
IT TAKES ALL KINDS!

FOR THE TEACHER

Discipline

Biology

Theme

Scale and Structure

Key Concept

Fish come in a great array of forms, colors and shapes which can be used to predict the habitat and lifestyle to which they are adapted.

Synopsis

Students observe color and shape adaptations in diverse fish and use this information to predict their habitat and lifestyle.

Science Process Skills

observing, communicating, comparing, categorizing, relating, inferring

Social Skills

cooperation, checking for understanding

Vocabulary

adaptation, camouflage, evolution, fins: (anal, caudal or tail, dorsal, pectoral, pelvic), gill rakers, predator, prey

MATERIALS

INTO the activities

- small pictures of a variety of fish (cutout from magazines or calendars)
- flip chart, butcher paper, blackboard or overhead projector
- videotape of fish (use visual images of various colorful fish to show the tremendous variety in their size, shape, color and habitat)
- drawing paper for each student

THROUGH the activities

- One fresh fish for each small group of 5-6 students. *It works best if there is a great diversity of fish, with each group concentrating on a different one. Asian markets are a wonderful source for many different local and exotic fish. Make sure that the fish are not scaled or gutted and that they are very fresh! The following fish make good examples:*

- mackerel or bonita, salmon, eels, herring, rockfish, flatfish (such as halibut, sanddabs, flounder), pompano or other exotic fish

- copies of Fish Feature Worksheet for each group
- paper plates, trays or newspaper for each fish
- pictures, books, slides, videotape and/or posters of various fish
- Fish Adaptation Charts (4) for Body Shape, Tail Shape,
- Mouth/Teeth/Gill Rakers and Coloration Patterns. See sample charts in THROUGH activity.

Optional

- reference books on fish
- 8 1/2" x 11" sheet blank paper for Mini-Book
- paper quilt square (one per student), glue, book-binding tape (2 colors),
- construction paper (various colors)

INTRODUCTION

A great diversity of fishes inhabit coral reefs. Well over 2,000 species have been identified in the Philippine Islands alone. Even more remarkable is the high diversity found within a limited area; over 500 species have been found living on a single reef in the great Barrier Reef system! The great variety of habitats existing on a reef certainly contributes to high fish diversity. Coral heads of many different kinds provide shelter and food, and the reef is quite three-dimensional. Numerous crevices and caves occur throughout the reef, interspersed with sand patches and channels. In addition, different zones occur with depth and degree of wave action. Not only are there a great many habitats within the coral reef, but many are utilized on a "time-share" basis. During the day, nocturnal predatory fishes like squirrel fishes and grunts take shelter in the reef. When they depart at dusk, diurnal fishes like tangs and parrot fishes move in.

The variety of reef habitats can't completely account for the great diversity of reef fishes, and scientists propose differing theories to explain this diversity. The classical view was that each species is so highly specialized that it has the competitive edge within a narrow set of conditions. Such narrow ecological niches would lessen competition and allow more species to live in a smaller area. An opposing view is that many species are not specialized and that there is active competition among them. According to this "lottery" hypothesis, local success and persistence depends on which species is first to occupy a vacant space on the reef. Evidence so far is inconclusive as to which of these theories best explains the surprising diversity of fishes on coral reefs.

Fish are one of the most successful groups of animals with backbones, the vertebrates, and in fact represent over 50% of all the living vertebrate species. In addition to being one of the most numerous groups, they are also among the most diverse. The incredible variety of forms and behavioral adaptations for survival seen in fish are a reflection of the complex and diverse habitats available to them in their ocean home.

The tremendous diversity in fish is the result of numerous adaptations since fish first evolved over 500 million years ago. The interplay of these adaptations has shaped fish in countless ways, but each form or shape has evolved to allow fish to successfully feed, swim, escape predators and reproduce in their habitat. These adaptations can be grouped into categories of size, shape of body and tail, coloration patterns, location of mouth and size of teeth and gill rakers. Close observation of these fish adaptations can lead to predictions about their behavior and choice of habitat within the ocean environment.

The shape and the position of fish fins are related to their body shape and the location of the center of buoyancy of the fish. The differences between fish in their fin shape and location are adaptations for their habitat and lifestyle and are reflected in their locomotion and maneuvering abilities. For example, the lower part of the tail fin in bottom dwellers like rays is usually reduced, but it is enlarged in the flying fish which may use it to help them take-off out of the water. Other examples of adaptations include the dorsal fin of remoras which is modified as a sucker to allow it to hitchhike on sharks and the dorsal fin of anglerfishes which provides the "rod and lure" attracting prey to its large mouth.

Fish usually have the streamlined or fusiform shape which is very efficient in the water, but they do show a great range of departures from this "typical" shape. Each of these represents an adaptation to a specific way of life which puts a premium on something other than fast swimming.

INTO THE ACTIVITIES

Partner Parade

1. Share your favorite memory about fish.
2. What different kinds of fishes can you think of?
3. Describe a fish and tell how it swims.
4. Tell all the things a fish needs to obtain in order to survive.
5. Tell as many ways as you can that people interact with fishes.
6. What kinds of places do fish live in?
7. Tell a tall fish tale.

Have students sit with their last partner and list and/or draw as many things as they can remember from the Tea Party. *Alternatively, you can have each student do their own recording to use for individual assessment.* Lead a class discussion about the group's ideas.

Anticipatory Chart

1. Have students sit in small groups where they can quietly discuss the video they are about to watch. Have one student in each group act as the recorder and count the number of people in their group who answer yes, no or maybe to each of the questions below **before they watch the video**. Encourage the students to discuss the questions with each other as the recorder counts their answers. *The questions should reflect what is actually being shown on your particular videotape.*

Anticipatory Chart

What do you think?:

YES

NO

MAYBE

1. Fish all seem to have the same tail shape.
2. Fish with squared tails swim the fastest.
3. Some fish hide by lying flat on the bottom.
4. The body shape of fish tells us about where it might live.
5. Long, skinny fish usually can be found swimming out in the open.
6. Slow moving fish don't have any protection against being eaten.
7. Make up your own sentence or question.

2. Turn on the video (turn down the sound completely). Again encourage the students to discuss the video and questions in their small groups as the video is playing.

3. Have students fill in this Extended Anticipatory Chart after watching the video. Tell them they can change their answers.

Extended Anticipatory Chart

Now what do you think?

If you decided to change your answer, explain what you saw in the video to make you change your mind.

YES

NO

MAYBE

1.

2.

3.

Ask if there are questions for which we still don't have an answer? What other questions do we now want to answer? Make a list of these questions where everyone can see them. Refer to this list throughout the activity.

Sketch a Fish

Have students draw a picture of a fish. It could be their favorite fish or one they just find interesting. Tell them they can use the pictures and posters around the room for ideas.

Silent Mingle

Place posters/pictures/books of various fish around the room and have students walk around the room silently, holding their drawing or another picture of a fish they have chosen from their table. Have students discuss the following questions with the closest student when you say "Pair-up".

1. Show your fish picture to your partner. Why is this your favorite (or most interesting) fish? Describe to your partner what it looks like and why it is interesting to you.
2. How do you think this fish captures its food? What do you think it eats?
3. Look at the mouths of the fish around you. How are they different from one another? How many different mouths can you see?
4. Describe the body shape of your fish. How many fish with that body shape do you see on the posters/pictures/books near you?
5. Describe the fins that you see. How many fins come in pairs? Look at the different tail fins - how many different shapes can you find?

Think Pair Share

1. Have students "Think" about the following two questions, jotting down some ideas in words or pictures:

What are some adaptations that all fish seem to have in common?

In what ways do fish seem to differ and do you think these differences have something to do with where they live in the ocean? Why or why not?

2. Now have each student "Pair" up with another and compare/discuss their ideas. They can add to their notes after discussion with their partner if they like.
3. Finally, have each pair "Share" their ideas with another pair of students.
4. Lead a class discussion and record the group's responses on a class chart.

PORTFOLIO ASSESSMENT:

Teacher observation of participation in Tea Party and Silent Mingle

At least 5 items recorded from Tea Party

Participation in Group Anticipatory and Extended Anticipatory Chart

Fish Sketch

Individual recording of "Think" in Think Pair Share

THROUGH THE ACTIVITIES

Fish Adaptation Charts

Use the four fish adaptation charts you made (*see below for example charts, be sure to add a sketch for each listed word*) to describe the body and tail shapes, coloration patterns and mouth shape, size and location including the teeth and gill rakers. Describe how these adaptations can be used to determine their food and habitat. As you introduce each color or shape on the fish charts, have cooperative groups of students find those features on the posters/pictures/books at their table. Have groups share their findings with the class. **(See attached for examples of fish adaptation sketches and representative fish to use when making your charts).**

FISH ADAPTATION CHARTS

BODY SHAPE

TAIL SHAPE

COLOR PATTERNS

MOUTH, TEETH, GILL RAKERS

Fusiform
Lunate
Camouflage
Location
Depressed
Forked
Disruptive
Size & Shape
Sphere
Squared
Countershading
Teeth (Size & Shape)
Ribbon
Rounded
Advertising
Gill Rakers
Compressed
Tapered
Deceiving Size & Shape

Group Brainstorm

Pick out a few representative fish from the posters and have students help you use the new vocabulary from the fish charts to describe their features. Have groups hypothesize about the fishes habitat and what it might eat. Have groups share their speculations with the class. As an example you might want to complete the Fish Feature Worksheet for one of these fish or with a fresh fish if you have enough.

Fish Feature Worksheet and Mystery Fish

1. Distribute a Fish Feature Worksheet and one fresh fish to each group and have them make drawings of the adaptations they see, including those listed on the Worksheet and two other features of this fish that they find interesting (such as size of scales, fleshy appendages, spines, size of eye). Remind them to use the new vocabulary to label their drawings. Everyone in the group must agree on the label chosen to describe the adaptations.
2. Based on these adaptations, have the groups discuss and complete the worksheet for their fish, including where they think it lives and what it eats.
3. Have the groups share their findings, drawings and hypotheses about the adaptations, diet and lifestyle of their fish with the entire class. (Optional): use a reference book to help students find a description of their fish and lead a discussion of the similarities and differences between their hypotheses and how the fish was described in the literature.

Mini-Book on Fish Diversity and Adaptations

1. Have individual students create a mini-book which includes words and graphic information about what they learned. Have students fold an 8 1/2" x 11" sheet of plain paper lengthwise and then into thirds. Cut along two of the folds so a book is formed with three pages that open vertically.
2. With the book folded shut and only the cover showing, have students write a name for their book on the cover. Open the cover and on the first page (title page) write the author's name. Open the title page and label each of the three revealed sections. Now flip up each section and draw a picture in one subsection and write text in the other. The drawings can represent the fresh fish or those seen on posters or in books. The written descriptions can be about something they learned from this activity about adaptations, habitat and/or lifestyles pertaining to the drawing on that subsection.

Quilt Story

1. Have each student contribute a quilt square to a class paper quilt representing the vast array of fish diversity and adaptations.
2. Distribute a blank paper quilt square, colored construction paper and glue to each student and instruct them to make a fish in its habitat. The attributes

of the fish should reflect its adaptations to its habitat. They should also name their fish. Be sure to have them leave a 1" border around the outside.

3. Once the blocks are completed, have each student work with a partner to learn about their partner's fish including habitat, adaptations, lifestyle and name. Have them introduce each others fish and how it lives to the class.

4. Once all the fish have been described, have the class designate some "master quilters" to piece them together using different colors of book binding tape to form the lattice strips and the border.

PORTFOLIO ASSESSMENT:

Teacher observation of participation in each activity

Teacher observation of Checking for Understanding and Cooperation

Group Fish Feature Worksheet and Drawing and Labeling of Mystery Fish

Individual Mini-Book and Quilt

Verbal Description of Partner's Quilt Square

BEYOND THE ACTIVITIES

Create a Fish

a. Have students pick adaptations from each of the following categories and use these attributes to design their own unique fish.

Color, body and tail shape, mouth size and position, size of teeth and gill rakers, unique structures (such as lures, bioluminescence, fleshy appendages, suckers), size, speed, behavior and etc.

b. Have students draw the fish and its habitat and then describe its adaptations and lifestyle. Also have them label and name their fish. Students could then make their fish in 3-D using miscellaneous craft supplies and/or vegetables.

c. Have students form partners and make predictions of lifestyle, diet and name of their partners creation. The "predictor" and "creator" then make presentations to the class, switching roles as their creation is introduced.

Gyotaku (fish printing).

Use the finished prints to show different species adaptations for speed, defense and food capture. Label the print with the species name.

Charting Fish Behavior and Movement

If possible, set up a classroom aquarium so students can observe and keep daily logs of behaviors, patterns of movement, individual variations in feeding, growth and breathing patterns. (See "Mapping Fish Habitats", GEMS Lawrence Hall of Science, UC Berkeley).

Field Trips

Visit an aquarium or aquarium store or fish market to observe the great diversity of fish. Take a fishing trip to a local pier. Note the various kinds of fishing techniques and bait used by different fisherpersons.

Dissection

Dissect the fish used in this activity to compare their internal anatomy. Try to make correlations between the internal anatomy and their lifestyle, e.g. tuna have mostly red muscle reflecting their ability at long distance swimming and flatfish have no gas bladder thereby allowing them to lie motionless on the bottom.

Student Posters

Have each group select one of the following topics to discuss and represent graphically on a poster. Have students share their poster with the rest of the class.

Topics:

1. What sort of adaptations do people have that help us to be successful land dwellers? How are people adapted to be good predators on fish? What have people invented to help us capture fish?
2. If you were an ichthyologist (someone who studies fish), how would you determine the lifestyle and habitat of a fish brought to you by a fisherperson who wanted to know all about it? What sort of questions would you ask the fisherperson? What would you do next to find out all you could about the fish?
3. If you could turn yourself into a fish, how would you have to change? What kind of fish would you be? What special adaptations would you have? Where would you live? How would you escape from fisherpersons and other predators?
4. What do the expert fisherpersons need to know about fish in order to capture them in great enough numbers to be successful? What should they keep in mind so that they can continue to capture fish year after year? What might affect the number of fish they capture from year to year?
5. Compare fish and whales. How are they similar? What adaptations do they have in common? In what ways are they different? Many species of both groups have been hunted in great numbers. Some whales have become extinct and some are endangered. Do you think fish have this same problem? Why/Why not?

Consequence Charts

Have students work in cooperative groups to complete charts in which they describe consequences over time given the following scenario:

What would be the immediate, short term, medium term, and long term consequences on fish, invertebrate and plant diversity in the coral reef if shell collectors removed most of the triton trumpet snails which eat the crown-of-thorns seastar which devours coral.

What would be the immediate, short term, medium term and long term consequences on fish populations if their habitat became polluted with a toxic spill?

Debriefing

Have students debrief their favorite/least favorite part of the activity. What did they learn the most from? What was a waste of time? How would they change the activity if they were the teacher?

EXAMPLES OF FISH ADAPTATIONS

BODY SHAPE

DESCRIPTION

EXAMPLE

FUSIFORM

streamlined and cylindrical; very fast and can swim continuously for long distances

bonita, mackerel, anchovy

DEPRESSED

flattened from back to belly like a pancake; ambush prey with short bursts of speed; burrow into sand

skates, rays, goosfish

SPHERE

rounded, globe-like; slow swimmers; may attract prey to them with light and lures

porcupine fish, puffer fish, anglerfish

RIBBON

snake-like; slow swimmers but easily move through crevices; hide under rocks or in cracks and ambush prey which come too near their hideout

wolf eels, moray eel

COMPRESSED

flattened side to side; sharp, quick turns and very maneuverable; viewed head-on they almost seem to disappear

surf perch, opaleye, flounder, angelfish,

TAIL SHAPE

	DESCRIPTION	EXAMPLE
LUNATE (fastest)	fastest swimmers, maximum speed with minimum effort over long distances	marlin, mackeral, dolphinfish
FORKED	moderately fast, continuous swimmers	anchovy, herring
SQUARED	very maneuverable, capable of bursts of speed for short distances	rockfish
ROUNDED	very maneuverable, capable of bursts of speed for short distances	senorita, goby
TAPERED (slowest)	slow swimmers, use body undulations to swim	moray eel

**MOUTH, TEETH,
GILL RAKERS**

	DESCRIPTION	EXAMPLE
MOUTH ORIENTATION	<ol style="list-style-type: none">1. oriented upwards denotes surface feeder or feeds on prey above it;2. downwards suggests bottom-grubber	<ol style="list-style-type: none">1. stargazer, stonefish2. goatfish
MOUTH SIZE & SHAPE	<ol style="list-style-type: none">1. large jaws engulf prey;2. protrusible jaws suck in prey;3. elongate jaws reach into crevices;4. elongate lower jaw feeds on prey seen above	<ol style="list-style-type: none">1. lingcod2. trumpetfish3. butterflyfish4. halfbeak

TEETH SIZE & SHAPE

1. fisheaters have pointed, knife-like;
2. snail and clam eaters have plate-like grinders and crushers;
3. choppers on plants and corals have fused, beak-like
 1. barracuda
 2. bat ray
 3. parrotfish

GILL RAKERS SIZE & SHAPE

1. comb-like gill rakers filter food;
2. large, coarse gill rakers protect gills from large prey items.
 1. anchovy
 2. lingcod

COLOR PATTERNS

DESCRIPTION

EXAMPLE

CAMOUFLAGE

match surroundings to blend in and hide
flounder, stonefish, cabezon

DISRUPTIVE COLORATION

spots, stripes and patches of color breakup and diffuse the actual outline
kelpfish, sergeant-major

COUNTER- SHADING

dark back and lighter belly hides fish from predators as sunlight penetrates from above
anchovy

ADVERTISING

1. warning to stay away from poisons or spines;
 2. attract mates, defend territories
 3. clean other fish
- lionfish (1), California
Sheephead (2), senorita (3)

DECEIVING

1. false eyespots confuse predators into attacking the wrong end or miscalculating size/shape of fish;
 2. fish resembles objects of no interest to enemies;
 3. fish mimics something:
 - a. helpful like a cleaner or
 - b. dangerous like a poisonous seasnake
- Big Skate, butterfly fish (1);
stonefish, sargassum fish (2);
blenny (3.a.); snake-eel (3.b.)

The following table compares the adaptations of four diverse fish:

FISH FEATURE CHART

	MACKEREL	ROCKFISH	FLATFISH	ANCHOVY
BODY SHAPE	FUSIFORM	COMPROMISE-	CHUNKY HEAD, SLENDER COMPRESSED	FUSIFORM
TAIL SHAPE	CRESCENT	SQUARISH OR ROUNDED	ROUNDED	FORKED
MOUTH, TEETH, GILL RAKERS	LARGE MOUTH, SHARP TEETH, NOT FINE GILL RAKERS	FAIRLY LARGE MOUTH & SHARP TEETH, NOT FINE GILL RAKERS	SMALL MOUTH, SHARP TEETH, NOT FINE GILL RAKERS	EXTREMELY LARGE MOUTH, TINY TEETH, FINE GILL RAKERS
COLORATION PATTERNS	COUNTER-SHADING	DISRUPTIVE & CAMOUFLAGE	CAMOUFLAGE	COUNTER-SHADING

Based on the above table, the fish can be predicted to have the following lifestyles:

food

fish

fish & crabs

fish, shrimp & clam siphons

microscopic
plankton

habitat

open ocean

kelp forest, rocks

bottom, sand covered

open ocean

The **mackerel** appears to be an open water fish based on its countershade coloration. Its streamlined body and crescent shaped tail denotes it to be an active, fast swimmer. Its sharp teeth indicates it to be a fish eater.

The **rockfish** is camouflaged to match kelp growing on rocks. The chunky body and squared tail shows it can achieve only short spurts of speed to capture prey that comes too near its hiding place and large mouth.

The **flatfish** is extremely well camouflaged while lying on a sandy bottom. These fish are flattened side-to-side (compressed) with both eyes on one side of their head. It uses quick bursts of speed achieved with its rounded tail and strong tail muscles to capture small fish and shrimp that swim too near.

The **anchovy** is a fast swimming, open water fish based on its countershade coloration, streamlined body and forked tail. The extremely large mouth, tiny teeth and very fine gill rakers allow it to filter-feed on microscopic plankton.

FISH FEATURE CHART

NAME OF FISH SPECIES

Fish #1 Fish #2 Fish #3 Fish #4
BODY SHAPE

TAIL SHAPE

**MOUTH,
TEETH,
GILL RAKERS**

COLORATION PATTERNS

**I PREDICT:
FOOD:
HABITAT:
INTERESTING FEATURES
1 AND 2**