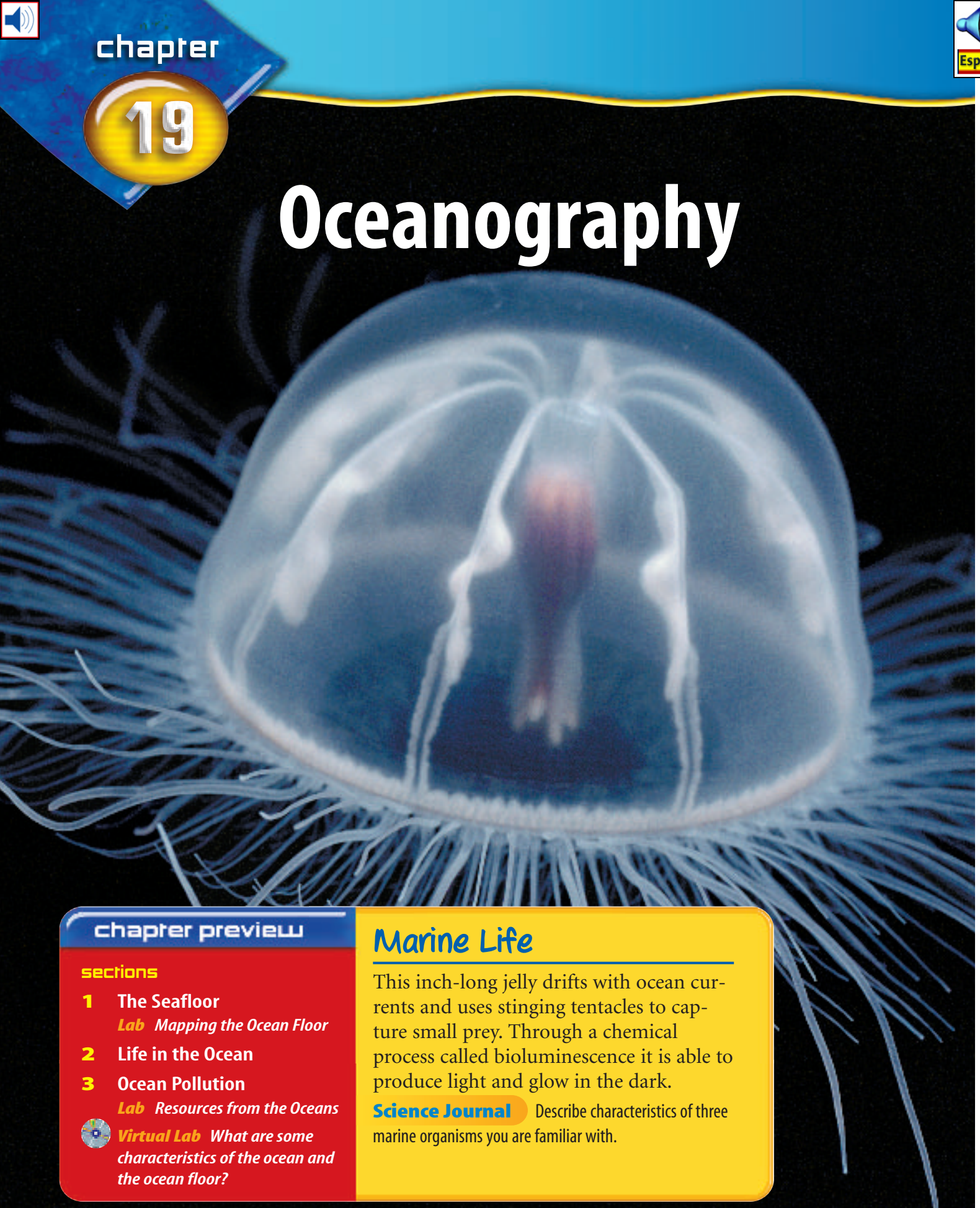
chapter 19

Oceanography



chapter preview

sections

1 The Seafloor
Lab Mapping the Ocean Floor

2 Life in the Ocean

3 Ocean Pollution
Lab Resources from the Oceans

Virtual Lab What are some characteristics of the ocean and the ocean floor?

Marine Life

This inch-long jelly drifts with ocean currents and uses stinging tentacles to capture small prey. Through a chemical process called bioluminescence it is able to produce light and glow in the dark.

Science Journal Describe characteristics of three marine organisms you are familiar with.

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Start-Up Activities

Launch LAB

How deep is the ocean?

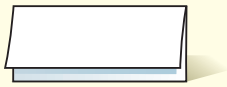
Sonar is used to measure ocean depth. You will model sonar in this lab.

1. With one person holding each end, stretch a spring until it is taut. Measure the distance between the ends.
2. Pinch two coils together. When the spring is steady, release the coils to create a wave.
3. Record the time it takes the wave to travel back and forth five times. Divide this number by five to calculate the time of one round trip.
4. Calculate the speed of the wave by multiplying the distance by two and dividing this number by the time.
5. Move closer to your partner. Take in coils to keep the spring at the same tension. Repeat steps 2 and 3.
6. Calculate the new distance by multiplying the new time by the speed from step 4, and then dividing this number by two.
7. **Think Critically** Write a paragraph in your Science Journal that describes how this lab models sonar.

FOLDABLES™ Study Organizer

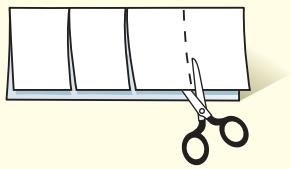
The Seafloor Make the following Foldable to help you identify the features of the seafloor.

STEP 1 **Fold** a sheet of paper in half lengthwise. Make the back edge about 1.25 cm longer than the front edge.

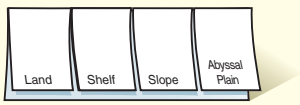


STEP 2 **Fold** in half, then fold in half again to make three folds.

STEP 3 **Unfold and cut** only the top layer along the three folds to make four tabs.



STEP 4 **Label** the tabs as shown.



Find Main Ideas As you read the chapter, draw seafloor features on the front of the tabs and write information about them under the tabs.

ScienceOnline Preview this chapter's content and activities at earth.msscience.com

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section 1

The Seafloor

as you read

What You'll Learn

- **Differentiate** between a continental shelf and a continental slope.
- **Describe** a mid-ocean ridge, an abyssal plain, and an ocean trench.
- **Identify** the mineral resources found on the continental shelf and in the deep ocean.

Why It's Important

Oceans cover nearly three fourths of Earth's surface.

Review Vocabulary

magma: hot, melted rock beneath Earth's surface

New Vocabulary

- continental shelf
- continental slope
- abyssal plain
- mid-ocean ridge
- trench

The Ocean Basins

Imagine yourself driving a deep-sea submersible along the ocean floor. Surrounded by cold, black water, the lights of your vessel reflect off of what looks like a mountain range ahead. As you continue, you find a huge opening in the seafloor—so deep you can't even see the bottom. What other ocean floor features can you find in **Figure 1?**

Ocean basins, which are low areas of Earth that are filled with water, have many different features. Beginning at the ocean shoreline is the continental shelf. The **continental shelf** is the gradually sloping end of a continent that extends under the ocean. On some coasts, the continental shelf extends a long distance. For instance, on North America's Atlantic and Gulf coasts, it extends 100 km to 350 km into the sea. On the Pacific Coast, where the coastal range mountains are close to the shore, the shelf is only 10 km to 30 km wide. The ocean covering the continental shelf can be as deep as 350 m.

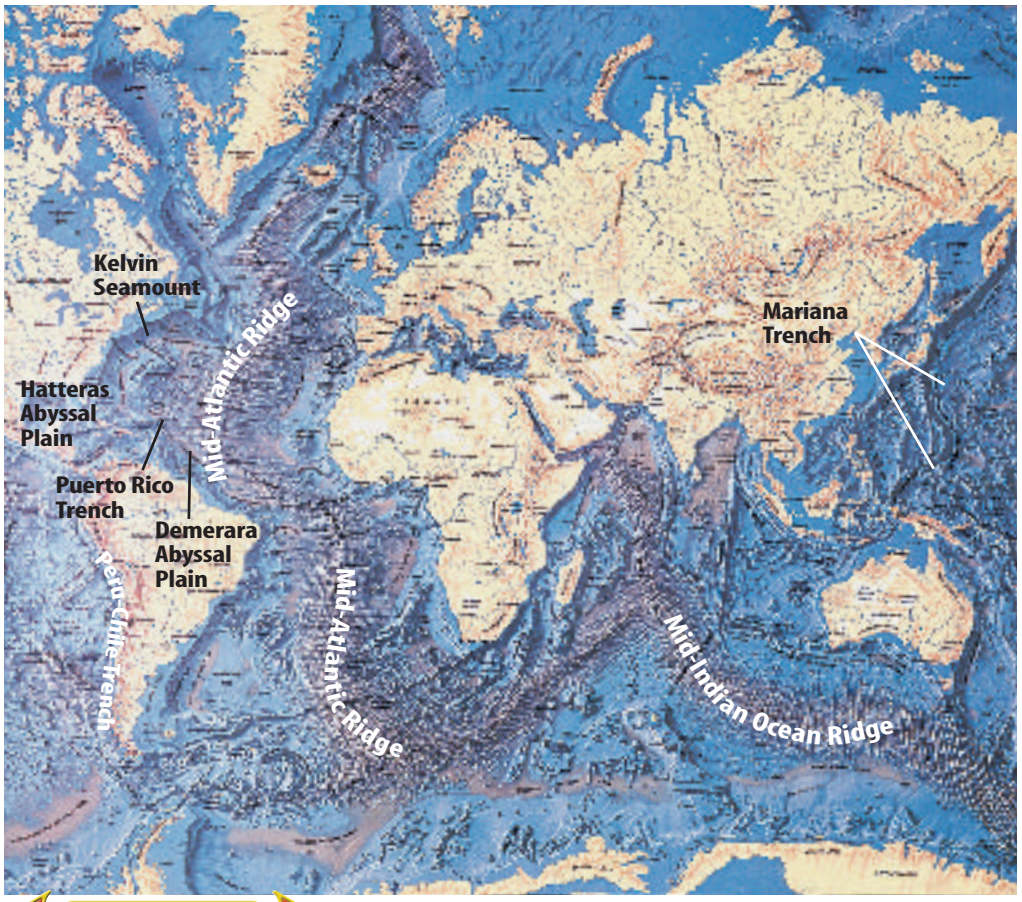

Figure 1 This map shows features of the ocean basins. Locate a trench and a mid-ocean ridge.

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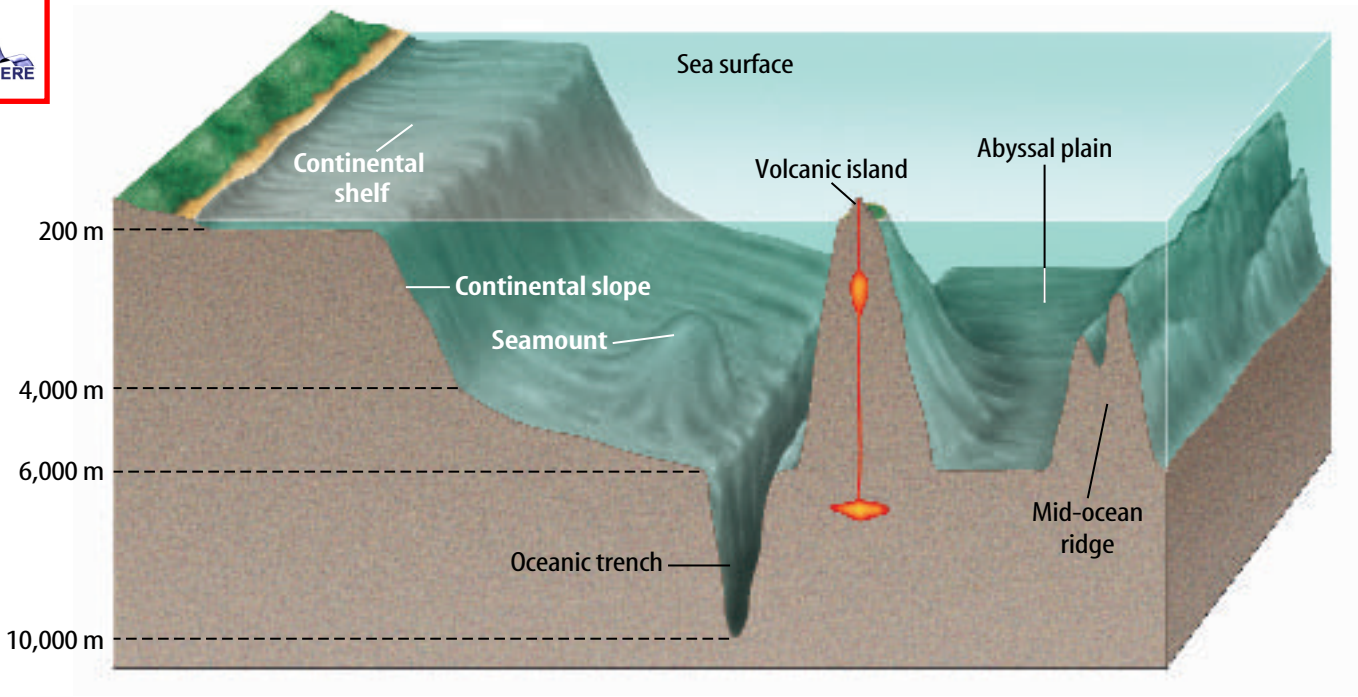
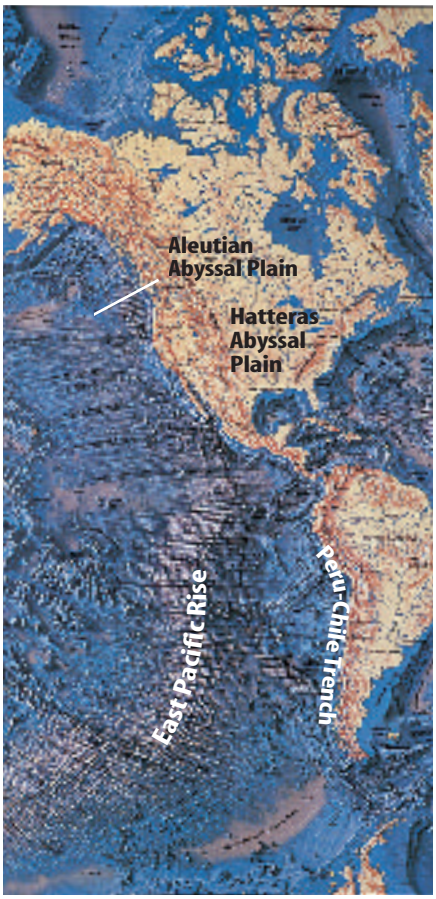


Figure 2 Ocean basin features are continuous from shore to shore. (Features in this diagram are not to scale.)
Describe *where the continental shelf ends and the continental slope begins.*

Figure 2 shows that beyond the shelf, the ocean floor drops more steeply, forming the continental slope. The **continental slope** extends from the outer edge of the continental shelf down to the ocean floor. Beyond the continental slope lie the trenches, valleys, plains, mountains, and ridges of the ocean basin.

In the deep ocean, sediment, derived mostly from land, settles constantly on the ocean floor. These deposits fill in valleys and create flat seafloor areas called **abyssal** (uh BIH sul) **plains.** Abyssal plains are from 4,000 m to 6,000 m below the ocean surface. Can you locate the abyssal plain shown in **Figure 2?**



In the Atlantic Ocean, areas of extremely flat abyssal plains can be large. One example is the Canary Abyssal Plain, which has an area of approximately 900,000 km^2. Other abyssal plains found in the Atlantic Ocean include the Hatteras and Demerara Abyssal Plains, both shown in **Figure 1.** Some areas of abyssal plains have small hills and seamounts. Seamounts are under-water, inactive volcanic peaks. They most commonly are found in the Pacific Ocean. Can you locate a seamount in **Figure 1?**

Reading Check ***What are seamounts?***

Science Online

Topic: Ocean Basins

Visit earth.msscience.com for Web links to information about ocean basins.

Activity Find five fun facts about ocean basins, such as the location of the deepest known point in the ocean. Present your facts to the class.

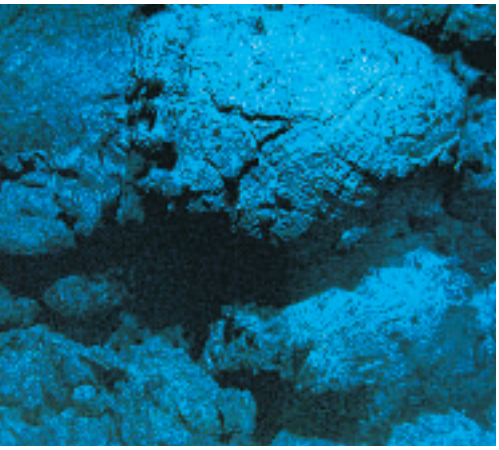


Figure 3 New seafloor forms at mid-ocean ridges. A type of lava called pillow lava lies newly formed at this ridge on the ocean floor.

Ridges and Trenches

Locate the Mid-Atlantic Ridge in **Figure 1.** Mid-ocean ridges can be found at the bottom of all ocean basins. They form a continuous underwater ridge approximately 70,000 km long. A **mid-ocean ridge** is the area in an ocean basin where new ocean floor is formed. Crustal plates, which are large sections of Earth's uppermost mantle and crust, are moving constantly. As they move, the ocean floor changes. When ocean plates separate, hot magma from Earth's interior forms new ocean crust. This is the process of seafloor spreading. New ocean floor is being formed at a rate of approximately 2.5 cm per year along the Mid-Atlantic Ridge.

New ocean floor forms along mid-ocean ridges as lava erupts through cracks in Earth's crust. **Figure 3** shows newly erupted lava on the seafloor. When the lava hits the water, it cools quickly into solid rock, forming new seafloor. While seafloor is being formed in some parts of the oceans, it is being destroyed in others. Areas where old ocean floor slides beneath another plate and descends into Earth's mantle are called subduction zones.

Reading Check *How does new ocean floor form?*

Applying Math — Find the Slope

CALCULATING A FEATURE'S SLOPE If the width of a continental shelf is 320 km and it increases in depth a total of 300 m in that distance, what is its slope?

Solution

1 *This is what you know:*	• width = 320 km • increase in depth = 300 m
2 *This is what you need to find:*	slope: s
3 *This is the equation you need to use:*	s = increase in depth ÷ width
4 *Solve the equation by substituting in known values:*	s = 300 m ÷ 320 km = 0.94 m/km

Practice Problems

1. The width of a continental slope is 40 km. It increases in depth by 2,000 m. What is the slope of the continental slope?
2. If the depth of a continental slope increases by 3,700 m and the slope is 74 m/km, what is the width of the slope?

ScienceOnline For more practice, visit earth.msscience.com/math_practice

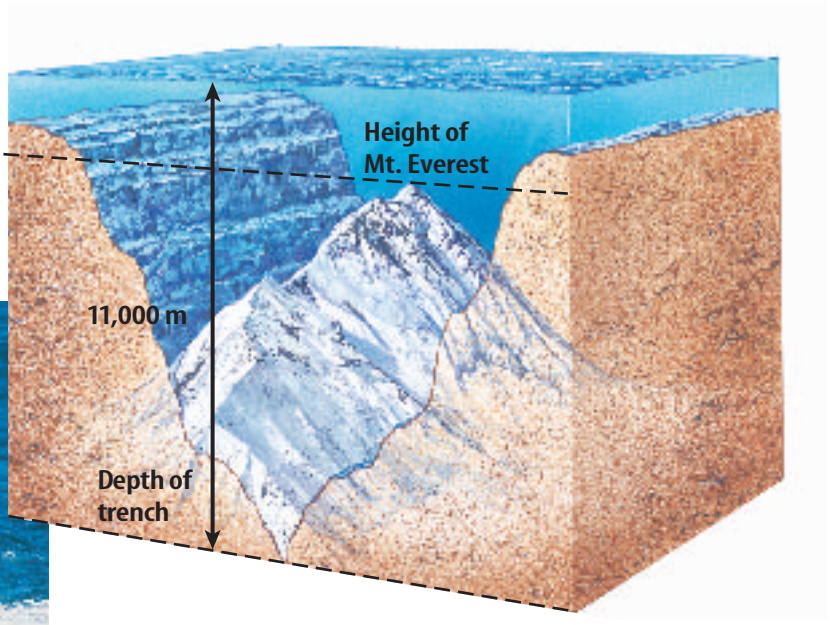


Figure 4 Located at subduction zones, trenches are important ocean basin features.

If Earth's tallest mountain, Mount Everest, were set in the bottom of the Mariana Trench of the Pacific Basin, it would be covered with more than 2,000 m of water.

In 1960, the world's deepest dive was made in the Mariana Trench. The *Trieste* carried Jacque Piccard and Donald Walsh to a depth of almost 11 km.

Subduction Zones On the ocean floor, subduction zones are marked by deep ocean trenches. A **trench** is a long, narrow, steep-sided depression where one crustal plate sinks beneath another. Most trenches are found in the Pacific Basin. Ocean trenches are usually longer and deeper than any valley on any continent. One trench, famous for its depth, is the Mariana Trench. It is located to the south and east of Japan in the Pacific Basin. This trench reaches 11 km below the surface of the water, and it is the deepest place in the Pacific. The photo in **Figure 4** shows the deep-sea vessel, the *Trieste,* that descended into the trench in 1960. **Figure 4** also illustrates that the Mariana Trench is so deep that Mount Everest could easily fit into it.

Mineral Resources from the Seafloor

Resources can be found in many places in the ocean. Some deposits on the continental shelf are relatively easy to extract. Others can be found only in the deep abyssal regions on the ocean floor. People still are trying to figure out how to get these valuable resources to the surface. As you read, suggest some methods that could be used to retrieve hard-to-reach resources.

Mini LAB

Modeling the Mid-Atlantic Ridge

Procedure

1. Set two **tray tables** 2 cm apart.
2. Gather ten **paper towels** that are still connected. Lay one end of the paper towels on each table so the towels hang down into the space between the tables.
3. Slowly pull each end of the paper towels away from each other.

Analysis

1. Explain how this models the Mid-Atlantic Ridge.
2. How long does it take for 2.5 cm of new ocean crust to form at the Mid-Atlantic Ridge? How long does it take 25 cm to form?

Try at Home

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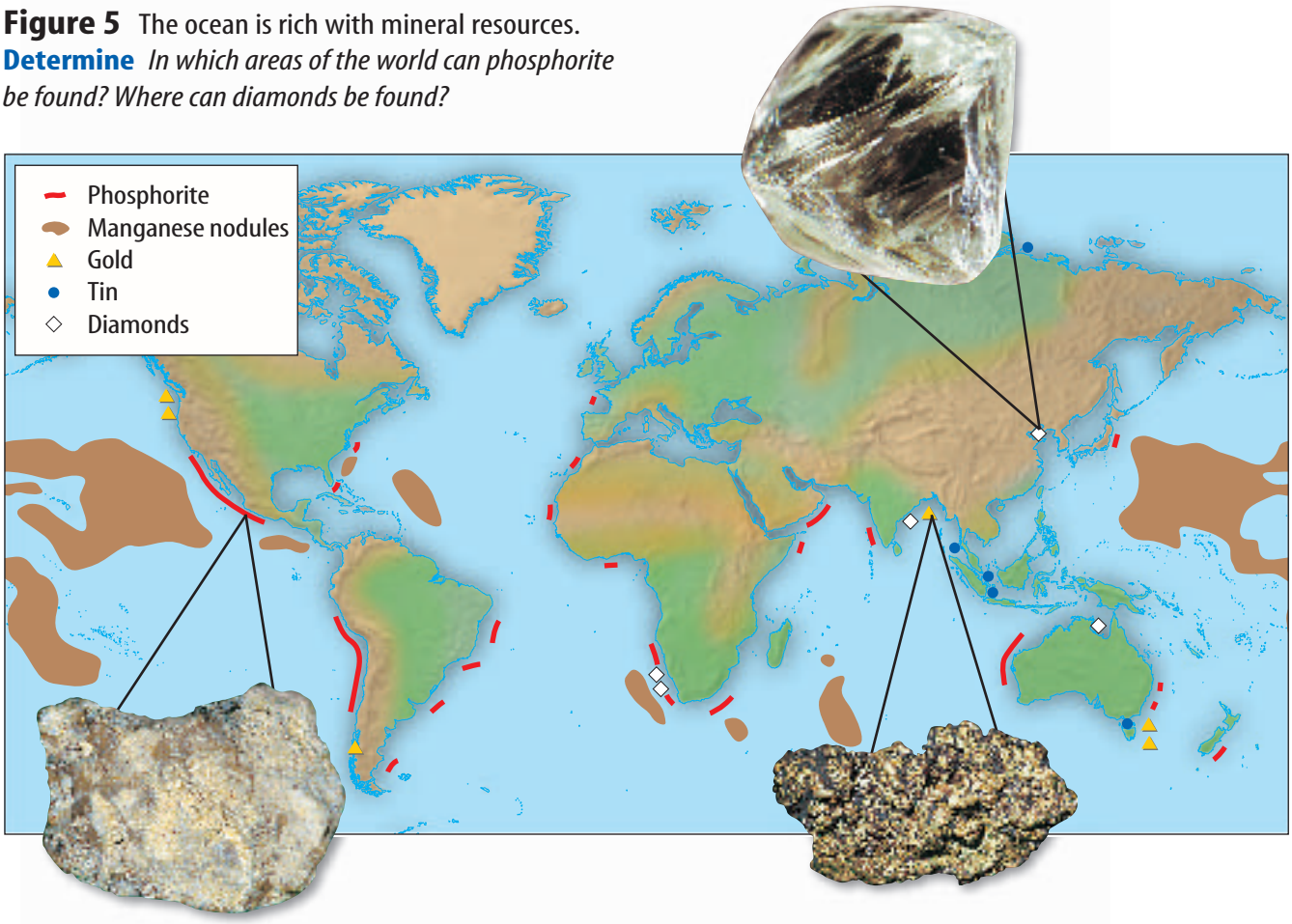
Figure 5 The ocean is rich with mineral resources.
Determine *In which areas of the world can phosphorite be found? Where can diamonds be found?*



Continental Shelf Deposits A high amount of organic activity occurs in the waters above the continental shelf, and sediment accumulates to great thickness on the ocean floor. This is why many different kinds of resources can be found there, such as petroleum and natural gas deposits. Approximately 20 percent of the world's oil comes from under the seabed. To extract these substances, wells are drilled into the seafloor from floating vessels and fixed platforms.

Other deposits on the continental shelf include phosphorite, which is used to make fertilizer, and limestone, which is used to make cement. Sand and gravel, both economically important, also can be dredged from the continental shelf.

Rivers that flow into oceans transport important minerals to the continental shelf from land. Sometimes the energy of ocean waves and currents can cause denser mineral grains that have been brought in by rivers to concentrate in one place. These deposits, called placer (PLAHS ur) deposits, can occur in coastal regions where rivers entering the ocean suddenly lose energy, slow down, and drop their sediment. Metals such as gold and titanium and gemstones such as diamonds are mined from placer deposits in some coastal regions. **Figure 5** shows where some resources in the ocean can be found.

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Deep-Water Deposits Through the holes and cracks along mid-ocean ridges, plumes of hot water billow out into surrounding seawater. As the superheated water cools, mineral deposits sometimes form. As a result, elements such as sulfur and metals like iron, copper, zinc, and silver can be concentrated in these areas. Today, no one is mining these valuable materials from the depths because it would be too expensive to recover them. However, in the future, these deposits could become important.

Other mineral deposits can precipitate from seawater. In this process, minerals that are dissolved in ocean water come out of solution and form solids on the ocean floor. Manganese nodules are small, darkly colored lumps strewn across large areas of the ocean basins. **Figure 6** shows these nodules. Manganese nodules form by a chemical process that is not fully understood. They form around nuclei such as discarded sharks' teeth, growing slowly, perhaps as little as 1 mm to 10 mm per million years. These nodules are rich in manganese, copper, iron, nickel, and cobalt, which are used in the manufacture of steel, paint, and batteries. Most of the nodules lie thousands of meters deep in the ocean and are not currently being mined, although suction devices similar to huge vacuum cleaners have been tested to collect them.

Figure 6 These manganese nodules were found on the floor of the Pacific Ocean.
Think Critically *Can you think of an efficient way to gather the nodules from a depth of 4 km?*

section 1 review

Summary

The Ocean Basins

- Ocean basins have many different features, including the continental shelf, continental slope, and abyssal plains.

Ridges and Trenches

- New ocean floor forms along mid-ocean ridges.
- Trenches mark areas of ocean floor where one crustal plate is sinking beneath another.

Mineral Resources from the Seafloor

- Many mineral deposits, such as petroleum and natural gas, can be found on the continental shelf.
- Other mineral deposits, such as manganese nodules, can be found in deep water.

Self Check

1. **Compare and contrast** continental shelves and continental slopes.
2. **Contrast** mid-ocean ridges and trenches.
3. **Describe** how an abyssal plain looks and how it forms.
4. **Think Critically** Why is the formation of continental shelf deposits different from that of deep-water deposits? Name two examples of each type of deposit.

Applying Skills

5. **Infer** Depth soundings, taken as a ship moves across an ocean, are consistently between 4,000 m and 4,500 m. Over which area of seafloor is the ship passing?

LAB

Mapping the Ocean Floor

In this lab you will use sonar data from the Atlantic Ocean to make a profile of the ocean bottom.

Real-World Question

What does the ocean floor look like?

Goals

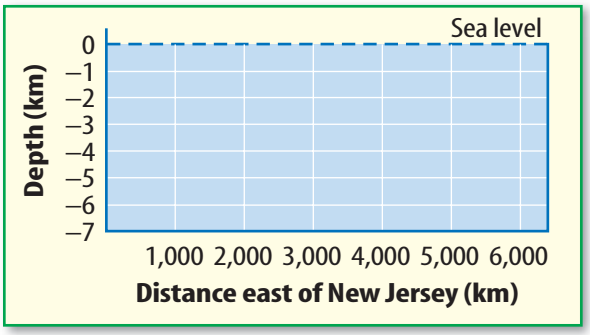
- **Make** a profile of the ocean floor.
- **Identify** seafloor structures.

Materials

graph paper

Procedure

1. Copy and complete a graph like the one shown.
2. **Plot** each data point and connect the points with a smooth line.



3. Color water blue and the seafloor brown.

Conclude and Apply

1. What ocean floor structures occur between 160 km and 1,050 km east of New Jersey? Between 2,000 km and 4,500 km? Between 5,300 km and 5,500 km?
2. When a profile of a feature is drawn to scale, the horizontal and vertical scales must be the same. Does your profile give an accurate picture of the ocean floor? Explain.

Ocean Floor Data

Station Number	Distance from New Jersey (km)	Depth to Ocean Floor (m)
1	0	0
2	160	165
3	200	1,800
4	500	3,500
5	1,050	5,450
6	1,450	5,100
7	1,800	5,300
8	2,000	5,600
9	2,300	4,750
10	2,400	3,500
11	2,600	3,100
12	3,000	4,300
13	3,200	3,900
14	3,450	3,400
15	3,550	2,100
16	3,700	1,275
17	3,950	1,000
18	4,000	0
19	4,100	1,800
20	4,350	3,650
21	4,500	5,100
22	5,000	5,000
23	5,300	4,200
24	5,450	1,800
25	5,500	920
26	5,650	0

section 2

Life in the Ocean

Fred Bavendam/Minden Pictures

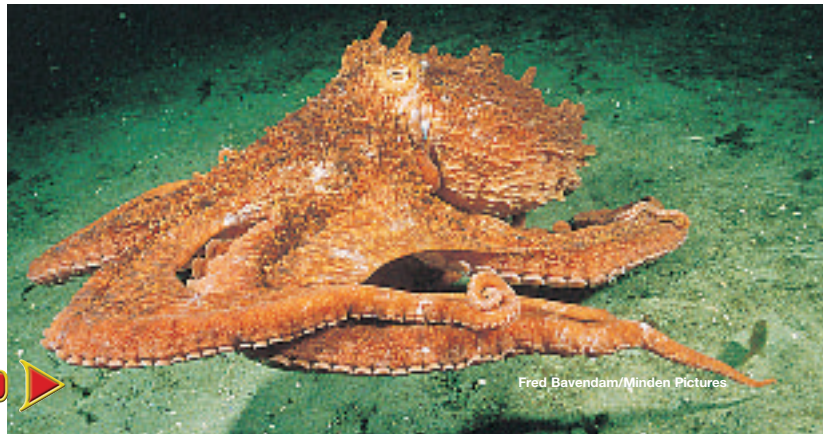
Life Processes

Life processes such as breathing oxygen, digesting food, making new cells, and growing take place in your body every day. It takes energy to do this, plus walk between classrooms or play soccer. Organisms that live in the ocean also carry out life processes every day. The octopus shown in **Figure 7** will get the oxygen it needs from the water. It will have to eat, and it will use energy to capture prey and to escape predators. It will make new cells and eventually reproduce. Like other marine organisms, it is adapted to accomplish these processes in the salty water of the ocean.

One of the most important processes in the ocean, as it is on land, is that organisms obtain food to use for energy. Obtaining the food necessary to survive can be done in several ways.

INTEGRATE Life Science

Photosynthesis Nearly all of the energy used by organisms in the ocean ultimately comes from the Sun. Radiant energy from the Sun penetrates seawater to an average depth of 100 m. Marine organisms such as plants and algae use energy from the Sun to build their tissues and produce their own food. This process of making food is called **photosynthesis.** During photosynthesis, carbon dioxide and water are changed to sugar and oxygen in the presence of sunlight. Organisms that undergo photosynthesis are called producers. Producers also need nutrients, such as nitrogen and phosphorus, in order to produce organic matter. These and other nutrients are obtained from the surrounding water. Marine producers include sea grasses, seaweeds, and microscopic algae. Although they might seem unimportant because they are small, microscopic algae are responsible for approximately 90 percent of all marine production. Organisms that feed on producers are called consumers. Consumers in the marine environment include shrimp, fish, dolphins, whales, and sharks.



Fred Bavendam/Minden Pictures

Figure 7 Hunting at night, this Pacific octopus feeds on snails and crabs. It uses camouflage, ink, and speed to avoid predators.

as you read

What You'll Learn

- **Describe** photosynthesis and chemosynthesis in the oceans.
- **List** the key characteristics of plankton, nekton, and benthos.
- **Compare and contrast** ocean margin habitats.

Why It's Important

The ocean environment is fragile, and many organisms, including humans, depend on it for their survival.

Review Vocabulary

nutrient: a substance needed for the production of organic matter

New Vocabulary

- photosynthesis
- chemosynthesis
- plankton
- nekton
- benthos
- estuary
- reef

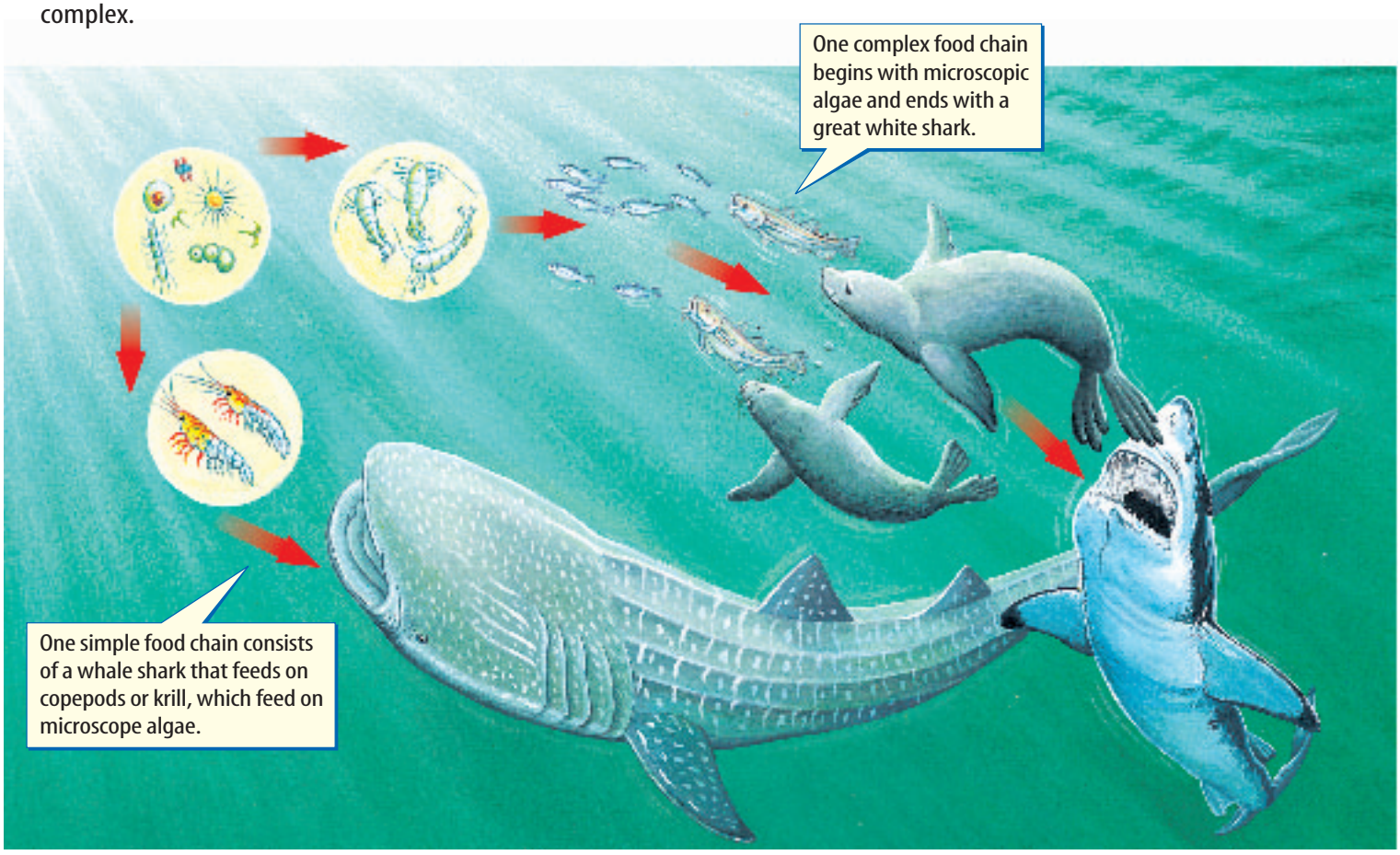
Ecologist An ecologist is a scientist who studies the interactions between organisms and their environment. Ecologists may specialize in areas such as marine ecosystems or tropical rain forests. They may also study how energy is transferred from one organism to another, such as through a food web.

Energy Relationships Energy from the Sun is transferred through food chains. Although the organisms of the ocean capture only a small part of the Sun's energy, this energy is passed from producer to consumer, then to other consumers. In **Figure 8,** notice that in one food chain, a large whale shark consumes small, shrimplike organisms as its basic food. In the other chain, microscopic algae found in water are eaten by microscopic animals called copepods (KOH puh pahdz). The copepods are, in turn, eaten by herring. Cod eat the herring, seals eat the cod, and eventually great white sharks eat the seals. At each stage in the food chain, energy obtained by one organism is used by other organisms to move, grow, repair cells, reproduce, and eliminate waste.

What is passed on at each stage in a food chain?

In an ecosystem—a community of organisms and their environment—many complex feeding relationships exist. Most organisms depend on more than one species for food. For example, herring eat more than copepods, cod eat more than herring, seals eat more than cod, and white sharks eat more than seals. In an ecosystem, food chains overlap and are connected much like the threads of a spider's web. These highly complex systems are called food webs.

Figure 8 Numerous food chains exist in the ocean. Some food chains are simple and some are complex.



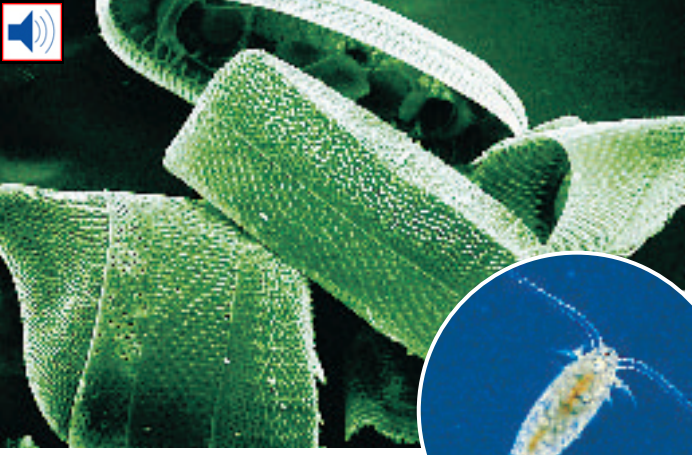
Chemosynthesis Other types of food webs do not depend on the Sun and photosynthesis. These food webs depend on bacteria that perform chemosynthesis. **Chemosynthesis** (kee moh SIHN thuh sus) involves using sulfur or nitrogen compounds as an energy source, instead of light from the Sun, to produce food. Bacteria that perform chemosynthesis using sulfur compounds live along mid-ocean ridges near hydrothermal vents where no light is available. Recall that superheated water from the crust contains high amounts of sulfur. The bacteria found here form the base of a food chain and support a host of highly specialized organisms such as giant tube worms, clams, crabs, and shrimp.

Figure 9 Because sponges live attached to the ocean bottom, they depend on currents to carry their reproductive cells to nearby sponges.
Infer *what would happen if a sponge settled in an area without strong currents.*

Other Life Processes Reproduction also is a vital life process. Some organisms, such as corals and sponges, depend on ocean currents for successful reproduction. Shown in **Figure 9,** these organisms release reproductive cells into the water where they unite to form more organisms of the same type. Other organisms, such as salmon and the Atlantic eel, travel long distances across the ocean in order to reproduce in a specific location. One important aspect of successful reproduction is finding a safe place for eggs and newly hatched larvae to develop. You will learn later in this section that some places in the ocean are used by marine organisms for this purpose.

Ocean Life

Many varieties of plants and animals live in the ocean. Although some organisms live in the open ocean or on the deep ocean floor, most marine organisms live in the waters above or on the floor of the continental shelf. In this relatively shallow water, the Sun penetrates to the bottom, allowing for photosynthesis. Because light is available for photosynthesis, large numbers of producers live in the waters above the continental shelf. These waters also contain many nutrients that producers use to carry out life processes. As a result, the greatest source of food is located in the waters of the continental shelf.



Diatoms are phytoplankton that live in freshwater and ocean water.

The zooplankton shown here is a copepod. Although it has reached its adult size, it is still microscopic.

Figure 10 Some plankton are producers, others are consumers.

Plankton Marine organisms that drift with the currents are called **plankton.** Plankton range from microscopic algae and animals to organisms as large as jellyfish. Most phytoplankton—plankton that are producers—are one-celled organisms that float in the upper layers of the ocean where light needed for photosynthesis is available. One abundant form of phytoplankton is a one-celled organism called a diatom. Diatoms are shown in **Figure 10.** Diatoms and other phytoplankton are the source of food for zooplankton, animals that drift with ocean currents.

Zooplankton includes newly hatched fish and crabs, jellies, and tiny adults of some organisms like the one shown in **Figure 10,** which feed on phytoplankton and are usually the second step in ocean food chains. Most animal plankton depend on surface currents to move them, but some can swim short distances.

Nekton Animals that actively swim, rather than drift with the currents in the ocean, are called **nekton.** Nekton include all swimming forms of fish and other animals, from tiny herring to huge whales. Nekton can be found from polar regions to the tropics and from shallow water to the deepest parts of the ocean. In **Figure 11,** the Greenland shark, the manatee, and the deep-ocean fish are all nekton. As nekton move throughout the oceans, it is important that they are able to control their buoyancy, or how easily they float or sink. What happens when you hold your breath underwater, then let all of the air out of your lungs at once? The air held in your lungs provides buoyancy and helps you float. As the air is released, you sink. Many fish have a special organ filled with gas that helps them control their buoyancy. By changing their buoyancy, organisms can change their depth in the ocean. The ability to move between different depths allows animals to search more areas for food.

Reading Check *What are nekton?*

Some deep-dwelling nekton are adapted with special light-generating organs. The light has several uses for these organisms. The deep-sea fish, shown in **Figure 11,** dangles a luminous lure from beneath its jaw. When prey attracted by the lure are close enough, they are swallowed quickly. Some deep-sea organisms use this light to momentarily blind predators so they can escape. Others use it to attract mates.

INTEGRATE Chemistry

Bioluminescence Some marine organisms, including types of bacteria, one-celled algae, and fish, can make their own light through a process called bioluminescence. The main molecule involved in producing light is luciferin. In the process of a chemical reaction involving luciferin, a burst of light is produced.

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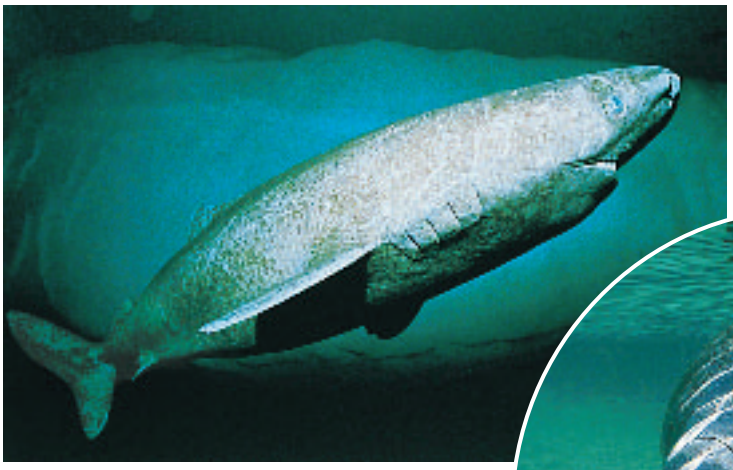
Figure 11 Nekton are found living in all areas of the ocean, warm or cold, shallow or deep.



This Greenland shark lives in the cold waters of the North Atlantic.

Manatees are found in tropical regions around the world.

This deep-sea fish is adapted to living under pressure at a depth of 4 km.

Bottom Dwellers The plants and animals living on or in the seafloor are the **benthos** (BEN thahs). Benthic animals include crabs, snails, sea urchins, and bottom-dwelling fish such as flounder. These organisms move or swim across the bottom to find food. Other benthic animals that live permanently attached to the bottom, such as sea anemones and sponges, filter out food particles from seawater. Certain types of worms live burrowed in the sediment of the ocean floor. Bottom-dwelling animals can be found living from the shallow water of the continental shelf to the deepest areas of the ocean. Benthic plants and algae, however, are limited to the shallow areas of the ocean where enough sunlight penetrates the water to allow for photosynthesis. One example of a benthic algae is kelp, which is anchored to the bottom and grows toward the surface from depths of up to 30 m.

Ocean Margin Habitats

The area of the environment where a plant or animal normally lives is called a habitat. Along the near-shore areas of the continental shelf, called ocean margins, a variety of habitats exist. Beaches, rocky shores, estuaries, and coral reefs are some examples of the different habitats found along ocean margins.

Mini LAB

Observing Plankton

Procedure

1. Place one or two drops of **pond, lake, or ocean water** onto a **microscope slide.**
2. Use a **microscope** to observe your sample. Look for microscopic life.
3. Find at least three different types of plankton.

Analysis

1. Draw detailed pictures of three types of plankton.
2. Classify the plankton as phytoplankton or zooplankton.

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Beaches At the edge of a sandy beach where the waves splash, you can find some microscopic organisms and worms that spend their entire lives between moist grains of sand. Burrowing animals such as small clams and mole crabs make holes in the sand. When water covers the holes, these animals rise to the surface to filter food from the water. Where sand is covered constantly by water, larger animals like horseshoe crabs, snails, fish, turtles, and sand dollars reside. **Figure 12** shows some of the organisms that are found living on sandy beaches.

Although the beach is great fun for people, it is a very stressful environment for the plants and animals that live there. They constantly deal with waves, changing tides, and storms, all of which redistribute large amounts of sand. Large waves produced by storms, such as hurricanes, can cause damage to beaches as they crash onto shore. These organisms must adapt to natural changes as well as changes created by humans. Damming rivers, building harbors, and constructing homes and hotels near the shoreline disrupts natural processes on the beach.

Rocky Shore Areas In some regions the shoreline is rocky, as shown in **Figure 13.** Algae, sea anemones, mussels, and barnacles encrust submerged rocks. Sea stars, sea urchins, octopuses, and hermit crabs crawl along the rock surfaces, looking for food.

Tide pools are formed when water remains onshore, trapped by the rocks during low tide. Tide pools are an important habitat for many marine organisms. They serve as protected areas where many animals, such as octopuses and fish, can develop safely from juveniles to adults. Tide pools contain an abundance of food and offer protection from larger predators.

Science Online

Topic: Beach Erosion

Visit earth.msscience.com for Web links to information about beach erosion.

Activity Find two examples of beaches that are having problems with erosion. What is being done to help solve the problem?

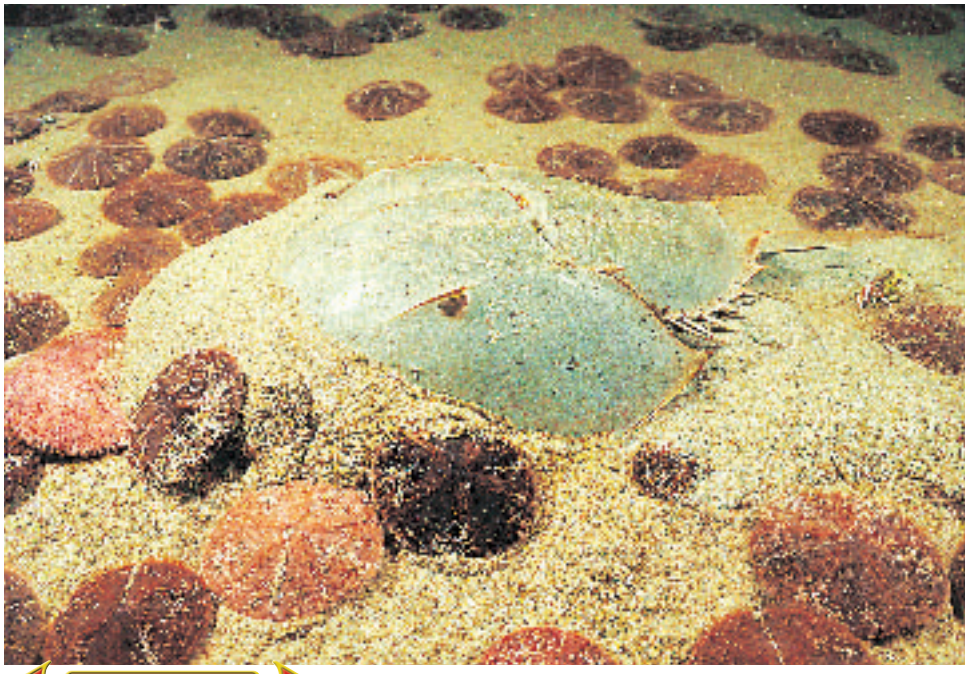

Figure 12 Organisms inhabit many different shore areas. **Describe** *where you would want to live if you were a marine organism.*

Fred Bavendam/Peter Arnold, Inc.

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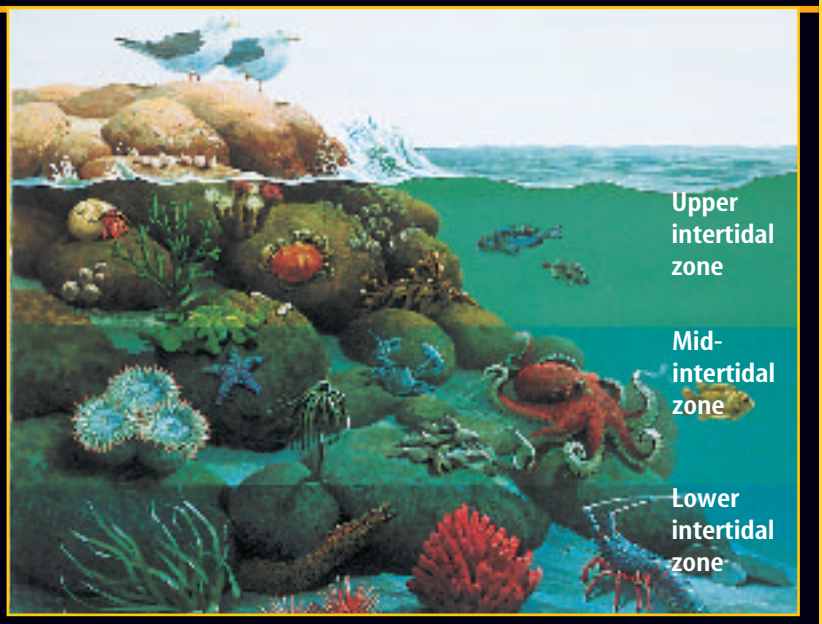
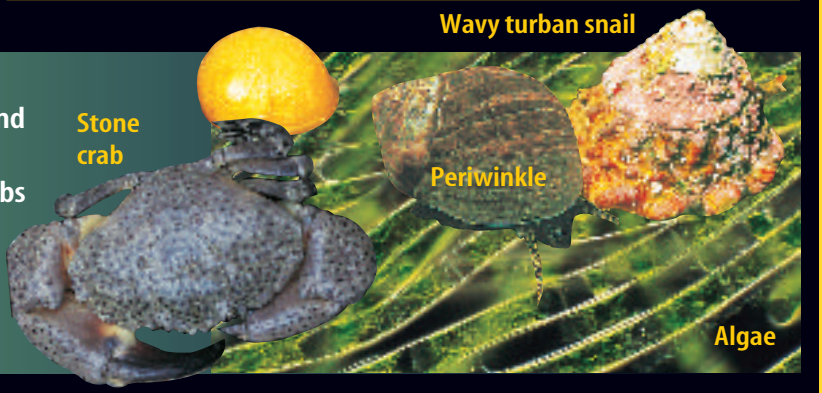
NATIONAL GEOGRAPHIC VISUALIZING THE ROCKY SHORE HABITAT

Figure 13

Life is tough in the intertidal zone—the coastal area between the highest high tide and the lowest low tide. Organisms here are pounded by waves and alternately covered and uncovered by water as tides rise and fall. These organisms tend to cluster into three general zones along the shore. Where they live depends on how well they tolerate being washed by waves, submerged at high tide, or exposed to air and sunlight when the tide is low.



UPPER INTERTIDAL ZONE This part of the intertidal zone is splashed by high waves and is usually covered by water only during the highest tides each month. It is home to crabs that scuttle among periwinkle snails, limpets, and a few kinds of algae that can withstand long periods of dryness.



MID-INTERTIDAL ZONE Submerged at most high tides and exposed at most low tides, this zone is populated by brown algae, sponges, barnacles, mussels, chitons, snails, and sea stars. These creatures are resistant to drying out and good at clinging to slippery surfaces.

LOWER INTERTIDAL ZONE This section of the intertidal zone is exposed only during the lowest tides each month. It contains the most diverse collection of living things. Here you find sea urchins, large sea stars, brittle stars, nudibranchs, sea cucumbers, anemones, and many kinds of fish.

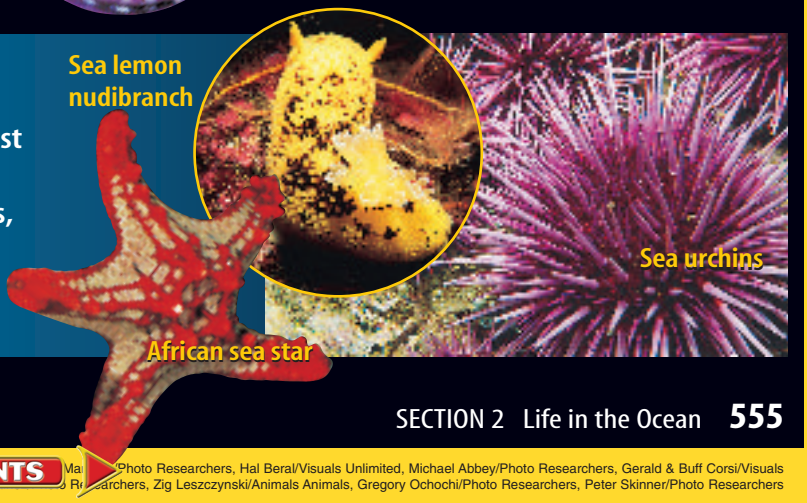


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Figure 14 Estuaries are called the nurseries of the oceans because many creatures spend their early lives there.

Estuaries An **estuary** is an area where the mouth of a river opens into an ocean. Because estuaries receive freshwater from rivers, they are not as salty as the ocean. Rivers also bring nutrients to estuaries. Areas with many nutrients usually have many phytoplankton, which form the base of the food chain. Shown in **Figure 14,** estuaries are full of life from salt-tolerant grasses to oysters, clams, shrimps, fish, and even manatees.

Estuaries are an important habitat to many marine organisms. Newly hatched fish, shrimps, crabs, and other animals enter estuaries as microscopic organisms and remain there until adulthood. For these vulnerable animals, fewer predators and more food are found in estuaries.

Coral Reefs Corals thrive in clear, warm water that receives a lot of sunlight. This means that they generally live in warm latitudes, between 30°N and 30°S, and in water that is no deeper than 40 m. Each coral animal builds a hard capsule around its body from the calcium it removes from seawater. Each capsule is cemented to others to form a large colony called a reef. A **reef** is a rigid, wave-resistant structure built by corals from skeletal material. As a coral reef forms, other benthos such as sea stars and sponges and nekton such as fish and turtles begin living on it.

In all ocean margin habitats, nutrients, food, and energy are cycled among organisms in complex food webs. Plankton, nekton, and benthos depend on each other for survival.

section 2 review

Summary

Life Processes

- Organisms in the ocean obtain food to use for energy in several ways.
- Photosynthesis and chemosynthesis are processes used by producers to make food. Other organisms are consumers.
- Reproduction is also a vital life process.

Ocean Life

- Organisms in the ocean can be classified as plankton, nekton, or benthos depending on where they live.

Ocean Margin Habitats

- Ocean margin habitats such as beaches, rocky shore areas, estuaries, and coral reefs exist along the near-shore areas of the continental shelf.

Self Check

1. **Describe** the processes of photosynthesis and chemosynthesis.
2. **Identify** the key characteristics of plankton, nekton, and benthos.
3. **Compare and contrast** the characteristics of coral reef and estuary habitats.
4. **Think Critically** The amount of nutrients in the water decreases as the distance from the continental shelf increases. What effect does this have on open-ocean food chains?

Applying Skills

5. **Use Graphics Software** Design a creative poster that shows energy relationships in a food chain. Begin with photosynthesis. Use clip art, scanned photographs, or computer graphics.

section 3

Ocean Pollution

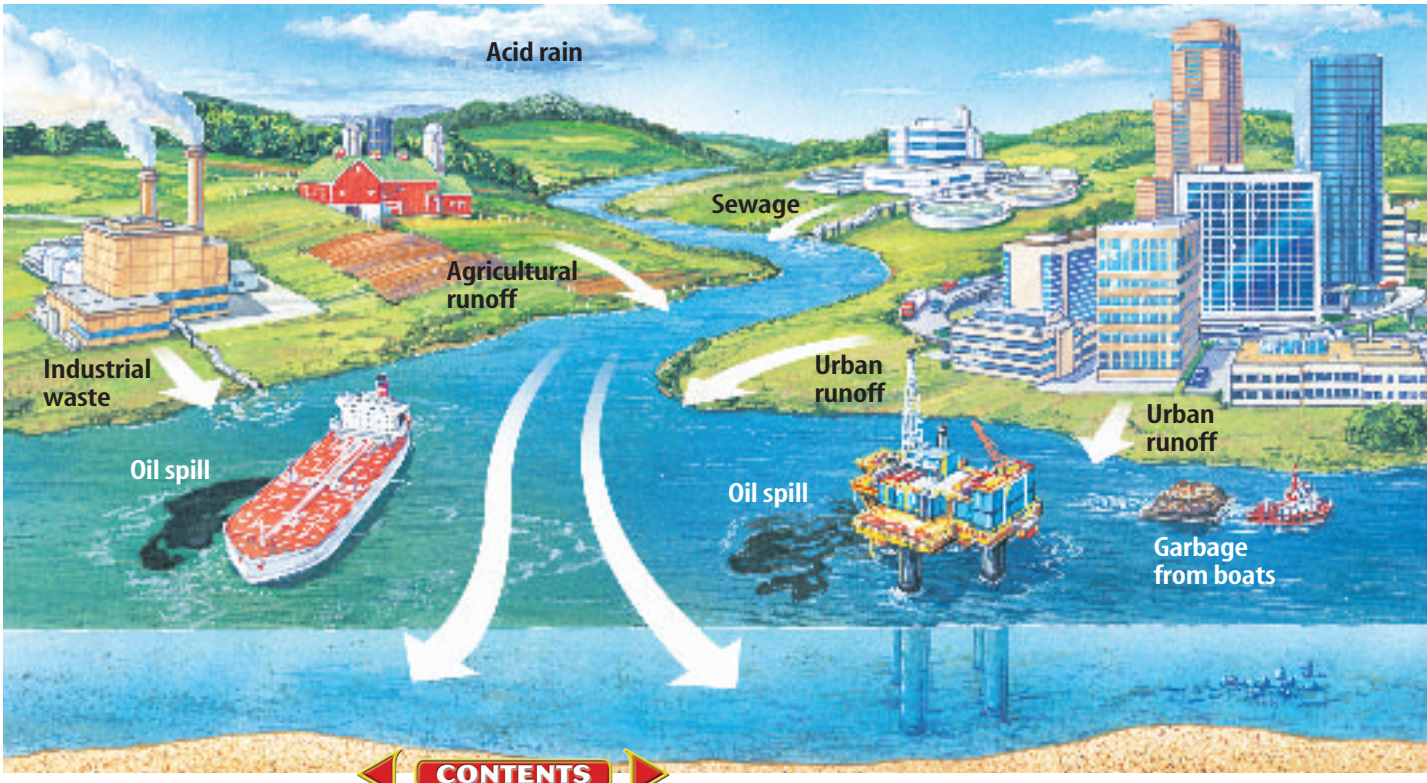
Sources of Pollution

How would you feel if someone came into your bedroom; spilled oil on your carpet; littered your room with plastic bags, cans, bottles, and newspapers; then sprayed insect killer and scattered sand all over? Organisms in the ocean experience these things when people pollute seawater.

Pollution is the introduction of harmful waste products, chemicals, and other substances not native to an environment. A pollutant is a substance that causes damage to organisms by interfering with life processes.

Pollutants from land eventually will reach the ocean in one of four main ways. They can be dumped deliberately and directly into the ocean. Material can be lost overboard accidentally during storms or shipwrecks. Some pollutants begin in the air and enter the ocean through rain. Other pollutants will reach the ocean by being carried in rivers that empty into the ocean. **Figure 15** illustrates how pollutants from land enter the oceans.

Figure 15 Ocean pollution comes from many sources.



as you read

What You'll Learn

- **List** five types of ocean pollution.
- **Explain** how ocean pollution affects the entire world.
- **Describe** how ocean pollution can be controlled.

Why It's Important

Earth's health depends on the oceans being unpolluted.

Review Vocabulary

runoff: water that does not soak into the ground or evaporate but instead flows over Earth's surface, eventually entering streams, lakes, or oceans

New Vocabulary

- pollution

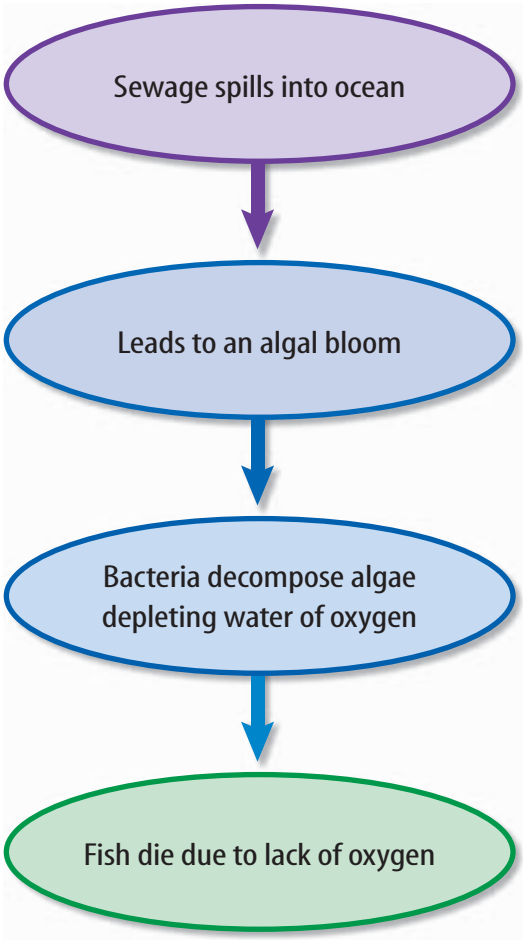


Figure 16 Fish kills occur when the oxygen supply is low. **Infer** *how fish kills affect the food web.*

Sewage In some regions, human sewage leaks from septic tanks or is pumped directly into oceans or into rivers leading to an ocean. The introduction of sewage to an area of the ocean can cause immediate changes in the ecosystem, as shown by the following example. Sewage is a pollutant that acts like fertilizer. It is rich in nutrients that cause some types of algae to reproduce rapidly, creating what is called a bloom. The problem occurs when the algae die. As huge numbers of bacteria reproduce and decompose the algae, much of the oxygen in the water is used up. Other organisms, such as fish, cannot get enough oxygen. As a result, fish die in a phenomenon called a fish kill, as illustrated in **Figure 16.**

Reading Check ***What is an algal bloom?***

When sewage is dumped routinely into the same area year after year, changes take place. Entire ecosystems have been altered drastically as a result of long-term, repeated exposure to sewage and fertilizer runoff. In some areas of the world, sewage is dumped directly onto coral reefs. When this happens algae can outgrow the coral because the sewage acts like a fertilizer. Eventually, the coral organisms die. If this occurs, other organisms that depend on the reef for food and shelter also can be affected.

Chemical Pollution Industrial wastes from land can harm marine organisms. When it rains, the herbicides (weed killers) and insecticides (insect killers) used in farming and on lawns are carried to streams. Eventually, they can reach the ocean and kill other organisms far from where they were applied originally. Sometimes industrial wastes are released directly into streams that eventually empty into oceans. Other chemicals are released into the air, where they later settle into the ocean. Industrial chemicals include metals like mercury and lead and chemicals like polychlorinated biphenyls (PCBs). In a process called biological amplification (am plah fah KAY shun), harmful chemicals can build up in the tissues of organisms that are at the top of the food chain. Higher consumers like dolphins and seabirds accumulate greater amounts of a toxin as they continue to feed on smaller organisms. At high concentrations, some chemicals can damage an organism's immune and reproductive systems. Explosives and nuclear wastes also have been dumped, by accident and on purpose, into some regions of the oceans.

Oil Pollution Although oil spills from tankers that have collided or are leaking are usually highly publicized, they are not the biggest source of oil pollution in the ocean. As much as 44 percent of oil that reaches the ocean comes from land. Oil that washes from cars and streets, or that is poured down drains or into soil, flows into streams. Eventually, this oil reaches the ocean. Other sources of oil pollution are leaks at offshore oil wells and oil mixed with wastewater that is pumped out of ships. **Figure 17** shows the percentage of different sources of oil entering the oceans each year.

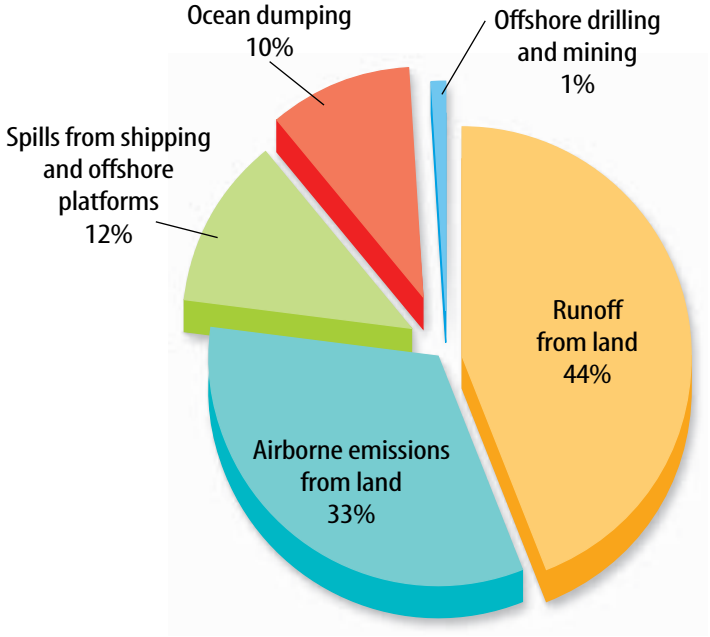


Figure 17 Although oil spills are highly publicized and tragic, the same harmful oil enters the ocean every day from many other sources.
Think Critically *What can be done to reduce the amount of oil entering the oceans?*

Solid-Waste Pollution Even in the most remote areas of the world, such as uninhabited islands that are thousands of miles from any major city, large amounts of trash wash up on the beach. **Figure 18** shows the amount of debris collected by a scientist on an island in the Pacific Ocean, 8,000 km east of Australia in just one day. The presence of trash ruins a beautiful beach, and solid wastes, such as plastic bags and fishing line, can entangle animals. Animals such as sea turtles mistakenly eat plastic bags, because they look so much like their normal prey, floating jellyfish. Illegally dumped medical waste such as needles, plastic tubing, and bags also are a threat to humans and other animals.


6 Lightbulbs


7 Aerosol cans


25 Shoes


71 Plastic bottles


171 Glass bottles


268 Plastic pieces

Figure 18 These items are like the ones found washed ashore on one of the Pitcairn Islands in the South Pacific. The number of each item found is shown below the figure. Also among the rubble were broken toys, two pairs of gloves, and an asthma inhaler.

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Figure 19 When large amounts of silt enter seawater, the filter-feeding systems of animals such as oysters and clams can be clogged.

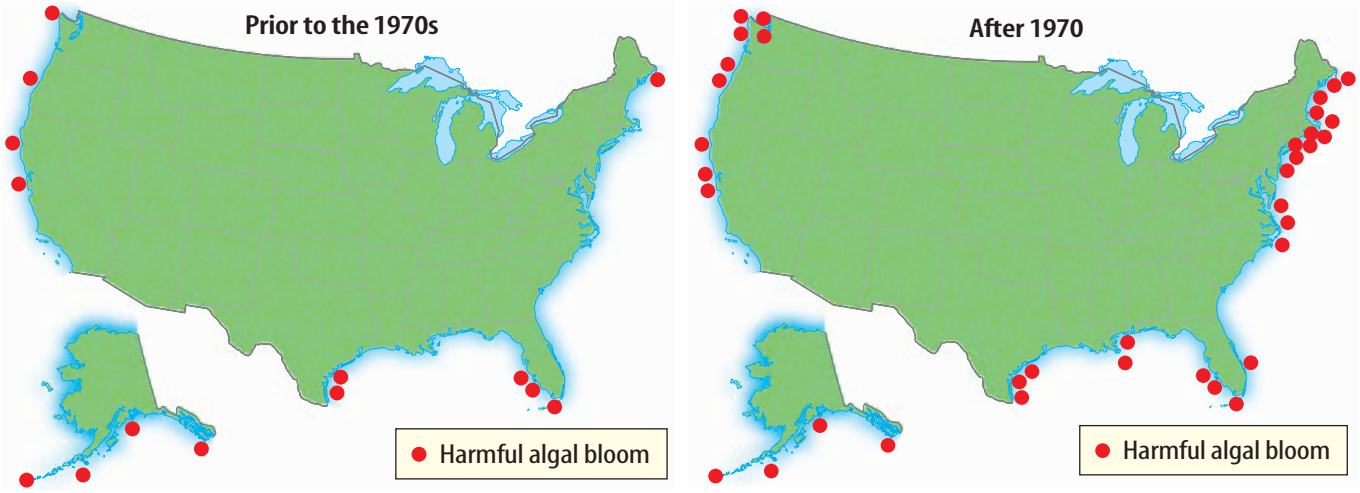
Sediment Silt also can pollute the ocean. Human activities such as agriculture, deforestation, and construction tear up the soil. Rain washes soil into streams and eventually into an ocean nearby, as shown in **Figure 19.** This causes huge amounts of silt to accumulate in many coastal areas. Coral reefs and saltwater marshes are safe, protected places where young marine organisms grow to adults. When large amounts of silt cover coral reefs and fill marshes, these habitats are destroyed. Without a safe place to grow larger, many organisms will not survive.

Effects of Pollution

You already have learned some examples of how pollution affects the ocean and the organisms that live there. Today, there is not a single area of the ocean that is not polluted in some way. As pollution from land continues to reach the ocean, scientists are recording dramatic changes in this environment.

Estuaries and the rivers that feed into them from Delaware to North Carolina have suffered from toxic blooms of *Pfiesteria* since the late 1980s. These blooms have killed billions of fish. *Pfiesteria,* a type of plankton, also has caused rashes, nausea, memory loss, and the weakening of the immune system in humans. The cause of these blooms is thought to be runoff contaminated by fertilizers and other waste materials. In Florida, toxic red tides kill fish and manatees. Some people also blame these red tides on sewage releases and fertilizer runoff. **Figure 20** shows an increase in the number of harmful algal blooms since the early 1970s.

Figure 20 Some scientists hypothesize that a relationship exists between increased pollution in the ocean and the number of harmful algal blooms in the last 30 years.



NASA
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Controlling Pollution

Some people believe that oceans take care of themselves because they are large. However, other people view ocean pollution as a serious problem. Many international organizations have met to develop ways of reducing ocean pollution. Treaties prohibit the dumping of some kinds of hazardous wastes from vessels, aircraft, and platforms. One treaty requires that some ships and operators of offshore platforms have oil pollution emergency plans. This includes having the proper equipment to combat oil spills and practicing what to do if a spill takes place. Recall that a large amount of pollution enters the ocean from land. Although the idea of reducing land pollution to better protect the ocean has been discussed, no international agreement exists to prevent and control land-based activities that affect the oceans.

Reading Check ***What has been done to help control ocean pollution?***

What You Can Do Current international and U.S. laws aren't effective enough. Further cooperation is needed to reduce ocean pollution. You can help by disposing of wastes properly and volunteering for beach or community cleanups, like the one shown in **Figure 21.** You can recycle materials such as newspapers, glass, and plastics and never dump chemicals like oil or paint onto soil or into water. One of the best things you can do is continue to learn about marine pollution and how people affect the oceans. What other things will help reduce ocean pollution?

Figure 21 Under careful supervision, picking up trash is an easy way to help reduce ocean pollution.

section 3 review

Summary

Sources of Pollution

- Sewage, industrial wastes, oil, solid waste, and sediment are the main types of pollution entering ocean water.

Effects of Pollution

- As pollution from land continues to reach the ocean, ecosystems and organisms are negatively affected.

Controlling Pollution

- International treaties and U.S. laws have been made to help reduce ocean pollution.
- Everyone can help reduce ocean pollution.

Self Check

1. **Identify** five human activities that pollute the oceans. Suggest a solution to each.
2. **Explain** how pollution of the oceans affects the world.
3. **Describe** the ways international treaties have helped reduce pollution.
4. **Think Critically** To widen beaches, some cities pump offshore sediment onto them. How might this affect organisms that live in coastal waters?

Applying Skills

5. **Concept Map** Make an events-chain concept map that describes how runoff can reach the ocean. Include examples of pollution that could be in the runoff.

LAB

Use the Internet

Resources from the Oceans

Goals

- **Research and identify** organisms that are used to make products.
- **Explain** why it is important to keep oceans clean.

Data Source

ScienceOnline

Visit earth.msscience.com/internet_lab for Web links to more information about resources from the oceans, hints on which products come from the oceans, and data from other students.

Real-World Question

Oceans cover most of Earth's surface. Humans get many things from oceans, such as seafood, medicines, oil, and diamonds. Humans also use oceans for recreation and to transport materials from place to place. What else comes from oceans? Scientists continue to discover and research new uses for ocean resources. You might not realize that you probably use many products every day that are made from organisms that live in oceans. Think about the plants and animals that live in the oceans. How could these organisms be used to make everyday products? Form a hypothesis about the types of products that could be manufactured from these organisms.

Make a Plan

1. **Identify** Web links shown in the Data Source section above and identify other resources that will help you complete the data table shown on the right.
2. **Observe** that to complete the table you must identify products made from marine organisms, where the organisms are collected or harvested, and alternative products.
3. **Plan** how and when you will locate the information.

(t)Jim Nilsen/Stone/Getty Images, (b)Fred Bavendam/Minden Pictures

Ocean Resources Data

Organism	Location Where Collected or Harvested	Product (name and use)	Alternatives
	Do not write in this book.		

Follow Your Plan

1. Make sure your teacher approves your plan and your resource list before you begin.
2. **Describe** at least three ocean organisms that are used to make products you use every day.
3. **Identify** the name and any uses of the product.
4. **Research** where each organism lives and the method by which it is collected or harvested.
5. **Identify** alternative products.

Analyze Your Data

1. **Describe** the different ways in which ocean organisms are useful to humans.
2. **Explain** Are there any substitutes or alternatives available for the ocean organisms in the products?

Conclude and Apply

1. **Infer** How might the activities of humans affect any of the ocean organisms you researched?
2. **Determine** Are the substitute or alternative products more or less expensive?
3. **Describe** Can you tell whether the ocean-made product is better than the substitute product?
4. **Explain** why it is important to conserve ocean resources and keep oceans clean.

Communicating Your Data

Find this lab using the link below. Post your data in the table provided. Compare your data to those of other students.

ScienceOnline

earth.msscience.com/internet_lab

Strange Creatures from the Ocean Floor

In 1977, the *Alvin*, a small submersible craft specially designed to explore the ocean depths, took three geologists down about 2,200 m below the sea surface. They wanted to be the first to observe and study the formations of the Galápagos Rift deep in the Pacific Ocean. What they saw was totally unexpected. Instead of barren rock, the geologists found life—a lot of life. And they had never even considered having a life scientist as part of the research team!

The crew of the *Alvin* discovered hydrothermal vents—underwater openings where hot water (400°C) spurts from cracks in the rocks on the ocean floor. Some organisms thrive there because of the hydrogen sulfide that exists at the vents. Many of these organisms are like nothing humans had ever seen before. They are organisms that live in extremely hot temperatures and use hydrogen sulfide as their food supply.

The discovery and study of hydrothermal vents almost has been overshadowed by the amazing variety of life that was found there. But scientists think these openings on the ocean floor (many located along the Mid-Atlantic Ridge) control the temperature and movement of nearby ocean waters, as well as have a significant effect on the ocean's chemical content. These vents also act as outlets for Earth's inner heat.

Scientists also have discovered that the vent communities are temporary. Each vent eventually shuts down and the organisms somehow disperse to other vents. Exactly how this happens is an area of ongoing research.

Blood-red tube worms live deep beneath the sea.

Creative Writing Imagine you were a passenger on the *Alvin*. Write about your adventure as you came upon the hydrothermal communities. Describe and draw in detail some of the unique creatures you saw.

ScienceOnline
For more information, visit earth.msscience.com/oops

Reviewing Main Ideas

Section 1 The Seafloor

1. The continental shelf is a gently sloping part of the continent that extends into the oceans. The continental slope extends from the continental shelf to the ocean floor. The abyssal plain is a flat area of the ocean floor.
2. Along mid-ocean ridges, new seafloor forms. Seafloor slips beneath another crustal plate at a trench.
3. Petroleum, natural gas, and placer deposits are mined from continental shelves. Manganese nodules and other mineral deposits can be found in deep water.

Section 2 Life in the Ocean

1. Marine organisms are specially adapted to live in salt water. They produce or consume food, and reproduce in the oceans.
2. Photosynthesis is the basis of most of the food chains in the ocean. Chemosynthesis is a process of making food using chemical energy. Energy is transferred through food webs.
3. Organisms that drift in ocean currents are called plankton. Nekton are marine organisms that swim. Benthos are plants and animals that live on or near the ocean floor.
4. Ocean margin habitats, found along the continental shelf, include sandy beaches, rocky shores, estuaries, and coral reefs.

Section 3 Ocean Pollution

1. Sources of pollution include sewage, chemical pollution, oil spills, solid waste pollution, and sediment.
2. Ocean pollution can disrupt food webs and threaten marine organisms.
3. International treaties and U.S. laws have been made to help reduce ocean pollution.

Visualizing Main Ideas

Copy and complete the following chart on ocean-margin organisms.

Ocean-Margin Organisms

Organism	Ocean-Margin Environments			
	Sandy Beach	Rocky Shore	Estuary	Coral Reef
Plankton	phytoplankton zooplankton		phytoplankton zooplankton	
Nekton		octopuses, fish		fish, turtles
Benthos			grasses, snails, clams	

Fred Bavendam/Minden Pictures

Using Vocabulary

abyssal plain p. 543
benthos p. 553
chemosynthesis p. 551
continental shelf p. 542
continental slope p. 543
estuary p. 556
mid-ocean ridge p. 544
nekton p. 552
photosynthesis p. 549
plankton p. 552
pollution p. 557
reef p. 556
trench p. 545

Fill in the blanks with the correct words.

1. Animals such as whales, sea turtles, and fish are examples of _____.

2. _____ occurs in areas where organisms use sulfur as energy to produce their own food.

3. The _____ drops from the edge of a continent out to the deep abyssal plains of the ocean floor.

4. New ocean floor is formed at _____.

5. An area where the mouth of a river opens into an ocean is a(n) _____.

Checking Concepts

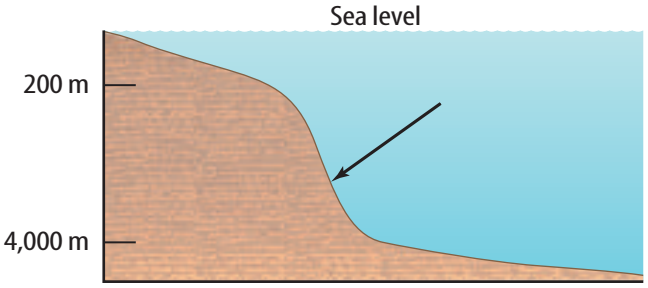
Choose the word or phrase that best answers the question.

6. What are formed along subduction zones?
A) mid-ocean ridges
B) continental shelves
C) trenches
D) density currents

7. What are ocean organisms that drift in ocean currents called?
A) nekton **C)** benthos
B) pollutants **D)** plankton

8. How do some deep-water bacteria in the ocean make food?
A) photosynthesis **C)** respiration
B) chemosynthesis **D)** rifting

Use the illustration below to answer question 9.



9. Which feature of the ocean floor is the arrow pointing to?
A) rift valley **C)** abyssal plain
B) seamount **D)** continental slope

10. What might be found in areas where rivers enter oceans?
A) rift valleys
B) manganese nodules
C) abyssal plains
D) placer deposits

11. Which organisms reproduce rapidly, resulting eventually in a lack of oxygen?
A) fish **C)** algae
B) corals **D)** animal plankton

12. In which area of the ocean is the greatest source of food found?
A) on abyssal plains
B) in trenches
C) along continental shelves
D) along the mid-ocean ridge

13. Where does most oil pollution originate?
A) tanker collisions
B) runoff from land
C) leaks at offshore wells
D) in wastewater pumped from ships

14. Where does new seafloor form?
A) trenches
B) mid-ocean ridges
C) abyssal plains
D) continental shelves

Thinking Critically

15. **Infer** why some industries might be interested in mining manganese nodules.

16. **Explain** why ocean pollution is considered to be a serious international problem.

17. **Summarize** How can agricultural chemicals kill marine organisms?

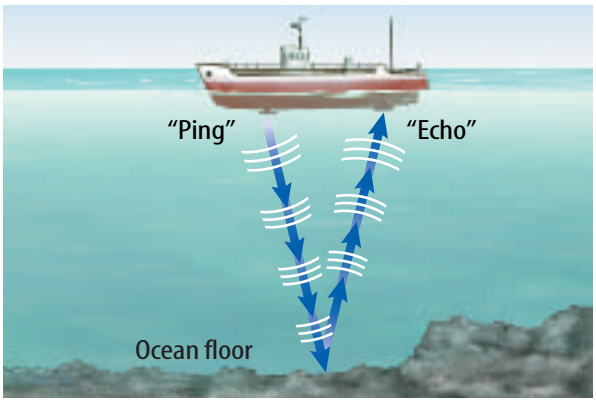
18. **Draw Conclusions** Would you expect coral reefs to grow around the bases of underwater volcanoes off the coast of Alaska?

19. **Think Critically** Scientists currently are researching the use of chemicals produced by marine organisms to help fight diseases including certain types of cancer. How would ocean pollution affect the ability to discover and research new drugs?

20. **Use Scientific Illustrations** Use **Figure 8** to determine which organisms would starve if phytoplankton became extinct.

21. **Classify** each of these sea creatures as plankton, nekton, or benthos: shrimps, dolphins, sea stars, krill, coral, manatees, and algae.

Use the illustration below to answer question 22.



22. **Draw Conclusions** At point A an echo, a sound wave bounced off the ocean floor, took 2 s to reach the ship. It took 2.4 s at point B. Which point is deeper?

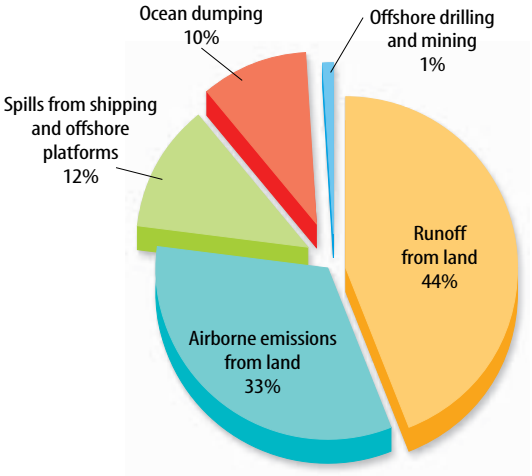
Performance Activities

23. **Graph a Profile** Previously, you made a profile of the ocean bottom along the 38° N latitude line, but it was not drawn to scale. Make a scale profile of the area between 3,600 km and 4,100 km from New Jersey. Use the scale 1 mm = 1,000 m.

24. **Poster** Choose a sea animal and research its life processes. Classify it as plankton, nekton, or benthos. Design a poster that includes all of this information.

Applying Math

Use the graph below to answer questions 25 and 26.



25. **Oil Production** If 6,600,000 tons of oil enter the world's oceans in one year, approximately what amount (in tons) is from runoff from land?

26. **Sources of Pollution** How many more times are airborne emissions from land a source of oil pollution than ocean dumping?

27. **Kelp Growth** If kelp grows at a steady rate of 30 cm per day, how long would it take to reach a length of 25 m?

28. **Seafloor Spreading** The distance between two locations across an ocean basin increases by 1.8 cm, 4.1 cm, and 3.2 cm, each year respectively. What is the average rate of separation of these locations during this time?

Part 1 Multiple Choice

Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

Use the table below to answer questions 1 and 2.

Oil Spills Around the World		
Year	Location	Spill Size (millions of liters)
1967	Land's End, England	144.7
1972	Gulf of Oman, Oman	143.5
1978	Brittany, France	260.2
1979	Bay of Campeche, Mexico	530.3
1983	South Africa	297.3
1988	Newfoundland, Canada	163.2
1991	Persian Gulf	909.0
2001	Galápagos Islands	0.6

1. At which location was the largest spill?
- **A.** Brittany, France
- **B.** South Africa
- **C.** Persian Gulf
- **D.** Land's End, England

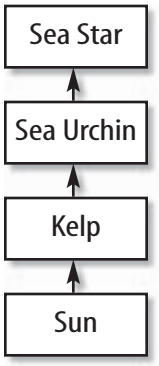
2. Approximately how many more liters were spilled in the Persian Gulf than in the Bay of Campeche, Mexico?
- **A.** 530 million liters
- **B.** 470 million liters
- **C.** 379 million liters
- **D.** 279 million liters

3. Why is oil entering the ocean a concern?
- **A.** The presence of oil can reduce water quality.
- **B.** The presence of oil in the water is not harmful to marine life.
- **C.** Large spills can be easy to clean up.
- **D.** The presence of oil can improve water quality.

4. A rigid, wave-resistant structure built by corals from skeletal materials is
- **A.** an estuary.
- **B.** a reef.
- **C.** a beach.
- **D.** a rocky shore.

5. Some bacteria undergo chemosynthesis. Chemosynthesis is
- **A.** a process that involves using sulfur or nitrogen compounds as an energy source to produce food.
- **B.** a process by which other organisms are consumed as a source of energy.
- **C.** a process by which reproductive cells are released into the water.
- **D.** a process that involves using light from the Sun as an energy source to produce food.

Use the illustration of a simple food chain below to answer questions 6 and 7.



6. Which is a producer?
- **A.** the Sun
- **B.** kelp
- **C.** sea urchin
- **D.** sea star

7. Producers undergo which process in order to make food?
- **A.** bioluminescence
- **B.** respiration
- **C.** reproduction
- **D.** photosynthesis

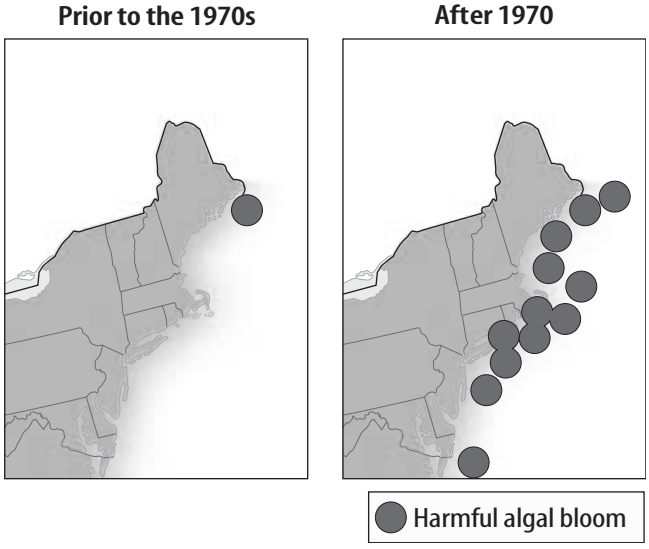
Part 2 Short Response/Grid In

Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

8. Define the words *producer* and *consumer*. Give two examples of each that can be found in the ocean.

9. Compare and contrast rocky shore and beach habitats.

Use the illustration below to answer question 10.



10. What changes have occurred in regard to harmful algal blooms since 1970? What do some scientists hypothesize is the cause of these changes?

11. Explain the process of seafloor spreading.

12. Ten percent of the total available energy is stored by a consumer at each level of the food chain. If 2,533 energy units are passed on to a salmon feeding on zooplankton, how many energy units will the salmon store?

13. Why are estuaries referred to as nurseries? What other marine habitat could also be referred to this way? Why?

Part 3 Open Ended

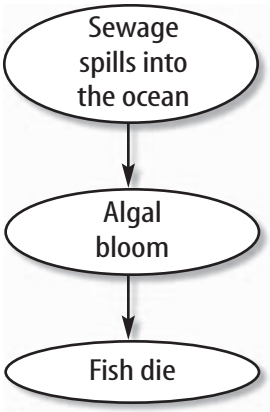
Record your answers on a sheet of paper.

14. Compare and contrast the Atlantic Ocean Basin with the Pacific Ocean Basin. Which basin contains many deep-sea trenches? Which basin is getting larger with time?

15. Describe how you could set up an experiment to test the effects of different amounts of light on marine producers.

16. Write a paragraph that explains why ocean pollution is a problem that people can help prevent. List examples of things people can do to help.

Use the illustration below to answer question 17.



17. Explain in detail how the events are related.

18. Explain the relationship between hydrothermal vents and minerals on the ocean floor. Why are these minerals not being mined?

Test-Taking Tip

Organize Main Ideas For essay questions, spend a few minutes listing and organizing the main ideas on your scratch paper.

Question 14 Make two columns, titled *Atlantic Ocean* and *Pacific Ocean,* on your scratch paper. Fill in information about each topic in the columns.