



*Jonathan Bird goes to the bottom of the blue world, Antarctica in the Southern Ocean. What marine life can live in freezing water? Jonathan is amazed at the biodiversity of the Southern Ocean. He finds numerous colorful invertebrates such as sponges, limpets, sea stars, anemones and sea cucumbers. Jonathan is excited when he finds a gigantic jellyfish three feet across with 50-foot tentacles, small fish that have “antifreeze” to prevent them from freezing and penguins that cannot fly, but put on a spectacular underwater acrobatic show. The Leopard seal is an apex predator of Antarctica, yet a curious 12-foot seal poses curiously for Jonathan for over an hour. Jonathan explores the towering walls of icebergs underwater. Above the water, Jonathan is in awe of the majestic beauty of Antarctica.*

**Science Lesson:** Biodiversity in the Southern Ocean - Related to Webisodes 34 & 35

**Grade Level:** 6-8

**Time:** One to two (45-50 min) class periods plus time for student research and presentation

### Introduction

The Arctic and Southern Oceans are similar and yet different. Both are located within the polar seas, both experience 24-hour daylight period at least once a year, and both have unique polar marine ecosystems.

The Arctic Ocean is bordered by the shallow continental shelves of North America, Greenland, Eurasia, and Russia. This northern most part of the ocean connects to the rest of the ocean at the Bering Strait and the Upper North Atlantic. The Arctic is a deep basin, and much of it is permanently frozen ice cap. Melting of Arctic sea ice does not cause sea level to rise because according to Archimedes’ principal, floating ice displaces its own volume of fluid and should not add more water when it melts.

Antarctica is a continent, not a frozen sea, buried under two continental glaciers separated by the Transantarctic Mountains. Antarctica has its own continental shelf, is not enclosed by the continental shelves of other continents and is surrounded by the Southern Ocean. Approximately 98% of the continent is covered with a thick, ancient sheet of ice with an average thickness of 7,000 feet and a maximum depth of nearly 3 miles. This ice sheet contains an enormous quantity of frozen water and scientists speculate that if the Antarctica Ice Sheet melted, sea level would rise by about 200 feet.

When sea ice melts, more sunlight enters the sea, and algae grow rapidly. These algae provide energy for a variety of pelagic organisms, including floating crustaceans, zooplankton and jellyfishes, which are the energy source for larger pelagic animals including fishes, squids, seals, and whales. When pelagic organisms die, they settle to the ocean bottom and become the energy source for inhabitants of the benthic realm. These animals, in turn, provide energy for bottom-feeding fishes, whales, and seals. In this lesson you will study the three realms of marine life in the Southern Ocean surrounding Antarctica.

### Science Standards

#### *National Science Education Standards*

#### **Science As Inquiry**

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

#### **Life Science**

- Populations and Ecosystems
- Diversity and adaptations of organisms

#### **Science in Personal and Social Perspectives**

- Populations, Resources, and Environments
- Natural Hazards

#### **Ocean Literacy Principles**

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

### Objectives

By the end of the lesson, the students will be able to:

1. Compare and contrast the pelagic, benthic and sea ice realms of the Southern Ocean.
2. Name at least three organisms that are typical of each of these three realms.
3. Explain how the pelagic, benthic and sea ice realms interact with each other in the Southern Ocean.



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### **Prior Knowledge**

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Students should have a solid understanding of food webs.

Students should have an understanding of plate tectonics and the continental drift theories.

Students should have general understanding of the geology and geography of Antarctica.

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### **Helpful Vocabulary**

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Antarctica:	The continent surrounding the South Pole; approximately 5,000,000 sq. mi. and almost entirely covered by an ice sheet.
Antarctic Circle:	The Antarctic Circle is located at 66.33 degrees south of the Equator. It has one or more days when the sun neither rises nor sets each year.
Benthic realm:	The benthic realm refers to the floor of the oceans, extending from the high tide line to the greatest ocean depths.
Pelagic realm:	The area of ocean water from the surface to the benthic realm.
Sea ice realm:	The sea ice realm includes plants and animals that live on, in, and just under the ice that floats on the Southern Ocean's surface.

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### **Background**

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The Southern Ocean lies in the Southern Hemisphere and is also known as the Antarctic Ocean, and the South Polar Ocean. The Southern Ocean extends from the coast of Antarctica north to 60 degrees south latitude, which coincides with the Antarctic Treaty Limit and approximates the extent of the Antarctic Convergence. The Southern Ocean, geologically the youngest of the oceans, formed when the continents of Antarctica and South America moved apart, opening the Drake Passage, roughly 30 million years ago. The separation of the continents allowed the formation of the Antarctic Circumpolar Current. The Southern Ocean is the fourth largest of the world's five oceans (after the Pacific Ocean, Atlantic Ocean, and Indian Ocean, but larger than the Arctic Ocean). This ocean zone is where cold, northward flowing waters from the Antarctic mix with warmer sub-Antarctic waters. The Southern Ocean has typical depths of between 4,000 and 5,000 meters (13,000 to 16,000 ft.) over most of its extent with only limited areas of shallow water. The Antarctic continental shelf appears generally narrow and unusually deep, its edge lying at depths up to 800 meters (2,600 ft.), compared to a global mean of 133 meters (436 ft.).

The continent of Antarctica is a land mass located within the Antarctic Circle. Like the Arctic Circle, the Antarctic Circle experiences a period of 24-hours continuous daylight at least once per year and a period of 24-hour continuous night time at least once a year. These events usually occur at the December and June solstices respectively.

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The Southern Ocean has three distinct biological realms that are linked in many ways, with food webs in each community interacting with those of the other realms.

1. The *sea ice realm* includes plants and animals that live on, in, and just under the ice that floats on the ocean's surface.
2. The *pelagic realm* includes organisms that live in the water column between the ocean surface and the sea floor bottom. The pelagic realm is always moving, forming part of a dynamic oceanographic system. The system is subject to climatic and ocean variability, which drives the variability in sea, ice cover, which in turn determines the structure of the pelagic ecosystem in the Antarctic.
3. The *benthic realm* composed of organisms that live on the bottom, including sponges, bivalves, crustaceans, polychaete worms, sea anemones, bryozoans, tunicates, and ascidians.

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### Lesson Procedure

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- **Materials:** Computer with internet access; paper; pencils
- **Review the geology and geography of Antarctica and the Southern Ocean.** View the Antarctica webisodes part 1 and 2 on the Jonathan Bird's Blue World website (webisodes 34 & 35).
- **Team Research:**  
Assign students into three-member teams.  
Within each team one student will become the research expert for one of the three realms: benthic, pelagic, or sea ice.  
Students will be expected to:
  1. Research what organisms inhabit their assigned realm
  2. Find and label pictures of at least five organisms giving the classification of the organism (phylum and class) as well as its genus, species and common name
  3. Contribute to a team presentation
- **Each team will create a power point presentation** illustrating the food webs in each of the three realms and the interconnections between the realms.

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### Extending the Lesson

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Questions for discussion:

1. What affect is climate change having on the Southern Ocean?
2. How do the three realms of the Arctic and Southern Ocean compare?
3. Explore hydrothermal vents in the Southern Ocean and life forms that make-up a fourth realm, a chemical-based food web.
4. What affect does commercial fishing have on the Southern Ocean?

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## Antarctica Lesson References

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What is sea ice?

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Comparison of Arctic and Antarctic Sea Ice

<http://nsidc.org/cryosphere/seaice/characteristics/difference.html>

Polar Ecology from Wikipedia

[http://en.wikipedia.org/wiki/Polar\\_ecology](http://en.wikipedia.org/wiki/Polar_ecology)

Krill

<http://www.coolantarctica.com/Antarctica%20fact%20file/wildlife/krill.htm>

Antarctica Animal Adaptations

[http://www.coolantarctica.com/Antarctica%20fact%20file/wildlife/antarctic\\_animal\\_adaptations.htm](http://www.coolantarctica.com/Antarctica%20fact%20file/wildlife/antarctic_animal_adaptations.htm)

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The Southern Ocean

[http://website.lineone.net/~dave\\_reay/](http://website.lineone.net/~dave_reay/)

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