Name ______________________ Class ______________ Date____________

Voyagers and Acrobats

Comparing Fish Body Shapes

Question What body shapes can be observed in cartilaginous and bony fishes? How does body shape affect the way a fish moves?

Lab Overview In this investigation you will study examples of fishes with different body shapes and learn how each body shape is an adaptation for survival in a specific environment. You will make a model of one of the fish body shapes and test how fast the model can move across an aquarium.

Introduction The amount of effort a fish uses as it moves through the water depends directly on the resistance that the water exerts on the fish. In general, the more streamlined the body of the fish, the less water resistance there is. In this lab, you will determine which of two body shapes enables a fish to swim forward at a faster rate by dragging model fish through the water at a constant degree of resistance. You will measure the "fitness" of a particular fish body shape in regards to moving forward through the water.

Prelab Activity The ability to move quickly forward through the water is an important adaptation for many types of fishes. However, there are other types of fishes that do not spend much of their time moving forward through the water. For example, some fishes lie in wait for their prey. Other fishes make quick, precise movements in all directions to evade predators.

The body shapes of fishes are adaptations that allow them to move through the water in different ways. Read the descriptions below and on the next page of various types of fish shapes. Then, match the letter of the description with the correct diagram on the next page. Afterward, answer the Prelab Questions.

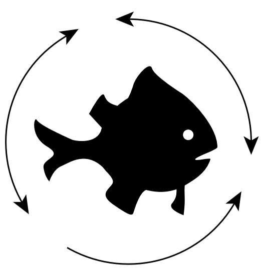
a. Fishes with a streamlined body shape and pointed head encounter little water resistance as they swim. Fishes with this body shape usually have a narrow, forked tail, which helps to generate forward power. They are the long-distance voyagers of the sea. Examples of this type of fish body shape include the tuna, mackerel, and anchovy.

b. Fishes with compressed, disklike bodies can maneuver in all directions like acrobats. These fishes are adapted to capture tiny floating prey, and have rippling, waving fins that allow for control of precise movements. Examples of this type of fish body shape include the butterfly fish and angelfish.

c. Fishes with flexible bodies and large, traplike mouths are adapted to move forward quickly and "pounce" on their prey. Their bodies bend into a curve, which provides quick forward motion over a short distance, and their large heads have powerful jaws to clamp prey. Examples of this type of fish body shape include the bass and kelp rockfish.

d. Fishes with long, snakelike bodies can easily hide in rock crevices. These fishes have very small fins or no fins at all and move by undulating their bodies (moving in a wavelike motion). They lurk in narrow spaces and lie in wait for prey. Eels are an example of this type of fish body shape.

e. Fishes that rest on the ocean floor usually have flat bodies. These fishes often have eyes on the top of their head so that they can see while lying on the ocean floor. These fishes move by making wavelike motions with their bodies. Many have body coloring that allows them to blend in with the ocean floor. They sometimes partially cover their bodies with sand, which makes them even less visible. Examples of this type of fish body shape are the ray, flounder, and sand dab.



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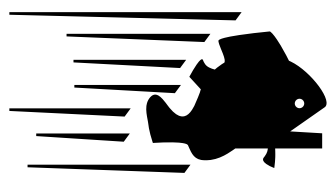

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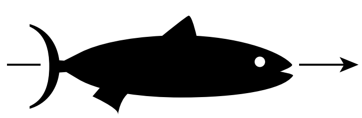

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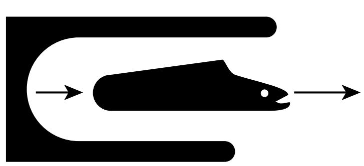

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Prelab Questions

1. Which body type do you think a fish that migrates to different areas of the ocean would have? Explain.

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2. Which body type is best for a fish that ambushes its prey? Explain.

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3. Which body type is best for a fish that feeds on tiny, floating zooplankton? Explain.

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Materials

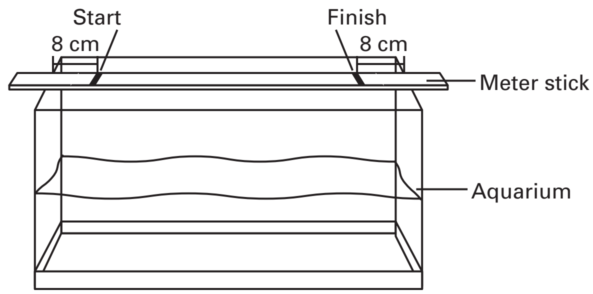
- modeling clay
- copper or brass wire (0.5 m, 28 gauge)
- protractor
- large aquarium or large, shallow plastic box (clear)
- water
- pencil or tape
- stopwatch

Procedure

Part A: Setting Up the Tank

1. Fill the aquarium or storage box half full of water.
2. Place the meter stick across the top of the length of the aquarium or storage box as shown in the diagram on the next page.
3. With a pencil or a small piece of tape, mark the "start" point on the meter stick, 8 cm from the left edge of the container.

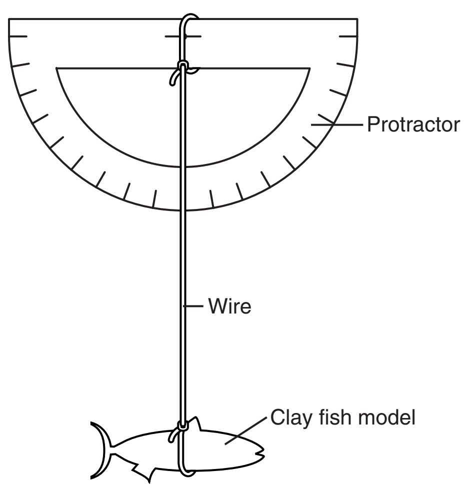
4. Mark the "finish" point on the meter stick, 8 cm before the end of the right edge of the container.



Aquarium setup

Part B: Preparing the Fish Models

1. With one piece of modeling clay make a model of a streamlined, long-distance voyager fish.
2. Use the second piece of clay to make a model of a compressed, disklike acrobat fish. The two fish must have the same mass, so use all of the clay to make the models.
3. Attach one end of the wire to the center of the straight edge of the protractor as shown below. To attach it, wrap the wire once around the protractor and then twist the wire end around the rest of the wire.
4. Wrap the other end of the wire around the middle of one of your fish shapes. Twist the wire end around the rest of the wire. Adjust the wire so that the fish hangs down straight. You may need several practice tries to get the fish model to hang straight and parallel (horizontal) to the ground.



5. Predict which fish you think you will be able to move across the tank faster. Explain your prediction.

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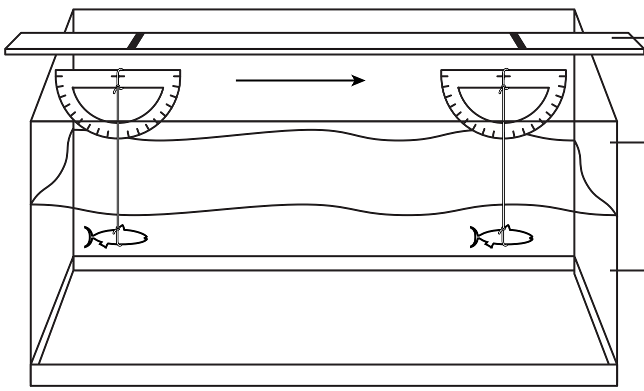
Part C: Testing the Fish Models

1. Position the first fish in the water so that it is fully submerged and its “head” is at the “start” mark on the meter stick. See the diagram below for guidance. Hold the protractor upside down so that the straight edge is at the top. Note that the wire is taut and hangs straight down so that it crosses the 90° mark on the protractor. Use the meter stick as a guide to keep the protractor level as you pull the “fish” through the water. Notice that the wire is no longer hanging straight down. The resistance of the water causes the fish to “lag” behind your hand. The faster you pull the fish, the more the wire deflects. Practice adjusting your movement to keep the wire deflected only 5° so that the protractor reads 95°.



Hold the protractor at about the level of the meter stick as you pull the fish through the water.

2. Once you feel comfortable moving the fish through the water at a constant rate of deflection, bring the fish back to the “start” mark and start the stopwatch. Move the fish so that the wire deflects 5° during the entire distance of the tank. Remember to use the meter stick as a guide to be sure that the top of the protractor remains level. Stop the stopwatch when the head of your model fish reaches the “finish” point marked on the meter stick.
3. Repeat Step 2 three times for each fish. Record your data in the data table below.

Data Table

Voyager Model	Time (sec)	Acrobat Model	Time (sec)
Trial 1		Trial 1	
Trial 2		Trial 2	
Trial 3		Trial 3	

Analysis and Conclusions

1. Calculate the average time it took for each of your fish to reach the end of the tank.

   Voyager: __________ sec

   Acrobat: __________ sec

2. Which of your fish moved through the water faster? Were the results of your investigation what you expected? If not, offer possible explanations.

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3. Compare the times of your fish with the fish of other groups. Describe characteristics of the fastest fish model that could have contributed to its "success."

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Extension

Make another fish from 25 g of clay. See if you can improve on the streamlined shape or test another fish body shape and see how it compares to the ones you tested in this activity.