Inside-out Adaptations

Students learn about the unique adaptations of sea stars and then research and develop a presentation on the adaptations of two other organisms.

SUBJECT
Science

GRADE LEVEL
5 – 8

TIME
Two to three class periods

OBJECTIVES
Students will be able to
- define the term adaptation.
- describe adaptations of sea stars.
- explain how adaptations of animals enable them to survive in different environments.

MATERIALS
- "The Two-Stomached Wonder" video (3 minutes 24 seconds); available to stream or download at www.pbs.org/kqed/oceanadventures/video/echinoderms
- Notebook paper
- Pens or pencils
- Copies of Sea Star Adaptation Chart (one per student)
- Sea Star Adaptation Chart With Answers
- Copies of blank Adaptation Chart (one per student)
- Internet access
- Computers with PowerPoint or a similar program

BACKGROUND

Sea stars, sea urchins, sand dollars and sea cucumbers are all members of the phylum Echinodermata. *Echinoderm* means "spiny skin" in Greek. Echinoderms are found in ocean ecosystems worldwide, from rocky shores to the deep sea. Animals in this phylum are characterized by radial symmetry as adults, with body parts that repeat around an axis. Many echinoderms have five of these similar body parts, giving them *pentaradial* symmetry. They are able to regenerate body parts, and some species of sea stars are even able to grow a new body from a severed arm.

Sea stars have an internal skeleton made of stiff calcified plates that are often spiny. The degree of tightness with which these plates fit together determines the sea star's flexibility. In the sunflower star (*Pycnopodia helianthoides*) these plates spread out, allowing it to open its mouth widely to engulf large prey. The internal skeleton is covered by a thin layer of skin. On the top, or *aboral*, surface of the sea star, skin gills absorb oxygen from the water. *Pedicellariae*, tiny pincer-like organs, keep the skin and gills of the sea star free from organisms that might grow on it, such as algae and barnacles.

Rows of tube feet run along the underside, or *oral* surface, of the sea star. They are used for walking and for grasping and manipulating prey. The movement of the tube feet is controlled by a *water vascular system*, a series of fluid-filled canals and chambers connected to the tube feet. By moving the fluid around and in and out of the chambers, the sea star is able to stretch and contract its tube feet.

Sea stars do not have a centralized brain, but they do have eyespots that can detect light. They are also able to sense odors, temperature and textures, allowing them to find prey. Sea stars eat a variety of organisms, including mussels, clams, snails, barnacles and even other sea stars. The mouth of a sea star is located in the middle of its underside. Some sea stars have mouths much smaller than the prey that they eat; a special adaptation gets around this problem. After prying a shell open with their tube feet, some species of sea stars can evert one of their two stomachs (the *cardiac* stomach) through their mouth and into the shell of the prey. Digestive enzymes work to dissolve the prey inside its own shell. Once the prey is dissolved, the cardiac stomach, which now contains the dissolved prey, pulls back inside the sea star's body, and its other stomach, the *pyloric* stomach, finishes digestion.

STANDARDS

National Science Education Standards Grades 5-8
www.nap.edu/readingroom/books/nses/6d.html#ls

Life Science - Content Standard C:
Regulation and behavior
Diversity and adaptations of organisms

Ocean Literacy: Essential Principles and Fundamental Concepts
http://coexploration.org/oceanliteracy/

Essential Principle #5:
The ocean supports a great diversity of life and ecosystems.

PROCEDURE

1. Tell students that they are going to watch a short video about a few species of echinoderms. Inform them that echinoderm means "spiny skin" and ask them what types of animals they think they might see. Then tell them that the animals in the video live in water. Do their ideas change once they know this?

2. The echinoderms they are going to see in the video are sea stars. Ask students to draw a sea star on a piece of notebook paper and label any parts that they know.

3. Place students in groups of three to four. As they watch the video, students should list examples of the sea stars' physical characteristics, such as body shape and form, on the other side of their notebook paper.

4. Play the video. Stop at 1:34, just after the narrator says, "Sunflower stars grow up to 3 feet in diameter and can move at a pace of about 3 feet per minute, which is pretty fast for a sea star." Let students share their lists with the others in their group. Watch the same segment again so they can catch anything they missed the first time. Share again in groups.

5. As a class, create a list on the blackboard of all of the characteristics the students noticed. These may include
   - radial symmetry
   - internal skeleton made of stiff plates
   - tube feet
   - water vascular system
   - ability to regenerate body parts
   - spines
   - pincers
   - five to many arms

   Discuss and review any of the terms that are new or difficult.

6. Ask students why sea stars would have developed these characteristics. Talk about how these characteristics, developed over thousands of years, help sea stars survive in their watery environments and why they are called *adaptations*.

7. The next portion of the video shows a special adaptation some sea stars have for eating. After watching the remaining portion of the video, discuss differences in how the knobby star and the sunflower star feed. Why does the knobby star evert its stomach from its body?

8. Hand out a copy of the Sea Star Adaptation Chart to each student. Have students work together in groups to complete their charts. For each adaptation listed, they should write reasons it is beneficial. Remind students that some adaptations benefit the sea star in more than one way. Students can use the following Web page from the Oceanic Research Group's Web site to help them with their charts if needed:
Echinoderms: The Spiny Animals!
http://www.oceanicresearch.org/education/wonders/echinoderm.html

9. Review the sea stars' adaptations and how the adaptations help them survive in their environment. How might their adaptations be different if they lived in a different environment? (You may also have students revise their original drawings of the sea star for review.)

10. Next have each group choose two organisms (plants or animals) to research. You may have them select from a list of organisms in your local environment or from a specific biome, or they can choose two on their own. They should learn about at least four adaptations for each organism. Students may use the blank Adaptations Chart to keep notes on what they find.

11. Once the students have completed their research, have them create a 5-minute PowerPoint or multimedia presentation to share with the class. The presentation should include images and demonstrate how adaptations help their organisms survive in their respective environments. Every student should have a role in the presentation.

12. Have each group share their presentation with the class.

Assessment

- Have students write their own definition of *adaptation*.
- Have students label the adaptations of a sea star on a diagram or picture.
- In their presentations, were students able to identify four adaptations of each of their organisms? Did they also explain or demonstrate how these adaptations helped their organisms survive in their environments?

Extensions

- Have students compare and contrast specific adaptations of different species of echinoderms, including sea urchins, sea cucumbers, sand dollars and other sea stars.

- Take a field trip to a local nature center, zoo or aquarium to learn about other organisms' adaptations.

- Complete the ***Ocean Adventures*** Adaptations—What a Concept lesson plan to learn about adaptations of river and marine dolphins.
  www.pbs.org/oceanadventures/educators

Additional Resources

Additional educator resources for ***Jean-Michel Cousteau: Ocean Adventures*** can be found at **pbs.org/oceanadventures.**

Also try:

- The Shape of Life's Web page on echinoderms
  http://www.pbs.org/kcet/shapeoflife/animals/echinoderms.html

- ***Ocean Adventures'*** Download Library for images to use in student projects
  http://www.pbs.org/kqed/oceanadventures/educators/library/

- Flickr for images of plants and animals that may be used in student projects
  http://www.flickr.com/groups/oceanadventures/
  http://www.flickr.com/groups/kqedquest/
  http://www.flickr.com/groups/pbsnature/

About the Author
Andrea Swensrud is the KQED Education Network Project Supervisor for ***Jean Michel Cousteau: Ocean Adventures.*** She has a Multiple Subject Teaching Credential and has taught and managed marine science education programs. KQED Education Network uses the power of KQED Public Broadcasting to inspire learning by providing projects for youth and curriculum materials and professional development for teachers, child-care providers and families.

CREDITS

Jean-Michel Cousteau: Ocean Adventures is produced by KQED Public Broadcasting and Ocean Futures Society.

The corporate sponsor is The Dow Chemical Company.

Additional major support comes from the Richard and Rhoda Goldman Foundation, KQED Campaign for the Future, and the Corporation for Public Broadcasting.

Sea Star Adaptation Chart

Organism: Sea star

ADAPTATION	HOW IT HELPS THE ORGANISM SURVIVE
TUBE FEET	
WATER VASCULAR SYSTEM	
ABILITY TO REGENERATE BODY PARTS	
SPINES	
PINCERS (ALSO CALLED *PEDICELLARIAE*)	
STOMACH THAT EXTENDS OUTSIDE OF THE BODY	

Sea Star Adaptation Chart With Answers

Organism: Sea star

ADAPTATION	HOW IT HELPS THE ORGANISM SURVIVE
TUBE FEET	• WALK • CAPTURE PREY • PRY OPEN SHELLS OF PREY • STICK TO ROCKS IN STRONG CURRENT/WAVES • STICK UNDERNEATH ROCKS TO HIDE FROM PREDATORS
WATER VASCULAR SYSTEM	• CONTROLS TUBE FEET
ABILITY TO REGENERATE BODY PARTS	• REGROW ARMS FOR WALKING, CAPTURING PREY • REGROW ORGANS IF HARMED
SPINES	• PROTECTION FROM PREDATORS
PINCERS (ALSO CALLED *PEDICELLARIAE*)	• KEEP ALGAE AND OTHER ORGANISMS FROM GROWING ON IT
STOMACH THAT EXTENDS OUTSIDE OF THE BODY	• CAN FEED ON PREY LARGER THAN ITS MOUTH, SUCH AS CLAMS AND MUSSELS

Blank Adaptation Chart

Organism: _____

ADAPTATION	HOW IT HELPS THE ORGANISM SURVIVE