Topic/Lesson:	**Adaptation to Life**
Subject:	Adaptations and Evolution
Author:	Tracy Bowen
Overview:	The diversity of species can be attributed to evolution through natural selection. Genetic mutations over the eons, combined with natural selection, have helped organisms adapt to specific niches and habitats, leading to creation of new species. In this lesson students will begin to have an understanding of the role of physical adaptations in the survival of individuals and species.
Objectives:	Students will be able to: Give examples of physical and behavioral adaptations and describe how they help an organism thrive in its environment.
Background Knowledge:	**Natural Selection:** The process by which individual organisms with favorable traits are more likely to survive and reproduce. Individuals and species with the best-suited characteristics for their environment are more likely to survive and to reproduce. If there's competition for survival and not all the organisms are the same, the ones with advantageous traits are more likely to survive. If these traits can be inherited, the next generation will show more of these advantageous traits. **Over time, beneficial mutations accumulate, and eventually, a new species evolves.** **Adaptation:** Any <u>hereditary</u> characteristic in an organism's physical structure or behavior that helps it to survive in its habitat or ecosystem; also used to describe the process of genetic change within a population, as influenced by natural selection. There are two major kinds of adaptations: physical and behavioral (we will talk mostly about physical adaptations today). Animals depend on their physical features to help them obtain food, keep safe, build homes, withstand weather, and attract mates. The shape of a beak, the color and thickness of fur, the shape of the nose or ears are all examples of physical adaptations which help animals to survive. Physical adaptations, or changes to the animal's physical body, usually occur by accident. Sometimes an animal is born with a mutation. Even though this mutation is accidental, sometimes it actually helps the individual to survive better than individuals without the mutation.

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	Imagine, for example, that a bird is born with a beak that is longer than the beak of other birds in that species. The longer beak helps the bird catch more food. Because of this, it is healthier, lives longer, and breeds more. The gene for a longer beak is passed on to its offspring. The gene continues to be inherited generation after generation. Eventually, the longer beak is found on every individual in the species. This doesn't happen overnight. It takes thousands of years for a mutation to be found in an entire species. **Physical adaptations do not develop during one lifetime, but over many generations.**
Materials:	• Computers with internet access; • Projector; • "Darwin's Evolution Game" Answer sheet (optional); • "Darwin's Evolution Game" Answer Key for Teachers; • "Fish Anatomy Basics" PDF slide; • "Fish Anatomy Basics" accompanying notes; • "Habitats" PDF (2 slides); • Large butcher paper or drawing paper (have sheets in two sizes); • Markers/colored pencils, scissors, and tape; • "Adaptation Cards" (laminate and cut cards before class; duplicate as needed for class size. Note: There are cut and laminated cards in the "Miscellaneous Cards" bag in the SCUTES kit.); • "Atlantic Sturgeon Adaptations" fact sheet; • "Atlantic Sturgeon Questions"; • Atlantic Sturgeon Answer Key for teachers.
Vocabulary:	**Adaptation**: For animals, adaptation means having certain body parts or behaviors that enable them to survive and thrive in their environments. **Evolution**: Change of a population's gene pool over time through mutation and natural selection. Plants and animals are descended from other species that lived in earlier times; the differences are due to inherited changes that take place over many generations. **As mutations occur and spread over long periods of time, they cause new species to form.** Over the course of many millions of years, the processes of mutation and natural selection have created every species of life that we see in the world today, from the simplest bacteria to humans and everything in between. **Fossil**: A trace, print, or the remains of a plant or animal of a past age preserved in earth or rock. Scientists have used the fossil record to construct a history of life on Earth. **Habitat**: The place or type of place where a plant or animal naturally or normally lives or grows. **Mutation:** A basic and important change; a permanent change in hereditary

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	material. **Niche**: The habitat that contains the things necessary for a particular plant or animal to live. Also, the role a particular living thing plays in an ecological community. **Offspring**: The young of a person, animal, or plant. **Reproduction**: The process by which plants and animals produce offspring. **Species**: The basic classification in biology that describes a group of organisms that resemble one another and are able to reproduce among themselves (identified by a two-part scientific name). **Trait**: An inherited characteristic. **Variation**: A change in the usual characteristics of a species or group.
Procedures:	**"Who Wants to Live a Million Years?"** 1) Bring up "Darwin's Evolution Game" on your computer and project it for the class to see: (http://science.discovery.com/interactives/literacy/darwin/darwin.html). 2) Click the "More About Darwin" link and review/discuss with the class. 3) Click the "Glossary" link; review with the class. 4) View and discuss the "Natural Selection" section with the entire class. 5) Open the "Survival Game" and review the game and the "Hints" with the entire class. 6) Have the students open it up on their own computers and play two or three rounds of "Who Wants to Live a Million Years?" choosing different traits each time. Alternately, you could play once or twice with the whole class on your own computer – allowing the students to choose the traits and direct the action – and then let them play on their own, or have them play in small groups. 7) After they have played the game a few times have them take the "Darwin's Evolution Game Quiz".This can be done as a group when everyone is done playing the game, or individually. If done individually, have them just answer for themselves online, or have them fill out and turn in the answer sheet. 8) Have students brainstorm/discuss observations made in playing the game. What did they learn about natural selection and evolution? How many were able to survive 1,000,000 years and what strategies enabled them to do that?

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The Basics of Fish Anatomy

9) Project the "Basics of Fish Anatomy" PDF slide and, using the "Fish Anatomy Basics" notes and "Fish Shapes Table", review the different adaptive structures of fish anatomy.

10) Show the "Habitats" slides; get the students thinking and talking about which of the physical adaptations they just learned about would be useful in the different habitats.

A Fishy Take on Adaptations

11) Explain to your students that they are going to get the opportunity to create their own fish.

12) Have them break up into small groups (3 or 4 students per group).

13) Distribute two sheets of drawing paper to each group (a small piece for the fish, and a large piece for the habitat), as well as markers, scissors, and tape.

14) Have the groups randomly choose from the "Adaptation Cards" for each of the three adaptations we're looking at: body shape, mouth shape and placement, and tail shape.

15) Allow groups to design and draw their fish using the "Adaptation Cards" they chose as a guideline.

    On the larger sheet have them draw the habitat that their fish is best suited for.

16) When all groups are finished, have each group share with the class their fish, explaining adaptations and why the fish is well-suited to its environment.

17) After sharing this information, have the groups exchange habitats and discuss among themselves the fate of their fish in its new habitat.

    Could it survive and why/how?

    How would the species need to adapt to survive in the new environment?

A Specific Fish: Atlantic Sturgeon Adaptations

18) Explain to your students that they are going to learn about adaptations that have helped a specific fish survive for millions of years.

19) Explain that sturgeon are relatively unchanged since the dinosaurs.

20) Show the two videos of sturgeon feeding. The first one shows how the protusible mouth works, the second shows how the barbels help the sturgeon find food.

    http://www.youtube.com/watch?v=0gWphqF6zZ8&NR=1

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	http://www.youtube.com/watch?v=qUe5yyESznE 21) Begin a discussion about how/why the sturgeon would have evolved to fill the niche it fills.
Conclusions:	Hand out the "Atlantic Sturgeon Adaptations" paper and the Question sheet for homework. Have students take the paper home to read and answer the questions. All questions, except one, can be answered directly from the Adaptation paper.
Massachusetts Frameworks:	Life Science (Biology) #10: Give examples of ways in which genetic variation and environmental factors are causes of evolution and the diversity of organisms.
Resources:	http://science.discovery.com/interactives/literacy/darwin/darwin.html http://www.ucmp.berkeley.edu/education/lessons/birdbeaks/birdbeaks.html http://www.tpwd.state.tx.us/kids/wild_things/fish/fishshapes.phtml http://www.youtube.com/watch?v=0gWphqF6zZ8&NR=1 http://www.youtube.com/watch?v=qUe5yyESznE

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Darwin's Evolution Game Quiz

Name_____ Date_____

Question 1: In the first part of the explanation for Darwin's theory of natural selection, every species exhibits what?

A) The same traits

B) Variations

C) Colors

D) None of the both

Question 2: What was the name of the ship that Darwin served as naturalist aboard from 1831 to 1836?

A) Indefatigable

B) Bugle

C) Sloop John B

D) Beagle

Question 3: Natural selection is only one of the processes of evolution. What is one other process that can cause change in a species over time?

A) Reproduction

B) Disease

C) Mutation

D) All of the above

Question 4: A species of organism has survived in a mild environment for thousands of years. Suddenly, the climate becomes much colder. Which of the following traits might help the species to survive?

A) Thick fur

B) Small size

C) Short neck

D) All of the above

Question 5: In 1835, Darwin studied variations in plants and animals on the Galapagos Islands. The islands are located off the coast of what major continent?

A) North America

B) South America

C) Central America

D) Antarctica

Question 6: Which of the following traits might be passed from parent to offspring but not necessarily be beneficial to the survival of the species?

A) Eye color

B) Long legs

C) Large size

D) Heightened senses

Question 7: Part Three of Darwin's theory of natural selection states that life in the wild is competitive, and organisms with the most beneficial traits will prosper. What is this commonly known as?

A) Survival of the strongest

B) Survival of the fittest

C) Survival of the fattest

D) Outwit. Outplay. Outlast.

Question 8: In what book did Darwin publish his main theories on evolutionary selection?

A) Descent of Man

B) On Proper Selection

C) The DaVinci Code

D) Origin of Species

Question 9: How do you get to Carnegie Hall?

A) Take the A Train

B) A slow boat to China

C) Get on the bus, Gus

D) Practice

Question 10: In the survival game, how long are you trying to keep your theoretical species alive and prospering?

A) 100,000 years

B) Three generations

C) Until it says to stop

D) 1,000,000 years

Darwin's Evolution Game Quiz
Answer Key for Teachers

Question 1:
In the first part of the explanation for Darwin's theory of natural selection, every species exhibits what?
B) Variations

Question 2:
What was the name of the ship that Darwin served as naturalist aboard from 1831 to 1836?
D) Beagle

Question 3:
Natural selection is only one of the processes of evolution. What is one other process that can cause change in a species over time?
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A species of organism has survived in a mild environment for thousands of years. Suddenly, the climate becomes much colder. Which of the following traits might help the species to survive?
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D) Origin of Species

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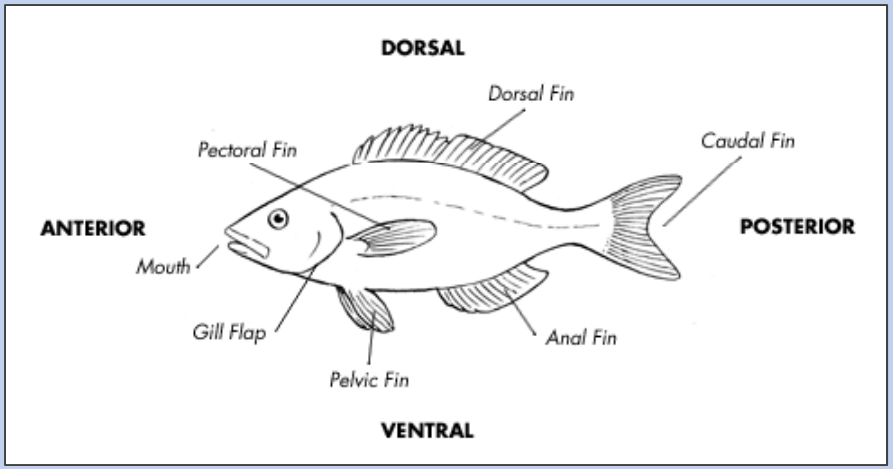
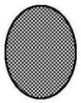
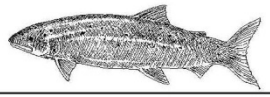
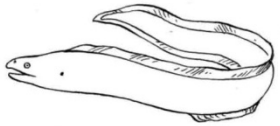
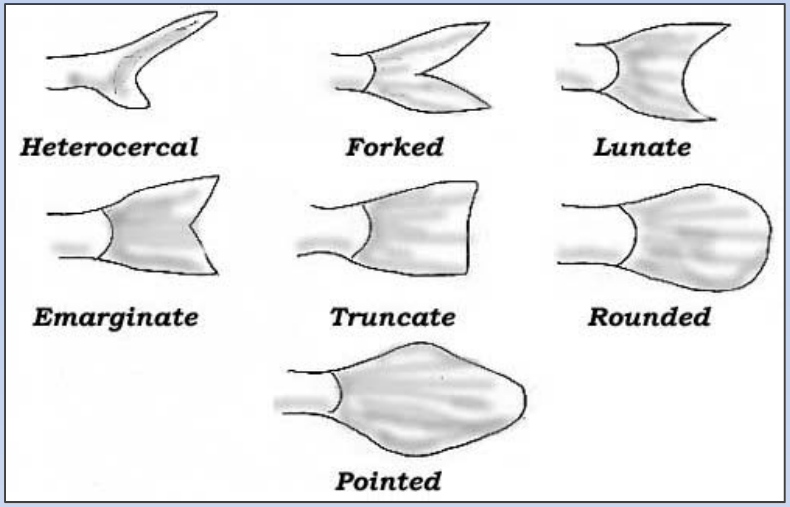
How do you get to Carnegie Hall?
D) Practice

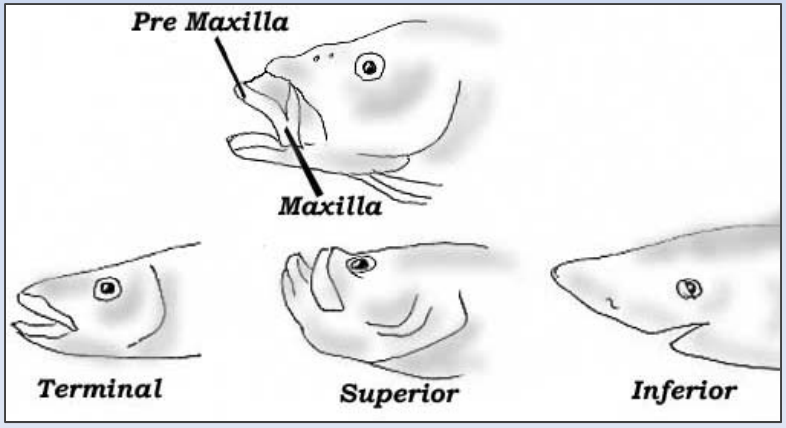
Question 10:
In the survival game, how long are you trying to keep your theoretical species alive and prospering?
D) 1,000,000 years

The Basics of Fish Anatomy and Adaptations



Cross-Section Body Shape	Type	Example	Fish	Characteristics
	Fusiform		Tuna Salmon	Elongated, ultra-streamlined; fast swimming, tapered at the head and tail
	Compressed		Angelfish Filefish	Not constantly moving, require bursts of speed
	Depressed		Skates Rays Flounder	Flight-like swimming
	Ribbon		Eel	Long thin body; moves like a wavy ribbon
	Combination of shapes		Boxfish Cowfish Puffers	Body covered with bony armor, slow-moving





Fish Anatomy Basics

There is great diversity in the size, shape, and details of fish anatomy. Some fish are string-like, some are globe-shaped, and some are flattened. A fish is shaped for where it lives and how it feeds. One with a torpedo shape swims quickly through the water. A flat fish easily hides on the ocean floor. Some fish have long shovel-shaped snouts, while others are spear-nosed.

Tails: Fish tails take many shapes. A crescent-shaped (or lunate) tail, like that of the swordfish, allows the fish to swim rapidly through the water. A forked tail, like that of the trout, can also enable fast swimming. A rounded tail, like that of the angelfish, enables quick bursts of speed to escape predators.

Fins: Fins help a fish move. The top fins are called dorsal fins; there can be one, two, or three dorsal fins. The belly or lower part of the fish is the ventral region. Within this section is the pectoral fin, which is located near the gills, and the pelvic fins. The bottom fin at the back of the fish is called the anal fin. The tail fin is called the caudal fin. Pectoral and pelvic fins come in pairs. Dorsal, anal, and caudal fins are single.

Mouths: Mouths come in a variety of shapes and are found in different places on the head. A fish's mouth is adapted to the food it eats. A fish with a mouth that slants upward might attack prey from underneath. A fish with a flat lower jaw probably feeds on or near the bottom. The mouth might extend directly from the front of the fish, or be found on the underside of the fish's head. Or the mouth might be snout-like to suck in food.

Bodies: The shape of a fish's body depends on its habits. It might be streamlined or rounded. A fish could be flattened from side to side to maneuver in narrow spaces, or flattened from top to bottom to glide along the seafloor. Other fishes are snake-like, enabling them to move easily between rocks. Fishes are found in many shapes.

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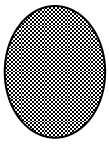
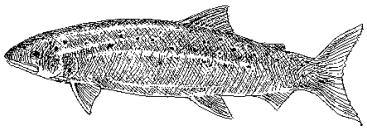
Cross-Section Body Shape	Type	Example	Fish	Characteristics
	Fusiform		Tuna Salmon	Elongated, ultra-streamlined; fast swimming, tapered at the head and tail
	Compressed		Angelfish Filefish	Not constantly moving, require bursts of speed
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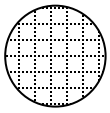
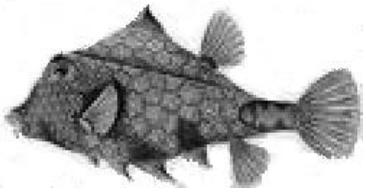
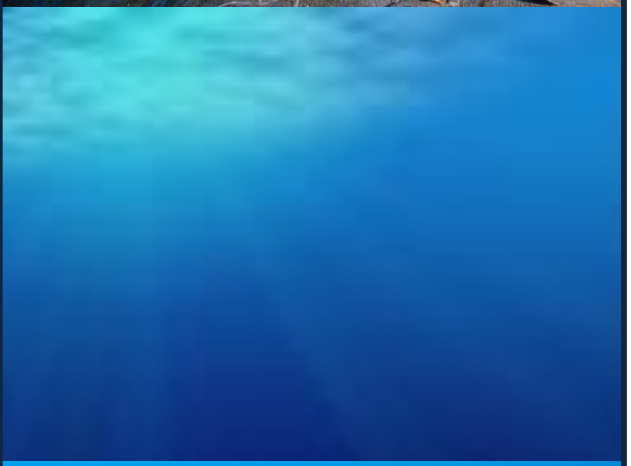
	Ribbon		Eel	Long thin body; moves like a wavy ribbon
	Combination of shapes		Boxfish Cowfish Puffers	Body covered with bony armor, slow-moving

Salmon: Robert Savannah, U. S. Fish and Wildlife Service (http://www.fws.gov/r9extaff/drawings/page38c.gif)
Angelfish & Skate: http://www.fordesigner.com/imguploads/Image/cjbc/zcool/20080523/1211532356.jpg
Eel: Nova (http://www.pbs.org/wgbh/nova/teachers/activities/pdf/3003_fish_01.pdf)
Boxfish: Ookaboo (http://images.ookaboo.com/photo/s/Haeckel_Ostraciontes_s.jpg)

Deep (Benthic) Sea:
The deepest, darkest, coldest parts of the ocean. Composed of a variety of sediment types and exposed to a range of water conditions, leading to diverse plant and animal communities. Influenced by wave action and currents. The plants and animals in benthic communities are determined by the nature of the sea bottom. Habitats range from bedrock, to coarse sand and gravel, to silt and clay. Benthic animals include a wide variety of invertebrates and fish.



Open Ocean - the Pelagic Zone:
The open ocean, or pelagic zone, is the area of the ocean outside of coastal areas where you'll find some of the biggest marine life species. The sea floor is not included in the pelagic zone.

Coral Reef:
Thought to support more than 1 million species (nearly one-quarter of the world's marine species). This includes not only several hundred species of coral, but thousands of fish and invertebrate species. While the majority of coral reefs are found in tropical and sub-tropical water, there are also deep water corals in colder regions.

Coastal (Intertidal zone)

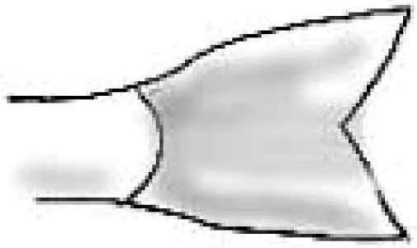
Where land and sea meet. Covered with water at high tide, and exposed to air at low tide. Can be rocky, sandy, or covered in mudflats. The plants and animals in the rocky intertidal habitat must be able to withstand both pounding waves and hours of dryness. During low tide small pools form where organisms like crabs, snails, mussels, barnacles, and many kinds of seaweed are able to thrive. At high tide larger animals take advantage of the shelter and food these rocky settings provide.

Rivers:

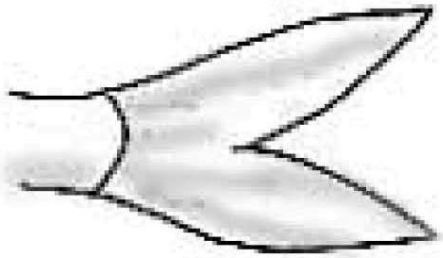
The main feature of all river environments is continuous movement of water and currents. In fast-moving streams, there is very little photosynthesis in open-water due to the speed of the current. Riffle areas provide valuable habitat for juvenile trout and salmon, while pools are important resting areas for several fish species. Slow-moving streams support more fish species.

Lakes and ponds:

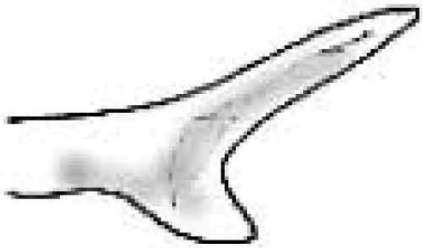
Most lakes are deep enough to have open-water habitats. Most ponds are shallow and support submerged vegetation throughout. Ponds are greatly affected by local climatic and geological conditions and vary greatly.



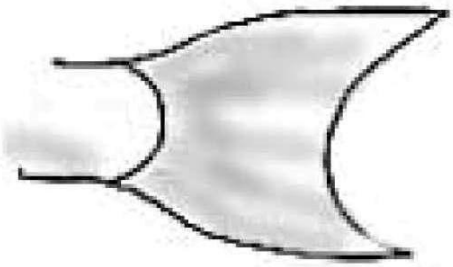
Emarginate



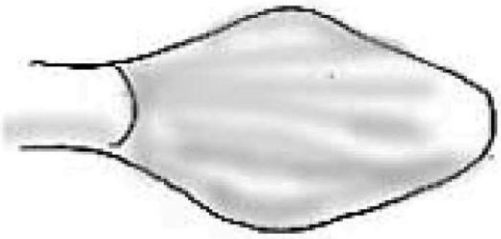
Forked



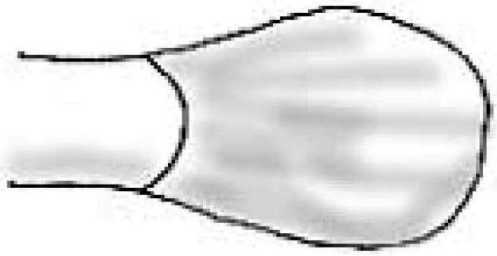
Heterocercal



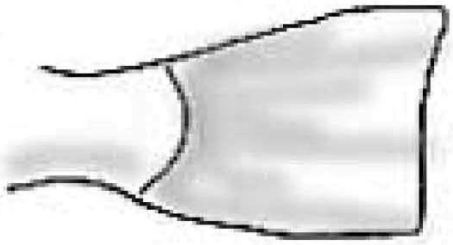
Lunate



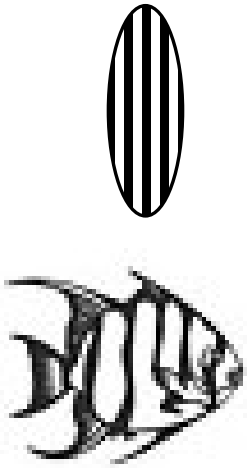
Pointed



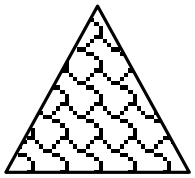
Rounded

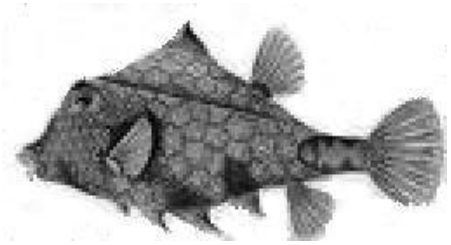


Truncate



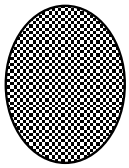
Compressed

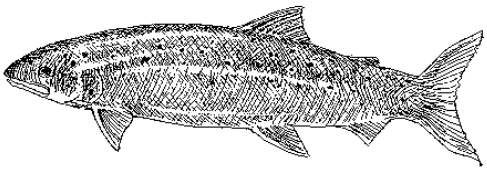




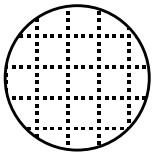
Combination of shapes

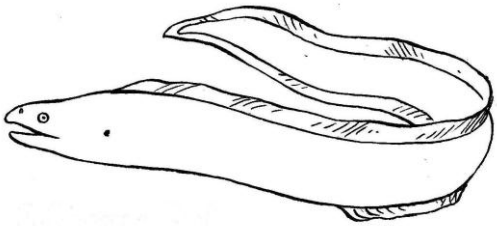
Depressed



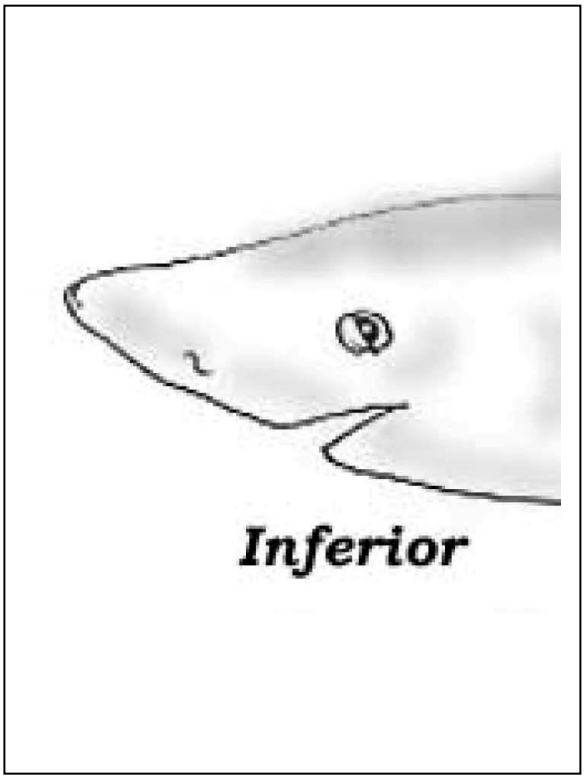


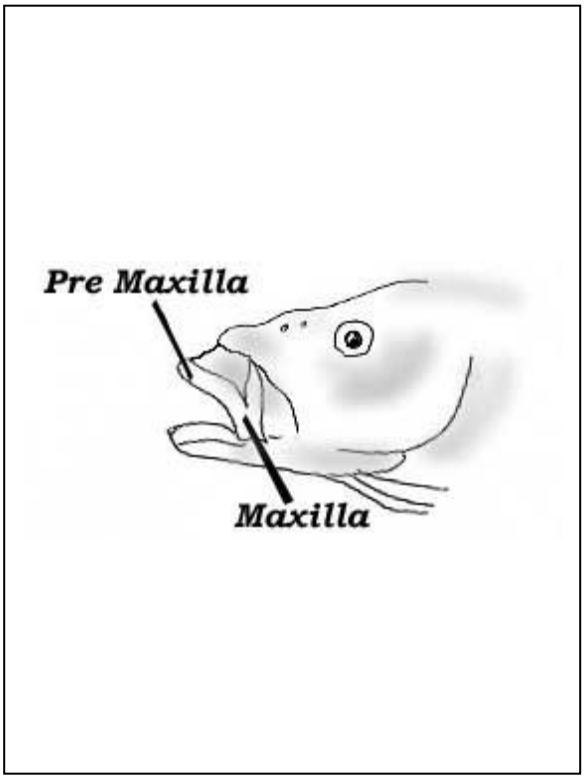
Fusiform





Ribbon


Inferior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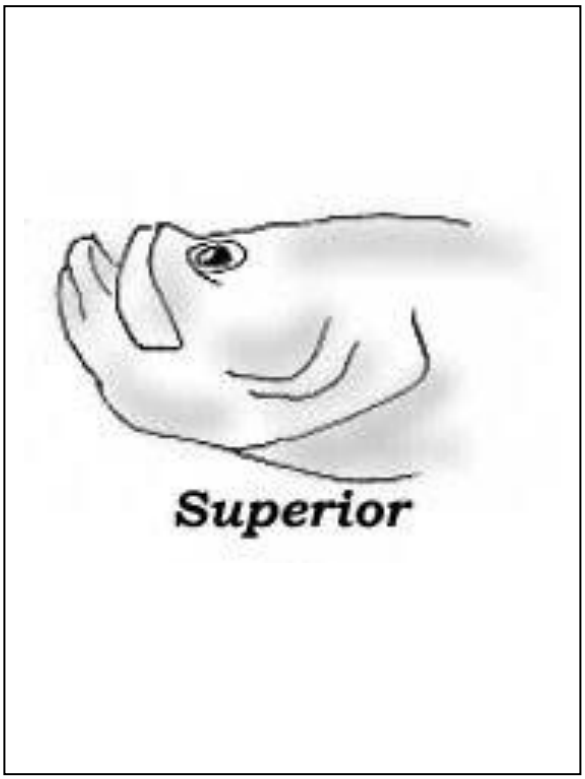
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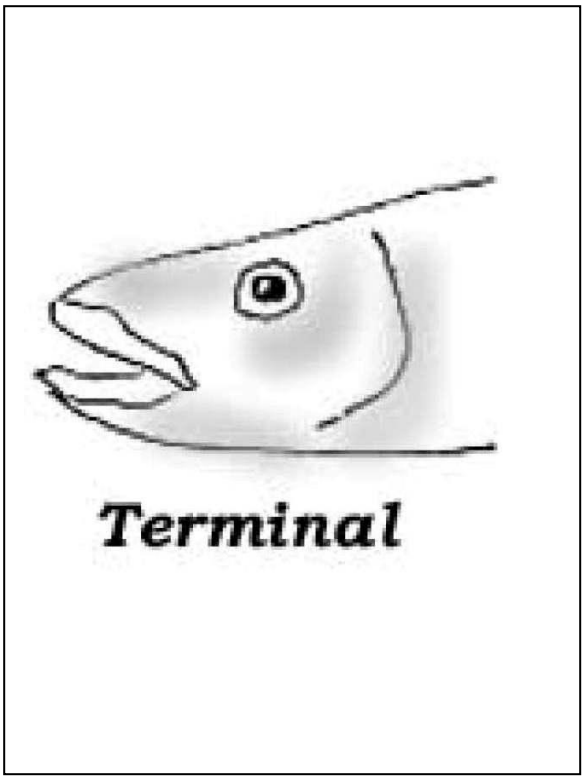
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Atlantic Sturgeon Adaptations

General Information

Sturgeon, relatively unchanged for 120 million years, are survivors of a primitive group of fishes. Modern sturgeon retain the primitive, almost entirely cartilaginous skeleton, of their ancestors but have bony, rigid protective plates rather than the smooth and enameled plates of their ancestors. There are about two dozen species of sturgeon found world-wide; they are found in every major river system in the Northern hemisphere. Sturgeon are a slow-growing and late-maturing long-lived genus of fish.

The Atlantic sturgeon is an anadromous species that migrates from the ocean into the coastal estuaries and rivers to spawn. An Atlantic sturgeon practices "natal homing" and spawns in the same river where it hatched. They can live up to 60 years, reach up to 14 feet in length, and weigh over 800 pounds. Atlantic sturgeon typically reach sexual maturity within 15-20 years, depending on location (northern sturgeon mature more slowly). Sturgeon usually cruise slowly along the bottom of sandy or muddy stretches, but sometimes leap from the water. They are known to be curious and will stop to look at an unusual object.

Adaptation Information

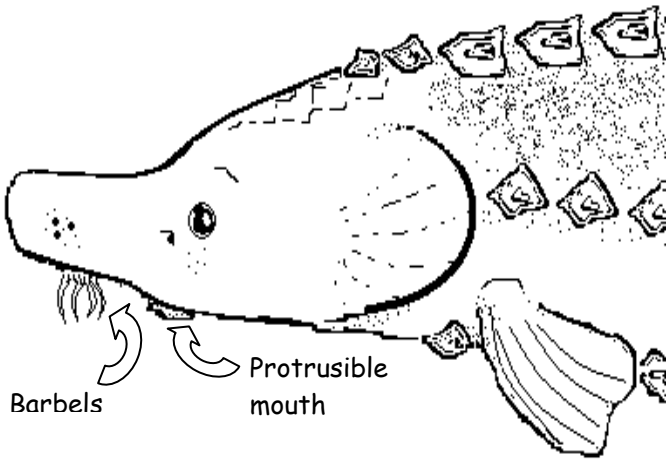
Some examples of physical adaptations are: camouflage; mimicry; chemical defenses such as venom, sprays or inks; and body coverings like beaks, claws, teeth, feet, and scales. Camouflage is when an animal's body covering color or shape helps it blend into its environment. Mimicry is an adaptation where a harmless animal looks like, or "mimics", an animal that is harmful. For example, the harmless Milk Snake's coloration mimics that of the venomous Coral Snake and predators stay away. Chemical defenses such as sprays, and venom also keep predators away. Think of a skunk. If a dog sees a skunk in the backyard it will probably run toward the skunk. The skunk protects itself by lifting its tail and spraying in the dog's direction. Usually this is enough to stop the dog from attacking or hurting the skunk. The last type of physical adaptation is body coverings. Some examples are webbed feet, sharp claws, whiskers, sharp teeth, large beaks, wings, striped fur, bright feathers, and scales.

Behavioral adaptations are different because they are related to an animal's actions and not just a physical trait. Some of these behavioral adaptations are instinctive, meaning they happen naturally, and others are learned, meaning the animal must be taught to do it. Instinctive adaptations include behaviors like hibernation, migration, finding shelter, gathering food, raising young, and self defense. Animals are born with the natural ability to do these things. Learned adaptations are behaviors that animals would not do naturally on their own. Animals must learn to do these things by interacting with their environment or ecosystem. If a mother tiger learns a new behavior to survive, she must teach this behavior to her offspring, since it will not be passed on naturally as instinctive behaviors are. Think of dolphins that do tricks. Dolphins are not born with the ability or knowledge to perform tricks, but are able to learn them with enough practice and experience.

Sturgeon Adaptation

Atlantic sturgeon are shaped like sharks with a deeply forked heterocercal tail, meaning the top lobe extends farther than the bottom lobe. They have a single, small dorsal fin, paired pectoral fins, paired pelvic fins, and a single anal fin. Like all other animals, they possess various adaptations to help them survive in their habitat, or ecosystem. Some of their physical and behavioral adaptations are described below.

A sturgeon's mouth is ventral, or under the head, to help it feed off the bottom. The **protrusible** mouth is small with extendable lobed lips. It has a unique snout with four pointed barbels across the lower side of the snout in front of the mouth that help the sturgeon find prey along the river bottom. The sucker-shaped mouth then vacuums up the worms, mollusks, crustaceans, insect larvae, and small fish the sturgeon prefers. Adult sturgeon do not have teeth, but have bony plates in their throats that they use to crush their food.



The sturgeon's body is rounded and flat-bellied so it can rest on the bottom while feeding and be less noticeable to predators. They also have special coloration that helps them blend in to their surroundings: they are dark on top making them less visible to predators from above, and lighter on the belly making them less visible to predators from below. This type of camouflage, known as countershading, is common among fish species. A sturgeon has thick tough skin; its body and head are covered with five rows of bony plates, called scutes. These scutes, or bony scales, help to protect the sturgeon, acting like a type of armor. The sturgeon's bony scutes and large size both help to protect it from predators.

When a sturgeon is hooked or caught it will defend itself by lashing its tail. This long and strong tail is capable of injuring a fisherman and damaging fishing equipment. If the fish is strong enough it will free itself from capture. This type of defense is an instinctive behavior.

Another important instinctual behavioral adaptation of the Atlantic sturgeon is migration. Adults spend the majority of their time in the ocean, but return home to their natal river (the river in which they hatched) to spawn. This is an instinctive behavior that they perform automatically. Atlantic sturgeon face many challenges as they attempt to return to their natal rivers to spawn. For example, decades ago dams were built in some rivers that resulted in blocking the Atlantic sturgeon from returning to their spawning habitat. In other cases, sturgeon may return to their natal rivers only to find the spawning habitat has been destroyed by dredging. Individual sturgeon might alter their behavior and search for different spawning grounds, but others might not spawn that year.

Atlantic sturgeon, like all animals, have many adaptations - both behavioral and physical. These adaptations help the sturgeon to survive in an ecosystem that is constantly changing. If the sturgeon species did not make these necessary adaptations, the species' survival would be in danger.

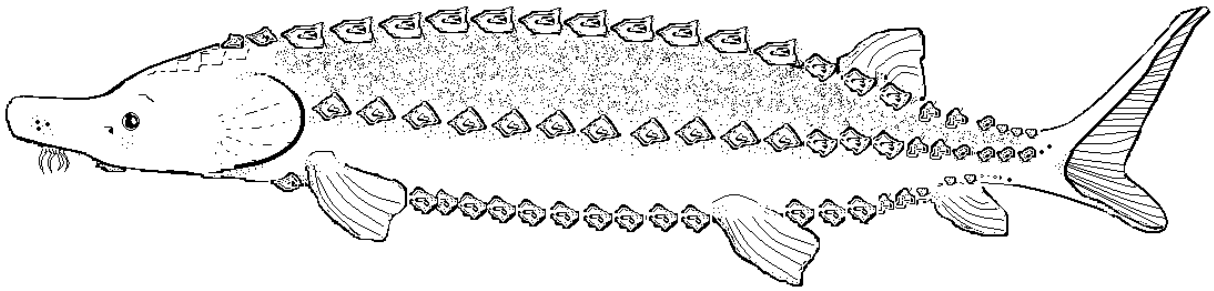
SCUTES

Students Collaborating to Undertake Tracking Efforts for Sturgeon

Atlantic Sturgeon Adaptations

Name _____ Date _____

1. Label the physical adaptations of the sturgeon.



2a. Name two examples of behavioral adaptations.

2b. Which of these behaviors is described in the sturgeon paper?

3. Using context clues, what does anadromous mean?

4. Where is a sturgeon's mouth? Why is it there?

5. What is countershading and how does it help the sturgeon?

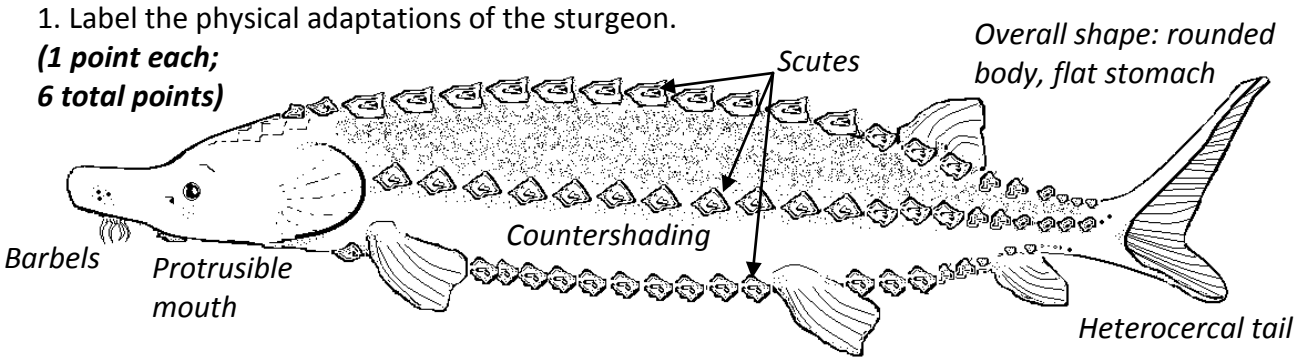
6. Define “protrusible” (search online or in a dictionary).

7. What are two ways behavioral adaptations are acquired?

8. Will a sturgeon hatched in a Georgia river mature faster or slower than one hatched in a Maine river?

Atlantic Sturgeon Adaptations: Teacher Answer Key

1. Label the physical adaptations of the sturgeon.
(1 point each;
6 total points)



2. Name two examples of behavioral adaptations. ***(1 point)***

Finding shelter	*Gathering food*	*Hibernation*
Migration	*Raising young*	*Self-defense*

2b. Which of these behaviors is described in the sturgeon paper. ***(1 point)***
Any one of these is fine:

Gathering food	*Migration*	*Self-defense*	*Spawning*

3. Using context clues, what does anadromous mean? ***(2 points)***
Anadromous means they live in the ocean and return to the river to spawn.

4. Where is a sturgeon's mouth? Why is it located there? ***(2 points)***
The mouth is located on the underside of the head. Sturgeon are bottom-feeders.

5. What is countershading and how does it help the sturgeon? ***(2 points)***
Countershading means the sturgeon is dark on the top and lighter underneath. This makes it hard for predators to see it from above and from below.

6. Define "protrusible". ***(2 points)***
Capable of being thrust outward.

7. What are two ways behavioral adaptations are acquired? ***(2 points)***
Instinctual (inherited)
Learned

8. Will a sturgeon hatched in a Georgia river mature faster or slower than one hatched in a Maine river? ***(2 points)***
A sturgeon hatched in a Georgia river will mature faster than one hatched in a Maine river; northern sturgeon mature more slowly than southern sturgeon.