

مبادئ علم البيئة



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التواصل الاجتماعي بحسب الصف الثاني عشر المتقدم



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المزيد من الملفات بحسب الصف الثاني عشر المتقدم والمادة فيزياء في الفصل الأول

المجالات الكهربائية وقياسها

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أ/ عبدالرحمن عصام عيد
Mr. Abdelrahman Esam Eid

Grade
9
General

UNIT 1

Principles of Ecology

01



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Organisms and Their Relationships

02



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Flow of Energy in an Ecosystem

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Lesson 3:
Cycling of Matter

وفق المخرجات التعليمية
ونمط الاختبار الوزاري

تشمل جميع الأسئلة الوزارية السابقة علي الدروس

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Section 1 Organisms and Their Relationships

1.1 Ecology

Scientists learn about the interactions between organisms and their environments mainly by **observation**. Every organism depends on **nonliving factors** in its environment and on **other organisms** living in the same environment. In other words, all living things need both nonliving things and other living things to survive.

Example: green plants give food and a place to live to many organisms. The animals that eat the plants become food for other animals.

Ecology: the scientific discipline in which the relationships among living organisms and the interactions they have with their environments are studied.

WORD ORIGIN

ecology comes from the Greek words **oikos** = house and **ology** = study of. The word was first used in 1866 by the German biologist Ernst Haeckel.

Ecologists and models

Scientists who study ecology are called **ecologists**. Ecologists **observe, ask questions, analyze data, conclude,** and then **build models**.

- ✓ A **scientific model** is a visual representation used to answer a question or test a hypothesis. Models can be **physical, mathematical** (equations), or **computer** models.
- ✓ A model allows a scientist to **simulate a process or system**.
- ✓ Studying organisms in the field is difficult because there are many variables at one time. Models let ecologists **control the number of variables** and introduce new variables slowly.

Question 1 **MINISTRY** Ecology is the scientific discipline that studies all the interactions between:

- a** organisms and their environments
- b** all the different regions of Earth
- c** different forms of matter on Earth
- d** humans and their polluting behaviors

Question 2 The suffix -ology comes from a word meaning to study. What is ecology the study of?

- a** the interrelationships between organisms and their environment
- b** organic molecules
- c** how organisms use sound to locate objects
- d** the interrelationships between single-cell organisms

Question 3 **MINISTRY** Which of the following tasks would be completed by an ecologist?

- a** Explore the medicinal uses of nectar
- b** Inoculate cattle against infection
- c** Test the effect of cyanide on algae
- d** Survey and classify mollusk fossils

Question 4 In which scientific study would an ecologist take part?

- (a) observe how coral colonizes a sunken ship (b) compare fossilized ant species in amber
(c) classify three new rain forest insect species (d) assess the rabies risk of wild raccoons

Question 5 Ecologists often use modeling, instead of field studies, because it _____.

- (a) allows them to control all of the variables involved (b) is less expensive than working in the field
(c) lets them study many organisms at once (d) helps them collect more samples

Question 6 What is the importance of building models for scientists?

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1.2 The Biosphere

Biosphere: the portion of Earth that supports life — a thin layer that extends from high in the atmosphere to deep in the ocean.

- ✓ **bio** = life, **sphere** = ball → "ball of life". But the biosphere is only a **thin layer** around Earth, not the whole planet.
- ✓ It includes **landmasses**, **bodies of fresh water and salt water**, and all locations below Earth's surface that support life.
- ✓ The biosphere contains very diverse places: rain forests, deserts, deep-ocean vents. The organisms in each place are **adapted** to the conditions there.
- ✓ The biosphere is the **highest level** of organization.

Question 7 **MINISTRY** The area between the highest mountain and the deepest ocean where there is life is called:

- (a) Habitat (b) Biosphere
(c) Biome (d) Ecosystem

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Question 8 What is the biosphere?

- (a) biological community and all the nonliving factors that affect it
- (b) the relatively thin layer of Earth and its atmosphere that supports life
- (c) physical area where an organism lives
- (d) all the interacting populations of different species in the same place

Question 9 Deep ocean vents, African wildlife, and arctic glaciers are all part of the _____.

WORD BANK

biosphere • ecosystem • population

1.3 Biotic and Abiotic Factors

Biotic factors: the **living** factors in an organism's environment.

Example (a stream community): fish, algae, frogs, microscopic organisms, the organisms living on the land next to the water, and **migratory animals** such as birds that pass through the area.

Interactions among organisms are necessary for the health of all species in the same place: to **reproduce**, an organism needs other members of its own species; to **feed**, it needs other species.



The deer is a biotic factor in this stream community.

Abiotic factors: the **nonliving** factors in an organism's environment.

Examples: temperature, air or water currents, sunlight, soil type, rainfall, available nutrients, pH, and salt concentration (salinity).

	Biotic factors	Abiotic factors
Meaning	the living factors in the environment	the nonliving factors in the environment
Examples	plants (grass), frogs, deer, fish, insects, bacteria, fungi, migratory birds	sun, water, air, soil, wood, temperature, rainfall, currents, pH

✓ REMEMBER

- ✓ Organisms **depend on abiotic factors** to survive (a plant needs rainfall, sunlight, suitable temperature, and soil nutrients).
- ✓ Organisms are **adapted** to the abiotic factors of their own environment. If an organism is moved to a new place, it may **die** because it cannot adjust — e.g. a lush green plant from a swamp moved to a dry desert.

Question 10 **MINISTRY** Which of the following are considered as biotic factors?

- (a) Migratory animals, such as birds
- (b) Air or water currents
- (c) Sunlight
- (d) Rainfall and temperature

Question 11 **MINISTRY** Which of the following is an abiotic factor?

- ☐ a An ocean current of cold water
- ☐ b A polar bear on an ice floe
- ☐ c Fungi and moss on a rotting log
- ☐ d A forest of deciduous trees

Question 12 Which of the following is a biotic factor?

- ☐ a sand winds
- ☐ b dew drops
- ☐ c a cactus plant
- ☐ d sun rays

Question 13 Which of the following is an abiotic factor for a tree in a forest?

- ☐ a a caterpillar eating its leaves
- ☐ b a bird building a nest between its branches
- ☐ c wind blowing through its branches
- ☐ d fungi growing on its roots

Question 14 Which of the following is a biotic factor in soil?

- ☐ a the quantity of humus in the soil
- ☐ b worms living in the soil
- ☐ c the water level in the soil
- ☐ d the nutrients in the soil

Question 15 Classify each factor as biotic or abiotic.

Statement / Item	Your answer
Temperature	
Algae	
Soil pH	
Soil bacteria content	
Wind	
Plant life	
Predators	
Water	

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Question 16 What does a decrease in salmon population due to an increase in river temperature indicate?

- (a) an unchanging biological community
- (b) change in population but not in abiotic factors
- (c) an abiotic factor affecting a biotic factor
- (d) an effect of predation

Question 17 How do abiotic factors affect biotic factors? Give an example.

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1.4 Limiting Factors and Range of Tolerance

Limiting factor:

any abiotic or biotic factor that **restricts** the numbers, reproduction, or distribution of organisms.

- ✓ **Abiotic limiting factors:** sunlight, climate, temperature, water, nutrients, fire, soil chemistry, and space.
- ✓ **Biotic limiting factors:** other living things, such as other plant and animal species.
- ✓ A factor that limits one population might help another population to thrive.
- ✓ In a desert oasis, **water** is a limiting factor for all organisms; desert species must withstand extreme **temperatures**.

Tolerance: the ability of an organism to **survive** when subjected to abiotic or biotic factors.

For any environmental factor there is an **upper limit** and a **lower limit** for survival. Look at the steelhead trout (Figure 6):

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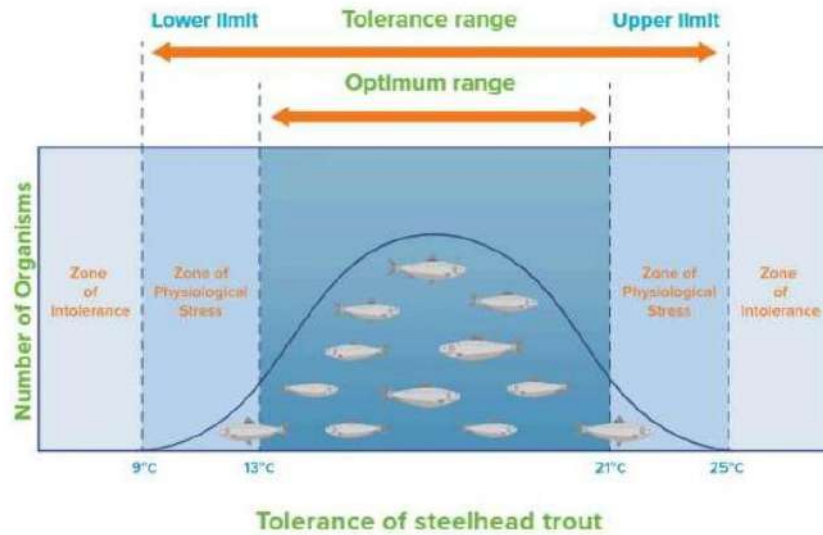


Figure 6 — Tolerance of steelhead trout to water temperature.

Zone	Water temperature	What happens to the trout
Tolerance range	9°C – 25°C	The trout can survive.
Optimum range	13°C – 21°C	Best conditions the greatest number of fish.
Zones of physiological stress	9°C – 13°C and 21°C – 25°C	Fewer fish; they may be unable to grow or reproduce.
Zones of intolerance	below 9°C or above 25°C	No trout — the fish die.

Question 18 Using Figure 6, what does the portion of the graph from 13°C to 21°C represent?

- ☐ a zone of physiological stress ☐ b zone of intolerance
☐ c upper limit ☐ d optimum range

Question 19 The amount of oxygen in a fish tank is a _____ that affects the amount of fish that can live in the tank.

Question 20 A biotic or abiotic factor that restricts the numbers of organisms in an ecosystem is called a(n) _____.

- ☐ a primary succession ☐ b tolerating factor
☐ c limiting factor ☐ d end point

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Question 21 In an environment, many factors affect a population's growth and survival.

These include _____ (1), which are all the living factors in an organism's environment.

There are also _____ (2), which are all the nonliving factors, such as water, sunlight, temperature, and _____ (3), which are chemical substances that organisms use to carry out processes and sustain life.

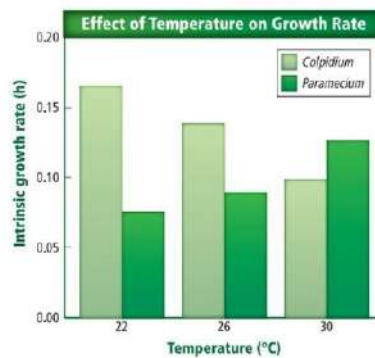
Any factor that restricts the number, distribution, or reproduction of a population is a _____ (4). To survive, organisms must have a certain level of _____ (5), the ability to survive these factors.

WORD BANK

limiting factor • nutrients • abiotic factors • biotic factors • tolerance

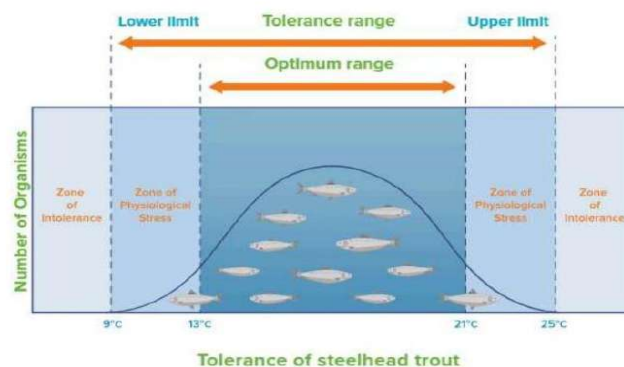
Question 22 **MINISTRY** The graph shows the effect of temperature on the growth rate of Colpidium and Paramecium.

Describe the differences in population growth for the two species.



- a Colpidium grows faster than Paramecium at 22°C and 26°C, but Paramecium grows faster at 30°C
- b Colpidium grows faster than Paramecium at 22°C and 30°C, but Paramecium grows faster at 26°C
- c Colpidium grows faster than Paramecium at 30°C and 26°C, but Paramecium grows faster at 22°C
- d Colpidium grows faster than Colpidium at 30°C, but Paramecium grows faster at 22°C and 26°C

Question 23 Predict the general growth trend for steelhead trout in a stream that is 22°C



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1.5 Levels of Organization

The biosphere is too large and complex for most ecological studies. To study relationships, ecologists look at **smaller pieces** of the biosphere. The levels increase in complexity as the numbers and interactions between organisms increase.

Level	Definition
1 Organism	an individual living thing — the lowest (simplest) level. Example: one striped fish.
2 Population	a group of organisms of the same species that interbreed and live in the same place at the same time. Example: a school of fish.
3 Biological community	a group of interacting populations of different species that occupy the same geographic area at the same time.
4 Ecosystem	a biological community and all of the abiotic factors that affect it. Example: a coral reef + the sea water.
5 Biome	a large group of ecosystems that share the same climate and have similar types of communities. Example: a marine biome.
6 Biosphere	the thin layer of Earth and its atmosphere that supports life — the highest level.

Biosphere The highest level of organization is the biosphere, which is the layer of Earth—from high in the atmosphere to deep in the ocean—that supports life.

Biome A biome is a group of ecosystems, such as the coral reefs off the coast of the Florida Keys, that share the same climate and have similar types of communities.

Ecosystem A biological community, such as the coral reef, and all of the abiotic factors, such as the sea water, that affect it make up an ecosystem.

Biological community All of the populations of species—fishes, coral, and marine plants—that live in the same place at the same time make up a biological community.

Population A group of organisms of the same species that interbreed and live in the same place at the same time, such as the school of striped fish, is a population.

Organism An individual living thing, such as one striped fish, is an organism.

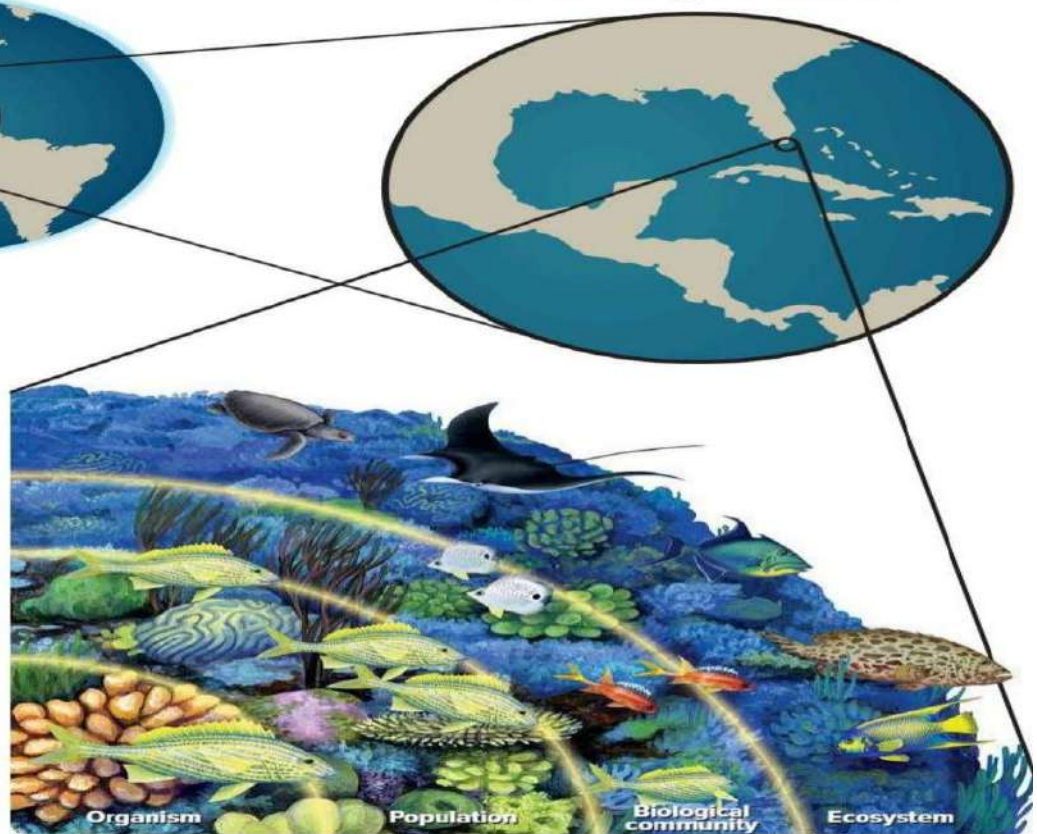


Figure 7 Visualizing levels of organization

Chapter 1 Principles of Ecology

✓ NOTES ON THE LEVELS

- ✓ Individuals of a population often **compete** for the same resources. When resources are plentiful the population grows; when it grows beyond what resources can support, it **declines**.
- ✓ An ecosystem can be **large** or **small** (an aquarium or a tiny puddle). Its boundaries are flexible and ecosystems can overlap.
- ✓ Example of an ecosystem — a pond: living things (grass, trees, fish, insects, turtles, rabbits, bacteria, fungi) **plus** nonliving components: physical (sunlight, heat, air pressure, gravity) and chemical (oxygen in water, carbon dioxide, nitrogen, pH).

Question 24 **MINISTRY** Based on your study of the concept of ecology, what does the picture below represent?



- ☐ (a) Ecosystem
- ☐ (b) Biosphere
- ☐ (c) A biome
- ☐ (d) Population

Question 25 **MINISTRY** Based on your study of the concept of ecology, what do the biotic factors in the picture below represent?



- ☐ (a) Community
- ☐ (b) Biosphere
- ☐ (c) A biome
- ☐ (d) Population

Question 26 **MINISTRY** "It includes living and non-living components in a region" is a definition of:

- ☐ (a) The ecosystem
- ☐ (b) The biological population
- ☐ (c) The biosphere
- ☐ (d) The biological community

Question 27 Which of the following is the least complex?

- (a) biological community
- (b) biome
- (c) population
- (d) ecosystem

Question 28 Which term describes all individuals of one species that occupy a certain area?

- (a) population explosion
- (b) carrying capacity
- (c) population
- (d) biological community

Question 29 Which level of organization includes all the other levels listed?

- (a) biological community
- (b) ecosystem
- (c) population
- (d) individual

Question 30 Which of the following would be considered an ecosystem?

- (a) bacteria living in a deep-ocean vent
- (b) the biotic factors in a forest
- (c) the living and nonliving things in a pond
- (d) populations of zebras and lions

Question 31 What is a population?

- (a) a role, or position, of an organism in its environment
- (b) physical area where an organism lives
- (c) group of organisms of the same species that occupy the same area at the same time
- (d) biological community and all the nonliving factors that affect it

Question 32 What is a biological community?

- (a) group of organisms of the same species in the same area
- (b) physical area where an organism lives
- (c) a role, or position, of an organism in its environment
- (d) all the interacting populations of different species in the same place at the same time

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Question 33 Match each description to the correct key term.

Statement / Item	Your answer
A large school of barracuda	
A barracuda	
All the conifer forests growing in Canada	
All the groups of organisms that interact with each other in the same region	
WORD BANK	biological community • biome • population • organism

Question 34 Match each example to its level of organization.

Statement / Item	Your answer
All the salmon living in a lake	
The deciduous forests of the eastern United States	
All the living and nonliving things in an oasis pond in the desert	
All the corals, invertebrates and fish in a coral reef in the Red Sea	
WORD BANK	population • biome • ecosystem • biological community

Question 35 The algae, insect larvae, protozoans, and other living things in a large puddle would be an example of a(n) _____.

WORD BANK	population • ecosystem • biological community
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1.6 Ecosystem Interactions: Habitat and Niche

Interactions between organisms are important in an ecosystem. A community of organisms **increases the chances of survival** of any one species by using the available resources in different ways — for example, different bird species in one tree: one eats insects on the leaves, another uses pieces of bark as nesting material.

Habitat: the **area where an organism lives**. It may be a single tree, or a grove of trees if the organism moves from tree to tree.

Niche: the **role or position** that an organism has in its environment — how it meets its needs for **food, shelter, and reproduction**.



Figure 8 — These trees are the habitat for a community of organisms.

	Habitat	Niche
Meaning	the place (area) where the organism lives	the role (job) of the organism in its environment
Examples	birds on trees, bats in caves, camels in the desert	hunting, finding mates, making a nest, gathering pollen
Importance	meets the organism's needs for food, shelter, water and reproduction	described by needs for living space, temperature, moisture, and mating conditions

Question 36 **MINISTRY** The tree in the figure below represents the area where an organism lives and spends its life on.

What is this tree called?



- ☐ (a) Biome ☐ (b) Ecosystem
☐ (c) Habitat ☐ (d) Niche

Question 37 **MINISTRY** The area where an organism lives is called:

- ☐ (a) community ☐ (b) Habitat
☐ (c) ecosystem ☐ (d) house

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Question 38 **MINISTRY** The region of land — approximately 4 km² — a gazelle must roam to collect food would be an example of a(n):

- (a) habitat
- (b) population
- (c) ecosystem
- (d) biome

Question 39 **MINISTRY** What term best describes the bee's role of gathering pollen?



- (a) Niche
- (b) Parasite
- (c) Predator
- (d) Habitat

Question 40 The region of land a jaguar must roam to collect food would be an example of a(n) _____.

WORD BANK

habitat • biome • ecosystem

Question 41 An organism in a community inhabits a specific physical area, or _____ (1). Each organism has a unique role to play, known as its _____ (2).

A biological community and all the biotic and abiotic factors that affect it is called a(n) _____ (3). When several of these have the same climate and similar communities, they are classified as a(n) _____ (4).

Question 42 Compare between a habitat and a niche. Give one example of each.

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1.7 Community Interactions: Competition and Predation

Organisms that live together in a biological community **constantly interact**. These interactions, along with the abiotic factors, shape an ecosystem. Community interactions include: **competition**, **predation**, and **symbiosis**.

Competition: occurs when more than one organism uses a **resource** at the same time (food, water, space, light, mates, shelter).

During a **drought**, water is scarce: strong organisms compete directly with weak ones; usually the **strong survive and the weak die**, or some move away. When water is plentiful, competition is **not as fierce**.



Figure 9 — During droughts, animals compete for water.

Predation: the act of one organism **pursuing and consuming** another organism for food.

The organism that pursues is the **predator**; the organism that is pursued is the **prey**. Example: a cat catching a bird or a mouse.



A wolf (predator) feeding on a moose (prey).

- ✓ Some insects prey on other insects — **ladybugs** and **praying mantises**. They are called **beneficial insects** because organic gardeners use them for insect control instead of insecticides.
- ✓ Some **plants** are predators: the **Venus flytrap** has leaves that form traps. It gives off a sweet, sticky substance; when an insect lands, the leaf snaps shut and digests it over several days.

Question 43 Two leaf-eating species of animals live in a habitat with a severe drought, and many plants die. Which term describes the relationship the two species will probably have?

- (a) predator-prey
- (b) abiotic
- (c) symbiotic
- (d) competitive

Question 44 **MINISTRY** Which of the following is an example of predation?

- (a) Tick lodging in the skin of a wolf
- (b) Clownfish protecting its anemone
- (c) Two male rams fighting for females
- (d) Mallard eating aquatic invertebrates

Question 45 What is predation?

- (a) process in which fixed nitrogen compounds are converted back into nitrogen gas
- (b) exchange of matter through the biosphere
- (c) act of one organism feeding on another organism
- (d) process through which nitrogen gas is converted into a form plants can use

Question 46 Describe one example each of competition and predation.

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1.8 Symbiotic Relationships

Symbiosis: the **close relationship** that exists when two or more species live together. There are three kinds: **mutualism**, **commensalism**, and **parasitism**.

Mutualism (+ / +)

Mutualism: a relationship between two or more organisms that live closely together and **both benefit**.

- ✓ **Sloth and algae:** the algae get **shelter** and **moisture** in the sloth's fur; the sloth gets **camouflage** and maybe some nutrients.
- ✓ **Lichens (fungi + algae):** the algae provide **food** for the fungi; the fungi provide a **habitat** (water and shelter) for the algae.
- ✓ **Bee and flower:** the bee gets pollen and nectar for food; the flower gets help in reproduction (pollination).



Figure 10 — Algae live in the sloth's fur.

Commensalism (+ / 0)

Commensalism:

a relationship in which one organism **benefits** and the other is **neither helped nor harmed**.

- ✓ **Lichens on a tree:** the lichens gain more exposure to **sunlight**; the tree is not harmed and gets no benefit.
- ✓ **Clownfish and sea anemone:** the clownfish swims among the stinging tentacles without harm and gets **food and protection**; the anemone is not harmed and gets no apparent benefit.
- ✓ **Remora and shark:** the remora collects scraps of food; the shark is unaffected.

Parasitism (+ / -)

Parasitism: a relationship in which one organism (the parasite) **benefits at the expense** of another organism (the host).

- ✓ **External** parasites: ticks and fleas (on dogs).
- ✓ **Internal** parasites: bacteria, tapeworms, roundworms (heartworms).
- ✓ Usually the parasite does **not kill** the host — the death of the host would also mean the death of the parasite.
- ✓ The tomato hornworm with wasp cocoons is unusual: the wasps will likely **kill** their host.



Figure 11

A hornworm hosting parasitic wasps.

⚠ BROOD PARASITISM

The **brown-headed cowbird** lays its eggs in another bird's nest and abandons them. The host bird incubates and feeds the young cowbirds, which often push the host's eggs or young out of the nest. This has lowered the populations of songbirds in some areas.

Relationship	Organism 1	Organism 2	Example
Mutualism	benefits (+)	benefits (+)	lichens (fungi + algae), sloth & algae, bee & flower
Commensalism	benefits (+)	not affected (0)	clownfish & anemone, lichens on a tree, remora & shark
Parasitism	benefits (+)	harmed (-)	ticks on a dog, tapeworms, cowbird (brood parasitism)
Predation	predator gains food	prey is eaten	cat & bird, wolf & moose
Competition	both lose some resources	both lose some resources	two leaf-eaters in a drought

Question 47 **MINISTRY** In the figure below, which shows lichens, the algae provide food for the fungi, and the fungi provide a habitat for the algae.

Which term best describes the relationship between the two species?



- ☐ a Commensalism
- ☐ b Competition
- ☐ c Mutualism
- ☐ d Predation

Question 48 **MINISTRY** The insect in the photo below is gathering pollen and nectar for food, but at the same time is aiding in the plant's reproduction.

What does this relationship demonstrate?



- ☐ a Mutualism
- ☐ b Commensalism
- ☐ c Predation
- ☐ d Parasitism

Question 49 **MINISTRY** Which of the following is an example of mutualism?

- ☐ a Crayfish and minnows resting under the same rock
- ☐ b Two snake species with similar markings advertising their toxic venom
- ☐ c A fish protecting a shrimp, who builds a burrow for the pair to share
- ☐ d A peacock courting and mating with a peahen

Question 50 **MINISTRY** Clownfish swim among the stinging tentacles of sea anemones without harm. The sea anemones protect the fish from predators while the clownfish eat bits of food missed by the anemones.

Which of the following describes this relationship?

- (a) Brood parasitism
- (b) Competition
- (c) Mutualism
- (d) Commensalism

Question 51 **MINISTRY** The relationship between two living things in which one gains benefits at the expense of the other is called:

- (a) commensalism
- (b) predation
- (c) parasitism
- (d) mutualism

Question 52 A remora fish swimming beneath a shark to collect scraps while the shark remains unaffected is an example of _____.

Question 53 A close association between two or more species that live together is called a _____ relationship. It can be mutualistic, parasitic, or commensalistic.

- (a) symbiotic
- (b) biosphere
- (c) food web
- (d) food chain

Question 54 What is mutualism?

- (a) symbiotic relationship in which one organism benefits and the other is neither helped nor harmed
- (b) symbiotic relationship in which one organism benefits at the expense of another
- (c) symbiotic relationship in which both organisms benefit

Question 55 What is commensalism?

- (a) symbiotic relationship in which both organisms benefit
- (b) symbiotic relationship in which one organism benefits at the expense of another
- (c) symbiotic relationship in which one organism benefits and the other is neither helped nor harmed

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Question 56 What is parasitism?

- (a) symbiotic relationship in which one organism benefits and the other is neither helped nor harmed
- (b) symbiotic relationship in which both organisms benefit
- (c) symbiotic relationship in which one organism benefits at the expense of another

Question 57 Choose the type of relationship that best defines each scenario.

Statement / Item	Your answer
Red-tailed hawks and black racer snakes prey on the same species of rodents in the same habitat.	
One organism benefits, while another is unharmed during a long-term relationship between the two.	
A tick becomes lodged on the skin of a hiker.	
Coyotes eat mice and rabbits.	
WORD BANK	competition • parasitism • predation • commensalism

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Section 2 Flow of Energy in an Ecosystem

One way to study the interactions of organisms is to **follow the energy** that flows through an ecosystem. Organisms are classified into **autotrophs** and **heterotrophs** based on **how they obtain energy**.

2.1 Autotrophs (Producers)

Autotroph: an organism that **collects energy from sunlight or inorganic substances** to produce its own food. Autotrophs are also called **primary producers**.

Type	How it makes food	Examples
Using light (photosynthesis)	Organisms with chlorophyll absorb light energy during photosynthesis and use it to convert inorganic carbon dioxide and water into organic molecules (sugar). Oxygen is released.	green plants, algae, mosses
Using chemicals	Where sunlight is unavailable , some bacteria use hydrogen sulfide and carbon dioxide to make food.	some bacteria (e.g. at deep-ocean vents)

WHY ARE AUTOTROPHS IMPORTANT?

Autotrophs are the **foundation of all ecosystems** because they make energy available for all other organisms in the ecosystem.

Question 58 **MINISTRY** Which of the following is an autotroph?

- ☐ a Sparrow
- ☐ b Alga
- ☐ c Wolf
- ☐ d Mushroom

Question 59 Which of the following is an autotroph?

- ☐ a falcon
- ☐ b fox
- ☐ c cat
- ☐ d mosses

Question 60 A(n) _____ collects energy from sunlight or inorganic substances to produce food.

WORD BANK

autotroph • heterotroph • chemotroph

Question 61 **MINISTRY** Which of the following is a product of the photosynthesis process?

- ☐ a Oxygen
- ☐ b Carbon dioxide
- ☐ c Nitrogen
- ☐ d Water vapor

Question 62 Which of the following is a product of photosynthesis?

- (a) chlorophyll (b) water vapor
(c) carbon dioxide (d) sugar

Question 63 Where does the energy for most ecosystems originate, and how does it first enter an ecosystem such as a pond?

.....

.....

.....

2.2 Heterotrophs (Consumers)

KEY TERM Heterotroph: an organism that gets its energy requirements by **consuming other organisms**. Heterotrophs are also called **consumers**.

There are five types of heterotrophs:

Type	Definition	Examples
Herbivore	eats only plants	cow, rabbit, grasshopper
Carnivore	preys on other heterotrophs (eats meat)	wolves, lions, lynxes
Omnivore	eats both plants and animals	bears, humans, mockingbirds, mice
Detritivore	eats fragments of dead matter in an ecosystem, returning nutrients to the soil, air, and water	worms, many aquatic insects, (scavengers such as hyenas and vultures)
Decomposer	breaks down dead organisms by releasing digestive enzymes	fungi, bacteria

Why are detritivores and decomposers important?

- ✓ They break down organic compounds and make **nutrients available to producers** (autotrophs).
- ✓ Without them, organic material and the nutrients would **not be available** to other organisms to reuse.
- ✓ All heterotrophs perform some decomposition when they consume another organism.



Figure 13 A fungus obtaining food energy from a dead log.

Question 64 **MINISTRY** In the figure below, the lynx is about to consume a deer.
Which type of heterotrophs is the lynx?



- (a) Herbivore
- (b) Omnivore
- (c) Carnivore
- (d) Detritivore

Question 65 **MINISTRY** In the figure below, which of the following are considered as heterotrophs biotic factors?



Shrimp
(A)

روبيان



Ferns
(B)

سراخس



Algae
(C)

طحالب



Mushroom
(D)

مشروم

- (a) B and C
- (b) C and D
- (c) A and D
- (d) A and C

Question 66 **MINISTRY** Which of the following is an example of omnivores?

- (a) Mockingbirds
- (b) Worms
- (c) Lions
- (d) Wolves

Question 67 Which of the following is an example of omnivores?

- (a) bears
- (b) snakes
- (c) eagles
- (d) wolves

Question 68 To which group of heterotrophs does the mouse belong?

- (a) carnivore
- (b) detritivore (scavenger)
- (c) herbivore
- (d) omnivore

Question 69 **MINISTRY** Which of the following is a decomposer?

- (a) Frogs
- (b) Fungus
- (c) Plants
- (d) Mice

Question 70 Which of the following is a detritivore (scavenger)?

- (a) cat (b) mouse
(c) sunflower (d) shrimp

Question 71 A mushroom feeding on a dead log is an example of a(n) _____.

Question 72 How can detritivores be beneficial to the environment?

- (a) provide food for autotrophs (b) facilitate photosynthesis in plants
(c) allow predation to occur (d) rid waste and dead matter

Question 73 A doctorfish grazing on ocean algae is an example of a heterotroph that is an herbivore.

- (a) True (b) False

Question 74 Match each definition to its vocabulary term.

Statement / Item	Your answer
an organism that eats only plants	
captures energy from sunlight or inorganic substances to produce its own food	
an organism that preys on other heterotrophs	
decomposes organic material and returns the nutrients to soil, air, and water	
cannot make its own food; gets nutrients and energy by feeding on other organisms	
an organism that eats both plants and animals	
WORD BANK Herbivore • Carnivore • Omnivore Detritivore • Autotroph • Heterotroph	

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Question 75 What is the importance of detritivores and decomposers for the autotrophs (plants)?

2.3 Models of Energy Flow: Food Chains and Trophic Levels

Ecologists use **food chains**, **food webs**, and **ecological pyramids** as models of the energy flow through an ecosystem.

Food chain: a simple model that shows **how energy flows** through an ecosystem (a **single path**).

Trophic level: each step in a food chain or food web.

- ✓ **Arrows** represent the energy flow — from autotrophs to heterotrophs.
- ✓ The flower uses energy from the Sun → the grasshopper eats the flower → the mouse eats the grasshopper → the snake eats the mouse.
- ✓ At each step, some energy is used for cellular processes and to build new cells; some energy is **released into the environment** (as heat).
- ✓ **Autotrophs (producers)** make up the **first trophic level** in all ecosystems. Heterotrophs make up the remaining levels.
- ✓ Energy flow is **one way**.



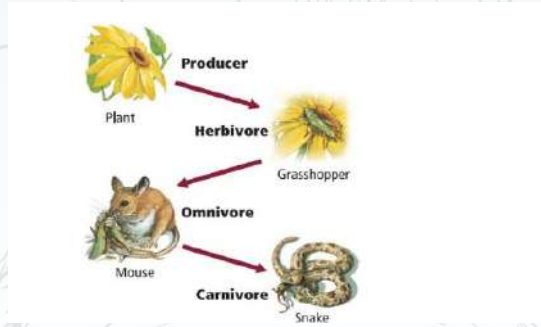
Figure 14 — A food chain.

Trophic level	Name	Example in Figure 14
1st	Producer (autotroph)	plant (flower)
2nd	Primary consumer (herbivore)	grasshopper
3rd	Secondary consumer	mouse (omnivore)
4th	Tertiary consumer	snake (carnivore)

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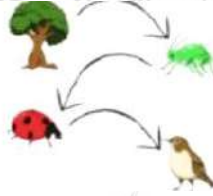
Question 76 **MINISTRY** The figure below represents a food chain.

Which of the following represents the second trophic level?



- ☐ a The mouse
- ☐ b The grasshopper
- ☐ c The plants
- ☐ d The snake

Question 77 **MINISTRY** The picture below refers to:



- ☐ a only consumers
- ☐ b Trophic levels
- ☐ c food web
- ☐ d food chain

Question 78 What is a trophic level?

- ☐ a chemical substance organisms obtain from the environment
- ☐ b each step in a food chain or food web
- ☐ c model that shows many interconnected food chains
- ☐ d simplified model that shows a single path for energy flow

Question 79 In the food chain: phytoplankton → krill → penguin → seal, which organism is at the third trophic level?

- ☐ a phytoplankton
- ☐ b krill
- ☐ c penguin
- ☐ d seal

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2.4 Food Webs

Feeding relationships are usually **more complex** than a single food chain, because most organisms feed on **more than one species** (birds eat seeds, fruits, and insects).

Food web: a model representing the **many interconnected food chains** and pathways in which energy flows through a group of organisms.

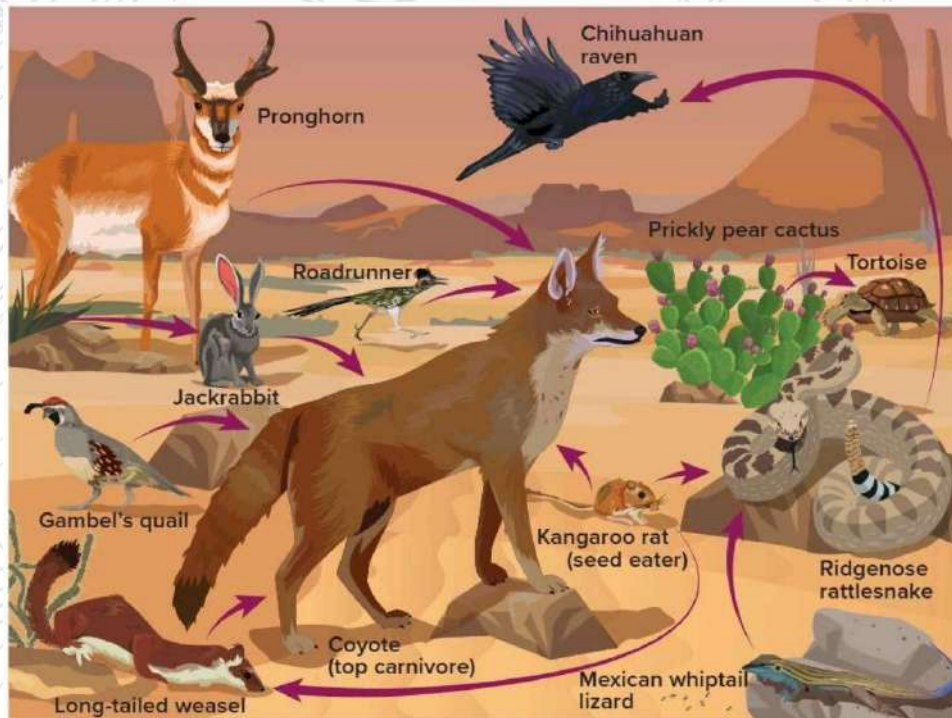
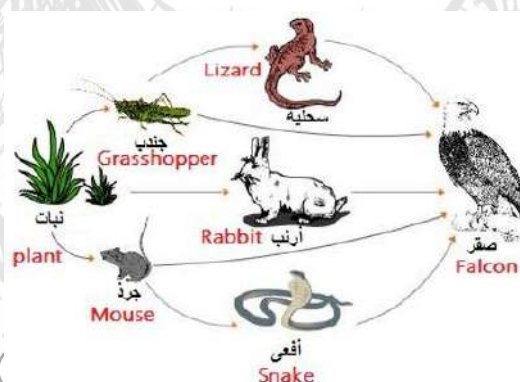


Figure 15 — A food web in a desert community.

⚠ WEAKNESS OF FOOD WEBS

A food web does **not represent all the links** in an actual ecosystem.

Question 80 **MINISTRY** How many food chains are there in the food web shown below?



a 4

c 6

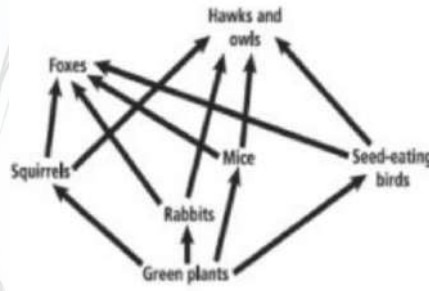
b 5

d 7

Question 81 **MINISTRY** Which of the following is a weakness of traditional food webs when they are applied to complex ecological problems?

- (a) A food web does not represent all the links in an actual ecosystem
 (b) Trophic levels are not taken into account when creating a food web
 (c) Food webs do not account for non-native species in the environment
 (d) The many food chains of a food web make it too complicated to use

Question 82 **MINISTRY** Use the illustration below to answer the following question: What happens to the energy that the fox uses for maintaining its body temperature?



- (a) It moves into the surrounding environment
 (b) It stays in the fox through the metabolism of food
 (c) It is taken up by decomposers that consume the fox
 (d) It travels to the next trophic level when the fox is eaten

Question 83 Use the same illustration (foxes, hawks and owls, squirrels, mice, rabbits, seed-eating birds, green plants).

What does the illustration represent? _____ (1) Which organisms in it are autotrophs?
 _____ (2)

WORD BANK

a food pyramid • a food web • a food chain
 foxes • green plants • rabbits

Question 84 In the same food web, which organisms have the greatest biomass?

- (a) foxes
 (b) hawks and owls
 (c) rabbits
 (d) green plants

Question 85 Give a definition for: a) food chain b) food web

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2.5 Ecological Pyramids

KEY TERM **Ecological pyramid:** a diagram that shows the relative amounts of **energy**, **biomass**, or **numbers of organisms** at each trophic level in an ecosystem.



Figure 16 — Pyramids of energy, biomass, and numbers.

Pyramid	What each level shows	Key fact
Pyramid of energy	the amount of energy available at that trophic level	only about 10% of the energy is transferred to the level above; about 90% is lost at each step
Pyramid of biomass	the amount of biomass (total mass of living matter) at each level	biomass usually decreases at each trophic level
Pyramid of numbers	the number of individual organisms at each level	the number of organisms decreases because less energy is available to support them

Biomass: the **total mass of living matter** at each trophic level.

WHY IS ONLY 10% OF ENERGY TRANSFERRED?

Because most of the energy contained in the organisms at each level is **consumed by cellular processes** or **released to the environment as heat**. Parasites and decomposers feed at each level.

WORKED EXAMPLE — ENERGY AT EACH LEVEL

Food chain: grass → caterpillar → tiger beetle → lizard → snake → roadrunner.

Assume 100% of the energy is available for the grass.

Divide by 10 at each step:

grass 100% → caterpillar 10% → tiger beetle 1% → lizard 0.1% → snake 0.01% → roadrunner 0.001%

Example 2: if 1000 calories enter the producer level of a 3-level chain.

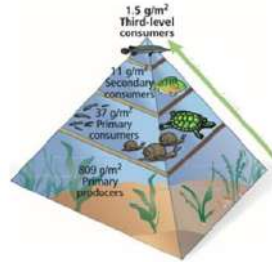
1000 → 100 → 10. Energy lost = 1000 - 10 = 990 calories.

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Question 86 **MINISTRY** Food chains, food webs and ecological pyramids are models used to show

- (a) how energy moves through ecosystems
- (b) symbiotic relationships
- (c) the levels of organization
- (d) types of ecosystems

Question 87 **MINISTRY** What does the below figure represent?



- (a) Pyramid of Numbers
- (b) Pyramid of Biomass
- (c) Pyramid of Energy
- (d) Biogeochemical cycle

Question 88 **MINISTRY** Only% of energy gets passed on from one trophic level to the next:

- (a) 10%
- (b) 20%
- (c) 50%
- (d) 5%

Question 89 **MINISTRY** The models used to represent trophic levels in ecosystems are called:

- (a) food chain
- (b) Relationship between organisms
- (c) Ecological pyramids
- (d) food web

Question 90 What is released at each level of a pyramid of energy?

- (a) plants
- (b) decomposers
- (c) animals
- (d) heat

Question 91 The total mass of living matter at each trophic level is called its _____.

- (a) abiotic factors
- (b) food chain
- (c) biotic factors
- (d) biomass

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Question 92 In the energy pyramid, how much energy is transferred to the next level, and why?

Question 93 What happens to the number of organisms at each trophic level, and why?

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Section 3 Cycling of Matter

3.1 Cycles in the Biosphere

The **law of conservation of mass** states that matter is **not created or destroyed**. All new life on Earth is built from existing atoms, so natural processes **cycle matter** through the biosphere.

Matter: anything that **takes up space and has mass**.

Nutrient: a chemical substance that an organism must **obtain from its environment** to sustain life (e.g. water, carbon, nitrogen, phosphorus).

Biogeochemical cycle: the **exchange of matter through the biosphere**. It involves living organisms (**bio**), geological processes (**geo**), and chemical processes (**chemical**).

How do nutrients move through the biotic and abiotic parts of an ecosystem?

- ✓ Green grass (biotic) captures substances from the air, soil and water (abiotic) and converts them into usable nutrients.
- ✓ A cow eats the green grass.
- ✓ If an organism eats the cow, the **nutrients** in the cow pass to the next consumer.
- ✓ **Decomposers** return the nutrients to the cycle.
- ✓ At each link only a **fraction** of matter and energy is transferred, so fewer organisms are found at higher levels — but matter and energy are always **conserved**.



Figure 17 — Chemical elements are cycled through the biosphere.

THE BIOGEOCHEMICAL CYCLES INCLUDE

- ✓ The **water** cycle
- ✓ The **carbon and oxygen** cycles
- ✓ The **nitrogen** cycle
- ✓ The **phosphorus** cycle

Question 94 What is matter?

- | | |
|---|---|
| a anything that takes up space and has mass | b the ability to do work |
| c a combination of two or more substances that keep their properties | d a pure substance formed when two or more atoms combine |

Question 95 Iron, water, and sugar are examples of matter that are nutrients.

- | | |
|---------------|----------------|
| a True | b False |
|---------------|----------------|

Chapter 1 Principles of Ecology

Question 96 The movement of chemicals on a global scale from abiotic through biotic parts of the environment is a _____.

Question 97 The exchange of matter through the _____ is called the biogeochemical cycle.

WORD BANK

atmosphere • biosphere • community • population

Question 98 Which is part of the biogeochemical cycle?

- ☐ a carbon trapped on the ocean floor
- ☐ b solar radiation traveling to Earth
- ☐ c helium gas escaping into space
- ☐ d lava flowing from an active volcano

Question 99 Why is it important to living organisms that nutrients cycle?

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3.2 The Water Cycle

Water moves through the biosphere in the **water cycle**. Energy from the **Sun** keeps water evaporating from Earth's surface.

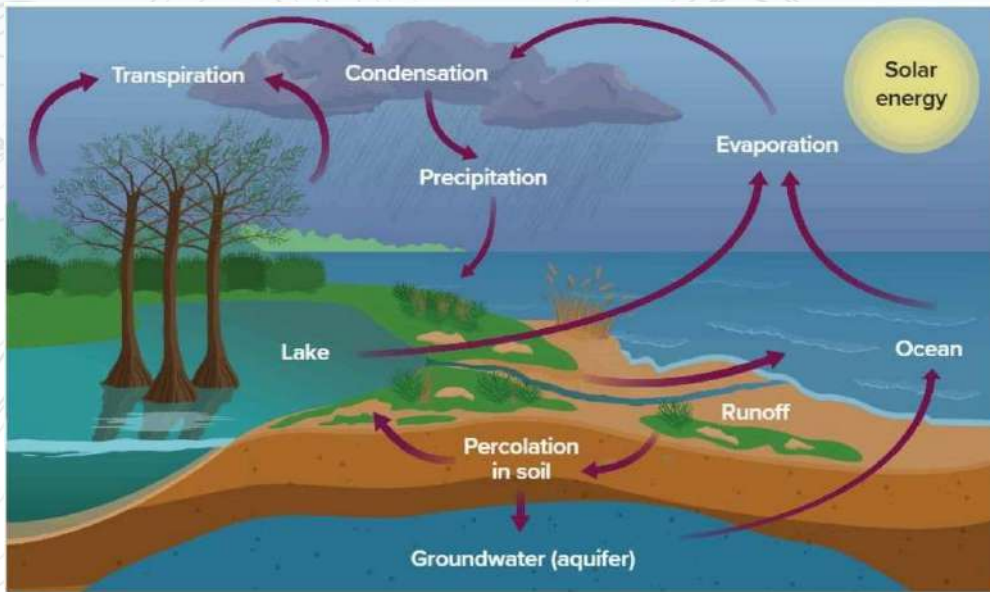


Figure 18 — The water cycle.

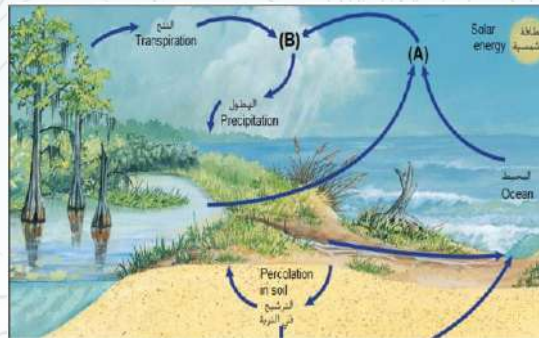
Process	What happens
1 Evaporation	water changes to water vapor and enters the atmosphere; about 90% evaporates from oceans, lakes, and rivers
2 Transpiration	water evaporates from the surfaces of plants (about 10% of water vapor)
3 Condensation	water vapor rises, cools , and condenses into droplets around dust particles → clouds form
4 Precipitation	water falls from clouds as rain, snow, or hail
5 Percolation	surface water seeps through the soil and becomes groundwater
Runoff	water flows over Earth's surface into streams, rivers, lakes, and oceans

✓ IMPORTANT FACTS

- ✓ Fresh water is only about 3% of all the water on Earth.
- ✓ About 69% of all fresh water is found in **ice caps and glaciers**, so it is **unavailable** for living organisms.
- ✓ The largest water reservoirs are the **oceans**.

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Question 100 **MINISTRY** The figure below is an illustration of the water cycle. What do the letters (A) and (B) represent?



- ☐ (A): Evaporation and (B): Condensation ☐ (A): Condensation and (B): Evaporation
☐ (A): Lake and (B): Runoff ☐ (A): Runoff and (B): Lake

Question 101 Write the name of each process in the water cycle.

Statement / Item	Your answer
Water vapor rises, cools, and forms clouds	
Water evaporates from the surfaces of plants	
Water falls from clouds as rain or snow	
Water seeps through the soil	
Water flows over the surface into streams and rivers	
Water from oceans and lakes changes into water vapor	
WORD BANK	evaporation • transpiration • condensation precipitation • percolation • runoff

Question 102 Where is the largest percentage of Earth's fresh water found?

- ☐ groundwater ☐ ice caps and glaciers
☐ lakes and rivers ☐ the atmosphere

Question 103 About what percentage of water vapor comes from transpiration by plants?

- ☐ 10% ☐ 50%
☐ 90% ☐ 3%

3.3 The Carbon and Oxygen Cycles

Carbon and oxygen often combine to form molecules **essential for life**, such as **carbon dioxide** and **simple sugars** (carbohydrates, fats, and proteins all contain C and O). The two cycles are **closely intertwined**.

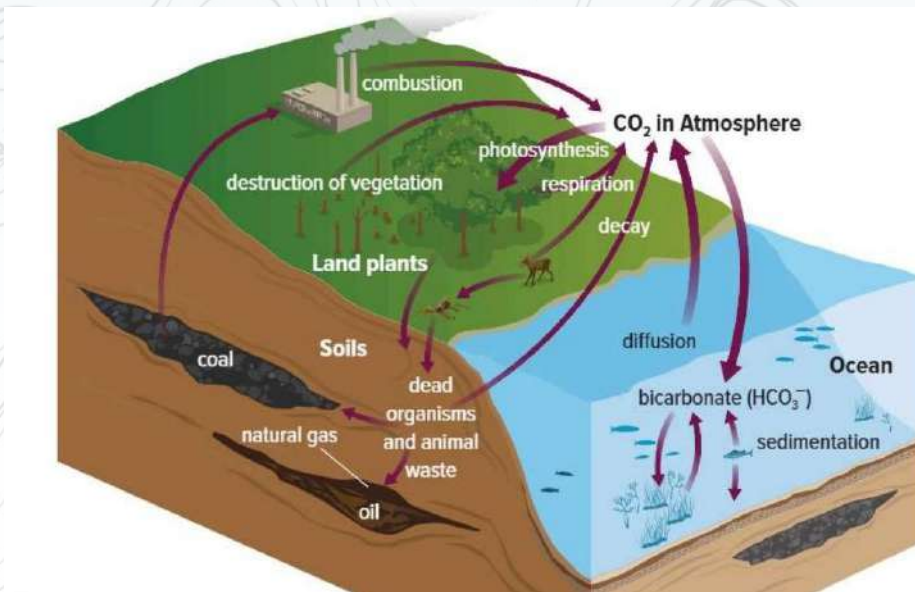


Figure 19 — How carbon and oxygen cycle through the environment.

A. Short-term cycle (fast)

Process	Takes in	Releases
Photosynthesis (plants, algae)	$\text{CO}_2 + \text{water}$	carbohydrates + O_2 into the air
Cellular respiration (living organisms, e.g. humans)	O_2	CO_2 into the air
Decay of dead organisms	—	CO_2 ; carbon also enters the soil by decomposition of plant and animal matter and waste

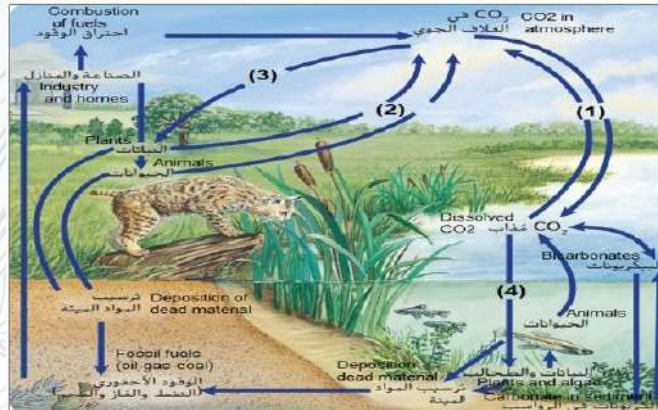
B. Long-term cycle (slow)

- ✓ **Deposition of dead material:** organic matter is **buried** underground and converted into **fossil fuels** (peat, coal, oil, gas).
- ✓ **Combustion of fuels:** carbon dioxide returns to the atmosphere when fossil fuels are **burned**.
- ✓ **Calcium carbonate:** carbon and oxygen combine with calcium to make **calcium carbonate** (CaCO_3) in the shells of sea animals (coral, clams, oysters). When they die, the shells fall to the ocean floor and form limestone deposits — like the **white cliffs of Dover**.
- ✓ **Weathering and erosion** of these rocks slowly release the carbon and oxygen again.
- ✓ **Other processes in Figure 19:** **diffusion** of CO_2 between the air and the ocean, and **sedimentation**.



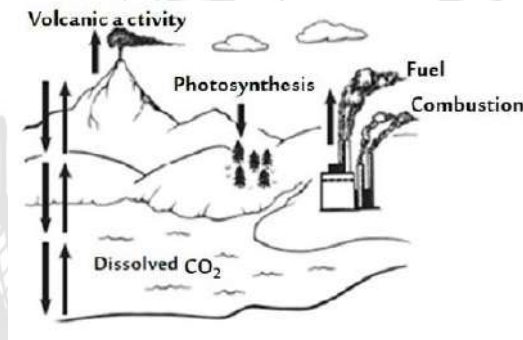
Figure 20 — The white cliffs of Dover (calcium carbonate) are part of the long-term cycle.

Question 104 **MINISTRY** The figure below is an illustration of the carbon and oxygen cycles. Which of the following refers to the process of photosynthesis?



- (a) 1 and 2
- (b) 2 and 3
- (c) 3 and 4
- (d) 4 and 2

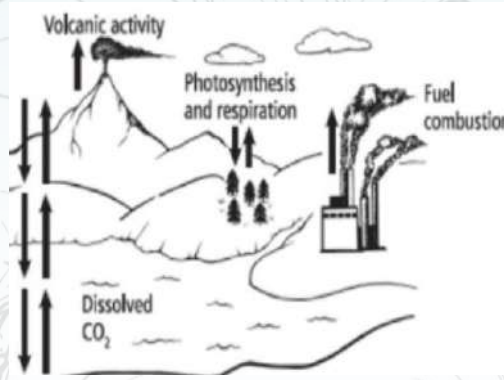
Question 105 **MINISTRY** Which part of the diagram below relates to carbon moving from an abiotic to a biotic part of the ecosystem?



- (a) Dissolved CO₂
- (b) Fuel combustion
- (c) Photosynthesis
- (d) Volcanic activity

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Question 106 **MINISTRY** Which part of the diagram below relates to carbon leaving a long-term cycle?



- ☐ a Dissolved CO₂
☐ b Fuel combustion
☐ c Volcanic activity
 ☐ d Photosynthesis and respiration

Question 107 **MINISTRY** How is carbon released from calcium carbonate?

- ☐ a burned as fossil fuels
 ☐ b by decomposition
☐ c by a process of diffusion
 ☐ d by a process of erosion

Question 108 The white cliffs of Dover (calcium carbonate) are part of which cycle?

- ☐ a the water cycle
 ☐ b the short-term carbon cycle
☐ c the long-term carbon and oxygen cycle
 ☐ d the nitrogen cycle

Question 109 What are the two main biological processes in which carbon and oxygen enter and leave living things?

- ☐ a coal formation and photosynthesis
 ☐ b photosynthesis and respiration
☐ c fuel combustion and forest fires
 ☐ d death and decay

Question 110 Which process is related to the long-term recycling of matter in the biosphere?

- ☐ a decomposition of organic matter by decomposers
 ☐ b formation of minerals and weathering of rocks
☐ c formation of food compounds used by organisms
 ☐ d movement of fresh water from land to water bodies by runoff

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Question 111 Summarize the five main processes in the carbon and oxygen cycle.

Question 112 What happens to the carbon in organisms when they die? How is carbon stored in aquatic ecosystems?

3.4 The Nitrogen Cycle

✓ FACTS ABOUT NITROGEN

- ✓ Nitrogen builds proteins.
- ✓ Most of Earth's nitrogen is in the **atmosphere** (about 78%).
- ✓ Plants and animals **cannot use** nitrogen gas (N_2) **directly** from the atmosphere — it must first be converted into usable compounds (nitrates).
- ✓ Plants absorb nitrates and make proteins; animals and humans get nitrogen by eating plants (or animals).

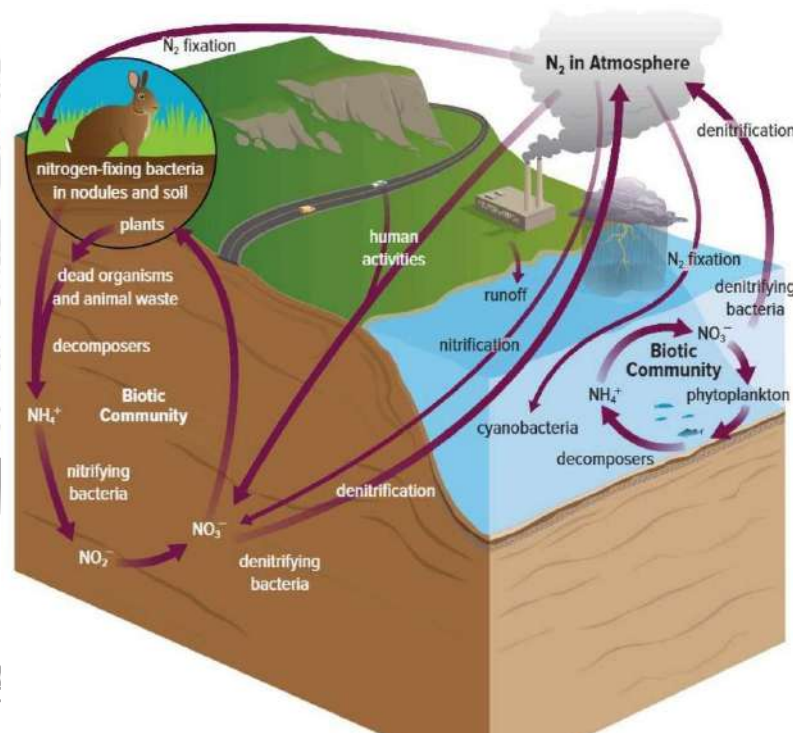


Figure 21 — Nitrogen is used and reused as it cycles through the biosphere.

Process	What happens	Done by
Nitrogen fixation	nitrogen gas N_2 is converted into ammonium NH_4^+ (usable form)	nitrogen-fixing bacteria in soil and in plant root nodules (legumes); also lightning; humans add fertilizer
Nitrification	ammonium NH_4^+ is turned into nitrogen-oxygen compounds NO_2^- and NO_3^- ; plants use them to make proteins	nitrifying bacteria
Moving through the food web	nitrogen passes to consumers when organisms eat plants and each other	consumers
Return to the soil	animal wastes and decomposition of dead matter produce ammonia	decomposers
Denitrification	NO_3^- is converted back into nitrogen gas N_2 , which returns to the atmosphere	denitrifying soil bacteria

⚠ HUMAN EFFECTS ON THE NITROGEN CYCLE

- ✓ High nitrogen in runoff from **fertilizer** causes **algae blooms** (algae overgrowth).
- ✓ Nitrogen-oxygen compounds released from **factories** combine with water to form **acid rain**.

Question 113 **MINISTRY** Which organisms capture atmospheric nitrogen for the process of nitrogen fixation?

- ☐ (a) Fungi
 ☐ (b) Bacteria
 ☐ (c) Plants
 ☐ (d) Animals

Question 114 **MINISTRY** What is the name of the process in which bacteria and lightning convert nitrogen into compounds that are useful to plants?

- ☐ (a) denitrification
 ☐ (b) nitrate cycling
 ☐ (c) ammonification
 ☐ (d) nitrogen fixation

Question 115 What process involves the capture and conversion of nitrogen into a form usable by plants?

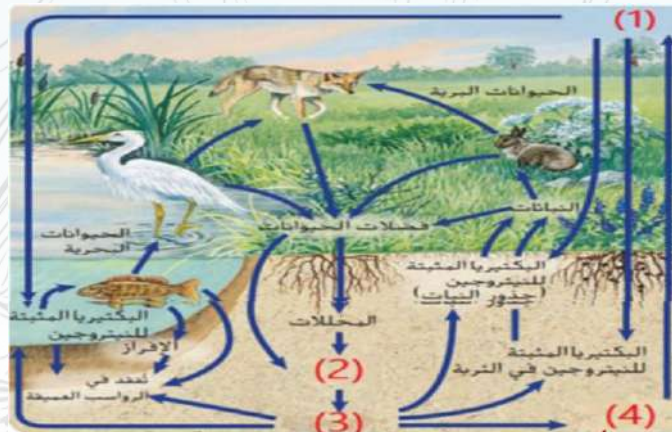
- ☐ (a) phosphate cycle
 ☐ (b) nitrogen fixation
 ☐ (c) condensation
 ☐ (d) denitrification

Question 116 **MINISTRY** The process of changing nitrates to nitrogen gas is called:

- ☐ (a) Denitrification
 ☐ (b) Nitrogen fixation
 ☐ (c) Ammonification
 ☐ (d) Nitrogen cycle

Question 117 **MINISTRY** The figure below is an illustration of the nitrogen cycle. Nitrogen is used and reused as it is cycled continuously through the biosphere.

What does the number (4) refer to?



- (a) Denitrifying bacteria
- (b) Nitrifying bacteria
- (c) Atmospheric nitrogen
- (d) Soil nitrates

Question 118 In the nitrogen cycle, which type of organisms break down nitrogen compounds in dead organisms and recycle them into the soil?

- (a) green plants
- (b) autotrophs
- (c) herbivores
- (d) bacteria

Question 119 _____ is the substance formed from decomposing matter.

WORD BANK

Ammonia • Nitrogen • Phosphorus

Question 120 _____ (1) such as the water cycle, the nitrogen cycle, and the carbon and oxygen cycles allow the exchange of matter through the biosphere.

The atmosphere is mostly nitrogen gas. This gas is captured by organisms and converted into a usable form for plants by a process called _____ (2).

Later, the usable nitrogen compounds are converted back into nitrogen gas and returned to the atmosphere by a process called _____ (3).

WORD BANK

**biogeochemical processes • nitrogen fixation • evaporation
denitrification • precipitation**

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- Question 121** a) How does nitrogen enter the food web?
 b) How do consumers (humans and animals) get nitrogen?
 c) How is nitrogen returned to the soil?

3.5 The Phosphorus Cycle

Phosphorus is an element essential for the **growth and development** of organisms. The phosphorus cycle has a **short-term** cycle and a **long-term** cycle.

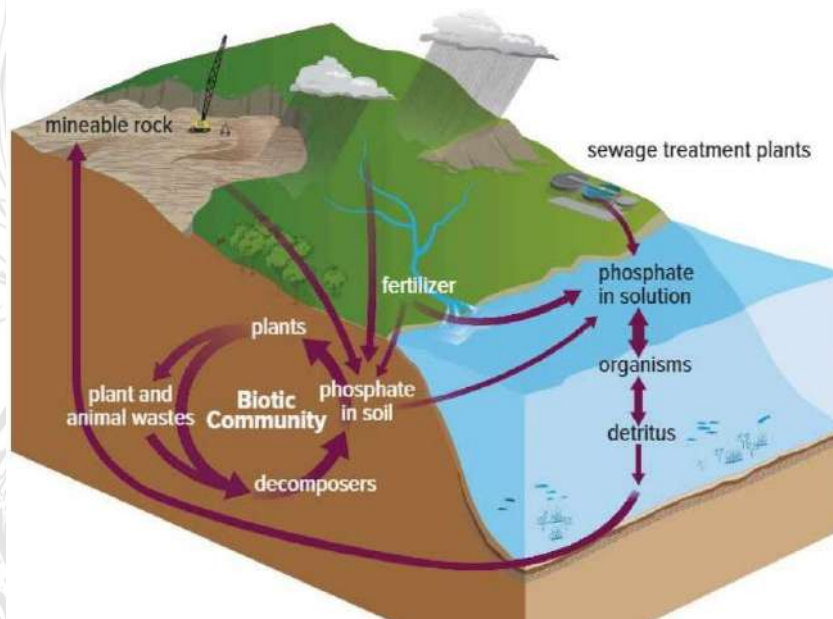


Figure 22 — The phosphorus cycle.

Cycle	What happens
Short-term cycle	phosphates in solution are cycled from the soil → producers → consumers . When organisms die or produce wastes, decomposers return the phosphorus to the soil .
Long-term cycle	phosphorus moves into the long-term cycle by precipitation and sedimentation to form rocks. Geological uplift moves the sediments to land, and weathering or erosion of rocks slowly adds phosphorus back to the soil.

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△ HUMAN EFFECTS

Phosphate **mining**, **sewage treatment**, and **fertilizer** production increase the amount of phosphate in the environment. Too much phosphate causes **algae blooms** that **upset the balance** of an ecosystem (in fresh water or marine ecosystems).



Figure 23 Algae overgrowth caused by extra nitrogen and phosphorus.

✓ REMEMBER

Phosphorus and carbon both have short-term and long-term cycles. Phosphorus can be a **limiting factor** because it is found in **small amounts** in soil and water.

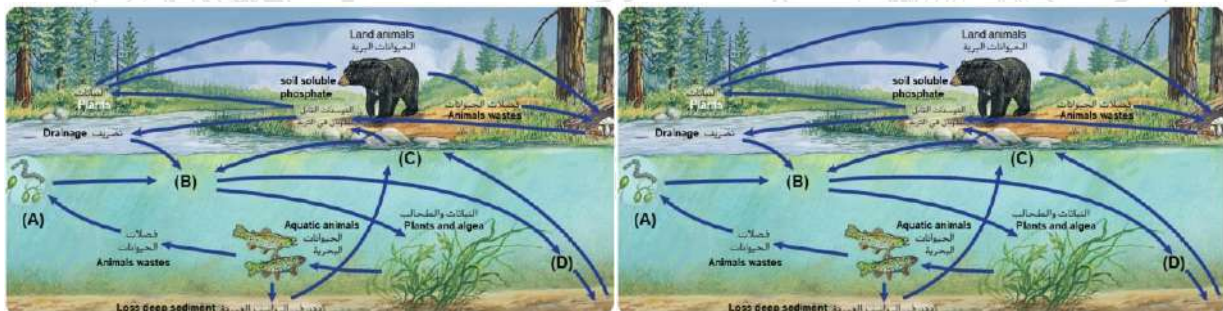
Question 122 **MINISTRY** The phosphorus has a short-term cycle and a long-term cycle.

Which of the following returns the phosphorus to the soil?

- (a) Decomposers
- (b) Land animals
- (c) Rainwater
- (d) Photosynthesis

Question 123 **MINISTRY** The figure below is an illustration of the phosphorus cycle.

What do the letters (A) and (B) represent?



- (a) (A): Decomposers and (B): Phosphates in solution
- (b) (A): Phosphates in solution and (B): Decomposers
- (c) (A): Rocks and minerals and (B): Precipitates
- (d) (A): Precipitates and (B): Rocks and minerals

Question 124 **MINISTRY** Which process locks phosphorus in a long-term cycle?

- (a) Rain eroding mountains
- (b) Animals and plants eliminating wastes
- (c) Phosphates released into the soil
- (d) Organic materials buried at the bottom of oceans

Question 125 The weathering and eroding of rocks releases a substance, which is essential for the growth of many autotrophs, called _____.

Question 126 Which of the following has both a short-term and a long-term cycle?

- ☐ a water ☐ b oxygen
☐ c phosphorus ☐ d nitrogen

Question 127 Why is phosphorus sometimes a limiting factor for organisms?

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