to create a pressure map of their environment. This is helpful when navigating through reefs or around schools of fish.

Sharks also have an **inner ear** on each side of their head. Sound travels farther and faster underwater, so this sense is especially helpful when searching for prey. They are able to detect prey from more than two football fields away using their incredible sense of hearing!

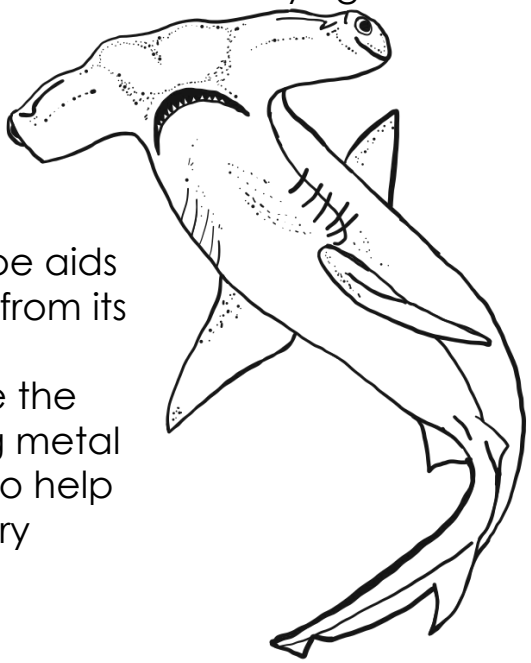


Orders of Sharks

Sharks and rays are divided in biological orders based upon their shared characteristics. The over **470 species of sharks are arranged into twelve orders**, but only eight have surviving, or extant, members. Four orders of sharks have fossil records to prove their existence but are extinct.

Carcharhiniformes contain some of the most commonly seen species of sharks. Tigers, bulls, blacktips, and hammerheads are sorted into eight families within the order. Carcharhinids, or ground sharks, share five identifying characteristics:

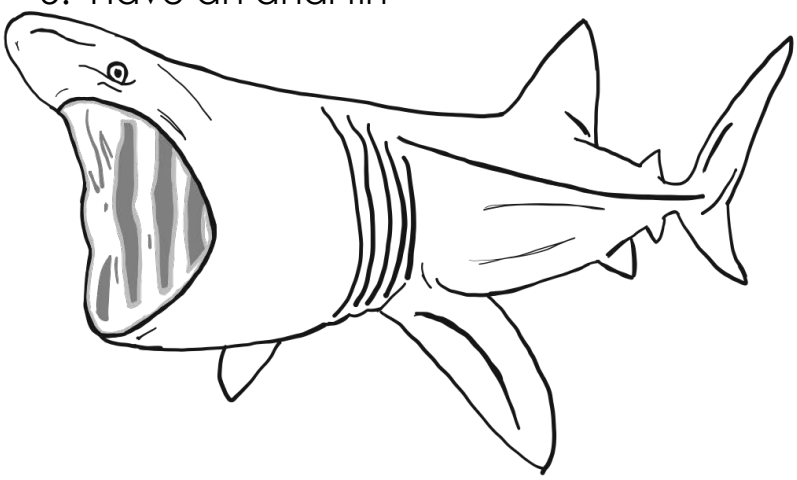
1. Nictitating membranes
2. Eyes are in front of their mouths
3. Five gill slits on either side of head
4. No spines on dorsal fins
5. Have an anal fin



A **hammerhead's** distinct head shape aids it in sensing electromagnetic pulses from its prey hidden under the sand. The cephalofoil, or extensions that make the "hammer" head, act as a sweeping metal detector and may act as a rudder to help in changing direction and depth very quickly.

Lamniformes, or mackerel sharks, contain many well-known and popular sharks. White sharks, goblins, threshers, and makos share this order and five characteristics:

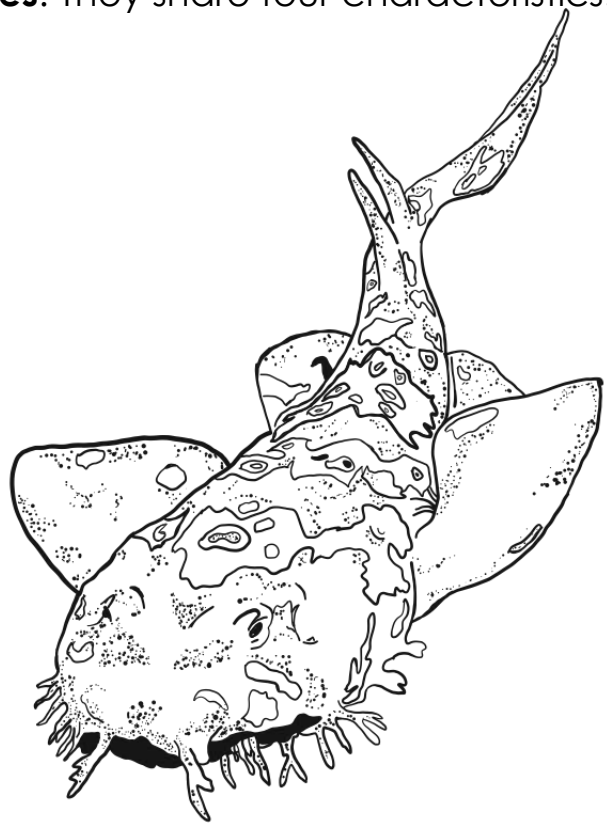
1. Lack of nictitating membranes
2. Eyes are in front of their mouths
3. Five gill slits on either side of head
4. No spines on dorsal fins
5. Have an anal fin



Although seemingly different from its order members, **basking sharks** share the same characteristics including a very large jaw. These sharks are filter feeders and the second largest fish in the world, growing to 40 feet in length. Like the whale shark, basking sharks swim with their mouth open to ingest giant amounts of plankton.

Have you ever heard of carpet sharks? Nurse, zebra, wobbegong, and whale sharks all belong to Order **Orectolobiformes**. They share four characteristics:

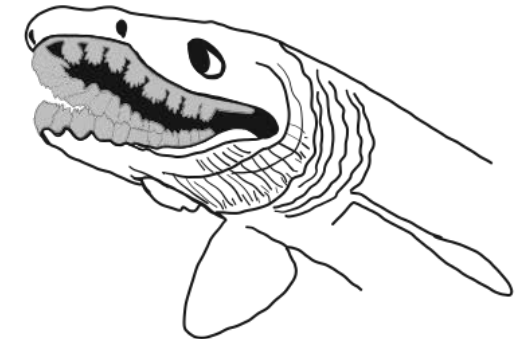
1. Mouths are in front of their eyes
2. Five gill slits on either side of head
3. No spines on dorsal fins
4. Have an anal fin



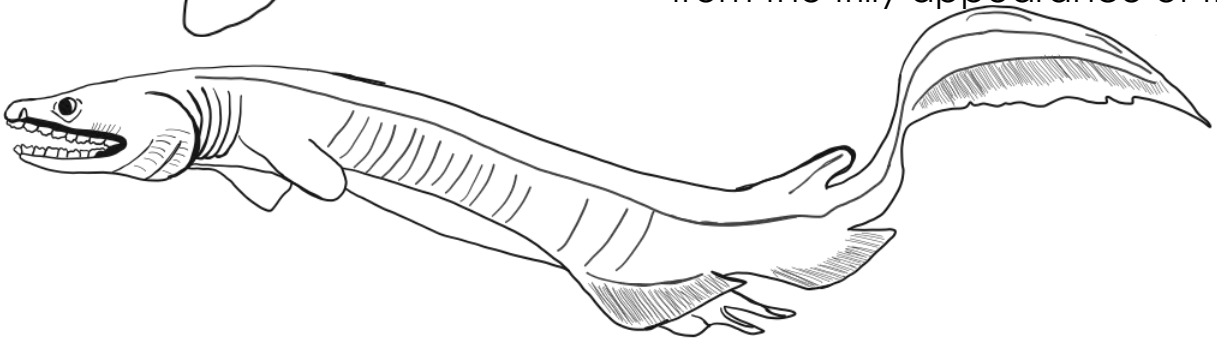
Wobbegongs sit stealthily on the ocean floor waiting for an unsuspecting meal to swim by. Their camouflage coloration and many dermal flaps, or fleshy lobes, around their face break up their body shape, allowing them to more effectively ambush their prey. Wobbegongs create vacuums as they open their mouths and suck prey animals directly into their stomachs. If a wobbegong bites onto a fish too large, they lock their jaws and squeeze until the animal is deceased.

Hexanchiformes mainly inhabit deep seas and are rarely seen by divers. Their characteristics include:

1. Six or seven gill slits on either side of head
2. A single dorsal fin far back on body
3. Have an anal fin
4. Caudal fin extends slightly above body and with a very small lower lobe
5. Large, teardrop-shaped eyes



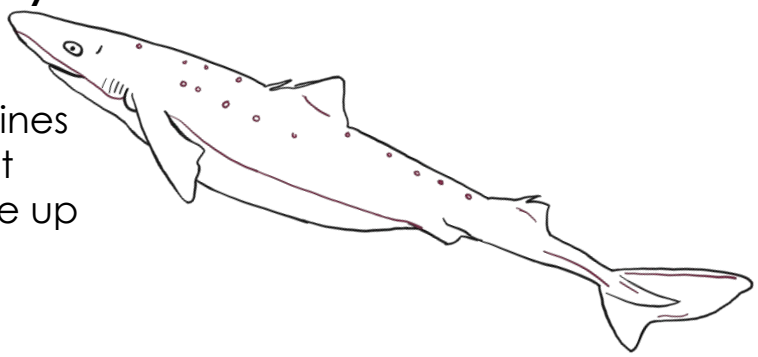
Frilled sharks resemble something from sea-faring legends. Their elongated body grows up to seven feet long; to swim, they undulate much like a snake slithering on land. Frilled sharks have pronged teeth, similar to a trident or fork, to aid in prey capture and retention. Their name comes from the frilly appearance of their gill slits.

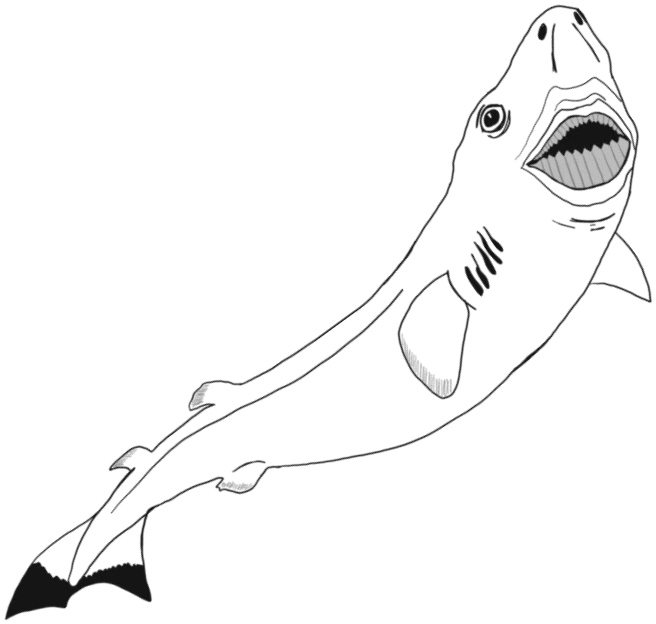


If you have dissected a shark, it was more than likely a member of **Squaliformes.** Dogfish and rough sharks share the following characteristics:

1. Spine along at least one dorsal fin
2. No anal fin
3. Large, almond-shaped eyes
4. Spiracle large and visible above and behind each eye
5. Many capable of bioluminescence

Reaching roughly four feet in length, **spiny dogfish** have been observed hunting in shivers (the name given to a group of sharks). They have unique venomous spines in front of their dorsal fins to help protect them against predators. These sharks live up to 40 years and mature between six to twelve years of age. Many species of dogfish also use **bioluminescence** to camouflage in the ocean's dark depths.

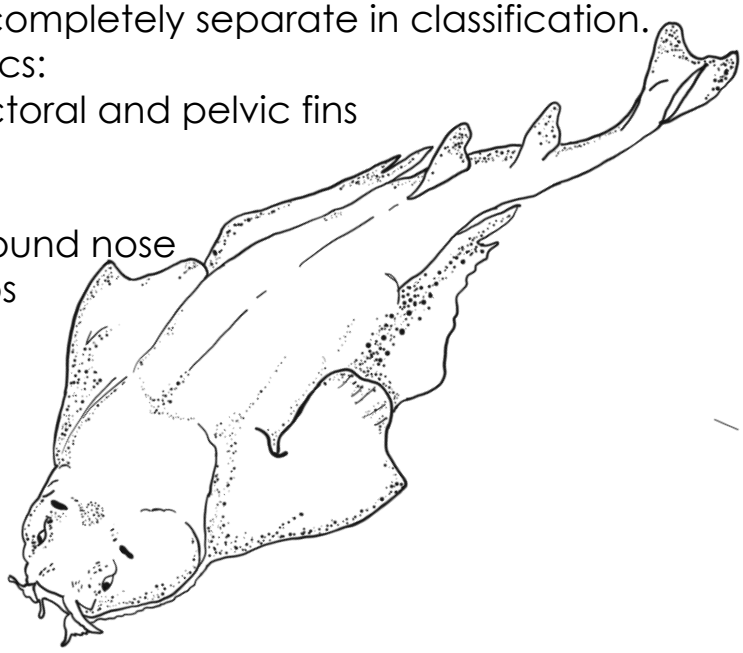




Another representative squalid is the elusive **cookiecutter shark**. This shark is considered a parasite and takes perfectly round chunks of flesh from much larger animals like dolphins, tuna, and even other sharks. The cookiecutter is a small shark, growing to no more than 20 inches in length. It has a weird trait that the dentist or tooth fairy wouldn't be very happy to hear about. Cookiecutter sharks swallow any teeth they lose, potentially because they live in a nutrient-poor deep sea environment. Talk about recycling!

Squantiformes, or angelsharks, may resemble rays and skates or even their fellow sharks, wobbegongs, but are completely separate in classification. They share the following characteristics:

1. Flattened with large, angled pectoral and pelvic fins
2. Pectoral fins start in front of gills
3. No anal fin
4. Simple, cone-shaped barbels around nose
5. Front of head with fleshy skin flaps

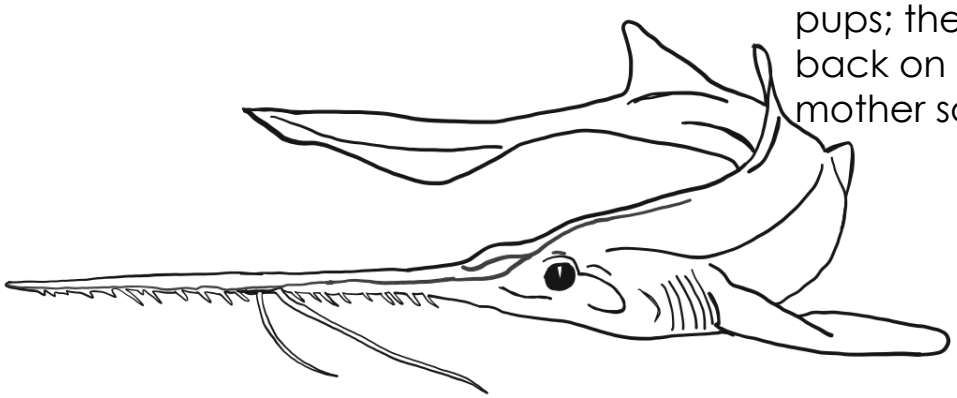


Atlantic **angelsharks**, or sand devils, stay in deeper waters around Florida and use the ocean bottom as their buffet. They give birth to 16 pups in a litter.

Pristiphoriformes, or sawsharks, strongly resemble sawfish, but don't grow nearly as large. To be a sawshark, you must have:

1. Long, flattened snout or rostrum with weakly embedded, small teeth that alternate in size
2. Long barbels located underneath, half-way down the saw
3. Two spineless dorsal fins
4. Five or six gill slits on either side of head
5. Large spiracles
6. No anal fin

Unlike sawfish, **sawsharks** can replace the teeth on their saws. They also have what looks like a mustache hanging underneath that they use to find buried prey. Mothers will birth up to 17 pups; the pups have their teeth folded back on the rostrums to hopefully keep mother safe from unintentional harm.



Horn sharks and bullhead sharks make our final extant order, **Heterodontiformes**. Their characteristics include:

1. Strong spines on front edge of both dorsal fins
2. Have an anal fin
3. Ridge above each eye
4. Pig-like snout
5. Small mouth in front of eyes
6. Caudal fin with large bottom lobe

Heterodontidae translates to "different teeth." **Port Jackson sharks** not only constantly replace their teeth like all sharks, but as they mature, their teeth change shape with their diet. As pups and young sharks, they primarily dig up small fishes, shrimp, and other small crustaceans. As they mature into adults, their diet transitions to include larger crustaceans, echinoderms (sea urchins), and mollusks (snails and clams). The sharp, spiky teeth found in juveniles cannot break through the hard shells of these crunchy creatures. As Port Jackson sharks get older, their back teeth elongate and flatten to act like crushing molars.

Orders of Skates and Rays

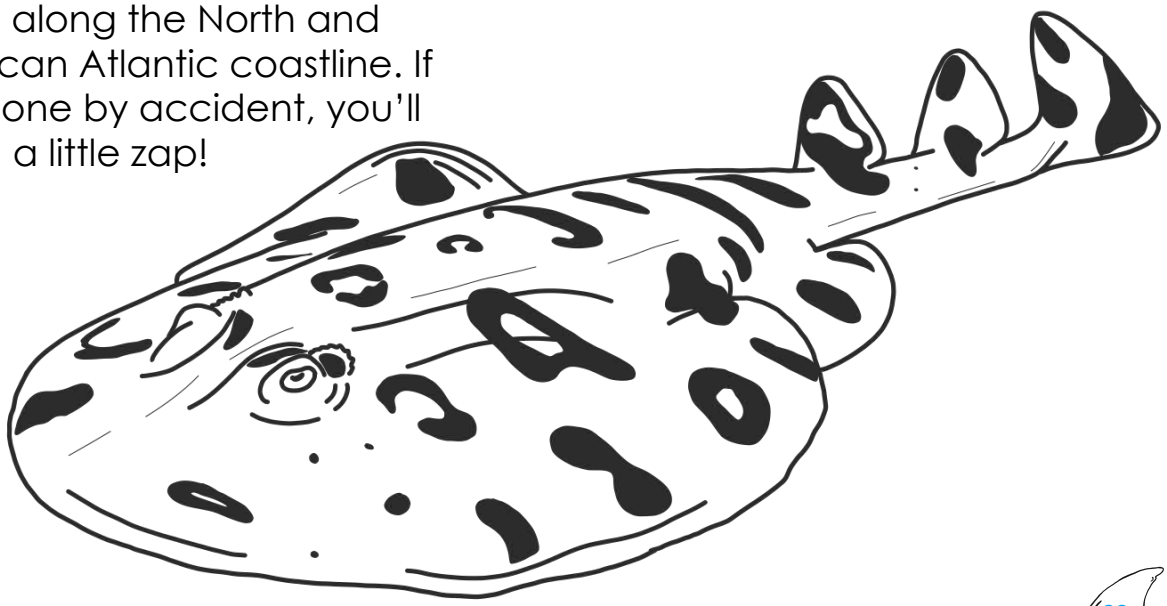
Skates and rays belong in the superorder **Batoidea** which include rays, skates, and sawfish. There are over 630 species of skates and rays, which are split into four orders.

Batoids are separated from sharks by having a dorsoventrally flattened body, meaning they are flattened from top to bottom like a pancake. Gill slits are underneath their body, instead of on the sides like sharks. They are commonly found resting on or moving along the seafloor, and have large spiracles on the top of their heads, usually behind the eyes. Fins are modified; anal fins are absent and most dorsal and caudal fins are absent or greatly reduced. Pectoral and pelvic fins are enlarged and connect directly to the head, often causing the batoid to be circular in shape.

Order **Torpediniformes** exemplifies the round shape found in many rays. These rays use electricity to capture their prey and defend against predators. Their characteristics include:

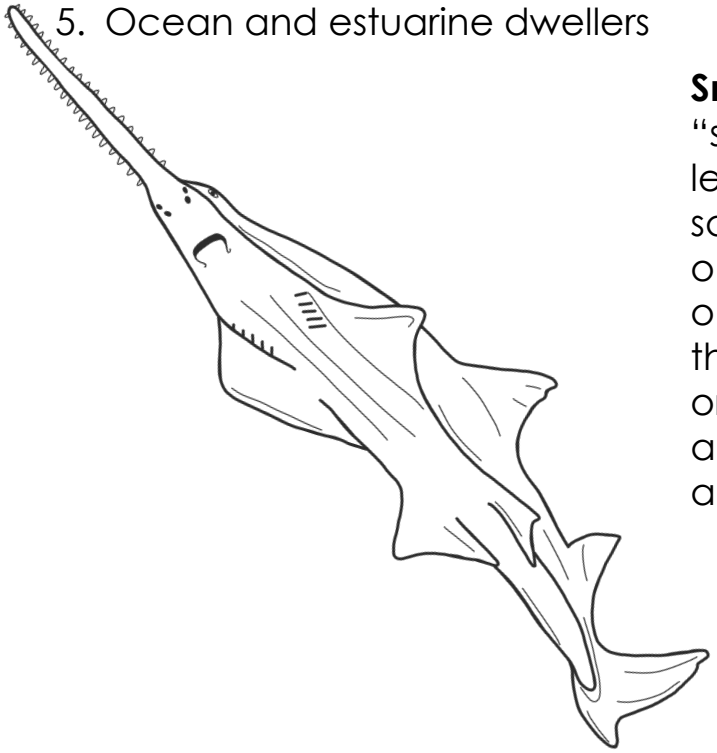
1. Rounded nose and body
2. Large, bean-shaped electricity producing organs
3. Thick and fleshy body
4. Small eyes (or no eyes)
5. Well developed caudal fin
6. Ovoviviparous
7. Only found in the ocean from temperate to tropical waters

Lesser electric rays can produce up to 37 volts of electricity. These rays are common in seagrass beds and shallow seas along the North and South American Atlantic coastline. If you step on one by accident, you'll actually feel a little zap!



Sawfishes and sawsharks look very similar to each other, however there are some pretty big differences between the groups. Sawfish, members of the order **Rhinopristiformes**, have the following characteristics:

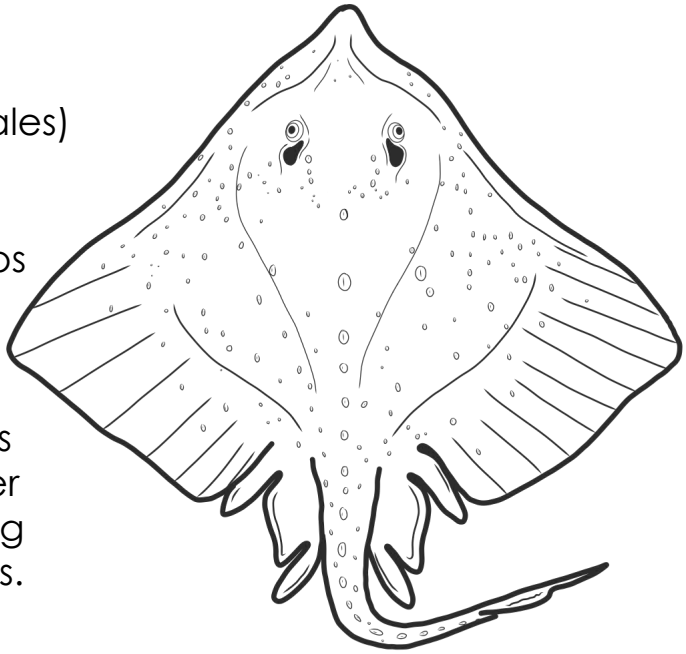
1. No barbels
2. Saw-like rostrum with deeply embedded with equal-sized "teeth"
3. Shark-like body
4. Two dorsal and one caudal fin
5. Ocean and estuarine dwellers



Smalltooth sawfish may have the word "small" in their name, but they grow to lengths of up to 18 feet! Unlike sawsharks, sawfish are not able to replace lost "teeth" on their rostrum, or saw. In fact, the spikes on a sawfish's rostrum aren't even teeth—they are highly modified dermal denticles, or scales. These animals are endangered and mysterious. There is very little is known about their life cycle.

Skates belong to Order **Rajiformes**, which includes over 200 species. Most skates are found in colder waters and have several differences from rays. Their characteristics include:

1. Pointed nose
2. More diamond-shaped body
3. Long, slender tail
4. Large, thorny dermal denticles (scales)
5. Lays egg cases

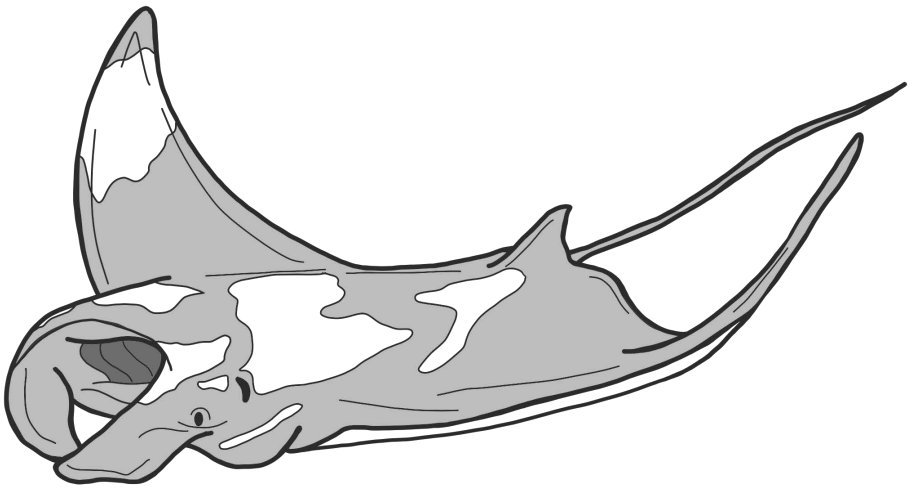


Clearnose skates have translucent flaps on either side of their snout. Florida beachcombers find clearnose skate egg cases, called "mermaid's purses", washed up on the beach. These skates migrate between shallow inshore water and deeper offshore waters depending on the season and water temperatures.

When you think of a "typical" ray, members of Order **Myliobatiformes** are what probably pop into your head. These highly recognized, sometimes enormous animals share the following characteristics:

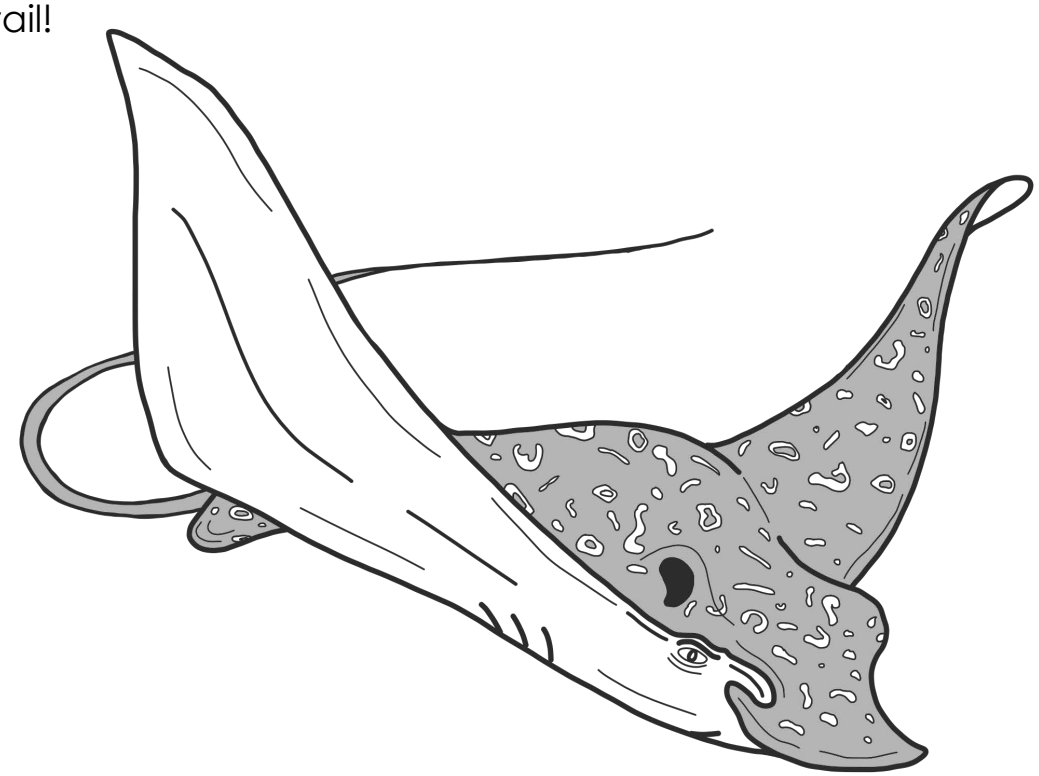
1. Body shape diamond, oval, or triangular in shape
2. Tail ranges between somewhat thick to long and slender
3. Most have a sharp, defensive **barb** on their tail—a great tool to help deter predators
4. Most have five pairs of gill slits
5. Give live birth
6. Found in marine and coastal waters in temperate to tropical zones. Some species even live in fresh water!

Many of the benthic (bottom-dwelling) species in this order have round or diamond-shaped bodies. However, species that spend more time swimming through the water have enlarged, wing-like pectoral fins. These triangular fins allow for more lift and better propulsion through the water as most pelagic (inhabiting open water) rays migrate long distances throughout their range. Some of these migrations are traveled in masses, several thousand strong. These mass migrations of rays are called "fevers."



Manta ray wingspans can reach more than 25 feet in width, making them the largest rays in the world. These gentle giants filter feed on plankton and do spirals and backflips through the water as they vacuum up their tiny prey. The cephalic lobes, a set of flaps that extend just in front of the mouth, help to funnel water through their open mouths while feeding. Although different species of fishes jump from the water for different reasons, it is thought that some mantas use belly flopping competitions as a form of courtship. The higher the jump and larger the flop, the more attractive the males are to potential mates.

Spotted eagle rays also exhibit jumping behaviors, but scientists believe it might be used by females avoiding males, for predator evasion, or to shake off parasites. Their rostrum folds into a point but opens to form a "shovel" during feeding, allowing these rays to dig through sand to find prey. Spotted eagle rays are also a type of stingray, meaning they are equipped with sharp defensive spikes known as barbs. They have been known to grow as many as seven barbs at the base of their tail!



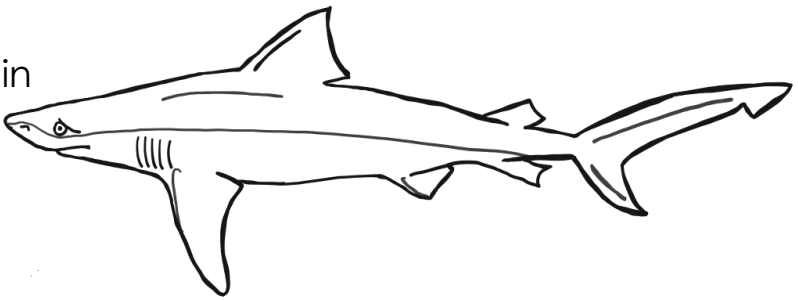
Species of Cartilaginous Fishes Found Within the Indian River Lagoon Estuary

The Indian River Lagoon Estuary is a very important body of water in our part of Florida. This shallow coastal lagoon is home to more than 4,000 different plant and animal species. Estuaries, like the Indian River Lagoon, are places where salt water and fresh water mix together, forming brackish water. Of the 4,000 total species found in the Indian River Lagoon, 23 are cartilaginous fishes.

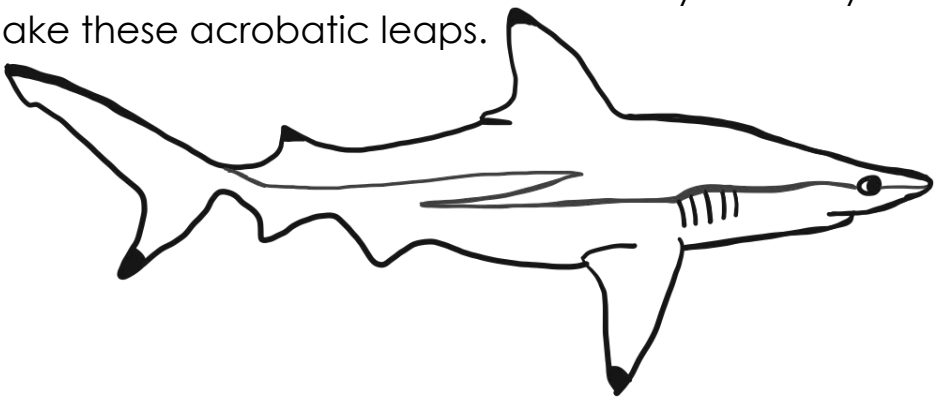
Below is a chart showing the shark and ray species found in the Indian River Lagoon and descriptions of a few of the more common species that live in the estuary.

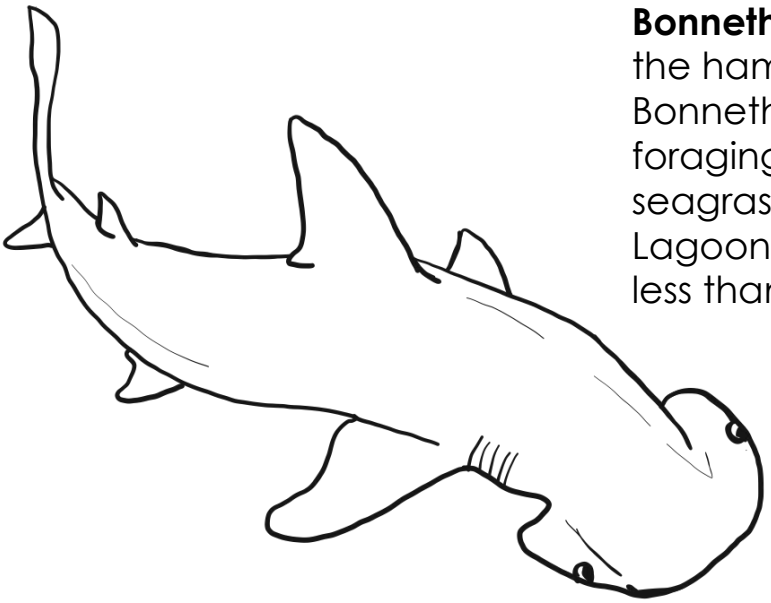
Order	Genus/Species	**Common Name**
Carcharhinformes	Carcharhinus leucas	**Bull shark**
Carcharhinformes	Carcharhinus limbatus	**Blacktip shark**
Carcharhinformes	Carcharhinus plumeus	**Sandbar shark**
Carcharhinformes	Galeocerdo cuvieri	**Tiger shark**
Carcharhinformes	Mustelus canis	**Smooth Dogfish**
Carcharhinformes	Negaprion brevirostris	**Lemon shark**
Carcharhinformes	Sphyrna lewini	**Scalloped hammerhead**
Carcharhinformes	Sphyrna mokarran	**Great hammerhead**
Carcharhinformes	Sphyrna tiburo	**Bonnethead**
Orectobiformes	Ginglystoma cirratum	**Nurse shark**
Rajiformes	Dasyatis americana	**Southern stingray**
Rajiformes	Dasyatis sabina	**Atlantic stingray**
Rajiformes	Dasyatis sayi	**Bluntnose stingray**
Rajiformes	Gymnura micrura	**Smooth Butterfly ray**
Rajiformes	Manta birostris	**Atlantic Manta ray**
Rajiformes	Aetobatus narinari	**Spotted Eagle ray**
Rajiformes	Myliobatis freminvillei	**Bullnose ray**
Rajiformes	Myliobatis goodei	**Southern Eagle ray**
Rajiformes	Rhinoptera bonasus	**Cownose ray**
Rajiformes	Pristis pectinata	**Smalltooth sawfish**
Rajiformes	Rhinobatos lentiginosus	**Atlantic Guitarfish**
Rajiformes	Narcine brasiliensis	**Lesser Electric ray**

Bull sharks are one of the most common shark species found in the IRL. This species spends a lot of time in brackish and even freshwater. They eat a variety of prey items including bony fishes, small sharks, birds and sea turtles.



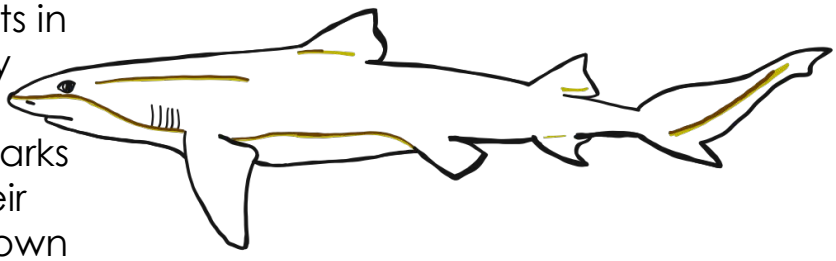
Blacktip sharks are not to be confused with blacktip reef sharks, which are a completely different species found in the Pacific Ocean. This species migrates in groups that are often separated by gender. During the winter, thousands of blacktip sharks gather right off the beach in southeast Florida. This species eats a variety of fishes and invertebrates, including many bony fishes, cephalopods, and stingrays. Blacktip sharks get their name because the tips of every fin except for the anal fin are black. The anal fin is white. Blacktip sharks are sometimes misidentified as spinner sharks because both species share a unique behavior—they jump high out of the water and spin around multiple times before splashing back to the water's surface. Scientists aren't totally sure why blacktip and spinner sharks make these acrobatic leaps.





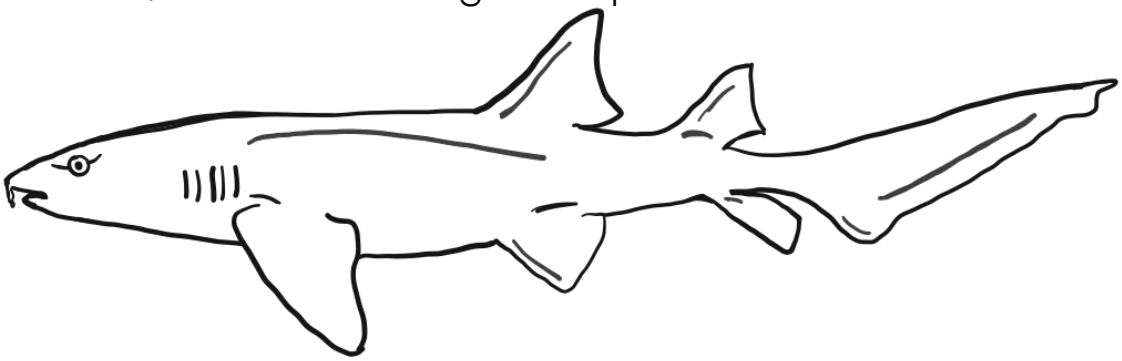
Bonnethead sharks are tiny members of the hammerhead shark family. Bonnetheads spend much of their time foraging for crabs and shrimp on seagrass beds in the Indian River Lagoon. Most adult bonnetheads are less than 4 feet long.

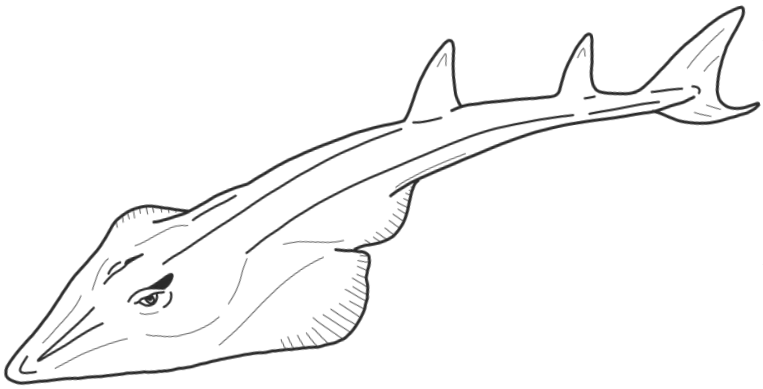
Lemon sharks are sometimes seen swimming across seagrass beds and along the edges of mangrove forests in the Indian River Lagoon, where they feed on a variety of small fishes, crustaceans, and mollusks. These sharks get their name from the color of their skin. They appear to be a yellow-brown color, which helps them blend in with the sandy bottom.



Bull, black tip, bonnethead, and lemon sharks are all in the Order **Carcharhiniformes** which includes hammerheads.

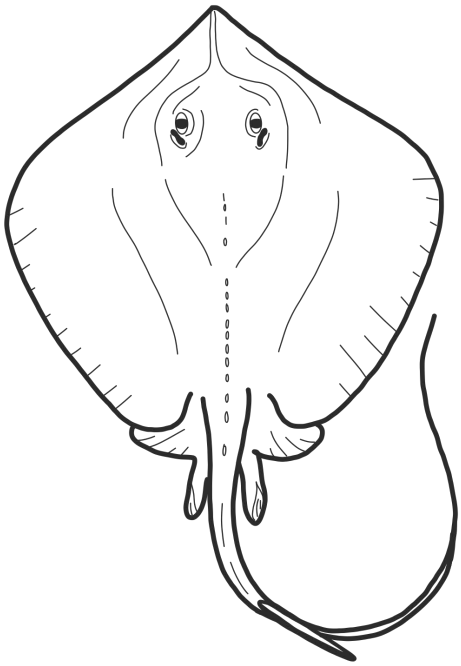
Nurse sharks are in the Order **Orectolobiformes**, along with wobbegongs and zebra sharks from the Pacific Ocean. Another name for this group of sharks is carpet sharks. This name is fitting for them because they spend most of their time resting on the bottom of the sea floor. Nurse sharks have barbels on the front of their face, which are used to help find prey. They are nocturnal, meaning that they do most of their hunting at night. Nurse sharks are suction feeders. This means that they use their mouth to slurp up food. They have such strong suction that they can vacuum a queen conch right out of its shell! You can see nurse sharks in the Gamefish Lagoon Aquarium at the Coastal Center.





At first glance, this fish looks a lot like a shark, but it's actually a shark cousin, belonging to the order **Rajiformes**, which includes rays, sawfish, and skates. You can easily see how this **Atlantic Guitarfish** gets its name. They have a pointed anterior end, a flat, disc shaped body, and a tapered, whip-like tail which resembles a guitar. These are bottom dwellers, which can be found submerged in sandy or muddy bottoms of the estuary and sometimes even in freshwater habitats.

A defining feature of the **Cownose Ray** is the indented area at the anterior end of the body, which looks a little bit like a cow's nose. The color of the dorsal surface of this species varies from brown to grey coloration. On the ventral surface, these rays are white or off-white in color. This type of color pattern—where the dorsal surface is dark and the ventral surface is light—is called **countershading**. Countershading is a type of camouflage that allows a fish to blend in with the water or sea floor when viewed from above, and with the sky when viewed from below. Many **pelagic** (living in the open ocean) sharks use countershading. Because cownose rays are pelagic, and spend much of their time swimming near the water's surface, countershading makes them less visible to predators. Cownose rays are a highly migratory species, forming huge **fevers** as they travel. You can meet and feed cownose rays at the Coastal Center.



Atlantic Stingrays are a smaller ray species, only growing to be between 1 to 2 feet across. Although they prefer shallow coastal and estuarine waters, and are primarily a **benthic** (bottom dwelling) species, Atlantic stingrays also have countershading. Dorsally, they are brown in color. Ventrally, they are wihte or grey. Along the dorsal surface of females there are rough, bumpy scales called **tubercles**. Atlantic stingrays, which can be seen at the Coastal Center, are the most abundant ray in the Indian River Lagoon.

The largest bottom-dwelling ray that you'll see in the Indian River Lagoon is the **Southern Stingray.** The tail of this much larger ray can be up to two times the length of its body! In total, they can reach 6.5 feet in length. This species is also a bottom dweller that has tubercles on its back. They prefer to live by themselves, rather than traveling in groups. They also have countershading, with a dark grey dorsal surface and a white ventral surface. Like most ray species, southern stingrays use their powerful jaws to crunch up mollusks and crustaceans for dinner. Be sure to look for southern stingrays during your next Coastal Center visit.

Shark and Ray Vocabulary

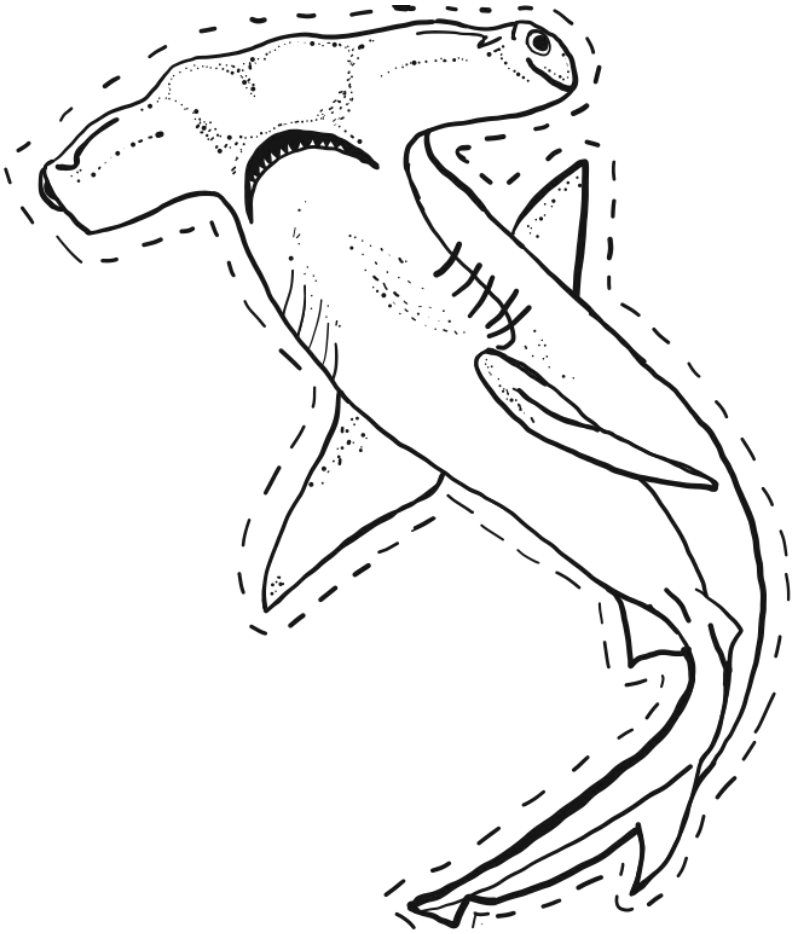
1. **Vertebrate:** An animal with a backbone
2. **Ectothermic:** Cold-blooded
3. **Hydrodynamic:** Shaped to move through water with little resistance or drag
4. **Gametes:** Reproductive cells. Eggs in female organisms, sperm in male organisms.
5. **Bilateral Symmetry:** Symmetry down the middle of an animal
6. **Solutes:** Minor component in a solution, dissolved in the solvent
7. **Brackish:** Fresh and salt water mixed together. Less salty than the ocean.
8. **Endothermic:** Warm-blooded
9. **Zooplankton:** Animal-like plankton that eat things to gain energy
10. **Phytoplankton:** Plant-like plankton that use sunlight to create food
11. **Operculum :** Hard covering of the gills in bony fish
12. **Spiracles:** water pumps used to pump water to the gills in cartilaginous fish
13. **Mermaids purse:** A skates egg case
14. **Swim Bladder:** Used for buoyancy in the water
15. **Oily Liver:** Cartilaginous fish use this for buoyancy in the water
16. **Squalene:** An oily liquid in the liver
17. **Ampullae of Lorenzini:** Electroreceptors in cartilaginous fish used to find prey
18. **Nictating Membrane:** A third eyelid that covers the eye, which protects the eye during feeding
19. **Tapetum lucidum:** Located behind the retina and reflects light into the retina to help see better
20. **Lateral Line:** A visible line along the side of a fish consisting of a series of sense organs which detect pressure and vibration
21. **Bioluminesence:** The biochemical emission of light by living organisms such as fireflies and deep-sea fishes.
22. **Barb:** A serrated hardened cartilage piece that grows out of a stingrays tail and used for protection against predators

Create your own shark lengths rope!

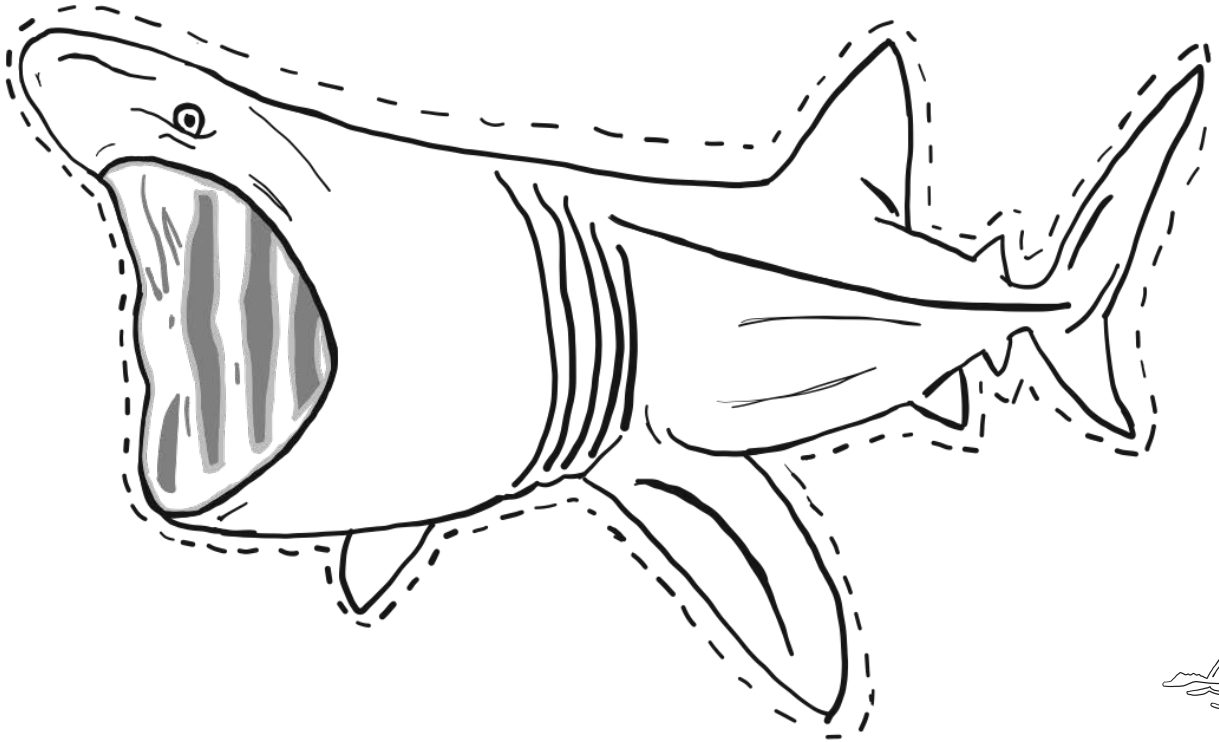
Have you ever wondered just how big sharks are compare to you?

Gather a spool of string, then cut out each of these sharks. Once each shark is cut out, measure with a measuring tape how long each shark is on the string and tape the shark cut out to the string. Then share your ropes with us on social media!

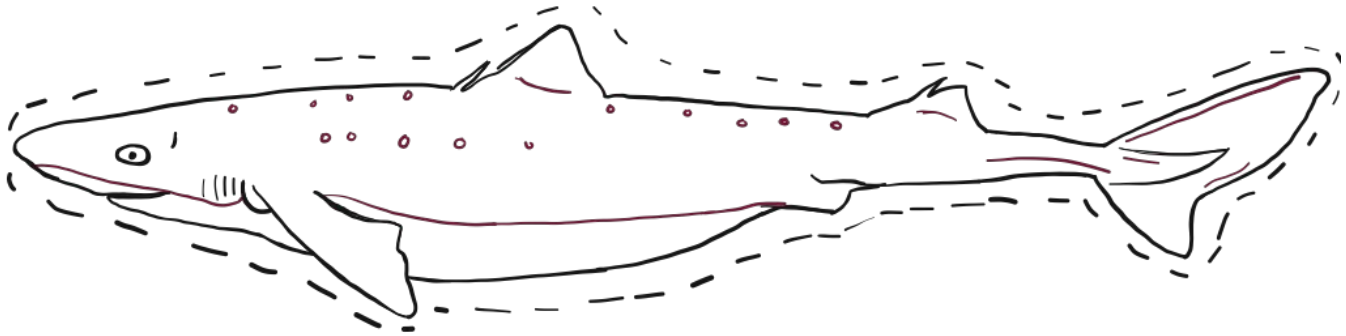
Great Hammerheads **20 ft**



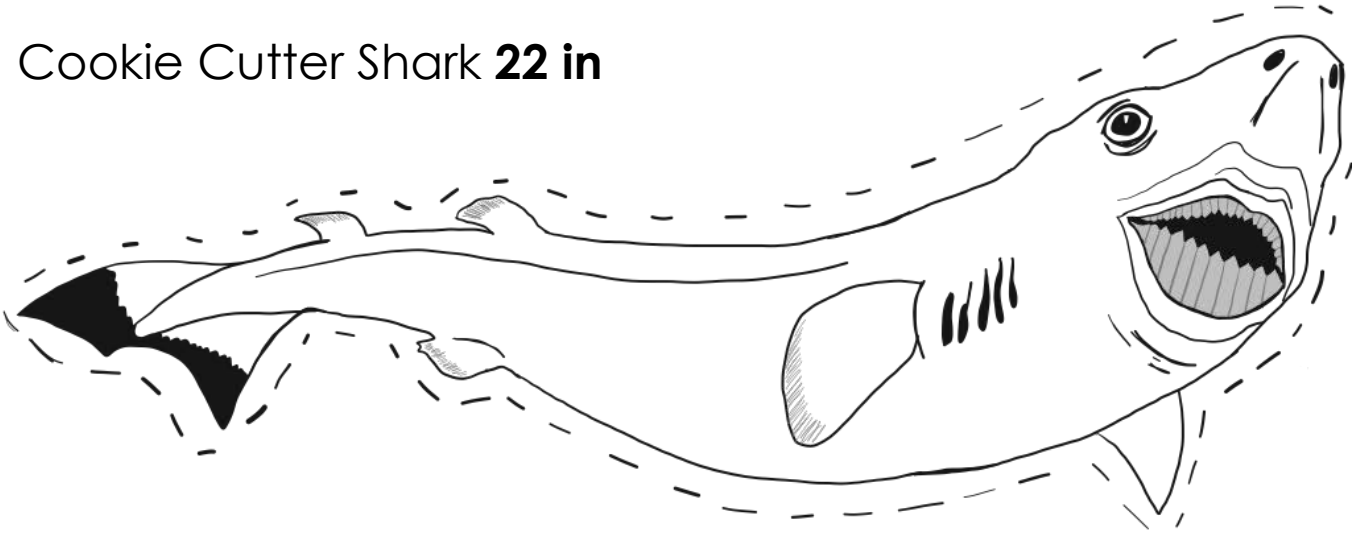
Basking Shark **26 ft**



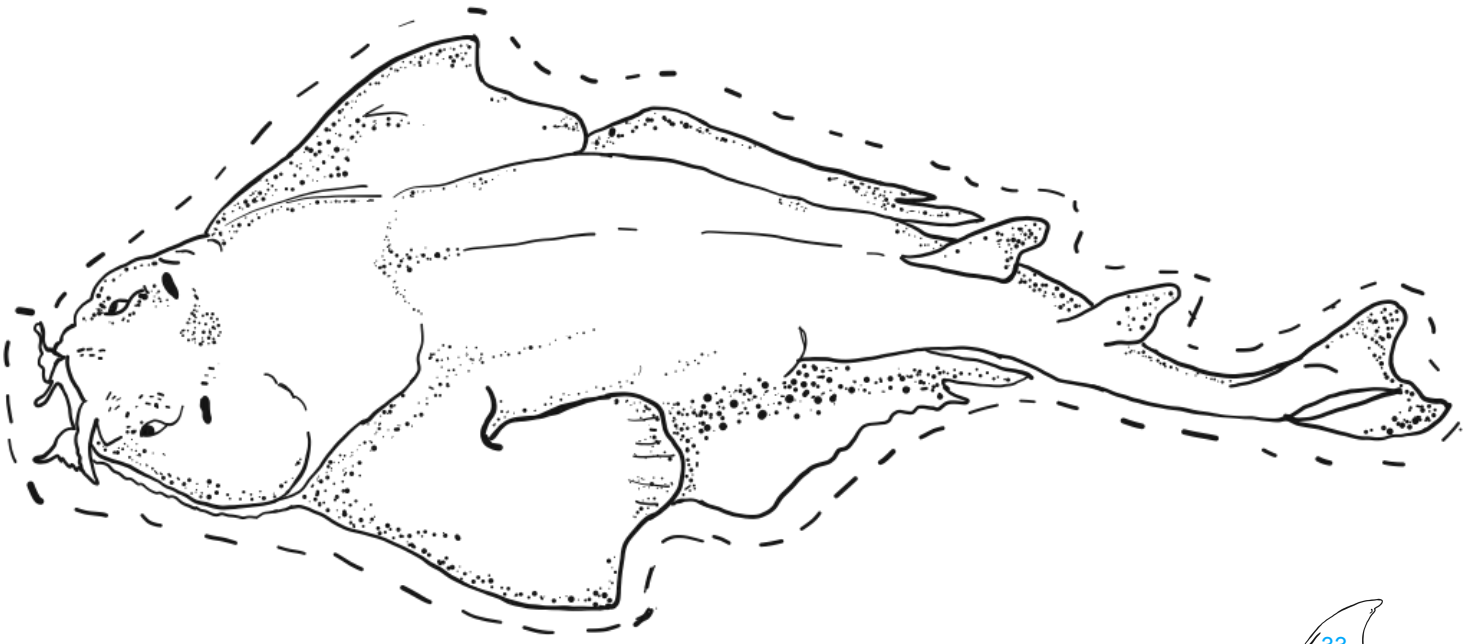
Spiny Dogfish Shark **39 in**



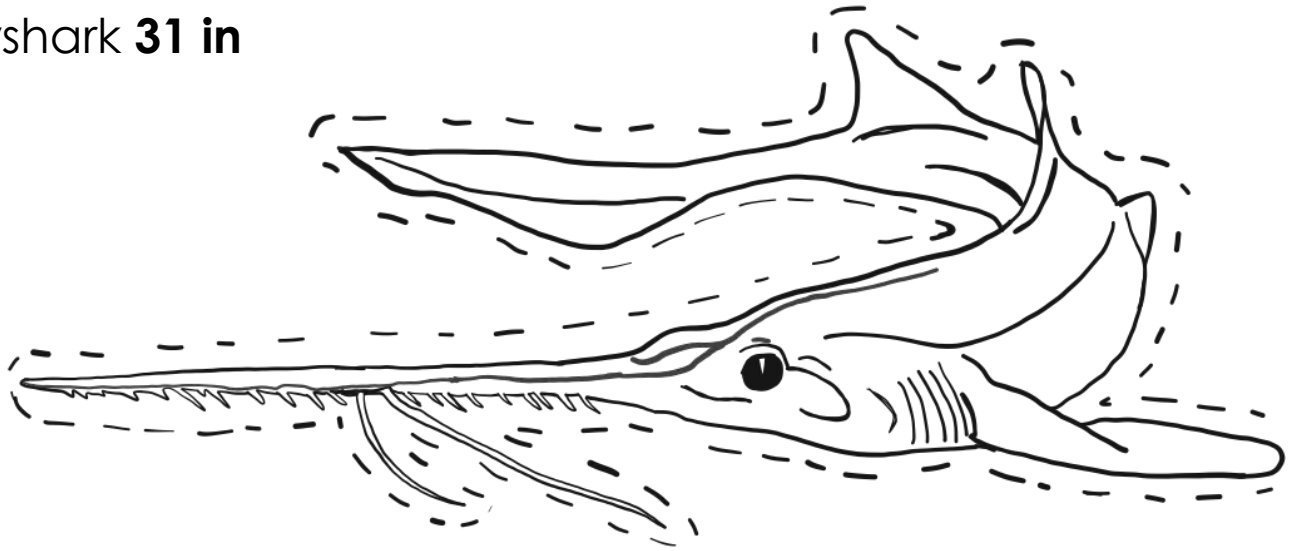
Cookie Cutter Shark **22 in**



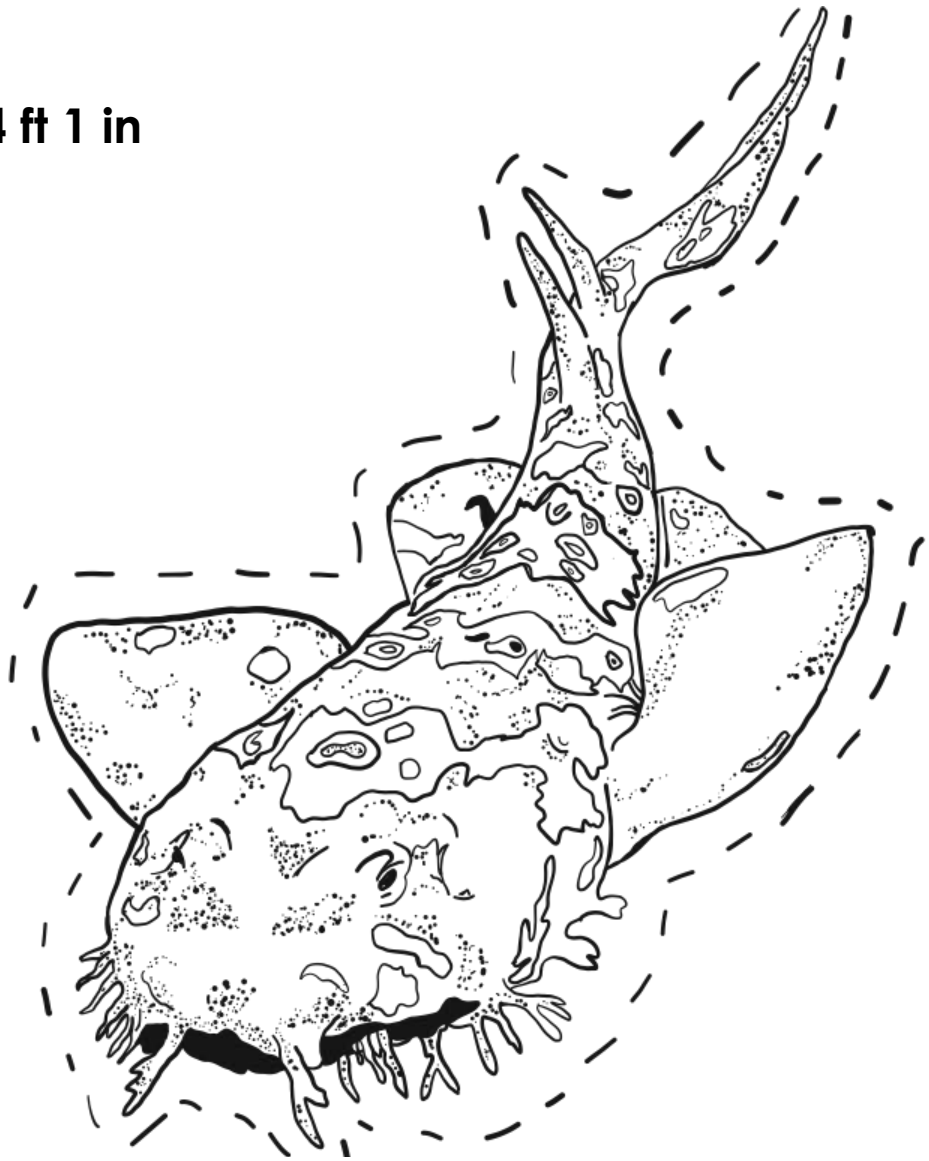
Angel Shark ***5 ft***



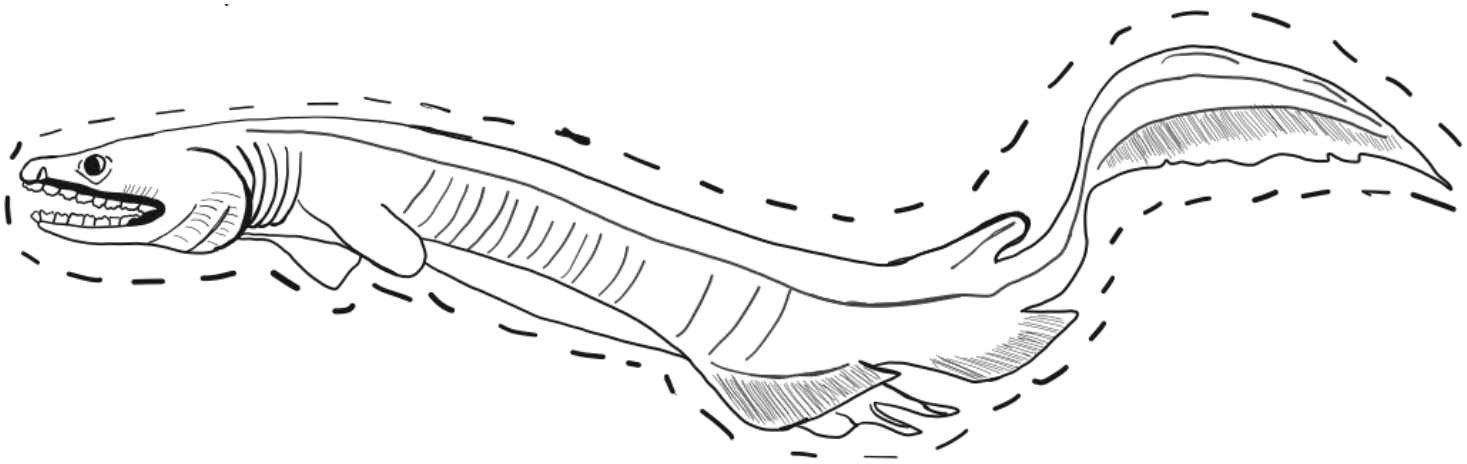
Sawshark **31 in**



Wobbegong **4 ft 1 in**

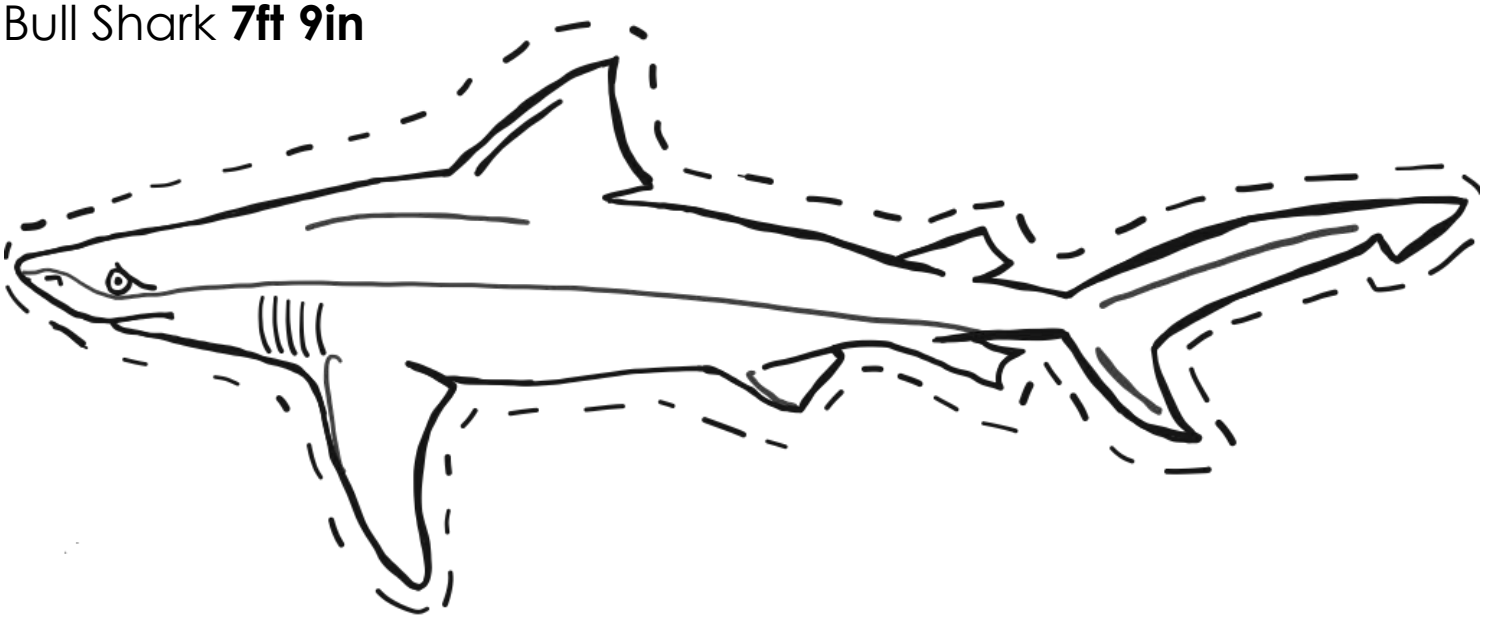


Frilled Shark **6ft 6in**

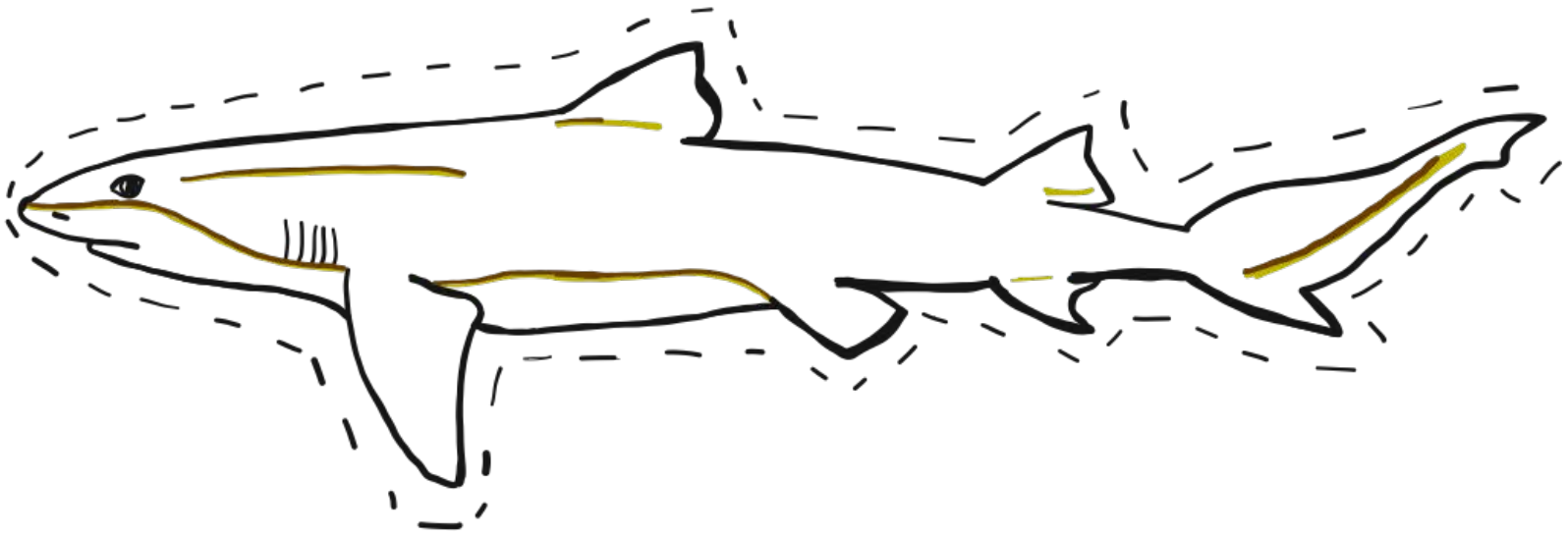


Port Jackson Shark **5ft 4in**

Bull Shark **7ft 9in**



Lemon Shark **11ft**



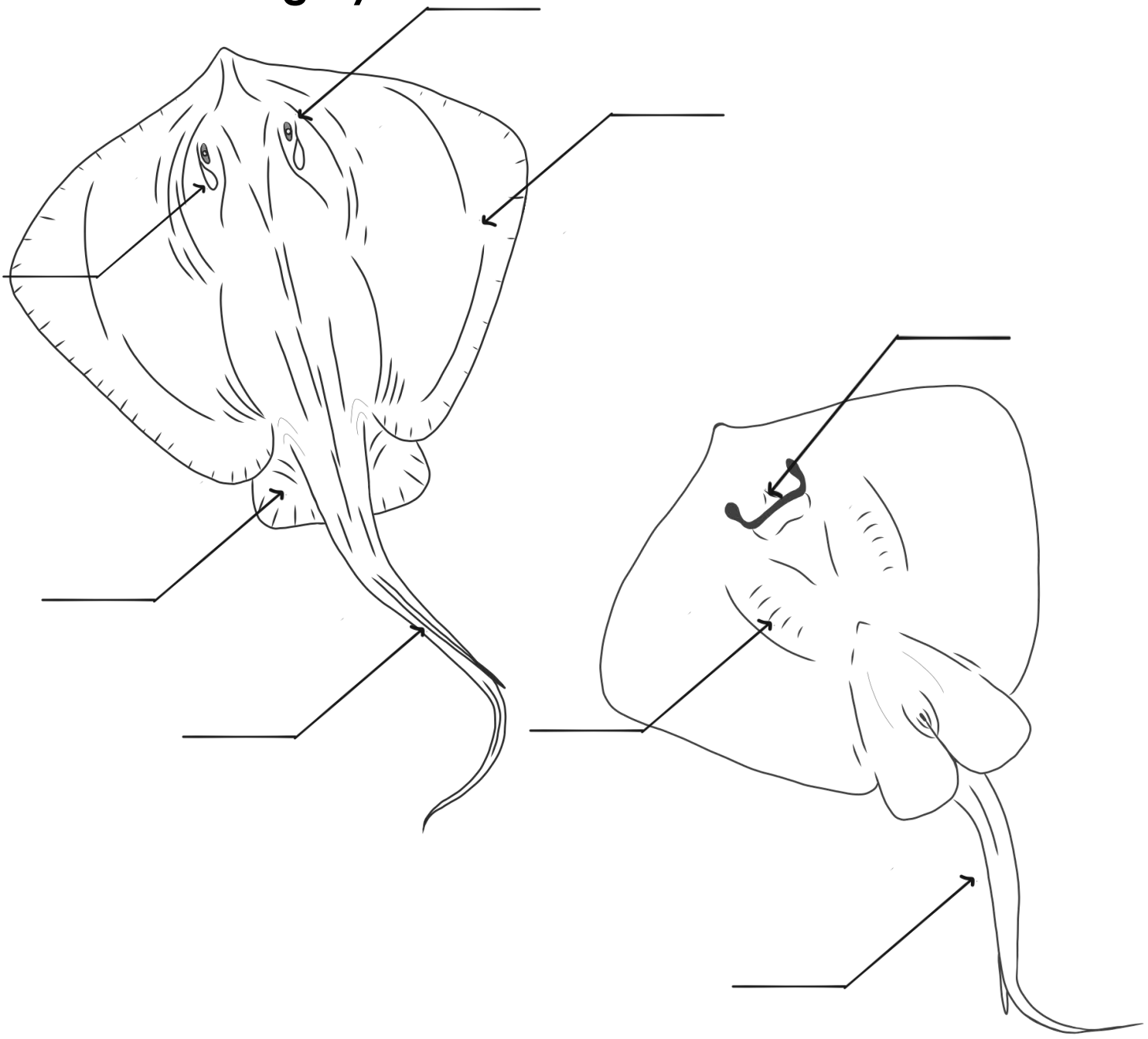
Shark and Ray Word Match

Write the letter of the correct match next to each word

1. _____Vertebrate
2. _____Ectothermic
3. _____Endothermic
4. _____Bilateral Symmetry
5. _____Spiracles
6. _____Dermal Denticles
7. _____Mermaid's Purse
8. _____Swim Bladder
9. _____Nares
10. _____Barbles
11. _____Ampullae of Lorenzini
12. _____Nictating membrane
13. _____Lateral Line

a. Sensory network used to detect pressure changes
b. Warm blooded
c. An egg case for a skate
d. An extension from the face used to sense prey
e. Electrical sensors
f. Symmetrical on both sides
g. An organ to help fish float
h. Another word for an animal with a backbone
i. Cold blooded
j. Scales that resemble teeth
k. Holes behind the eyes to help with breathing
l. Pull water into these to detect prey
m. Helps protect the eyes while feeding

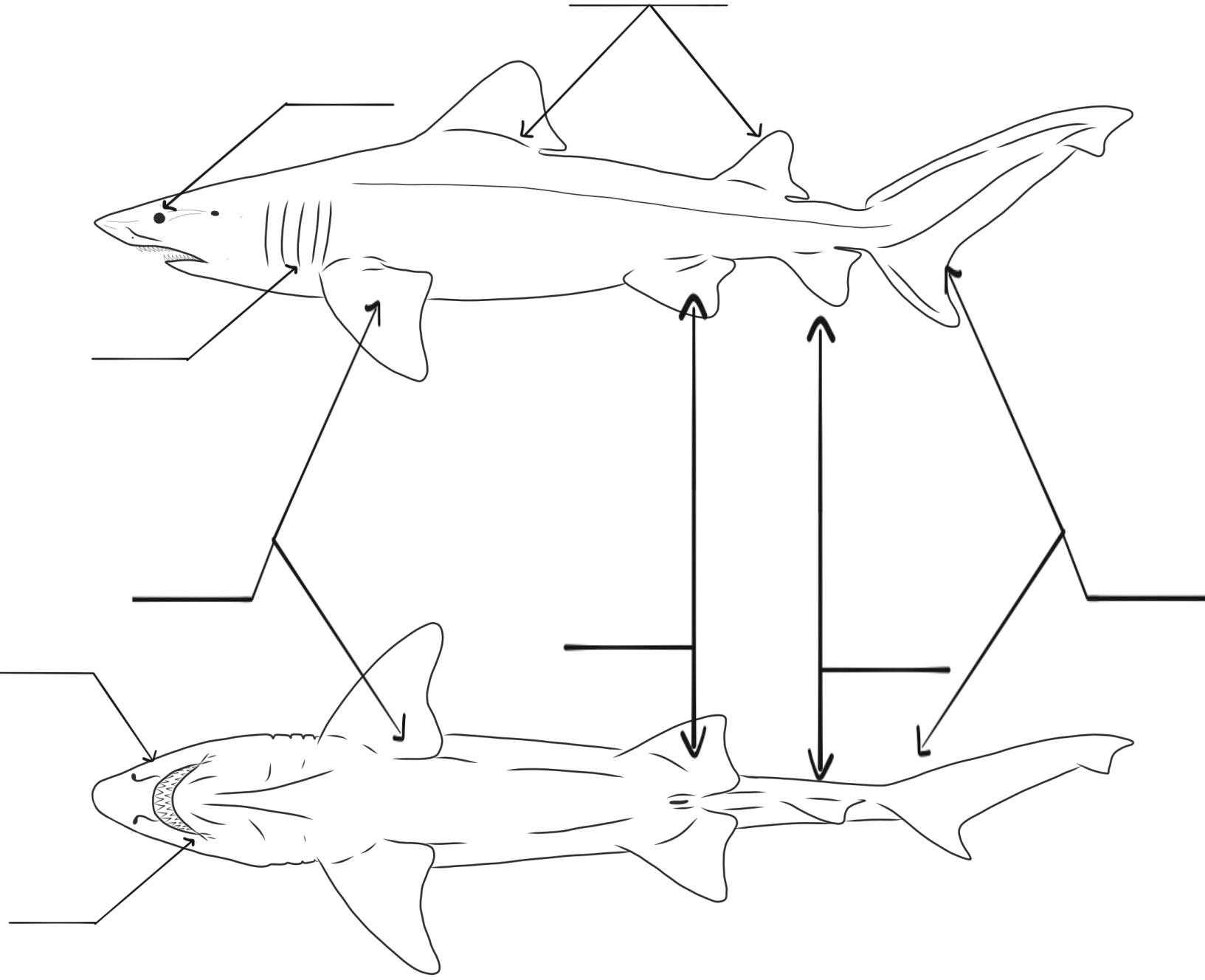
Label the Stingray



Word Bank

a. Pectoral fins
b. Tail
c. Barb
d. Eyes
e. Spiracles
f. Gills
g. Pelvic fin

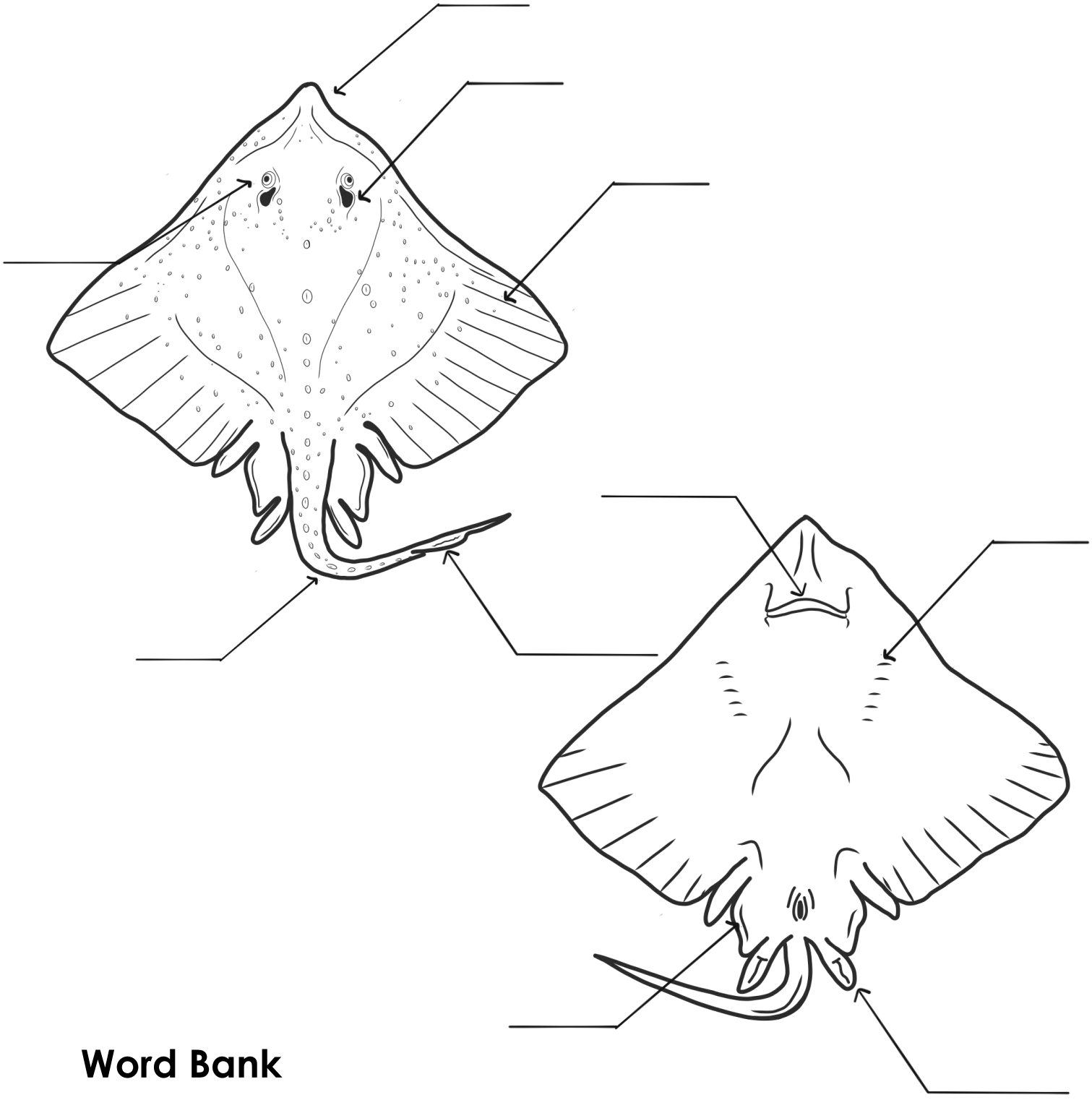
Label the Shark



Word Bank

a. Dorsal fin
b. Anal fin
c. Caudal fin
d. Mouth
e. Nares
f. Pelvic fin
g. Pectoral fin
h. Gills

Label the Skate



Word Bank

a. Pelvic fin
b. Claspers
c. Tail
d. Dorsal fin
e. Mouth
f. Spiracles
g. Pectoral fin
h. Snout
I. Gills
j. Eyes

Swim Bladder vs Oily Liver

In this activity you will be creating a swim bladder and an oily liver to compare the two and which animals these would be helping survive in the water.

Materials for **swim bladder** and **oily liver**:

- Small glass bottle (Mason jar, 8 oz jar, or smaller glass bottles)
- Balloon that fits inside the bottle
- Straw (plastic, metal, bamboo) the hardier the better
- Big tub or container that is waterproof and preferably transparent (It should have enough room so the glass bottle can float in it freely. A large Tupperware container)
- Strong, waterproof tape
- Water (enough to fill the tub or container)
- Towels
- Plastic water bottle
- Cooking oil (enough to fill the water bottle, you can use a smaller water bottle if you have it to save oil or reuse the oil afterwards.

Preparation:

- Set up in a place that can get wet. Outdoors would be great!
- Place the straw about one inch inside the balloon and tape the balloon to the straw.
- Blow up the balloon and place it in the glass bottle and then tape the straw to the opening of the bottle.
- Next, completely fill the water bottle with cooking oil and close it. (make sure there are no air bubbles!)
- On each bottle, you can draw the fish you are representing.
- Finally, fill the tub with water.

Hypothesis:

In the space below, write what you think will happen to the glass jar with the empty balloon when you put it into the tub of water? What will happen to the glass jar when you blow up the balloon? What will happen when you put the oil-filled bottle into the tub?

Experiment:

Once the tub is filled with water and you've written down your hypotheses, you will start the experiment:

- Place the glass bottle with the empty balloon, into the water filled tub. What do you observe?
- Start to slowly blow up the balloon using the tube. What happens to the jar as the balloon fills?
- Once the balloon is filled, push the glass jar to the bottom of the tub. What happens?
- Place water bottle with cooking oil in tub as well. What happens to the bottle?
- Push the bottle to the bottom of the tub. What happens?
- Write the results down on the next page
- For an extra challenge, add a small balloon to a larger (and heavier) glass container and a larger balloon to a smaller (and lighter) container, and repeat the above steps to see how jar size and balloon size affect buoyancy.

Explanation:

In the space below, describe what happened when you put the glass jar with the empty balloon into the tub of water. What happened when you blew air into the balloon? Did you have to inflate the balloon all the way to see a reaction? What happened when you placed the water bottle filled with oil into the tub?

- If you tried adding a small balloon to a larger glass container or vise versa, describe how balloon size and jar size affected buoyancy.

Think about how this simple experiment relates back to what you learned about fish anatomy in this packet.

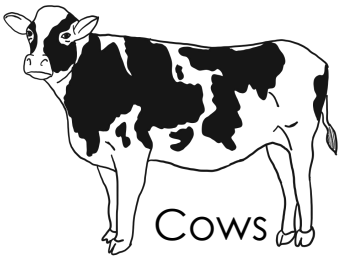
- What fish body part is being represented by the balloon? Which fish body part is being represented by the oil-filled bottle?
- What group of fishes uses an air-filled swim bladder to maintain buoyancy? Which group uses an oily liver?
- Which floated higher in the water – the jar with the fully inflated balloon, or the bottle filled with oil?
- When slowly inflating the balloon, what occurred? What happened when if you deflated it?
- How do you think a bony fish adjusts its buoyancy?
- Did your results support your hypotheses?

What's more dangerous?

Match the pictures to the blanks in the sentences.

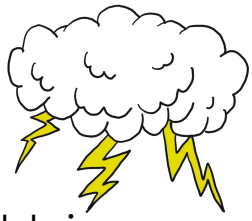
Toilet

Over 250 people have died taking _____ in the last 6 years, according to a report from the All India Institute of Medical Sciences.



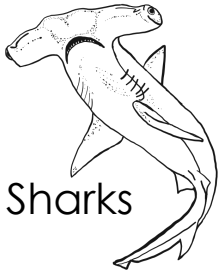
Cows

According to Matt Roper's book "101 Crazy Ways to Die" more than 2 dozen people each year are killed by _____.



Lightning

According to the Centers for Disease Control and Prevention, on average there are 22 deaths a year by _____.

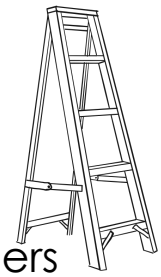


Sharks

According to the World Health Organization, the US leads the world in _____deaths. Each year, there are 300 deaths in the US caused by falls from _____.

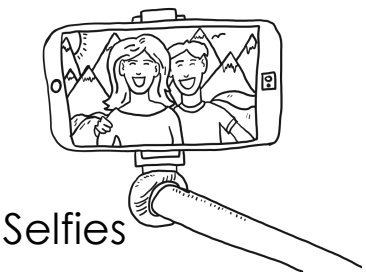
Corks

The National Weather Service reports that an average of 49 people are killed by _____ each year in the US.



Ladders

The CDC reports over 30,000 Americans are injured while using the _____each year.



Selfies

On average there are only 6 fatalities caused by _____ worldwide each year. In 2018, there were only 4 worldwide.

answers: selfies, corks, cows, ladders, lightning, toilets, sharks

Discover the Depths

To complete this activity, visit https://neal.fun/deep-sea/ and answer the following questions:

1. What animal do you find 577 meters below the surface? _____

Research this animal online. Write down an interesting fact about it and list its classification.

_____

_____

2. What is the average depth of the ocean? _____

3. Who were the first humans to reach the deepest part of the ocean? _____

What depth did they reach? _____

What was the name of their vessel? _____

4. Why do many deep sea species use the color red as camouflage?

_____

_____

5. What animal, found around 800 meters below the surface, can reach 11 meters in length? _____

6. In which zone do you find the frilled shark and the cookie cutter shark? List the depth at which you found each (Refer to packet for the different zones).

_____

7. What is the deepest a human has ever scuba dived? _____
Who was it? _____

In what year did they set this record? _____

8. At what depth do you find the deepest dwelling shark species? _____

Buoyancy and Density Experiment!

Follow the instructions below in order to create a density tower. The density of salt water determine whether a marine animal floats, sinks, or stays neutrally buoyant. Bony fish use air-filled swim bladders to maintain neutral buoyancy, while sharks achieve neutral buoyancy with a liver filled with oil. In this experiment, you will liquids with different densities affect the buoyancy of various household items.

Supplies Needed:

- Honey
- Milk
- Dish Soap
- Water
- Vegetable Oil
- Turkey Baster
- Measuring Cup
- Food Coloring
- Tower- Tall Jar, Vase, or Cup
- 5 Cups
- Die
- Cherry Tomato
- Bolt (Nail or Screw Will Work)
- Beads (1 or 2)
- Bottle Cap

Step 1: Gather materials.

Step 2: Place equal parts of the honey, milk, dish soap, water, and vegetable oil into individual cups.

Step 3: Use food coloring (you choose what color) to change the color of the water in the cup.

Step 4: ***Carefully*** pour the honey into the tower.

Step 5: Use the turkey baster to add in the layer of milk, ***slowly***.

Step 6: Use the turkey baster to add in the layer of dish soap, ***slowly***.

Step 7: Use the turkey baster to add in the layer of water by letting the water run down the inside glass of the tower, ***slowly.***

Step 8: Use the turkey baster to add in the layer of vegetable oil by letting the oil run down the inside glass of the tower, ***slowly.***

Step 9: Discuss where you think each object will fall. Then, ***Carefully*** drop in the objects: die, cherry tomato, bolt, beads, and cap.

Step 10: Observe where the objects fall, then answer the questions below.

Where did each of the objects settle?

Is this what you thought would happen? If yes, why? If no, why not?

For each item that floated somewhere in the tower, list the liquid that had a similar density. (Hint - the object will be floating on top of a more-dense layer)

Be sure to include and explain the word **DENSITY** in your answer.

Shark Perception Study

Do you believe in mind control? What if someone told you that your perception of an object is impacted by the images and words you see and hear? In this activity, we are going to look at how sharks are portrayed in media, and how this influences people's feelings about these fish.

You will need:
-Computer or device with video streaming capabilities
-Paper and writing utensil

First, write down the first word that pops into your head when you think of the word:

"FISH"

What images come to mind when you think of the word "fish"? Are there any other words that you associate with the word "fish"?

Using a search engine, type in "fish" and write down the top five search results. Next, click on "images" in the search engine. Write a brief description of the first 5 photos that appear in an image search for "fish"?

Would you describe these words and images as having a positive feeling associated with them? Negative? Neutral? Write down your results.

Now, write down the first word that pops into your head when you think of the word:

"SHARK"

What images come to mind when you think of the word "shark"? Are there any other words that you associate with the word "shark"?

Using a search engine, type in "shark" and write down the top five search results. Next, click on "images" in the search engine. Write a brief

description of the first 5 photos that appear in an image search for "shark"?

Would you describe these words and images as having a positive feeling associated with them? Negative? Neutral? Write down your results.

Which word had the most positive words and images— "fish" or "shark"?

Now let's start watching videos.

As you watch the next three videos, take notes to describe what you are seeing. For each video, write down the words that are most often used to describe sharks. Note whether there was any mention of sharks harming humans (and if so, how often that was mentioned). What camera angles and behaviors are shown in the videos? Write down anything else that might influence how you feel about sharks from each video.

- **So Good You'll Scream: Shark Week Starts Sunday, July 28!** — https://youtu.be/Ytjlns9zpo8
- **Testing if Sharks Can Smell a Drop of Blood** — https://youtu.be/ugRc5jx80yg
- **Sharks 101 | National Geographic** — https://youtu.be/4HGNqFdaD34

After you have finished viewing all three, decide whether each note you made has a positive, negative, or neutral feeling associated with it. What did you find?

Now, watch a few or all of these videos from shark advocates completing the same exercise as you did with the previous videos:

- **Andrea Marshall: Queen of the Manta Rays | Nat Geo Live** — https://youtu.be/0k_Ky_H8Ods
- **Great White Sharks - individual, misunderstood and life changing | Dan Abbott | TEDxFolkestone** — https://youtu.be/0qn7HI32tIU
- **Chris Neff: The myth of the rogue shark** — https://youtu.be/Vcmy2Bd23wE
- **Glow-in-the-dark sharks and other stunning sea creatures | David Gruber** — https://youtu.be/96HHmILhyrE
- **Shark! Rebranding the "monster" | Steve Backshall | TEDxUniversityofGlasgow** — https://youtu.be/u1hOCR7DI5k
- **Changing Perspectives: Sharks | Michael Muller | TEDxSonomaCounty** — https://youtu.be/NyDEbvsxiBA

Is there a different emphasis in these videos? Is the language used similar to the previous videos? If not, how was the language different? What did you find most compelling or powerful? Did any of these videos change your thoughts or feelings about sharks?

In your opinion, if more people saw the last group of videos instead of the first, would sharks be treated and viewed differently?

Why do you think some television shows focus on negative traits associated with sharks, while other television shows focus on positive stories? Other than sharks, can you think of any other animals that are portrayed in a negative manner on television?