BC SCIENCE 10

Provincial Exam Study Guide

Unit 1: Sustaining Earth's Ecosystems

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Table of Contents

Part A Strategies for Success

Study Tips for Provincial Exam Preparation

Introduction

This guide is designed to help you study for the BC Science 10 provincial exam. Completing all the questions in this Study Guide will not guarantee that you will pass the exam, but it will help prepare you for success.

Each unit in this Study Guide matches up to a unit in your *BC Science 10* student book. Each Study Guide unit begins with a checklist of what you should be able to do by the end of that unit. You can use this checklist to help you figure out which concepts you already know and which concepts you need to study further. Each Study Guide unit ends with a checklist of Processes of Science Vocabulary Terms that you should know and a Glossary of terms from the unit that you should understand.

Each section in the Study Guide has the following features.

- Summary of Key Points—you must know each of these key points for the exam
- Study Notes—these are the key points expanded to include details that may be on the exam
- Quick Check—these are questions to check your understanding of the Study Notes. If you cannot answer Quick Check questions, review the material in your student book or talk to your teacher.
- Sample Exam Questions Explained—this feature explains in detail the right and wrong answers for questions that are similar in style to the questions that will be on the provincial exam. The feature also describes why each question was asked and where you can get additional help if you did not understand the question. One strategy to help you study is to cover up the right-hand column in the question and try to answer the question first. Then, uncover the column to check your answer or to figure out why an answer is wrong. Figuring out why you got an answer wrong can help you to learn the concept.
- Practice Questions—these are questions that are similar in style to the questions that will be on the provincial exam. There are 10 Practice Questions at the end of each section.

Support for Studying

When you study for the provincial exam, you should have the following materials. If you are missing any of the items below, please see your teacher.

- ***BC Science 10* student book** Your student book covers the same curriculum that the provincial exam was developed for. It is an excellent source of information for studying.
- **Your notes** Your teacher has worked the whole semester or school year with you to help you develop the right knowledge, skills, and attitudes. A key part of this work is the notes you have created. Remember to review these notes while you study.
- **BC Science 10 Provincial Exam Data Pages** It is very important that you understand the parts of the Provincial Exam Data Pages and how to use them. Your teacher can answer your questions about these pages.
- **BC Science 10 Provincial Exam Vocabulary List** You should know the meaning of each of these terms. If you are unsure of any of the terms, check the Glossary at the end of each Study Guide unit or at the back of your student book.
- **The BC Science 10 website** You can find practice questions and web links that will help you study the material you have covered in Science 10 this year. Visit www.bcscience10.ca.

Getting Help

When you study for a year-end test like the provincial exam, it is not uncommon to get stuck on concepts or have questions on material you have previously covered in class. If you are unsure about a concept or something covered in class, check with a classmate first. If both of you cannot figure out the answer, visit your teacher together.

Tips from Experts

Study experts have a common list of hints they provide to people of all ages. Research has shown that these tips help you study.

- Have a **positive attitude.**
- **Be motivated** and take responsibility for your learning.
- **Attend class** so you do not miss key points about what you are learning. Your friend's notes are not a replacement for being present in class and learning the concepts while they are being taught.
- **Study regularly** to help you identify areas where you need extra help.
- **Get help** when you need it, and do not be afraid to ask questions. There are no bad questions when it comes to figuring something out.
- **Be a good test taker.** Have a good sleep the night before the test and be sure to eat a nutritious breakfast the day of the test. During the test, read each question carefully before selecting your answer.

Here is a list of common hints that science teachers in British Columbia have shared with their students.

- Know how to use your Data Pages.
- Practise reading graphs.
- Practise interpreting illustrations.
- Do not spend extra time studying what you already know.
- When you are writing the exam, read the question first, then read the possible answers. If you do not know the answer, then look at the picture (if there is a picture).
- Take your time when you write the exam. Answer the questions you know first, and then go back to questions that you are not sure of.

Part B: Unit Study Notes and Exam Questions

Unit 1 Sustaining Earth's Ecosystems

By the end of this unit you should be able to:

1. Explain the interaction of abiotic and biotic factors within an ecosystem
   This includes being able to:
   - ☐ define *abiotic*, *biotic*, *biome*, and *ecosystem*
   - ☐ identify distinctive plants, animals, and climatic characteristics of Canadian biomes (tundra, boreal forest, temperate deciduous forest, temperate rainforest, grasslands)
   - ☐ identify biotic and abiotic factors in a given scenario or diagram
   - ☐ describe the relationships between abiotic and biotic elements within an ecosystem, including
     - air, water, soil, light, temperature (abiotic)
     - bacteria, plants, animals (biotic)
   - ☐ design and analyse experiments on the effectiveness of altering biotic or abiotic factors (e.g., nutrients in soil: compare two plant types with the same nutrients, compare one plant type with different nutrients)
   - ☐ explain various relationships with respect to food chains, food webs, and food pyramids, including
     - producer
     - consumer (herbivore, carnivore, omnivore)
     - predation (predator-prey cycle)
     - decomposers
     - symbiosis (mutualism, commensalism, parasitism)
   - ☐ illustrate the cycling of matter through abiotic and biotic components of an ecosystem by tracking
     - carbon (with reference to carbon dioxide—CO_2, carbonate—CO_3^{2-}, oxygen—O_2, photosynthesis, respiration, decomposition, volcanic activity, carbonate formation, greenhouse gases from human activity (combustion)
     - nitrogen (with reference to nitrate—NO_3^-, nitrite—NO_2^-, ammonium—NH_4^+, nitrogen gas—N_2, nitrogen fixation, bacteria, lightning, nitrification, denitrification, decomposition)
     - phosphorus (with reference to phosphate—PO_4^{3-}, weathering, sedimentation, geological uplift)
   - ☐ identify factors that affect the global distribution of the following biomes: tropical rainforest, temperate rainforest, temperate deciduous forest, boreal forest, grasslands, desert, tundra, polar ice (permanent ice)
   - ☐ using examples, explain why ecosystems with similar characteristics can exist in different geographical locations (i.e., significance of abiotic factors)
   - ☐ identify the effects on living things within an ecosystem resulting from changes in abiotic factors, including
     - climate change (drought, flooding, changes in ocean current patterns, extreme weather)
     - water contamination
     - soil degradation and deforestation

2. Assess the potential impacts of bioaccumulation
   This includes being able to:
   - ☐ define, using examples, the terms *bioaccumulation*, *parts per million (ppm)*, *biodegradation*, and *trophic levels* (with reference to producers and to primary, secondary, and tertiary consumers)
   - ☐ identify a variety of contaminants that can bioaccumulate (e.g., pesticides, heavy metals, PCBs)
   - ☐ describe the mechanisms and possible impacts of bioaccumulation (e.g., eradication of keystone species, reproductive impacts)
   - ☐ compare the impact of bioaccumulation on consumers at different trophic levels (e.g., red tide in oysters and humans; heavy metals in fish and humans; PCBs in fish, birds, whales)
   - ☐ research and analyze articles on the causes and effects of bioaccumulation (e.g., mercury contamination in Inuit communities and the Grassy Narrows First Nation community)
3. Explain various ways in which natural populations are altered or kept in equilibrium
   This includes being able to:
   - ☐ explain how species adapt or fail to adapt to environmental conditions, with reference to the following:
     - natural selection
     - proliferation
     - predator-prey cycle
     - ecological succession
     - climax community
     - extinction
     - adaptive radiation
   - ☐ describe the impact of natural phenomena (e.g., drought, fire, temperature change, flooding, tsunamis, infestations—pine beetle, volcanic eruptions) on ecosystems
   - ☐ give examples of how foreign species can affect an ecosystem (e.g., Eurasian milfoil, purple loosestrife, Scotch broom, American bullfrog, European starling in B.C.)
   - ☐ give examples of how traditional ecological knowledge (TEK) can affect biodiversity
     (e.g., spring burning by Cree in northern Alberta)
   - ☐ research and report on situations in which disease, pollution, habitat destruction, and exploitation of resources affect ecosystems

By the end of this unit, you should understand the following key ideas:

1. Biomes and ecosystems are divisions of the biosphere.
2. Energy flow and nutrient cycles support life in ecosystems.
3. Ecosystems continually change over time.

To help you study you should have the following:

- *BC Science 10* student book, pages 2 to 161. Note the practice exam questions on page 158 to 161.
- BC Science 10 Provincial Exam Data Pages, pages 5, 6, 8, and 9
- BC Science 10 Provincial Exam Vocabulary List, page 1
- Access to www.bcscience10.ca

Chapter 1 Biomes and ecosystems are divisions of the biosphere.

1.1 Biomes

I. Summary of Key Points

- Biomes are the largest divisions of the biosphere.
- The large regions within biomes have similar biotic and abiotic components.
- The interaction of these components determines the characteristics of biomes.
- Temperature and precipitation are the main abiotic factors that influence the distribution of biomes and the organisms within them.
- Organisms have adaptations for survival in the specific environmental conditions of their biome.

II. Study Notes

What Is a Biome?

1. The **biosphere** is the thin layer of air, land, and water at Earth's surface where living things exist.
2. A **biome** is a large area of the biosphere that has characteristic **climate** (long-term weather conditions in an area, including rainfall and temperature), plants, animals, and soil.
3. Examples of biomes include **aquatic** (related to water) biomes, such as the tropical ocean, and **terrestrial** (related to land) biomes, such as desert, tropical rainforest, and permanent ice.
4. Biomes are classified based on many qualities, such as water availability, temperature, and interactions between biotic and abiotic factors.
   - **Biotic** factors are all organisms in the environment, including bacteria, plants, and animals.
   - **Abiotic** factors are all non-living parts of the environment, such as air, water, soil, light, and temperature.
5. The interactions between biotic and abiotic factors determine what characteristics a biome will have.

Quick Check

Identify each of the following as either a biotic or an abiotic factor.

1. (a) crab _____
   (b) ocean temperature _____
   (c) lake water _____
   (d) dissolved oxygen _____
   (e) tides _____
   (f) seaweed _____

Introducing the Biomes of the World

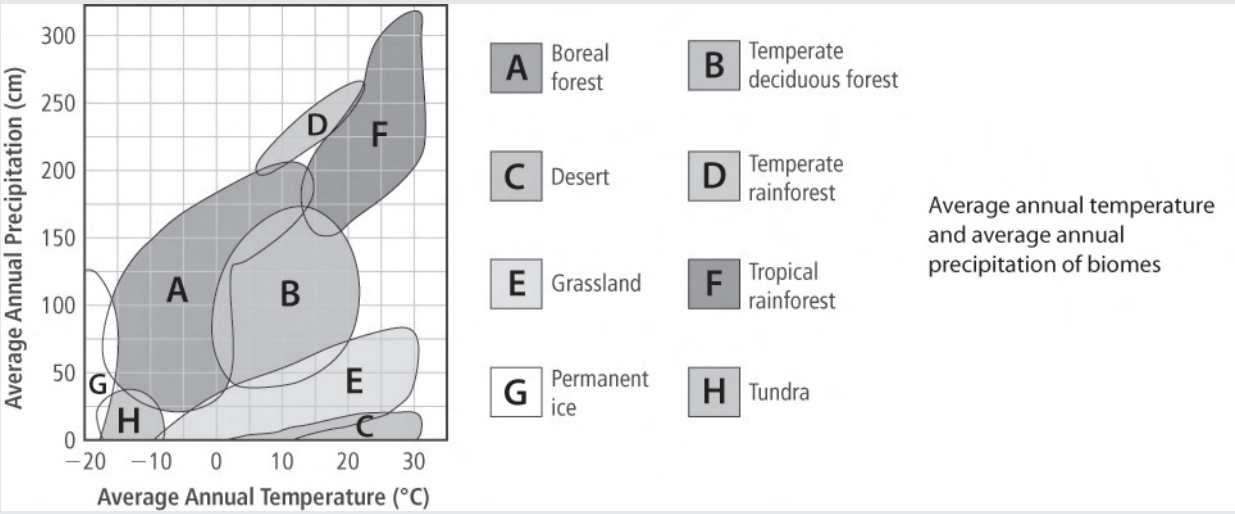
1. One way of classifying the biomes of the world is shown on page 6 of your Data Pages, which shows the following terrestrial (related to the land) biomes: boreal forest, desert, grassland, permanent ice, temperate deciduous forest, temperate rainforest, tropical rainforest, and tundra.
2. Similar biomes can exist far apart.
3. Tropical rainforests are found near the equator and have temperatures of 20°C to 25°C year-round, receive about 250 cm of rainfall per year, have a dark forest floor that limits plant growth there, and have plants and animals that survive in warm, wet environments.
4. Hot deserts are found on every continent at about 30° north and south latitude and have hot days with cold nights; receive less than 25 cm of precipitation per year, have soil that is salty, and have plants and animals that are able to live there because they can prevent water loss through their leaves or skin.
5. Permanent ice biomes are found near the poles and have very strong winds, receive less than 50 cm of precipitation a year, have very cold winter temperatures, and have plants that can tolerate drought and animals that have thick coats and fat layers for warmth.

Factors that Influence the Characteristics and Distribution of Biomes

1. **Annual** (yearly) **temperature** and **precipitation** (rainfall, snow, mist, and fog) are two of the most important abiotic factors that influence which biome will be in an area.
2. Other important abiotic factors include:
   - **Latitude**—the distance north and south from the equator. Latitude influences both temperature and precipitation. The tropical zone has very warm temperatures and high precipitation.
   - **Elevation**—the height above sea level. Higher elevations have less air, so retain less heat. Windward sides of mountains are wet, leeward sides are very dry.
   - Ocean currents carry warmth and moisture to coastal areas. Temperate biomes are found where warm currents meet land.

Quick Check

Use the Precipitation and Temperature Graph to answer the following questions.



1. (a) What is the highest average annual temperature that would be found in a grassland biome? _____

   (b) What is the range (lowest and highest) of annual average temperatures for a temperate deciduous forest biome? Highest _____ Lowest _____

   (c) What is the lowest average annual precipitation in a tropical rainforest biome? _____

   (d) What is the range (lowest and highest) of annual average precipitation in a boreal forest biome? Highest _____ Lowest _____

   (e) What is the highest average annual precipitation and temperature in a desert biome? Precipitation _____ Temperature _____

   (f) Which biomes can have both an annual average rainfall of less than 25 cm precipitation and a temperature below 0°C? _____ _____ _____

Use the Biomes of the World map on page 6 of your Data Pages to answer questions 2 and 3.

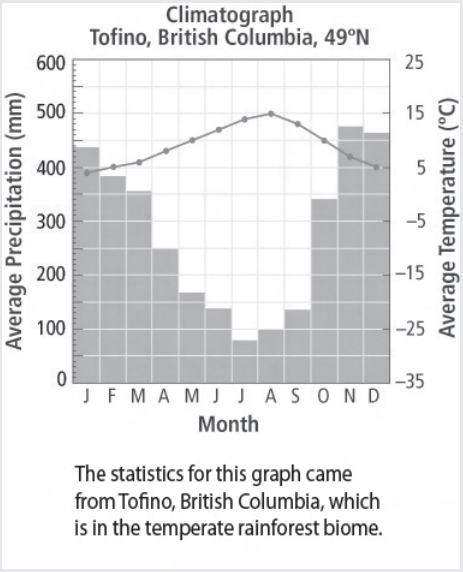
2. Which factor, latitude or elevation, is likely more responsible for the locations of the permanent ice biome? _____
3. Which factor, latitude or precipitation, is likely more responsible for the locations of the desert biome? _____

Climatographs

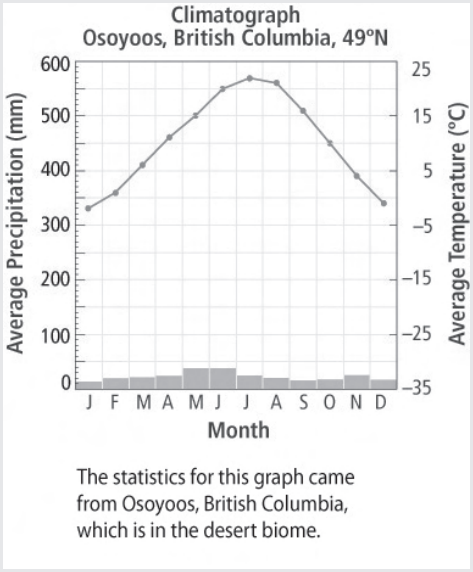
1. You can compare biomes using the information shown in climatographs.
2. A **climatograph** shows the average temperature and precipitation for a location over a period of 30 years or more.
3. The bars on the graph show the average precipitation.
4. The line on the graph shows the average temperature.

Quick Check

Examine the differences between the climatographs for Tofino and Osoyoos.



The statistics for this graph came from Tofino, British Columbia, which is in the temperate rainforest biome.



The statistics for this graph came from Osoyoos, British Columbia, which is in the desert biome.

1. (a) What does the horizontal axis of a climatograph show? _____

   (b) Does the line connecting the dots show temperature or precipitation? _____

   (c) What does the right vertical axis on a climatograph show? _____

   (d) What is the average temperature of Tofino in October? _____

   (e) What is the average temperature of Osoyoos in July? _____

   (f) In which month does Tofino have the lowest average temperature? _____

   (g) What does the left vertical axis on a climatograph show? _____

   (h) What is the average precipitation in Tofino in August? _____

   (i) How much precipitation is received in Osoyoos during its driest month? _____

   (j) How do the average temperatures compare for the two locations in October? _____

Adaptations and Biomes

1. Biomes are often identified with characteristic biotic factors, such as cactus in the desert or caribou on the tundra.
2. Many characteristic biotic factors have special adaptations for that biome. An **adaptation** is a characteristic that allows an organism to better survive and reproduce.
3. There are three types of adaptations:
   - Structural adaptation—a physical feature that helps an organism survive. For example, a wolf has large paws to help it run in snow.
   - Physiological adaptation—a physical or chemical event inside the body of an organism that allows it to survive. For example, a wolf maintains a constant body temperature.
   - Behavioural adaptation—a behaviour that helps an organism to survive. For example, wolves hunt in packs to capture large prey.

Quick Check

1. *What is meant by the term adaptation?* _____

   _____

   _____

2. *Identify each of the following characteristics of the common spotted owl as a structural, physiological, or behavioural adaptation.*

   (a) Its feathers have white spots on a brown background. _____

   (b) It maintains constant blood sugar levels. _____

   (c) It lines its nest with grass. _____

   (d) Its eyes face front to give depth perception. _____

   (e) It places cow dung at the front of its nest to hide from predators. _____

A Survey of Biomes of Canada

The main biomes of Canada are shown in the map below (Figure 1.1).

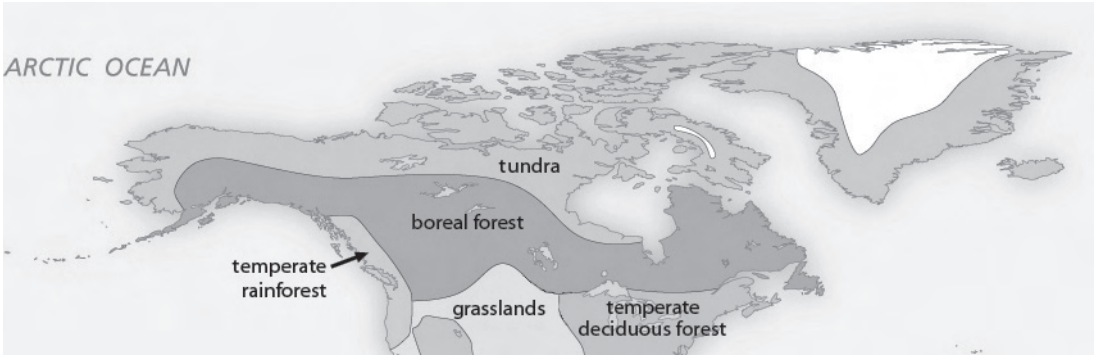


FIGURE 1.1 A map of Canadian biomes

1. Tundra (Figure 1.2)

- **Location:** 60° to 70° north latitude
- **Climate:** less than 25 cm precipitation annually
  Summer temperatures: 3°C to 12°C
  Winter temperatures: −20°C to −30°C
- **Physical Features:** flat layer of permafrost (permanently frozen soil); poor drainage; marshy in summer; 24 h daylight in brief summer; cold and dark in long winter
- **Plant Adaptations:** no trees due to permafrost; plants grow close to ground so they can absorb warmth and be sheltered; some plants have fuzzy coverings to protect them from wind; shrubs flower quickly; some plants keep old leaves for protection and to conserve nutrients
- **Animal Adaptations:** animals may grow more slowly and reproduce less often; Arctic foxes and hares have compact bodies and shorter legs and ears to reduce heat loss; the snowy owl has white colouring to blend in with surroundings; birds migrate here in summer to eat the many insects; caribou migrate away in winter to find food sources

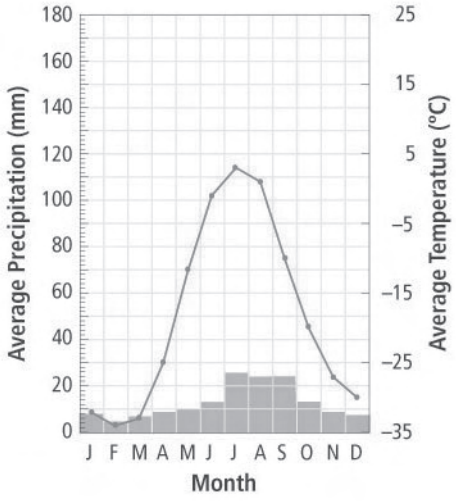


FIGURE 1.2 Alert, Nunavut, 82.5°N

2. Boreal Forest (Figure 1.3)

- **Location:** 45° to 65° north latitude
- **Climate:** precipitation, mostly snow, is 30 cm to 85 cm annually; temperatures are below freezing half the year
- **Physical Features:** short summer growing season; terrain is rough, soil is wet; many marshes, shallow lakes, and wetlands
- **Plant Adaptations:** trees are mostly coniferous, including spruce, and their waxy needles resist water loss and allow snow to slide off; little light reaches forest floor
- **Animal Adaptations:** insect-eating birds migrate south in fall, seed-eaters stay year-round; mammals have thick insulating coats; insects multiply rapidly; reptiles and amphibians are rare; snowshoe hares change fur from summer brown to winter white

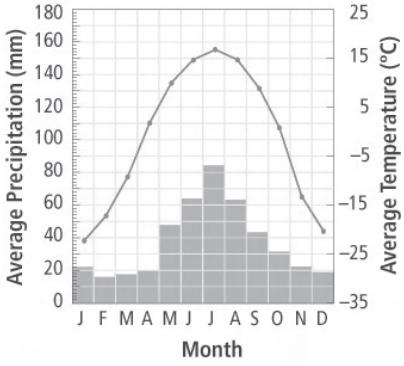


FIGURE 1.3 Fort Nelson, British Columbia, 59°N

3. Temperate Deciduous Forest (Figure 1.4)

- **Location:** eastern Canada, above 23.5° north latitude
- **Climate:** annual precipitation is 75 cm to 180 cm; temperatures range from −30°C winter to 30°C summer
- **Physical Features:** four distinct seasons; long, warm growing season; soil is enriched by fallen leaves; large seasonal changes between summer and winter
- **Plant Adaptations:** plants grow in four to five layers, with tall trees (maple, oak, and birch) in canopy layer, shorter trees in second layer, shrubs in third layer, berries in fourth layer, and ferns, herbs, and mosses on forest floor; deciduous trees shed leaves in winter to prevent water loss and reduce breakage of limbs with heavy snow
- **Animal Adaptations:** many animals live in the different layers of forest; some mammals hibernate; many birds migrate away in winter; chipmunks and blue jays store nuts and seeds in tree hollows

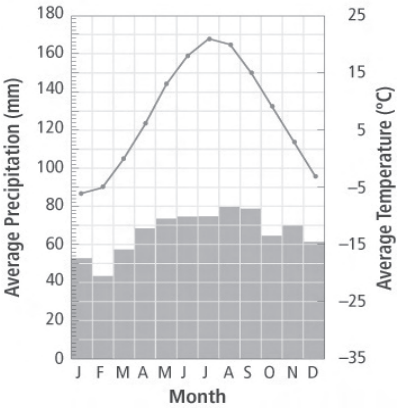


FIGURE 1.4 Toronto, Ontario, 44°N

4. Temperate Rainforest (Figure 1.5)

- **Location:** 38° to 61° north latitude, along coast of British Columbia
- **Climate:** more than 200 cm precipitation per year; average temperatures 5°C to 25°C
- **Physical Features:** biome occurs in narrow strips along coastlines backed by mountains where ocean winds drop large amounts of moisture on windward side of mountains
- **Plant Adaptations:** trees, such as Sitka spruce and Douglas fir, grow very tall; mosses on trees; ferns, mosses, and fungi on forest floor
- **Animal Adaptations:** most animals live on or near forest floor; many birds and small mammals eat seeds that fall on forest floor; many insects live in tree bark, and birds with long beaks and amphibians with sticky tongues eat those insects

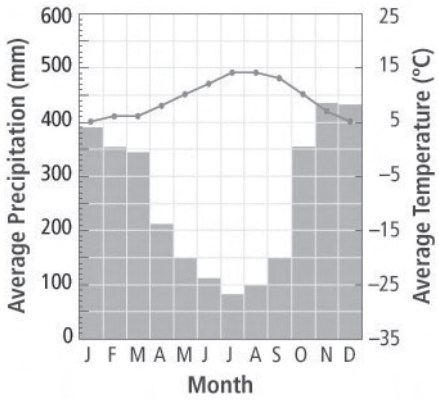


FIGURE 1.5 Pachena Point, British Columbia, 48°N

5. Grasslands (Figure 1.6)

- Also called temperate grasslands or prairies.
- **Location:** above 23.5° north latitude
- **Climate:** 25 cm to 100 cm precipitation annually; hot summers of 30°C and cold winters below −10°C
- **Physical Features:** land is mainly flat and soil is very rich and fertile; strong winds may cause soil erosion; precipitation usually occurs in late spring and early summer followed by an extended dry period
- **Plant Adaptations:** trees are scarce due to limited rainfall; grazing animals (animals that eat plants, such as grasses) and fire may kill seedlings; some grasses have sharp edges or are too bitter for grazing; grasses are adapted for drought and fire by having deep roots; grasses can bend without breaking in wind; many wildflowers pollinated by insects
- **Animal Adaptations:** large grazing mammals, such as antelope, have flat teeth that grind plant material; animals such as mice, rabbits, gophers, and snakes burrow to escape fire, predators, or extreme weather

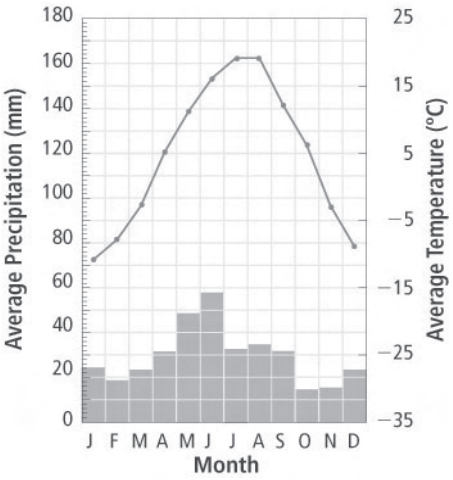


FIGURE 1.6 Manyberries, Alberta, 49°N

Quick Check

1. *Use the climatographs, biome map, and information above to answer the following questions.*
   (a) Which biome has the most constant temperature over the course of a year?

   _____

   (b) Which biome has the greatest range in monthly temperatures over the course of a year?

   _____

   (c) Which biome has the greatest range in monthly precipitation over the course of a year?

   _____

   (d) In which biome does precipitation exceed 100 mm in a single month? _____

   (e) For how many months of the year is the average temperature below freezing (0°C) in a grassland biome? _____
2. *Use the above data to compare animal adaptations.*
   (a) Which biome has large grazing animals as well as predators of the grazers?

   _____

   (b) In which biome do many animals live in different layers of the forest? _____

   (c) In which biome do insect-eating birds migrate south in the fall, while seed-eating birds stay year-round? _____
3. *Use the above data to compare plant adaptations.*
   (a) In which biome do the trees grow very tall? _____

   (b) In which biome are trees present but scarce due to limited rainfall? _____

   (c) Which biome is barren of trees? _____

III. Sample Exam Questions Explained

The Question	Why It Is Right/Why It Is Wrong
An ecologist gathers information about a forest of oak trees on a hillside characterized by mild, wet winters and hot, dry summers. Which of the following is a biotic factor?	
A. the rate of rainfall	A. Rainfall is an *abiotic* factor.
B. the temperature in winter	B. Temperature is an *abiotic* factor.
C. the spacing of the trees	C. This answer is correct.
D. mineral deposits in the area	D. Minerals are an *abiotic* factor.

➜ Why was this question asked?

This question was asked to determine if you can distinguish between biotic and abiotic factors.

➜ Where can I get extra practice on this type of question?

- Use page 9 in *BC Science 10*.
- Go to www.bcscience10.ca for extra practice.

The Question	Why It Is Right/Why It Is Wrong
You may wish to use the Biomes of the World map on page 6 of your Data Pages to help you answer the following question.	
Which of the following is a characteristic of the temperate rainforest?	
A. Trees grow very tall.	A. This answer is correct.
B. Trees are mainly maple, oak, and birch.	B. Maple, oak, and birch trees are found in temperate *deciduous* forests.
C. It is found on every continent except Antarctica.	C. Temperate rainforests are not found in Africa or Antarctica.
D. The soil is rich and fertile.	D. This is a characteristic of grassland.

➜ Why was this question asked?

This question was asked to determine if you distinguish the different biomes from each other based on important defining characteristics.

➜ Where can I get extra practice on this type of question?

- Use pages 20 to 25 in *BC Science 10*.
- Go to www.bcscience10.ca for extra practice.

IV. Practice Questions

Section 1.1

Biomes and ecosystems are divisions of the biosphere: Biomes

Circle the letter of the best answer.

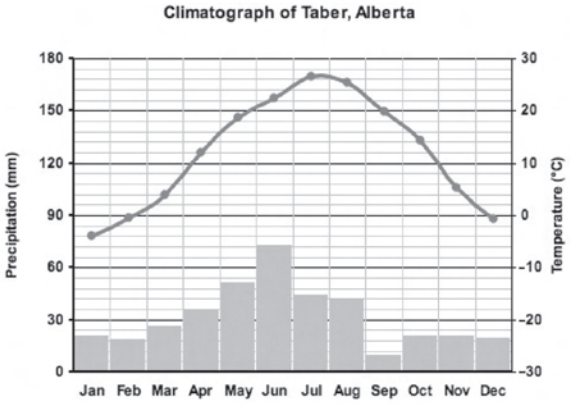
1. Which biome is **not** found in Canada?
   A. boreal forest
   B. temperate deciduous forest
   C. temperate rainforest
   D. tropical rainforest

2. Students made lists of the biotic and abiotic components of their neighbourhood. Which of the following lists describes only abiotic components of their neighbourhood?
   A. fungi, flower, water
   B. temperature, latitude, soil
   C. sunlight, moisture, bacteria
   D. grass, precipitation, latitude

3. Snowshoe hares of the boreal forest have fur that changes from summer brown to winter white to camouflage them from predators. What kind of adaptation is this an example of?

   A. chemical adaptation
   B. structural adaptation
   C. behavioural adaptation
   D. physiological adaptation

Use the following climatograph of Taber, Alberta, to answer question 4.

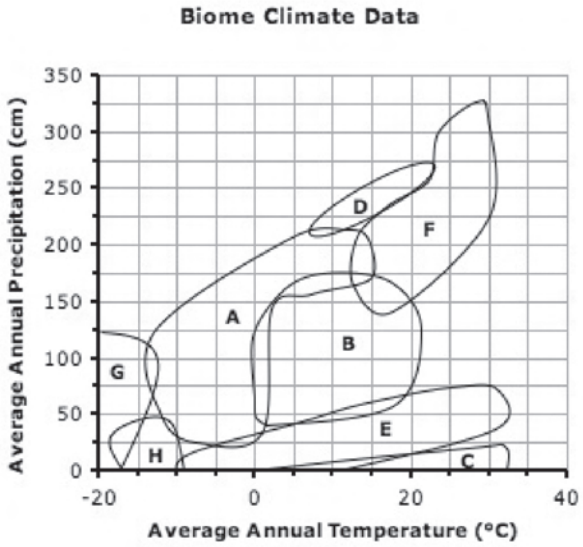


4. In which biome is Taber, Alberta, located?
   A. temperate deciduous forest
   B. boreal forest
   C. grassland
   D. desert

5. Which feature below is **not** a biotic component of a boreal forest biome?
   A. mammals with thick, insulating coats
   B. many marshes, shallow lakes, and wetlands
   C. coniferous trees with waxy needles to resist water loss
   D. small mammals that burrow in the ground to stay warm

6. Which combination of abiotic factors best explains why the regions along the equator receive the greatest amount of precipitation?
   A. sunlight and latitude
   B. sunlight and elevation
   C. latitude and ocean currents
   D. ocean currents and elevation

Use the following graph to identify the biome described in question 7.



A = Boreal forest

B = Temperate deciduous forest

C = Desert

D = Temperate rainforest

E = Grassland

F = Tropical rainforest

G = Permanent ice

H = Tundra

7. Which region has high average annual precipitation and an average temperature between 15°C and 30°C?

   A. temperate deciduous forest
   B. temperate rainforest
   C. tropical rainforest
   D. desert

8. Which of the following animal and plant adaptations is a physiological adaptation?

   A. Caribou of the tundra biome migrate to food sources in winter.
   B. Arctic foxes of the tundra biome have compact bodies and shorter legs and ears, which reduce heat loss.
   C. Grasses of the grassland biome have deep roots that form dense mats to collect water when it is available.
   D. Plants in the desert biome produce chemicals that protect them from being eaten by animals.

9. No trees grow above the tree line in the tundra biome of northern Canada. Which combination of abiotic factors of the tundra biome can best explain the absence of trees?

   A. soil, sunlight, temperature
   B. soil, moisture, ocean currents
   C. root growth, sunlight, temperature
   D. precipitation, elevation, temperature

10. Which kind of biome would you expect to find in an area with the characteristics listed below?

    - very tall trees
    - along the coastline
    - bordered by mountains on one side
    - average temperature range from 5°C to 25°C

    A. tropical grassland
    B. tropical rainforest
    C. temperate rainforest
    D. temperate deciduous forest

1.2 Ecosystems

I. Summary of Key Points

- The abiotic components of an ecosystem support the life functions of the biotic components of the ecosystem.
- Organisms within communities constantly interact to obtain resources such as food, water, sunlight, or habitat.
- Examples of these interactions in ecosystems include commensalism, mutualism, parasitism, competition, and predation.
- Every organism has a special role, or niche, within an ecosystem.

II. Study Notes

Parts of an Ecosystem

1. Within biomes are different ecosystems.
2. An **ecosystem** is a network of interactions linking biotic factors (organisms) and abiotic factors (air, water, soil, etc.).
3. Ecosystems can take up many hectares of land, such as the antelope brush grasslands of South Okanagan Valley, or can be small, such as a rotting log.
4. Within ecosystems are different habitats.
5. A **habitat** is where an organism lives, such as between the rocks at the bottom of a tidepool or in the bark of a rotting log.

Quick Check

1. Put the following divisions of life on Earth in order from the smallest to the largest:

   biome, biosphere, ecosystem, habitat

   _____

   _____

   _____

   _____

Abiotic Interactions in Ecosystems

1. Abiotic components of ecosystems include the following.
   - *Oxygen* is produced by the green plants and certain micro-organisms and is used by animals and most other micro-organisms.
   - Without *water*, no organism would survive. The cells of most living things contain between 50 and 90 percent water. Water carries nutrients from one place to another in an ecosystem.
   - ***Nutrients***, such as carbon, nitrogen, and phosphorus, are materials that organisms need to live and grow.
   - *Light* is required for **photosynthesis**, a chemical reaction that converts solar energy into chemical energy usable by plants. Photosynthesis provides energy to the ecosystem. The forest canopy receives more light than the forest floor; deep water receives less light than surface water.
   - *Soil* not only contains water and nutrients but also is home to many plants and animals.

Ecological Hierarchy

1. **Ecology** is the study of the relation of organisms to their environment and to each other.
2. A species is a group of closely related organisms that can reproduce with one another.
3. The biotic interactions in an ecosystem can be arranged into an ecological hierarchy. (Figure 1.7
   - An **ecological hierarchy** is the order of relationships in an ecosystem: organism, population, community, and ecosystem.

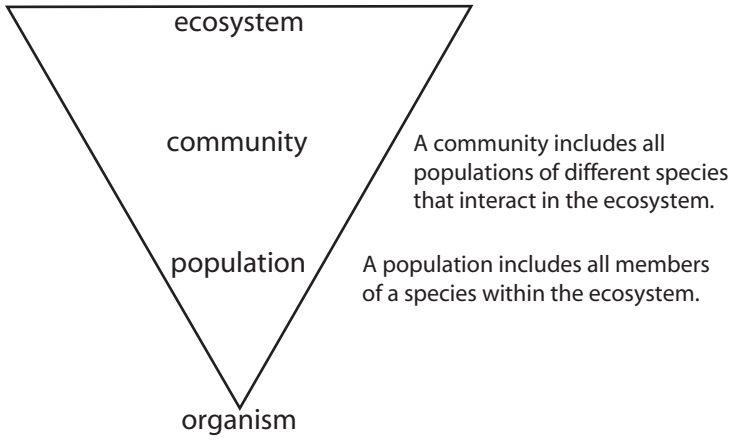


FIGURE 1.7 Ecological hierarchy

Quick Check

1. What is ecology?

   _____

   _____

2. What is the term for the order of relationships that go from organism to population to community to ecosystem? _____
3. What term refers to how many organisms of a particular species live in an ecosystem?

   _____
4. What term refers to all the different kinds of species present in an ecosystem?

   _____

Biotic Interactions in Ecosystems and **Symbiotic Relationships**

1. **Symbiosis** is a relationship in which two different organisms live together in a close association.
2. Examples of symbiotic relationships include the following.
   - **Commensalism**—one organism benefits and the other organism is not affected, such as the barnacles on a whale
   - **Mutualism**—both organisms benefit, such as a bee gathering nectar from a flower
   - **Parasitism**—one organism benefits and the other organism is harmed, such as mountain pine beetles destroying a lodgepole pine forest
     – A **host** is the organism that a parasite lives in or on.

Niches, Competition, and **Predation**

1. A **niche** refers to the role an organism has within an ecosystem, which means how an organism fits into and contributes to its environment physically, chemically, and biologically.
2. **Competition** is an interaction that occurs between two or more organisms when they need the same resource (such as food) in the same location at the same time.
   - For example, coyotes will compete with each other in areas where only smaller animals, such as mice, are available for food. However, they will cooperate with each and hunt in packs if larger animals, such as deer, are available for food.
   - Competition can limit the size of a population because organisms need energy to compete as well as to grow and reproduce.
3. **Predation** is the relationship where one organism (the predator) kills and consumes another organism (the prey).
   - Predators have adaptations to help them catch their prey, such as sharp teeth or good eyesight.
   - Prey have adaptations, such as spines, shells, camouflage, and mimicry, to help avoid predators.
   - The numbers of predators and prey influence each other.
     - The prey population grows when there are few predators.
     - The prey population shrinks when there are many predators.

Quick Check

1. Spanish moss grows on cedar trees in the temperate rainforests of British Columbia. The moss benefits from the physical support that a cedar tree provides. The cedar tree is not benefitted by the moss, but nor is it harmed. What relationship exists between the Spanish moss and the cedar tree?

   _____

   _____

2. The hookworm uses its teeth to attach to the wall of a dog's intestine so that it can feed on the dog's blood. Explain why the hookworm is considered a parasite.

   _____

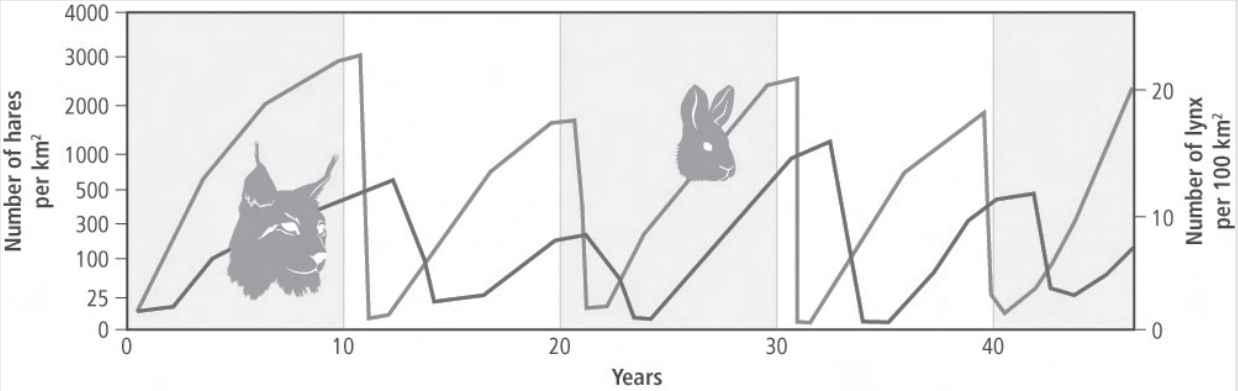
   _____

3. The great blue heron feeds on fish while standing in water. Its special role is to stand and fish in deep water where other species of herons with shorter legs cannot fish. What term best describes the great blue heron's special place within its ecosystem? _____
4. A plant called spotted knapweed grows wild across the rangelands of British Columbia. It is able to release chemicals into the soil that prevent the growth of other types of plants. Does this kind of interaction demonstrate competition, mutualism, predator/prey interaction, or symbiosis?

   _____

Quick Check

Use the following graph to answer question 1.



1. The lynx is a predator and the snowshoe hare is a prey. In which years did the predator population decrease, likely due to a decrease in the prey population?

   _____

Biodiversity in Ecosystems

1. **Biodiversity** is the variety of all living species of plants, animals, and micro-organisms.
2. Each ecosystem, such as a forest or a wetland, has unique biotic and abiotic components that contribute to the availability of food, water, and nutrients for all organisms.
   - For example, forest ecosystems prevent soil erosion, store nutrients, control climate, provide habitats for mammals, birds, fish, and amphibians, and provide timber and medicines.
3. Healthy ecosystems generally have high biodiversity.
4. Most biodiversity losses occur from the loss of habitat.
5. Humans often have a negative impact on biodiversity, such as by cutting forests and building cities.
6. Many efforts are now made to lessen human impact in order to maintain biodiversity.
7. Ecological management programs try to balance human progress with maintaining biodiversity.

III. Sample Exam Questions Explained

The Question	Why It Is Right/Why It Is Wrong
Which of the following is an example of parasitism?	
A. Aphids are tiny insects that produce a secretion called honeydew that is beneficial to ants. Ants use the honeydew and in return provide the aphids with protection from predators.	A. Both organisms benefit from the relationship, so this is called mutualism.
B. Lichens, found everywhere on Earth, are a combination of an alga, which produces sugars through photosynthesis, and a fungus, which provides minerals, water, and protection. Both organisms benefit from these processes.	B. Both organisms benefit from the relationship, so this is called mutualism.
C. The mountain pine beetle burrows into pine trees, lays eggs, and feeds on the tree, damaging or killing the tree.	C. This answer is correct because one organism benefits while the other is harmed.
D. An insect called a millipede attaches to a bird, which flies unharmed by the millipede. The millipede benefits by being transported to new habitats.	D. The millipede benefits, but the bird neither benefits nor is harmed. This is called commensalism.

➜ Why was this question asked?

This question was asked to determine if you understand symbiotic relationships. Symbiosis refers to the interaction between the members of two different species. Three important symbiotic relationships are commensalism (one benefits, the other neither benefits nor is harmed), mutualism (both benefit), and parasitism (one benefits, the other is harmed).

➜ Where can I get extra practice on this type of question?

- Use pages 40 to 43 in *BC Science 10*.
- Go to www.bcscience10.ca for extra practice.

The Question	Why It Is Right/Why It Is Wrong
The Chemainus River ecosystem on Vancouver Island includes bears, eagles, deer, elk, and foxes. What term best describes the grouping of all these types of animals?	
A. population	A. A population refers only to the animals of one species.
B. community	B. This answer is correct because a community refers to all the populations of different species that interact in an ecosystem or area.
C. species	C. A species is a group of animals that are similar enough to mate and produce offspring capable of reproducing.
D. habitat	D. A habitat is the place where an organism lives.

➜ Why was this question asked?

This question was asked to determine if you understand the biotic interactions (also called the ecological hierarchy) within an ecosystem. A hierarchy is a kind of structure in which various components are related. In an ecological hierarchy, the interactions are ordered as organism, population, community, and ecosystem.

➜ Where can I get extra practice on this type of question?

- Use pages 36 to 39 in *BC Science 10*.
- Go to www.bcscience10.ca for extra practice.

IV. Practice Questions

Section 1.2

Biomes and ecosystems are divisions of the biosphere: Ecosystems

Circle the letter of the best answer.

1. What is the best reason to explain why fewer plants can grow in deep water than can grow in shallow water in a marine ecosystem?
   A. There are more predators in deep water.
   B. The temperature of the water is colder at deep levels.
   C. Water pollution is more concentrated at deep levels than at shallow water levels.
   D. The amount of light available for photosynthesis is less in deep water than in shallow water.

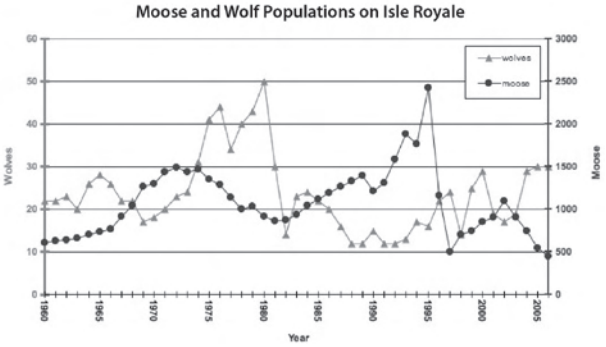
2. What is the largest division of the biosphere?
   A. biome
   B. habitat
   C. ecosystem
   D. population

3. Barnacles attach to whales and are transported to new locations in the ocean to find new food sources. Whales are not harmed in this process. What type of symbiotic relationship is this an example of?
   A. parasitism
   B. mutualism
   C. interaction
   D. commensalism

4. What is the correct order of the ecological hierarchy, from smallest to largest?
   A. ecosystem, population, community, organism
   B. organism, community, population, ecosystem
   C. organism, population, community, ecosystem
   D. population, ecosystem, organism, community

5. Which of the following statements about mutualism is false?
   A. Mutualism is a symbiotic relationship in which both organisms benefit.
   B. In some mutualistic relationships, two species are unable to survive without each other.
   C. In one type of mutualism, one species defends another species against attacks in return for food and shelter.
   D. One species protects another species from predators by camouflage. The host species is not harmed in the relationship.

6. **Use this graph of the population of moose and wolf to answer the question below.**



Isle Royale in Lake Superior has been designated an International Biosphere Reserve. The wolves of Isle Royale have no natural predators and primarily hunt and eat moose. In what years did the prey population increase likely due to a decline in the predator population?

   A. 1963–1966
   B. 1985–1988
   C. 1978–1981
   D. 2003–2006

7. A crab lives on a beach, which is where the crab finds food, shelter and a space to live. For the crab, the beach is an example of what division of the biosphere?

   A. niche
   B. habitat
   C. ecosystem
   D. community

8. Which of the following statements about water is **not** true?

   A. Water anchors plants in place.
   B. Without water, no organism would survive.
   C. Water carries nutrients from one place to another in an ecosystem.
   D. The cells of most living organisms contain between 50 and 90 percent water.

9. A biologist wants to introduce a new species (species A) into an ecosystem. Species B already lives in the ecosystem and occupies the same niche as species A. What will be the likely outcome if species A is introduced into the ecosystem?

   A. mutualism between the two species
   B. parasitism of species B by species A
   C. commensalism between the two species
   D. competition between species A and species B

10. Which of the following characteristics are common adaptations of predators?

I	good eyesight
II	mimicry
III	sharp, pointed teeth

   A. I only
   B. I and III only
   C. I, II, and III
   D. II and III only

Chapter 2 Energy flow and nutrient cycles support life in ecosystems.

2.1 Energy Flow in Ecosystems

I. Summary of Key Points

- In an ecosystem, energy flows from producers (plants) to primary consumers (herbivores) to secondary and tertiary consumers (carnivores).
- Food chains and food webs model this energy flow and these feeding relationships.
- Each step on a food chain is called a trophic level.
- Food pyramids model how energy is lost at each trophic level in an ecosystem.

II. Study Notes

How Energy Flows in Ecosystems

1. Within an organism's niche, the organism interacts with the ecosystem by:
   - obtaining food from the ecosystem
   - contributing energy to the ecosystem
2. The flow of energy from an ecosystem to an organism and from one organism to another is called energy flow.
3. Plants are called **producers** because they produce food in the form of carbohydrates during photosynthesis.
4. Organisms that feed on other organisms are called **consumers.**
   - A consumer may also be an energy source if it is eaten by another consumer.
5. Organisms contribute to energy flow even after they die.
   - **Biodegradation** is the process by which dead organic matter is broken down naturally by biological agents, especially bacteria.
   - **Decomposers** are organisms, such as bacteria and fungi, that change wastes and dead organisms into usable nutrients for other organisms in soil and water.

Quick Check

1. Plants use sunlight and nutrients to produce carbohydrates. What it the term that describes the role of plants in an ecosystem? _____
2. What does the term *energy flow* describe about an ecosystem? _____
   _____
3. What is the role of a decomposer in an ecosystem? _____
   _____
4. Describe each of the following as a producer, consumer, or decomposer (more than one may apply).
   (a) breaks down fallen leaves _____
   (b) does not need to consume other organisms to live _____
   (c) assists with biodegradation _____
   (d) is the first step in energy flow through an ecosystem _____
   (e) may consume another consumer _____

Energy Flow and Energy Loss in Ecosystems

1. **Food chains** show the flow of energy in an ecosystem from producer to consumer and from consumer to consumer.
2. Consumers in a food chain can be classified as:
   - **Detrivores**—consumers that eat dead organisms and waste matter.
     Examples: beetle, earthworm
     – Detrivores are an important energy source for consumers such as birds.
   - **Herbivores**—consumers that eat only plants
     Examples: deer, grasshopper
   - **Carnivores—**consumers that eat animals
     Examples: frog, hawk
   - **Omnivores**—consumers that eat both plants and animals
     Examples: human, black bear
3. A **trophic level** is the number of energy transfers an organism is from the original solar energy entering the food chain.
4. Each step in a food chain is a trophic level (Figure 2.1).

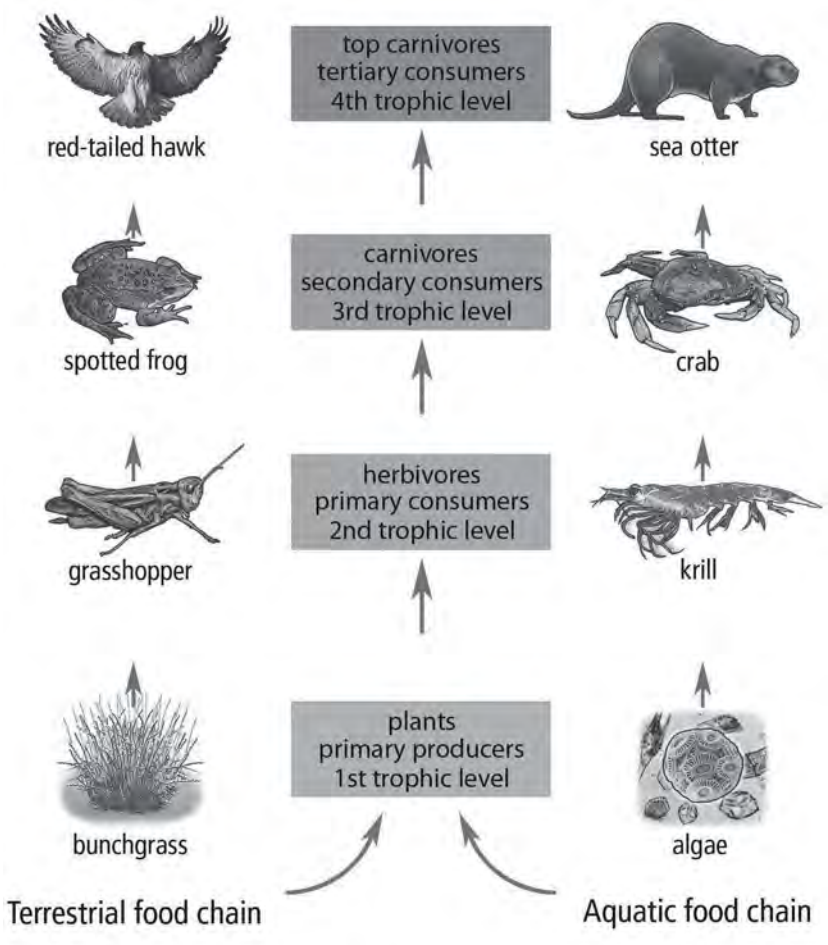


FIGURE 2.1 A terrestrial food chain and an aquatic food chain show the flow of energy up the trophic levels.

Quick Check

1. Draw a food chain that contains the following five organisms: grass, black bear, earthworm, cougar, rabbit. Label the grass as producer, and label each of the other organisms according to the kind of consumer that they are.

2. A fox's diet can contain beetles, eggs, berries, fish, and mice. What kind of consumer is a fox?

   _____

3. Which is most likely to occupy the second trophic level in a food chain: a potato, a worm that eats the potato, a bird that eats the worm, or a fox that eats the bird?

   _____

Food Webs

1. Most organisms are part of many food chains.
2. You can show the interconnections of food chains by using a food web (Figure 2.2).
3. A **food web** is a model of the feeding relationship in an ecosystem.
4. Arrows in a food web represent the flow of energy and nutrients.
5. Following the arrows in a food web leads to the top carnivore(s).

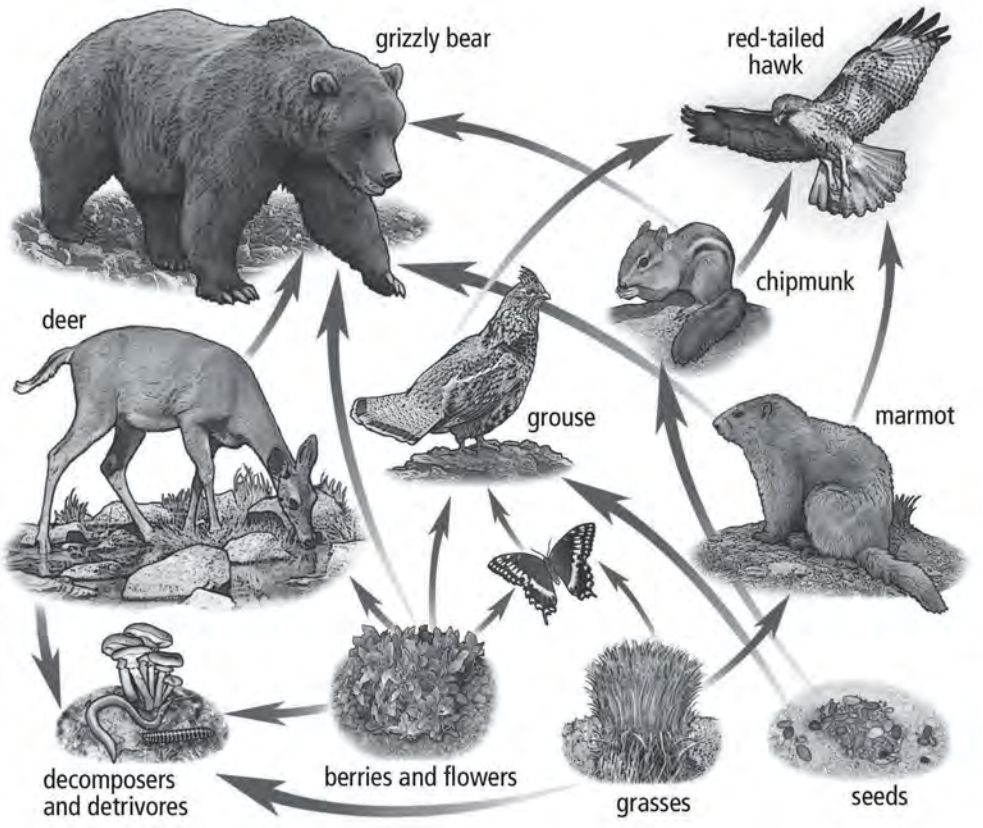


FIGURE 2.2 A food web in a terrestrial ecosystem.

Quick Check

1. Which two members of the food web above are omnivores?

   _____ _____

2. Which two members of the food web above are tertiary consumers?

   _____ _____

Food Pyramids

1. **Food pyramids**, also called **ecological pyramids**, show the changes in available energy from one trophic level to another in a food chain.
2. Energy enters at the first tropic level (producers), where there is a large amount of biomass.
3. Biomass is the total mass of all living things in a given area.
4. Lower trophic levels have much larger populations than upper levels.
5. It takes large quantities of organisms in one tropic level to meet the energy needs of the next trophic level.

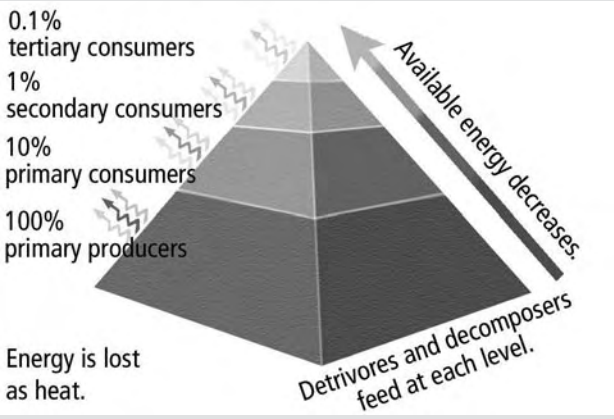
Energy Loss in Ecological Pyramids

1. Each trophic level of an ecological pyramid loses large amounts of the energy it gathers through basic processes of living.
2. Approximately 90 percent of energy taken in by consumers is used in chemical reactions in the body and is lost as heat energy.
   - There is very little energy left over for growth or increase in biomass.

Types of Ecological Pyramids

1. Types of ecological pyramids include the following.
   - A **pyramid of numbers** shows the number of organisms at each trophic level.
   - A **pyramid of biomass** shows the number of organisms at each trophic level multiplied by their mass, which compensates for differences in size among organisms.
   - A **pyramid of energy** shows the amount of energy that is available at each trophic level.
2. The amount of life an ecosystem can contain is based on the bottom level of the ecological pyramid, where producers capture energy from the Sun.
3. It is very important to maintain biodiversity and large populations at the lowest levels of the ecological pyramid.

Quick Check



1. What type of ecological pyramid is shown here? _____
2. Approximately how much energy is lost from producers to secondary consumers?

   _____

III. Sample Exam Questions Explained

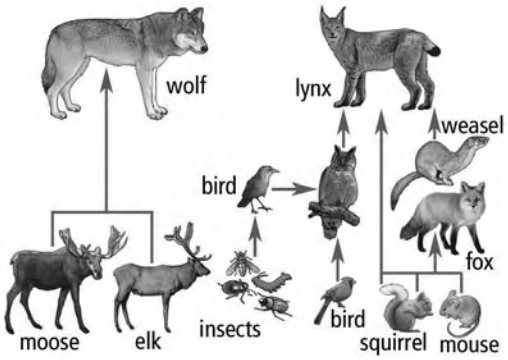
The Question	Why It Is Right/Why It Is Wrong
Use the following food chain to answer the next question. Wolves → eagles → pheasants Which of the following is likely to happen if a large number of mice are removed from the area?	
A. an increase in the rabbit population	A. The rabbit population will decrease as wolves are not able to eat as many mice.
B. an increase in the eagle population	B. The eagle population will stay the same or decrease since there are fewer mice to eat.
C. a decrease in the squirrel population	C. This answer is correct because with fewer mice to eat, wolves will prey on squirrels more.
D. a decrease in the populations of grasses, seeds, and nuts	D. These populations of plants will likely increase since there will be fewer mice feeding on them.

➜ Why was this question asked?

This question was asked to determine if you understand the different relationships within a food web (including producers, herbivores, carnivores, and decomposers and detrivores).

➜ Where can I get extra practice on this type of question?

- Use pages 60 to 62 in *BC Science 10*.
- Go to www.bcscience10.ca for extra practice.

The Question	Why It Is Right/Why It Is Wrong
Use the following food web to answer the next question.  Identify a tertiary consumer from the food web above.	
A. elk	A. An elk is a primary consumer (since it is a herbivore).
B. mouse	B. A mouse is a primary consumer (since it is a herbivore).
C. bird	C. A bird is a secondary consumer because it is a carnivore that itself can get eaten.
D. lynx	D. Lynx is the correct answer because a lynx eats secondary consumers.

➜ Why was this question asked?

This question was asked to determine if you understand the different relationships within a food web (including producers, consumers, herbivores, carnivores, and decomposers and detrivores).

➜ Where can I get extra practice on this type of question?

- Use pages 60 to 62 in *BC Science 10*.
- Go to www.bcscience10.ca for extra practice.

IV. Practice Questions

Section 2.1

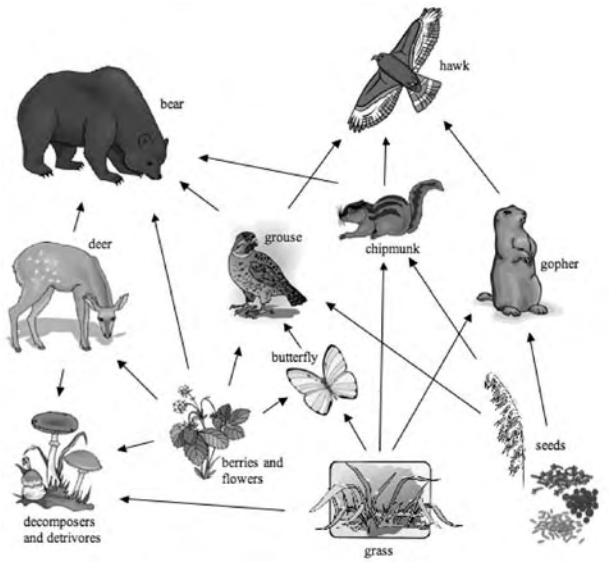
Energy flow and nutrient cycles support life in ecosystems: Energy Flow in Ecosystems

Circle the letter of the best answer.

1. Which of the following statements about biomass is true?
   A. Food webs are used to show the available biomass in an ecosystem.
   B. Biomass is usually expressed in units of metres per gram or kilogram.
   C. Biomass is the total mass of living plants, animals, fungi, and bacteria in a particular area.
   D. The biomass of animals on Earth is over 100 times greater than the biomass of plants.

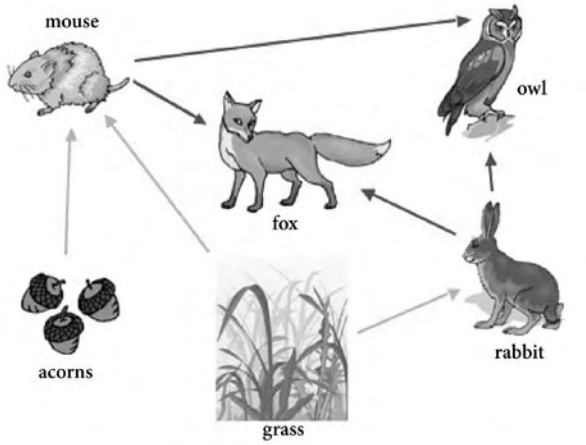
2. A field of wheat is an example of which member of a food chain?
   A. decomposer
   B. biodegrader
   C. consumer
   D. producer

Use this picture of a food web to answer question 3.



3. Which is the best description for the role of the grizzly bear in this food web?
   A. detrivore
   B. omnivore
   C. carnivore
   D. herbivore

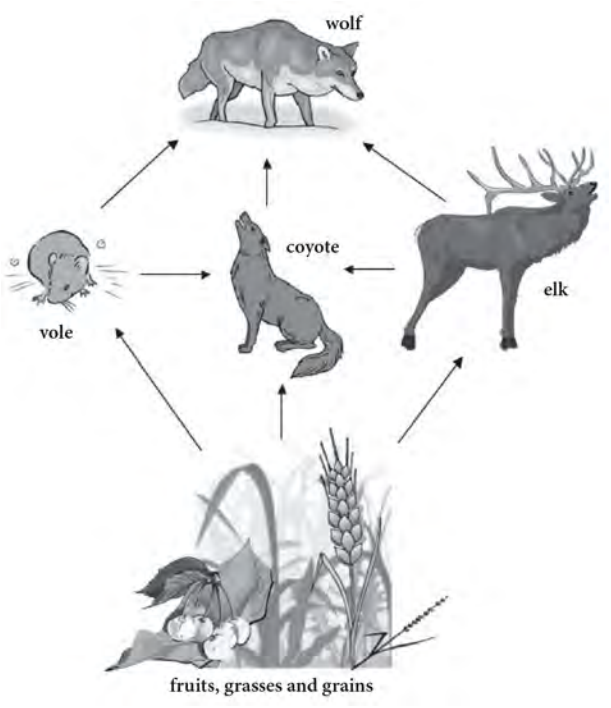
Use this picture of a food web to answer questions 4 and 5.



4. Which organisms in this food web are the primary consumers?
   A. owl and fox
   B. rabbit and fox
   C. acorns and grass
   D. rabbit and mouse

5. At which trophic level is the fox in this food web?
   A. first
   B. second
   C. third
   D. fourth

Use this picture of a food web to answer question 6.



6. Which is the best description for the role of the wolf in this food web?
   A. herbivore
   B. omnivore
   C. carnivore
   D. top carnivore

7. What is the best example of a detrivore from the list below?
   A. earthworm
   B. green algae
   C. grasshopper
   D. spotted frog

8. Your teacher asks you to design a diagram to show the models of feeding relationships within an ecosystem. Which type of model should you choose?
   A. food web
   B. food chain
   C. food pyramid
   D. ecological pyramid

9. What is the best reason for why an ecosystem supports fewer organisms at higher trophic levels than at lower trophic levels?
   A. Competition among organisms is more intense at higher trophic levels.
   B. Most of the food energy consumed is used for growth and to increase biomass.
   C. Animals are part of more than one food chain and eat more than one kind of food.
   D. There is a huge decrease in energy from lower trophic levels to higher trophic levels.

10. At the producer level of a food pyramid, there is 455 000 kcal/m^2 of energy available. If there is a 90 percent energy loss at each level, how many kilocalories will be incorporated into the bodies of the secondary consumers?
    A. 455 kcal/m^2
    B. 4550 kcal/m^2
    C. 45 500 kcal/m^2
    D. 500 500 kcal/m^2

2.2 Nutrient Cycles in Ecosystems

I. Summary of Key Points

- Earth's biosphere is like a sealed terrarium in which all nutrients that support life and all wastes that are produced are constantly recycled within its boundaries.
- The carbon cycle, nitrogen cycle, and phosphorus cycle move nutrients into and out of terrestrial and aquatic ecosystems.
- Human activities such as land clearing, agriculture, industry, and motorized transportation can affect nutrient cycles.

II. Study Notes

The Cycling of Nutrients in the Biosphere and the Carbon, Nitrogen, and Phosphorus Cycles

1. Nutrients are chemicals that are required for plant and animal growth and other life processes.
   - All the nutrients that support life and all the wastes that are produced recycle through the biosphere.
2. Nutrients move through the biosphere in nutrient cycles, or exchanges.
3. Nutrients are accumulated in "stores" for short or long periods in Earth's atmosphere, oceans, and land masses.
4. Without interference, the amount of nutrients flowing into a store generally equals the amount of nutrients flowing out.
5. Human activities can upset the natural balance of nutrient cycles.
   Example: Clearing forest land for agriculture, roads, and cities reduces the total amount of carbon (in the form of carbon dioxide) taken from the atmosphere by plants.
6. Land clearing, agriculture, urban expansion, mining, industry, and motorized transportation can all increase the levels of nutrients more quickly than the stores can absorb them.
7. Four essential chemical nutrients are:
   - carbon, oxygen, and nitrogen, which cycle between organisms and the atmosphere, and are found in proteins and DNA in every living organism
   - phosphorus, which cycles in from sedimentary rock

Quick Check

1. What does "nutrient" mean?_____

   _____

2. What is an example of human activity that can decrease the amount of carbon taken from the atmosphere by plants? _____

   _____

3. List four chemical elements that move through the biosphere as part of nutrient cycles.

   _____ _____

   _____ _____

How Carbon Is Stored

1. A **carbon store**, also called a **carbon sink,** is a short- or long-term accumulation of carbon.
2. Carbon is an essential part of the chemical reactions that sustain life.
   - All living things contain billions of carbon atoms in their cells.
3. Short-term shortage of carbon is found in aquatic and terrestrial organisms, and in carbon dioxide (CO_2) in the atmosphere and top layers of the ocean.
4. Longer-term storage is found in middle and lower ocean layers as dissolved CO_2, and in coal, oil, and gas deposits in land and ocean sediments.
5. The main carbon stores are shown in Table 2.1.

TABLE 2.1 Estimated Major Stores of Carbon on Earth

Carbon Store	**Amount of Carbon** (gT)
Marine sediments and sedimentary rock	68 000 000 to 100 000 000
Oceans (intermediate and deep water)	38 000 to 40 000
Coal deposits	3000
Soil and organic matter	1500 to 1600
Atmosphere	750
Terrestrial vegetation	540 to 610
Oil and gas deposits	300

Quick Check

1. What is another term that means a carbon store? _____
2. Refer to Table 2.1 to answer the following questions.
   (a) Is more carbon stored in the atmosphere or in oil and gas deposits? _____
   (b) Is the second-largest store of carbon a short-term or a long-term store? _____
   (c) Is more carbon stored in plants or in the soil that they grow in? _____
   (d) Which carbon store is larger than all the other carbon stores combined? _____

How Carbon Is Cycled through Ecosystems

1. **Carbon exchange** or the carbon cycle describes how carbon is moved through terrestrial and aquatic ecosystems.

Find each of the processes below in The Carbon Cycle, page 5 of your Data Pages.

2. *Photosynthesis* During photosynthesis, carbon, in the form of carbon dioxide, enters the leaves of plants and reacts with water in the presence of sunlight to produce energy-rich carbohydrates and oxygen.

$$6CO_2 + 6H_2O + \text{energy (sunlight)} \rightarrow C_6H_{12}O_6 + 6O_2$$

   - Photosynthesis also occurs in cyanobacteria (blue-green unicellular organisms) and **algae** (simple unicellular or multicellular organisms) in oceans.
3. ***Cellular respiration*** is the process in which both plants and animals release carbon dioxide back into the atmosphere by converting carbohydrates and oxygen into carbon dioxide and water.

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{energy}$$

   - The energy released is used for growth, repair, and other life processes.

4. *Decomposers*, such as bacteria and fungi, convert cellulose (carbohydrates in plants) back into carbon dioxide, which is released into the atmosphere.
5. *Carbonate formation* Carbon and oxygen dissolved in ocean water combine to form **carbonate** (CO_3^{2-}).
   - Carbonate is found in the shells of marine organisms.
   - When these organisms die, their shells can accumulate and gradually become limestone, which is a sedimentary rock.
6. *Volcanic activity* Sedimentary rock can be subducted and melted, and its carbon dioxide can be released in volcanic eruptions.
7. *Ocean mixing* involves the circulation of intermediate and deep waters in the ocean.
   - Ocean mixing absorbs CO_2 from the atmosphere at high latitudes and releases CO_2 to the atmosphere at tropical latitudes.

Human Activities and the Carbon Cycle

1. The amount of carbon dioxide gas in the atmosphere has increased by about 30 percent over the last 160 years.
   - This increase is due to human activities that involve burning **fossil fuels,** such as oil, gas, and coal, which releases carbon that was stored deep in Earth a long time ago.

Quick Check

Refer to The Carbon Cycle, page 5 of your Data Pages, to answer these questions.

1. How many gigatonnes of carbon are stored in each of the following locations?
   (a) the atmosphere _____
   (b) dissolved as organic carbon in the upper levels of the ocean _____
   (c) organic matter in the soil _____
2. Examine the carbon exchange values to answer the following questions.
   (a) Is carbon moving faster into the oceans or out of the oceans? _____
   (b) Does agriculture move more carbon into the air or out of the air? _____
   (c) Why does the exchange data for the fossil fuel combustion show carbon moving into the atmosphere but none moving out of the atmosphere? _____
   _____
3. How do volcanoes affect the amount of carbon in the atmosphere? _____

Nitrogen

1. Nitrogen is used to structure DNA and proteins, which are vital for muscle function in animals.
   - In plants, nitrogen is important for growth.
2. The largest store of nitrogen is in the atmosphere, where it exists in the form N_2.
3. Approximately 78 percent of Earth's atmosphere is N_2 gas, but most organisms cannot use this form of nitrogen.
4. Nitrogen is also stored in oceans and as organic matter in soil.
5. Smaller nitrogen stores are found in terrestrial ecosystems and waterways.

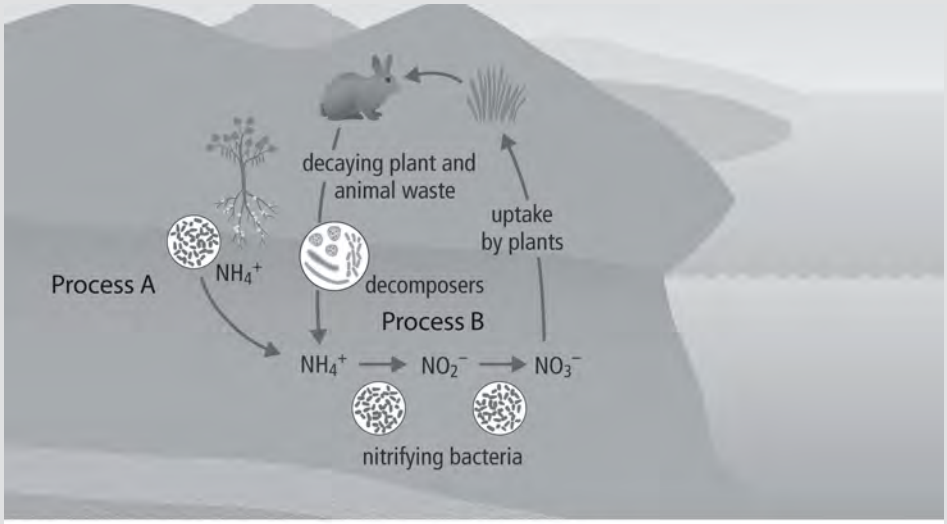
The Nitrogen Cycle

Find each of the processes below in the Nitrogen Cycle illustration, page 9 of your Data Pages.

1. *Nitrogen fixation* is the conversion of N_2 gas into compounds containing nitrate (NO_3^-) and ammonium (NH_4^+), which are usable by plants.
2. Nitrogen fixation occurs:
   - In the atmosphere—**lightning** (an atmospheric discharge of electricity) provides the energy for N_2 gas to react with O_2 gas to form nitrate and ammonium ions.
     - Compounds formed by these ions then enter the soil via precipitation.
     - This provides only a small amount of nitrogen fixation.
   - In the soil—nitrogen-fixing bacteria like *Rhizobium* convert N_2 gas into ammonium ions.
     - These bacteria grow on the root nodules of **legumes**, which are plants such as peas, beans, alfalfa, and clover that can fix atmospheric nitrogen.
     - The plants provide sugars, while bacteria provide nitrogen ions.
   - In the water—some cyanobacteria convert N_2 into ammonium during photosynthesis.
3. ***Nitrification*** is a two-step process that occurs when certain nitrifying bacteria convert ammonium into nitrite (NO_2^-). A different species of nitrifying bacteria converts the nitrite (NO_2^-) into nitrate (NO_3^-).
4. Decomposer bacteria and fungi convert the nitrogen trapped in the cells of dead organisms and convert it into ammonium (NH_4^+).
5. Nitrates enter plant roots through the process of *uptake*.
   - These nitrogen compounds compose plant proteins.
   - Herbivores eat the plants and use nitrogen for DNA and protein synthesis.

Quick Check

Use the following illustration to answer the next question.



The process of nitrification

1. Through Process A and Process B, nitrogen (N_2) moves from the atmosphere and becomes available to plants as a nutrient. What term identifies Process A? _____
2. What term identifies Process B? _____

_____

How Nitrogen Is Returned to the Atmosphere and Removed from Ecosystems

1. **Denitrification** is the process through which nitrogen is returned to the atmosphere.
2. In a series of chemical reactions, denitrifying bacteria convert nitrate (NO_3^-) back into nitrogen gas (N_2).
3. N_2 is also returned to the atmosphere through volcanic eruptions.
4. Excess nitrogen dissolves in water, enters the waterways, and washes into lakes and oceans.
5. Nitrogen compounds eventually become trapped in sedimentary rocks and are not released until the rocks weather.

Human Activities and the Nitrogen Cycle

1. Human activities have doubled the amount of available nitrogen in the biosphere in the last 50 years. This increase has been due to the following:
   - Burning fossil fuels and treating sewage releases nitrogen oxide (NO) and nitrogen dioxide (NO_2).
   - Burning also releases nitrogen compounds that increase acid precipitation in the form of nitric acid (HNO_3).
     - **Acid precipitation** has a lower pH (higher acidity) than precipitation that does not contain pollutants.
     - **pH** is a measure of how acidic or basic a solution is.
     - Acid precipitation has negative effects on forests, soils, and freshwater and the organisms living in those ecosystems.
   - Agricultural practices often use large amounts of nitrogen-containing fertilizers.
2. Excess nitrogen is washed away or leaches into the waterways.
   - Excess nitrogen promotes huge growth called "blooms" in aquatic algae.
   - Algal blooms use up CO_2 and O_2 and block sunlight, killing many aquatic organisms.
   - Algal blooms can also produce neurotoxins that poison animals.

Quick Check

1. How is the process of denitrification different from nitrogen fixation and nitrification?_____

   _____

2. List three human activities that increase the amount of available nitrogen in the biosphere.

   _____

3. Excess nitrogen in the ecosystem increases the amount of algal blooms. List two negative effects of algal blooms. _____

   _____

The Phosphorus Cycle

Find each of the processes mentioned below in the Phosphorus Cycle illustration, page 8 of your Data Pages.

1. **Phosphorus** is a chemical element that is essential for life processes in plants and animals.
   - Phosphorus is a part of the molecule that carries energy in living cells.
   - Phosphorus promotes root growth, stem strength, and seed production.
   - In animals, phosphorus is important for strong bones.
2. Phosphorus is not stored in the atmosphere.
3. Phosphorus is trapped in phosphates (PO_4^{3-}) found in rocks and in the sediments on the ocean floor.
4. Weathering releases these phosphates when geologic uplift exposes the rocks.
   - Geologic uplift refers to the process of mountain building in which Earth's crust folds and deeply buried rock layers rise and are exposed.
   - Chemical weathering releases phosphates via acid precipitation or lichens.
   - Physical weathering releases phosphates through wind, water, and freezing.
5. Phosphates are absorbed by plants, which are then eaten by animals.

Human Activities and the Phosphorus Cycle

1. Humans add excess phosphorus to the environment through commercial fertilizers, detergents, livestock farming, and industrial and human wastes.
2. Humans can also reduce phosphorus supplies.
   - Slash-and-burning of forests removes phosphorus from trees, and the phosphorus is then deposited as ash in waterways.

Quick Check

1. Unlike carbon and nitrogen, phosphorus is not stored in the atmosphere. Where is it stored?

   _____

2. Geologic uplift is the process in which mountains form as they are pushed up from below.
   How does geologic uplift relate to the phosphorus cycle? _____

   _____

3. How do phosphates that are present in rocks eventually make their way into animals? _____

   _____

4. How do humans add excess phosphorus into the environment? _____

   _____

How Changes in Nutrient Cycles Affect Biodiversity

1. Any significant changes to carbon, hydrogen, oxygen, nitrogen, or phosphorus can greatly affect biodiversity.
   - Carbon cycle changes are linked to climate change and global warming.
   - Increased levels of nitrogen can allow certain plant species to outcompete other species, decreasing the resources for every species in those food webs.
   - Decreased levels of phosphorus can inhibit the growth of algal species, which are very important producers in many food chains.
2. Slight temperature fluctuations and changes in water levels can drastically change ecosystems.
3. Changes influence every other organism in those food webs.

III. Sample Exam Questions Explained

The Question	Why It Is Right/Why It Is Wrong
What is nitrogen fixation?	
A. the application of nitrogen compounds to soil	A. Adding compounds or other materials to improve soil quality is called fertilization.
B. the removal of waste nitrogen from an ecosystem	B. The process of removing nitrogen from the soil and returning it to the atmosphere as nitrogen gas (N_2) is called denitrification. Nitrogen compounds can also be washed out of soil with rainwater in a process called leaching.
C. the conversion of nitrogen gas (N_2) into nitrogen containing compounds	C. This answer is correct. Fixing nitrogen means converting it from nitrogen gas into other chemical forms that can be used by plants and animals. The most important forms are as nitrates (NO_3^-), nitrites (NO_2^-), and ammonium (NH_4^+)
D. the release of nitrogen oxides from the exhaust of automobiles	D. Automobiles release nitrogen oxides, which are present in the air as smog. However, these are not useful ways to provide nitrogen to ecosystems. In fact, they combine with water to make acid precipitation, which is very harmful to the environment.

➜ Why was this question asked?

This question was asked to determine if you understand that the nitrogen in the atmosphere is not usable by most organisms and that nitrogen fixation is a process that makes it useful. Nitrogen must first be chemically converted or "fixed" by certain bacteria. Processes such as denitrification (turning nitrogen back into unusable nitrogen gas) and leaching (the washing away of nitrogen compounds with water) remove usable nitrogen from ecosystems.

➜ Where can I get extra practice on this type of question?

- Use pages 78 to 83 in *BC Science 10*.
- Go to www.bcscience10.ca for extra practice.

The Question	Why It Is Right/Why It Is Wrong
Refer to The Carbon Cycle on page 5 of your Data Pages to answer this question. Where is carbon stored in the greatest amount, as measured in gigatonnes?	
A. terrestrial vegetation	A. The data table gives a value of 540 to 610 gT.
B. coal, oil, and gas deposits	B. The data table gives a value of 300 gT.
C. the atmosphere	C. The data table gives a value of 750 gT.
D. sedimentary rocks and marine sediments	D. This answer is correct. The data table gives a value of 68 000 000 to 100 000 000 gT.

➜ Why was this question asked?

This question was asked to determine if you understand how to use the data table showing the carbon cycle, including reading values for the amounts of carbon (as gigatonnes) stored in different parts of the biosphere.

➜ Where can I get extra practice on this type of question?

- Use pages 71 to 77 in *BC Science 10*.
- Go to www.bcscience10.ca for extra practice.

The Question	Why It Is Right/Why It Is Wrong
Which of the following nutrients is **not** stored in the atmosphere?	
A. carbon	A. Carbon is present in the atmosphere primarily as carbon dioxide (CO_2).
B. nitrogen	B. Nitrogen is present in the atmosphere primarily as nitrogen gas (N_2).
C. oxygen	C. The oxygen we breathe is present in the air (about 21 percent).
D. phosphorus	D. This answer is correct. Phosphorus is trapped in compounds that make up phosphate rock and the sediments of ocean floors.

➜ Why was this question asked?

This question was asked to determine if you understand different properties of important elements (C, N, O, and P) in the biosphere and where they are located.

➜ Where can I get extra practice on this type of question?

- Use pages 84 and 85 in *BC Science 10*.
- Go to www.bcscience10.ca for extra practice.

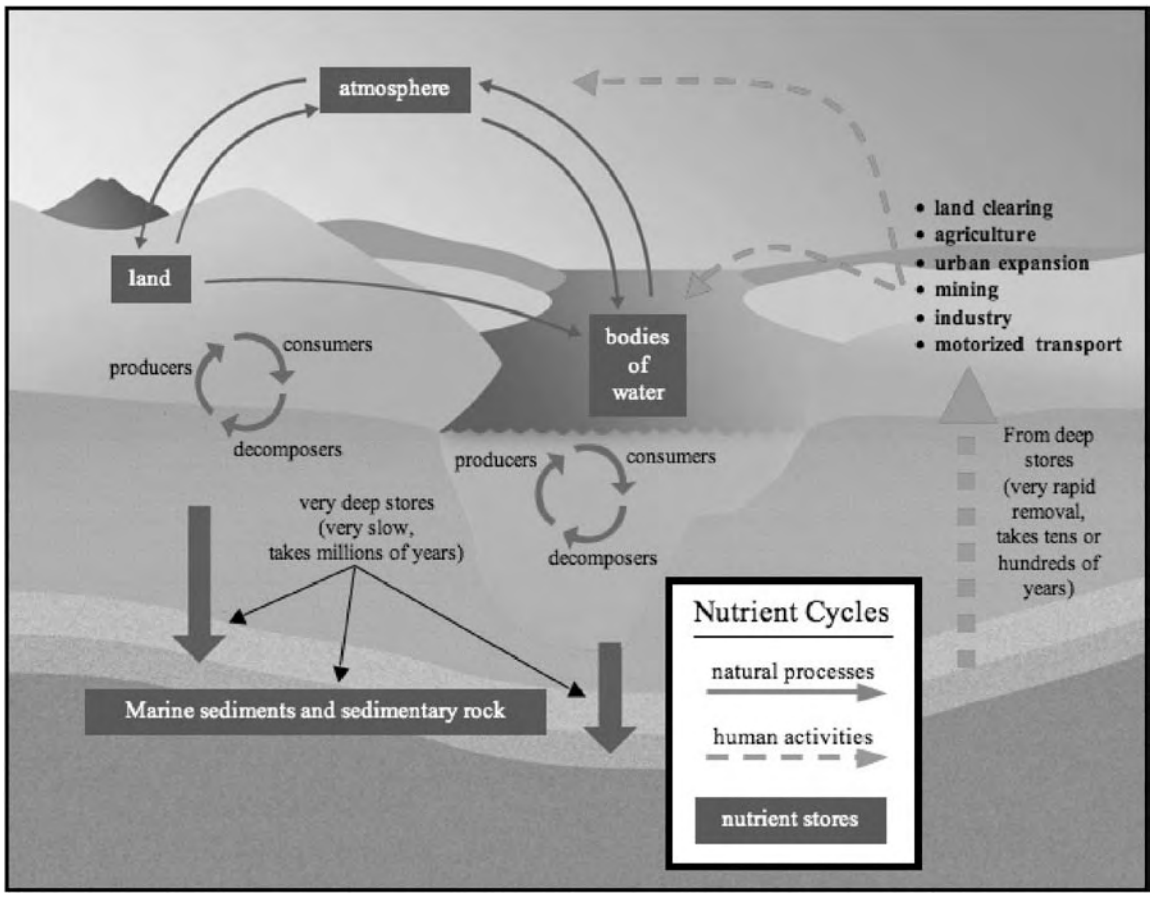
IV. Practice Questions

Section 2.2

Energy flow and nutrient cycles support life in ecosystems: Nutrient Cycles in Ecosystems

Circle the letter of the best answer.

Use this diagram of the nutrient cycle to answer question 1.



1. The effective cycling of nutrients in an ecosystem primarily depends on which of the following conditions?
   A. rapid return of nutrients to deep stores
   B. rapid rates of decomposition of organic matter
   C. abundant resources of nutrients in the atmosphere
   D. balanced rates of production, consumption, and decomposition

2. Which of the following chemical nutrients is **not** cycled between living organisms and the atmosphere?
   A. phosphorus
   B. nitrogen
   C. carbon
   D. oxygen

3. Where is the largest store of carbon found on Earth?
   A. in coal deposits
   B. in terrestrial vegetation
   C. in soil and organic matter
   D. in marine sediments and sedimentary rock

4. Which of the following processes does **not** increase the amount of carbon dioxide (CO_2) in the atmosphere?
   A. forest fires
   B. photosynthesis
   C. cellular respiration
   D. decomposing trees

5. Listed below are chemical compounds matched with a location where they can be found on Earth. Which of the pairs of chemical compounds and locations is incorrect?

   A. nitrate (NO_3^-): water
   B. nitrogen (N_2): atmosphere
   C. carbonate (CO_3^{2-}): atmosphere
   D. phosphate (PO_4^{3-}): sedimentary rock

6. Which term describes the process of converting nitrogen gas (N_2) into nitrate (NO_3^-) or ammonium (NH_4^+)?

   A. uptake
   B. nitrification
   C. denitrification
   D. nitrogen fixation

7. Biologists doing a yearly fish count in a small lake notice that the number of fish in the lake is dramatically less than the year before. They observe the bodies of dead fish near the shoreline. After testing a sample of the water, the biologists realize that the level of dissolved nitrogen has increased dramatically. What else might the biologists notice about the lake?

   A. increased oxygen
   B. increased algae production
   C. decreased lake temperature
   D. decreased algae production

8. How do carnivorous animals obtain the phosphorus that they need for growth and development?

   A. Plants produce phosphorus through cellular respiration and make it available to animals.
   B. Bacteria break down the phosphorus in the soil and make it available to animals.
   C. The animals eat other consumers that have obtained phosphorus from plants.
   D. The animals eat plants, which have absorbed phosphorus through the soil.

9. Which of the following relationships between human activities and nutrient cycles is **not** true?

   A. The clearing and burning of forests increases the amount of phosphate (PO_4^{3-}) available to organisms.
   B. The burning of fossil fuels for industry increases the amount of nitrogen oxide (NO) in the atmosphere.
   C. The use of fertilizers for agriculture increases the amounts of nitrate (NO_3^-) and phosphate (PO_4^{3-}) in water systems.
   D. The use of motorized vehicles increases the amount of carbon dioxide (CO_2) in the atmosphere.

10. Which of the following processes makes nitrogen available to plants and animals?

I	Nitrogen-fixing bacteria in the soil
II	Nitrogen-fixing cyanobacteria in the water
III	Decomposer bacteria and fungi in the soil
IV	Nitrifying bacteria in the soil

   A. I and IV only
   B. I, II, and III only
   C. I, III, and IV only
   D. I, II, III, and IV

2.3 Effects of Bioaccumulation on Ecosystems

I. Summary of Key Points

- Synthetic chemicals enter the environment in air, water, and soil.
- Plants take up some of these chemicals and the chemicals bioaccumulate in the fat tissues of herbivores and carnivores.
- Synthetic chemicals become biomagnified in food pyramids and harm organisms.
- Heavy metals such as lead, cadmium, and mercury also bioaccumulate in the environment and negatively affect organisms.
- Scientists are working to find ways to remove harmful environmental chemicals.
- In bioremediation, oganisms are used to help clean up chemical pollution.

II. Study Notes

Bioaccumulation

1. One of the biggest changes humans have made to the environment is the introduction of synthetic (human-made) chemicals.
2. **Bioaccumulation** is the accumulation of a substance, such as a toxic (poisonous) chemical, in various tissues of a living organism.
   - Many harmful chemicals cannot be decomposed naturally.
   - These chemicals can be eaten or absorbed and sometimes cannot be removed from the body of the organism effectively.
3. **Keystone species** are species that can greatly affect population numbers and the health of an ecosystem. Example: Salmon are a keystone species in many British Columbia forest ecosystems.
   - Salmon are an important food source for many animals, and their decaying bodies are a rich source of nitrogen for trees.
   - Salmon retain harmful chemicals in their body fat and transfer these chemicals to the other organisms.
4. **Biomagnification** is the process in which chemicals not only accumulate but become more concentrated at each trophic level.
   - At each level of the food pyramid, chemicals that do not get broken down build up in organisms.
   - When the consumer in the next trophic level eats organisms with a chemical accumulation, they receive a huge dose of the chemical(s).

Quick Check

1. What is bioaccumulation? _____

   _____

2. (a) How can the low-level presence of a harmful chemical stored in the body fat of salmons result in dangerously high levels of that same chemical in bears? _____

   _____

   (b) What is this process called? _____

3. Bears prey on salmon. The bears take salmon out of the water and into the forest. It has been estimated that bears leave half of the salmon that they catch on the forest floor. Explain why bears are a keystone species in British Columbia. _____

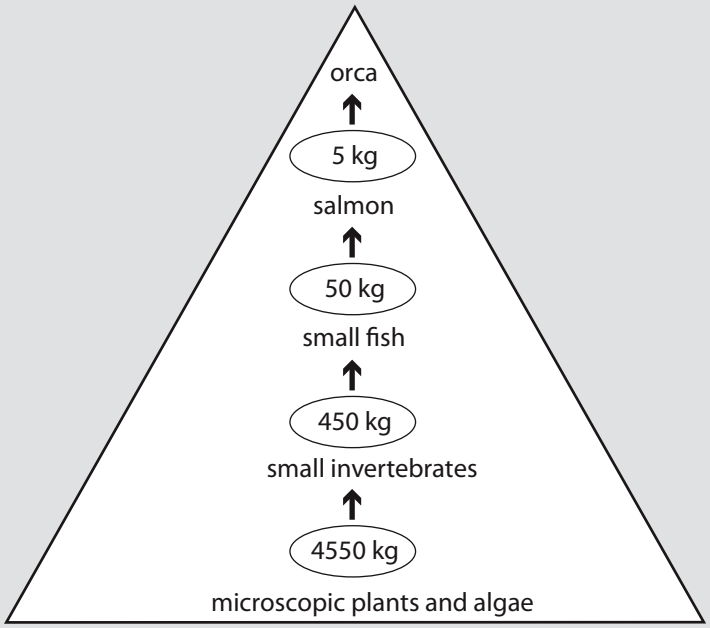
   _____

   _____

PCBs and the Orca

1. An example of bioaccumulation in British Columbia is the effect of PCBs on the orca.
   - **PCBs** are compounds that are produced by replacing hydrogen atoms in biphenyl with chlorine.
   - PCBs are poisonous environmental pollutants that tend to accumulate in animal tissues.
   - PCBs were used for many industrial and electrical applications but were banned in 1977 because of their environmental impact.
   - PCBs stay in organisms and the environment for a very long time, suppressing the immune system, probably causing cancer in humans, and interfering with the reproductive success of the orca.
   - The PCB load of orcas is much higher than that of any other animal in the world.

Quick Check



1. The illustration above shows biomagnifications through an aquatic ecosystem from producers through primary and secondary consumers and finally to the orca, which is the tertiary consumer. Explain why, in the entire food chain, that it is the orca is at greatest risk from PCB poisoning.

   _____

   _____

   _____

Persistent Organic Pollutants

1. **DDT** is a pesticide introduced in 1941 to control mosquito populations and is still used in some places.
   - A **pesticide** is a substance used to control populations of plant and animal pests.
2. DDT binds strongly to soil, bioaccumulates in plants, and then bioaccumulates in the fatty tissue of the fish, birds, and mammals that eat the plants.
3. Chemical accumulation is measured in parts per million (ppm).
   - One **ppm** means one particle of a given substance mixed with 999 999 other particles.
4. Even at low levels of 5 ppm, DDT can cause nervous, immune, and reproductive system disorders.

Quick Check

Use this table to answer questions 1 and 2.

TABLE 2.2 Bioaccumulation of DDT in a Food Chain

Consumer	Bioaccumulation (ppm)
Plankton	0.04
Minnow	0.94
Adult fish	2.07
Heron	3.57
Osprey	13.80
Cormorant	26.40

1. Approximately how many times more concentrated is DDT in herons than it is in minnows?

   _____

2. Explain why the concentration of the pesticide DDT is less in plankton than in cormorants.

   _____

   _____

Heavy Metals: Lead, Cadmium, and Mercury

1. **Heavy metals** are metals such as lead, cadmium, and mercury, which have no known vital or beneficial effect on organisms, and their accumulation over time in the bodies of mammals can cause serious illness.
2. Lead is not considered safe at any level.
   - Many electronics contain lead and must be recycled carefully.
   - Lead can cause anemia (a blood condition) and nervous and reproductive system damage.
   - Lead is harmful if it is absorbed through the skin, inhaled, or ingested (eaten).
3. Cadmium is used in the manufacture of plastics and nickel-cadmium batteries.
   - Cadmium is toxic to earthworms and causes many health problems in fish.
   - In humans, the main source of cadmium is exposure to cigarette smoke.
   - Cadmium causes lung diseases, cancer, and nervous and immune system damage.
4. Mercury has entered ecosystems through the burning of fossil fuels, waste incineration, mining, and the manufacture of items like batteries.
   - Coal burning adds 40 percent of the mercury released into the atmosphere.
   - Mercury bioaccumulates in the brain, heart, and kidneys of many animals.
   - Fish bioaccumulate methylmercury compounds, adding risk for any organisms that eat the fish, including humans.

Reducing the Effects of Chemical Pollution

1. If chemicals are trapped in the soil, they cannot enter the food chains as easily.
2. Bioremediation is the use of micro-organisms or plants to help clean up chemical pollution.
   Example: The oil industry sometimes uses bacteria to "eat" oil spills.

Quick Check

1. List three heavy metals known to be dangerous when released into the environment.

   _____ _____ _____

2. Poplar trees are sometimes planted in soil contaminated with chemicals. The poplar trees are not harmed by the chemicals, and as they grow they remove the chemicals from the soil and change them into other non-toxic chemicals. What is the term that describes this process?

   _____

III. Sample Exam Questions Explained

The Question	Why It Is Right/Why It Is Wrong
Which type of organism in the food chain is at greatest risk from bioaccumulation of the synthetic chemical PCB? **microscopic plants** ↓ **small invertebrates** ↓ **small fish** ↓ **salmon**	
A. microscopic plants	A. Plants have the lowest risk. They live short lives, and PCBs are at very low concentrations in the water.
B. small invertebrates	B. Small invertebrates have an increased risk over plants because they eat many plants and accumulate PCBs from the plants.
C. small fish	C. Small fish are at greater risk than small invertebrates because they eat many invertebrates and accumulate the PCBs from them.
D. salmon	D. This answer is correct. Salmon live two to seven years, during which time they eat many small fish, concentrating the PCBs from the small fish.

➜ Why was this question asked?

This question was asked to determine if you understand bioaccumulation. In bioaccumulation, some pesticides and other long-lasting toxins, such as PCBs, can become more concentrated (biomagnified) with each higher trophic level. For example, if a large fish eats 100 smaller fish, then most of the toxins from each of the smaller fish end up in the larger fish. These chemicals stay with the larger fish until it dies or is eaten by another organism.

➜ Where can I get extra practice on this type of question?

- Use pages 92 to 96 in *BC Science 10*.
- Go to www.bcscience10.ca for extra practice.

The Question	Why It Is Right/Why It Is Wrong
Which of the following is an example of bioremediation?	
A. Bacteria feed on persistent organic pollutants and change them to non-toxic forms.	A. This answer is correct. "Bio-" refers to living things, and "remediation" means to remedy, or to make better. Bioremediation is the use of living organisms to clean up toxins through biodegradation, the process of converting the toxins to harmless forms.
B. Electronic wastes are gathered and recycled to prevent the entry of lead into the environment.	B. This excellent recycling activity keeps toxins out of the environment, avoiding the need for cleanup later, but does not involve the process of bioremediation.
C. PCBs, which are toxins, degrade in the environment over time, eventually converting to non-toxic forms.	C. PCBs can degrade over time. Bioremediation can speed up this natural process.
D. DDT, a pesticide, accumulates in the fatty tissues of animals.	D. This is biomagnification, which is the opposite of bioremediation.

➜ Why was this question asked?

This question was asked to determine if you understand that, in some circumstances, living organisms can be employed to clean up or remove toxins from an ecosystem. Bioremediation is the use of organisms in this way. Biodegradation is the chemical process in which toxins are converted to less harmful forms.

➜ Where can I get extra practice on this type of question?

- Use page 99 in *BC Science 10*.
- Go to www.bcscience10.ca for extra practice.

The Question	Why It Is Right/Why It Is Wrong
Which of the following heavy metals is **not** considered toxic in small concentrations in the environment?	
A. cadmium	A. Cadmium is highly toxic to soil organisms, such as worms, as well as to fish.
B. iron	B. This answer is correct. Iron is essential to human life and is present in the environment in amounts that are usually harmless.
C. lead	C. Lead is highly toxic and can cause anemia, nervous system damage, impaired mental development, and kidney failure in humans and animals.
D. mercury	D. Mercury is highly toxic and can cause damage to nerve cells, the heart, and the kidneys and also suppresses the immune system.

➜ Why was this question asked?

This question was asked to determine if you understand that certain heavy metals (in particular lead, cadmium, and mercury) can be very toxic even at low concentrations.

➜ Where can I get extra practice on this type of question?

- Use pages 97 and 98 in *BC Science 10*.
- Go to www.bcscience10.ca for extra practice.

IV. Practice Questions

Section 2.3

Energy flow and nutrient cycles support life in ecosystems: Nutrient Cycles in Ecosystems

Circle the letter of the best answer.

1. Which is the best reason to explain why some synthetic and organic chemicals accumulate in the environment?
   A. Synthetic chemicals are metabolized by organisms.
   B. Organisms secrete synthetic chemicals as a waste product.
   C. The increase in ultraviolet radiation causes chemicals to accumulate in organisms.
   D. Synthetic chemicals that cannot be broken down by decomposers will build up in living organisms.

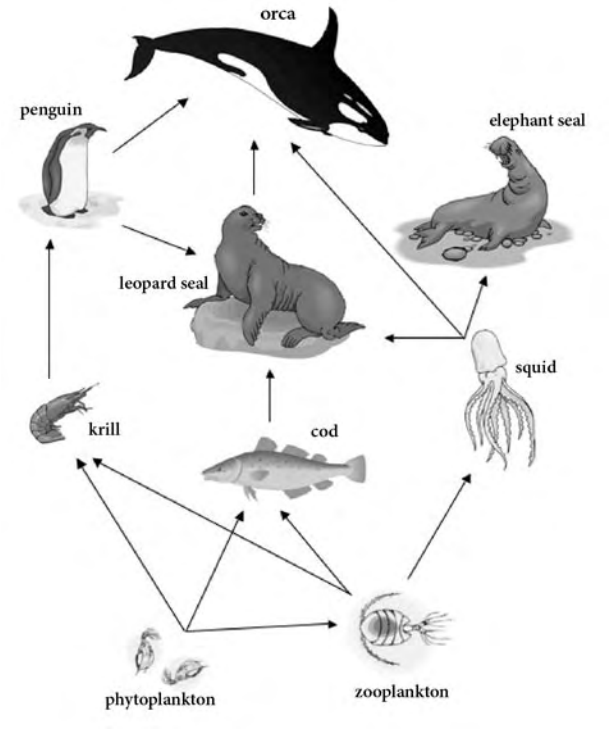
2. In which part of an animal would you expect to find the highest level of a synthetic chemical like PCB?
   A. brain
   B. fat storage
   C. lung tissue
   D. blood system

3. A biologist studied a sample taken from a squid in a marine food web. She found that the concentration of DDT in this sample was 2.0 ppm. What does a concentration of 2.0 ppm mean?
   A. There are 20 particles of DDT mixed with 999 980 other particles.
   B. There are two particles of DDT mixed with 999 999 other particles.
   C. There are two particles of DDT mixed with 999 998 other particles.
   D. There are two particles of DDT mixed with 1 000 000 other particles.

4. Sea otters that live off the west coast of Canada primarily eat sea urchins. The sea urchins are one of the main consumers of algae such as kelp. Toxic levels of synthetic chemicals in the sea otter population prevented the sea otters from reproducing, and the population of sea otters began to decrease significantly. As a result, the sea urchins and other herbivores quickly severely reduced the kelp, allowing barnacles and mussels to flourish at the cost of other species in the ecosystem. Which is the best description for the role of the sea otter in this marine ecosystem?
   A. keystone species
   B. indicator species
   C. top carnivore
   D. niche species

5. Which of the following statements about PCB contamination and orcas is **not** true?
   A. Orcas retain high levels of PCBs in their bodies because PCBs have a long half-life.
   B. The presence of high amounts of PCBs in orcas is an example of biomagnification.
   C. PCB-contaminated orcas usually give birth to calves that have no PCB contamination.
   D. PCBs are synthetic chemicals that were widely used in industrial products.

Use the following picture of a marine food web to answer question 6.



6. The squid in this food web was tested and found to have a DDT concentration of 2.0 ppm. Which organism would you expect to have a concentration of 16.0 ppm?

   A. cod
   B. krill
   C. zooplankton
   D. orca

7. Which of the following contaminants have these four characteristics in common?

   - potential to bioaccumulate within organisms
   - naturally present on Earth
   - binds to soil particles
   - toxic to animals

   A. lead and PCBs
   B. DDT and PCBs
   C. lead, cadmium, and mercury
   D. cadmium, mercury, and DDT

8. After an oil spill near Vancouver Island, the oil company decided to use bacteria to clean up the pollution created by the spill. What type of process is this an example of?

   A. biocleaning
   B. bioremediation
   C. bioaccumulation
   D. biomagnification

9. Which of the following is **not** an example of how humans can be exposed to heavy metal poisoning?

   A. smoking cigarettes
   B. ingestion of methylmercury
   C. skin absorption due to direct contact
   D. eating shellfish contaminated by a red tide

10. Which of the following are natural sources of heavy metals on Earth?

I	volcanic eruptions
II	geothermal springs
III	battery manufacturing
IV	rock weathering

   A. I and IV only
   B. II and III only
   C. I, II, and IV only
   D. I, II, III, and IV

Chapter 3 Ecosystems continually change over time.

3.1 How Changes Occur Naturally in Ecosystems

I. Summary of Key Points

- Over time, living organisms have changed as the abiotic and biotic factors in their environments have changed.
- The process that makes change in living things possible is called natural selection.
- In natural selection, the best-adapted members of a species will survive and reproduce.
- Changes also take place in ecosystems.
- Ecological succession refers to changes that take place over time in the types of organisms inhabiting an area.
- There are two types of ecological succession: primary succession and secondary succession.

II. Study Notes

How Organisms Adapt to Change

1. **Natural selection** is the process, proposed by Darwin, where environmental factors favour the selection of fit individuals.
2. Sometimes, organisms are born with unique characteristics that give them an advantage within their niche.
   - A salmon with a slightly larger tail may be able to swim faster or farther in a river.
3. Individuals with advantages are better able to reproduce and pass along their traits.
4. Individuals with unfavourable characteristics have less chance to reproduce and pass along their traits.
   - A salmon with a smaller tail may never have a chance to spawn because it cannot swim to the correct location.
5. An example of natural selection is the Galapagos finch.
   - There are thirteen species of finches on the Galapagos Islands that developed from a single species on the mainland. Four species are shown in Figure 3.1.
   - Each species has unique characteristics, such as differently sized beaks, which allow it to thrive in its own niche and not compete with other finches for resources.
6. **Adaptive radiation** is the process by which members of a species adapt to a variety of habitats.

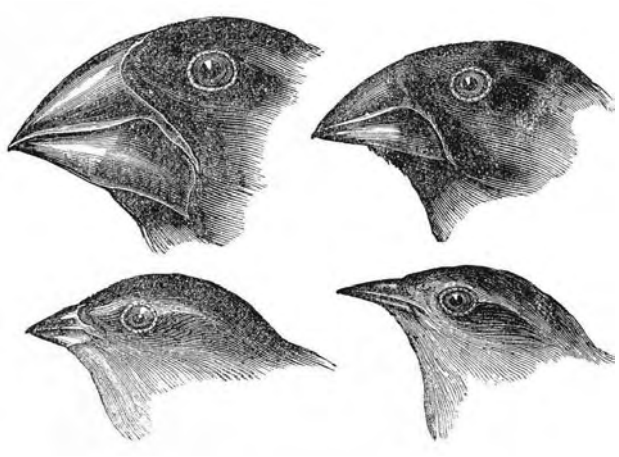


FIGURE 3.1 Illustration of beak differences in four Galapagos finches

Quick Check

1. What is natural selection? _____

   _____

   _____

2. How might random variations in the size of salmon tails cause natural selection to occur? _____

   _____

   _____

3. What is adaptive radiation? _____

   _____

4. How does adaptive radiation make it possible for several different species of finch to live together in the same location without having to compete with each other for food? _____

   _____

   _____

How Ecosystems Change Over Time

1. **Ecological succession** is the process of gradual change that occurs when organisms colonize a habitat, modify it, and are forced out by a new species better adapted to the now altered environment.
2. There are two types of ecological succession: primary succession and secondary succession.
3. **Primary succession** occurs in an area where no soil exists, such as on bare rock exposed after a glacier retreats or formed when lava cools.
4. The first organisms to survive and reproduce are called **pioneer species**.
5. Pioneer species alter the abiotic and biotic environment so that other organisms can survive there.
   - Wind carries spores of lichens and organisms that can survive and eventually, combined with the weathering of rock, they help form soil.
   - **Lichens** are examples of a mutualistic relationship between fungus and algae or cyanobacteria. The fungus provides minerals, water, and protection, and the algae or cyanobacteria provide sugars through photosynthesis.
6. The soil improves, plants are able to grow, and animals begin to appear.
7. Eventually, seeds of trees germinate and the first trees, such as deciduous trees, create shade, further changing the abiotic conditions.
8. As more niches are created, there is greater diversity of animals and more complex food webs.
9. The process of primary succession can last for hundreds of years.
10. **Secondary succession** occurs after a major disturbance, such as a forest fire, in an area that already has soil and once had living organisms.
    - The soil contains seeds, micro-organisms, earthworms, and insects.
    - Secondary succession is much more rapid than primary succession.
11. Eventually, coniferous forests form in northern latitudes, deciduous forests form in temperate zones, and tropical forests form in tropical zones.
12. The final stage of succession is a **climax community** (also called mature community), where a stable group of two or more species is able to survive and reproduce indefinitely in the same habitat.
    - Ecological **stability** in a community means that populations are able to return to their previous state when disturbed.

How Natural Events Affect Ecosystems

1. Terrestrial climax communities continue to change with changes in climate or other factors, such as flooding, drought, and insect infestations.
   - Marine climax communities can be affected by changes in ocean current patterns and extreme weather.
2. Flooding occurs in locations where water levels can change rapidly.
   - Flooding can result in soil erosion, as well as the spread of pollutants and harmful bacteria associated with wastes.
   - Climate change and global warming may be increasing incidents of flooding.
   - When a tsunami occurs, huge waves, from large earthquakes or volcanic eruptions, can flood coastal areas.
3. Drought occurs when an area receives a lower than average amount of rainfall over a long period of time.
   - Prolonged drought can destroy habitats and kill organisms.
4. Insect infestations
   - Many insects play important roles in their ecosystems.
   - Even insects that appear destructive, such as the mountain pine beetle, actually play a role in the renewal of the forest.
     – The mountain pine beetles have a symbiotic relationship with a species of fungus that inhibits the trees' ability to use resin for protection.
     – When normal conditions are changed, infestations can occur.
     – Older, weaker trees and trees stressed from overcrowding, drought, or animal grazing do not produce enough resin to trap and resist the insects as effectively.
     – A warmer climate and lack of forest fires allow the insects to spread more effectively.
   - Not only are the trees affected, but so is the entire forest ecosystem, as well as any human industries relying on the forest.

Quick Check

1. What is ecological succession? _____

   _____

   _____

2. In primary succession, organisms such as lichen, which can grow directly on rock, form the first populations in an area. What is the general term for these first organisms?

   _____

3. What is the difference between primary and secondary succession? _____

   _____

   _____

4. What is the term given to all the populations that inhabit an area in the final stage of succession?

   _____

5. What are four examples of factors that can cause a climax community to change? _____

   _____

   _____

III. Sample Exam Questions Explained

The Question	Why It Is Right/Why It Is Wrong
Six species of cichlid fish living in Lake Victoria in Africa have all evolved from a common ancestor, allowing each to occupy a slightly different niche. What is this process called?	
A. primary succession	A. Primary succession is a term that refers to the first life forms to occupy a newly created region, such as volcanic ash or the rock beneath a retreating glacier.
B. adaptive radiation	B. This answer is correct. Radiation refers to many species evolving from one species, like the spokes of a wheel radiating out from a common centre. An adaptation is a characteristic of an organism that has been favoured through evolution because it increases an organism's chance for survival.
C. extinction	C. Extinction is the dying out of a species rather than its adaptation into other forms. Adaptive radiation does not necessarily mean the common ancestor has disappeared.
D. ecological succession	D. Ecological succession is the process in which changes take place over time in the types of organisms that live in an area.

➜ Why was this question asked?

This question was asked to determine your understanding of how organisms change over time due to the process of natural selection. Adaptive radiation describes the change from a common ancestor into a number of different species that "radiate out" to inhabit different niches.

➜ Where can I get extra practice on this type of question?

- Use pages 108 to 110 in *BC Science 10*.
- Go to www.bcscience10.ca for extra practice.

The Question	Why It Is Right/Why It Is Wrong
Consider the following stages of succession. I A new plant species replaces the first plant species. II A community with a wide variety of species and a complex food web is established. III Pioneer species become established. IV A climax mature community is established. What is the correct order of these stages?	
A. I, II, III, IV	A. New plant species arrive after pioneer species.
B. IV, III, II, I	B. The climax community is the last to be established.
C. III, I, II, IV	C. This answer is correct. In primary succession, pioneer species are the first to arrive and reproduce. Eventually, other species replace them, followed by an increasingly complex community, culminating in a climax community.
D. II, IV, III, I	D. A complex food web comes after several species have established themselves.

➜ Why was this question asked?

This question was asked to determine if you understand the sequence of events that occur in establishing an ecosystem beginning with a barren landscape. In primary succession, pioneer species are the first species of plants and they begin the conversion of barren rock and other abiotic components into material that will support other life forms. Later, animals and new species of plants begin to take hold. The pioneer plants may reduce in number or be eliminated altogether. As time passes, the ecosystem may support more species and a complex food web. A mature community ultimately forms, such as boreal forest, grassland, or desert.

➜ Where can I get extra practice on this type of question?

- Use pages 111 to 114 in *BC Science 10*.
- Go to www.bcscience10.ca for extra practice.

The Question	Why It Is Right/Why It Is Wrong
Over many years, a pond gradually fills in with silt and plants. New animals begin to arrive in the area, and eventually, the pond is completely filled in with soil. Bushes and small trees begin to grow. What biological process does this illustrate?	
A. bioremediation	A. Bioremediation is the use of living organisms to clean up or restore habitats that have been damaged through exposure to toxic substances.
B. evolution	B. Evolution is the gradual appearance of new species where they did not exist before, due to changes in existing species. In this illustration, one species is not evolving into others. The new species are moving in from other areas.
C. ecological succession	C. This answer is correct. Ecological succession describes the changes that take place over time in the types of organisms that live in an area.
D. adaptive radiation	D. Adaptive radiation is the term used to describe the change from a common ancestor into a number of different species that "radiate out" to inhabit different niches.

➜ Why was this question asked?

This question was asked to determine if you understand that mature ecosystems are produced over time from after pioneer species take hold and begin to modify the biotic and abiotic components of the ecosystem, creating habitats for other succeeding species.

➜ Where can I get extra practice on this type of question?

- Use pages 110 to 114 in *BC Science 10*.
- Go to www.bcscience10.ca for extra practice.

IV. Practice Questions

Section 3.1

Ecosystems continually change over time: How Changes Occur Naturally in Ecosystems

Circle the letter of the best answer.

1. Marsupials are mammals that have a pouch in which females raise their young through early infancy. Many marsupials, such as kangaroos and koala bears, live in Australia, where it is believed that they all evolved from a common ancestor. Each species occupies its own ecological niche within Australia. This an example of which type of process?
   A. artificial selection
   B. adaptive radiation
   C. primary succession
   D. ecological succession

2. Which of the following statements about natural selection is **not** true?
   A. The finches of the Galapagos Islands are an example of natural selection.
   B. The development of antibiotic-resistant bacteria is an example of natural selection.
   C. Natural selection occurs when an organism tries to change and adapt to new surroundings.
   D. In natural selection, members of a species who have a favourable trait will be more likely to reproduce.

3. What do the following events have in common?
   - flooding
   - tsunami
   - drought
   - insect infestation

   A. They occur only in coastal areas.
   B. They result in primary succession.
   C. They affect biotic and abiotic factors of mature communities.
   D. They have all increased in frequency because of climate change.

4. Which of the following statements regarding pioneer species is **not** true?
   A. Galapagos finches are an example of a pioneer species.
   B. Pioneer species change the biotic and abiotic environment in a variety of ways.
   C. Pioneer species are the first organisms that survive and reproduce in an area.
   D. Lichens that grow on rock in areas where glaciers have retreated are an example of a pioneer species.

5. An example of natural selection is the increase in the population of dark-coloured moths during the Industrial Revolution in England. During this time, large amounts of ash and soot released into the atmosphere blackened the trees and vegetation near industrial areas, which was the habitat of the moth. Before the Industrial Revolution altered the environment, the light-coloured moth population was much higher than the dark-coloured moth population. Which of the following reasons best explains the increase in the dark-coloured moth population?
   A. The colour of the moths alternates every few years between light and dark.
   B. The dark-coloured moths were better able to avoid predators through camouflage against the dark-coloured trees.
   C. The dark-coloured moths were the moths that were more exposed to pollution, which changed their pigmentation.
   D. The light-coloured moths were more susceptible to the environmental impact of the ash and soot in their environment.

6. Vegetation gradually takes hold on bare rock formed by cooling lava. What kind of ecological process is happening?

   A. secondary succession
   B. primary succession
   C. adaptive radiation
   D. natural selection

7. In which of the following locations would you expect the process of secondary succession to occur?

   A. on lava after a volcanic eruption
   B. in a rocky landscape in the Arctic
   C. in an area left from a retreating glacier
   D. in an empty field where crops were once grown

8. Which of the following statements about flooding is **not** true?

   A. Flooding can cause tsunamis.
   B. Flooding can cause widespread disease among humans.
   C. Flooding can be part of the normal cycle of an ecosystem.
   D. Climate change may have caused an increase in flooding.

9. Which of the following statements regarding the mountain pine beetle are true?

I	Pine beetles have a symbiotic relationship with a fungus.
II	Pine beetles only attack older, weaker pine trees.
III	The spread of the pine beetle in British Columbia has decreased spruce, fir, and younger pine populations.
IV	Tree resin can trap beetles.

   A. I and II only
   B. III and IV only
   C. I, III, and IV only
   D. I, II, III, and IV

10. What is the correct order for the following stages of primary succession, from earliest to latest?

I	A mature community develops.
II	The decay of pioneer species creates soil.
III	Lichens begin breaking down rocks and forming soil.
IV	Micro-organisms and insects begin to occupy the area.
V	Sun-tolerant trees begin to grow.

   A. II, III, V, IV, I
   B. III, II, IV, V, I
   C. III, II, V, I, IV
   D. IV, II, III, I, V

3.2 How Humans Influence Ecosystems

I. Summary of Key Points

- A sustainable ecosystem provides economic opportunities today while maintaining biodiversity and ecosystem health for the future.
- Economic sustainability is threatened by habitat loss that results from human activities, such as urban development and deforestation.
- Other human activities, such as certain agricultural practices and overfishing, also change ecosystems, decrease biodiversity, and affect ecosystem health.
- Better resource management practices in activities such as forestry, agriculture, and mining can help sustain ecosystems.

II. Study Notes

Understanding Sustainability

1. A sustainable ecosystem provides economic opportunities today while maintaining biodiversity and ecosystem health for the future.
2. Human expansion into ecosystems has resulted in the destruction or fragmentation of habitats.
3. Aquatic ecosystems, such as wetlands and estuaries, include unique populations of plants, animals, and micro-organisms that are threatened by human expansion and the release of **toxins** (poisons) far upstream.
   - **Estuaries** are coastal bodies of water where rivers or streams (freshwater) meet the ocean (salt water).
   - Micro-organisms affected by human expansion include **phytoplankton** (plant-like micro-organisms) and **zooplankton** (animal-like micro-organisms), which are the basis of many aquatic ecosystem food chains.

The Effects of Land and Resource Use, Habitat Loss, and **the Effects of Deforestation**

1. **Deforestation** is the practice in which forests are logged or cleared for human use and are not replanted.
   - Deforestation of tropical rainforests continues at an alarming rate.
   - Deforestation reduces the number of plants and animals in an ecosystem and results in soil degradation.
2. **Soil degradation,** which means the soil becomes less healthy and less able to support life, occurs when water and wind erosion removes topsoil from bare land.
   - Topsoil, the upper layer of soil, is where most of the nutrients, water, and air are found for plant growth.

Quick Check

1. What does "sustainable ecosystem" mean? _____

   _____

   _____

2. Deforestation of tropical rainforests continues to occur. Give two negative effects of deforestation. _____

   _____

3. What is soil degradation? _____

   _____

   _____

The Effects of Agriculture

1. If fields are left exposed during non-planting seasons, water and wind erosion can occur.
2. Farm vehicles and grazing animals can cause soil compaction, which means that soil particles are squeezed together.
   - Compaction reduces the movement of air, water, and soil organisms between the particles, all of which are essential for soil health.
3. When soil is compacted, water and air cannot enter, so water runs off instead of soaking in.
   - Run-off can add excess nitrogen and pollutants, such as pesticides, to the environment.

The Effects of Resource Exploitation

1. Resource exploitation, also called resource use, includes such activities as harvesting fish and timber, mining coal and minerals, and extracting oil and gas.
2. Humans depend on resource exploitation for jobs, materials, food, shelter, and energy.
3. Resource exploitation can lead to habitat loss, soil degradation, and contamination of water supplies.
   - Contamination is the introduction of harmful chemicals or micro-organisms into the environment.
4. Many mining and resource exploitations need reclamation efforts to restore the land and must develop water treatment facilities to remove heavy metals.
   - Reclamation often involves use of plants to restore the land and decontaminate soil and water.
5. Overexploitation is the use or extraction of a resource until it is depleted.
   - Overexploitation can affect the interactions in food webs for decades to come.
   - Overexploitation can cause populations to become less resistant to disease and less able to adapt to changes in their environment.
   - Overexploitation can result in **extinction**, the dying out of a species.

Quick Check

1. Name two negative effects of poor agricultural practices on soil. _____

   _____

2. List three kinds of human activities that are types of resource exploitation. _____

   _____

3. List five ways humans depend on resource exploitation. _____

   _____

   _____

4. List three ways that resource exploitation can harm the environment. _____

   _____

   _____

5. What does "overexploitation" mean? _____

   _____

   _____

6. What is extinction? _____

   _____

Resource Management and Traditional Ecological Knowledge

1. In Aboriginal cultures, traditional ecological knowledge is passed down from generation to generation.
2. This knowledge reveals what past conditions were like and how the ecosystem and humans interact.
3. Knowledge is found in stories, songs, cultural beliefs, rituals, community laws, and traditional practices.
4. Current ecological restoration and usage guidelines often involve traditional knowledge from Aboriginal representatives.
5. Traditions such as the "spring burn" allow for ecological renewal.
   - Burning improves the growth of berry plants, which attracts more animals.
   - Burning recycles nutrients, creates more diversity, reduces forest litter, and opens the canopy to allow more sunlight to reach the plants.
   - Fire suppression, enforced in British Columbia for over 100 years, has led to recent issues like the mountain pine beetle infestation and huge wildfire losses.

Quick Check

1. What practices have Aboriginal peoples used to pass ecological knowledge from generation to generation? _____

   _____

2. In some areas, a tradition called the spring burn has been used. What positive ecological results can occur from a spring burn? _____

   _____

III. Sample Exam Questions Explained

The Question	Why It Is Right/Why It Is Wrong
Identify which term best matches this description: "Society's demand on nature is in balance with nature's ability to meet that demand."	
A. ecology	A. Ecology is the study of the interactions and relationships between organisms and their environment.
B. sustainability	B. This answer is correct.
C. ecological succession	C. Ecological succession describes changes that take place over time in the types of organisms that live in an area.
D. bioremediation	D. Bioremediation is the use of living organisms to improve or detoxify an ecosystem.

➜ Why was this question asked?

This question was asked to determine if you understand the relationship between sustainability and ecosystems. Sustainability refers to the ability of an ecosystem to sustain biological processes.

➜ Where can I get extra practice on this type of question?

- Use pages 125 to 134 in *BC Science 10*.
- Go to www.bcscience10.ca for extra practice.

The Question	Why It Is Right/Why It Is Wrong
A four-lane divided highway is built through the middle of a wilderness area. Which of these threats to the environment does the highway introduce? I habitat loss II deforestation III extinction of species IV habitat fragmentation	
A. I only	A. Habitat loss will occur, partly because of the construction of the road, but also because the existence of a road could lead to increased human access to wilderness areas.
B. I and IV only	B. Habitat fragmentation is the division of habitats into smaller, isolated fragments. The highway can affect migration, access to food and water supply, and the ability of animals to find a mate.
C. I, II, and III only	C. Extinction of some species is a possibility if the effect of habitat loss and fragmentation is severe enough.
D. I, II, III, and IV	D. This answer is correct. The existence of the highway may produce all the listed effects.

➜ Why was this question asked?

This question was asked to determine your understanding of the negative effects of land and resource use including loss of habitat and habitat fragmentation.

➜ Where can I get extra practice on this type of question?

- Use pages 126 to 129 in *BC Science 10*.
- Go to www.bcscience10.ca for extra practice.

IV. Practice Questions

Section 3.2

Ecosystems continually change over time: How Humans Influence Ecosystems

Circle the letter of the best answer.

Use the following information to answer questions 1 and 2.
A large moss-covered rock provides a habitat for a community of organisms. Algae, bacteria, fungi, and insects live on the rock. In an experiment, researchers scraped most of the moss off of the rock. They left one large patch of moss in one region of the rock. They also left six much smaller patches close together in another region of the rock. They repeated the same procedure on six different rocks. After six months, the patches were analyzed and researchers counted the number of distinct species living in each region.

1. What do the two regions represent in the experiment?
   A. Larger patch: control
      Six smaller patches: habitat loss
   B. Larger patch: control
      Six smaller patches: habitat fragmentation
   C. Larger patch: habitat fragmentation
      Six smaller patches: control
   D. Larger patch: habitat loss
      Six smaller patches: control

2. Across all six rocks, an average of 40 percent of the species became extinct in the smaller patches. What could the researchers conclude from this experiment?
   A. This experiment shows how to create a sustainable ecosystem.
   B. Habitat loss does not affect the biodiversity of the rock ecosystem.
   C. Many of the species living on the rock were affected by habitat fragmentation.
   D. The species were able to move among the smaller patches to obtain the nutrients they needed.

3. Which of the following is **not** a characteristic of a sustainable ecosystem?
   A. biodiversity
   B. no resource use
   C. responsible land use
   D. ability to sustain ecological process

4. Which of the following is an example of a sustainable land use approach in British Columbia?
   A. grassland management plans
   B. urban expansion into farmlands
   C. cutting large areas of forest
   D. draining and drying out wetlands

5. Which of the following statements about deforestation are true?

I	Deforestation is a problem only in tropical rainforests.
II	Deforestation reduces the number of plants and animals living in an ecosystem.
III	Deforestation can cause soil erosion.

   A. I and II only
   B. I, II, and III
   C. II only
   D. II and III only

6. Which of the following statements about land use is **not** true?
   A. Bare fields can cause topsoil erosion.
   B. The use of tractors can cause soil compaction.
   C. Mine reclamation can cause water contamination.
   D. Road construction can cause habitat fragmentation.

Use this picture of an open-pit copper mine, similar to those found in British Columbia, to answer question 8.

7. Which of the following practices is likely to happen after the mine closes?
   A. use of plants to decontaminate soil
   B. use of topsoil to fill in the open pit
   C. resource exploitation
   D. destruction of habitat

8. Which of the following is a likely outcome of overexploitation?
   A. biodiversity
   B. extinction
   C. sustainability
   D. ecological succession

9. Which of the following is an example of traditional ecological knowledge?
   A. soil compaction of agricultural lands
   B. the introduction of non-native plant species
   C. the overexploitation of the salmon fishery
   D. the spring burning of prairie grasslands in Alberta

10. Which of the following statements about forest fires is **not** true?
   A. Secondary succession can occur after a forest fire.
   B. Forest fires are an example of resource exploitation.
   C. Controlled burns of forest fires can improve the diversity of the forest.
   D. Forest fire suppression practices have resulted in large numbers of dead or diseased trees.

3.3 How Introduced Species Affect Ecosystems

I. Summary of Key Points

- Native species are organisms that naturally inhabit an area.
- Introduced species are introduced into an ecosystem and are usually beneficial or harmless.
- Some introduced species are invasive and can destroy ecosystems.
- These species reproduce rapidly and are often aggressive.
- Lacking natural predators, they easily outcompete native species and alter habitats.

II. Study Notes

Native Species and Foreign Species

1. **Native species** are plants and animals that naturally inhabit an area.
2. **Foreign species** are organisms that people intentionally or accidentally have introduced into regions where they did not exist previously.
   - Foreign species are also called introduced species.
   - Many foreign species are harmless or even may be beneficial.
3. Invasive species are organisms that can take over the habitat of native species or invade their bodies, weakening their immune systems.
   Example: Purple loosestrife was brought to North America several hundred years ago and has destroyed wetlands because it quickly reproduces and chokes out other plants.
   - Introduced invasive species in British Columbia include Eurasian milfoil, Norway rat, American bullfrog, and European starling.

Quick Check

1. What is the difference between a native species and a foreign species? _____

   _____

2. What is the definition of an invasive species? _____

   _____

The Impact of Introduced Invasive Species

1. The rapid spread of introduced invasive species is a major cause of global biodiversity loss.
2. Invasive species often have high reproduction rates, are aggressive competitors, and lack natural predators in new habitats.
3. Invasive species often take advantage of their new habitat, resulting in their proliferation.
   - **Proliferation** means to grow or multiply by rapidly producing new tissues, cells, or offspring.
4. Foreign species can affect native species through:
   - *Competition:* Native species have an established balance in the competition for food and habitat, and the invasive species disturbs this balance. The European starling outcompetes British Columbia's western bluebird for nesting habitat.
   - *Predation:* If the invasive species is a predator, it may have a huge advantage since the native species may have no methods to survive against it. The Norway rat preys on British Columbia's ground-nesting birds, and the American bullfrog preys on British Columbia's native frogs.
   - *Disease and Parasitism:* By weakening certain species, a micro-organism invading an ecosystem can drastically alter the entire ecosystem and the niches within it.
   - *Habitat Alteration:* Some invasive species can change the physical structure of the ecosystem by digging, burrowing, blocking sunlight, or changing the ecosystem's chemistry. Eurasian milfoil forms wide, dense mats at lake surfaces, cutting off sunlight to organisms below. It grows from plant fragments, which are often spread by boats.

Saving an Ecosystem Under Siege

1. The Garry Oak Ecosystem Recovery Team (GOERT) is working to save one of the most biologically rich ecosystems in the province, which is also one of the most threatened.
   - The team is a partnership of governments, First Nations, conservationists, scientists, and businesses.
2. Ninety-five percent of the original ecosystem has been lost to urban development, and the remaining 5 percent is threatened by foreign species, including Scotch broom, English ivy, invasive grasses, grey squirrels, and gypsy moths.
   - Scotch broom is a bushy shrub that replaces native shrubs, ruins the habitat for native birds and butterflies, and fixes nitrogen in the soil, creating an overload of nitrogen.
   - The grey squirrels outcompete the native red squirrel for acorns and are larger and stronger.
   - The gypsy moth larvae strip oak trees of their leaves, making the trees vulnerable to infections and unable to perform photosynthesis.
3. Garry oak ecosystems may be the forests of the future because they are better able to withstand drought than Douglas fir forests.

Quick Check

1. What does proliferation mean? _____

   _____

   _____

2. What are four ways in which introduced species can affect ecosystems? _____

   _____

3. What is the major threat to the Garry oak ecosystem today? _____

4. How do gypsy moths harm the Garry oak ecosystem? _____

   _____

   _____

III. Sample Exam Questions Explained

The Question	Why It Is Right/Why It Is Wrong
Scotch broom is a plant that was brought from Europe to Vancouver Island in 1850. It has since spread widely to the Pacific coastal regions of North America, where it has a negative effect on other plant species such as Garry oak. Which term best describes the role of Scotch broom in North America?	
A. deforestation	A. Deforestation does not occur even though Scotch broom threatens the habitat of some species of trees.
B. resource exploitation	B. Resource exploitation is the over use or incorrect use of a resource. It was a misuse to bring Scotch broom to North America, but this is because it was an invasive species.
C. introduced species	C. This answer is correct. The Scotch broom was introduced and dominated its new habitats. By spreading widely on its own, it can also be classified as an invasive species.
D. pollution	D. Pollution is the addition of harmful chemicals to the environment.

➜ Why was this question asked?

This question was asked to determine if you understand the role of habitat alteration in the health of ecosystems.

➜ Where can I get extra practice on this type of question?

- Use pages 138 to 142 in *BC Science 10*.
- Go to www.bcscience10.ca for extra practice.

The Question	Why It Is Right /Why It Is Wrong
The Norway rat was introduced in the Queen Charlotte Islands/Haida Gwaii by early European explorers. The female rat can produce up to 72 young per year. The young feed on ground-nesting sea birds by eating their eggs and young. The rats eat almost any food source, including meat, grains, seeds, fish, and birds. What is the likely cause for the decline in the population of ground-nesting birds?	
A. competition	A. Competition would refer to the need for the ground-nesting birds to compete for the same resources as the rat.
B. predation	B. This answer is correct. The rats attack nests and eat eggs or young birds.
C. disease and parasites	C. Although rats can carry disease, it is their appetite for birds that is causing the problem.
D. habitat alteration	D. Rats do not significantly alter the habitat.

➜ Why was this question asked?

This question was asked to determine if you understand how introduced species can change an ecosystem through competition, predation, disease and parasites, and habitat alteration.

➜ Where can I get extra practice on this type of question?

- Use pages 138 to 142 in *BC Science 10*.
- Go to www.bcscience10.ca for extra practice.

IV. Practice Questions

Section 3.3

Ecosystems continually change over time: How Introduced Species Affect Ecosystems

Circle the letter of the best answer.

1. Which of the following characteristics accurately describe most invasive species?

I	aggressive competitors
II	low reproduction rates
III	lack natural predators in new habitats
IV	contribute to biodiversity loss

   A. I and II only
   B. I, II, III, and IV
   C. I, III, and IV only
   D. III and IV only

2. An invasive predator species is introduced into a new environment. The predator is quickly able to find suitable prey. In a short period of time, the prey population has been dramatically reduced by the new predator. Which of the following best explains how the predator was able to do this?
   A. The prey population began to occupy a new niche.
   B. The prey population had a high reproduction rate.
   C. The invasive predator became a parasite on the prey species.
   D. The prey population probably did not have adaptations to escape or fight the new predator.

3. What type of impact has the European starling had on native birds in British Columbia?
   A. predation
   B. competition
   C. habitat alteration
   D. disease and parasites

4. Which of the following species have these three characteristics in common?
   - invasive species
   - outcompete native species
   - found in British Columbia

   A. gypsy moth and grey squirrels
   B. grey squirrels and American bullfrog
   C. gypsy moth and American bullfrog
   D. grey squirrels and red squirrels

5. Which of the following statements accurately describes introduced species?
   A. They naturally inhabit the new environment.
   B. Native species is another name for introduced species.
   C. Many are harmless or beneficial in their new environment.
   D. They are always intentionally introduced into a new environment.

6. Which of the following are reasons why there has been an increase in invasive introduced species?

I	creation of new niches in ecosystems
II	increased international air travel
III	increase in biodiversity of ecosystems
IV	climate change

   A. I, II, and III only
   B. II and IV only
   C. III and IV only
   D. I, II, III, and IV

Use this picture to answer question 7.

7. The purpose of this sign is to prevent the spread of which species?
   A. English ivy
   B. Scotch broom
   C. Eurasian milfoil
   D. purple loosestrife

8. Which of the following examples of how Scotch broom alters the habitat in the Garry oak ecosystem is false?
   A. interferes with the growth of native species by altering the nutrients in the soil
   B. ruins habitat for native birds and butterflies by replacing native shrubs
   C. makes trees more vulnerable to infections
   D. fixes nitrogen in the soil

Use the following information to answer questions 9 and 10.

Rabbits were introduced to Australia by European settlers. The rabbits quickly multiplied and spread throughout the country, feeding on the native vegetation and destroying food and habitat for many native species. The Australian government decided to use myxoma virus to eradicate the rabbit population. The myxoma virus is from Uruguay, and it causes the fatal disease myxomatosis. It is usually transmitted by mosquitoes or fleas.

9. Which of the following best summarizes the actions of the Australian government?
   A. the use of an introduced species to control an invasive population
   B. the use of a native species to control an invasive population
   C. the use of an invasive species to control a native population
   D. the use of a foreign species to control a native population

10. Initially, the virus killed 90 percent of the rabbit population. In more recent years, the rabbit population has begun to grow again even though the virus is still present in the environment and continues to kill up to 50 percent of the rabbit population annually. What is the best explanation for why the virus currently kills only half of the rabbit population?
    A. The rabbit population became a native species.
    B. The rabbit population found a new niche to occupy.
    C. The rabbit population learned to hide from the virus.
    D. Natural selection favoured virus-resistant rabbits that were able to survive and reproduce.

Processes of Science Vocabulary Terms

You may encounter the following Processes of Science vocabulary terms on the exam.

- ☐ **accuracy** the difference between a measurement and its accepted value
- ☐ **conclusion** the explanation of the results of an experiment as they apply to the hypothesis being tested
- ☐ **control** a test you carry out with no independent variables so you can observe whether your independent variable in an experiment does indeed cause a change
- ☐ **controlled experiment** an investigation in which only one variable is changed, and the resulting effect on another variable is observed, while all other variables are held constant
- ☐ **dependent variable** in an experiment, the factor that changes in response to a change in the independent variable; also called the responding variable
- ☐ **extrapolation** a prediction that is out of the range of the collected data
- ☐ **hypothesis** a testable proposal used to explain an observation or to predict the outcome of an experiment; often expressed in the form of an "If ..., then ..." statement
- ☐ **independent variable** in an experiment, the factor that is selected or adjusted to see what effect the change will have on the dependent variable; also called the manipulated variable
- ☐ **interpolation** a prediction that is within the range of collected data
- ☐ **observation** information gathered through one or more senses, including hearing, touch, sight, taste, and smell
- ☐ **precision** a measure of the detail, such as the number of digits, with which a quantity is expressed
- ☐ **prediction** a forecast about what you expect to observe when you do an investigation
- ☐ **principle** a fundamental law, assumption, or fact
- ☐ **procedure** a specific set of actions which if executed in the same manner under the same circumstances will yield the same results
- ☐ **scale** ratio between a single unit of distance, such as on a map, model, or drawing, and the corresponding distance in reality
- ☐ **scientific literacy** an evolving combination of the science-related attitudes, skills, and knowledge necessary to develop inquiry, problem-solving, and decision-making abilities, to become lifelong learners, and to maintain a sense of wonder about the world
- ☐ **slope** the direction of a line on a graph, which may be horizontal (zero), slanting up (positive), or slanting down (negative). Slope is calculated by determining the ratio of rise/run.
- ☐ **uncertainty** a lack of certainty; having limited knowledge to describe a state or outcome, often where more than one outcome is possible
- ☐ **validity** the degree to which a conclusion is likely to be true
- ☐ **variable** a factor that can influence the outcome of an experiment
- ☐ **Venn diagram** a type of graphic organizer that can be used to compare and contrast two or more concepts or objects by using two or more intersecting circles

Unit 1 Glossary

abiotic the non-living parts of the environment, such as air, water, soil, light, and temperature

acid precipitation/rain precipitation that has a lower pH (higher acidity) than precipitation that does not contain pollutants

adaptation a characteristic that allows an organism to better survive and reproduce

adaptive radiation the process by which members of a species adapt to a variety of habitats

algae simple unicellular or multicellular organisms

annual precipitation total yearly average rainfall, snow, mist, and fog

annual temperature average yearly temperature

aquatic related to water

bacteria unicellular micro-organisms that do not have a nucleus surrounded by a membrane

bioaccumulation the accumulation of a substance, such as a chemical, in various tissues of a living organism

biodegradation the process by which dead organic matter is broken down naturally by biological agents, especially bacteria

biodiversity the variety of all living species of plants, animals, and micro-organisms

biomagnification the process in which chemicals not only accumulate but become more concentrated at each trophic level

biome a large area of the biosphere that has characteristic climate, plants, animals, and soil

biosphere the thin layer of air, land, and water at Earth's surface where living things exist

biotic the organisms in the environment, including bacteria, plants, and animals

carbon exchange how carbon is moved through terrestrial and aquatic ecosystems; also called the carbon cycle

carbon sink a short- or long-term accumulation of carbon

carbon store *See* carbon sink

carbonate a combination of carbon and oxygen (CO_3^{2-}) that is dissolved in ocean water

carnivore a consumer that eats animals

cellular respiration the process in which both plants and animals release carbon dioxide back into the atmosphere by converting carbohydrates and oxygen into carbon dioxide and water; represented by the chemical equation $C_6H_{12}O_6 + 6O_2$ [INSERT ARROW] $6CO_2 + 6H_2O$ + energy

climate long-term weather conditions in an area, including rainfall and temperature

climatograph a graph that shows the average temperature and precipitation for a location over a period of 30 years or more

climax community the final stage of ecological succession where a stable group of two or more species is able to survive and reproduce indefinitely in the same habitat; also called mature community

commensalism a relationship in which one organism benefits and the other organism is not affected, such as barnacles on a whale

community all populations of different species that interact in an ecosystem

competition an interaction that occurs between two or more organisms when they need the same resource in the same location at the same time

consumers (primary, secondary, tertiary) organisms that feed on other organisms: primary consumers in the second trophic level obtain their energy by eating producers; secondary consumers in the third trophic level obtain their energy by eating primary consumers; tertiary consumers in the fourth trophic level obtain their energy by eating secondary consumers

DDT a pesticide introduced to control mosquito populations and which is banned in many countries; abbreviation for dichlorodiphenyl trichloroethane

decomposers organisms such as bacteria and fungi that change wastes and dead organisms into usable nutrients for other organisms in soil and water

deforestation the practice in which forests are logged or cleared for human use and are not replanted

denitrification the process through which nitrogen is returned to the atmosphere

detrivore a consumer that eats dead organisms and waste matter

ecological hierarchy (organism, population, community, ecosystem) the order of relationships in an ecosystem

ecological pyramid (pyramid of biomass, pyramid of energy, pyramid of numbers) model that shows the changes in available energy from one trophic level to another in a food chain: a pyramid of numbers shows the number of organisms at each trophic level; a pyramid of biomass shows the number of organisms at each trophic level multiplied by their mass; and a pyramid of energy shows the amount of energy that is available at each trophic level

ecological succession (primary, secondary) the process of gradual change that occurs when organisms colonize a habitat, modify it, and are forced out by a new species better adapted to the now altered environment; primary succession occurs in an area where no soil exists, secondary succession occurs after a major disturbance, such as a forest fire, in an area that already has soil and once had living organisms

ecology the study of the relation of organisms to the environment and to each other

ecosystem a network of interactions linking biotic factors (organisms) and abiotic factors (air, water, soil, etc.)

elevation height above sea level

estuary coastal body of water where a river or stream (freshwater) meets the ocean (salt water)

extinction the dying out of a species

food chains series of organisms that represent the flow of energy in an ecosystem from producer to consumer and from consumer to consumer

food pyramids See ecological pyramids

food web a model of the feeding relationship in an ecosystem

foreign species organisms that people have introduced into area where they did not exist previously

fossil fuels non-renewable sources of energy, such as oil, gas, and coal, formed by plants and animals that lived millions of years ago

grazing feeding method of animals such as deer and antelope that have flat teeth to grind plant materials

habitat where an organism lives

heavy metals metals such as lead, cadmium, and mercury, which have no known vital or beneficial effect on organisms; their accumulation over time in the bodies of mammals can cause serious illness

herbivore a consumer that eats only plants

host the organism that a parasite lives in or on

keystone species species that can greatly affect population numbers and the health of an ecosystem

latitude the distance north and south from the equator

legumes plants such as peas, beans, alfalfa, and clover that can fix atmospheric nitrogen

lichen organism formed through a mutualistic relationship between fungi and algae or cyanobacteria

lightning an atmospheric discharge of electricity

mutualism a relationship in which both organisms benefit, such as a bee gathering nectar from a flower

native species plants and animals that naturally inhabit an area

natural selection the process, proposed by Darwin, where environmental factors favour the selection of fit individuals

niche the role an organism has within an ecosystem; how an organism fits into and contributes to its environment physically, chemically, and biologically

nitrification a two-step process that occurs when certain nitrifying bacteria convert ammonium into nitrite (NO_2^-)

nutrients materials that an organism needs to live and grow

omnivore a consumer that eats both plants and animals

parasitism a relationship in which one organism benefits and the other organism is harmed, such as mountain pine beetles destroying a pine forest

PCBs compounds that are produced by replacing hydrogen atoms in biphenyl with chlorine; an abbreviation for polychlorinated biphenyls

pesticide a substance used to control populations of plant and animal pests

pH a measure of how acidic or basic a solution is

phosphorus a chemical element that is essential for life processes in plants and animals

photosynthesis a chemical reaction that coverts solar energy into chemical energy usable by plants; during photosynthesis, carbon in the form of carbon dioxide enters the leaves of plants and reacts with water in the presence of sunlight to produce energy-rich carbohydrates and oxygen; represented by the chemical equation: $6CO_2 + H_2O + \text{energy (sunlight)} \rightarrow C_6H_{12}O_6 + 6O_2$

phytoplankton plant-like micro-organisms

pioneer species organisms such as lichens and other plants that are the first organisms in an area to survive and reproduce; these organisms change the abiotic and biotic conditions of an area so that other organisms can survive there

ppm one particle of a given substance mixed with 999 999 other particles; an abbreviation for parts per million

predation the relationship where one organism (the predator) kills and consumes another organism (the prey)

producer organisms that produce food in the form of carbohydrates during photosynthesis

proliferation to grow or multiply by rapidly producing new tissues, cells, or offspring

soil degradation the process in which soil becomes less healthy and less able to support life

stability in a community, after populations are able to return to their previous state after a disturbance

symbiosis a relationship in which two different organisms live together in a close association

terrestrial related to land

top consumer/predator/carnivore organisms in the fourth trophic level (e.g., hawks and sea otters), which obtain their energy by eating secondary consumers

toxin poison

trophic level the number of energy transfers an organism is away from the original solar energy entering the food chain

zooplankton animal-like micro-organisms

Part C – Unit 1 Answer Key

Chapter 1

Quick Check Answers

page 5

1. (a) Biotic
   (b) Abiotic
   (c) Abiotic
   (d) Abiotic
   (e) Abiotic
   (f) Biotic

page 7

1. (a) 31°C
   (b) 0°C to 22°C
   (c) 150 cm
   (d) 20 cm to 205 cm
   (e) 20 cm and 32°C
   (f) Permanent ice, tundra, boreal forest, and grassland
2. Latitude
3. Latitude

page 8

1. (a) Time in months
   (b) Temperature
   (c) Average temperature in degrees Celsius
   (d) 10°C
   (e) 22°C
   (f) January
   (g) Average precipitation in millimetres
   (h) 100 mm
   (i) 10 mm
   (j) They are the same.

page 9

1. An adaptation is a characteristic that enables an organism to better survive and reproduce. Adaptations can be structural, physiological, or behavioural.
2. (a) Structural
   (b) Physiological
   (c) Behavioural
   (d) Structural
   (e) Behavioural

page 12

1. (a) Temperate rainforest
   (b) Boreal forest
   (c) Temperate rainforest
   (d) Temperate rainforest
   (e) 5
2. (a) Grassland
   (b) Temperate deciduous forest
   (c) Boreal forest
3. (a) Temperate rainforest
   (b) Grassland
   (c) Tundra

page 16

1. Habitat, ecosystem, biome, biosphere

page 17

1. Ecology is the study of the relation of organisms to their environment and to each other.
2. Ecological hierarchy
3. Population
4. Community

page 18

1. Commensalism
2. The hookworm benefits but the dog is harmed.
3. Niche
4. Competition

page 19

1. Approximately 11–13, 21–23, 32–34, 43–45

Practice Questions Answers

Section 1.1

1. D
2. B
3. B
4. C
5. B
6. A
7. C
8. D
9. A
10. C

Section 1.2

1. D
2. A
3. D
4. C
5. D
6. B
7. B
8. A
9. D
10. B

Chapter 2

Quick Check Answers

page 24

1. Producers
2. Energy flow describes the flow of energy from the ecosystem to an organism and from one organism to another.
3. Decomposers are organisms such as bacteria and fungi that change wastes and dead organisms into usable nutrients for other organisms in soil and water.
4. (a) Decomposer
   (b) Producer
   (c) Decomposer
   (d) Producer
   (e) Consumer, decomposer

page 26

1. Grass (producer) → rabbit (herbivore) → cougar (carnivore) → bear (omnivore) → earthworm (detrivore)
2. Omnivore
3. Worm

page 27

1. Grizzly bear, grouse
2. Grizzly bear, red-tailed hawk

page 28

1. Pyramid of energy
2. 99 percent is lost.

page 33

1. A nutrient is a chemical that is required for plant and animal growth and other life processes.
2. Deforestation (clearing of land)
3. Carbon, nitrogen, oxygen, phosphorus

page 34

1. Carbon sink
2. (a) Atmosphere
   (b) Long-term (intermediate and deep water)
   (c) More is stored in the soil
   (d) Marine sediments and sedimentary rock

page 35

1. (a) 750
   (b) 700
   (c) 1600
2. (a) Faster into the oceans
   (b) Into the air
   (c) Burning fossil fuels produces carbon dioxide, which remains in the air.
3. Volcanoes put carbon into the atmosphere.

page 36

1. Nitrogen fixation
2. Nitrification

page 37

1. Denitrification returns nitrogen to the atmosphere, while nitrogen fixation and nitrification take nitrogen from the atmosphere and make it available to plants for use.
2. Burning fossil fuels, treating sewage, and fertilizing for agriculture
3. Kill aquatic organisms by using up CO2 and oxygen and blocking sunlight; produce neurotoxins

page 38

1. In rocks and sediments on the ocean floor in compounds that contain phosphate (PO_4^{3-})
2. Geologic uplift brings phosphorus-containing rocks to the surface and exposes them to weathering processes such as chemical (lichens feeding on the rocks)and physical (erosion, freezing and cracking).
3. Plants grow in phosphate-containing rocks and soils. Animals obtain phosphate by eating the plants.
4. Mining for fertilizer components

page 43

1. Bioaccumulation is the accumulation of a substance, such as a toxic (poisonous) chemical, in various tissues of a living organism.
2. (a) When a bear eats many salmon, the chemical builds up to high levels in the bear.
   (b) Biomagnification

3. Keystone species are species that can greatly affect population numbers and the health of an ecosystem. The health of the forest depends on it receiving nutrients. By moving salmon from the water to the forest, they transfer essential nutrients to the forest. This makes the bears extremely important for the forest—which is why they are a keystone species.

page 44

1. The orca is at the top of the food chain and receives all the PCBs that were present in 4550 kg of microscopic plants and algae. This means that the PCB levels are greater in the orca than at any trophic level beneath it. In general, the tertiary consumer is always at greater risk than the producers or primary consumers.

page 45

1. About 3 to 4 times more concentrated (3.8×)
2. Biomagnification causes the concentration of DDT to increase at each trophic level. Plankton is a producer and takes on the same concentration as is present in the environment. Cormorants are secondary or tertiary consumers and contain DDT that was in many times their body weight worth of plankton.

page 46

1. Lead, mercury, cadmium
2. Bioremediation

Practice Questions Answers

Section 2.1

1. A
2. D
3. B
4. D
5. C
6. D
7. A
8. A
9. D
10. B

Section 2.2

1. D
2. A
3. D
4. B
5. C
6. D
7. B
8. C
9. A
10. D

Section 2.3

1. D
2. B
3. C
4. A
5. C
6. D
7. C
8. B
9. D
10. C

Chapter 3

Quick Check Answers

page 52

1. Natural selection is the process, proposed by Darwin, where the environment acts to select fit individuals.
2. Salmon that have slightly larger or more efficient tails may be able to catch prey or escape from predators better than other salmon. This gives them a better chance to reproduce.
3. Adaptive radiation is the process by which members of a species adapt to a variety of habitats.
4. Each species of finch has a differently sized beak that allows it to eat only certain kinds of food. Finches with differently shaped beaks eat different food. Each species has its own niche within the same habitat.

page 53

1. Ecological succession is the process of gradual change that occurs when organisms colonize a habitat, modify it, and are forced out by a new species better adapted to the now altered environment.
2. Pioneer species
3. In primary succession, no soil exists, such as after a glacier retreats or when lava cools. Secondary succession occurs after a major disturbance, such as a forest fire or a flood.

4. Climax community (or mature community)
5. Changes in climate, flooding, drought, and insect infestations (also correct: changes in ocean patterns, extreme weather)

page 59

1. A sustainable ecosystem provides economic opportunities today while maintaining biodiversity and ecosystem health for the future.
2. Deforestation reduces the number of plants and animals in an ecosystem and results in soil degradation.
3. Soil degradation occurs when water and wind erosion removes topsoil from bare land.

page 60

1. Soil erosion and soil compaction
2. Harvesting fish and timber, mining coal and minerals, and extracting oil and gas
3. Jobs, materials, food, shelter, and energy
4. Habitat loss, soil degradation, and contamination of water supplies
5. Overexploitation is the use or extraction of a resource until it is depleted.
6. Extinction is the dying out of a species.

page 61

1. Stories, songs, cultural beliefs, rituals, community laws, and traditional practices
2. Burning improves the growth of berry plants, which attracts more animals. Burning recycles nutrients, creates more diversity, reduces forest litter, and opens the canopy to allow more sunlight to reach the plants.

page 65

1. Native species are plants and animals that naturally inhabit an area. Foreign species are organisms that people intentionally or accidentally have introduced into regions where they did not exist previously.
2. Invasive species are organisms that can take over the habitat of native species or invade their bodies, weakening their immune systems.

page 66

1. Proliferation means to grow or multiply by rapidly producing new tissues, cells, or offspring.
2. Competition, predation, disease and parasitism, habitat alteration
3. Foreign species (introduced species)
4. The gypsy moth larvae strip oak trees of their leaves, making the trees vulnerable to infections and unable to perform photosynthesis.

Practice Questions Answers

Section 3.1

1. B
2. C
3. C
4. A
5. B
6. B
7. D
8. A
9. C
10. B

Section 3.2

1. B
2. C
3. B
4. A
5. D
6. C
7. A
8. B
9. D
10. B

Section 3.3

1. C
2. D
3. B
4. B
5. C
6. B
7. C
8. C
9. A
10. D