



Starfish Adaptations: Peer-Taught

Subject (Focus/Topic): Life Science: Animal adaptations, structure and function, habitat, natural selection.

Grade Level: Second Grade (2); taught by high school biology students.

Average Learning Time: This lesson will take approximately two 45-minute periods.

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*Figure 1: Crown of Thorns Sea Star
Image credit: divegallery.com*

LESSON PLAN DESCRIPTION

Lesson Summary (Overview/Purpose)

Students will observe, explore, dissect, and compare members of the animal *phylum Echinodermata* to understand what particular traits make them successful in their environment. Second grade students work with peer (high school student) teachers.

Overall Concept (Big Idea/Essential Question)

Students explore an unknown organism to understand that every living creature has traits that impact their use of habitat. The structure and function of traits are important in an individual's survival and the survival of populations.

Specific Concepts (Key Concepts)

Students will:

- Understand 3 key features of starfish systems: water vascular, digestive and integument (skin)
- compare these systems to human and describe ways that the starfish systems are beneficial to them in their environment
- relate the success of starfish to their adaptations.

Focus Questions (Specific Questions)

1. Where do starfish live? What is their habitat?
2. If you lived in the ocean, what would you need to survive?
3. What do you notice about the starfish's skin? How might the starfish skin help it in its habitat?
4. What do starfish use to move? How do they do this?
5. Do starfish need oxygen like humans do? How do they get their oxygen?
6. How do starfish get food? What do they use to get food?
7. How do starfish see? Where do you think their eyes are located?

Objectives/Learning Goals

- Students will be able to describe three structures of starfish anatomy and relate the structure to function with 80% accuracy.
- Students will be able to predict how these three systems enable a starfish to be successful in its habitat with 80% accuracy.

Background Information

Starfish have dramatically different methods of locomotion (a water vascular system versus a muscular), digestion (sac-like and external), gas exchange (gills on the skin versus lungs) and overall morphology than humans. Their unique adaptations make them an excellent and interesting organism to teach how

structure relates to function and success in a habitat. The following is provided as a guide for individuals who might not be familiar with starfish morphology, or for the high school peer teachers.

Locomotion/Water vascular system:

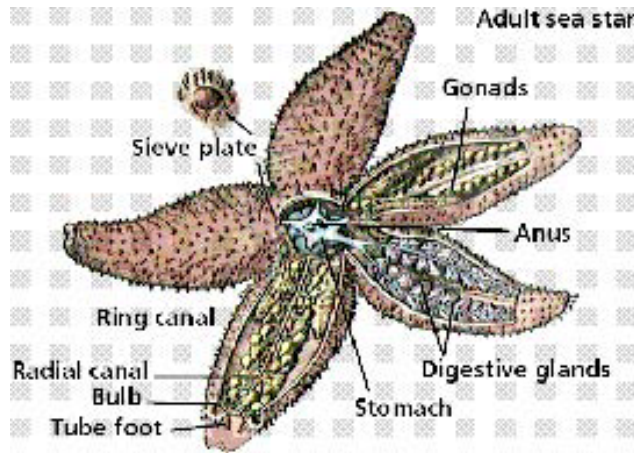


Figure 2: Adult Sea Star anatomy.
Image credit: biology.unm.edu

Starfish move through their habitats via a water vascular system in lieu of a skeletal and muscular system. They take in water through a “sieve plate” or *Madeporite* on their aboral (top) surface. The water is transferred through a system of bony canals to each arm, where it is pumped and retracted from each of the hundreds of tube feet. Some very astute students may notice the sieve plate between two of the arms on the top surface. After dissection it will be difficult to find, so make certain to call attention to this feature before you begin the dissection. A

careful dissection will enable students to see where the sieve plate connects to the central ring canal and attachments out to each of the arms (radial canals). To see these structures, the digestive glands and gonads in each arm will be removed, so make sure students see these first before proceeding. The canals are very sturdy and can withstand many second graders’ fingers.

Integument and Respiratory system:



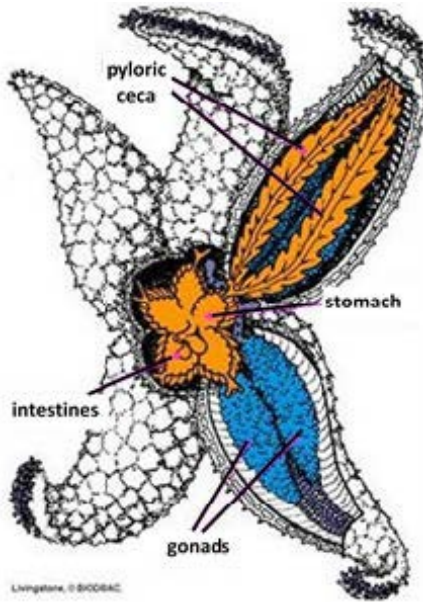
Figure 3: Starfish skin.
Image credit: Science Photo Library

Upon first examination of a starfish’s skin, students will notice immediately how rough and spiny it is. The name of the phyla that starfish belong to is *echinodermata*, or “Hedge-hog skin.” Students will be able to predict what a hedgehog’s skin looks like, even without ever seeing an example—it is indeed very spiny. Further examination of the starfish’s skin will yield several interesting structures. With hand-lenses, students will be able to see larger white spines easily. Smaller pincher like structures called pedicellariae

ring each of the white spines, and in freshly preserved specimens students should be able to distinguish sac-like gills covering the surface (dermal *branchiae*) in between the spines. The function of the skin is to protect the body and internal organs from harm and provide a surface for gas exchange to take place. The function of the pedicellariae is thought to keep the skin of the starfish free from algae and debris. In life, these little pinchers are in constant motion. Once

you dissect the arms of the starfish, the top layer of skin can be saved and dried. The spines will be visible, but the gills and pedicellariae will not. Typically, my students will find all three skin structures in freshly preserved organisms (ordered within the year).

Digestive System:



*Figure 4: Sea Star digestive system.
Image credit: LivingPlanet*

Humans have “extracellular digestion,” meaning that the breakdown of food particles takes place outside of cells (in our stomach, intestine, etc.). Most starfish have “external digestion.” They actually digest their food outside of their bodies entirely. Students will notice an opening on the underside of starfish. This opening serves as the mouth, but starfish do not put food into their mouths as we do; they push their stomachs out of their mouths onto their food, secreting digestive enzymes and then sucking up the liquefied and digested prey. Because of this adaptation, they are able to eat bivalves (clams and mussels, etc.) by extruding their stomachs into the shelled organisms and digesting them from the inside out. A great metaphor to use for 2nd graders: “if you were a starfish you would throw up all over your cheeseburger and then suck it up with a straw.” (Quote from S.E., one of my high school peer teachers.) Gross... but memorable.

Equally interesting for students are the sheer amount of digestive glands, illustrating how important digestive juices are for the starfish. Each of the arms is lined with “ramen looking” (2nd grader in test lesson) glands that can be removed carefully to show the water vascular system below. The function of these glands is to secrete digestive enzymes and absorb nutrients.

I tested this lesson with two second grade classes of 15 students each. I suggest groups of 3-4 second graders with one high school peer teacher each. The 2nd grade teacher was present for the lesson, but was able to interact with different groups, take photos and work more closely with special need students. I was not sure if the children would be able to explain the adaptations and relate the structure to the function—and then later to connect these to the starfish’s habitat. Although they did not remember terms like “water vascular system” with a great deal of precision (~50%), I was surprised by their overwhelmingly accurate descriptions of these structures and their function. My high school students already had an understanding of starfish anatomy. If you have a group that does not, it will be helpful to provide them these notes, focusing questions, and a practice dissection.

Common Misconceptions/Preconceptions

Teachers often use animals that students are familiar with when addressing life science standards of organism structure and function. Utilizing a relatively unknown organism allows children to make the connection between an organism’s needs and how it might meet these needs in a creative way.

Starfish (and echinoderms in general) are often considered to be a “primitive” animal, but it may interest your (high school?) students to know that this phyla of organisms is more closely related to ours (*chordata*) than any other. We share a similar process during early development—like echinoderms, *chordata* are categorized as *deuterosomes*.

Teaching Materials

Appended Resources (AR's)

Non-interactive, printed materials inserted into this document after the Lesson Plan Description.

- none

Digital Resources (DR's)

Interactive, electronic files created by the Teacher-At-Sea to support this lesson.

- none

Physical Resources

Any items used in the classroom to facilitate learning, especially during activities:

- Dissecting trays and tools
- Preserved starfish (1 per group of 4 students)
- Preserved echinoderm specimens (sand dollar, brittle star, sea urchin, sea cucumber)
- Hand lenses
- *Blue World Adventures* Issue 9

Technical Requirements

Any connectivity, software, hardware, or A/V equipment needed to teach this lesson:

- Access to Internet for video
- Projector

Teacher Preparation

Our campus is K-12, which provides opportunities for elementary and secondary collaboration. Here are a few suggestions to make this lesson work if you do not have as easy collaboration as I do:

- If you are a high school teacher: Arrange a trip to elementary school or have elementary students come to high school science lab. My students plan science labs for elementary classes frequently. The starfish lab could be just one component of a larger outreach.
- If you are an elementary teacher: Pre-teach lesson to parent volunteers, rather than high school students.

For all: Review websites and background information to understand starfish internal and external anatomy. Order one extra starfish to teach high school students/parent teachers starfish anatomy. Each can learn the technique from dissecting one of the five arms of the practice organism.

Keywords

- Structure
- Function
- Adaptation
- Habitat
- (Echinoderm), (Water vascular system), (Tube feet), (Gills)

Pre-assessment Strategy/Anticipatory Set (Optional)

KWL chart in 2nd grade classroom prior to lab activity.

Lesson Procedure

The first session will be spent in the high school science lab; the latter with the classroom teacher for follow up video, cartoon and science exploration.

Session 1

1. Pre-teach. (high school students) lesson vocabulary, expectations, focus questions, background information, outcomes, and procedures.
2. Pre-lab. Have elementary teacher create groups of 3-4 elementary students for each high school student.
3. All class. Review science lab expectations and explain ethics of dissections. Review use of lab equipment (dissecting lenses) and lab procedures.
4. All class. Where do they live, what do they need to survive in their habitat? Review starfish habitat. Show photos and video from links below.
5. Small groups. Questions, questions, questions. Explore preserved specimens with hand lenses and other senses. Elementary students make observations in small groups about starfish. High school students guide explorations and ask focus questions (above). Students compare how humans move, digest, breathe, etc. to how starfish might do these same jobs. High school students introduce extra vocabulary of echinoderm, tube feet, and water vascular system if students make direct observations about these features. Have students examine in detail the external surface of the starfish with hand lenses. Point out the gills, spines, sieve plate and pedicellariae, as after the dissection they will not be visible.
6. All class. High school teacher summarizes student comments and provides background information on starfish. Vocabulary is reviewed.
7. Small groups. High school students dissect an arm and central disc of starfish. Explain the digestive system and glands. Highlight the water vascular system, letting students touch the canals, tube feet and skeleton.
8. Small groups. Extrapolation: groups explore preserved specimens of sea cucumbers, sand dollars, brittle stars and sea urchins. High school students lead second graders in exploration of these related organisms.
9. All class. Video: first class concludes with video showing starfish feeding and sunflowers sea star behavior (video links below in addendum).

Session 2

1. Read cartoon with second graders. Students color cartoon and post on their refrigerator to share with family.
2. Watch video segments in class.
3. Use hand lenses to observe preserved starfish specimens.
4. Assess student knowledge on habitat, adaptations, structure and function.

Assessment and Evaluation

Classroom teacher. Review KWL charts. Label diagram of starfish and explain adaptations.

Standards

Ocean Literacy Principles Addressed

- 5: The Ocean supports a great diversity of life and ecosystems:
 - c. Some major groups are found exclusively in the ocean. The diversity of major groups of organisms is much greater on the ocean than on land. (Life science: Characteristics of organisms)
 - d. Ocean biology provides many unique examples of life cycles, adaptations and important relationships among organisms (symbiosis, predator-prey dynamics and energy transfer) that do not occur on land. (Life Science: Characteristics of Organisms, Life Cycles of Organisms and Organisms and Environments)

Other National or State Science Standard(s) Addressed (optional)

- Science as Inquiry: 4ASI1.1, 4ASI1.5
- Life Science: Characteristics of Organisms (4CLS1.1, 4CLS1.2), Life Cycles of Organisms (4CLS2.1), Organisms and Environments (4CLS3.2, 4CLS3.3)
- Unifying Concepts and processes: Evolution and Equilibrium, Form and Function

Colorado Science Standard(s) Addressed

- **Standard: 2.2 Life Science (Second grade).** Analyze the relationship between structure and function in living systems at a variety of organizational levels, and recognize living systems' dependence on natural selection: Each plant or animal has different structures or behaviors that serve different functions.
 - Students can: a. Use evidence to develop an explanation as to why a habitat is or is not suitable for a specific organism, b. Analyze and interpret data about structures or behaviors of a population that help that population survive.

Additional Resources

- [Planet Earth: Shallow Seas](#): Video segment 30:36-32:47 shows a variety of echinoderms: sea urchins, sea stars, sunflower sea stars and sand dollars.
- Starfish eating: www.youtube.com/watch?v=A100m5EpfFI
- Sunflower starfish: www.youtube.com/watch?NR=1&v=2eLhud7DURQ
- Sunflower sea star with voice over: www.youtube.com/watch?v=ALaMoS_vvNE
- PBS ocean adventures: www.youtube.com/watch?v=6Z0K4RKwa5E
- Section from Planet Earth: www.youtube.com/watch?v=D3W4OCnHyCs
- www.wardsci.com: [preserved starfish specimens](#): pail of 10 preserved specimens (68 W 7692) and [Echinoderm collection](#) (68 W 7708)