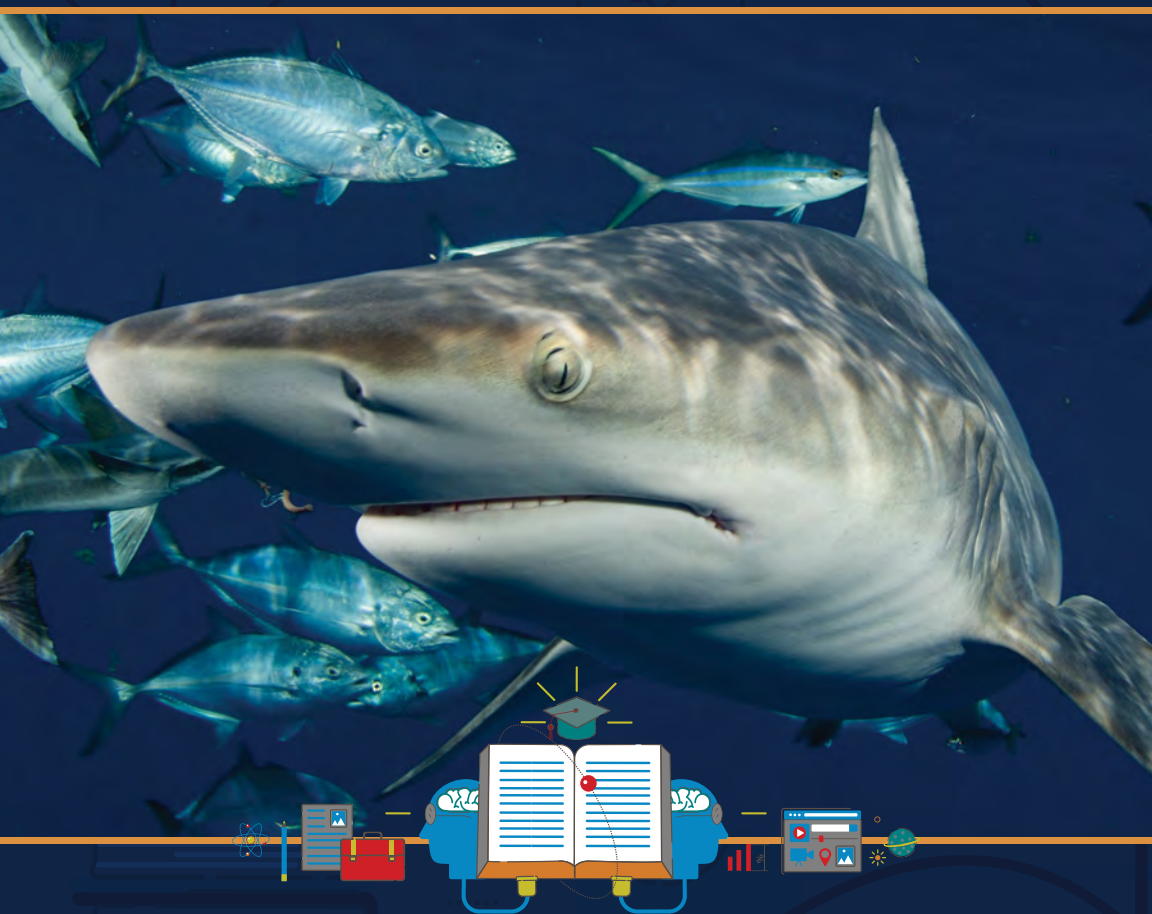


SHARKS!

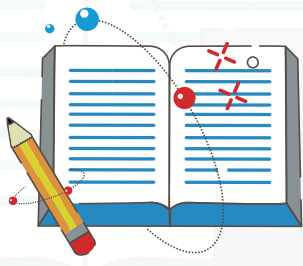
A SCIENCE 3D ADVENTURE

GRADE 4



By MIKE HEITHAUS Ph.D

symbioeducation™



KEY WORDS

Look for these words and see if you can figure out their meaning.

CONDUCTOR

DIGESTION

ELECTRORECEPTION

ENDOSKELETON

EXOSKELETON

INSULATION

PHOTOPHORES

PREDATOR

PREY

SENSOR 1.

VERTEBRATE



TABLE OF CONTENTS

Shark World	2
Many Sharks, Many Sizes	3
Many Habitats	6
When Did the First Sharks Live?	7
Body Check	8
Shark Shapes	11
Weird Sharks	12
What's Inside?	14
Shark Moves	16
What's for Dinner?	17
Catching Dinner	19
Getting Energy	21
Oxygen Please	22
Baby Shark!	23
Shark Senses	25
Making Tracks	29
Disappearing Sharks?	31
Shark Studies	32
Glossary	34

SHARK WORLD

Look at the picture of the world below. What do you see? Can you see mountain ranges? Can you see islands? Do you see ice? Do you see a lot of water? About 70% of the world is covered by water. However, not much of that water is freshwater. Rivers and lakes can barely be seen on the map! Most of the world is covered by oceans and seas, which are saltwater. They are the home to most of the life on Earth, including sharks! Sharks and other ocean animals have body systems that help them live in saltwater.



2

Can you see different types of habitats in this satellite view of the world? What are the green and tan areas?

MANY SHARKS, MANY SIZES

When most people think of sharks, they probably imagine the big body and sharp teeth of great white sharks. But great white sharks are just one of more than 500 species of sharks. In fact, scientists discover new species of sharks every year!

Do you think all sharks are huge? Many people do! However, sharks come in a broad range of sizes. Many sharks never grow longer than 1.2-1.5 m (4-5 ft) long. The dwarf lantern shark is the smallest, only growing to 20 cm (about 8 in) long. It could fit in the palm of your hand! Whale sharks are the largest. They can grow over 12.5 m long (more than 40 ft) and weigh over 21 tons. That is about the size of a school bus! The extinct Megalodon was even bigger. It reached around 18 m (60 ft) long. Megalodon ate whales, dolphins, sharks, and other very large prey.



The whale shark is the largest living shark. The dwarf lantern shark is the smallest.

Shark fossil



Scientists use fossils to learn about extinct organisms. They can compare fossils to living species. Modern day great white shark teeth are similar to the fossilized teeth of the extinct species *megalodon*.



The extinct *megalodon* shark was enormous! It was about three times the size of modern day great white sharks.

Different shark species have different lifespans. Some sharks may only live a few years. Others can live for centuries. Scientists discovered that one Greenland shark lived to be almost 400 years old! That is older than any other known **vertebrate**, or animal with a backbone.



A Greenland shark has the longest lifespan of any known vertebrate on Earth.

MANY HABITATS

Sharks live in many different habitats. Most species live in warm waters. Some can survive in the very cold waters of the Arctic and near Antarctica. Some sharks live near the surface. Other types of sharks are found very deep in the ocean. They can live at depths of more than 1,500 m (5,000 ft). Certain sharks swim from surface waters down into the deep to feed, while others spend most of their time deep underwater but come towards the surface at night to grab a meal.

Sharks are found in rivers and lakes in some parts of the world. The bull shark has been seen in the rivers of the southern United States, South America, Australia, Asia, and Africa. Several species of river sharks live in northern Australia and Asia. Unfortunately, many of these freshwater sharks are threatened by overfishing and habitat degradation. Many sharks have found new places to live due to environmental changes. For example, increasing water temperatures have allowed bull sharks to live in places that used to be too cold for them.



WHEN DID THE FIRST SHARKS LIVE?

Sharks are fish. They are part of a group that includes sharks, skates, rays, and ghost sharks. The first sharks appeared around 400 million years ago. They didn't look much like sharks that are around today. Some were very weird. One species even had a big bump coming out of its head! Sharks that looked like present-day sharks appeared around 100 million years ago. How have sharks managed to survive for hundreds of millions of years? They are adapted to their environments. This means they have external and internal structures that help them survive!

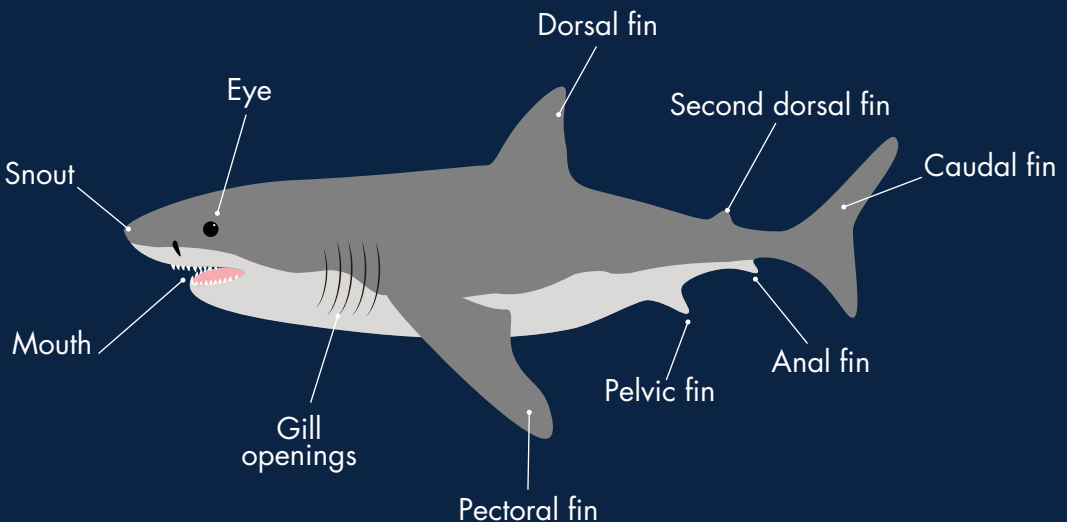


Ghost shark or chimera (top), skate (lower left) and rays (lower right).

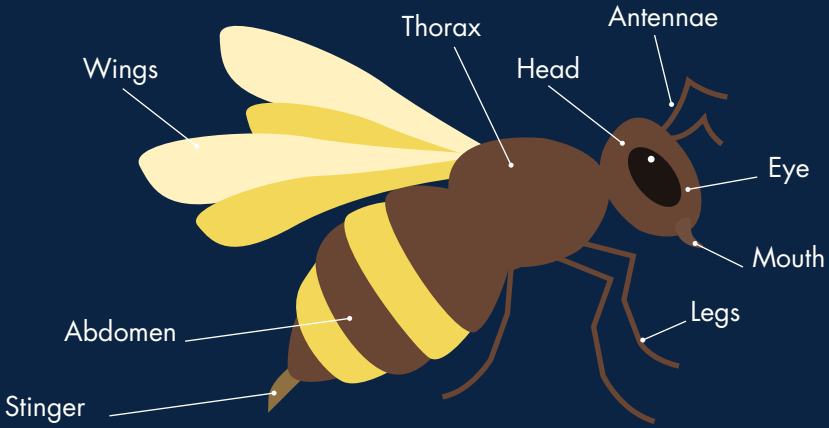
BODY CHECK

Just like other animals, sharks have external structures. These structures help them survive. Some help them reproduce. Different types of animals have many structures in common. Let's consider the sea urchin, shark, honey bee, and elephant - animals that many consider very different! They all have mouths to eat food. The bee, sea urchin, and elephant have legs that help them move. The shark has a tail (called the caudal fin) that helps it move through the water. The shark, bee, and elephant all have eyes to see. The shark and elephant have noses to smell. The elephant's nose can do other things too! Its trunk can pick things up and even suck in water. Then, it squirts the water in its mouth or on its back! The bee doesn't have a nose. It has antennae instead. The antennae sense chemicals similar to noses! The bee uses them to "smell" things. Some external structures are for protection. For example, the sea urchin has spines and the bee has a stinger!

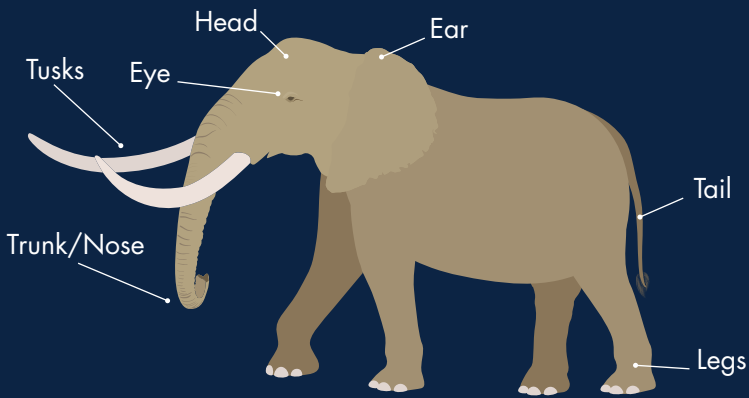
Shark



Honey bee



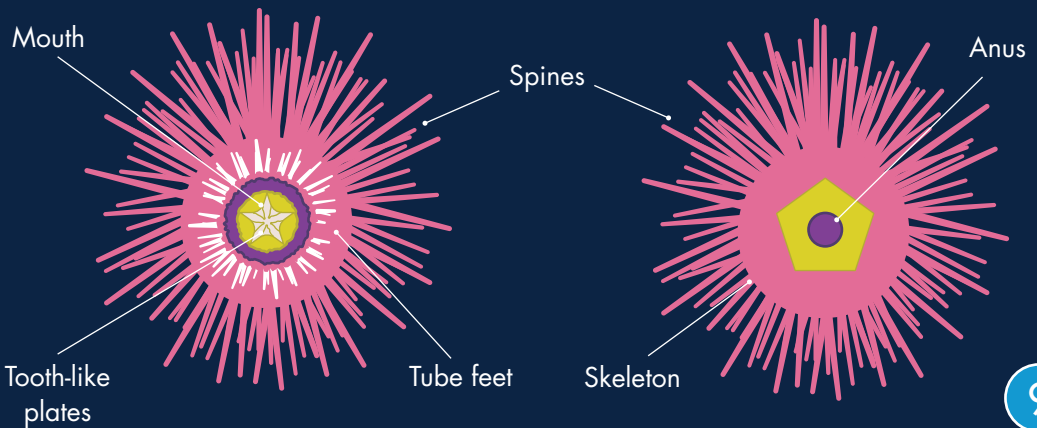
Elephant



Bottom side

Sea urchin

Top side



The external structures of a shark help it sense the world and move. The caudal fin provides the power to swim. The dorsal fin and pectoral fins help the shark stay stable in the water. They keep the shark from rolling over. To breathe, sharks swim with their mouths open. The water goes across the gills and out the gill openings. Bony fish, like bass, have one gill opening on each side. Most sharks have five. Some have six or seven!

Some sharks, like the wobbegong, have tassels or barbels on their jaws. The barbels sense nearby prey movement. They are also used to sense chemicals. Catfish have similar structures to find their prey in murky water.



Wobbegong sharks have barbels that help them sense their environment.

The glowing velvet belly lantern shark, a deep-sea shark.



Another cool external structure of some sharks are **photophores**. Photophores produce light. They make a shark glow! Many deep-sea sharks glow. What are the benefits of glowing? It may help them blend in with other glowing organisms in the deep sea.

SHARK SHAPES

Most sharks have shapes that are perfect for moving through the water. Their shapes are a lot like those of dolphins, tunas, and torpedoes. This long, cylindrical shape moves through the water easily. They also have teeth-shaped scales that help them slip through the water. These tiny scales are very different from the scales of other fish. They are smaller. They make a shark's skin very rough! But, they make water slide past the shark.

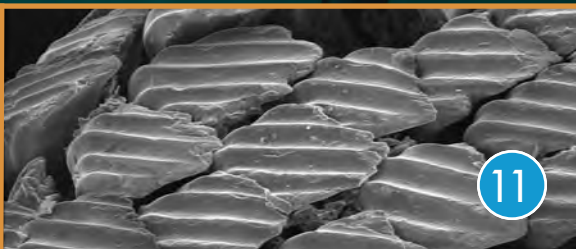
Blue sharks are built to cruise long distances.



The shape of a salmon shark helps it swim easily.



These are the scales of a shark under a high-powered microscope.



WEIRD SHARKS

Some sharks have rather crazy body shapes! Each one of these weird shapes are adapted to the shark's environment. Angel sharks look like they have been run over by a steamroller! Their flat bodies help them hide in the sand and squeeze under reefs.

Angel sharks have flat bodies to help them hide in the sand.



The upper part of thresher sharks' tails are very long. They use them like a whip! They smack their prey with their tails to stun, or shock them.

Thresher sharks use their long tails to stun prey!



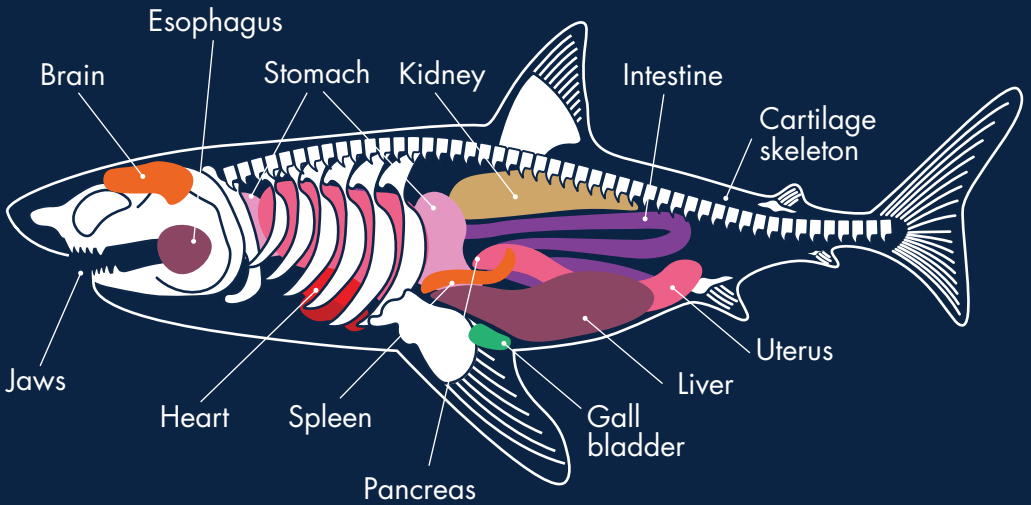
Hammerhead sharks have flat and wide heads. Scientists still don't know exactly why their heads are shaped that way. Maybe having bigger heads help them detect their prey. Maybe it helps them turn quickly to catch prey.



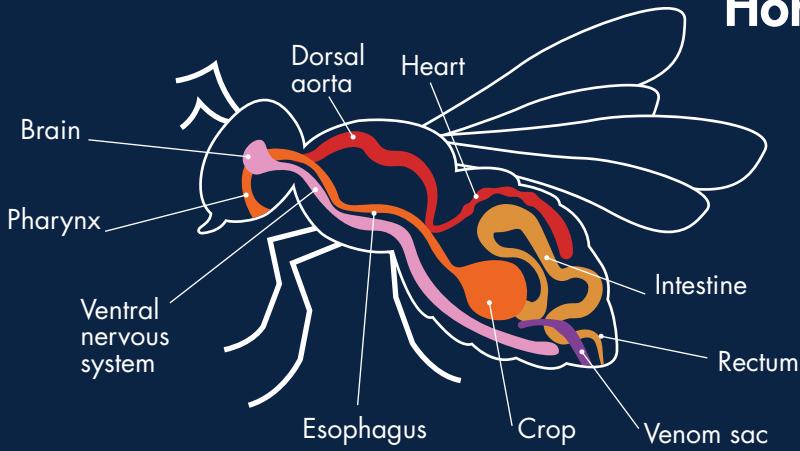
WHAT'S INSIDE?

The structures inside animals are needed to help them eat, move, grow, survive, and reproduce. Different animals may have different looking structures, but they all have structures that do important work. Animals like sea urchins have simple internal structures. Bees are more complex. Sharks and elephants have even more systems in their bodies.

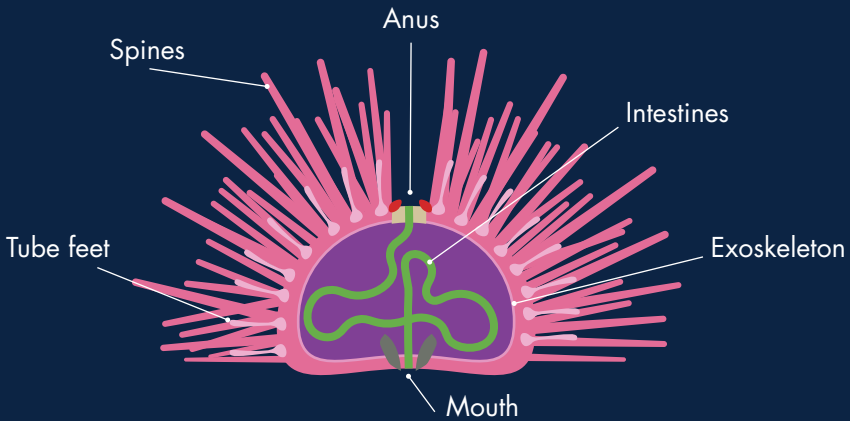
Shark



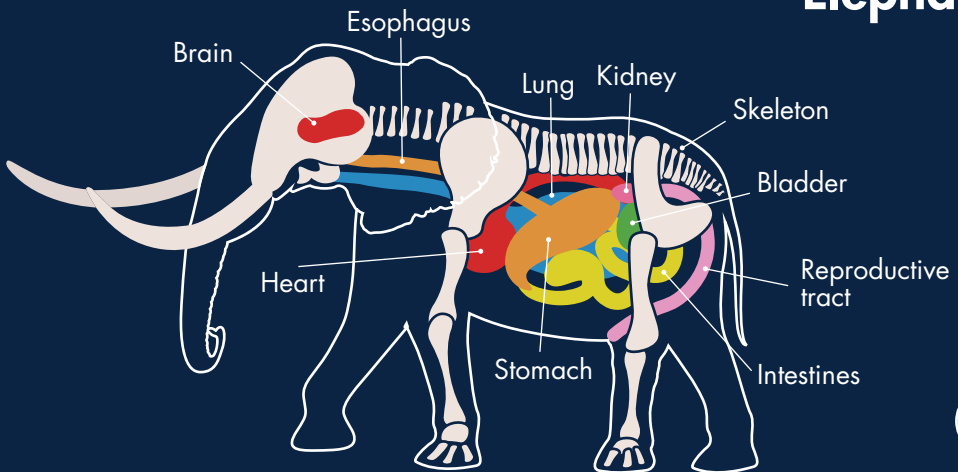
Honey bee



Sea urchin



Elephant



SHARK MOVES

Animals need structural support. Skeletons provide that support. Some animals, like insects, have skeletons on the outside of their bodies. This is called an **exoskeleton**. Sharks, like people, have skeletons on the inside of their bodies. This is called an **endoskeleton**. Human skeletons are made of bone. Shark skeletons are made up of cartilage. People have cartilage in their ears. Cartilage is more flexible than bone.

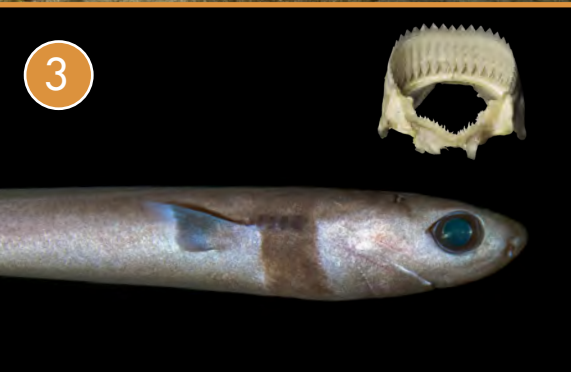
Muscles move the skeleton. Sharks have muscles that can work for a long time without getting tired. This helps them swim long distances. Muscles also make the jaws work. The heart is an important muscle. It pumps blood to the body. The blood carries oxygen and nutrients to other muscles and organs.



Strong muscles help sharks swim long distances. They help them swim quickly! The shortfin mako shark can swim around 65 km per hour (40 mph) in short bursts!

WHAT'S FOR DINNER?

Sharks, like all other organisms, need energy. Their cells need energy to work. Energy powers sharks' bodies and movement. It is also needed for reproduction. Sharks are **predators**. They get their energy by eating their **prey**. But first, they need to catch it! Sharks eat many different kinds of prey. The shape of a shark's jaws and teeth differ based on the type of food they eat. Most sharks have pointy teeth. These teeth are perfect for holding on to slippery prey, like fish and squid. Then, the sharks can swallow the meal whole.



1) The horn shark is small and eats crabs and clams. It has a narrow jaw and flat teeth that won't break when crushing shells. 2) Tiger sharks have big, wide jaws and teeth that are like saws. They can cut prey as they saw their head back and forth. 3) Cookiecutter sharks have a unique set of jaws and teeth. They take small, circular bites out of the bodies of whales, dolphins, seals, and fish. 4) Great white sharks eat other big animals. They need to be able to take bites out of their soft prey. Their teeth are triangles that are made for cutting.



JAWS & TEETH

Did you know jaws and teeth are part of a shark's skeleton? Sharks have a lot of teeth! They even have rows of extra teeth. When a shark loses a tooth, another one slides in to replace it. A shark may use 30,000 teeth in its lifetime! Humans only have two sets of teeth.



CATCHING DINNER

Different kinds of sharks have different ways of grabbing a meal. The biggest sharks, like whale sharks and basking sharks, eat the tiniest prey... but a lot of it! Shrimp-like creatures, plankton, and fish and coral eggs are their favorite foods. These sharks usually feed by swimming through the water with their huge mouths open.



Basking shark



Whale shark

Basking sharks and whale sharks have big mouths that help them collect a lot of small prey.

Most sharks eat their prey one at a time. Some sharks cruise through the ocean, looking for prey. Great white sharks surprise fur seals by attacking them from below. Several types of sharks feed on fish they have herded together into “bait balls.” These sharks swim through the tightly packed school to grab prey. Many sharks also scavenge dead prey that they find. A huge meal from a dead whale could last them for six weeks!



A great white shark hunts fur seals by ambushing them from below (top). A bronze whaler shark hunting a school of fish (bottom).

GETTING ENERGY

When sharks or other animals eat food, it goes into their stomachs. The stomach breaks the food down so the body can use it for energy. This is called **digestion**. But even shark stomachs can't digest everything. Items that can't be digested, like turtle shells, can be thrown up! Food travels from the stomach into the intestine and eventually leaves the body as waste. Some very unexpected, undigestible items have been found inside the stomach of sharks.



You ate what?!



Many unusual items like dolls, shoes, and license plates, have been found inside the stomachs of sharks!

OXYGEN PLEASE!

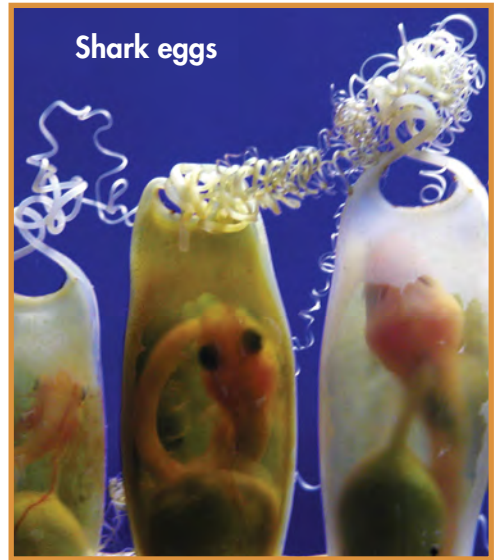
Animals need oxygen to release energy from their food. Animals on land have lungs to get oxygen from the air. Sharks and other fish have the gills that get oxygen from the water. Gills are one way to tell the difference between sharks and other kinds of fish. Bony fish, like trout and bass, have one gill opening on each side. Sharks have five to seven gill slits. To get enough oxygen to breathe, most sharks have to keep swimming. A few kinds of sharks, like whitetip reef sharks, can rest on the bottom and suck water in through their mouths and release it over their gills. They don't have to swim to breathe.



Unlike most sharks, whitetip reef sharks can lie on the bottom and pump water over their gills to breathe.

BABY SHARK!

Some sharks hatch from eggs. Female sharks lay eggs on the bottom and leave them there. After a few months, the eggs hatch. Other sharks develop inside their mothers and are born alive. Hammerhead sharks, white sharks, lemon sharks, and many others are born alive, just like cats and dogs.



This photo shows the live birth of a lemon shark.

Baby sharks are ready to swim and fend for themselves as soon as they are born or hatch. However, that doesn't mean that they are safe. Many bigger sharks, like hammerhead sharks, love to eat smaller sharks. To stay safe, many baby sharks live in very shallow water. Big sharks can't swim in these shallow waters.

Baby sharks aren't the only ones that have to worry about predators. Many sharks never get very big. They stay safe by finding places to live where there are not many big and dangerous sharks. Similar to how sea urchins and porcupines defend themselves with spines, some sharks have spines in front of their dorsal fins that can hurt predators.



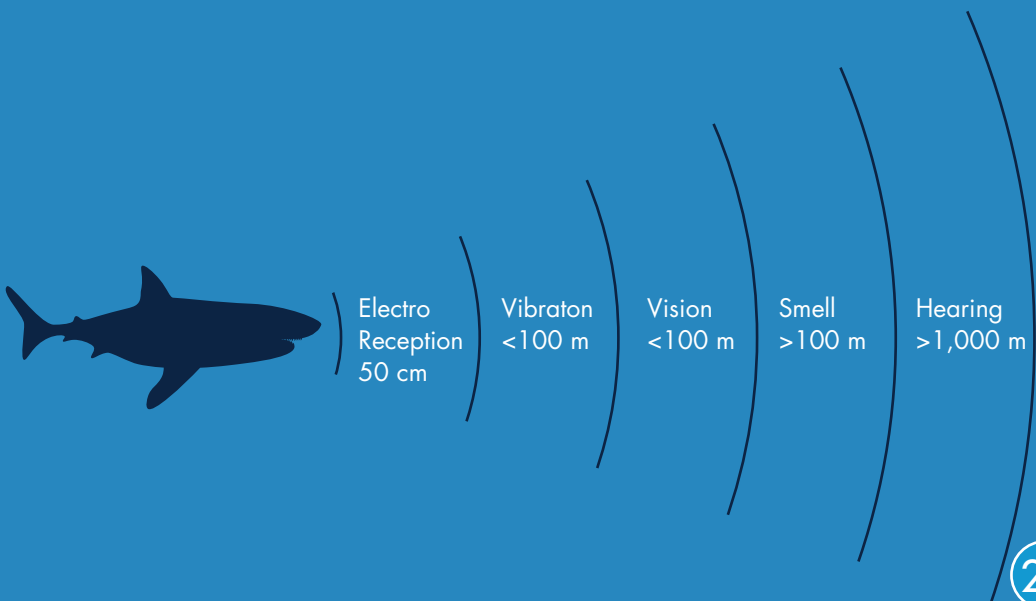
Baby lemon sharks live in shallow waters. They stay near the roots of mangrove trees. If they swim into deeper waters, a larger shark might eat them!

SHARK SENSES

Think about the ways people observe the world. The five main senses are sight, smell, hearing, touch, and taste. Sharks have all of these, plus a super-sense called **electroreception**! Do people use all of their senses all of the time? Of course not! Neither do sharks. Sharks use different senses at different times. Their senses help them find their way around and catch prey. They help them sense danger and escape. They enable them to find mates and locate waters that are the right temperatures.

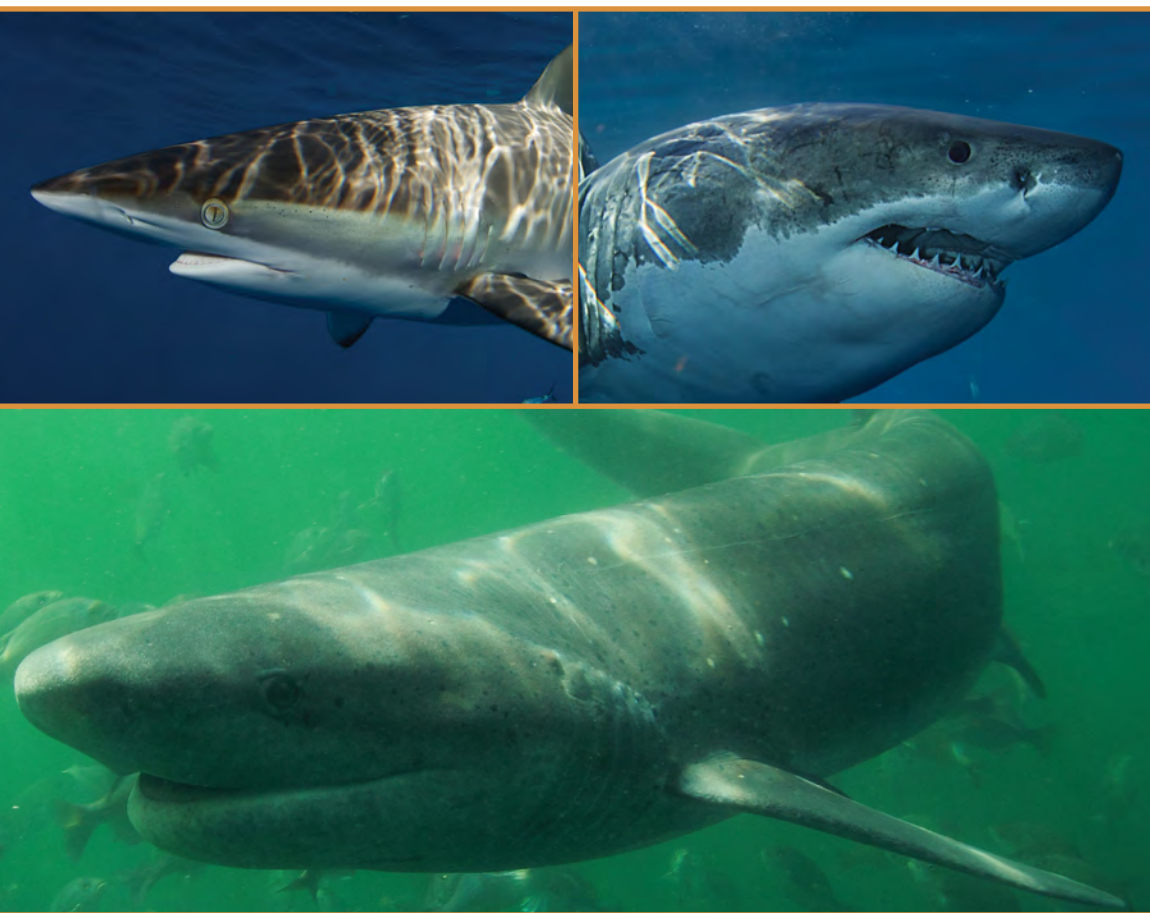
Sharks have a good sense of hearing. Sound travels very far in the ocean. Loud sounds, like the call of a blue whale, might be heard across an entire ocean! Sharks can hear loud sounds from many kilometers away.

Sharks are famous for their sense of smell. They can detect one drop of blood in a million drops of water! They follow their noses to find their meals. They use their heightened sense of smell to quickly find dead whales and feast. Sharks can smell things further away than the length of several football fields!



Do all animals and humans see the same way? It turns out that different animals can see different colors. Some don't have color vision. Some have good eyesight while others have poor eyesight. It is the same for sharks. Many sharks are colorblind or do not see the same colors as people. Most sharks can see very well, even better than humans, in low light. Some sharks probably use vision to hunt and find their way around.

Other sharks probably don't use vision much. Some sharks live in waters that are very murky. Even if sharks there have good eyesight, they wouldn't be able to see. It's similar to how people can't see very well in dark rooms! Greenland sharks may be mostly blind so they have to rely on their other senses!



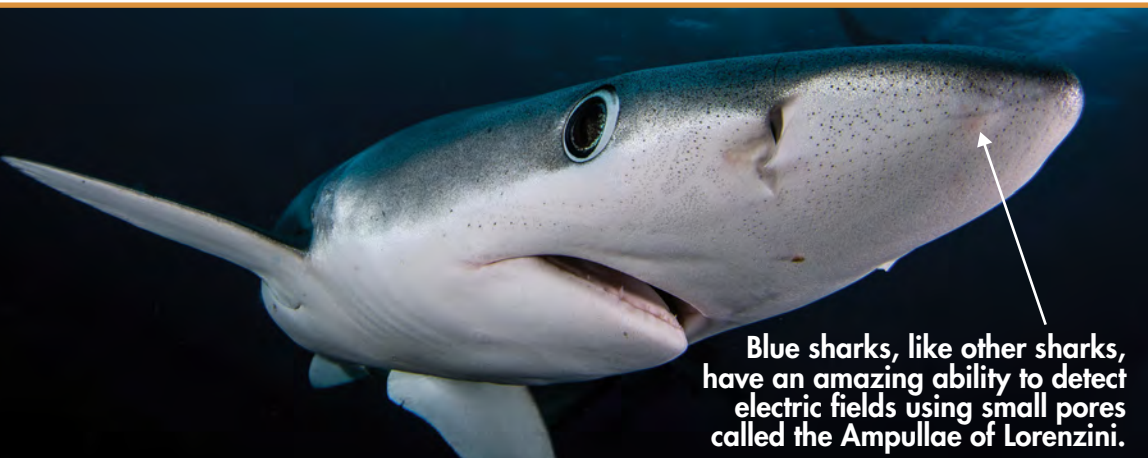
Not all shark eyes work the same way. Some are good for seeing in very little light. Others work better when there is bright light.

The sense of touch is very important for many animals, including sharks. Monkeys and raccoons use their hands to feel things. Otters and cats have sensitive whiskers. An elephant feels things with its trunk. All of these animals can feel when something touches their bodies. Sharks have a special sense of touch. They have cells along their bodies that detect when there are ripples in the water. These ripples may be caused by prey or by other sharks swimming near them. This sense of touch is very important for sharks. What can you learn about an object with your sense of touch?



Different animals use the sense of touch in different ways. Raccoons use their hands, otters have whiskers, and elephants use their trunks. Hammerhead sharks can sense the presence of others nearby by feeling ripples in the water.

Saltwater is a good **conductor** of electricity. That means that electricity passes through seawater easily. Sharks and some other aquatic organisms can detect electric fields. Why would this ability help sharks? Living things, including sharks' prey, give off electric fields. Sharks have small jelly-filled pits on the underside of their snouts and around their heads that detect these fields. This special sense is called electroreception.



Blue sharks, like other sharks, have an amazing ability to detect electric fields using small pores called the Ampullae of Lorenzini.

Sharks can also detect magnetic fields, including those generated by the earth. Scientists think they may use these fields to navigate across entire oceans! Even though sharks have taste buds on the inside of their mouths, scientists don't think that they have a good sense of taste. More research is needed to learn about how sharks might use their sense of taste.



MAKING TRACKS

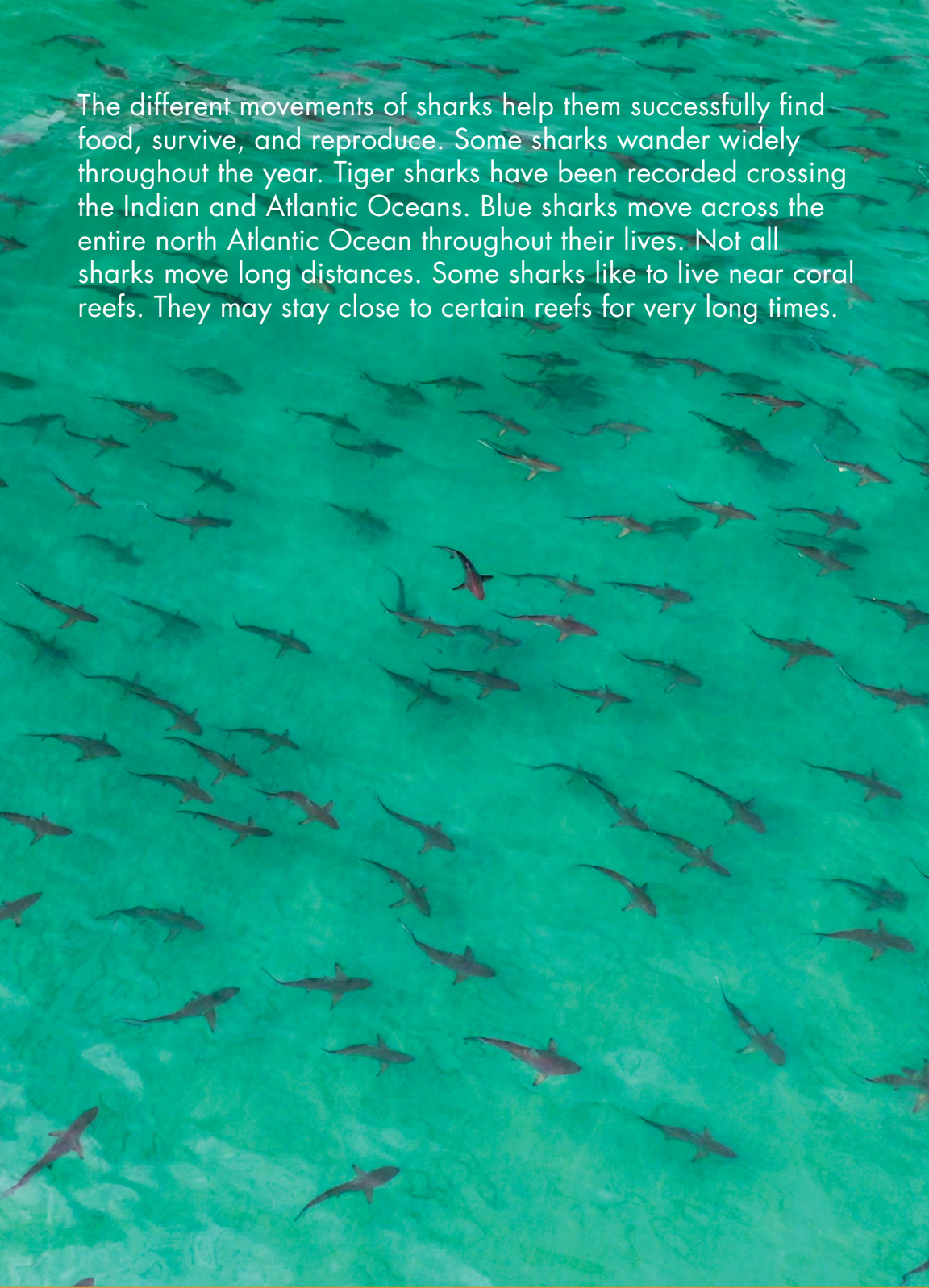
Some sharks live in places with seasons. In the winter, the water is cold. In the summer, it is warm. Many sharks leave areas when the water gets too cold in search of places that are just the right temperature.

How do scientists know about where sharks are located? Scientists use special devices to track sharks. Some of these devices emit a sound. The sound can be detected by a special microphone called a hydrophone. Scientists use these hydrophones from boats to follow sharks.

Other special tracking devices, called satellite tags, are attached to the sharks and ride with them for months or years. When sharks come to the surface, the tags send information to a satellite in space. The satellite sends shark location data to the scientists.

What has tagging sharks helped scientists learn? Some sharks don't move much. They stay in small areas that they consider their homes. Others move very long distances. Some swim across entire oceans! Blacktip sharks and spinner sharks form huge schools when the water temperature changes. They swim from northern waters to southern waters during the fall and return north in spring.



An aerial photograph showing a vast school of blacktip sharks swimming in clear, turquoise water. The sharks are densely packed, appearing as dark, elongated shapes against the lighter water. They are moving in various directions, creating a sense of dynamic movement. The water's clarity allows for a detailed view of the sharks' bodies and fins.

The different movements of sharks help them successfully find food, survive, and reproduce. Some sharks wander widely throughout the year. Tiger sharks have been recorded crossing the Indian and Atlantic Oceans. Blue sharks move across the entire north Atlantic Ocean throughout their lives. Not all sharks move long distances. Some sharks like to live near coral reefs. They may stay close to certain reefs for very long times.

DISAPPEARING SHARKS?

Sharks may be amazing predators, but they are also in trouble. Many sharks are being taken from the oceans. People use sharks for their meat and also for shark fin soup. Some countries have helped protect shark populations by setting limits on how many sharks can be caught. Other countries protect all sharks from being caught, and shark tourism allows people to pay money to see them up close. The protection of sharks is important for the health of oceans.

Many people are afraid of sharks because they can attack people. But, most sharks are no risk to people at all. In fact, they are good for the oceans and people. If sharks no longer existed, ecosystems could collapse. This could result in less fish available to catch and eat!



People will pay to swim with sharks, like this great hammerhead shark in The Bahamas.

SHARK STUDIES

There is still a lot to learn about sharks! New devices help scientists learn more about sharks than ever before. Video cameras help them learn a lot about sharks in clear waters.

Teams of scientists put cameras on the bottom of the ocean. They then place bait in front of the camera. The sharks that swim to check out the bait are recorded on the video. Scientists collect thousands of hours of video that then needs to be watched to count the sharks. Computers help make this a lot easier! Cameras help scientists in other ways. They can even be put on sharks. These shark cameras provide sharks-eye views of the world. Shark-cams also have sensors that measure the environmental conditions, shark movement, and energy use.

Now that you know all about sharks and how to study them, you are ready for your mission. Let's unravel the mysteries of the blacktip shark migration off the coast of Florida!





Shark-cam



GLOSSARY

CONDUCTOR

a substance that transmits heat, electricity, or sound

DIGESTION

the process of breaking down food

ELECTRORECEPTION

the ability to detect electric fields

ENDOSKELETON

a skeleton on the inside of the body

EXOSKELETON

a skeleton on the outside of the body

INSULATION

material that slows the transfer of heat or other energy

PHOTOPHORES

organs that produce light

PREDATOR

an animal that catches and eats other animals

PREY

an animal that is eaten by other organisms

SENSOR

a device that measures or detects a physical property

VERTEBRATE

an animal with a backbone

PHOTO CREDITS

Abbreviation Key: SS = Shutterstock.com,
BPA = BluePlanetArchive

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SCIENCE 3D

Thanks for exploring with us! Our science adventures take us around the world to uncover secrets of the most amazing animals and places. Our mission and passion is to share these scientific discoveries with you. There are so many cool things to see out there, even in your own backyard, so get outside and explore!

MIKE HEITHAUS PH.D.

Dr. Mike Heithaus is an explorer, author, educator, and television host. He is a professor of biology and Dean of the College of Arts, Sciences & Education at Florida International University. Mike and his students study sharks, whales, sea turtles, and other large marine animals around the world. They also work with people to help protect these species. Mike loves sharing his work with others. He has written text books and helped create programs for students in elementary, middle, and high school. He has been on television programs including on PBS, National Geographic, and Discovery Channel's Shark Week.



PATRICK GREENE

As a wildlife filmmaker, Patrick has always had a passion for animals. He started to draw pictures of sharks and whales when he was just five years old. Later, he went to college to become a marine biologist and learned a lot about science. Then he got a job in television and learned how to make videos, too. Since then, he's gone all over the world studying and filming wild animals. He's made shows for National Geographic, PBS and ABC, and even won an Emmy Award. He loves making videos to teach students about science and about the many creatures that share our world.







SHARKS!

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