Author
Wayne Garnsey

Editor
Paul Stich

Assistant Editor
Fran Harrison

Artwork & Graphics
Eugene B. Fairbanks & Wayne Garnsey

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18 Montgomery Street Middletown, New York 10940-5116

For Ordering & Information
1-800-NN 4 TEXT

Website: www.nn4text.com email: nn4text@nandnpublishing.com

Dedication and Thanks

Dedicated to my students, with the sincere hope that this book will further enhance their education and better prepare them with an appreciation and understanding of their role in the care and protection of Earth's biosphere.

Special Credits

A very special word of appreciation, "thanks, Dear,"
to my long-suffering spouse, Jane,
who has for two and a half decades supported my writing
with words of encouragement
and especially with long-enduring patience.

To Michelle and Gary Gluckow, our printer,
and more importantly, our good friends,
thanks for all your excellent work, beating the impossible deadlines,
and providing professional assistance and personal encouragement.

Thanks to the many teachers, including
Patrick Ryan (passed 2004), Douglas Bean, Virginia Page,
and so many more that have contributed
their knowledge, skills, years of experience, and friendship
over these many years.
You have helped me be both a better teacher and writer.

To all my colleagues who have ameliorated these books
with their many suggestions for improvement, a sincere thanks
for your assistance in the preparation, proofing, and editing.

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CONTEXT OF THE LIVING ENVIRONMENT

Laboratory Performance Skills for the Living Environment

How to use the STAR guide: The ☆ followed by a page number, directs you to related material. Stars can help you either (1) better define the material or (2) provide additional information making your total understanding better.

KEY IDEA 6

PLANTS AND ANIMALS DEPEND ON EACH OTHER AND THEIR PHYSICAL ENVIRONMENT.

The fundamental concept of ecology is that living organisms interact with, and are dependent on, their environment and each other. These interactions result in a flow of energy and a cycling of materials that are essential for life.

Competition can occur between members of different species for an ecological niche. Competition can also occur within species. Competition may be for abiotic resources, such as space, water, air, and shelter, and for biotic resources such as food and mates. Students should be familiar with the concept of food chains and webs.

KEY IDEA 6 – MAJOR UNDERSTANDINGS

- ☆ energy flows through ecosystem, from Sun through photosynthetic organisms to herbivores, carnivores, and decomposers
- ☆ biosphere is recycled by Earth processes
- ☆ chemical elements pass through food webs as illustrated in the pyramid of energy
- ☆ carrying capacity is limited by available energy, water, oxygen, minerals, and recycling
- ☆ competition exists for resources such as food, space, water, air, and shelter
- ☆ ecosystem dependent on physical conditions including light, pH, temperature, soil/rock type
- ☆ environments and resources are finite
- ☆ relationships between organism may be competitive or beneficial
- ☆ biodiversity increases the stability of the ecosystem
- ☆ biodiversity ensures a variety of genetic material, which in turn increases chances for survival
- ☆ interrelationships and interdependencies affect the development of stable ecosystems
- ☆ environmental alteration comes from both natural and human made changes
- ☆ altered ecosystems may last for thousands of years
- ☆ damaged ecosystem will likely recover in states to stability

Plant and Animal Interdependency

Performance Indicator 6.1 *Explain factors that limit growth of individuals and populations.*

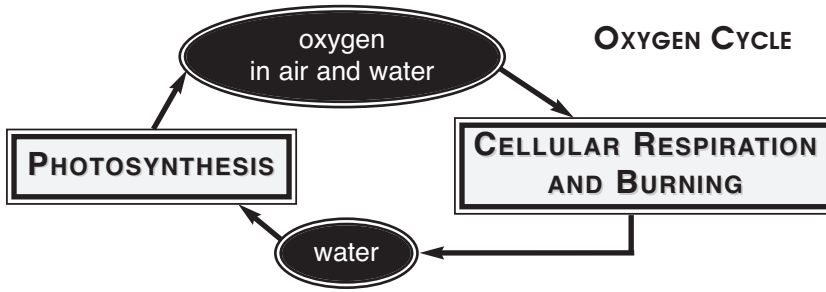
6.1 Environmental Limiting Factors

In a self-sustaining ecosystem, material must be cycled among the organisms – **biotic** (living) and **abiotic** (nonliving) environment. Thus, the same materials can be reused by different living organisms. The nonliving environment includes physical and chemical factors which affect the ability of organisms to live and reproduce. These factors include:

- intensity of light
- range of temperatures
- amount of moisture (H_2O)
- type of substratum such as soil and rock
- availability of inorganic substances such as common salts (NaCl)
- supply of gases such as oxygen (O_2), carbon dioxide (CO_2), nitrogen (N_2)
- pH (such as the acidity or alkalinity of the air, water, and soil)

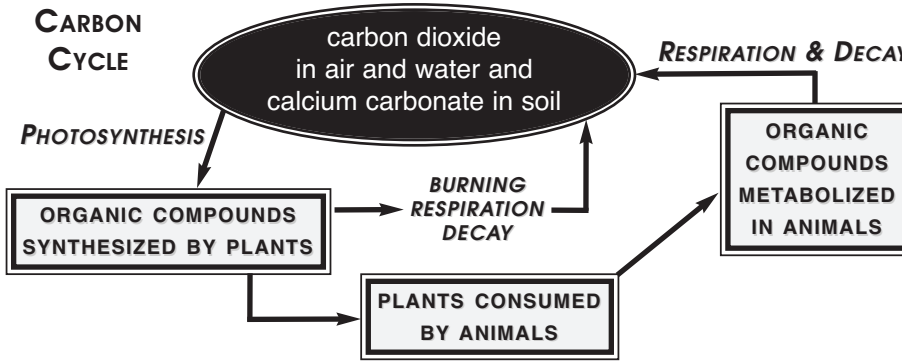
Each of these factors varies in the environment and, as such, may act as a **limiting factor** – determining the types of organisms which may exist in that environment. Examples of limiting factors include:

- Some plants live well on a forest floor under tall trees, but will not do well in an open field due to the increased light.
- The low annual temperature common to the northern latitudes determines in part what plants can exist there, because some plant enzymes work best at higher temperatures.
- If a body of water's dissolved oxygen level is low, fish that need higher oxygen levels could suffocate and die.
- The salt-laden air and water of coastal areas limit what species can exist in those regions. Some species of fish, shellfish, and other marine species could die in freshwater due to an imbalance of water pressure in their tissues.
- Because of low pH caused by acid rain, more than 200 lakes in the Adirondacks (NY) have virtually no life in them.

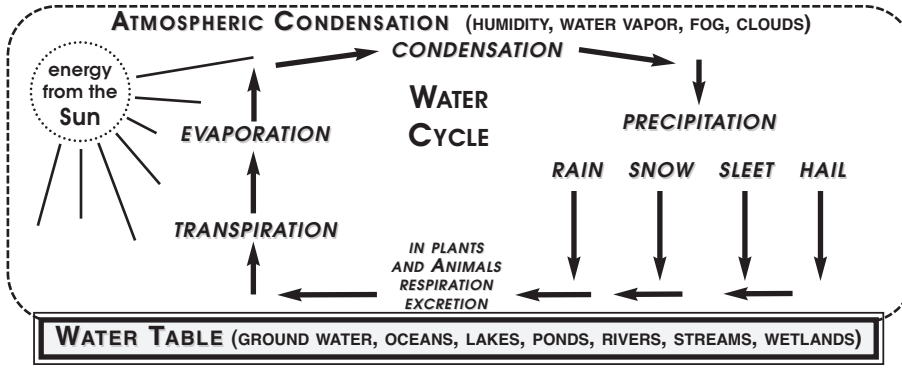


MATERIAL CYCLES

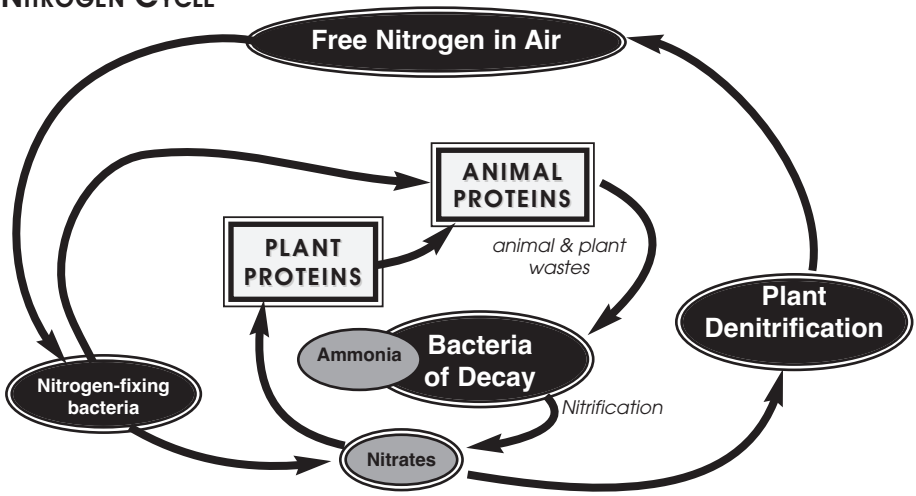
The **carbon-hydrogen-oxygen cycle** involves the processes of **respiration** and **photosynthesis**. In respiration, oxygen and glucose are combined releasing energy and producing water and carbon dioxide. In photosynthesis, water and carbon dioxide with the energy from the Sun are combined to produce glucose (containing the energy) and oxygen. Each process compliments the other, and the ecosystem maintains its balanced communities.



The **water cycle** is vital to all living organisms and is a primary limiting factor within any ecosystem. The water cycle involves the processes of **photosynthesis**, **transpiration**, **evaporation** and **condensation**, **respiration**, and **excretion**.



Nitrogen Cycle



The **nitrogen cycle** "recycles" the nitrogen necessary for the production of proteins, essential to all living things. It is an example of a material cycle involving decomposers and other soil bacteria which, in part, break down and convert nitrogenous wastes and the remains of dead organisms into materials usable by autotrophs. The essential parts of the nitrogen cycle include:

- Atmospheric nitrogen is converted into nitrates by **nitrogen-fixing bacteria**.
- Plants use **nitrates** for protein synthesis.
- Animals which eat plants convert the plant protein into animal protein.
- Nitrogenous wastes and the bodies of dead plants and animals are broken down by decomposers (**bacteria of decomposition**) and ammonia is released.
- Ammonia may be converted into nitrates by **nitrifying bacteria**.
- Nitrogen containing compounds may also be broken down by **denitrifying bacteria**, resulting in the release of nitrogen into the atmosphere.

Energy Flow Relationships

If an ecosystem is to be self-sustaining it must contain a constant supply of energy which is available to all the organisms within the ecosystem. The *energy must flow from organism to organism*.

Energy Flow. Green plants convert radiant energy from the Sun into chemical energy (food). A **food chain** involves the transfer of energy from green plants through a series of organisms with repeated stages of eating and being eaten. For example, green grass obtains its energy directly from sunlight; in turn, a frog may obtain its energy from the grass (plant); a snake could use the frog as its source of energy; and finally, when the snake dies, its remains may be consumed by bacteria and fungi providing them with an energy source and recycling materials back into the ecosystem.

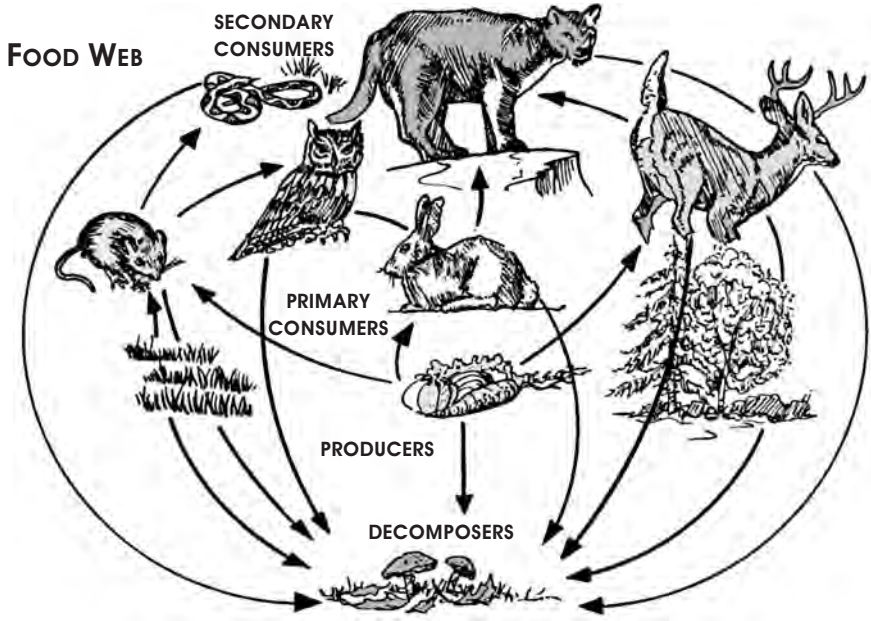
FOOD CHAIN

In a natural community [☆ 7], the flow of energy and materials is more complicated. Since organisms may be consumed by more than one species, many interactions occur among the food chains of any community. These interactions are described as a **food web**. Interactions involve:

- **Producers**. The energy for a community is derived from the organic compounds synthesized by green plants. **Autotrophs** are therefore considered the primary producers in ecosystems.

- **Consumers**. Organisms that feed directly upon green plants are primary consumers or **herbivores**. Secondary consumers, or carnivores, feed upon other consumers. Omnivores may be either primary or secondary consumers.

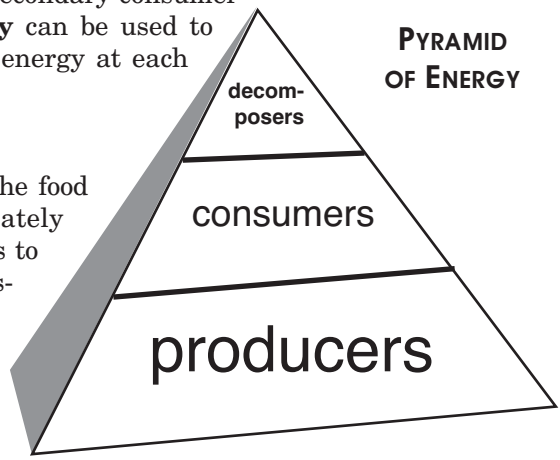
FOOD WEB



- **Decomposers**. Organic wastes and dead organisms are eventually broken down to simpler substances by **decomposers**, such as the bacteria of decay. Through this action, chemical substances are returned to the environment where they can be used by other living organisms.

There must be much more energy at the producer level in a food web than at the consumer levels. In turn, there is more energy at the primary consumer level than at the secondary consumer level. A **pyramid of energy** can be used to illustrate the loss of usable energy at each feeding level.

PYRAMID OF ENERGY

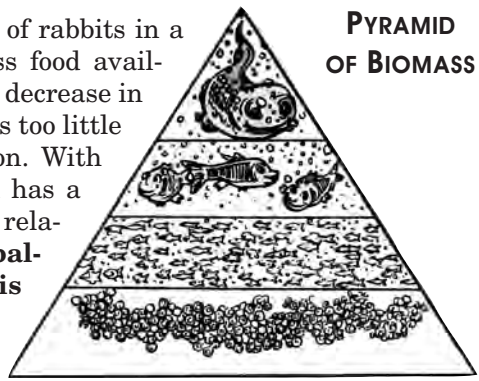


Each consumer level of the food pyramid utilizes approximately 10 % of its ingested nutrients to build new tissue. This new tissue represents the food for the next feeding level. The remaining energy is lost in the form of heat and unavailable chemical energy.

Eventually, the energy in an ecosystem is lost and is radiated from Earth's system. Thus, an ecosystem *cannot* sustain itself without the constant input of energy from the Sun.

In general, the decrease of energy at each successive feeding level means that *less* biomass (amount of organic matter) can be supported at each level. This illustrates the **pyramid of biomass**. Thus, the total mass of carnivores in a particular ecosystem is less than the total mass of the producers.

PYRAMID OF BIOMASS



For example, if the population of rabbits in a community decreases, there is less food available for the foxes. This will cause a decrease in the number of foxes born as there is too little food to support a large population. With fewer foxes, the rabbit population has a chance to increase. The biomass relationship is a good example of the **balance in nature**, the **homeostasis** of an ecosystem.

Nutritional and Symbiotic Relationships

Biotic factors are all the living things that directly, or indirectly, affect the environment. Thus, the organisms, their presence, parts, interaction, and wastes, all act as biotic factors. Biotic factors interact in many ways such as in **nutritional relationships** and **symbiotic relationships**.

Nutritional Relationships involve the transfer of nutrients from one organism to another within an ecosystem [☆ 7-8].

Autotrophs. These organisms can synthesize their own food (organic nutrients, such as carbohydrates, proteins, lipids, and nucleic acids) from inorganic compounds and a usable energy source.

Heterotrophs. These organisms *cannot* synthesize their own food and are dependent upon other organisms for food. On the basis of this dependency, organisms are classified as either saprophytes, herbivores, carnivores, or omnivores.

- **Saprophytes** include those heterotrophic (nongreen) plants, fungi, and bacteria which live on dead matter. Saprophytes function to recycle materials in the environment. Examples include mushrooms, bread mold, and bacteria of decay.

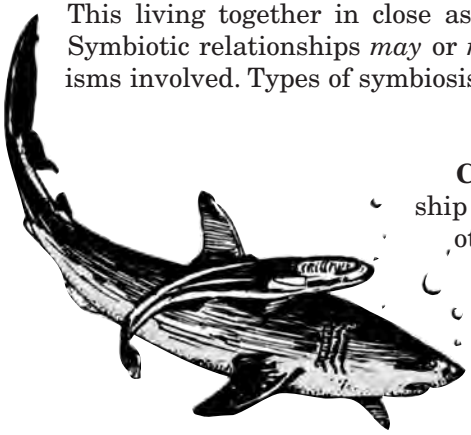
- **Herbivores** are those animals which consume plants. Herbivores include the "grazing" animals such as cows, rabbits, and deer.

- **Carnivores** are those animals which consume other animals. These include: **predators** which are animals that kill and consume their prey (such as wolves and eagles); and, **scavengers** which are animals which feed on other animals they have not killed (such as buzzards and crabs).

- **Omnivores** are those animals that consume both plants and animals. The human is an example of an omnivore.

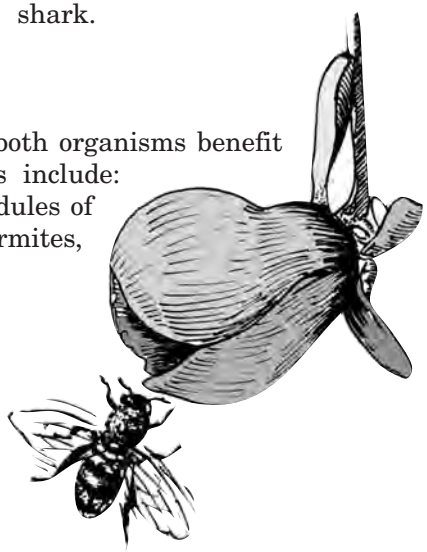
Symbiotic Relationships

Different organisms live together in a close association (dependency) which may include: nutritional, reproductive, and protective relationships. This living together in close association is known as **symbiosis**. Symbiotic relationships *may* or *may not* be beneficial to the organisms involved. Types of symbiosis include:

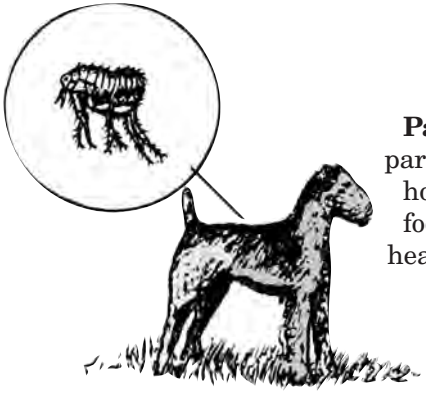


Commensalism. In this relationship one organism is benefited and the other is not adversely affected (**+**,**0**). Examples include: barnacles on whales, orchids on large tropical trees, and the remora fish and shark.

Mutualism. In this relationship both organisms benefit from the association (**+**,**+**). Examples include: nitrogen-fixing bacteria within the nodules of legumes, certain protozoa within termites, and a flower and bee.



+ = benefit to
– = expense of
0 = not affected



Parasitism. In this relationship, the parasite benefits at the expense of the host (**+**,**–**). Examples include: athlete's foot fungus on humans and tapeworm, heartworm, and fleas in dogs.

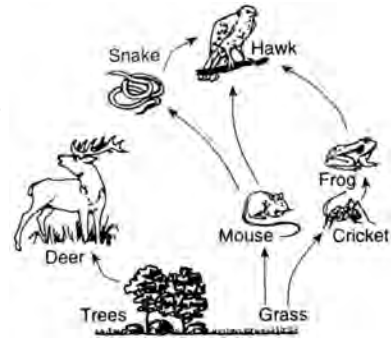
Recent research indicates that lichens may represent a controlled parasitic relationship of the fungus on an algae host.

Performance Indicator 6.1
Questions

Part A – Multiple Choice

1 Which element is not recycled throughout an ecosystem by the process of photosynthesis and respiration?
1 carbon 2 hydrogen 3 nitrogen 4 oxygen

2 Nutritional relationships between organisms are shown in the diagram at the right. Which organisms are primary consumers?
1 mouse, snake, and hawk
2 snake, hawk, and frog
3 cricket, frog, and deer
4 mouse, deer, and cricket



3 The trout in a lake will compete with aerobic bacteria for
1 dissolved oxygen in the water
2 nitrates in the lake sediments
3 sunlight needed for autotrophic reactions
4 ammonia released from decaying organisms

Base your answers to questions 4 through 6 on the diagram at the right which shows nutritional relationships between organisms of various populations in a food web and on your knowledge of the living environment.

4 Which population would most likely have the smallest biomass?
1 rabbit 2 plant 3 hawk 4 frog

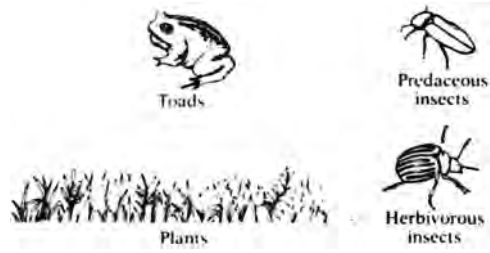
5 The interaction between the frog and the grasshopper indicates that the frog can be classified as a
1 parasite 2 carnivore 3 herbivore 4 decomposer

6 Which organisms are classified as secondary consumers?
1 hawk, grasshopper, and mouse
2 rabbit, mouse, and snake
3 grasshopper, frog, and rabbit
4 snake, hawk, and frog

7 Which statement best describes an energy pyramid?
1 There is more energy at the consumer level than at the producer level.
2 There is more energy at the producer level than at the consumer level.
3 There is more energy at the secondary-consumer level than at the primary-consumer level.
4 There is more energy at the decomposer level than at the consumer level.

8 The exchange of useful chemicals between organisms and their abiotic environment is an example of
1 a material cycle
2 competition
3 a limiting factor
4 succession

9 The diagrams at the right represent four members of a food chain. Which sequence best represents the transfer of energy between these organisms?



1 toads → predaceous insects → herbivorous insects → plants
2 predaceous insects → herbivorous insects → plants → toads
3 plants → herbivorous insects → predaceous insects → toads
4 plants → herbivorous insects → toads → predaceous insects

Base your answers to questions 10 and 11 on the passage below and on your knowledge of the living environment.

Algae live inside the body cells of a species of hydra. The hydra uses the products of the alga's photosynthesis. Ammonia resulting from the hydra's metabolism is thought to contribute to the alga's nutrition.

10 The relationship between the hydra and the alga is best described as
1 commensalism
2 mutualism
3 saprophytism
4 parasitism

11 The ammonia is part of which important ecological cycle?
1 oxygen cycle
2 water cycle
3 carbon cycle
4 nitrogen cycle

12 Which abiotic factor limits the distribution of life in the oceans, but does not usually limit the distribution of life on land?
1 minerals 2 water 3 oxygen 4 nitrogen

13 The cartoon at the right illustrates a type of nutritional relationship. Frank and the other birds in this cartoon are classified as
1 saprophytes
2 herbivores
3 scavengers
4 producers


"Just think . . . Here we are, the afternoon sun beating down on us, a dead, bloated rhino underfoot, and good friends flying in from all over. . . . I tell you, Frank, this is the best of times."

14 In the nitrogen cycle, plants use nitrogen compounds to produce
1 glucose
2 starch
3 lipids
4 proteins

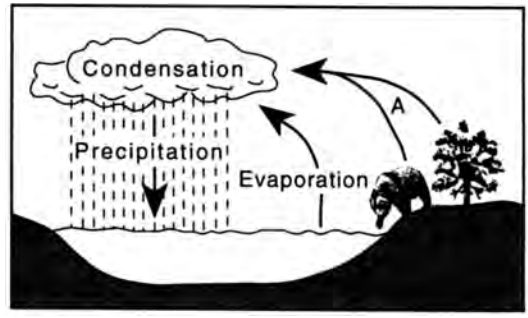
15 A flee in the fur of a mouse benefits at the mouse's expense. This type of relationship is known as
1 commensalism 3 saprophytism
2 parasitism 4 mutualism

16 An incomplete food chain is shown below:

algae → minnow → lake trout → *X*

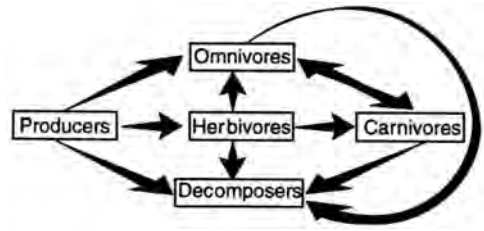
Which organism could be represented by letter ***X***?
1 lobster 2 jellyfish 3 human 4 robin

17 In the diagram at the right, which processes are most closely associated with the arrows labeled A?
1 runoff and respiration
2 photosynthesis and decomposition
3 respiration and transpiration
4 nitrogen fixation and synthesis



18 The type of herbivorous mammals present in a given terrestrial community depends most directly on the
1 type of plants present
2 amount of nitrogen in the atmosphere
3 number of decomposers present
4 amount of oxygen dissolved in ponds and streams

Base your answers to questions 19 and 20 on the diagram at the right and on your knowledge of the living environment.

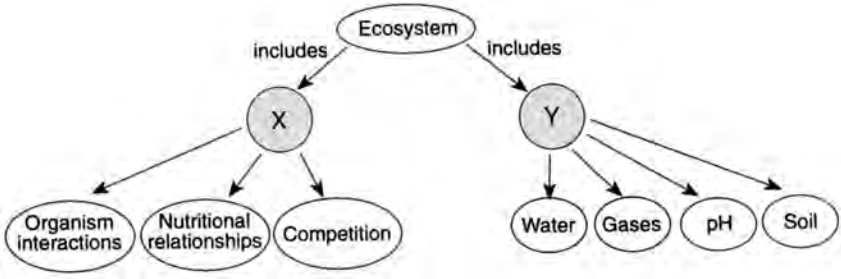


19 Which organisms break down chemical substances in the environment, making these substances available for use by other organisms?
1 producers
2 decomposers
3 herbivores
4 carnivores

20 Which group has the greatest biomass?
1 omnivores
2 herbivores
3 carnivores
4 producers

PART B – CONSTRUCTED-RESPONSE

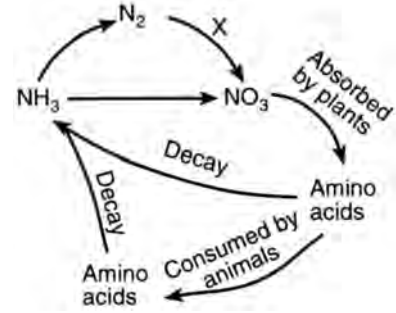
Base your answers to questions 21 and 22 on the diagram below providing information relating to an ecosystem and on your knowledge of the living environment.



21 Which information belongs in areas *X* and *Y*?
1 ***X*** – biotic factors; ***Y*** – abiotic factors
2 ***X*** – ecological relationships; ***Y*** – biotic relationships
3 ***X*** – abiotic factors; ***Y*** – interacting populations
4 ***X*** – energy flow; ***Y*** – biotic factors

22 Using one or more complete sentences, describe the primary effect that the group represented by ***Y*** has on the group represented by ***X***.

Base your answers to questions 23 through 25 on the diagram at the right and on your knowledge of the living environment.



23 Which gas is released when the tissues of dead plants and animals are broken down by bacteria?

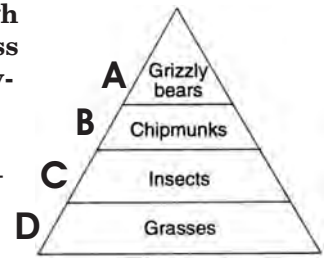
1 NO_3 3 NH_3
2 N_2 4 O_2

24 Bacteria responsible for process ***X*** are known as

1 nitrogen-fixing bacteria 3 denitrifying bacteria
2 nitrifying bacteria 4 autotrophic bacteria

25 The abiotic cycle shown in the diagram is best referred to as the (*chemical name*) _____ cycle.

Base your answers to questions 26 through 28 on the diagram at the right of a biomass pyramid and on your knowledge of the living environment.



26 Which level of the pyramid most likely contains the greatest mass of herbivores?

1 *A* 3 *C*
2 *B* 4 *D*

27 Which level of the pyramid contains most of the producers?

1 *A* 2 *B* 3 *C* 4 *D*

28 Using one or more complete sentences, explain what effect would be caused, if the biomass of level ***B*** became larger than the biomass of level ***D***.

Base your answers to questions 29 and 30 on the passage below and on your knowledge of the living environment.

> Leeches often attach to the tongue of a crocodile and consume the crocodile's blood as food. The Egyptian plover is a bird that flies into the mouth of the crocodile and eats the leeches. The crocodiles do not harm the plovers.

Directions (29-30): For *each* relationship identified in questions 29 and 30, select the ecological term, *chosen from the list below*, that identifies that relationship.

Ecological Terms

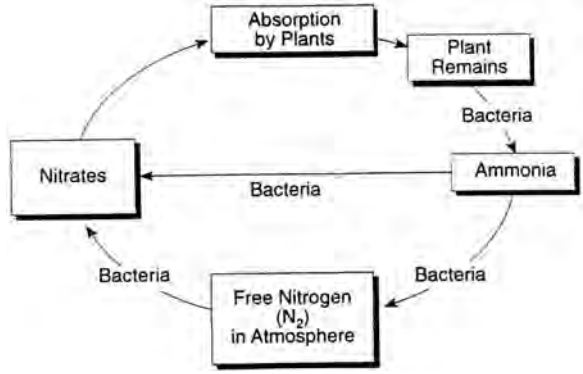
Commensalism	Mutualism
Parasitism	Saprophytism

29 The relationship between the plover and the crocodile _____

30 The relationship between the leech and the crocodile _____

PART C – EXTENDED CONSTRUCTED-RESPONSE

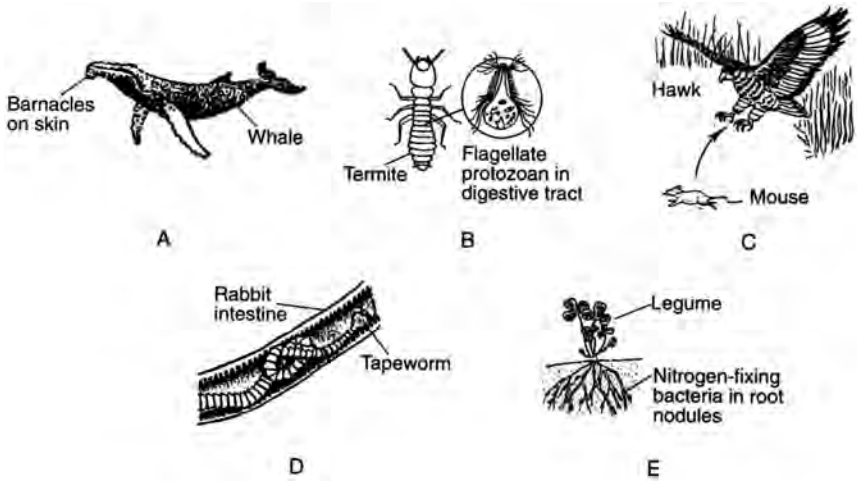
Base your answers to questions 31 and 32 on the diagram at the right and on your knowledge of the living environment.



31 Which of the material cycles is represented in the diagram? [1]

32 Using one or more complete sentences, describe the importance of this material cycle to the consumers living in the same ecosystem. [2]

Base your answers to questions 33 through 36 on the nutritional relationships shown below and on your knowledge of the living environment.



33 Which two diagrams illustrate the same type of nutritional relationship? [1]

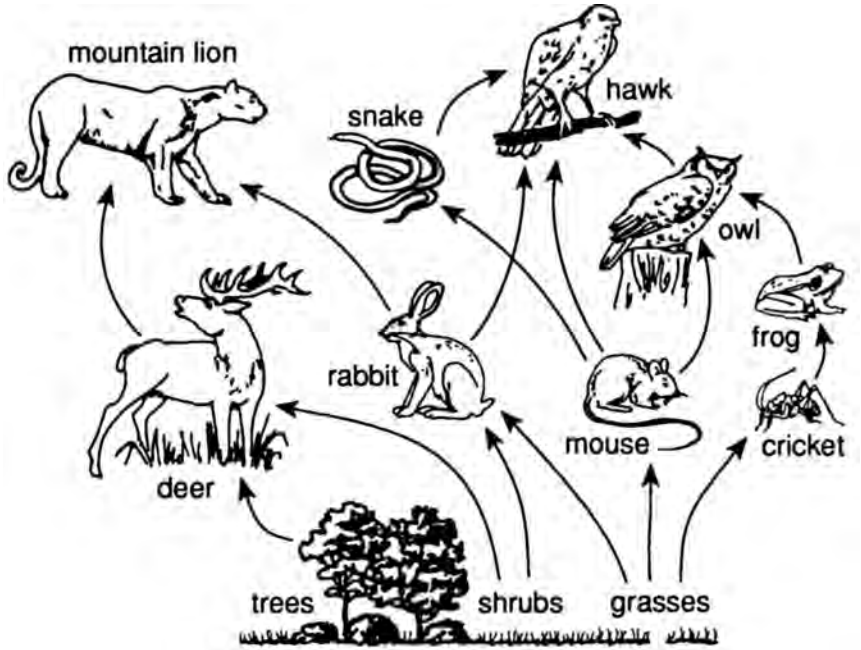
1 *A* and *D*
2 *B* and *E*
3 *A* and *C*
4 *C* and *D*

34 Of the relationships shown which would be considered a parasitic relationship? [1] _____

35 Which diagram shows the relationship that is most similar to that between humans and an athlete's foot fungus?[1] (letter) _____

36 Using one or more complete sentences, choose one example of mutualism from the relationships shown and describe the benefits to each organism. [2]

Base your answers to questions 37 through 40 on the diagram below and on your knowledge of the living environment.



37 Within the food web illustrated, there are several food chains. List the other *four* organisms in the food chain that includes the rabbit as one of the organisms. [1]

_____ _____ _____ _____

38 What type of nutritional relationship exists between the snake and the hawk? [1] _____

39 At what level in a pyramid of energy do your place the deer, rabbit, mouse, and cricket. [1] _____

40 Using one or more complete sentences, explain the importance of the trees, shrubs, and grasses in this food web. [2]

6.2 Biodiversity
6.3 Change and Response

Performance Indicator 6.2 *Explain the importance of preserving diversity of species and habitats.*

Performance Indicator 6.3 *Explain how the living and nonliving environments change over time and respond to disturbances.*

Ecosystems tend to go through dynamic change with time until a stable system (climax community in a state of equilibrium) is attained. The type of ecosystem that is formed depends on the climatic limitations of a particular geographical area.

As a result of evolutionary processes, there is a diversity of organisms and roles in ecosystems. This diversity of species increases the chance that at least some will survive in the face of large environmental changes. **Biodiversity** increases the stability of the ecosystem. It also ensures the availability of a rich variety of genetic material that may lead to future agricultural or medical discoveries with significant value to humankind. As diversity is lost, potential sources of these materials may be lost with it.

Changes in Succession

The replacement of one community by another until a stable stage (**climax community**) is reached is called **ecological succession**.

Succession may be said to begin with **pioneer organisms**, since these are the first living things to populate a given location. For example, lichens (a symbiotic association between fungus-alga) are the pioneer organisms on bare rock. Pioneer organisms modify their environment. Seasonal die-back and erosion, for example, would create pockets of "**soil**" in the crevices in bare rock.

Each community modifies the environment, often making it more unfavorable for itself and, apparently, more favorable for the following community which infiltrates the first community over a period of years. For example, as lichens grow and reproduce, they add organic matter and moisture to their substratum. After a period of time, humus is made and is too rich and moist for the lichen to survive. The lichens die but produce a richer substratum that will support seeds for the development of grasses and herbs, the next stage of succession.

STAGES OF SUCCESSION

PIONEER ORGANISMS		CLIMAX COMMUNITY	
bare rock to lichens (small amount of soil produced)	grasses and shrubs (organic material added to soil)	conifers, pines, and firs (evergreens with soft woods)	maples, oaks, and beeches (deciduous trees, hard woods)

Plant species (**flora**) dominate in the sense that they are the most abundant food sources. **Plant succession** is a major limiting factor for animal (**fauna**) succession. Communities are composed of populations able to exist under the prevailing conditions and are identified by their *dominant plant* species — the one that exerts the most influence over the other species present. Some examples include: Pine Barrens and a Sphagnum Bog.

A **climax community** is a self-perpetuating community in which populations remain stable and exist in balance with each other and the environment. The oak-hickory and the hemlock-beech-maple associations represent two climax communities found in throughout much of the northern United States. A **climax community** continues until a catastrophe or a change in a major biotic or abiotic factor alters or destroys it, thus producing "non-climax" conditions. Some examples of natural and man-caused factors that affect a climax community include:

- forest fires
- abandoned farmlands
- areas where topsoil has been removed

Thereafter, succession once again occurs leading to another climax community. The original climax community same (species) may be reestablished or a new climax community (different species) may be established.

CHANGE THROUGH COMPETITION

Competition occurs when different species of organisms living in the same environment (**habitat**) utilize the same limited resources, such as food, space, water, light, oxygen, and minerals. The more similar the requirements of the organisms involved, the more intense the competition. Competition may be between the same or different species.

A **niche** is the role that a species plays in its environment. If two different species compete for the same food or reproductive sites, one species may be eliminated. This usually establishes one species per niche in a community. For example, in environments where both bluebirds and starlings compete for reproductive sites, the more aggressive starlings are likely to "win" causing the bluebird to be pushed out of that community.

BIOMES

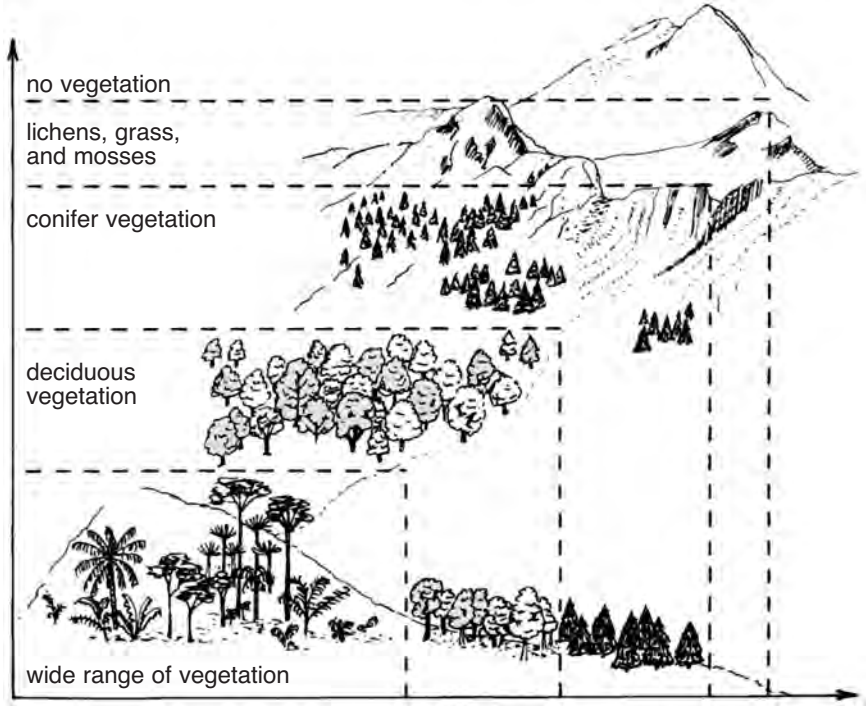
The term **biome** refers to the most common climax ecosystem that will form in geographic regions of similar climatic conditions. Biomes are **terrestrial** or **aquatic**. The temperate deciduous forest of the United States is a terrestrial (dry) biome. The ocean is an aquatic (wet) biome.

The major plant and animal associations on land are determined by the major climatic zones of the world, which are modified by local land and water conditions. Climates will vary as to **temperature**, **solar radiation**, and **precipitation**. The presence or absence of water is a major limiting factor for **terrestrial biomes**.

Land (terrestrial) biomes are characterized and sometimes named by the climax vegetation in the region. The major land biomes and their characteristic flora and fauna are listed in the following chart.

WORLD BIOMES

BIOME	CLIMAX FLORA	CLIMAX FAUNA	CHARACTERISTICS
Tundra	lichens, mosses, and grasses	caribou, snowy owl	permanently frozen subsoil
Taiga	conifers	moose, black bear	long, severe winters, summers with thawing subsoil
Temperate - Deciduous Forest	trees that shed leaves (deciduous trees)	gray squirrel, fox, and deer	moderate precipitation, cold winters, warm summers
Tropical Forest	many species of broad-leaved plants	snake, monkey, and leopard	heavy rainfall, constant warmth
Grasslands	grasses	pronghorn antelope, prairie dog, and bison	rainfall and temperature vary greatly, strong prevailing winds
Desert	drought-resistant shrubs and succulent plants	kangaroo rat, lizard	sparse rainfall, extreme daily temperature changes



ALTITUDE AND LATITUDE COMPARISON
(BIOME FORMATION)

Climatic conditions change with latitude and altitude. Earth latitude and altitude are similar in that as both increase, the limiting factors change in a similar manner, and the organisms change as well.

Aquatic biomes represent the largest ecosystems on Earth. More than 70 percent of Earth's surface is covered by water and most of the life on this planet exists under conditions where water is the principal external medium.

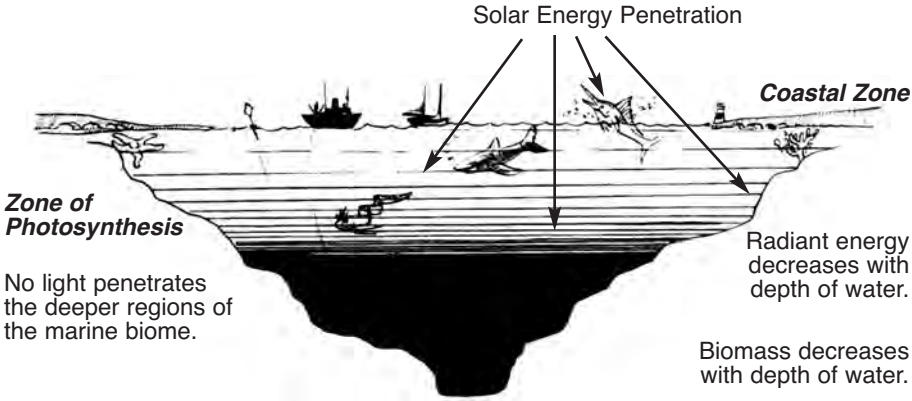
The temperature variation in aquatic biomes is not as great as in the terrestrial biomes, due to the ability of water to absorb and hold heat. In addition, moisture is not a limiting factor. Thus, aquatic biomes are typically more stable than terrestrial biomes.

Such factors as the quantity of available oxygen and carbon dioxide, temperature, light, dissolved minerals and suspended particles are the major factors affecting the kinds and numbers of organisms in an aquatic biome.

Aquatic organisms are well adapted to remove oxygen which is dissolved in water. They must also maintain a proper water balance. This water balance is affected by the concentration of dissolved salts in the water. Because light is most intense near the surface of the aquatic biome, plants exist there in large numbers and most photosynthesis takes place in the first one hundred feet of water. The oceans (**marine biomes**) of the world are a continuous body of water that

- provides the most stable aquatic environment
- absorbs and holds large quantities of solar heat and helps to stabilize Earth's atmosphere
- contains a relatively constant supply of nutrient materials and dissolved salts
- serves as a habitat for a large number of diverse organisms

A great amount of food production in the world occurs in the oceans along the edges of the land masses (coastal waters), the deeper regions being too dark.



MARINE BIOME – COASTAL ZONE
(PHOTOSYNTHETIC LIFE TO APPROXIMATELY 100 FEET)

The **fresh water biome** includes ponds, lakes, and rivers. The areas which make up a fresh water biome show considerable variation in

- size
- current velocity
- temperature
- concentration of dissolved gases
- suspended particles
- rate of succession

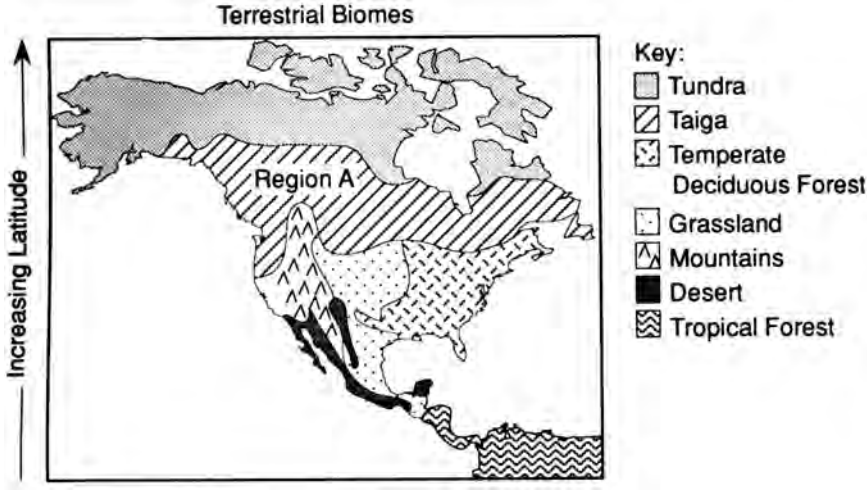
Ponds and small lakes, for example, fill in due to the seasonal die-back of aquatic vegetation and the erosion of their banks. Eventually a small body of water enters into terrestrial succession, terminating in a terrestrial climax community.

Performance Indicators 6.2 and 6.3
Questions

Part A – Multiple Choice

1 Which statement concerning the climax stage of an ecological succession is correct?
   1 It changes rapidly.
   2 It persists until the environment changes.
   3 It is the first community to inhabit an area.
   4 It consists entirely of plants.

Base your answers to questions 2 through 4 on the map below that illustrates various terrestrial biomes in selected areas of North, Central, and South America and on your knowledge of the living environment.



2 Which symbol represents the biome having mosses and lichens as the climax flora?

(1)  (2)  (3)  (4) 

3 Region ***A*** would most likely contain an abundance of
   1 broad-leaved plants and bison
   2 drought-resistant shrubs and succulent plants
   3 evergreen forests, moose, and bears
   4 grasses, prairie dogs, and antelope

4 Which statement best explains why mountain ranges are shown separately rather than as a part of neighboring biomes?
1 Mountains are totally covered by snow.
2 Species of plants and animals vary with altitude in mountainous regions.
3 Few animals are found in mountainous regions.
4 Mountainous regions constantly undergo ecological succession.

5 When Mount Saint Helens erupted in 1980, a portion of the surrounding area was covered by lava, which buried all of the vegetation. Four months later, *Anaphalis margaritacea* plants were found growing out of the lava rock crevices. The beginning of plant regrowth in this area is part of the process known as
1 species preservation
2 organic evolution
3 biotic competition
4 ecological succession

Base your answers to questions 6 through 8 on the following information about biomes and on your knowledge of the living environment.

Directions (6-8): For *each* description in questions 6 through 8, select the biome, *chosen from the list below*, that best matches the description.

Biomes

1 Tundra
2 Taiga
3 Desert
4 Tropical Rain Forest
5 Grassland
6 Temperate Deciduous Forest

6 _____ A biome that is characterized by heavy rainfall, constant warmth, and many species of plants and animals.

7 _____ A biome that is characterized by coniferous forests and moose.

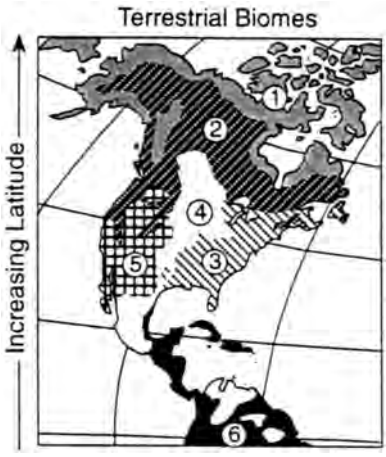
8 _____ A biome with little rainfall, extreme daily temperature variations, and kangaroo rats.

9 The role of an organism within a community is known as its
1 niche 2 habitat 3 biome 4 succession

10 To which biome does the greatest amount of photosynthetic activity take place?
1 tundra 2 desert 3 marine 4 fresh water

PART B – CONSTRUCTED-RESPONSE

Base your answers to questions 11 through 13 on the map at the right that illustrates the general location of various terrestrial biomes in selected areas of North, Central, and South America. For *each* statement, select the biome, chosen from the map at the right, that is most closely associated with the statement.



11 _____ Snowy owls hunt mice that try to escape among the lichens growing on ground that has permanently frozen subsoil.

12 _____ Prairie dogs hide in their burrows in a vast area of tall grasses that provide food for herds of pronghorn antelope and bison.

13 _____ Deer nibble on low-lying shrubs while cardinals sit on branches of trees in a large deciduous forest.

14 Which ecological unit provides the physical setting for the poem below?

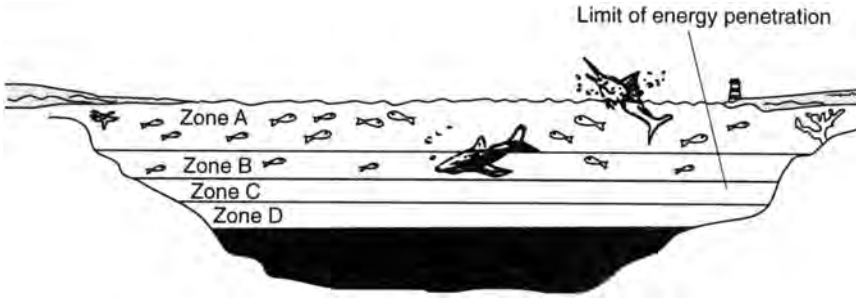
The days be hot, the nights be cold,
But cross we must, we rush for gold.
The plants be short, the roots spread wide,
Me leg she hurts, thorn's in me side.
I fall, I crawl, I scream, I rave,
Tiz me life that I must save.
How can it be, I've come undone,
Here 'neath this blazin' eternal Sun?
The days be hot, the nights be cold,
Me lonely bones alone grow old.

1 desert biome
2 terrestrial food chain
3 deciduous forest
4 coniferous-tree biome

15 Complete the following statement: Ecosystems tend to change with time until a *stable* system is formed. Complete the following statement: All *stable* ecosystems are characterized by the presence of

_____

Base your answers to questions 16 through 18 on the diagram below of a marine biome and on your knowledge of the living environment.



16 Complete the following statement: In zone ***B***, competition is probably most intense between two species that are

_____

17 In which zone does the greatest amount of food production occur?
1 *A* 2 *B* 3 *C* 4 *D*

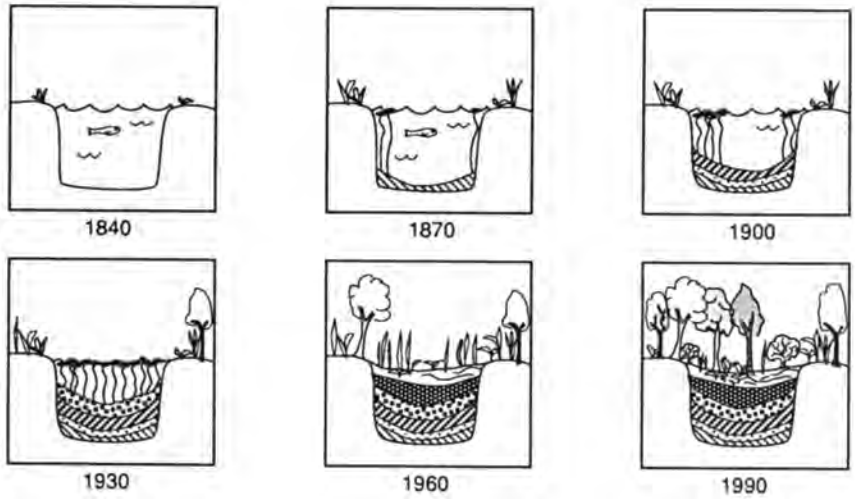
18 Autotrophs in zones ***A*** through ***C*** depend on the metabolic activities of other organisms for a continuing supply of
1 water
2 carbohydrates
3 respiratory enzymes
4 carbon dioxide

19 A pond in a temperate deciduous forest fills in with dead leaves and silt and eventually dries up, leading to terrestrial succession. Which sequence of plant communities would inhabit the area during the states of this succession?
1 shrubs → grasses → coniferous trees
2 shrubs → coniferous trees → grasses
3 grasses → deciduous trees → shrubs
4 grasses → shrubs → deciduous trees

20 In a forest in northern New York State, the most intense competition would most likely occur between white-tailed deer and
1 brown bears
2 humans
3 other white-tailed deer
4 coyotes

Part C – Extended Constructed-Response

Base your answers to questions 21 through 24 on the sequence of diagrams below and on your knowledge of the living environment.



21 Complete the following: This sequence of diagrams best represents the natural process of [1] _____.

22 If no human intervention or natural disaster occurs, by the year 2050, what will this area will most likely become? [1]

_____

23 From 1840 to 1930, there was a natural increase in the amount of vegetation. Using one or more complete sentences, explain why this was true. [2]

24 Assume that there was a natural disaster – a major forest fire – that destroyed the climax forest in 1995, using one or more complete sentences, describe what the first stages of a new succession would be. [2]

Base your answers to questions 25 and 26 on the passage below and on your knowledge of the living environment.

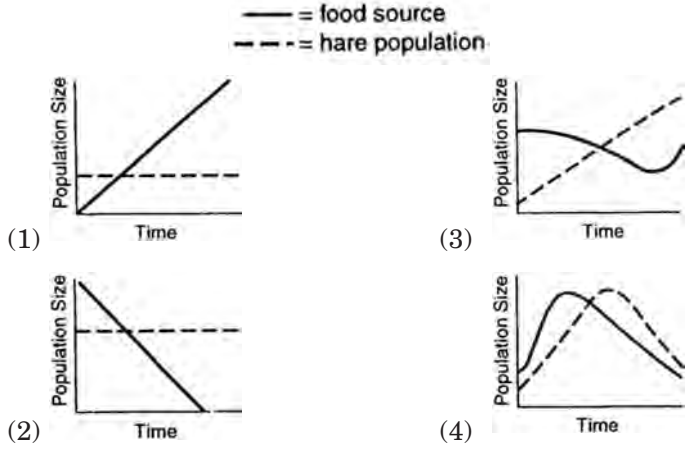
Avoid Being Eaten

The snowshoe hare is the prey of many woodland animals. Foxes, coyotes, martens, and weasels hunt the hares by day, while the great horned and barred owls hunt them on silent wings at night. The snowshoe hare survives this predation partly as a result of the effects of changing environmental conditions on the expression of genes for fur color, resulting in effective camouflage. In winter months, the hare has white fur, which blends into the snowscape. During the warmer months, the fur changes to reddish brown.

Some favorite foods of the hare during the winter months are twigs of the maple, birch, and apple trees. Grasses and clover replace this diet during the spring and summer. Hares tend to feed during the hours of dusk and dawn, when the light is low and the predators are inactive.

The hares prefer habitats along streams, wetlands, and spruce forests. Their breeding season in the Northeast United States begins in March, and a female can have a litter of one to six young only 5 weeks after mating. The young hares are able to see, are fully furred, and are able to walk and hop soon after birth. Females nurse their young until they are about a month old. Within one season, a female may have up to four litters. The snowshoe hare population tends to vary throughout the year because individual animals have a short lifespan. There seem to be cycles of about 10 years, during which the population varies from about 0.1 hare per acre up to 5 hares per acre. Some biologists suggest that the cycles are related to predation and depletion of the hare's food sources.

25 If food supply is the only limiting factor, which graph best represents a possible relationship between the population of snowshoe hares and their food supply over a 10-year period? [1]



26 Using one or more complete sentences, state one adaptive advantage to the hare of being able to see, being fully furred, and being able to walk and hop soon after birth. [2]

Base your answers to questions 27 through 29 on the information below, data table at the right, and on your knowledge of the living environment.

A field study was conducted to observe a deer population in a given region over time. The deer were counted at different intervals over a period of 40 years. During this period of time, both ranching and hunting increased in the study region. A summary of the data is presented in the table at the right.

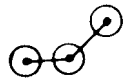
Data Table

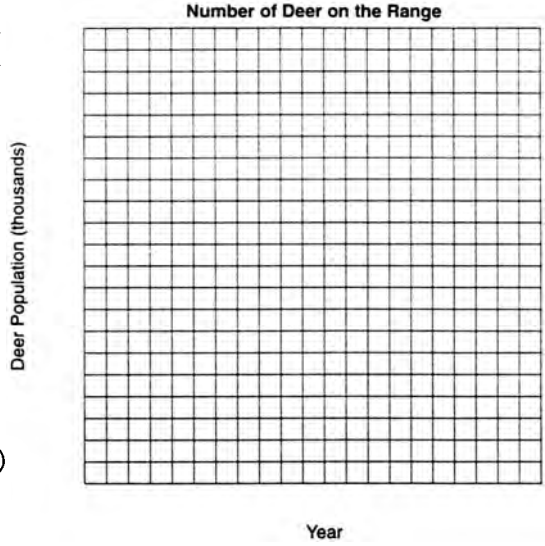
Year	Deer Population (thousands)
1900	3.0
1910	9.5
1920	65.0
1924	100.0
1926	40.0
1930	25.0
1940	10.0

Directions (28-29): Using the information in the data table, construct a line graph following the directions below.

27 Mark an appropriate scale on each labeled axis. [2]

28 Plot the data for the deer population on the grid. Surround each point with a small circle and connect the points. [2]
Example:





29 Using one or more complete sentences, state one possible action that could have been used to help maintain a more stable population of deer in the area. [2]