



**Module Theme** | Biology of the Deep

**Instruction Supplement Video** |

<https://www.youtube.com/watch?v=-nvMtXorwVs&t=2s>

**Pacing** | 1 - 2 class periods (~45 minutes)

selection, and the relationship between structure and function

**Assessment** | Scientific Modeling and Communication Rubric provided

**Background Needed** | Understanding of basic ecology, food web dynamics, natural

**Materials/Resources**

- Paper
- Markers / colored pencils
- Printable fish parts (<http://nautil.us/2dRYTjw>) or additional craft supplies for creating your fish

**Overview**

In this module, students will learn about a variety of fish adaptations for marine and freshwater environments. Students will design a fish and justify the adaptation choices given to the species with information about how that fish has evolved to be successful for its environment.

**Objectives & Learning Outcomes**

- Students will be able to explain how adaptations and physiology allow certain organisms to be successful in their environment.
- Students will be able to apply the concept of natural selection to explain the traits of certain organisms in an ecosystem.
- Students will design an organism to be successful in an ecosystem while understanding how each structure contributes to the organism's success.

**Guiding Questions**

- What characteristics do all fish share?
- What's the difference between anatomy and physiology?
- How are fish physically and physiologically adapted to their home habitats?
- What environmental challenges do fish face living in extreme environments?



**Activity/Tasks**

Students will:

- Learn vocabulary and basic body designs of fish.
- Complete adaptation matching worksheet to pair fish structures with adaptation functions. Discuss trends as a class.
- Design a fish using the materials provided. Printable body shapes are included. Students may draw fish or build them from classroom materials.
- Complete a new species worksheet to describe the capabilities of their fish and justify all anatomical and physiological decisions in written form.
- Share their model with the class.



### Links to Next Generations Science Standards

- MS-LS4-2: Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships

### Links to Common Core Standards

- CCSS.ELA- LITERACY.RST.6-8.4: Determine the meaning of symbols, key terms, and other domain- specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.

### Educator: Lesson Directions

#### 1. Introduction

- Use selected biology highlights to introduce students to biology of the deep
- Ask students to discuss the introduction from the student sheet

*Teaching Tip: After having students read the introduction, ask the students to brainstorm possible traits that link fishes to their lifestyle or environment. Use the discussion to introduce the difference between physiology and anatomy.*

- Guide students through vocabulary and adaptation matching worksheet.

*Teaching Tips:*

*After the students define vocabulary and fish basics, begin the adaptation matching worksheet. This activity can be done individually, in groups, or as a class.*

*Students will use adaptations to design a new fish species. You may assign habitats and ask students to build fish for that environment or have students justify their fish designs by also identifying the fish's habitat.*

#### 2. Designing a new fish species:

*Encourage students to consider these questions: What part of the ocean does your fish live in? Does your fish migrate, maintain a territory or live in one location? What type of prey does it hunt or forage? How does it catch its prey? What is the primary sense used to find prey? What types of sensing organs are needed in this habitat? What predators are your fish trying to avoid? Does your fish live in schools, pairs or solitarily?*

- Walk around the classroom and provide guidance for the groups as they design, sketch, and build their fish.

#### 3. Analysis/Conclusion

- Facilitate a reflective discussion where students share their fish and explain the reasons behind their fishes' adaptations.

*Teaching Tip: To wrap up the lesson, explore [NautilusLive](https://www.NautilusLive.org) videos of deep sea fish. Keyword search "fish" in the search field or find videos in the highlight section. Point out deep sea adaptations you touched on as a class. Discuss the correlation between extreme adaptations and environments.*

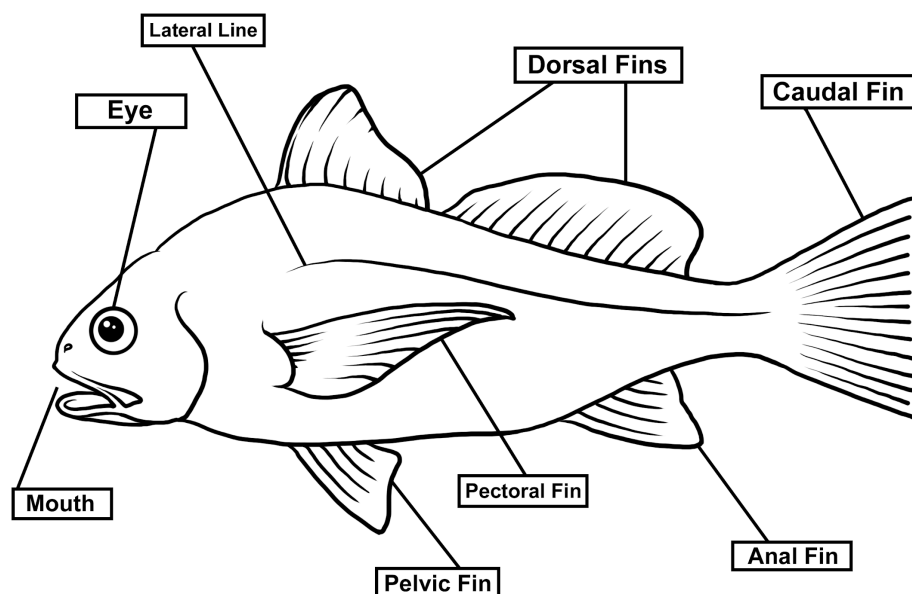


### Vocabulary

1. **Adaptation:** *a change or the process of change by which an organism or species becomes better suited to its environment.*
2. **Anatomy:** *the branch of biology concerned with the study of the structure of organisms and their parts.*
3. **Evolution:** *the process by which different kinds of living organisms are thought to have developed and diversified from earlier forms during the history of the earth.*
4. **Natural Selection:** *the process whereby organisms with different adaptations better suited for their environment tend to survive longer and produce more offspring.*
5. **Physiology:** *the branch of biology that examines how living systems function.*

### Description and the function of fish body parts

1. **Caudal fin:** *tail fin of fish, main mechanism of propulsion for most fish, may be many shapes for specialized function*
2. **Pectoral fin:** *paired fins on the side of the body; function primarily for maneuverability; some fish scull/ paddle with these fins for propulsion*
3. **Pelvic fin:** *forward paired set of fins on the base of the body; function as stabilizing fins; can be highly modified for bottom dwelling fish*
4. **Anal Fin:** *rear fin on the base of the body; functions as a stabilizing fin*
5. **Dorsal fins:** *fin(s) along the top of the body; many fish have forward and rear sets, some fish have fused dorsal fins; function as stabilizers against rolling*
6. **Lateral Line:** *system of sensory structures along the side body; functions to detect motion and vibration in surrounding water via pressure waves*
7. **Mouth:** *highly specialized for prey type; function also in eating, mating, or to pump water over the gills*
8. **Eye:** *sensory organ to detect light or images from habitat; fish eyes have rods and cones for color vision but are highly adapted within each species.*





## Extensions & Adaptations

### Introductory |

Simplify adaptation chart or provide teacher edition (no matching), provide information for each ocean environment instead of student research.

Students can build a digital fish through

<https://cptv.pbslearningmedia.org/resource/lsp07.sci.life.evo.buildafish/build-a-fish/>

### Advanced Extensions |

Elaborate on buoyancy control, pressure adaptations, physiological changes and euryhalinity.

Make digital model or 3D printer model; Have students present to the class; Student panel for questioning rationale (peer review); Have students make a dichotomous key for class species list.

Encourage students to share new species with younger students and teach them about adaptations

## Adaptation Matching Worksheet Answer Key

**Body Shape:** Most fish bodies are fusiform, meaning wide in the middle and tapered at each end. Specific adaptations to this basic blueprint provide advantages for speed or stealth. Pair these body shapes and example fish to their adapted function.

1. \_\_C\_ Torpedo (large at front, skinny at the back) [tuna]
2. \_\_A\_ Laterally (side-to-side) compressed [angelfish]
3. \_\_F\_ Dorso-ventrally (top-to-tummy) compressed [catfish]
4. \_\_B\_ Humpbacked [pink salmon]
5. \_\_E\_ Attenuated (long body compared to diameter) [hagfish]
6. \_\_D\_ Slender, tapering body [Grenadier rattail]

- A. Rapid maneuverability in small spaces
- B. Added stability in fast moving water
- C. Efficient shape for sustained swimming
- D. Reduced muscle mass for minimized metabolism
- E. Minimized water resistance
- F. Low-profile for bottom dwelling



**Mouths:** Mouth size, jaw orientation, and tooth shape are all adaptations which make fish specialized for a particular hunting style and prey type. Pair these adaptations and example fish with the function of their adapted jaws.

- |   |  |
|---|--|
| 1. ___A___ Protruding lips, sucker-shaped mouth [carp]                                    | A. Feeds on small plants and animals             |
| 2. ___G___ Terminal mouth (points forward from body front, equal length jaws) [mahi mahi] | B. Crush prey in shells                          |
| 3. ___C___ Mouth points up; long lower jaw [barracuda]                                    | C. Feeds on prey the fish looks up at            |
| 4. ___D___ Large round jaws [bass]  | D. Gulp/ surround prey                           |
| 5. ___F___ Sharp serrated teeth [tiger shark]   | E. Feeds on fast-moving prey, captured from side |
| 6. ___B___ Dull, flattened plate teeth [spotted eagle ray]                                | F. Cut/ shred prey                               |
| 7. ___H___ Teeth fused together into beak [parrotfish]                                    | G. Feeds in mid-water on prey ahead              |
| 8. ___E___ Duckbill, v-shaped jaws [pike]   | H. Scrapes reefs for algae and polyps            |

**Fins:** Most fish gain locomotion primarily from their caudal fins while adding stability or maneuverability from the pectoral, anal and pelvic fins. Fin size, shape and orientation are all important factors. Highly active and sedentary fish have very different adaptations. Match these fin adaptations and example fish with the function of their fin design.

- |   |  |
|---|--|
| 1. ___F___ Rounded caudal fin [grouper]                       | [American eel]                                   |
| 2. ___E___ Lunate (crescent) caudal fin [swordfish]           | A. Create drag, reduce lift in swift currents    |
| 3. ___B___ Deeply forked caudal fin [pilotfish]               | B. Most efficient shape for non-stop swimming    |
| 4. ___D___ Elongated, reinforced pelvic fins [tripod fish]    | C. Increase stability at slow swimming speed     |
| 5. ___C___ Round, high-surface area pectoral fins [clownfish] | D. Stable platform to keep body still for ambush |
| 6. ___G___ Pointed pectoral fins [surgeonfish]                | E. Most effective shape to produce speed         |
| 7. ___A___ Large, angled pectoral fins [sculpin]              | F. Slow swimming with short burst acceleration   |
| 8. ___H___ Continuous (fused dorsal, pectoral, caudal) fins   | G. Helpful for turning, added maneuverability    |
|   | H. Locomotion in small places                    |



**Coloration:** Coloration and patterns help disguise fish while hunting and from being hunted. Coloration can serve as warnings to others or lures to mates. Match these coloration trends and example fish to their adaptation function.

- |   |  |
|---|--|
| 1. ___H___ Countershading: dark dorsal, light belly [whale shark] | A. Disguises fish's true orientation               |
| 2. ___A___ Disruptive coloration: spots [butterflyfish]           | B. Warning, truthful or untruthful, about toxicity |
| 3. ___E___ Disruptive coloration: stripes [perch]                 | C. Difficult to see in murky/turbid waters         |
| 4. ___H___ Mottled coloration [soapfish]                          | D. Difficult to see in well-lit open ocean         |
| 5. ___C___ Muted green/brown [trout]                              | E. Disguises fish's shape in vegetation            |
| 6. ___D___ Silver/ blue [trevally jack]                           | F. Camouflage among rocks or sediment              |
| 7. ___H___ Red scales [orange roughy]                             | G. Difficult to see in low light conditions        |
| 8. ___B___ Bold, bright colors [longhorn cowfish]                 | H. Defense against predation from above/below      |

**Sensory Structures:** Fish have organs and complex senses to see, smell, hear, taste, touch, and detect electrical impulses from their environment. Rainbow trout can detect chemical concentrations as low as a thimble-full of bile acids in one billion gallons of water. Most fish have a lateral line, a row of pressure and vibration sensors along their body, used in schooling, predation and orientation. Depending on habitat and lifestyle, this sensory structure and others may be specifically adapted. Match these select sensory characteristics and example fish to their adaptation function below.

- |  |  |
|--|--|
| 1. ___F___ Magnetoreception (ability to detect magnetic fields) [salmon] | A. Increased peripheral (all around) vision                            |
| 2. ___B___ Large eyes [chimaera]   | B. Precise vision in low light   |
| 3. ___H___ Chin barbels (sensory whiskers) [saddle goatfish]             | C. Communication without visibility to predators                       |
| 4. ___C___ Biofluorescent skin (reflecting nonvisible light) [catshark]  | D. Metabolic energy not spent on a nonessential sense for this habitat |
| 5. ___D___ Eyes reduced to eyespots [cavefish]                           | E. Eyes protected while feeding  |
| 6. ___A___ Eyes raised onto stalks [mudskippers]                         | F. Ability to locate/ recognize specific locations                     |
| 7. ___G___ Illuminated lures (modified dorsal fin) [anglerfish]          | G. Attract prey in dark environments                                   |
| 8. ___E___ Movable nictitating membrane on eyes [blue shark]             | H. Enhanced chemical reception in sediment                             |



**Challenge:** Learn about fish adaptations and create a new fish species with the necessary characteristics to thrive in an ocean environment.

### Introduction

From the shoreline, the ocean can look like a single continuous habitat. However, under the waves, the habitats vary tremendously from warm surface waters to the deep sea, nearshore shallows to open mid-ocean. Fish have evolved to be successful in many environments through diverse and specific adaptation. An adaptation is a feature that is common in a population because it provides improved function and is produced by natural selection. Adaptations can take many forms like novel behavior or proteins that function better at specific salinity or temperature; in this lesson you'll look at anatomical adaptations that allow fish to avoid predators or access valuable new resources. Did you know there are about 22,000 species of fish that began evolving 480 million years ago? Bony fish share some features: gills for breathing, fins for motion, a mouth for eating, and most have scales for protection. However, some fish need strong muscles for constant swimming in the open ocean; other fish species are better adapted to hiding among the coral reef. Some fish have specialized mouths to eat only one food; some have modified scales as spines for defense. Remotely Operated Vehicle (ROV) Hercules encounters many different fish species traveling from the sunny shallows to the ocean floor, each one specifically adapted for their habitat. In this module, you will explore the variability in fish features and use your new observation skills to design and describe a new fish species. Be creative! As the ocean shows us, "any fin is possible!"



**Learning Goals**

1. Explain how adaptations and physiology allow certain organisms to be successful in their environment.
2. Apply the concept of natural selection to explain the traits of certain organisms in an ecosystem.
3. Design a fish to be successful in an ecosystem while understanding how each structure contributes to the organism's success.

**THINK About It!**

What is the most unique creature you have ever seen?

Discuss the following with a partner:

- What features did the creature have that made it unique?
- What do you think this creature uses its features for?
- What kind of habitat did the creature live in?
- How might the features be useful in this habitat?

**Guiding Questions**

1. What characteristics do all fish share?
2. What's the difference between anatomy and physiology?
3. List five ways fish can differ physically or physiologically based on their home habitat.
4. What environmental challenges do fish face living in extreme environments?





**Don't Miss Playlist**

- Strange Behavior: Crabs Fend off Cat Shark: [http:// nautl.us/210bbFJ](http://nautl.us/210bbFJ)
- Predation and Digestion in the Galapagos: [http:// nautl.us/1VJ9f2M](http://nautl.us/1VJ9f2M)
- Fish Goes Crazy in Brine Pool: [http:// nautl.us/1S6S2kO](http://nautl.us/1S6S2kO)
- Creepy Ghost Shark with Parasites: [http://nautl.us/ 1LKIBSZ](http://nautl.us/1LKIBSZ)

**Vocabulary**

1.      Adaptation:

2.      Anatomy:

3.      Evolution:

4.      Natural Selection:

5.      Physiology:

**Describe the function of each fish body part and label it on the fish below:**

Caudal fin:

Pelvic fin:

Dorsal fins:

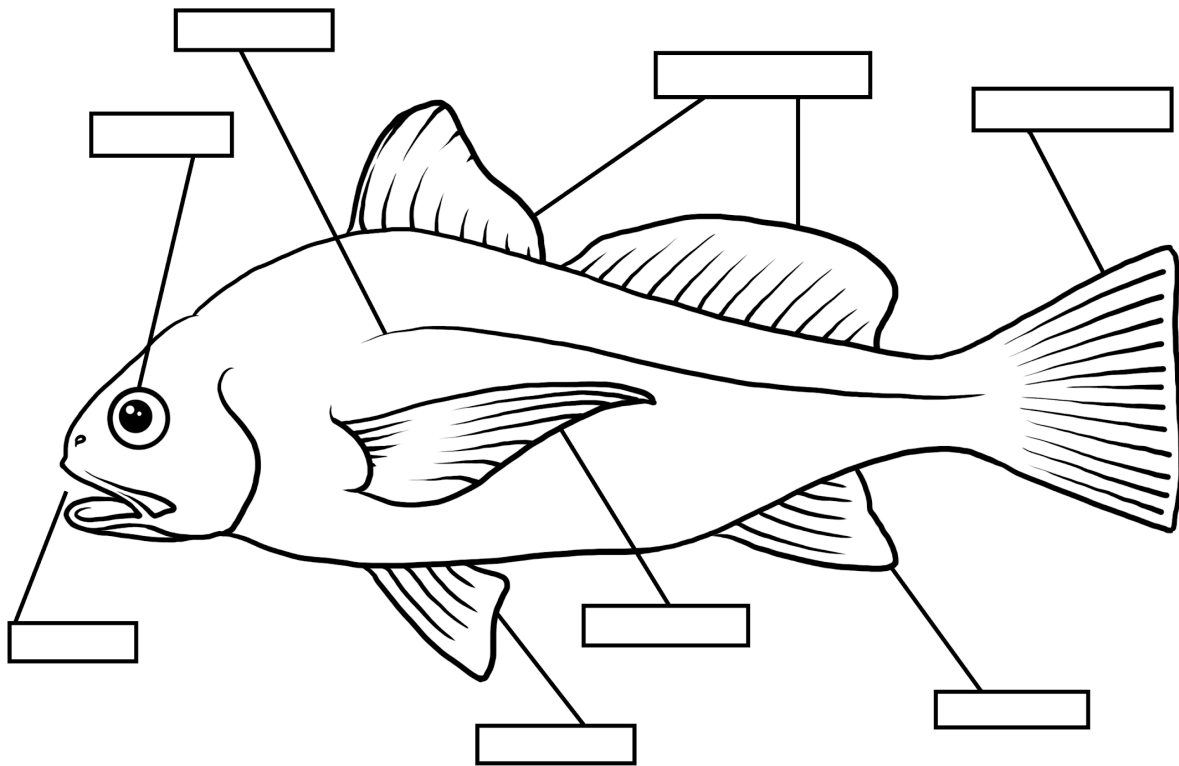
Mouth:

Pectoral fin:

Anal fin:

Lateral line:

Eye:



### Adaptation Matching Worksheet

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Time to get CREATIVE- any fin is possible!

- I. Use the adaptations you learned above and these guiding questions to design your own fish. Create a model or drawing of this new species.**

*What part of the ocean does your fish live in? Does your fish migrate, maintain a territory or live in one location? What type of prey does it hunt or forage? How does it catch those prey? What is the primary sense used to find this prey? What types of sensing organs are needed in this habitat? What predators are your fish trying to avoid? Does your fish live in schools, pairs or solitarily?*

- Label each feature accurately.
- The selected features must make sense for the habitat and lifestyle of the fish.

- II. Complete the New Species Description worksheet to provide justification for the adaptations you see on your fish.**



**New Species Description Worksheet**

Common Name \_\_\_\_\_

Scientific Name \_\_\_\_\_

Discovered by \_\_\_\_\_

1. Description of the Environment:

2. Body Shape:

3. Locomotion and Fin Design:

4. Coloration:

5. Feeding Style and Mouth:

6. Special Sensory Features:



### Scientific Modeling and Communication Rubric

OBJECTIVE	CRITERIA			
	4 Exemplary	3 Commended	2 Emerging	1 Developing
<b>Evidence of Planning and Research  </b>	Student submits thoroughly completed and accurate worksheets, documents, outlines, drafts, etc. of preliminary planning and research on topic.	Student submits completed and mostly accurate worksheets, documents, outlines, drafts, etc. of preliminary planning and research on topic.	Student submits partially completed worksheets, documents, outlines, drafts, etc. of preliminary planning and research on topic. Some information may be inaccurate.	Student submits minimally completed worksheets, documents, outlines, drafts, etc. of preliminary planning and research on topic. Information may be inaccurate.
<b>Student Model or Product  </b>	Adheres to all guidelines and expectations set forth. Model or product exhibits neatness, creativity and thoughtfulness in design.	Adheres to most guidelines and expectations set forth. Model or product exhibits neatness, some creativity and thoughtfulness in design.	Adheres to some guidelines and expectations set forth. Model or product exhibits some neatness, creativity and thoughtfulness in design, or these may be inconsistent.	Adheres to few guidelines and expectations set forth. Model or product does not exhibit neatness, creativity or thoughtfulness in design.
<b>Communication of Content  </b>	Student is able to thoroughly discuss content through use of their model/ product. Student thoroughly completes all associated follow-up worksheets, questions, reports, etc. with no content errors. Student can answer questions about their ideas using examples from what they learned.	Student is able to discuss content through use of their model/product. Student completes follow-up worksheets, questions, reports, etc. with few content errors. Student can answer questions about their ideas using examples from what they learned.	Student is able to weakly discuss content through use of their model/ product. Student completes some associated follow-up worksheets, questions, reports, etc. There may be some content errors. Student can answer rudimentary questions about their ideas.	Student is able to minimally discuss content through use of their model/ product. Student minimally completes associated follow-up worksheets, questions, reports, etc. Student has difficulty answering questions about their ideas.
<b>Total Score:</b>	<b>Comments:</b>			