DEERING ESTATE

SHARK RESEARCH & CONSERVATION PROGRAM MIAMI

Marine Conservation Science & Policy: Cartilaginous Fish and Dogfish

Grade Level:

4th -12th

Subject Area

Science

Biology

Duration

1.5 Hrs

Benchmarks:

Body of Knowledge

Life Science

Nature of Science

Physical Science

Big Idea

Organization and Development of Living Organisms.

The Practice of Science

Standards

SC.3.L.15.1

Classify animals into major groups according to their physical characteristics and behaviors.

SC.5.L.17.1

Compare and contrast adaptations displayed by animals that enable them to survive in different environments such as behaviors and physical characteristics.

SC912.L.14.2

Relate structure to function for the body parts of animals.

Focus Question

What are cartilaginous fish? What features differentiate them and where are their habitats? How do humans affect them and why are they important?

Objectives

Students will research the cartilaginous fish class and their defining characteristics. Students will learn to:

- Identify the defining features of the cartilaginous fish.
- Explain what resources they depend on and where they can be found.
- Demonstrate knowledge by researching and presenting a species of cartilaginous fish.

Student will discuss how these organisms can be protected for future generations. This will be a project-based activity where students will dissect a dogfish.

Background

The **cartilaginous fish** class, or Chondrichthyes, is defined by one particular feature: a skeleton made of **cartilage**, a dense, rubbery material that is lighter and more flexible than bone. This class encompasses all sharks, rays and skates, as well as sawfish and chimaeras. All modern Chondrichthyes are thought to have evolved from acanthodians almost 400 million years ago, from which they retained a few common characteristics, including their skeleton. Because of this cartilage, the species in this class do not have bone marrow, so their red blood cells, essential for delivering oxygen throughout the body, are produced in the spleen.

Aside from being jawed vertebrates, all Chondrichthyes also share paired nostrils, gills, scales, and a multi-chambered heart. Unlike fish, these species have no swim bladder. The respiratory system of these organisms relies upon five to seven **gill** pairs on the underside or side of the head, which extract oxygen as water passes through them. Some species must remain moving in order to keep water flowing through their gills, while others have adapted active-pumping spiracles. The spiracle allows species like the nurse shark to rest, while thresher sharks and mackerel sharks no longer have them and must maintain motion.

The scales of these species are called **dermal denticles** and are physically similar to rows of tiny teeth, giving their skin the distinct sandpaper-like texture that both protects and streamlines. The scales of bony fish grow in size, while those of the Chondrichthyes class form new scales in new spaces as the body grows. Other features of these species, such as the nose of sawfishes and the spines of stingrays, are also structurally modified scales. Rather than being firmly attached to their jaws, the teeth of Chondrichthyes are imbedded in a fibrous material so that when one becomes broken or worn down, it is replaced by another moving forward from behind, with new tooth buds developing as needed.

While some species of this class lay egg cases, most are considered **ovoviviparous**, with females giving birth to live young. Males of these species tend to have modified fins called **claspers** that are used to inseminate the female. Pregnant females often stop eating and select isolated nursery areas to give birth, but often leave shortly thereafter.

Vocabulary:

Cartilaginous Fish:
A class of fish characterized by a rubbery cartilage skeleton, complex and diverse bodies, and species that include sharks, rays, skates, sawfish and chimaeras.

Cartilage:
A dense connective tissue that is lighter and more flexible than bone.

Dermal Denticles:
The tooth-like scales of cartilaginous fish.

Ovoviviparous:
Producing young by means of eggs that hatch within the female body.

Claspers:
A pair of appendages on male sharks and rays, used for reproduction.

Tapetum Lucidum:
A layer of tissue within the eye that maximizes light reflection to allow for superior night vision.

Gills:
Paired respiratory organs of which extract oxygen from water flowing over the surface.

Countershading:
A protective coloration of some fish with distinct delineation between a dark upper and a light lower section.

Apex Predators:
An organism residing at the top of a food chain, upon which no other organisms prey.

Bycatch:
The unwanted fish and marine organisms caught in commercial fishing nets.

Finning:
A process by which only the fin is removed from a shark while the body is left to die.

Background

Most species also feature a **tapetum lucidum**, a layer of tissue that maximizes light reflection in the eye, allowing for superior night vision. While this adaptation is particularly useful to the nocturnal carnivores of the Chondrichthyes class, feeding during the day is also common. The diet of this class varies, some eating almost anything from birds to seals to tuna to other sharks; others like the whale, basking and megamouth sharks prefer plankton.

While a few of these species venture into brackish and fresh water, most are found strictly in marine habitats. While some species like the bonnethead shark spend their entire lives within a hundred mile range, others like the blue and mako sharks migrate thousands of miles to breed and hunt. The majestic golden cow-nose rays, measuring up to 6 ½ feet, migrate twice a year from Mexico to Florida to New England in groups, or fevers, of up to 10,000!

There are at least 1,100 known species of cartilaginous fish, ranging in size from the short-nosed electric ray at 4 inches to the massive whale shark, which grows up to 30 ft. and can weigh up to 10 tons. Coloration varies, but most feature a distinct lateral line and many show **countershading**, a dark-upper and light-lower body that helps them camouflage in the water. While most sharks live between 20 and 30 years, and most rays and skates an average 40-50 years, the spiny dogfish and whale shark have been known to survive for over a century. Most cartilaginous fish are considered **apex predators**, organisms at the top of food chains. As apex predators, these organisms play a crucial role in sustaining the health of the marine ecosystem, maintaining stability by keeping the prey species' populations balanced. Without sharks, the increased populations of smaller fish cause a crash in plankton, upon which the entire food web depends as primary producers. Humans also use cartilaginous fish to create various products, including meat, shark liver oil, leather, jewelry, rope, and even drumheads.

Despite their importance, cartilaginous fish have declined by 80%, with one third of species facing extinction. These population drops are mostly due to anthropogenic, or human-caused threats. Marine pollution from fisheries, plastic that amasses in apex predators through bioaccumulation, agricultural and urban runoff, coastal development and sewage destroy habitat and prey populations. Overfishing threatens these species on multiple levels: by decreasing their food sources as well as unintentionally tangling them in nets where they often die needlessly as **bycatch**. By far the greatest threat to most species is fishing, as 126,000 tons of rays and an estimated 100 million sharks are killed each year, about 73 million of these deaths due to finning. **Finning** refers to the practice in which a fisherman cuts off just the shark's fin, throwing the body overboard to die a slow death by suffocation or predation. The problems in the food web are already evident in an increase in jellyfish numbers and a steep decline in fish populations. In order to protect these fascinating creatures, individuals can reduce plastic use, symbolically adopt a great white, donate to conservation organizations, urge government officials to limit fisheries and increase marine protected areas, consume only sustainable seafood, and educate others on the importance of all cartilaginous fish.

Supplemental Resources

1- "Sharks." National Geographic Education.
http://education.nationalgeographic.org/search/?q=sharks
2- "Sharks and Rays." Smithsonian Natural Museum of Natural History—Ocean Portal.
http://ocean.si.edu/ocean-life-ecosystems/sharks-rays
3- Virtual Tour: "Sharks: Predators in Peril." Odyssey Earth.
http://www.odysseyearth.com/videos/sharks-predators-in-peril/

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Extension Activity:

Have students research another cartilaginous species with a parent or adult. Have them cut construction paper lengthwise into bookmark size. On one side, the student should illustrate their chosen species, while the other side should feature its name, habitat, food, and three fun facts.

Assessment:

Have students complete the Cartilaginous Fish worksheet in class. In their science journal, have them write a paragraph summarizing today's lesson and its relevance to them.

Program Partner:

University of Miami – Shark Research & Conservation Program

Dogfish Dissection

Materials

- A large dissection tray
- Surgical scissors
- Scalpel
- Probe
- Forceps

Procedure

1. Divide students into small groups of 3-4. Explain that as teams of ichthyologists, each group will be dissecting a dogfish specimen in order to better understand its organs and their functions. Hand each group their materials and read the Guidelines together. An incision diagram should be placed on the board or demonstrated on an overhead projector.
2. Students may wish to assign one person to note taking during the dissection, completing the assigned sections of the worksheet.
3. Students should measure and examine the external features of the dogfish.
4. Students should begin the dissection by carefully following the incision diagram.
5. Students should examine the musculature of the specimen.
6. Have students examine the digestive system of the specimen. They should then remove those organs to examine the urogenital, nervous and circulatory systems.
7. Students should clean up after the dissection by placing all dogfish parts in the bag, secure the bag with a rubber band, and place the bag in one of the used specimen boxes. They should wash all dissection tools and the tray, and return tools and tray to the teacher.
8. Students should all complete their Shark Anatomy worksheets. Go over the questions as a class and encourage discussion on the importance o the scientific method, the similarities and differences to human anatomy, and the evolution, function and importance of the body's systems.
9. Dissection Extension: Students should research and discuss the ethics of dissection with a parent or adult. Students should prepare a of list pros and cons and formulate their own opinion. Students should summarize both arguments and elaborate their own decision in a paragraph.

Answer Key

1. D
2. C
3. F
4. G
5. E
6. B
7. A

8. Cartilaginous fish play an important role in most marine food webs as apex predators, helping to maintain balance in ecosystems.
9. Cartilaginous fish are threatened by finning and unsustainable fishing practices that reduce prey species and lead to bycatch of cartilaginous fish, and other anthropogenic factors like bioaccumulation from contaminants.
10. Individuals can help protect these species by eating sustainably caught seafood, supporting wildlife organizations and programs like Adopt-a-Shark, and educating others.

Shark Anatomy

Spiny Dogfish Dissection

Section I: External Anatomy

1. Illustrate the external anatomy. Measure the specimen and label features.

2. What interesting things do you observe about the skin and external organs?

_____

3. What purpose might the lateral line system serve, especially for a fish in murky waters? _____

4. Is the shark's skin as thick as you expected it to be? Why or why not? _____

_____

Section II: The Digestive System

5. Illustrate the digestive tract from mouth to anus. Label the organs.

6. How does the oil in the liver aid in buoyancy? _____

_____

7. How does the shark's digestive system compare with that of a human? _____

_____

_____

Section III: Internal Organs

8. Illustrate the heart.

9. Unlike a mammal's heart, the shark's heart circulates deoxygenated blood. Where is the blood oxygenated in the shark? _____

_____

10. Is the shark male or female? What internal and external features helped you identify sex? _____

_____

11. What is the largest part of the shark's brain and why? _____

_____

12. How is the shark's skeleton different from our own? _____

_____

13. What did you find interesting about this dissection and why? _____

_____

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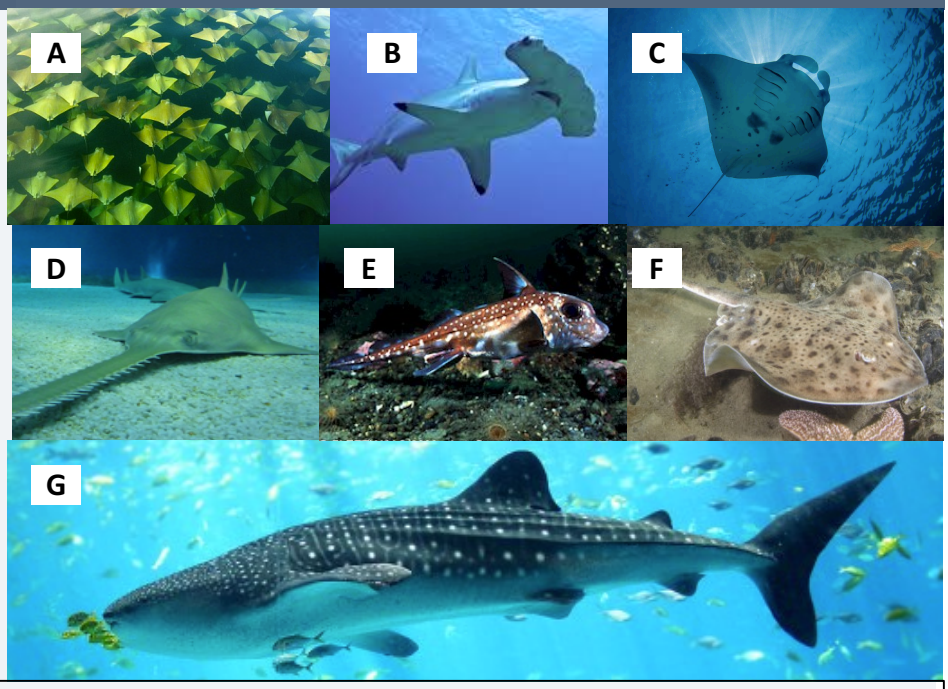
Cartilaginous Fish

The cartilaginous fish class contains over 1,100 known species of sharks, rays, skates, sawfish and mysterious chimaeras. These species vary in size, shape, color and behavior, but all feature a skeleton made of cartilage, gills, nostrils, and tiny, tooth-like scales that protect their skin and feel like sandpaper. Cartilaginous fish play an essential role in the ecosystem, but many are endangered.



Identify the species in the above photos:

1. _____ The large-toothed sawfish can use its long snout to dig through sediment or cut prey in half.
2. _____ The majestic manta ray can have a wingspan of 15 ft. and live up to a hundred years.
3. _____ The little skate lives in the Atlantic and is often used for medical research.
4. _____ Despite being the world's largest fish, the whale shark's diet consists of the ocean's smallest organisms, filtering plankton through its mouth.
5. _____ The spotted chimaera hunts small fish and crustaceans off the Pacific coast of North America.
6. _____ Because its eyes are on both sides of its unusual head, the hammerhead is able to scan more of the ocean for its favorite food: stingrays.
7. _____The golden cow-nose ray migrates annually from Mexico to Florida in groups of over 10,000.

8. Why are cartilaginous fish important? _____

9. What are some of the threats that are affecting cartilaginous fish? _____

_____

10. What can you do to help protect these fascinating and important creatures? _____

_____

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