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RESOURCE LIBRARY
LESSON

Symbiotic Relationships in Marine Ecosystems

Students analyze videos to make observations about species, populations, and communities of organisms and discuss their symbiotic relationships. Then they create a hypothetical marine ecosystem and describe the adaptive, trophic, and symbiotic relationships between the biotic and abiotic components of the ecosystem.

GRADES

9 - 12+

SUBJECTS

Biology, Ecology, Earth Science, Oceanography, Geography, Physical Geography

CONTENTS

ACTIVITY 1: MARINE ECOLOGY VIDEO SCAVENGER HUNT | 50 MINS

DIRECTIONS

1. Introduce the activity using a KWL chart.

Provide each student with a copy of the Marine Ecology Video Scavenger Hunt worksheet and divide them into groups of four. Give each group a large sheet of paper to create a KWL chart based on the key terms listed at the top of the worksheet. Ask groups to draw the "K" column of their chart and then discuss and write down what they **K**now about the key terms. Observe and facilitate student groups and then have them draw the "W" column on their chart. Ask them to write down what they **W**ant to know about the key terms. Instruct them to list terms they are unfamiliar with or questions they might have. In small groups or as a whole class, address student questions.

2. Show students the four videos and have them complete the Video Scavenger Hunt worksheet.

Read aloud the directions for the worksheet. Instruct students to pay close attention to the ways in which species, populations, and communities of organisms are interdependent and interact with one another and with their environment. Then, for each video segment complete the following steps:

- As a class, have students use the Water Planet Mega Map, included in the World Physical MapMaker Kit, to geolocate the ecosystem in the video (Antarctic Ocean, Indian Ocean, Monterey Bay, California, United States, Everglades, Florida, United States).
- Introduce the video and focus student attention on the five key terms they will need to use in their description of the ecological concepts addressed in the video.
- Ask students to complete their worksheets individually as they watch the video and afterward review their responses as a group.
- Ask groups to draw the "L" column of their chart and then discuss and write what they **L**earned from watching the video.

3. Have a whole-class discussion about students' observations and KWL charts.

After all the videos have been viewed, student worksheets are completed, and group discussions have concluded, follow up with a class discussion. Ask each group to report what they learned using what they have written in the "L" column of their charts. Ask if there are still things they want to know. Clarify any questions or misconceptions and address important ecological principles that students may have overlooked.

4. Conclude the activity and discuss how humans impact marine ecosystems.

Explain to students that, although the videos represent very different marine ecosystems, the ecological themes—especially interdependence and interactions—are similar and are an essential part of characterizing and supporting these diverse ecosystems. Ask students to discuss the ways humans interact with and impact marine ecosystems in the videos. Ask: *Can you think of ways humans impact other marine ecosystems? Explain*.

Informal Assessment

Evaluate student comprehension:

- based on students' written responses in the KWL charts
- by using the provided answer key to check students' completed worksheets

Extending the Learning

Choose another National Geographic video about ecosystems and see if students can use all of the key terms to describe the ecological principles presented in the video.

OBJECTIVES

Subjects & Disciplines

Biology

- Ecology

Earth Science

- Oceanography

Geography

- Physical Geography

Learning Objectives

Students will:

- use scientific terminology to describe the ecological principles occurring in a variety of marine ecosystems
- infer that different marine ecosystems are characterized by the same ecological processes, including interdependence, niche selection, and adaptation
- describe specific ways in which species, populations, and communities of organisms are interdependent and interact with one another and with their environment
- discuss ways in which humans interact with and impact marine ecosystems

Teaching Approach

- Learning-for-use

Teaching Methods

- Cooperative learning
- Discussions

- Information organization
- Visual instruction

Skills Summary

This activity targets the following skills:

- Critical Thinking Skills
  - Analyzing
  - Applying
  - Understanding
- Geographic Skills
  - Acquiring Geographic Information
  - Analyzing Geographic Information
  - Organizing Geographic Information

National Standards, Principles, and Practices

NATIONAL GEOGRAPHY STANDARDS

• **Standard 1:**
How to use maps and other geographic representations, geospatial technologies, and spatial thinking to understand and communicate information
• **Standard 14:**
How human actions modify the physical environment
• **Standard 8:**
The characteristics and spatial distribution of ecosystems and biomes on Earth's surface

NATIONAL SCIENCE EDUCATION STANDARDS

• **(9-12) Standard C-4:**
Interdependence of organisms
• **(9-12) Standard D-1:**
Energy in the earth system
• **(9-12) Standard F-4:**

Environmental quality

OCEAN LITERACY ESSENTIAL PRINCIPLES AND FUNDAMENTAL CONCEPTS

- **Principle 5d:**

Ocean biology provides many unique examples of life cycles, adaptations and important relationships among organisms (such as symbiosis, predator-prey dynamics and energy transfer) that do not occur on land.

- **Principle 5f:**

Ocean habitats are defined by environmental factors. Due to interactions of abiotic factors such as salinity, temperature, oxygen, pH, light, nutrients, pressure, substrate and circulation, ocean life is not evenly distributed temporally or spatially, i.e., it is "patchy". Some regions of the ocean support more diverse and abundant life than anywhere on Earth, while much of the ocean is considered a desert.

- **Principle 5i:**

Estuaries provide important and productive nursery areas for many marine and aquatic species.

- **Principle 6e:**

Humans affect the ocean in a variety of ways. Laws, regulations and resource management affect what is taken out and put into the ocean. Human development and activity leads to pollution (such as point source, non-point source, and noise pollution) and physical modifications (such as changes to beaches, shores and rivers). In addition, humans have removed most of the large vertebrates from the ocean.

Preparation

BACKGROUND & VOCABULARY

Background Information

Marine ecosystems and the organisms, habitats, and relationships that comprise them are highly diverse, but the ecological principles that characterize them are similar. Several interacting biotic and abiotic components determine the trophic characteristics, symbiotic relationships, adaptive strategies, niche selection, and interdependent relationships among marine communities. Humans can impact these ecosystems in positive and negative ways, and the importance of anthropogenic interactions is a growing aspect of marine research.

Prior Knowledge

["ecological principles related to food webs, adaptations, niche selection, and symbioses", "the interactions between biotic and abiotic ecosystem components"]

Recommended Prior Activities

- Marine Food Chains and Biodiversity
- Marine Food Webs

Vocabulary

Term	Part of Speech	Definition
adaptation	*noun*	a modification of an organism or its parts that makes it more fit for existence. An adaptation is passed from generation to generation.
apex predator	*noun*	species at the top of the food chain, with no predators of its own. Also called an alpha predator or top predator.
aphotic zone	*noun*	the deepest ocean zone, below 914 meters (3,000 feet). Also known as the midnight or bathypelagic zone.
autotroph	*noun*	organism that can produce its own food and nutrients from chemicals in the atmosphere, usually through photosynthesis or chemosynthesis.
biodiversity	*noun*	all the different kinds of living organisms within a given area.
commensalism	*noun*	relationship between organisms where one organism benefits from the association while not harming the other.
decomposer	*noun*	organism that breaks down dead organic material; also sometimes referred to as detritivores
ecosystem	*noun*	community and interactions of living and nonliving things in an area.
food chain	*noun*	group of organisms linked in order of the food they eat, from producers to consumers, and from prey, predators, scavengers, and decomposers.
food web	*noun*	all related food chains in an ecosystem. Also called a food cycle.
habitat	*noun*	environment where an organism lives throughout the year or for shorter periods of time.
marine ecosystem	*noun*	community of living and nonliving things in the ocean.
mutualism	*noun*	relationship between organisms of different species, in which both organisms benefit from the association.

Term	Part of Speech	Definition
niche	*noun*	role and space of a species within an ecosystem.
parasitism	*noun*	relationship between organisms where one organism (a parasite) lives or feeds on the other, usually causing harm.
trophic level	*noun*	one of three positions on the food chain: autotrophs (first), herbivores (second), and carnivores and omnivores (third).

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ACTIVITY 2: ECOLOGICAL RELATIONSHIPS | 50 MINS

DIRECTIONS

1. Introduce vocabulary terms related to ecological interactions and symbiosis.

Explain that in this activity students will use a series of videos, images, and scenarios to identify and discuss examples of ecological and symbiotic relationships in the ocean. Write the following terms on the board: *competition, predation, symbiosis, mutualism, commensalism,* and *parasitism*. Do not include the definitions yet. First, ask students to identify the root words and brainstorm what types of ecological and symbiotic relationships the terms describe. Then, review the definitions of the terms. Point out that the term *symbiosis* is an overarching term for mutualism, commensalism, and parasitism and that the ecological relationships *predation* and *competition* are not generally considered to be symbiotic.

- **competition**—when two or more organisms rely on the same environmental resource
- **predation**—behavior of one animal feeding on another
- **symbiosis**—the close relationship of two dissimilar organisms
- **mutualism**—a symbiotic relationship where both organisms benefit
- **commensalism**—a symbiotic relationship where one organism benefits and one does not benefit but is unharmed

- **parasitism**—a symbiotic relationship where one organism benefits and one is harmed

2. Build background about National Geographic Crittercam.
Explain to students that they will watch footage from a National Geographic project called Crittercam. Crittercam's goal is to help researchers understand the day-to-day lives and ecological relationships of different species. Scientists fit wild animals with a GPS tracker and a combination video and audio recorder with environmental data instruments to measure such things as depth, temperature, and acceleration—which allow the study of animal behavior without interference by human observers. Ask students to think about the benefits of studying animal behavior and ecological interactions without interference by human observers.

3. Have students use a Crittercam video to identify ecological relationships.
Show students the National Geographic video "Fish Thieves Take Rare Seals' Prey" (3.5 minutes), in which an endangered Hawaiian monk seal preys upon and competes for fish and invertebrates on the seafloor at 80 meters (262 feet) deep. Ask: *What is the ecological relationship between the monk seal and the octopus/eel/trigger fish?* (predator/prey) Ask: *What is the ecological relationship between the monk seal and the jacks/sharks?* (competition) Ask students to again think about and discuss the benefits of studying animal behavior and ecological interactions without interference by human observers. Elicit from students that Crittercam allows researchers to examine the behavior and interactions of marine species that they normally would be unable to observe.

4. Have students view videos to identify symbiotic relationships.
Show students the three videos of different marine species interactions. After each video, have the class identify and discuss the symbiotic relationships they observed.

- "Caribbean Cleaners" (2.5 minutes)—mutualism
- "Giving Fish a Bath" (5.5 minutes)—parasitism
- "Clownfish and Sea Anemone Partnership" (1.5 minutes)—mutualism

Ask: *What type of symbiotic relationship was not shown in the videos?* (commensalism)

5. Use a National Geographic image to explore commensalism and discuss the origins of Crittercam.
Display the image "lemon shark" in the resource carousel and have students observe it closely. Ask: *Other than the shark, are there any other organisms you see?* Elicit from students that

the shark and the remoras, the smaller fish below the shark, have a symbiotic relationship called *commensalism*, where the remoras benefit from holding onto the shark, but neither species is harmed. Tell students that this commensal relationship is why Greg Marshall, marine biologist and filmmaker, invented Crittercam. In 1986, a shark approached him during a dive near Belize. Marshall noticed a remora clinging to a shark, and as he watched the shark disappear, it occurred to him that if he could put a camera in the place of the remora, he could see the shark's behavior unfold without disturbing the shark. Explain that with Crittercam, Marshall learned that remoras attach themselves to predatory fish like sharks for two reasons: a free ride and protection due to hanging onto a feared predator. The shark is not affected in the process since remoras eat only leftover food from the shark.

6. Have students read statements and identify types of ecological interactions.
Give each student a copy of the Symbiotic Interactions worksheet. Read aloud the directions. Tell them that they should be able to provide reasons for their choices. Discuss the answers as a class. Have students explain why they classified the different scenarios as one type of symbiosis and not the others. Ask: *How do ecological relationships shape the marine ecosystem? Why is it important to identify and understand these relationships?*

Informal Assessment

Use the provided answer key to check students' completed worksheet for accuracy. Ask students to orally explain why they labeled each *mutualism, commensalism,* or *parasitism*.

Extending the Learning

Have students identify one new marine-related example for each of the ecological relationships discussed in this activity: *predation, competition, mutualism, commensalism,* and *parasitism*. Discuss the examples as a class.

OBJECTIVES

Subjects & Disciplines

Earth Science

- Oceanography

Geography

- Physical Geography

Learning Objectives

Students will:

- describe possible ecological relationships between species that live in close proximity to each other
- define symbiotic relationships as mutualistic, parasitic, or commensalistic
- classify symbiotic relationships

Teaching Approach

- Learning-for-use

Teaching Methods

- Discussions
- Hands-on learning
- Visual instruction

Skills Summary

This activity targets the following skills:

- Critical Thinking Skills
  - Analyzing
  - Applying
  - Remembering
  - Understanding
- Geographic Skills
  - Analyzing Geographic Information
  - Answering Geographic Questions

National Standards, Principles, and Practices

NATIONAL GEOGRAPHY STANDARDS

• **Standard 8:**
The characteristics and spatial distribution of ecosystems and biomes on Earth's surface

NATIONAL SCIENCE EDUCATION STANDARDS

• **(9-12) Standard C-4:**
Interdependence of organisms
• **(9-12) Standard C-5:**
Matter, energy, and organization in living systems
• **(9-12) Standard C-6:**
Behavior of organisms

OCEAN LITERACY ESSENTIAL PRINCIPLES AND FUNDAMENTAL CONCEPTS

• **Principle 5d:**
Ocean biology provides many unique examples of life cycles, adaptations and important relationships among organisms (such as symbiosis, predator-prey dynamics and energy transfer) that do not occur on land.
• **Principle 5e:**
The ocean is three-dimensional, offering vast living space and diverse habitats from the surface through the water column to the seafloor. Most of the living space on Earth is in the ocean.
• **Principle 5f:**
Ocean habitats are defined by environmental factors. Due to interactions of abiotic factors such as salinity, temperature, oxygen, pH, light, nutrients, pressure, substrate and circulation, ocean life is not evenly distributed temporally or spatially, i.e., it is “patchy”. Some regions of the ocean support more diverse and abundant life than anywhere on Earth, while much of the ocean is considered a desert.
• **Principle 5g:**
There are deep ocean ecosystems that are independent of energy from sunlight and photosynthetic organisms. Hydrothermal vents, submarine hot springs, and methane cold seeps rely only on chemical energy and chemosynthetic organisms to support life.

Preparation

BACKGROUND & VOCABULARY

Background Information

Symbiosis is an ecological relationship between two species that live in close proximity to each other. Organisms in symbiotic relationships have evolved to exploit a unique niche that another organism provides. These relationships are based on the advantages that can be gained by finding and using a previously unexploited niche. Competition and predation are ecological relationships but are not symbiotic. Predation does not occur over a long period of time, and competition is an indirect interaction over resources.

Prior Knowledge

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Recommended Prior Activities

- Create an Imaginary Marine Ecosystem
- Marine Ecology Video Scavenger Hunt

Vocabulary

Term	Part of Speech	Definition
commensalism	*noun*	relationship between organisms where one organism benefits from the association while not harming the other.
mutualism	*noun*	relationship between organisms of different species, in which both organisms benefit from the association.
parasitism	*noun*	relationship between organisms where one organism (a parasite) lives or feeds on the other, usually causing harm.
predator	*noun*	animal that hunts other animals for food.
prey	*noun*	animal that is hunted and eaten by other animals.
symbiosis	*noun*	two or more distinct organisms living together for the benefit of one or both.

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ACTIVITY 3: CREATE AN IMAGINARY MARINE ECOSYSTEM | 2 HRS

DIRECTIONS

1. Review vocabulary.

Explain to students that they will work in small groups to create an imaginary marine ecosystem illustrating the various trophic levels, adaptations, symbiotic relationships, and niches of a community of marine organisms living in that ecosystem. Write the following vocabulary terms on the board and ask students to define them and give examples:

- abiotic and biotic factors
- food web
- adaptation, niche, habitat
- symbiosis: mutualism (both benefit); parasitism (one benefits/one harmed); commensalism (one benefits/one unharmed)
- trophic levels: producer (autotroph); primary/secondary/tertiary consumer (heterotroph); herbivore, carnivore, omnivore, decomposer, parasite, apex predator

2. Introduce the activity.

Divide students into small groups and distribute the two worksheets: Imaginary Marine Ecosystem Instructions & Organism Descriptions and Imaginary Marine Ecosystem Analysis. Also give each group markers and two pieces of butcher paper. Read aloud the directions. Clarify that students will create at least eight different organisms to inhabit their imaginary ecosystem. Six must be real marine organisms and live in the same real world ecosystem. The other two must be organisms that students invent. Use the worksheet to review what students should include for each organism, using the terrestrial example provided. Next, explain that students will create an imaginary ecosystem illustration. The illustration will include all eight organisms and the important abiotic components of the ecosystem, including water, sediment, rock, energy source, and other habitat features such as ocean floor features. Then, explain that students will create an imaginary ecosystem food web. Tell students to label each organism by name and trophic level and to use different colored arrows to represent each trophic level. Emphasize the importance of using arrows to show the proper flow of energy between organisms and trophic levels. If needed, refer to the two provided

examples of rocky intertidal food web diagrams as examples. Finally, explain that students will answer the questions on the Imaginary Marine Ecosystem Analysis worksheet and present their ecosystems to the class.

3. Give small groups time to complete the activity.
Answer any questions students may have. In their small groups, give students 1 hour, 30 minutes to complete the project, which includes organism descriptions, an ecosystem drawing, a food web, and analysis questions. Remind them of the time periodically and make sure that they are making appropriate progress.

4. Have groups share their ecosystems and discuss them.
With approximately 20 minutes of class time remaining, ask groups to present and discuss their imaginary marine ecosystems to the rest of the class. Allow other students to ask questions about each ecosystem and their imaginary organisms. To wrap up the activity and assess student comprehension, ask students to discuss question #11 from the Imaginary Marine Ecosystem Analysis worksheet. Ask: *How do ecological and symbiotic relationships shape your imaginary marine ecosystem? Why is it important to understand these relationships?* Display each group's work in the classroom and refer to them throughout the remainder of the unit.

Modification

As time allows, challenge students to create additional imaginary organisms for their ecosystems.

Tip

Have students mark their invented organisms with an asterisk to avoid misconceptions about the real versus imagined ones.

Modification

You may choose to modify the activity as needed based on time constraints, group sizes, and student background knowledge. For example, the organisms and ecosystems used can be based on those provided in Lesson 2: Marine Ecosystems and Biodiversity.

Informal Assessment

Check students' completed Imaginary Ecosystem Analysis worksheet for accuracy and comprehension.

Extending the Learning

Have students add humans to their imaginary ecosystems and discuss the roles and impacts humans might have within the ecosystem.

OBJECTIVES

Subjects & Disciplines

Biology

- Ecology

Earth Science

- Oceanography

Geography

- Physical Geography

Learning Objectives

Students will:

- describe the abiotic and biotic components of a marine ecosystem
- list several marine organisms and explain their trophic relationships using a food web
- describe the adaptations and niches of several marine organisms
- predict the effects abiotic changes or trophic imbalances might have upon an ecosystem as a whole

Teaching Approach

- Learning-for-use

Teaching Methods

- Brainstorming
- Cooperative learning

- Discussions
- Information organization

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Learning and Innovation Skills
    - Communication and Collaboration
    - Creativity and Innovation
  - Life and Career Skills
    - Initiative and Self-Direction
- Critical Thinking Skills
  - Analyzing
  - Applying
  - Creating
  - Understanding
- Geographic Skills
  - Answering Geographic Questions

National Standards, Principles, and Practices

NATIONAL GEOGRAPHY STANDARDS

• **Standard 14:**
How human actions modify the physical environment
• **Standard 8:**
The characteristics and spatial distribution of ecosystems and biomes on Earth's surface

NATIONAL SCIENCE EDUCATION STANDARDS

• **(9-12) Standard C-4:**
Interdependence of organisms
• **(9-12) Standard D-1:**

Energy in the earth system

- **(9-12) Standard F-4:**

Environmental quality

OCEAN LITERACY ESSENTIAL PRINCIPLES AND FUNDAMENTAL CONCEPTS

- **Principle 5d:**

Ocean biology provides many unique examples of life cycles, adaptations and important relationships among organisms (such as symbiosis, predator-prey dynamics and energy transfer) that do not occur on land.

- **Principle 5e:**

The ocean is three-dimensional, offering vast living space and diverse habitats from the surface through the water column to the seafloor. Most of the living space on Earth is in the ocean.

- **Principle 5f:**

Ocean habitats are defined by environmental factors. Due to interactions of abiotic factors such as salinity, temperature, oxygen, pH, light, nutrients, pressure, substrate and circulation, ocean life is not evenly distributed temporally or spatially, i.e., it is “patchy”. Some regions of the ocean support more diverse and abundant life than anywhere on Earth, while much of the ocean is considered a desert.

- **Principle 5i:**

Estuaries provide important and productive nursery areas for many marine and aquatic species.

Preparation

BACKGROUND & VOCABULARY

Background Information

Marine ecosystems and the organisms and habitats that comprise them are highly diverse. They are made up of several interacting biotic and abiotic components that define the trophic characteristics, symbiotic relationships, adaptive strategies, and niche selection that exist within different ecosystems. Alterations of abiotic conditions or food webs caused by natural and anthropogenic factors can result in negative effects—including ecosystem imbalances—that can disrupt the entire marine ecosystem.

Prior Knowledge

["ecological principles related to food webs, adaptations, niche selection, symbioses", "interactions between biotic and abiotic ecosystem components"]

Recommended Prior Activities

- Ecological Relationships
- Marine Ecology Video Scavenger Hunt

Vocabulary

Term	Part of Speech	Definition
adaptation	*noun*	a modification of an organism or its parts that makes it more fit for existence. An adaptation is passed from generation to generation.
food chain	*noun*	group of organisms linked in order of the food they eat, from producers to consumers, and from prey, predators, scavengers, and decomposers.
food web	*noun*	all related food chains in an ecosystem. Also called a food cycle.
habitat	*noun*	environment where an organism lives throughout the year or for shorter periods of time.
marine ecosystem	*noun*	community of living and nonliving things in the ocean.
niche	*noun*	role and space of a species within an ecosystem.
trophic level	*noun*	one of three positions on the food chain: autotrophs (first), herbivores (second), and carnivores and omnivores (third).

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