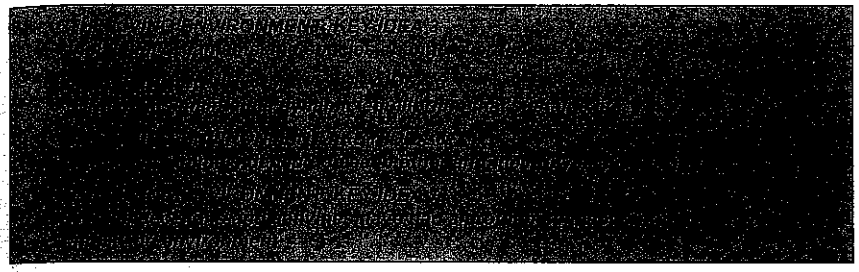
CHAPTER 4

6.L.2

ECOLOGY



Origin of the Living Environment

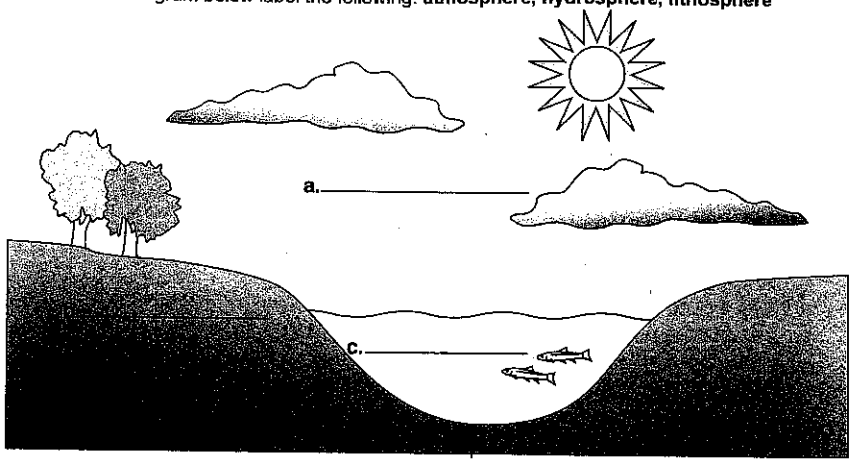
Living organisms depend on the **lithosphere** (rock and soil), the **hydrosphere** (water), and the **atmosphere** (air) of Earth. Throughout Earth's history these three areas have changed.

Earth's original atmosphere did not contain the gases, oxygen, and water vapor that life depends on. Volcanic eruptions released gases and water vapor from Earth's interior. As Earth cooled, water vapor condensed and precipitation filled the ocean and lake basins. This formed Earth's hydrosphere. Erosion of rock and soil added salts and minerals to the water. Photosynthesis by green plants, especially the algae in the oceans, removed the carbon dioxide from the atmosphere and released oxygen. The forces of weathering, erosion, volcanic activity, and crustal plate movement changed the shape of the land.

Review Questions

1. _____ eruptions released many gases into the atmosphere.
2. As Earth cooled, _____ condensed to water droplets.
3. The ocean basins were filled with water by the process of _____.
4. The oceans, lakes, and rivers of Earth make up the _____.
5. The solid outer layer of Earth is the _____.
6. Nitrogen and oxygen are the main gases in the _____.
7. Oxygen in the atmosphere is produced by _____ by green plants.

8. On the diagram below label the following: **atmosphere, hydrosphere, lithosphere**



Ecosystems

Ecology is the study of the interactions between organisms and the environment. Organisms depend on their physical environment. The survival of an organism is determined by its ability to sense and respond to the environment.

The number of organisms that an ecosystem can support depends on the resources that are available and the physical features of the area. There are two parts to an **ecosystem**: the living (biotic) factors and the non-living (abiotic) physical factors. Biotic factors are the living organisms. A **population** consists of the individuals of one species living in a location. For example, all the bullfrogs that live in a pond are a population. All the different populations in one location define a **community.** A pond community could include all the frogs, fish, and plants in the water.

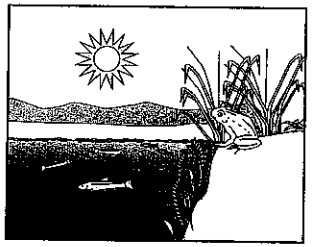


FIGURE 1. POND ECOSYSTEM

Some of the non-living factors in an ecosystem are temperature, light, soil, air, and water. Energy enters the ecosystem as sunlight. Energy and matter flow from one organism to another. Energy is eventually lost from the ecosystem to the environment mainly as heat.

Given enough resources and a lack of disease or predators, populations increase. Factors such as lack of resources, habitat destruction, predators, or a change in climate will limit the growth of some populations in an ecosystem. The environment may contain dangerous levels of substances called **pollutants**, which are harmful to organisms. For example, mercury in the water or carbon monoxide in the air can be harmful to organisms.

Review Questions

9. All the organisms in a forest will _____ with one another.
10. Classify the following parts of an ecosystem as (A) abiotic or (B) biotic:
    a. water _____ d. sunlight _____
    b. green plants _____ e. soil _____
    c. ants _____ f. bacteria _____
11. All the mountain gorillas in a rainforest are called a _____.
12. Communities are the different _____ of organisms in a location.
13. If there are adequate resources and no predators or disease, then populations will _____ in size.
14. The main source of energy for an ecosystem is _____.
15. Energy is lost from a system mainly in the form of _____.
16. Harmful substances in the environment are called _____.

Relationships Among Organisms

The organisms in an environment interact with one another. These interactions are classified as competitive, harmful, or beneficial.

INTERACTIONS BETWEEN ORGANISMS

TYPE OF INTERACTION	DESCRIPTION	EXAMPLE
Competitive	Organisms with the same needs compete for the same resources such as food and space	Foxes and hawks both eat rabbits
Harmful	One organism is harmed while the other benefits	Tapeworm in the human intestine
Beneficial	One or both organisms gain from the relationship while neither is harmed	Bacteria in the human intestine

Some species have adapted to be dependent upon each other with the result that neither could survive without the other. Some microorganisms are essential for the survival of living things. Humans could not survive if they did not have beneficial bacteria in their intestines. Bacteria live in the roots of pea plants where they convert nitrogen in the air to a useable form for the plant.

Review Questions

17. In an ecosystem, organisms will _____ with each other.
18. The interaction between a flea and a dog is classified as _____.
19. A snake and a hawk will _____ with each other for the same food.
20. Some species have adapted to be _____ upon each other for survival.
21. Some _____ are necessary for the survival of living organisms.

Feeding Relationships

In ecosystems two major types of nutrition occur: autotrophic and heterotrophic. Autotrophs or **producers** are organisms that make their own food. They convert light energy from the Sun into the chemical energy found in food. By the process of photosynthesis, autotrophic green plants produce sugar and oxygen from the water and carbon dioxide they absorb. They provide nutrients for all other organisms that cannot make their own food. All green plants are producers for ecosystems.

Heterotrophs or **consumers** cannot make their own food. They eat energy-rich food made by the producers. **Herbivores**, such as cows and rabbits, obtain energy by feeding on plants. **Carnivores**, such as lions and hawks, obtain energy by feeding on other animals. **Omnivores** are consumers that obtain energy by eating both plants and animals. Humans and bears are omnivores.

Decomposers obtain energy by consuming wastes and dead organisms. Bacteria and fungi are important decomposers in ecosystems. They break down the remains of dead organisms and return substances to the environment that can be reused by other organisms. This activity recycles substances for the ecosystem. For example, when leaves decay, the nutrients in the leaves are returned to the soil for plants to use for growth.

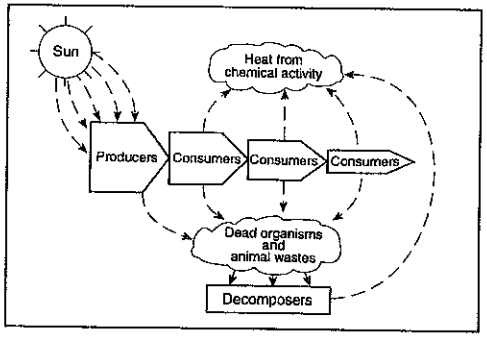


FIGURE 2. FEEDING RELATIONSHIPS

2

Review Questions

22. All organisms need _____ to survive.
23. Autotrophs _____ their own food.
24. _____ do not make their own food.
25. Substances in the ecosystem are recycled by the _____.
26. Complete the chart.

Nutrition Type	Producer or Consumer?	Description	Example
Autotroph	a.	b.	c.
Herbivore	d.	Feeds on plants	e.
Carnivore	Consumer	f.	g.
h.	i.	Feeds on plants and animals	j.
Decomposer	k.	l.	m.

Energy Flow in the Ecosystem

Matter is transferred from one organism to another and between organisms and the physical environment. Water, nitrogen, carbon dioxide, and oxygen are examples of substances cycled between the living and non-living environment. Green plants remove carbon dioxide from the air. The carbon is passed on to consumers in the form of sugar. The plants release oxygen and water vapor to the air.

Food chains illustrate the flow of energy and matter through an ecosystem. The energy flows in one direction and usually starts from the Sun. Food chains begin with producers. Energy passes from the producers to the consumers. Decomposers return the energy to the ecosystem. There are many types of organisms at each feeding level. There are many food chains in an ecosystem.

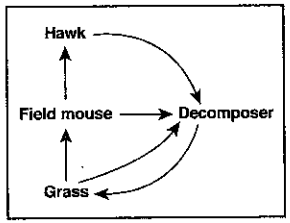


FIGURE 3. FOOD CHAIN

Food chains are interconnected at various points forming a **food web**. Food webs identify all of the feeding relationships among the producers, consumers, and decomposers in the ecosystem. The final organism in a food web is always a decomposer.

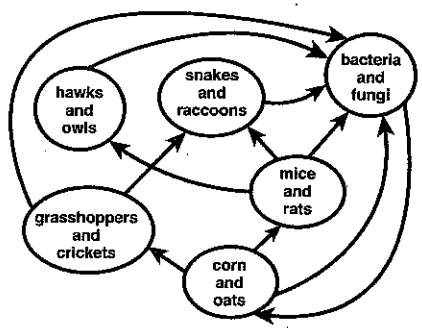


FIGURE 4. FOOD WEB

Energy pyramids show the amount of energy available in the ecosystem from one organism to the next. The greatest amount of energy is present in producers which are at the bottom of the pyramid. An ecosystem needs a large number of plants to support the other organisms. Producer plants are eaten by primary consumers known as herbivores. Herbivores are eaten by secondary consumers or carnivores.

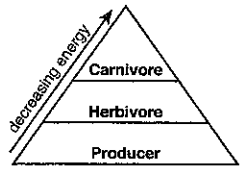


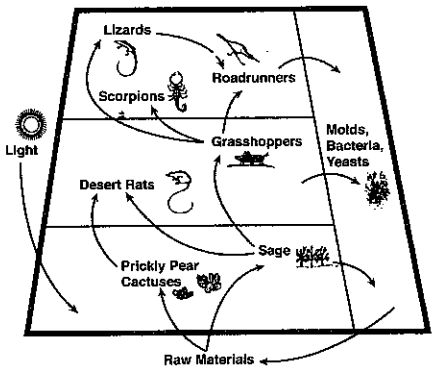
FIGURE 5. ENERGY PYRAMID

Energy is passed on and used in the food chain. Yet some energy is wasted and lost from one level to the next. The energy available decreases as one moves to the upper levels of the energy pyramid. Therefore the total mass of living organisms that can be supported at each level decreases.

Review Questions

27. Energy flows through the ecosystem in one _____.
28. The energy in the ecosystem begins with the _____.
29. The final organism in a food web or chain is always a _____.
30. Examples of substances cycled between living and non-living environment are water, _____, _____ and _____.
31. The greatest amount of energy in the pyramid is present at the _____ level.
32. Large numbers of _____ are consumed by smaller numbers of consumers.
33. The energy available in the pyramid _____ towards the top.
34. Refer to the diagram of a desert community.

DESERT COMMUNITY



a. This diagram represents a food _____.
b. Name one producer _____.
c. Name a carnivore _____.
d. Molds are classified as _____.
e. Name a "*raw material*" _____.
f. Complete this food chain:

_____ → _____ → scorpion

Changes in Ecosystems

For an ecosystem to remain unchanged, there must be a constant source of energy. There must be organisms which use this energy to produce food. These are producers such as green plants. There must also be a cycling of materials between the living organisms and the environment. This is done by decomposers.

Ecosystems change over time. The environment may be altered through the activities of organisms or by forces of nature. Natural events such as volcanoes, floods, and forest fires can change environments. As the environment changes some species may replace others. This results in a gradual change called **ecological succession.** The original organisms in an ecosystem are replaced with other types. A new community replaces the old community. For example, over time a pond of fish and snails may become a swamp of frogs and large plants.

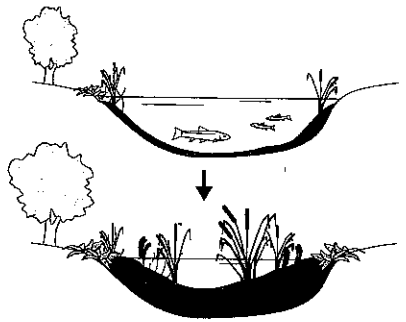


FIGURE 6. ECOLOGICAL SUCCESSION

An organism will survive only if it can adapt to its changing environment. Species that cannot adapt become **extinct**, or die out. This happens when something that is essential for the organism to survive is removed. Causes of extinction include changes in climate, natural disasters such as asteroid impacts, habitat invasion by predators, and hunting by humans. Pollution in the water can lead to a loss of habitat resulting in extinction of certain types of fish.

Evidence for extinction is found in fossils in sedimentary rock. Many organisms which lived in the past are no longer found on Earth. The dinosaur which was very abundant 70 million years ago, no longer exists.

Review Questions

35. Ecosystems will be unchanged if there is a constant source of _____.
36. Decomposers _____ material between living organisms and the environment.
37. A gradual change in the ecosystem of an area is called _____.
38. An organism will survive only if it can _____ to changes in its environment.
39. Evidence for extinction is found by studying _____ in sedimentary rock.

Human Effects on Ecosystems

The survival of living organisms on Earth depends on the conservation and protection of Earth's natural resources. **Non-renewable resources** are Earth materials which cannot be replaced by natural processes. For example, as we continue to remove and use copper ore from rocks, the amount of copper available to us becomes less. Recycling of metals can lessen this effect.

Renewable resources are replaced by natural processes within a period of time. Soil is replenished with nutrients by decomposition of plant and animal matter. Water is recycled by nature. Overuse and not allowing time for replenishment threatens renewable resources.

Overpopulation by any species affects the environment due to increased use of resources. Human activities have caused environmental degradation through resource acquisition and the use of non-renewable resources. **Urban** growth, that is the spreading of cities by humans, has caused habitat destruction as forests and wetlands have been destroyed. Land use decisions and waste disposal by humans have changed ecosystems.

Human activities have caused major pollution of the air, water, and soil. Since the start of the Industrial Revolution this impact has increased dramatically. The burning of fossil fuels for energy production and the use of Earth's natural resources in manufacturing have affected ecosystems. Pollution has had a cumulative and global impact. Acid rain, global warming, and ozone depletion impact many ecosystems worldwide.

Review Questions

40. The survival of organisms on Earth depends on the protection and _____ of natural resources.

41. _____ resources cannot be replaced in our lifetime.

42. Water is an example of a _____ resource.

43. Human activities have resulted in air, water, and soil _____.

44. The negative impact of human activities on ecosystems has increased since the _____ began.

1. An earthworm burrows in the soil. The earthworm is directly interacting with the

(1) atmosphere (2) hydrosphere (3) lithosphere (4) stratosphere

2. The oceans, lakes, and streams are part of the

(1) atmosphere (2) hydrosphere (3) lithosphere (4) stratosphere

3. Which process added oxygen to Earth's atmosphere?

(1) volcanic eruptions
(2) competition among species
(3) erosion of rock surfaces
(4) photosynthesis by green plants

4. The group of different organisms that live together in an area is the:

(1) community (2) niche (3) population (4) species

5. Pigeons of the same species living in a city park represent

(1) a population (2) a biome (3) a food chain (4) an ecosystem

6. Which term includes the other three?

(1) population (2) species (3) community (4) ecosystem

7. The study of the interactions between organisms and their interrelationships with the environment is

(1) ecology (2) zoology (3) physiology (4) cytology

8. A non-living (abiotic) factor that might affect the types of organisms in a pond is

(1) production of food by green algae
(2) number of offspring produced by the fish
(3) addition of goldfish to the pond
(4) amount of oxygen in the pond

9. The relationship between fleas and a dog is most similar to the relationship between

(1) bees and flowers
(2) fish and algae
(3) foot fungus and human
(4) hawk and mice

10. In a natural community in New York State, the producer organisms may include

(1) bacteria, fungi, protists
(2) deer, rabbits, squirrels
(3) fish, algae, frogs
(4) grasses, trees, weeds

5

11. Bacteria of decay (decomposers) are important components of an ecosystem because they

(1) recycle organic matter
(2) carry on photosynthesis
(3) absorb sunlight
(4) produce oxygen

12. As a member of the ecological community, humans are classified as

(1) producers (2) decomposers (3) consumers (4) autotrophs

13. Solar energy enters food chains through the life processes of

(1) omnivores (2) decomposers (3) carnivores (4) producers

14. The decomposers that decay plant and animal matter in an ecosystem include

(1) grasses and bacteria
(2) bacteria and mushrooms
(3) grasses and insects
(4) grasses and mushrooms

15. The typical sequence for a food chain is

(1) green plants ⟶ carnivores ⟶ herbivores
(2) green plants ⟶ herbivores ⟶ carnivores
(3) herbivores ⟶ green plants ⟶ carnivores
(4) herbivores ⟶ carnivores ⟶ green plants

16. An incomplete food chain is shown below

algae ⟶ minnow ⟶ trout ⟶ X

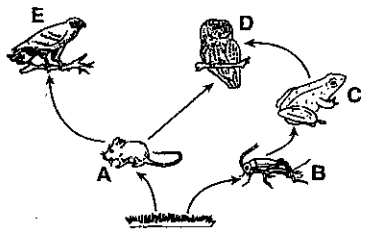
What organism could be represented by the **X**?

(1) human (2) jellyfish (3) pine tree (4) cow

17. In a food web, the greatest amount of chemical energy is provided by

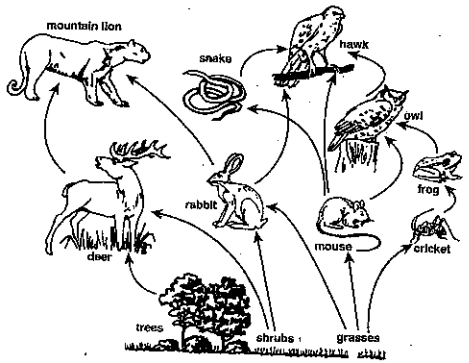
(1) producers
(2) decomposers
(3) primary consumers
(4) secondary consumers

18. The diagram shows a food web. Which organisms are most likely competitors?



(1) A and C
(2) B and C
(3) B and D
(4) D and E

Base your answers to **questions 19-24** on the food web diagram below.



19. Which is a food chain in this web?

(1) trees, mountain lion, snake, and hawk
(2) trees, rabbit, deer, and shrubs
(3) grasses, cricket, frog, and mouse
(4) grasses, mouse, snake, and hawk

20. What is the primary source of energy for this food web?

(1) Sun (2) grasses (3) snake (4) wind

21. Two herbivores (primary consumers) are the

(1) deer and mountain lion
(2) owl and snake
(3) rabbit and mouse
(4) cricket and frog

22. Which organisms not shown in this food web are important in all ecosystems?

(1) decomposers (2) consumers (3) producers (4) predators

23. The snake is classified as a(n)

(1) herbivore (2) carnivore (3) decomposer (4) omnivore

24. If a pesticide was sprayed that killed all the crickets, how would the food web be affected?

(1) the grasses would die
(2) the frog population would decrease
(3) the mountain lion would migrate
(4) the deer population would increase

6

25. Overpopulation of deer in an area will most likely cause

(1) a decrease in the number of predators of the deer
(2) a decrease in disease among the deer
(3) an increase in the amount of plants available for food
(4) an increase in competition among the deer

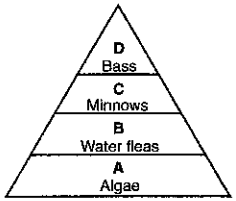
26. In an abandoned field, the grasses were slowly replaced by small bushes and then years later by a forest of trees. This is known as

(1) conservation of energy (3) competition
(2) ecological succession (4) predation

27. Which activity has a *negative* effect on the environment?

(1) recycling aluminum cans (3) establishing a wildlife preserve
(2) controlling air pollution (4) use of chemical pesticides

Base your answers to **questions 28-31** on the following statement:
The food pyramid below represents a pond community.



28. Which level contains the greatest amount of energy and biomass?

(1) A (2) B (3) C (4) D

29. A carnivore is found at level(s)?

(1) C only (2) D only (3) B and C (4) C and D

30. From level **A** to **D**, the amount of energy will

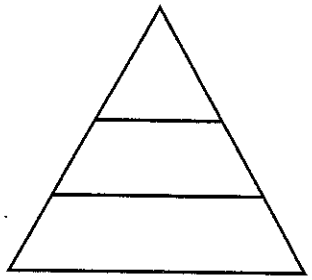
(1) decrease (2) increase (3) remain the same

31. Acid rain causes the algae to die in the pond. As a result the water flea population

(1) decreases (2) increases (3) remains the same

32. Place these organisms in the correct sequence in the energy pyramid.

Hawk ***Seeds*** ***Sparrow***



33. The characteristics of some organisms are listed below.

Trout	carnivorous fish
Minnow	herbivorous fish
Algae	green plant
Osprey	large carnivorous bird
Bacteria	decomposer

Arrange these organisms in a food chain.

_____ → _____ → _____ → _____ → _____

34. Aphids are insects that feed on and destroy crops. To control these pests, farmers place ladybugs in the farm fields. Ladybugs are natural predators of aphids.

a. The aphid is a (carnivore) (herbivore) (producer)

b. The ladybug is a (carnivore) (herbivore) (producer)

c. State one advantage of using this method of pest control. _____

_____

35. The diagram below shows a food web in a lake.

Algae → *Zooplankton* → *Perch fish* → *Pike fish*
Algae → *Zebra Mussels*

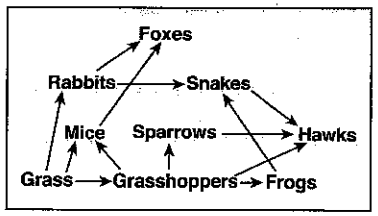
a. State the organism that is most affected by changes in sunlight. _____

b. Name the TWO organisms that are in competition for the same food.

(1) _____ (2) _____

7

37. Refer to the diagram below of a food web.



a. Select one organism and explain how its removal could affect the other species. (be brief)

_____

_____

b. Name a herbivore. _____

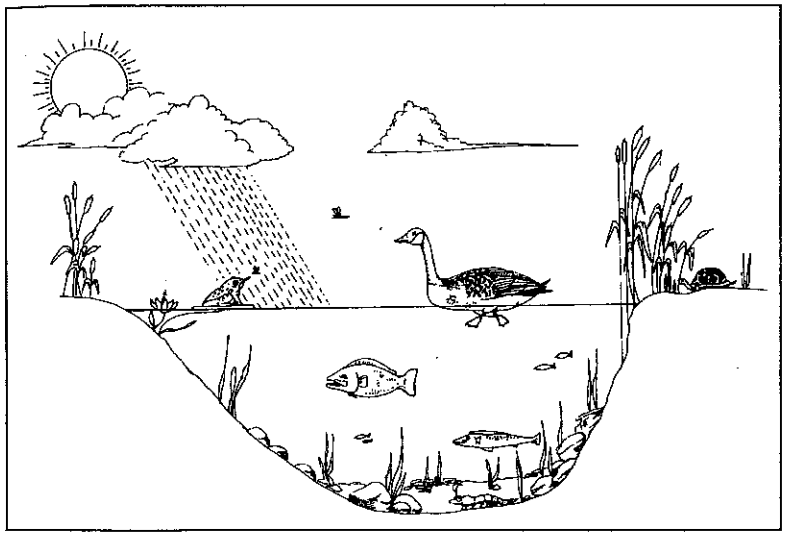
c. Name a producer. _____

d. Name an omnivore. _____

e. Name one organism that converts light energy to chemical energy. _____

f. Name the important organism missing from the food web. _____

38. The diagram illustrates a pond ecosystem.



a. Name TWO biotic (living) factors. (1) _____ (2) _____

cont. of #38

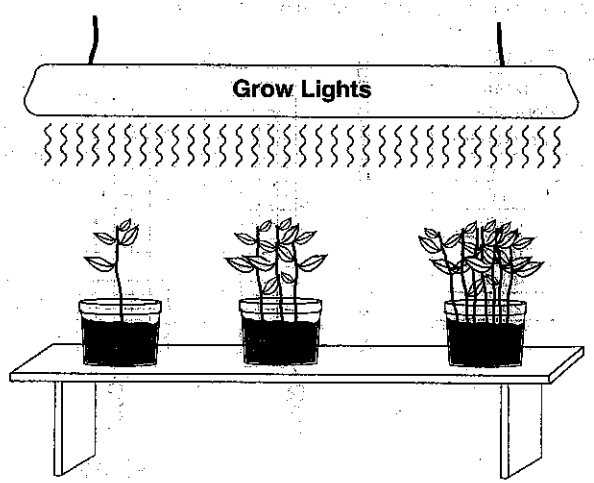
b. Name TWO abiotic (non-living) factors. (1) _____ (2) _____

c. Energy for this ecosystem is from the _____

d. Carbon dioxide is removed from the water by _____

e. The oxygen content of the water is provided by _____

41. A student sets up the following experiment using tomato plants in potting soil.



a. State the manipulated variable. (independent) _____

b. What would be a dependent variable?

c. Name THREE factors that should be kept the same during this experiment.

(1)_____ (2)_____ (3)_____

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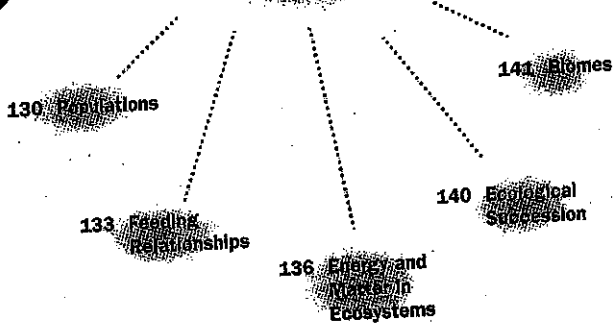
Ecosystems



An **ecosystem** is all the organisms that live in an area together with the nonliving factors of the environment. The study of how organisms interact with each other and with their physical environment is the focus of **ecology.**

Populations

When you talk about a certain *kind* of organism, you're really talking about a certain *species* of organism. A **species** is a group of organisms that can mate and produce offspring that in turn can produce more offspring.

The brown pelican is one kind of species. Humans are another.

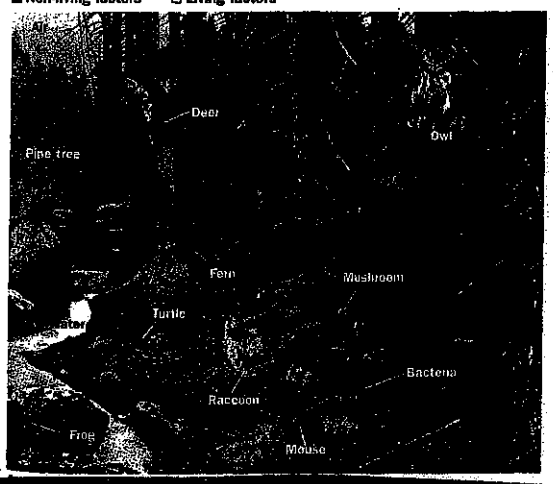
All the organisms of the same species that live in the same place at the same time make up a **population.** The mice living in a small meadow are an example of a population. All the pine trees in a forest are a different population.

Populations do not live alone. They share the environment with other populations to form a **community.** The pine trees in a forest, for example, may form a community with populations of deer, mice, raccoons, bacteria, mushrooms, and ferns.

Ecosystems can be named for a dominant physical feature, such as a pond ecosystem, or a dominant plant population, such as a pine forest ecosystem.

Populations do not interact only with each other. They also interact with the nonliving factors of the environment. Pine trees, for example, need soil to grow. They also need air and water. Together, these living and nonliving factors form an ecosystem. An **ecosystem** includes all the populations that live in an area along with physical factors in the environment.

■ Non-living factors ☐ Living factors



Factors That Affect Populations

For any population to thrive, there must be enough food, water, and living space. Such factors are called **limiting factors** because they limit how many organisms can live in an environment.

SEE ALSO
156 Protist Kingdom
157 Kingdom Monera
077 Animal Cell
078 Plant Cell
082 Tissues, Organs, and Systems
079 Cell Processes
107 Plant Physiology
113 Reproduction

Listed below are some of the different kinds of limiting factors.

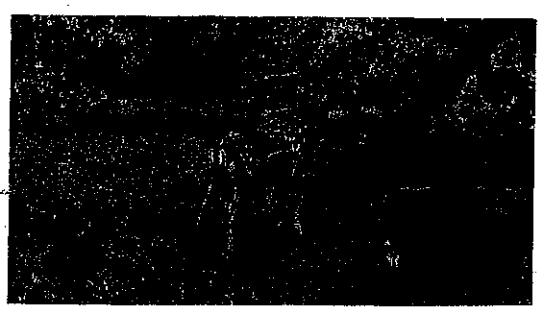
Food Plants (and a few other organisms) make their own food. All other organisms obtain food by eating plants or other organisms. Only so much food is available in an ecosystem.

Water The cells and tissues of animals and plants are made up mostly of water. All living things need water to move materials around in the cells and tissues of their bodies.

Light Plants and other organisms that make their own food need light to carry out photosynthesis. If light is limited, the growth of these organisms will also be limited.

Living space Organisms need enough room to live, obtain resources, and reproduce. The place where an organism lives is called its **habitat.**

One way organisms reduce competition for food and other resources is to occupy a specific niche within a habitat. A **niche** is the special role an organism plays within its habitat. Different species may share the same habitat, but no two can have exactly the same niche. For example, deer, rabbits, and squirrels may live in the same leafy forest, but because deer browse higher up on trees, rabbits graze on grasses, and squirrels eat acorns, each animal occupies a different niche.



Relationships Between Populations

Different species, or kinds, of organisms living together interact with one another. The relationships they form can be divided into three main categories:

SEE ALSO
130 Populations
127 Natural Selection

Competition occurs whenever more than one individual or population tries to make use of the same limited resource. Because resources such as food, water, and space are limited, there is not enough for every organism. Only those organisms able to get the resources they need will survive.

SEE ALSO
133 Feeding Relationships
134 Food Chains
135 Food Webs
129 Ecosystems

Predation is a type of feeding relationship in which one animal captures and eats another animal for food. The animal that is eaten is the **prey.** The animal eating the prey is the **predator.** Predator-prey relationships help keep an ecosystem in balance by preventing any one population from getting too large.

Symbiosis is a close relationship between two species. There are several types of symbiosis. **Mutualism** is a relationship in which both species benefit. **Commensalism** is a type of symbiosis in which one species benefits while the other seems to be unaffected. **Parasitism** occurs when an organism called a parasite feeds on the cells, tissues, or fluids of another organism called the **host.** In this relationship, the parasite benefits by getting food; the host is usually weakened, but not killed.

SEE ALSO
076 Cells
082 Tissues, Organs, and Systems

Mistletoe is a parasite that gets its nutrients from

Word Roots

Symbiosis comes from the Greek *symbiosis*, meaning "to live together."

Feeding Relationships

SEE ALSO
159 Heterotrophs and Autotrophs
107 Plant Physiology

All organisms need energy to live. Organisms can be divided into three main groups—producers, consumers, and decomposers—based on how they get the energy they need to live.

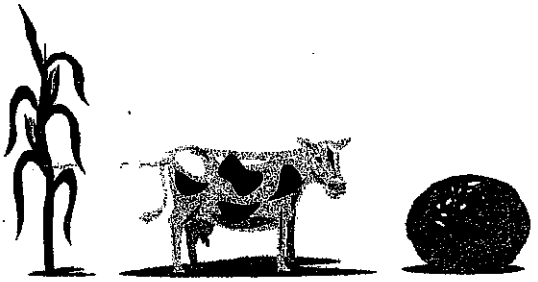
Plants, algae, and bacteria that make their own food are **producers.** Most producers make their food using the energy of the sun and raw materials from the environment.

Any organism that gets its food by eating other organisms is a **consumer.** Consumers are classified into groups based on what they eat.

SEE ALSO
153 Plant Kingdom
154 Animal Kingdom
155 Fungi Kingdom
156 Protist Kingdom
157 Kingdom Monera
139 Nitrogen Cycle

- **Herbivores** are plant-eaters. They feed directly on producers. Animals that eat plants (such as rabbits) or those that eat plant products (such as squirrels eating acorns) are herbivores.
- **Carnivores** are meat-eaters. They get food by eating herbivores or other carnivores. Examples of carnivores include sharks, wolves, and eagles. **Scavengers,** on the other hand, eat the remains of organisms left behind by other animals. Examples of scavengers include hyenas and crabs.
- **Omnivores** are organisms that feed on both producers and other consumers. Raccoons, bears, people (except strict vegetarians), and skunks are omnivores.

Organisms that feed on the remains or wastes of other organisms are known as **decomposers.** Many bacteria and fungi are decomposers.

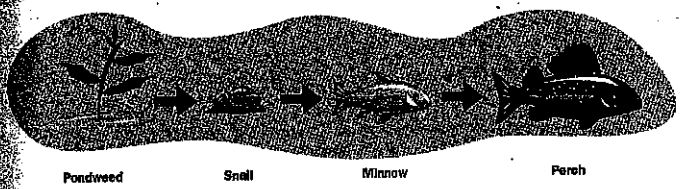


Producer Consumer Decomposer

Food Chains

Organisms get the energy they need from food. A **food chain** traces the path of energy as it moves from one organism to the next in an ecosystem. In most ecosystems, energy begins with the sun, so producers (organisms that use the sun's energy to make food) always form the base, or starting point, of a food chain. Arrows show the direction of energy movement in a food chain.

SEE ALSO
300 Forms of Energy
137 Energy

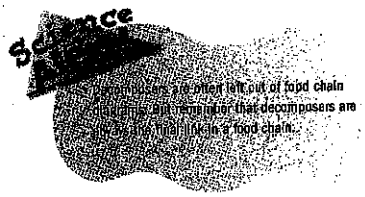


Pondweed Snail Minnow Perch

A food chain

In the food chain above, the pondweed is the producer. As shown by the arrow, energy moves from the pondweed to the snail that eats it. The snail is the **primary consumer** in this food chain because it is the first to feed. Energy next moves from the snail to the minnow. As the second consumer in the food chain, the minnow is a **secondary consumer.** When the perch eats the minnow, it takes in energy. The perch is the **tertiary consumer** in this food chain—the third feeder. The final link in a food chain is filled by the bacteria and fungi that act as decomposers. These organisms feed on and break down the remains of the perch when it dies.

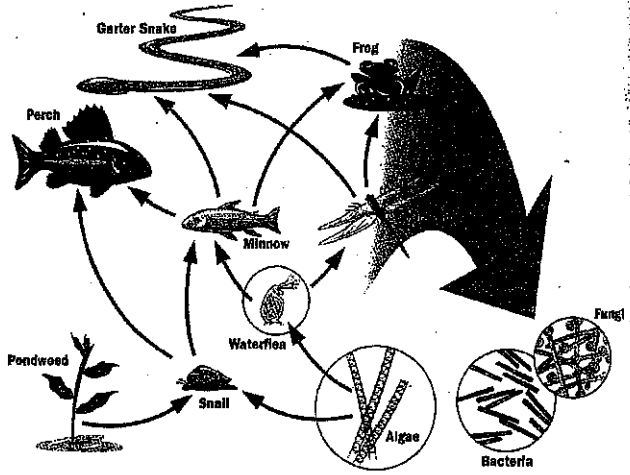
SEE ALSO
133 Feeding Relationships
139 Nitrogen Cycle



Food Webs

SEE ALSO
134 Food Chains
129 Ecosystems

A food chain shows only one energy path in an ecosystem. But most organisms are part of more than one food chain. Scientists often use a food web to show a more complete picture of the flow of energy in an ecosystem. A **food web** is a system of several overlapping food chains.



A food web

SEE ALSO
300 Forms of Energy
137 Energy
133 Feeding Relationships
139 Nitrogen Cycle

As with most ecosystems, the energy in a pond ecosystem starts with the sun. This energy is taken in by producers and converted to food energy. The energy in food then moves through different levels of consumers. The movement of energy ends with the many bacteria and fungi that live in the mud at the bottom of the pond. These decomposers feed on the wastes and remains of pond organisms. As they feed, they break down the organisms' tissues into valuable materials that are then returned to the ecosystem.

Energy and Matter in Ecosystems

Energy and matter are two factors present in every ecosystem. Most of the energy that enters an ecosystem comes from the sun. Some of this energy is converted into chemical energy that moves through the ecosystem by way of food chains. The matter in an ecosystem includes food, water, and air. This matter is constantly being changed in form and recycled through the environment.

SEE ALSO
250 Matter
300 Forms of Energy
134 Food Chains

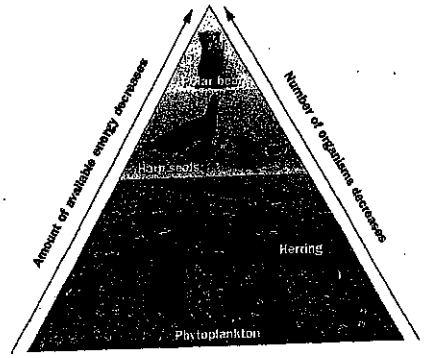
Energy

The energy in most ecosystems begins with the sun. Plants and other organisms with chlorophyll in their cells can capture this energy and use it to make food through photosynthesis. In this process, light energy is used to make sugar from carbon dioxide and water. Energy from food may be used by an organism for its life activities, or stored in its cells and tissues.

SEE ALSO
107 Plant Physiology
076 Cells
082 Tissues, Organs, and Systems

Energy stored in the cells and tissues of organisms is passed through the ecosystem by way of the food chain. Organisms at each level use the energy to carry out their life processes. As these processes are carried out, some energy is lost to the environment as heat. For this reason, only about 10 percent of the energy present at one feeding level is passed to the next feeding level. The decrease in available energy at each level of a food chain is shown in an **energy pyramid.**

SEE ALSO
134 Food Chains



Energy pyramid

Ecological Succession

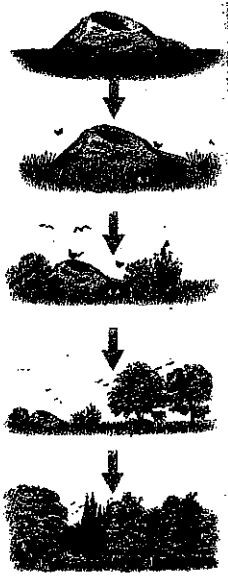
The set of organisms that occupy an area is constantly changing. The natural process by which one community of organisms slowly replaces another in a certain area is called **ecological succession.**

SEE ALSO
144 Deciduous Forests

Let's look at the development of one kind of ecological community, a deciduous forest.

SEE ALSO
079 Cell Processes
107 Plant Physiology

The first organisms to live in an area are called **pioneer species.** Mosses and **lichens,** organisms made up of a photosynthetic alga (or a cyanobacterium) and a fungus that live in close association with each other, are common pioneer species. They are both able to grow on bare rock. As they grow, they release acids that break down the rock to form soil. In time, enough soil is formed to support the growth of larger plants such as ferns or grasses.



An example of ecological succession

SEE ALSO
153 Plant Kingdom
154 Animal Kingdom

As a plant colony is established, small animals that feed on the plants will move into the area. Larger animals that feed on the small animals can also move in. Wastes and remains from these organisms decay, helping the soil to become richer and deeper. This deeper, richer soil can support the growth of larger plants, such as shrubs. As the shrubs replace the grasses, some populations of grass-eating animals leave the area in search of another food source. New animals that use the shrubs as food move in to take their place.

SEE ALSO
191 Soil

Soil continues becoming richer and deeper as new wastes and remains break down. In time, trees such as oaks and hickories take root and replace the shrubs. Still later, maples and beeches grow and mature. Eventually, the community reaches a stable point where very few new plants can **colonize,** or move into, the area. This type of community is known as a **climax community.**

Biomes

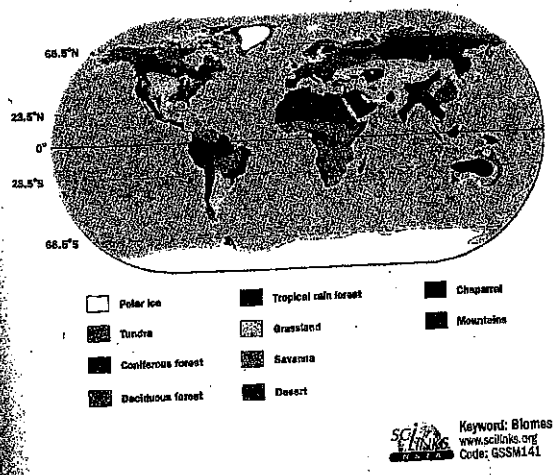
Organisms live almost everywhere on Earth. The part of Earth that supports life is called the **biosphere.** The biosphere extends several kilometers up into the atmosphere (where microscopic organisms float on air currents) and deep down to the ocean floor (where unusual tubeworms live near hot water vents).

SEE ALSO
215 Earth's Atmosphere
207 Ocean Floor

Physical factors such as climate determine what ecosystems exist in different parts of the biosphere. **Climate** is the general weather of an area over a long period of time, including its seasonal changes. The climate of an area is largely determined by its location on Earth. Areas close to the equator receive more direct sunlight than areas near the poles, and so are warmer year-round. Areas nearer the poles experience warm summers but cold winters.

SEE ALSO
227 Climate
230 Pattern of World Climates

The climate of an area determines what plants can grow in that area. The plants, in turn, determine what animals and other organisms the area can support. A **biome** is a large region characterized as having a distinct climate and specific types of plant and animal life. Biomes exist both in the ocean and on land.



SCI LINKS Keyword: Biomes www.scilinks.org Code: GSSM141

Tundra

The **tundra** is a cold, dry, mostly treeless land biome that encircles the Arctic Ocean. Temperatures in the tundra are well below freezing for much of the year. For this reason, most of the ground is covered by **permafrost,** soil that remains frozen to a depth of about 1 meter (about 3 ft). Only 20 to 50 cm (8 to 20 in.) of precipitation fall in the tundra each year. Most of this precipitation falls as snow or ice because of the cold temperatures.

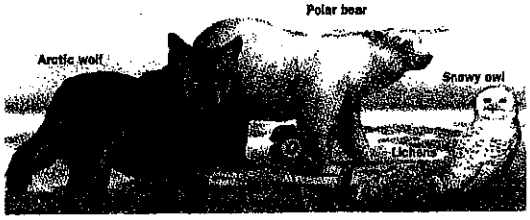
Did You Know?

There is almost no tundra in the southern hemisphere because there is very little land at that latitude.

The average winter temperature in the tundra is about −26°C (about −15°F), although temperatures often drop much lower. In the summer, the area receives continuous daylight that allows temperatures to rise to an average of 12°C (about 54°F). The warming temperatures of summer melt surface ice, creating many small ponds and streams.

SEE ALSO
133 Feeding Relationships

The growing season in the tundra is very short, lasting for only about 60 days. During this time, a limited number of flowering plants come to life to join the mosses and lichens that are the main producers of the tundra. These plants provide food to the arctic hares, caribou, and musk oxen that make their home in the tundra. Mosquitoes breed in large numbers and provide food to small animals like mice and birds. The most common land predator is the wolf. Along the coasts, seals and walruses eat plentiful fish, but may themselves be preyed upon by polar bears.



Tundra organisms

Coniferous Forests

Trees that remain green throughout the year, have needle-like leaves, and produce seeds in cones, are called **coniferous trees.** Many coniferous forests are found just south of the tundra in an area called the **taiga.** Much of Canada, Alaska, and the northern Rocky Mountains of the United States are taiga.

Science Article

Most coniferous forests are in the taiga. Forests of white pine, red pine, spruce, and hemlock exist in the mountains of the northern United States.

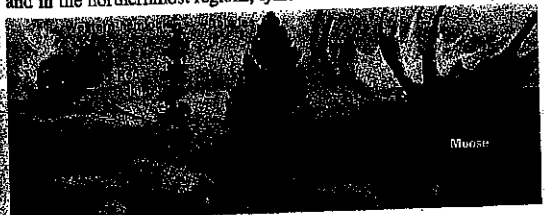
Winter temperatures in coniferous forests average about −10°C (about 14°F), while in summer they average about 14°C (about 57°F). The forests get about 50 cm (about 20 in.) of precipitation each year. This precipitation falls as snow during the winter and as rain during warmer seasons.

Warmer temperatures and regular precipitation make coniferous forests very suitable for tree growth. These forests are made up of firs, hemlocks, pines, and spruces. Coniferous trees have many adaptations to help them survive cold winters. These include needle-shaped leaves with a waxy covering that helps the tree retain water and withstand the cold. Many conifers also have flexible branches and a shape that helps keep snow from building up on and breaking their branches.

SEE ALSO
127 Natural Selection

In the coniferous forest, herbivores like moose, elk, porcupines, red squirrels, chipmunks, rabbits, mice, beavers, and geese are common. Wasps, beetles, and other insects are abundant. Many kinds of birds seek shelter in the trees. Carnivores include bobcats, foxes, wolves, and in the northernmost regions, lynxes.

SEE ALSO
133 Feeding Relationships



Coniferous forest organisms

Deciduous Forests

SEE ALSO
127 Natural Selection
227 Climate

Many broadleaf trees, such as oaks, maples, and birches, drop their leaves in autumn. This adaptation helps the trees conserve water and energy during winter months. Trees that drop all their leaves each year are called **deciduous trees** and are the main plants of the deciduous forest biome. Deciduous forests are located in temperate climates. Such areas are found in the eastern United States, parts of central Europe, and parts of Asia.

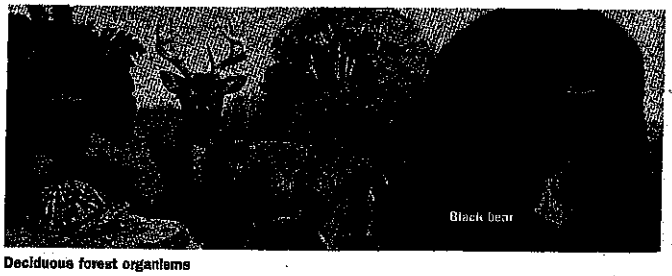
Word Origin
Deciduous comes from the Latin deciduus, meaning "to fall off."

With a lot of rain, moderate temperatures, and a long growing season, deciduous forests are home to a wide variety of trees and other plants. Rainfall averages between 75 and 125 cm (about 30 to 49 in.) per year. Temperatures range from 6°C to 28°C (about 43°F to 82°F). Soil and climate determine which deciduous trees will form the climax community. In the eastern and southern United States, hickory trees are common. Beech and maple form the climax community in many northern forests. Other trees of the forest include oak, elm, and poplar. Smaller plants, such as mosses, ferns, and grasses, grow nearer the ground.

SEE ALSO
140 Ecological Succession

Deer are the most common browsing herbivore in many deciduous forests. Other plant-eaters include squirrels, chipmunks, mice, rabbits, turtles, and many birds. Raccoons, opossums, and black bears are omnivores found in many deciduous forests. Carnivores include foxes, coyotes, snakes, insect-eating birds such as woodpeckers, and birds of prey such as hawks, owls, and falcons.

SEE ALSO
133 Feeding Relationships



Deciduous forest organisms

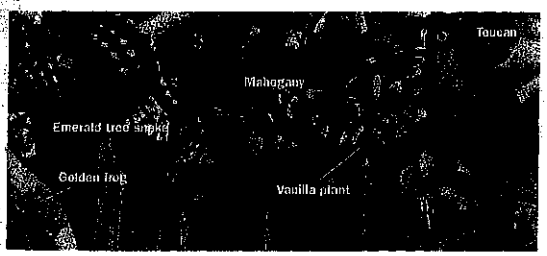
Tropical Rain Forests

Near the equator, warm temperatures (around 25°C, or 77°F) and abundant rainfall (more than 150 cm, or 60 in., each year) allow tropical rainforests to flourish. These ecosystems are home to more species than any other ecosystem on Earth.

The rainforest is divided into many vertical layers. Organisms live on the ground, in the trees, or in the **canopy**, the uppermost layer of the forest. Because of the thick vegetation, little light is able to reach the forest floor, and relatively few small plants grow there.

SEE ALSO
107 Plant Physiology

The tall plants of the rainforest ecosystem include a great variety of hardwood trees. In South America, these trees provide a home to monkeys and jaguars. In Africa, they provide habitat for leopards. In any one rainforest tree there may be hundreds of different species of ants, beetles, termites, and other insects. The rainforest abounds with crickets and tree frogs, toucans and parrots.



Tropical rainforest organisms

Did You Know?

The Amazon rain forest in South America is the world's largest rain forest. But as of 2004, 17% of the original forest has been cleared to make farmland and pasture.

SEE ALSO
341 Habitat Loss

Grasslands

SEE ALSO
139 Nitrogen Cycle
191 Soil

Grasslands are biomes in which the main types of plants are grasses. Temperatures in the grassland are mild in summer (about 30°C, or 86°F) and cool to cold in winter (about 0°C, or 32°F). With only 25–75 cm (about 10–30 in.) of rainfall each year, the grassland is too dry to support the trees of a forest, but it is fertile and can support many species of grasses. This grass provides a source of food to grazing animals. The roots of grasses spread, helping to hold the soil in place. As grasses die and decay, rich soils are formed.

SEE ALSO
140 Ecological Succession
134 Food Chains
135 Food Webs

North America is home to the Great Plains and tall-grass prairie where huge, thunderous herds of bison once grazed. Today there is a new population of bison as well as pronghorn antelope. They share the ecosystem with many other grassland dwellers. Prairie dogs, rabbits, and pocket gophers build vast underground homes—sometimes like cities. These animals provide a food source to snakes, prairie hawks, weasels, and coyotes.

Grassland organisms

A **savanna** is a grassland with a few scattered trees. In Australia, large savannas provide a home to kangaroos and wombats. A savanna near the Serengeti Plain in Africa provides a home to giraffes and elephants that feed on the trees. South America also has large savanna areas called pampas.

SEE ALSO
110 Animal Behavior

The best-known grassland of Africa is the Serengeti Plain. This region is home to antelope, zebra, and lion, among others. Twice a year, hundreds of thousands of wildebeests migrate across this immense grassland.

Deserts

When you think of the desert, you might imagine the Sahara Desert of northern Africa. But there are many other deserts throughout the world. The huge Gobi Desert cuts a large path across central Asia. More local deserts include the Sonoran and Mohave Deserts of the American west.

Deserts are dry environments that generally receive less than 25 cm (about 10 in.) of rainfall each year. So desert organisms must be able to survive in dry regions. In a typical desert food web, cacti, mesquite bushes, small flowering plants, and thorny bushes are the producers. Animals that eat seeds and other parts of these plants include kangaroo rats, insects, lizards, rabbits, and armadillos. These animals serve as prey for snakes and vultures.

SEE ALSO
133 Feeding Relationships
135 Food Webs

A cactus is a plant with obvious adaptations to desert life. Spiny leaves help prevent water loss. Well-developed roots spread out near the ground's surface to quickly take in any water that falls.

SEE ALSO
127 Natural Selection

Desert temperatures can reach over 38°C (100°F). For many animals, it is a daily challenge to keep cool. To accomplish this, many animals burrow in the ground or take cover under rocks during hot, daylight hours. The animals come out to find food at night, when temperatures are much lower. Animals that are active mainly at night are **nocturnal**.

SEE ALSO
110 Animal Behavior

Desert organisms

Did You Know?

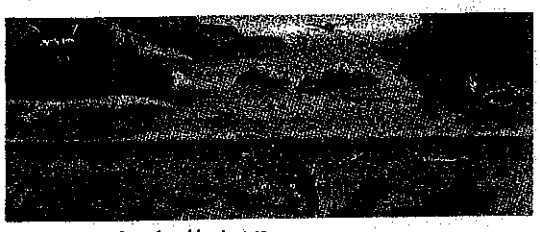
The kangaroo rat does not need to drink water. It gets the water it needs from the seeds and fruits it eats.

148

Freshwater Ecosystems

SEE ALSO
105 Animal Physiology
106 Animal Life Cycles

Freshwater ecosystems include lakes, ponds, swamps, streams, and rivers. Swift flowing rivers provide habitat to many fish species that need the high amount of oxygen that a fast-moving stream provides. These streams are also home to the larvae (young) of many kinds of insects.



Freshwater organisms found in streams

Slower moving streams that meander through valleys usually have more plants growing on their banks. This growth provides a sheltered habitat to fish, aquatic birds, and insects. Rivers that empty into oceans may be home to saltwater fish species that come upriver to have their young. Areas where freshwater rivers flow into the ocean are known as **estuaries.** Estuaries are very rich in nutrients and provide a good environment for the young of many types of fish and shellfish.

Freshwater organisms found in lakes

SEE ALSO
133 Feeding Relationships

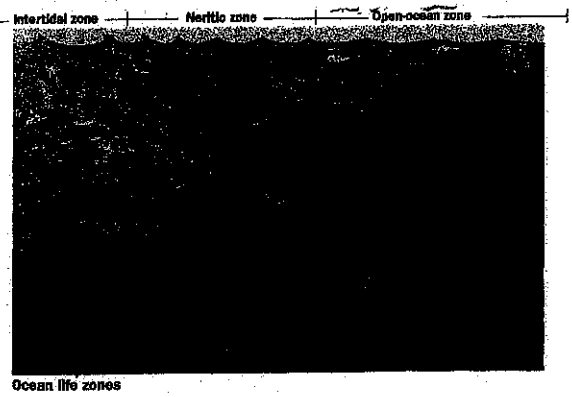
Lake ecosystems are home to a wide variety of organisms. Plants may grow along the edges of the lake where water is shallow and the plants can take root in soil. Algae are also important lake producers. Many animal species live near the lake's edges, visiting only to get water and food. Different types of fish live in the lake's waters. Amphibians, such as frogs and newts, may also make their home near the water.

149

Saltwater Ecosystems

SEE ALSO
211 Open-Ocean Zone
156 Protist Kingdom

The ocean is divided into three zones of life. The largest of these areas is the **open-ocean zone.** Lack of mineral nutrients and sunlight prevent many organisms from living in this region. The main food source in this zone is **plankton,** one-celled algae, protists, and tiny animal larvae that float at or near the water's surface.



Ocean life zones

SEE ALSO
210 Neritic Zone
209 Intertidal Zone
127 Natural Selection

Intertidal zones are shoreline areas that are covered by water at high tide and not covered by water at low tide. In this zone live many shelled animals that have adaptations for clinging to surfaces or burrowing in sand to avoid being carried out to sea. Periwinkles, snails, and other species often live near the tops of rocks, where they are exposed to sunlight, salt spray, and wind for much of the time, only to be covered by salt water during high tide.

SEE ALSO
131 Factors That Affect Populations

The **coral reef** is a type of marine ecosystem common in many tropical regions. Life in the coral reef centers on coral, a small animal that grows with others of its kind to form huge colonies. As these corals live and die, they build on the skeletons of others, expanding the reef structure. The crevices of a coral reef provide sheltered habitat to many types of animals, including sea stars, shrimps, lobsters, fish, sea anemones, and sponges.

A coral reef