# البناء الضوئي والتنفس الخلوي – الدرس الأول من الوحدة الأولى – تغطية امتحان نهاية الفصل – أسئلة اختيار من متعدد – انسباير


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MINISTRY OF EDUCATION

# End of Term 1 Exam Coverage

# Grade 7 General – Science

## Academic Year 2026-2027

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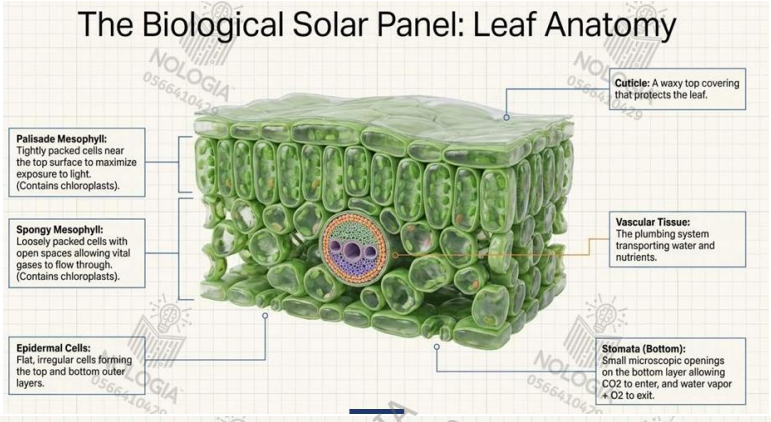
# Q1 : Module 1: Matter and Energy in Ecosystems

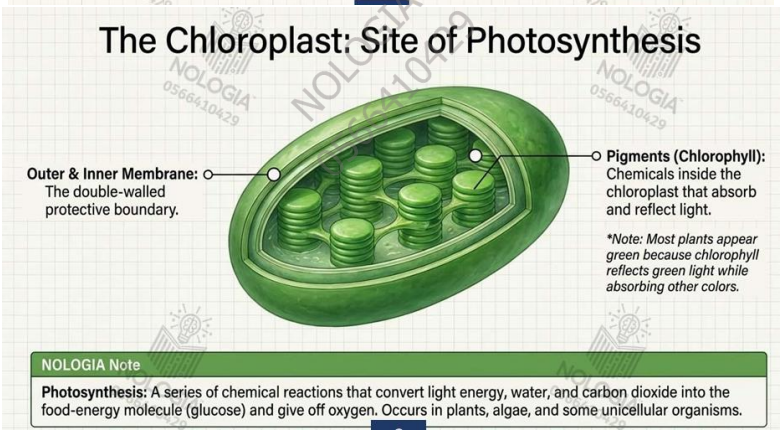
## Lesson 1: Photosynthesis and Cellular Respiration

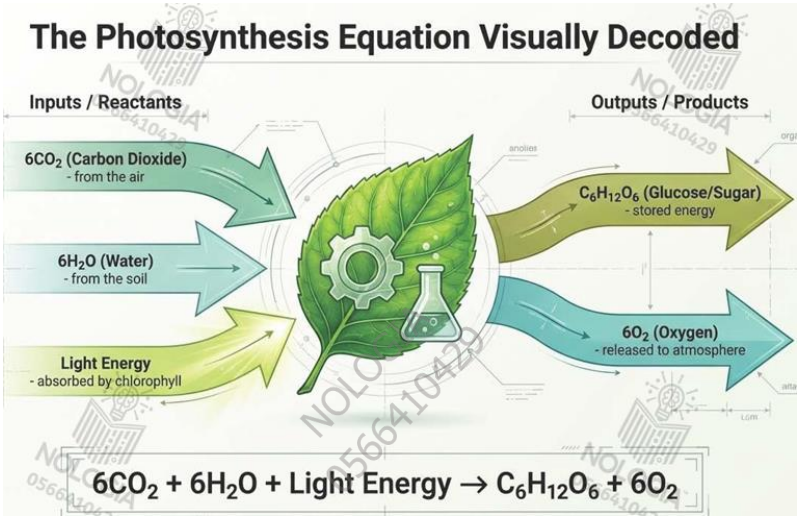
Identify the main plant structure where photosynthesis occurs.

( Pages 10 - 11 )

Multiple Choice Questions - MCQ



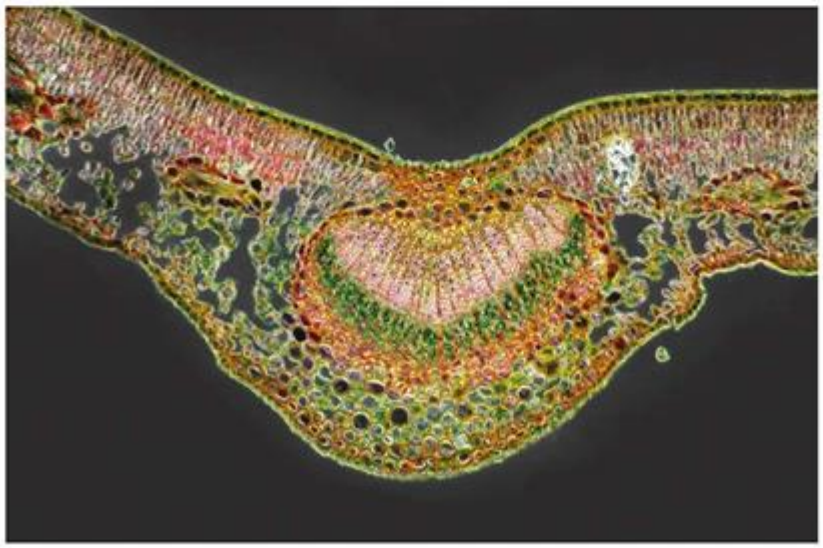
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**Photosynthesis** Leaves are the sites of photosynthesis in plants. Plants and some unicellular organisms such as algae, phytoplankton, and other microorganisms obtain energy from light through the process of photosynthesis. **Photosynthesis** (foh toh SIHN thuh sus) is a series of chemical reactions that convert light energy, water, and carbon dioxide into the food-energy molecule glucose, and give off oxygen. The sugars produced in photosynthesis can be used immediately or stored for growth or later use.



Leaves have many types of cells. Did you notice that? The cells that make up the top and bottom layers of a leaf are flat, irregularly shaped cells called epidermal (eh puh DUR mul) cells. On the bottom epidermal layer of most leaves are small openings called stomata (STOH muh tuh). Carbon dioxide, water vapor, and oxygen pass through stomata. Epidermal cells can produce a waxy covering called the cuticle.

Most photosynthesis occurs in two types of mesophyll (ME zuh fil) cells inside a leaf. These cells contain chloroplasts, the organelle where photosynthesis occurs. Near the top surface of the leaf are palisade mesophyll cells. They are packed together. This arrangement exposes the most cells to light. Spongy mesophyll cells have open spaces between them. Gases needed for photosynthesis flow through the spaces between the cells. You can see many of these structures in the cross section below.



*Check out this cross section of a leaf!*

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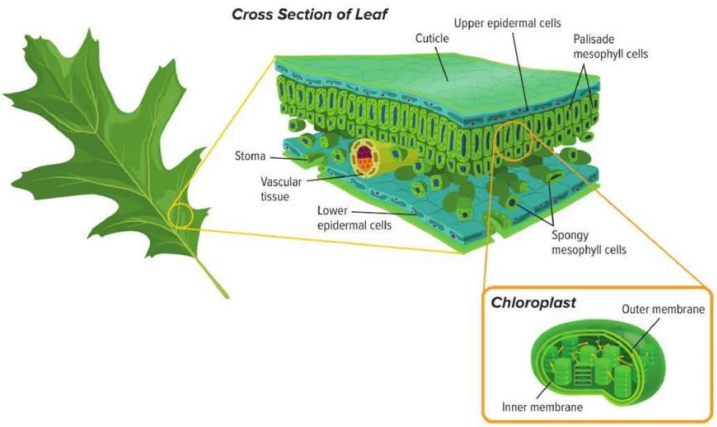
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## Questions :

Question 1: Examine the leaf cross section below. How do you think sunlight is absorbed by a leaf?




| | |
|---|---|
| (A) By the waxy cuticle on the outer layer | (B) By chloroplasts inside palisade and spongy mesophyll cells |
| (C) By small openings called stomata on the bottom layer | (D) By vascular tissue inside the stem and roots |

Question 2 Examine the leaf cross section above. How are other materials necessary for survival, such as carbon dioxide, oxygen, water, and other nutrients, moved through a leaf?

| | |
|---|---|
| (A) gases pass through stomata and spongy mesophyll spaces; water and nutrients move through vascular tissue | (B) Gases move only through the waxy cuticle; water enters through chloroplasts |
| (C) Water and nutrients exit through upper epidermal cells; gases are blocked | (D) All gases and nutrients are made in the outer membrane without moving |



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Question 3: Read the Textbook Passage - Photosynthesis: What are the major food-producing organs and sites of photosynthesis in plants?

| | |
|---|---|
| (A) Roots | (B) Leaves |
| (C) Stomata | (D) Cuticles |

Question 4: What is photosynthesis?

| | |
|---|---|
| (A) Chemical reactions that convert light energy, water, and CO2 into glucose and give off oxygen | (B) Breaking down glucose with oxygen to release CO2 and water |
| (C) Epidermal cells producing a waxy cuticle on the leaf | (D) Movement of water vapor and oxygen out of roots into soil |

Question 5: The flat, irregularly shaped cells that make up the top and bottom layers of a leaf are called:

| | |
|---|---|
| (A) Palisade mesophyll cells | (B) Spongy mesophyll cells |
| (C) Epidermal cells | (D) Chloroplast cells |

Question 6: What are the small openings on the bottom epidermal layer of most leaves through which carbon dioxide, water vapor, and oxygen pass?

| | |
|---|---|
| (A) Cuticles | (B) Chloroplasts |
| (C) Mesophylls | (D) Stomata |


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Question 7: Epidermal cells on a leaf can produce a waxy covering called the:

| | |
|---|---|
| (A) Cuticle | (B) Stoma |
| (C) Chloroplast | (D) Glucose layer |

Question 8: In which cells inside a leaf does most photosynthesis occur?

| | |
|---|---|
| (A) Top and bottom epidermal cells | (B) Two types of mesophyll cells (palisade and spongy mesophyll cells) |
| (C) Waxy cuticle cells only | (D) Guard cells on the stem |

Question 9: How do palisade mesophyll cells differ from spongy mesophyll cells inside a leaf?

| | |
|---|---|
| (A) Palisade cells have open spaces for gases; spongy cells make the cuticle | (B) Spongy cells are packed near the top; palisade cells form stomata. |
| (C) Palisade cells are packed near the top to absorb light; spongy cells have open spaces for gas flow | (D) Neither palisade nor spongy mesophyll cells contain chloroplasts. |

Question 10: Which organelle inside mesophyll cells is the specific site where photosynthesis occurs?

| | |
|---|---|
| (A) Stoma | (B) Cuticle |
| (C) Chloroplast | (D) Epidermal cell |

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Q2 : Module 1: Matter and Energy in Ecosystems

Lesson 1: Photosynthesis and Cellular Respiration

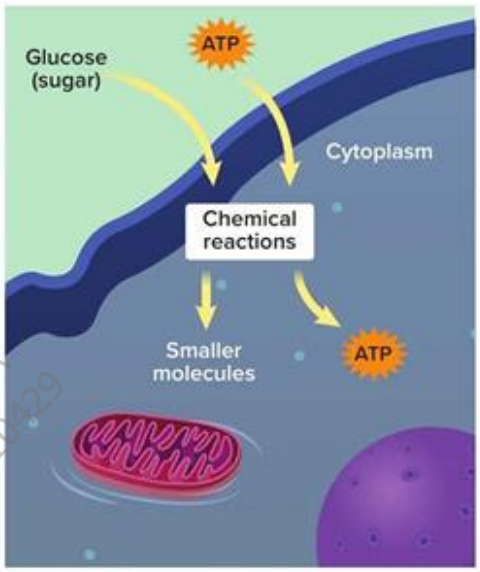
Identify where cellular respiration occurs.

( Page 19 )

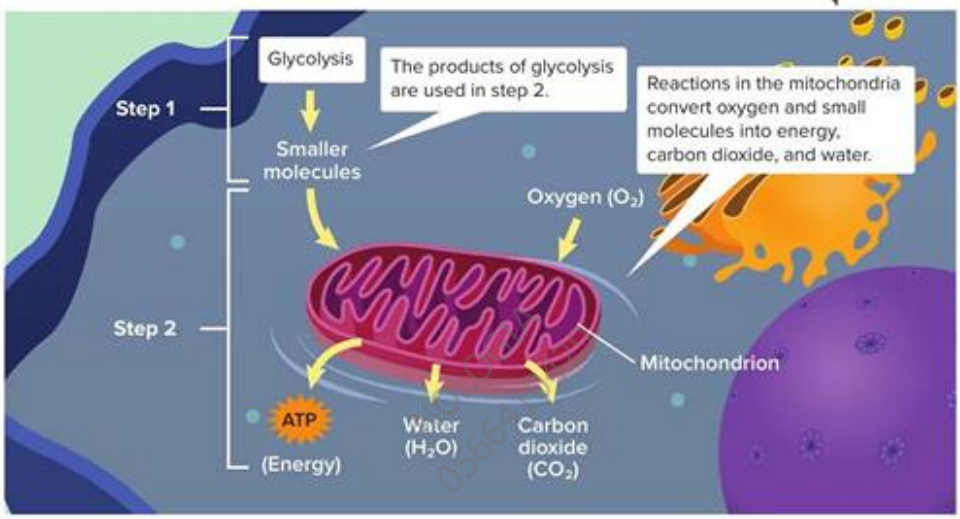
Multiple Choice Questions - MCQ

**Cellular Respiration** The bromthymol blue changed color due to the presence of carbon dioxide in your exhalations. Where did the carbon come from? It is a waste product from a process that releases energy from molecules. **Cellular respiration** is a series of chemical reactions that convert the energy in food molecules into a usable form of energy called ATP. Cellular respiration occurs in two parts of a cell—the cytoplasm and the mitochondria.

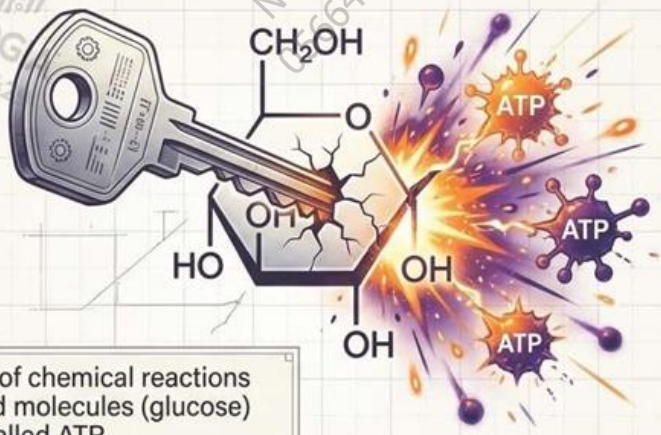
The first step of cellular respiration, called glycolysis, occurs in the cytoplasm of all cells. **Glycolysis** is a process by which glucose, a sugar, is broken down into smaller molecules. Glycolysis produces some ATP, an energy storage molecule. This process also uses energy from other ATP molecules.




The second step of cellular respiration occurs in the mitochondria of eukaryotic cells. This step requires oxygen. The smaller molecules made from glucose during glycolysis are broken down. Large amounts of ATP—usable energy—are produced. Cells use ATP to power all cellular processes. Two waste products—water and carbon dioxide ($CO_2$)—are given off during this step. The $CO_2$ released by cells as a waste product is used by plants and some unicellular organisms during photosynthesis.



# Cellular Respiration: Unlocking Stored Energy




**Key Definition Box**

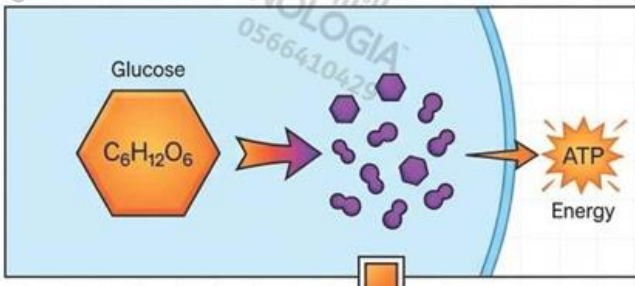
**Cellular Respiration:** A series of chemical reactions that convert the energy in food molecules (glucose) into a usable form of energy called ATP.

**Why is it important?**

- Most organisms (including plants!) perform cellular respiration.
- If your body did not break down and rearrange food, you would have no energy to survive.
- Plants also need it to grow, reproduce, and repair tissues using the food they made.

**Location:**
Occurs in two parts of a cell: the Cytoplasm and the Mitochondria.

# The ATP Engine: Two Steps of Respiration

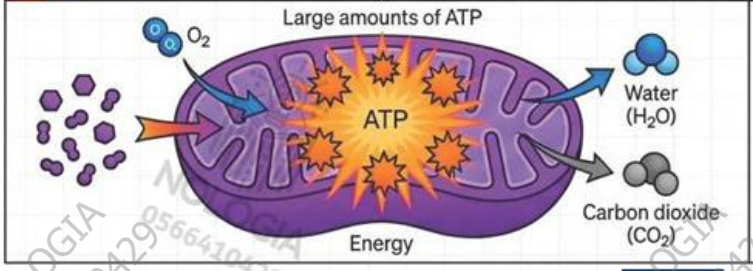



**Step 1: Glycolysis (in the Cytoplasm)**

**Action:** Glucose (sugar) is broken down into smaller molecules.

**Result:** Produces a small amount of ATP (usable energy).

**Step 2: The Mitochondria (Requires Oxygen)**




**Action:** The smaller molecules from Glycolysis are further broken down.

**Result:** Large amounts of ATP are produced to power cellular processes. Water and $CO_2$ are given off as waste products.

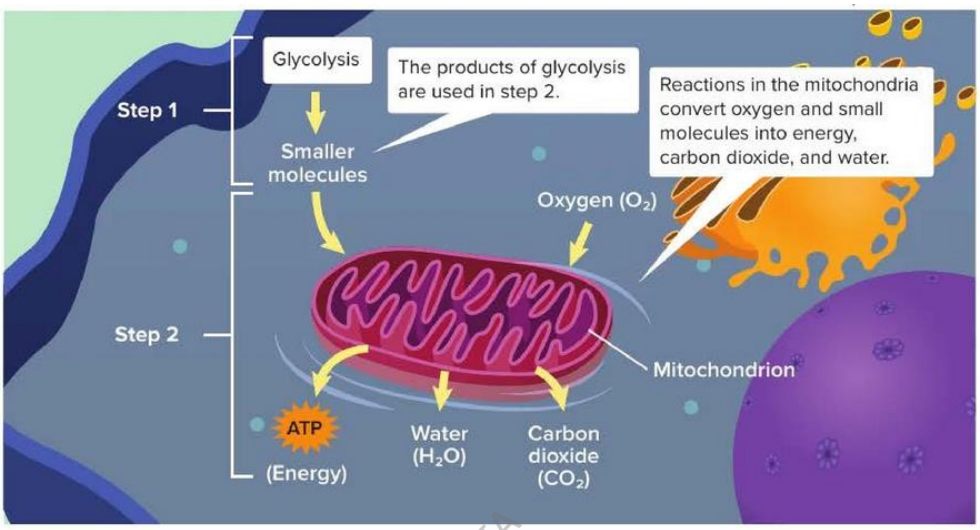


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## Questions :

**Question 1:** How do plants and animals process energy from food, and in which two parts of a cell does this process occur?




| | |
|---|---|
| (A) Through photosynthesis in the chloroplasts and the cell wall | (B) Cellular respiration in the cytoplasm (Step 1: glycolysis) and mitochondria (Step 2) |
| (C) Through transpiration in the cuticle and the stomata | (D) Through chemosynthesis in the nucleus and the ribosome |

**Question 2:** Read the Textbook Passage · Cellular Respiration: What is cellular respiration?

| | |
|---|---|
| (A) Chemical reactions that convert energy in food molecules into usable ATP energy | (B) Chemical reactions that convert light energy, water, and CO2 into glucose |
| (C) Movement of CO2 and oxygen through leaf stomata | (D) Production of a waxy cuticle by epidermal cells |

Question 3: Cellular respiration occurs in which two parts of a cell?

| | |
|---|---|
| (A) The chloroplasts and the nucleus | (B) The cytoplasm and the mitochondria |
| (C) The epidermal cells and the stomata | (D) The cell wall and the vacuole |

Question 4: Where does the first step of cellular respiration, called glycolysis, occur?

| | |
|---|---|
| (A) In the mitochondria of eukaryotic cells only | (B) In the chloroplasts of mesophyll cells |
| (C) In the cytoplasm of all cells | (D) Outside the cell membrane |

Question 5: Where does the second step of cellular respiration occur?

| | |
|---|---|
| (A) In the cytoplasm of all cells | (B) In the mitochondria of eukaryotic cells |
| (C) In the chloroplasts of plant cells | (D) In the stomata of leaves |

Question 6: Which gas is required for the second step of cellular respiration in the mitochondria?

| | |
|---|---|
| (A) Carbon dioxide | (B) Water vapor |
| (C) Nitrogen | (D) Oxygen |

Question 7: What is produced and given off during the second step of cellular respiration in the mitochondria?

| | |
|---|---|
| (A) Large amounts of ATP are produced, and two waste products—water and carbon dioxide ($CO_2$)—are given off | (B) Glucose and oxygen are produced and stored in chloroplasts |
| (C) Light energy is absorbed and converted into sugar | (D) Glucose is first broken down into smaller molecules without oxygen |



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Q3 : Module 1: Matter and Energy in Ecosystems

Lesson 1: Photosynthesis and Cellular Respiration

Apply the processes of photosynthesis and cellular respiration in plants.

( Pages 20, 22)

Multiple Choice Questions - MCQ

# How are photosynthesis and cellular respiration related?

While animals only perform cellular respiration, plants conduct both cellular respiration and photosynthesis. How do the processes compare?

**Comparing Photosynthesis and Cellular Respiration** Photosynthesis requires the reactants carbon dioxide and water. Oxygen and glucose are the products. Most plants, some protists, and some bacteria are photosynthetic. Photosynthesis is important because plants help maintain the atmosphere you breathe. Photosynthesis produces most of the oxygen in the atmosphere.

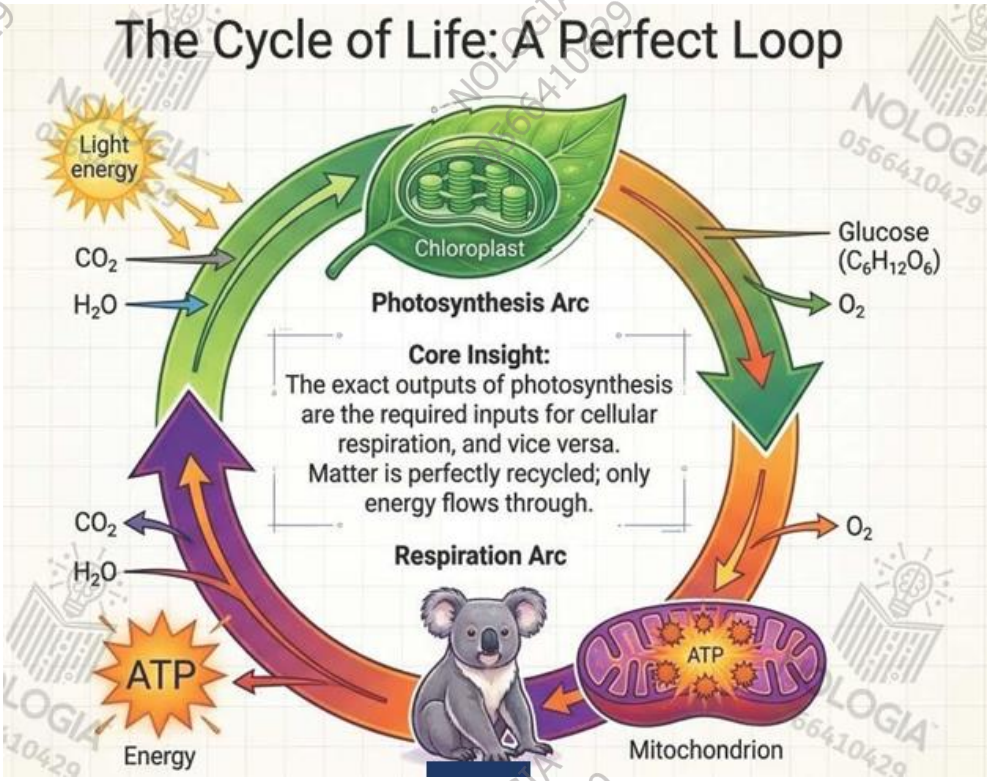
Cellular respiration requires the reactants glucose and oxygen, produces carbon dioxide and water, and releases energy. Most organisms perform cellular respiration. Cellular respiration is important because if your body did not break down and rearrange the food you eat, you would not have energy to do anything. Plants produce their own food, but without cellular respiration, plants could not grow, reproduce, or repair tissues.

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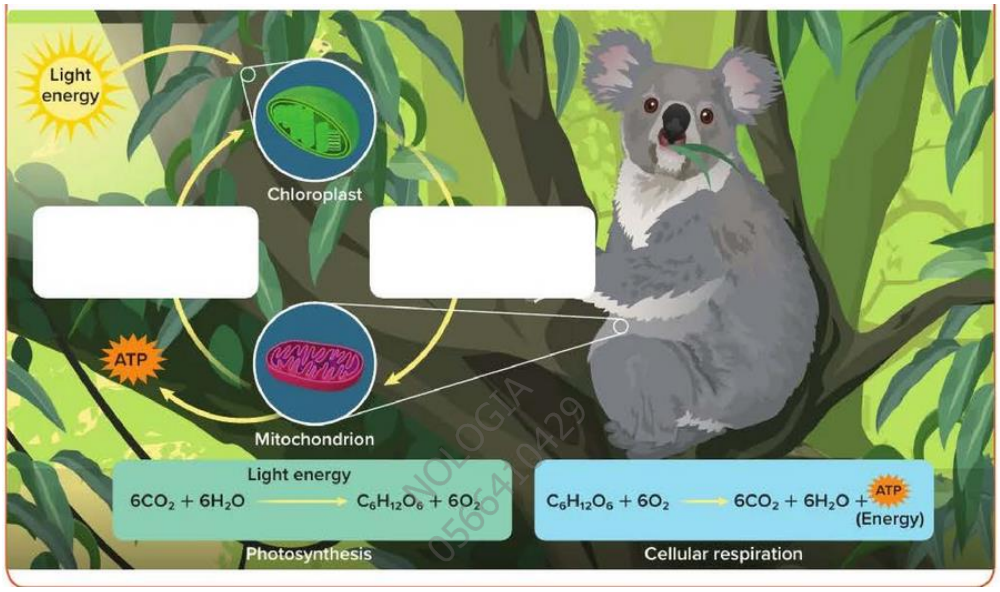



## The Master Comparison Matrix

| Dimension | Photosynthesis | Cellular Respiration |
|---|---|---|
| Primary Purpose | Energy Storage | Energy Release |
| Location | Chloroplasts | Cytoplasm & Mitochondria |
| Reactants (Inputs) | CO2, Water, Light | Glucose, Oxygen |
| Products (Outputs) | Glucose, Oxygen | CO2, Water, ATP |
| Who Performs It? | Plants, Algae, some bacteria | Most organisms: Animals, Plants, Fungi |
| Energy Source | The Sun | Chemical Bonds in Food |

## Questions :

Question 1: Label the image of the system below to track the energy transfer in photosynthesis and cellular respiration. What are the inputs and outputs in the left and right white boxes of the system?




| | |
|---|---|
| (A) Left box: Carbon dioxide (CO2) and Water (H2O); Right box: Glucose (C6H12O6) and Oxygen (O2) | (B) Left box: Glucose (C6H12O6) and Oxygen (O2); Right box: Light energy and ATP |
| (C) Left box: Nitrogen gas and ATP; Right box: Carbon dioxide (CO2) and Water (H2O) | (D) Both boxes contain only light energy and chlorophyll |

Question 2 :Explain the transfer of energy and cycling of matter by modeling the chemical reactions of photosynthesis and cellular respiration (including yourself and the Elodea plant).

| | |
|---|---|
| (A) Plants and humans perform only photosynthesis and never perform cellular respiration | (B) Chloroplasts use light, $CO_2$, and $H_2O$ to make glucose and $O_2$; mitochondria use glucose and $O_2$ to release ATP, $CO_2$, and $H_2O$ |
| (C) Humans release $O_2$ during cellular respiration, which plants use to break down water | (D) Energy cycles back to the Sun while matter is destroyed during respiration |

Question 3: Read the Textbook Passage · Comparing Photosynthesis and Cellular Respiration: Which statement correctly compares animals and plants?

| | |
|---|---|
| (A) Animals perform only photosynthesis, while plants perform only cellular respiration. | (B) Both animals and plants perform photosynthesis and cellular respiration. |
| (C) While animals only perform cellular respiration, plants conduct both cellular respiration and photosynthesis. | (D) Plants perform only photosynthesis and never perform cellular respiration. |

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## Question 4: What are the reactants and products of photosynthesis?

| | |
|---|---|
| (A) Reactants: carbon dioxide and water; Products: oxygen and glucose | (B) Reactants: oxygen and glucose; Products: carbon dioxide and water |
| (C) Reactants: ATP and glucose; Products: light energy and water | (D) Reactants: carbon dioxide and oxygen; Products: water and ATP |

## Question 5: What are the reactants and products of cellular respiration?

| | |
|---|---|
| (A) Reactants: carbon dioxide and water; Products: glucose and oxygen | (B) Reactants: glucose and oxygen; Products: carbon dioxide and water (and releases energy/ATP) |
| (C) Reactants: light energy and water; Products: oxygen and starch | (D) Reactants: ATP and carbon dioxide; Products: glucose and water |

## Question 6: Why is photosynthesis important to Earth's atmosphere?

| | |
|---|---|
| (A) It removes all oxygen from the atmosphere. | (B) It converts all nitrogen in the air into glucose. |
| (C) It releases large amounts of ATP gas into the air. | (D) It produces most of the oxygen in the atmosphere and helps maintain the atmosphere we breathe. |

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Question 7: Why do plants need cellular respiration even though they produce their own food?

| | |
|---|---|
| (A) Without cellular respiration, plants could not grow, reproduce, or repair tissues. | (B) Plants need cellular respiration to absorb sunlight through their roots. |
| (C) Cellular respiration allows plants to produce the waxy cuticle from sunlight. | (D) Without cellular respiration, plants could not take in carbon dioxide for photosynthesis. |

Question 8: Which chemical equation correctly represents cellular respiration?

| | |
|---|---|
| (A) $6CO_2 + 6H_2O + \text{Light energy} \rightarrow C_6H_{12}O_6 + 6O_2$ | (B) $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP$ (Energy) |
| (C) $6CO_2 + 6O_2 \rightarrow C_6H_{12}O_6 + 6H_2O + \text{Light energy}$ | (D) $C_6H_{12}O_6 + 6H_2O \rightarrow 6CO_2 + 6O_2$ |

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# Q4 : Module 1: Matter and Energy in Ecosystems

## Lesson 1: Photosynthesis and Cellular Respiration

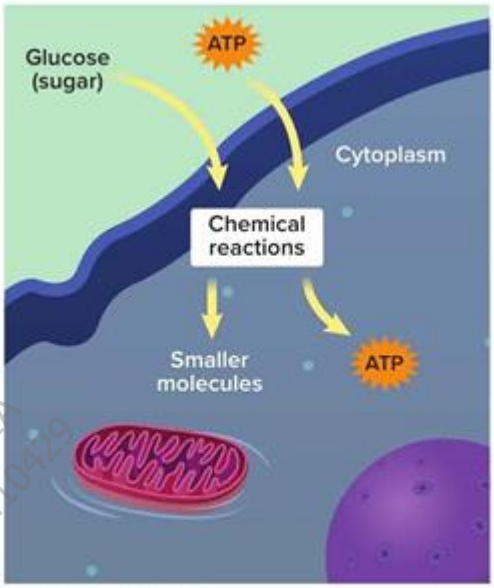
Demonstrate understanding of the process of glycolysis.

( Page 19 )

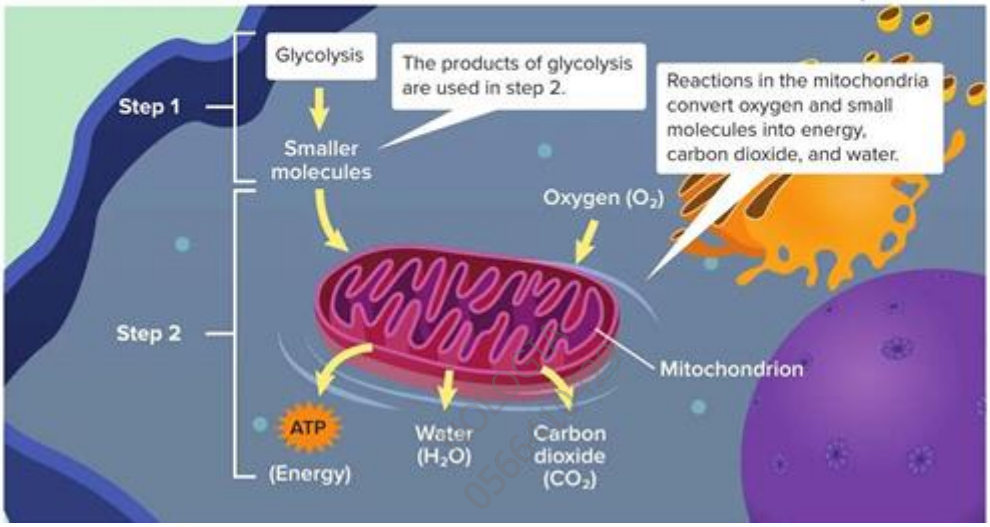
Multiple Choice Questions - MCQ

**Cellular Respiration** The bromthymol blue changed color due to the presence of carbon dioxide in your exhalations. Where did the carbon come from? It is a waste product from a process that releases energy from molecules. **Cellular respiration** is a series of chemical reactions that convert the energy in food molecules into a usable form of energy called ATP. Cellular respiration occurs in two parts of a cell—the cytoplasm and the mitochondria.

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The second step of cellular respiration occurs in the mitochondria of eukaryotic cells. This step requires oxygen. The smaller molecules made from glucose during glycolysis are broken down. Large amounts of ATP—usable energy—are produced. Cells use ATP to power all cellular processes. Two waste products—water and carbon dioxide ($CO_2$)—are given off during this step. The $CO_2$ released by cells as a waste product is used by plants and some unicellular organisms during photosynthesis.

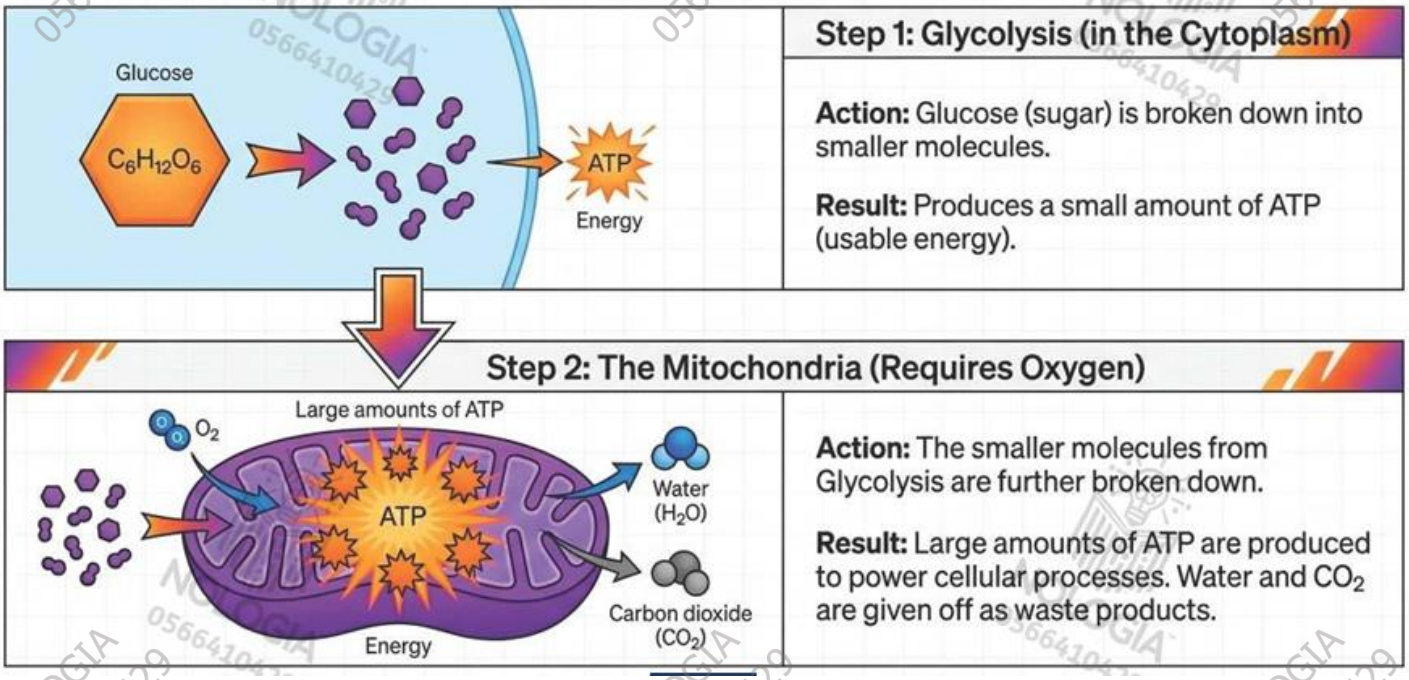





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# The ATP Engine: Two Steps of Respiration




## Questions :

Question 1: Based on the Step 1 (Glycolysis) model , what happens during glycolysis in the cytoplasm and how are its products used?

| | |
|---|---|
| (A) It is Step 2 in the mitochondria and requires oxygen | (B) In the cytoplasm, glucose is broken down into smaller molecules (producing some ATP) that are used in Step 2 in mitochondria |
| (C) In chloroplasts, CO2 and water combine using light energy to make glucose | (D) Water and CO2 are released from mitochondria directly into the air |

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**Question 2:** Read the Textbook Passage · Cellular Respiration: What is glycolysis?

| | |
|---|---|
| (A) A process by which light energy combines water and carbon dioxide | (B) A process by which glucose, a sugar, is broken down into smaller molecules |
| (C) A process in which oxygen is released through the stomata of a leaf | (D) A process that occurs only inside chloroplasts |

**Question 3:** Where does the first step of cellular respiration (glycolysis) occur?

| | |
|---|---|
| (A) In the cytoplasm of all cells | (B) In the mitochondria of eukaryotic cells |
| (C) In the chloroplasts of plant cells | (D) In the nucleus of animal cells |

**Question 4:** How does glycolysis involve ATP, an energy storage molecule?

| | |
|---|---|
| (A) Glycolysis neither uses nor produces any ATP molecules. | (B) Glycolysis converts ATP into sunlight and water. |
| (C) Glycolysis produces some ATP and also uses energy from other ATP molecules. | (D) Glycolysis destroys all ATP molecules in the cell. |

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Question 5: What happens to the smaller molecules produced from glucose during glycolysis?

| | |
|---|---|
| (A) They are immediately exhaled into the atmosphere as oxygen gas. | (B) They are sent to the chloroplasts to absorb sunlight. |
| (C) They form the waxy cuticle on the outside of the leaf. | (D) They are used in step 2 of cellular respiration in the mitochondria. |

Question 6: What molecule is broken down into smaller molecules during glycolysis?

| | |
|---|---|
| (A) Glucose, a sugar | (B) Carbon dioxide gas |
| (C) Water molecules | (D) Chlorophyll pigments |

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# Q5 : Module 1: Matter and Energy in Ecosystems

## Lesson 1: Photosynthesis and Cellular Respiration

Define ecosystem and what is included.

( Page 16 )

Multiple Choice Questions - MCQ

### Read a Scientific Text

Plants and other photosynthetic organisms absorb carbon dioxide and produce oxygen, making them a necessary part of any ecosystem. An **ecosystem** is all the living and nonliving things in a given area. During the process of photosynthesis, trees absorb carbon dioxide and transfer carbon into their limbs and roots. What is the effect of carbon storage on forest ecosystems?

**CLOSE READING**

**Inspect**

**Read** the passage *Forests and Carbon Storage*.

**Find Evidence**

**Underline** information that describes how carbon is stored in trees. Highlight information that describes carbon being released from trees back into the environment.

**Make Connections**

**Communicate** With your partner, summarize the central idea of the text distinct from prior knowledge or opinions.

PRIMARY SOURCE

**Forests and Carbon Storage**

Climate change increases the uncertainty of U.S. forests' ability to serve as a "sink" for carbon storage, but management options exist that could buffer the impacts of climate change on forests, and even lead to increased forest carbon storage potential.

Trees take up carbon dioxide ($CO_2$) and release oxygen ($O_2$) through photosynthesis, transferring the carbon (C) to their trunks, limbs, roots, and leaves as they grow. When leaves or branches fall and decompose, or trees die, the stored C will be released by respiration and/or combustion back to the atmosphere or transferred to the soil. Because of these processes, forests and forested landscapes can store considerable carbon and their growth can provide a carbon sink; landscapes that have been recently converted or reconverted to forests (from another land cover) can provide a carbon sink that is considerably larger than other land cover types.

[...]

While much about the forest carbon cycle is well understood, several key unknowns remain. The scientific community, including foresters, understands the carbon value of keeping forests as forests, planting forests where none existed historically (afforestation), replanting forests where they were located historically (reforestation), using forest biomass as fuel in place of fossil fuel, and storing carbon in long-lived products (which may continue to store carbon for years or decades). However, further research on several topics could improve our ability to design good forest management practices with respect to carbon.

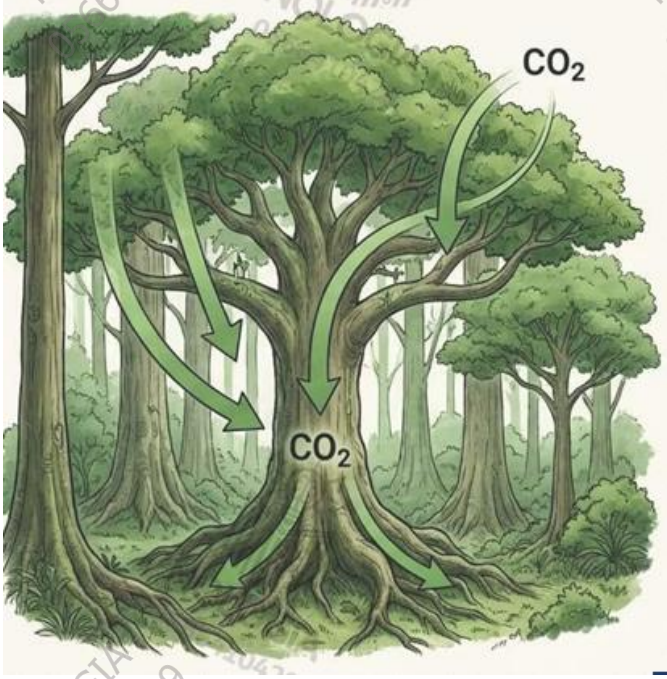
**Source:** United States Department of Agriculture



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# Macro Impact: Forests as Carbon Sinks




**Key Concept Box**

**What is an Ecosystem?** All the living and nonliving things in a given area.

## The Carbon Sink Mechanism

**Storage:** Trees take up CO2 through photosynthesis, transferring Carbon (C) into their physical structures as they grow. This makes forests a massive "sink" for carbon storage.

**Release:** When trees drop leaves, decompose, or burn, the stored Carbon is released back into the atmosphere via respiration or combustion.

**Management:** Reforestation (replanting) and afforestation (planting new forests) increase carbon storage, helping buffer climate change.

## Questions :

Question 1: What is an ecosystem, and how do forests store and release carbon?

| | |
|---|---|
| (A) All living and nonliving things in an area; trees absorb CO2 and store carbon in trunks, limbs, roots, and leaves, releasing it upon decomposition | (B) Only living trees, which absorb oxygen and release carbon dioxide during photosynthesis |
| (C) Only nonliving things, and forests cannot store carbon in trunks or roots | (D) Carbon storage removes all oxygen from the air and stops plant growth |



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Question 2: Based on the text "Forests and Carbon Storage," what is the effect of increasing forest area?

| | |
|---|---|
| (A) It reduces the amount of carbon stored in trees and soil | (B) It creates a larger carbon sink that absorbs more CO2 via photosynthesis, stores carbon, and buffers climate change |
| (C) It stops trees from releasing oxygen (O2) into the atmosphere | (D) It causes stored carbon in wood products to disappear immediately |

Question 3: What is an ecosystem?

| | |
|---|---|
| (A) Only the animals and plants in a forest | (B) Only the atmosphere and soil in a region |
| (C) All the living and nonliving things in a given area | (D) Only the decomposers and producers in a pond |

Question 4: Why are plants and other photosynthetic organisms a necessary part of any ecosystem?

| | |
|---|---|
| (A) Because they absorb carbon dioxide and produce oxygen | (B) Because they absorb oxygen and release sunlight |
| (C) Because they remove all water from the soil | (D) Because they only consist of nonliving things |

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Question 5: During photosynthesis, trees take up carbon dioxide ($CO_2$) from the atmosphere and transfer the carbon (C) into which parts as they grow?

| | |
|---|---|
| (A) Only into the surrounding air | (B) Their trunks, limbs, roots, and leaves |
| (C) Only into rocks and pebbles | (D) Only into animal lungs |

Question 6: What happens to the stored carbon in trees when leaves or branches fall and decompose, or when trees die?

| | |
|---|---|
| (A) The stored carbon turns into sunlight. | (B) The stored carbon disappears completely from the ecosystem. |
| (C) The stored carbon is converted into pure oxygen gas by photosynthesis. | (D) The stored carbon is released by respiration and/or combustion back to the atmosphere or transferred to the soil. |

Question 7: how does increasing forest area affect carbon in the environment?

| | |
|---|---|
| (A) It stops photosynthesis from occurring in the ecosystem. | (B) More trees absorb carbon dioxide ($CO_2$) during photosynthesis and store more carbon in their trunks, limbs, roots, and leaves. |
| (C) It reduces the amount of oxygen ($O_2$) released into the atmosphere. | (D) It removes all living things from the ecosystem. |

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# Q6 : Module 1: Matter and Energy in Ecosystems

## Lesson 2: Flow of Energy

Use a model to identify how energy flows through organisms in an ecosystem.

( Pages 31 -32 )

Multiple Choice Questions - MCQ

**Producers** Living things that make their own food are called **producers.** Producers make their food from materials found in their environments. Most producers are photosynthetic, such as plants. Other producers, including some bacteria, are chemosynthetic. Chemosynthesis is the process during which producers use chemical energy in matter rather than light energy to make food.

**Consumers** Unlike producers, **consumers** do not produce their own energy-rich food. Instead, they get the energy they need to survive by consuming other organisms. Consumers can be classified by the type of food that they eat. Herbivores feed on only producers. Carnivores eat other animals. Omnivores eat both producers and other consumers.



◄This caterpillar is an herbivore and eats only plants.

This shark is a ► carnivore and eats other animals.





◄These girls are omnivores and eat both producers and other consumers.

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**Detritivores** Another group of consumers are detritivores (dih TRI tuh vorz). **Detritivores** get their energy by eating the remains of other organisms. Some detritivores, such as bacteria and mushrooms, feed on dead organisms and help break down or decompose them. For this reason, these organisms often are called decomposers. The yeast in the activity above is a decomposer. During decomposition, decomposers produce carbon dioxide that enters the atmosphere. Some of the decayed matter enters the soil or water. In this way, decomposers help recycle nutrients through ecosystems. They also help keep ecosystems clean. Without decomposers, dead organisms would pile up in an ecosystem.



*These mushrooms are decomposers!*

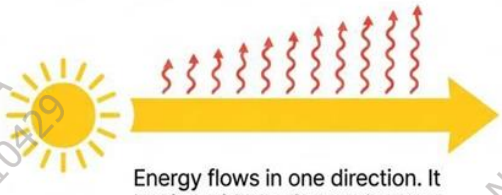
## The Core Rule: Matter Cycles, but Energy Flows

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### MATTER




### ENERGY



Energy flows in one direction. It begins with the Sun and moves from one organism to another.

**The Law of Conservation of Energy**

Energy cannot be created or destroyed, but it changes form. Not all energy is used for life processes—some is released into the environment as thermal energy (heat).

## How Organisms Obtain Their Energy

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### Producers



**Source:**
The Sun.

**Action:**
Makes energy-rich food using sunlight.

### Consumers



**Source:**
Other Organisms.

**Action:**
Gets energy by eating producers or other consumers.

### Detritivores



**Source:**
Dead organisms.

**Action:**
Gets energy by eating the remains of other organisms, breaking them down.

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## Questions :

**Question 1:** How do producers and consumers obtain the energy they need to survive?

| | |
|---|---|
| (A) Producers eat other organisms; consumers make food using sunlight | (B) Producers make food using light (photosynthesis) or chemical energy (chemosynthesis); consumers eat other organisms or dead remains |
| (C) Both producers and carnivores make their own food via chemosynthesis | (D) Herbivores eat only animals; omnivores eat only dead organisms |

**Question 2:** What are living things that make their own food from materials found in their environments called?

| | |
|---|---|
| (A) Producers | (B) Consumers |
| (C) Herbivores | (D) Detritivores |

**Question 3:** What is chemosynthesis?

| | |
|---|---|
| (A) The process by which herbivores feed on only producers | (B) The process by which plants use light energy to make sugar |
| (C) The process during which producers use chemical energy in matter rather than light energy to make food | (D) The process by which detritivores break down dead organisms |

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**Question 4:** How do consumers get the energy they need to survive?

| | |
|---|---|
| (A) By using light energy from the Sun to make glucose | (B) By consuming other organisms because they do not produce their own energy-rich food |
| (C) By using chemical energy in rocks through chemosynthesis | (D) By absorbing sunlight through chloroplasts in their skin |

**Question 5:** Which statement correctly distinguishes between herbivores, carnivores, and omnivores?

| | |
|---|---|
| (A) Herbivores eat animals, carnivores eat producers, and omnivores eat dead remains | (B) Herbivores make food, carnivores eat plants, and omnivores eat only bacteria |
| (C) All three make their own food using photosynthesis | (D) Herbivores eat only producers, carnivores eat other animals, and omnivores eat both producers and consumers |

**Question 6:** how are the caterpillar, the shark, and the girls classified?

| | |
|---|---|
| (A) The caterpillar is an herbivore, the shark is a carnivore, and the girls are omnivores. | (B) The caterpillar is a producer, the shark is an omnivore, and the girls are herbivores. |
| (C) The caterpillar is a detritivore, the shark is an herbivore, and the girls are carnivores. | (D) All three are chemosynthetic producers. |

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Question 7: Why are detritivores such as bacteria, yeast, and mushrooms often called decomposers?

| | |
|---|---|
| (A) Because they use light energy to produce glucose and oxygen | (B) Because they get their energy by feeding on dead organisms and help break down, or decompose, them |
| (C) Because they hunt live prey in the ocean like sharks | (D) Because they eat only living green leaves on trees |

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# Q7 : Module 1: Matter and Energy in Ecosystems

## Lesson 2: Flow of Energy

Analyze how a decrease in detritivores affects an ecosystem.

( Pages 32-33 )

Multiple Choice Questions - MCQ

**Detritivores** Another group of consumers are detritivores (dih TRI tuh vorz). **Detritivores** get their energy by eating the remains of other organisms. Some detritivores, such as bacteria and mushrooms, feed on dead organisms and help break down or decompose them. For this reason, these organisms often are called decomposers. The yeast in the activity above is a decomposer. During decomposition, decomposers produce carbon dioxide that enters the atmosphere. Some of the decayed matter enters the soil or water. In this way, decomposers help recycle nutrients through ecosystems. They also help keep ecosystems clean. Without decomposers, dead organisms would pile up in an ecosystem.



*These mushrooms are decomposers!*

Every year humans generate millions of tons of waste. You probably have a place where you take your trash. You might even recycle, but have you ever heard of composting? Compost is decayed organic matter that can be used as fertilizer. Many people collect their food scraps to create fertilizer and reduce waste. This is done by collecting food waste in your yard or a designated bin. Yard waste and food scraps make up 20 to 30 percent of the trash we throw away. These materials can be composted instead of being put in a landfill, where they take up space and release methane, which is a greenhouse gas.

Composting is possible because microorganisms such as bacteria will break down the scraps, turning them into nutrient-rich organic matter. You can even add earthworms and other detritivores to your compost to speed up the process.



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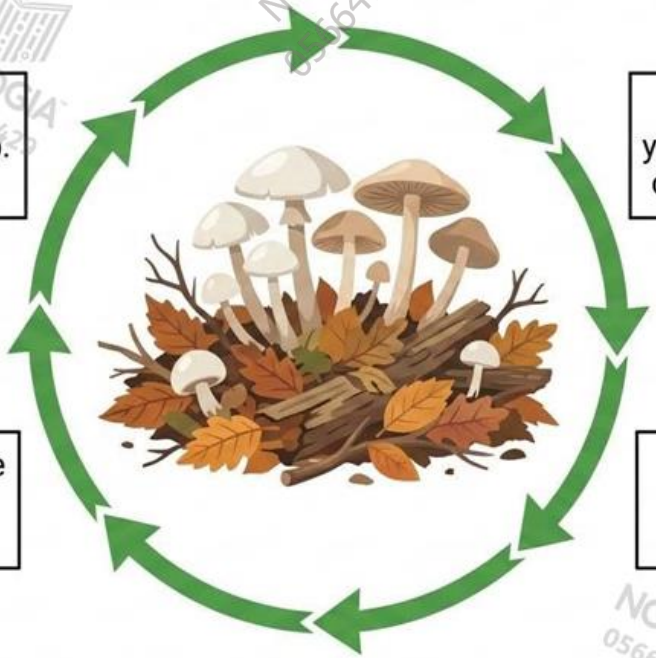
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## The Recyclers: Detritivores and Decomposers

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Dead organisms pile up.

Detritivores (bacteria, yeast, mushrooms) feed on the decayed matter.



**Output B:** Carbon dioxide is produced and enters the atmosphere.

**Output A:** Nutrients are recycled back into the soil and water.

**Without decomposers,** dead organisms would pile up. They are essential for keeping ecosystems clean and [illegible]g nutrients back to producers.

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## Applied Science: The Mechanics of Composting

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### Step 1: Collection



Gathering yard waste and food scraps (which make up 20-30% of trash).

### Step 2: Microbial Action



Microorganisms, bacteria, and earthworms fungi (detritivores) break down the scraps.

### Step 3: Fertilizer



Scraps are turned into nutrient-rich organic matter for gardens.

**Why it matters:** Composting reduces landfill space and stops waste from releasing methane, [illegible]ent greenhouse gas.

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## Questions :



These mushrooms are decomposers!

**Question 1:** How do decomposers (like yeast) affect organic matter, and what happens if detritivores decrease?

| | |
|---|---|
| (A) They decompose dead matter and recycle nutrients; if they decrease, dead organisms pile up and fewer nutrients recycle | (B) They keep dead matter fresh; if they decrease, dead organisms decompose faster |
| (C) They hunt live animals; if they decrease, more decayed matter enters the soil | (D) They have no effect on dead organisms or nutrient recycling |

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Question 2: Why compost yard waste and food scraps using detritivores instead of sending them to a landfill?

| | |
|---|---|
| (A) Yard waste and food scraps cannot be broken down by bacteria or earthworms | (B) Detritivores turn scraps (20-30% of trash) into nutrient-rich fertilizer (compost), saving landfill space and preventing methane gas |
| (C) Landfills turn food scraps into fertilizer and remove greenhouse gases | (D) Composting destroys all microorganisms and earthworms in the soil |

Question 3: What happens during decomposition?

| | |
|---|---|
| (A) Decomposers absorb carbon dioxide and turn dead matter into sunlight. | (B) Decomposers prevent nutrients from entering the soil or water. |
| (C) Decomposers produce carbon dioxide that enters the atmosphere, and some of the decayed matter enters the soil or water. | (D) Decomposers cause dead organisms to pile up without breaking down. |

Question 4: What two important roles do decomposers play in an ecosystem?

| | |
|---|---|
| (A) They help recycle nutrients through ecosystems and help keep ecosystems clean. | (B) They capture light energy for photosynthesis and hunt large predators. |
| (C) They increase landfill waste and release oxygen through stomata. | (D) They stop the cycling of matter and freeze organic waste. |

Question 5: What would happen in an ecosystem without decomposers?

| | |
|---|---|
| (A) Soil would immediately become richer in decayed organic matter. | (B) Dead organisms would pile up in the ecosystem. |
| (C) Dead organisms would decompose twice as fast. | (D) More carbon dioxide would be produced by decomposition. |

Question 6: Composting: What is compost?

| | |
|---|---|
| (A) Synthetic plastic waste buried in a landfill | (B) A greenhouse gas released by trash in landfills |
| (C) Living plants that perform photosynthesis in water | (D) Decayed organic matter that can be used as fertilizer |

Question 7: What percentage of the trash we throw away is made up of yard waste and food scraps?

| | |
|---|---|
| (A) 1 to 5 percent | (B) 20 to 30 percent |
| (C) 75 to 90 percent | (D) 100 percent |

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Question 8: Which organisms break down scraps into nutrient-rich organic matter and speed up the composting process?

| | |
|---|---|
| (A) Microorganisms such as bacteria, along with earthworms and other detritivores | (B) Carnivores such as sharks and hawks |
| (C) Only large trees and shrubs | (D) Photosynthetic phytoplankton in the ocean |

Question 9: What gas is released when yard waste and food scraps are put in a landfill instead of being composted?

| | |
|---|---|
| (A) Oxygen gas | (B) Methane, which is a greenhouse gas |
| (C) Water vapor only | (D) Pure nitrogen gas |

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# Q8 : Module 1: Matter and Energy in Ecosystems

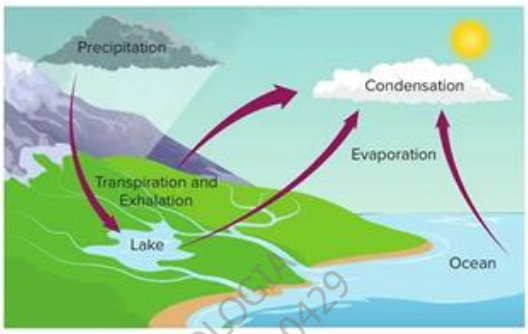
## Lesson 3: Cycling of Matter

Identify the processes in the water cycle.

( Page 52 )

Multiple Choice Questions - MCQ

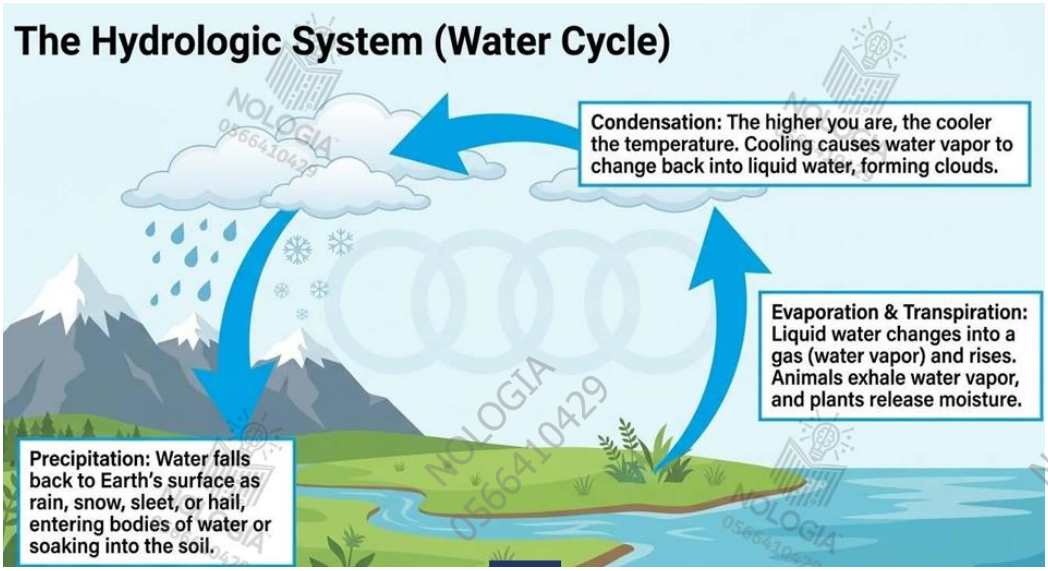
**The Water Cycle** Water continually cycles from Earth to its atmosphere and back again. This movement of water is called the water cycle. It involves three main processes: evaporation, condensation, and precipitation. You can see the processes in action in the figure below.




**Evaporation** is the process during which liquid water changes into a gas called water vapor. This water vapor rises into the atmosphere. Water vapor also enters the atmosphere when animals exhale and through transpiration, which occurs when plants release moisture.

The higher in the atmosphere you are, the cooler the temperature. As water vapor rises, it cools and condensation occurs. **Condensation** is the process during which water vapor changes into liquid water.

Water that falls from clouds to Earth's surface is called **precipitation.** It enters bodies of water or soaks into soil. Precipitation can be rain, snow, sleet, or hail.






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## Questions :

**Question 1:** Examine the water cycle figure. How does water move continually between Earth and its atmosphere?

| | |
|---|---|
| (A) Through photosynthesis, cellular respiration, and combustion | (B) Through evaporation (and transpiration/exhalation), condensation into clouds, and precipitation (rain, snow, sleet, hail) |
| (C) Through nitrogen fixation, decomposition, and sedimentation | (D) Through ingestion, digestion, and cellular respiration |

**Question 2:** What is the continual movement of water from Earth to its atmosphere and back again called?

| | |
|---|---|
| (A) The carbon cycle | (B) The oxygen cycle |
| (C) The water cycle | (D) The nitrogen cycle |

**Question 3:** What is evaporation?

| | |
|---|---|
| (A) The process during which liquid water changes into a gas called water vapor | (B) The process during which water vapor changes into liquid water |
| (C) Water that falls from clouds to Earth's surface as rain or snow | (D) Water soaking deep into the soil from rivers |

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Question 4: Besides evaporation from bodies of water, how else does water vapor enter the atmosphere?

| | |
|---|---|
| (A) Only when rocks weather and erode | (B) Only when snow melts on mountain peaks |
| (C) When fish absorb dissolved oxygen in lakes | (D) When animals exhale and through transpiration when plants release moisture |

Question 5: What is transpiration?

| | |
|---|---|
| (A) Water falling from clouds as sleet or hail | (B) The process that occurs when plants release moisture (water vapor) into the atmosphere |
| (C) Water vapor cooling and forming clouds high in the sky | (D) Liquid water freezing into ice in a pond |

Question 6: During which process of the water cycle does cooling water vapor in the atmosphere change into liquid water?

| | |
|---|---|
| (A) Evaporation | (B) Condensation |
| (C) Precipitation | (D) Transpiration |

Question 7: What is water that falls from clouds to Earth's surface as rain, snow, sleet, or hail called?

| | |
|---|---|
| (A) Evaporation | (B) Condensation |
| (C) Precipitation | (D) Transpiration |

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# Q9 : Module 1: Matter and Energy in Ecosystems

## Lesson 3: Cycling of Matter

Use a model to identify the processes of the oxygen cycle.

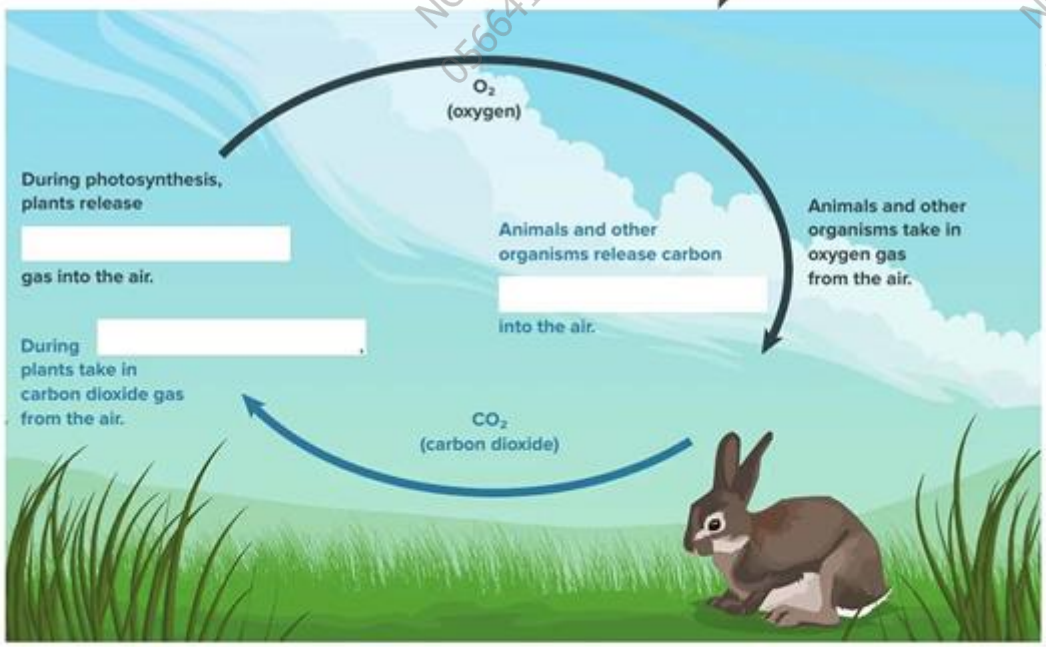
( Page 54 )

Multiple Choice Questions - MCQ

**The Oxygen Cycle** Oxygen is another element that cycles through ecosystems. Recall that oxygen is necessary for cellular respiration. Oxygen is also part of many substances that are important to life, such as carbon dioxide and water.

Earth's early atmosphere probably did not contain oxygen gas. Oxygen might have entered the atmosphere when certain bacteria evolved that could carry out the process of photosynthesis and make their own food. A by-product of photosynthesis is oxygen. Over time, other photosynthetic organisms evolved and the amount of oxygen in Earth's atmosphere increased. Today, photosynthesis is the primary source of oxygen in Earth's atmosphere. Some scientists estimate that unicellular organisms in water, called phytoplankton, release more than 50 percent of the oxygen in Earth's atmosphere.

Fill in the blanks with the correct terms.




Many living things, including humans, take in oxygen and release carbon dioxide. The interaction of the carbon and oxygen cycles is one example of a relationship between different types of matter in ecosystems. As the matter cycles through an ecosystem, both the carbon and the oxygen take different forms and play a role in the other element's cycle.

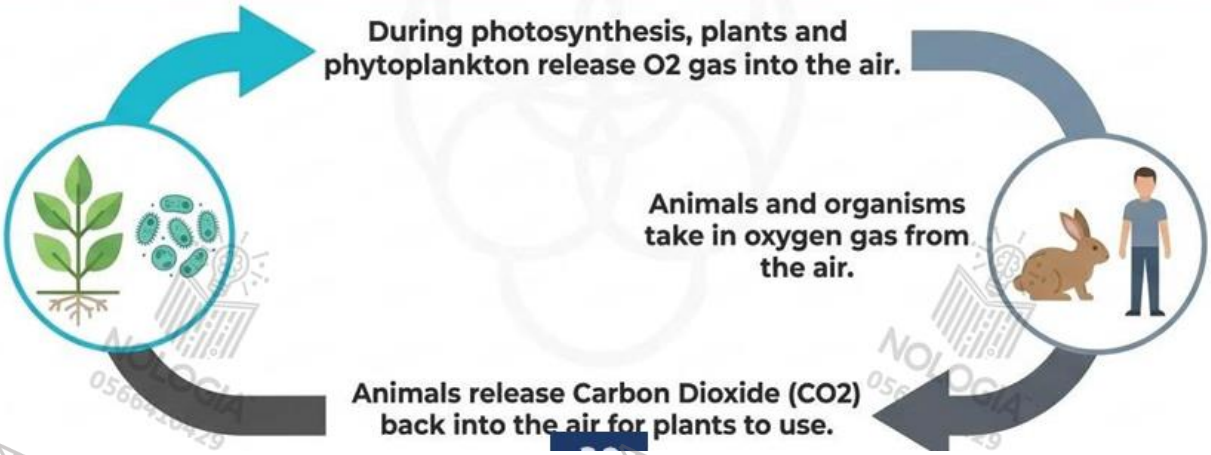


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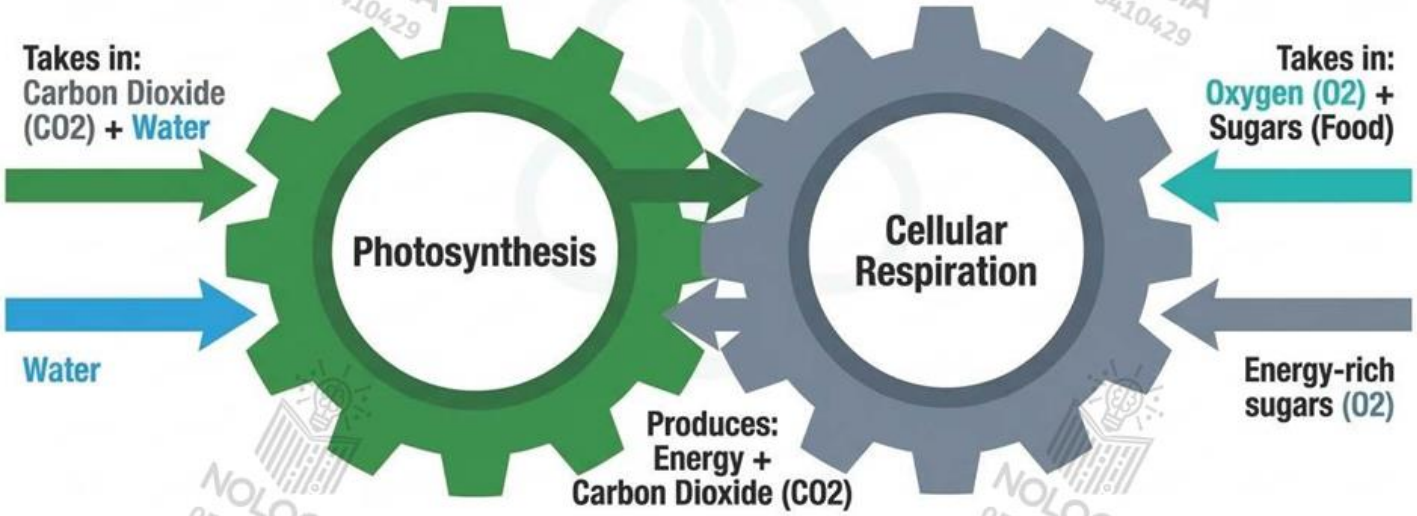
# The Oxygen Cycle

**> 50% of Earth's Oxygen comes from Phytoplankton in the water!**




## The Perfect Loop: Interlocking Cycles

The Carbon and Oxygen cycles interact perfectly. The output of one is the fuel for the other.



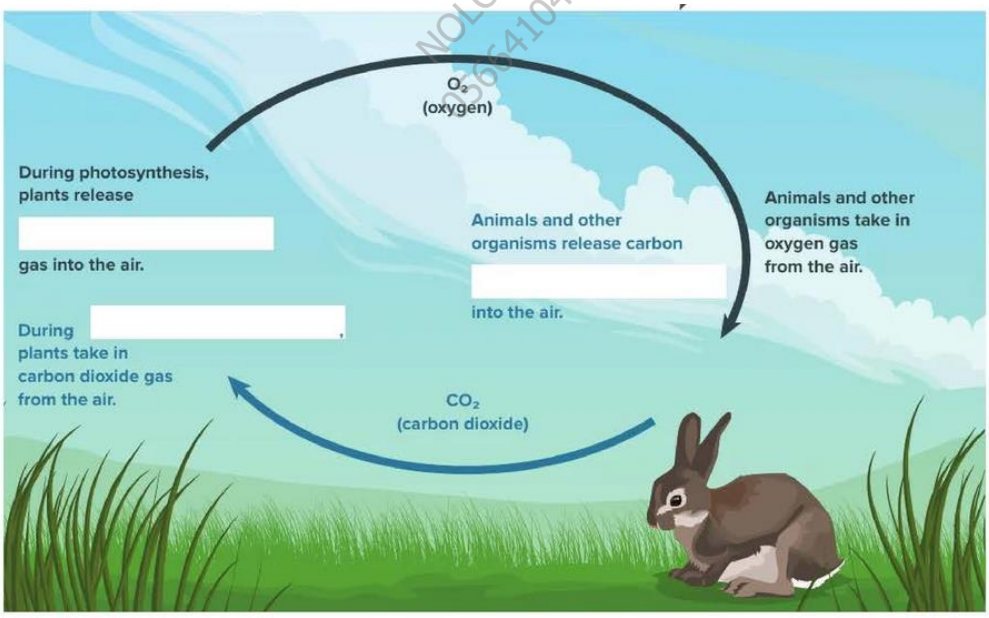

**Note:** Both cycles take different forms and play a direct role in the other's ecosystem function.



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## Questions :




**Question 1:** Fill in the three blanks in the oxygen cycle diagram.

| | |
|---|---|
| (A) 1: carbon dioxide; 2: cellular respiration; 3: oxygen gas | (B) 1: oxygen (plants release oxygen); 2: photosynthesis (plants take in CO2); 3: dioxide gas (animals release carbon dioxide gas) |
| (C) 1: nitrogen; 2: evaporation; 3: water vapor | (D) 1: glucose; 2: condensation; 3: methane gas |

**Question 2:** How does oxygen move through the environment?

| | |
|---|---|
| (A) Plants and phytoplankton release O2 during photosynthesis; animals take in O2 for respiration and release CO2 | (B) Animals exhale O2 gas, and plants absorb only O2 during photosynthesis |
| (C) Oxygen moves only through rocks and never enters living things | (D) Evaporation converts liquid water directly into oxygen gas in clouds |

Question 3: Why is oxygen necessary for living things, and what substances is it part of?

| | |
|---|---|
| (A) Oxygen is necessary for cellular respiration and is part of substances important to life, such as carbon dioxide and water. | (B) Oxygen is used only by rocks and is not part of water or carbon dioxide. |
| (C) Oxygen is a waste product of animal cellular respiration. | (D) Oxygen is needed only by anaerobic bacteria in the soil. |

Question 4: What is the primary source of oxygen in Earth's atmosphere today?

| | |
|---|---|
| (A) Cellular respiration | (B) Combustion of fossil fuels |
| (C) Photosynthesis | (D) Condensation of water vapor |

Question 5: Which unicellular organisms in water are estimated to release more than 50 percent of the oxygen in Earth's atmosphere?

| | |
|---|---|
| (A) Desert cacti | (B) Mushrooms and yeast |
| (C) Nitrogen-fixing bacteria on plant roots | (D) Phytoplankton |

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Question 6: According to the oxygen cycle diagram on page 54, what do plants take in and release during photosynthesis?

| | |
|---|---|
| (A) Plants take in oxygen gas from the air and release carbon dioxide gas into the air. | (B) Plants take in carbon dioxide gas from the air and release oxygen gas into the air. |
| (C) Plants take in nitrogen gas and release methane gas. | (D) Plants take in glucose from the air and release water into space. |

Question 7: According to the oxygen cycle diagram on page 54, what do animals and other organisms take in and release?

| | |
|---|---|
| (A) They take in oxygen gas from the air and release carbon dioxide gas into the air. | (B) They take in carbon dioxide gas from the air and release oxygen gas into the air. |
| (C) They take in sunlight and release chlorophyll. | (D) They take in carbon dioxide and release pure nitrogen. |

Question 8: How do the carbon cycle and the oxygen cycle interact in an ecosystem?

| | |
|---|---|
| (A) The carbon cycle and the oxygen cycle never interact with each other. | (B) Both plants and animals only release oxygen and never release carbon dioxide. |
| (C) Many living things take in oxygen and release carbon dioxide, while plants take in carbon dioxide and release oxygen during photosynthesis. | (D) Oxygen is converted into carbon atoms inside animal lungs. |

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Q10 : Module 2: Dynamic Ecosystems

Lesson 1: Resources in Ecosystems

Identify levels of organization in an ecosystem.

( Page 74 - 75 )

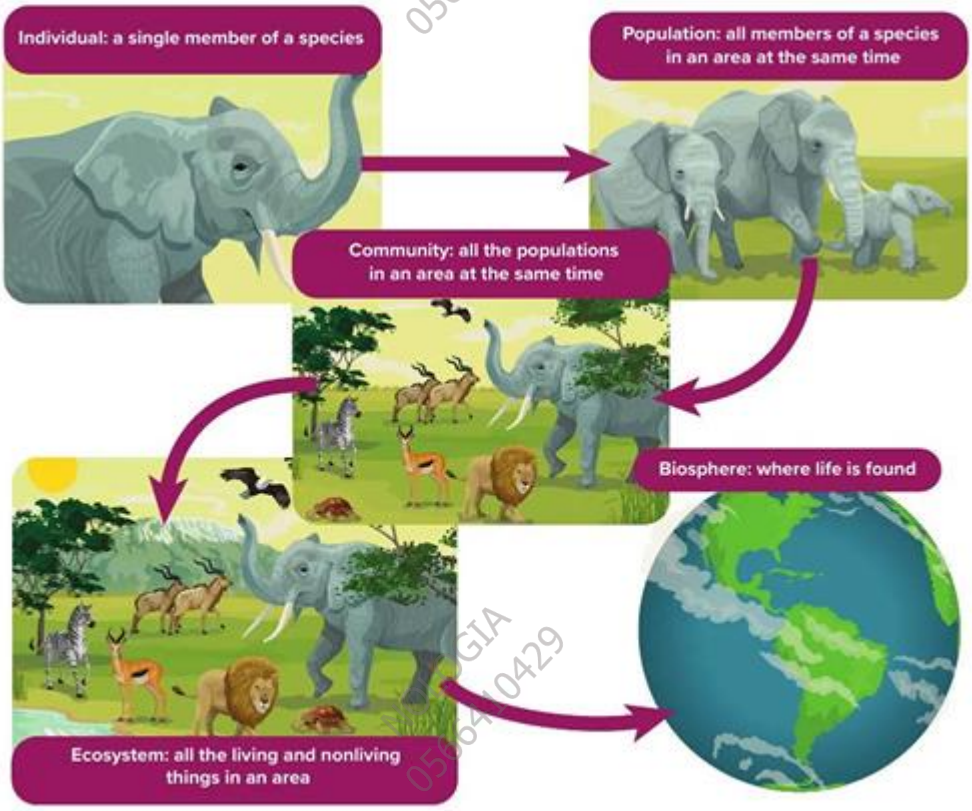
Multiple Choice Questions - MCQ

# What are the levels of organization in an environment?

When you observed the animals in the video, you may have noticed the environment around them. What were some of the living and nonliving things you noticed in the video?

**Want more information?** Go online to read more about resources in ecosystems.

In the video, while you noticed the antelope and the lions, you also may have seen grasses growing or birds flying by. The birds, mammals, and grasses are living things. The nonliving parts of the environment included the rocks and the water. Recall that all of the living and nonliving things in an area make up an ecosystem. All of the ecosystems on Earth make up the **biosphere**—the parts of Earth and the surrounding atmosphere where there is life. Examine the image below to see how an area, like the park seen in the video, is organized.



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**Ecosystems** As you can see, an individual elephant is part of an ecosystem. An elephant relies on interactions with other elephants to survive. They move in herds and keep each other safe. All of the elephants in the area make up a population. A **population** is all the organisms of the same species that live in the same area at the same time. A **species** is a group of organisms that have similar traits and are able to produce fertile offspring.

Many species besides elephants live in Etosha National Park. Zebras, tortoises, and lions all call the area their home. Plants that grow in the savanna include shrubs, grasses, and small trees. Together, all these plants, animals, and other organisms make up a community. A **community** is all the populations of different species that live together in the same area at the same time.

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## The Foundation of an Ecosystem

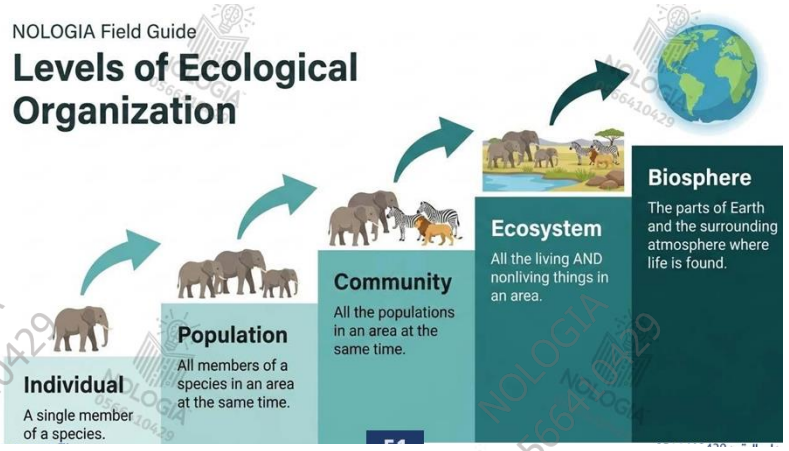
Every ecosystem is composed of two interacting components.

| Living Things (Biotic) | Nonliving Things (Abiotic) |
|---|---|
| ✓ Birds | ✓ Water |
| ✓ Mammals (e.g., Antelopes, Lions) | ✓ Rocks |
| ✓ Grasses | ✓ Sunlight |
| ✓ Shrubs & Small Trees | ✓ Temperature |
| ✓ Insects | ✓ Surrounding Atmosphere |

The **Core Interaction:** Organisms rely on interactions with both living and nonliving components to survive and thrive.

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## Levels of Ecological Organization




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# Defining the Players: Species vs. Population

## What makes a Species?



- ✓ Must share similar traits.
- ✓ Must be able to produce fertile offspring.

## What makes a Population?



**The 3 S's Criteria:**

- ✓ Same species
- ✓ Same area
- ✓ Same time

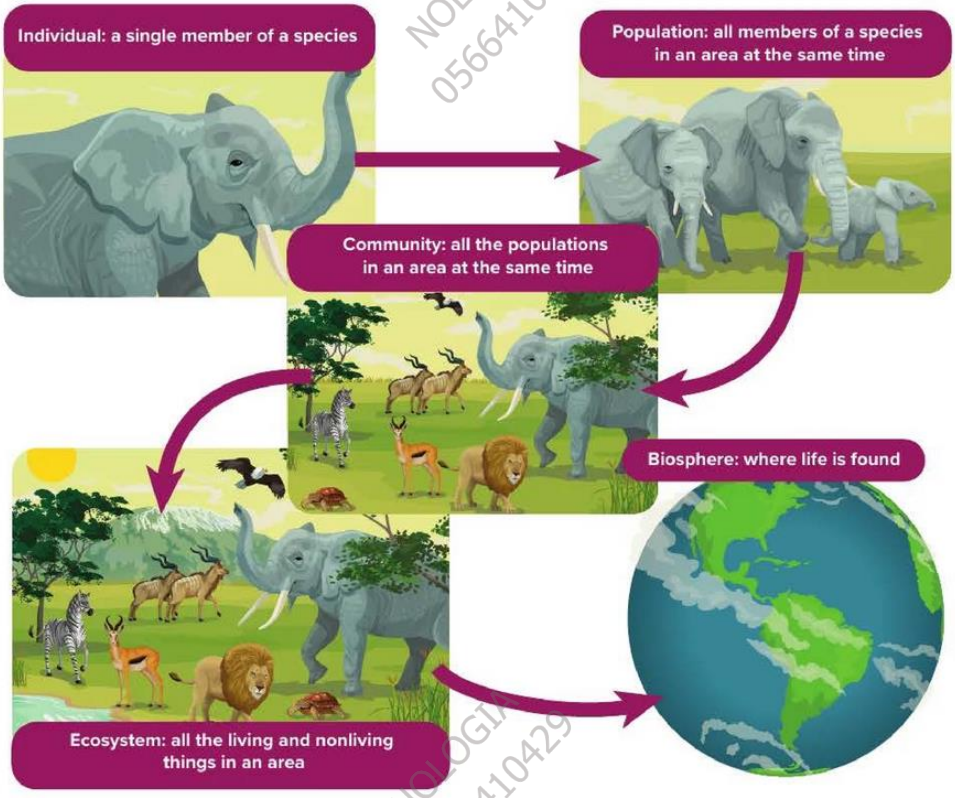
**Safety in Numbers:** Individuals form herds and populations to keep each other safe and rely on these interactions for survival.



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## Questions :




**Question 1:** What are the levels of organization in an environment, ordered from smallest to largest?

| | |
|---|---|
| (A) Individual → Community → Population → Ecosystem → Biosphere | (B) Individual → Population → Community → Ecosystem → Biosphere |
| (C) Species → Ecosystem → Community → Population → Biosphere | (D) Population → Individual → Community → Biosphere → Ecosystem |

Question 2: What are the levels of organization in an environment?: What is the biosphere?

| | |
|---|---|
| (A) A single member of one species in a park | (B) Only the rocks and water in a desert |
| (C) All the members of one species in a pond | (D) The parts of Earth and the surrounding atmosphere where there is life (all the ecosystems on Earth) |

Question 3: Which level of organization represents a single member of a species, such as one elephant?

| | |
|---|---|
| (A) Individual | (B) Population |
| (C) Community | (D) Biosphere |

Question 4: Which level of organization includes all the organisms of the same species that live in the same area at the same time?

| | |
|---|---|
| (A) Individual | (B) Population |
| (C) Community | (D) Ecosystem |

Question 5: What is a species?

| | |
|---|---|
| (A) All the living and nonliving things in an environment | (B) Different types of animals that cannot reproduce with one another |
| (C) A group of organisms that have similar traits and are able to produce fertile offspring | (D) The nonliving rocks, water, and air in a habitat |


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Question 6: What is a community, and how does it differ from an ecosystem?

| | |
|---|---|
| (A) A community includes rocks and water; an ecosystem is one species | (B) A community is all populations in an area; an ecosystem includes both the living community and nonliving things |
| (C) A community is one individual; an ecosystem is the entire planet Earth | (D) There is no difference between a community and an ecosystem |

Question 7: Zebras, tortoises, lions, shrubs, grasses, and small trees living together in Etosha National Park at the same time make up which level of organization?

| | |
|---|---|
| (A) Individual | (B) Population |
| (C) Community | (D) Nonliving factor |

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# Q11 : Module 2: Dynamic Ecosystems

## Lesson 1: Resources in Ecosystems

Apply the meaning of limiting factors to a specific population scenario.

( Page 77 - 78 )

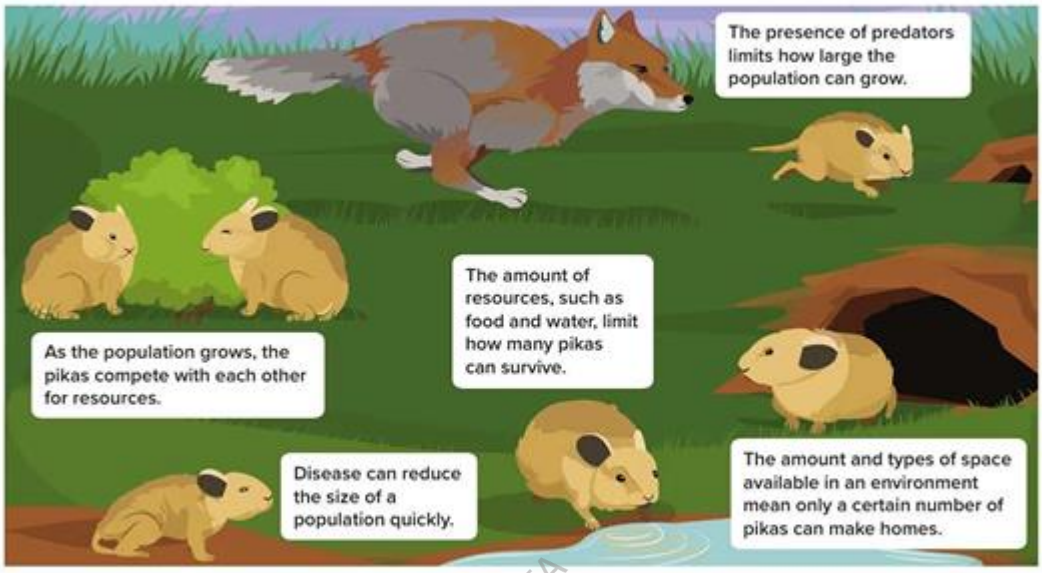
Multiple Choice Questions - MCQ

**Limiting Factors** Environmental factors, such as available water, food, sunlight, and temperature, are possible limiting factors for a population. A **limiting factor** is anything that restricts the size of a population. Populations can increase and decrease in size, but limiting factors might affect the number of individuals an ecosystem can support.

**How Limiting Factors Affect Populations** As you discovered in the Lab, *Fishy Population Changes*, the amount of space affects a population's size. Space is a limiting factor, just like available water, food, sunlight, and temperature. With too few resources, populations may migrate to new areas or even die out. Other factors that you will learn about may also limit how many individuals survive. Now, examine some limiting factors in a population of pikas.

### Pika Predicaments

Examine the figure of a population of pikas below. Read about how limiting factors affect their population and answer the following question.




In the illustration of the pikas, you examined how limiting factors affected their survivability. Think about everything you need to survive. Choose one factor and construct an explanation about why it might be a limiting factor for the human population.



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# The Rules of the Game: Limiting Factors

**Limiting Factor:** Any environmental factor that restricts the size of a population. These determine exactly how many individuals an ecosystem can support.




Without enough resources, populations are **forced to migrate to new ar[redacted] they will **die out.**

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# Limiting Factors in Action: The Pika Predicament

## 1. Predators



Foxes and other predators actively limit how large the pika population can grow.

## 3. Disease



Outbreaks of illness can reduce the size of a population extremely quickly.

## 2. Resource Competition



As population grows, pikas must compete with each other for limited food and water, capping survival rates.

## 4. Available Space



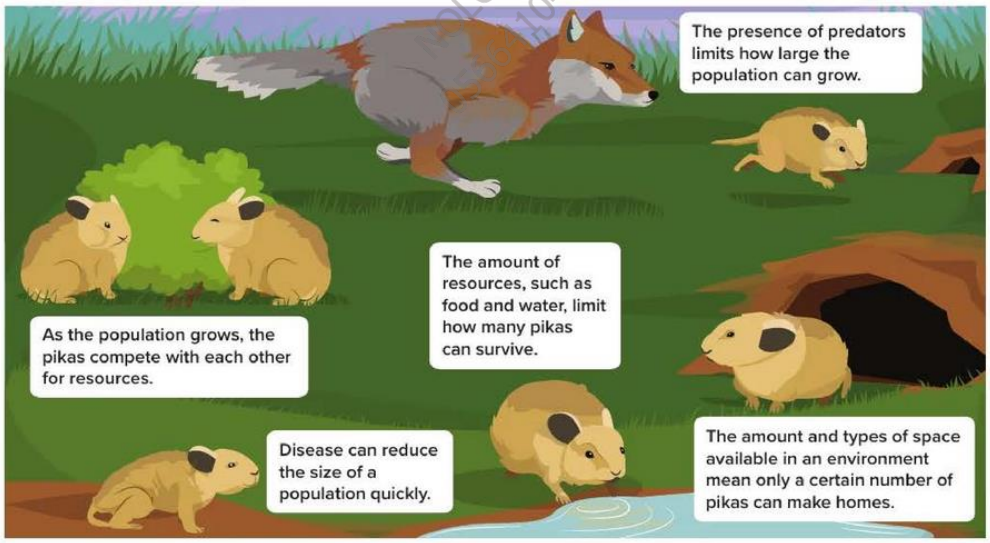
The physical amount and type of space means only a strict, certain number of pikas can successfully make homes.



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## Questions :




**Question 1:** Examine the figure of a population of pikas. How do limiting factors affect population size?

| | |
|---|---|
| (A) The pikas stop needing food and water to survive | (B) Limited food, water, and space cause competition, while predators and disease restrict population growth |
| (C) Predators and disease cause the pika population to increase indefinitely | (D) Every pika makes a home regardless of available space |

**Question 2:** What is a limiting factor?

| | |
|---|---|
| (A) Anything that restricts the size of a population | (B) A factor that allows a population to grow without any limits forever |
| (C) The total number of different ecosystems on Earth | (D) A single member of a species living in an area |

Question 3: Which of the following environmental factors are possible limiting factors for a population?

| | |
|---|---|
| (A) Only sunlight and air | (B) Available water, food, sunlight, space, and temperature |
| (C) Only the color of rocks in the area | (D) Only nonliving factors that never change |

Question 4: What may happen to populations when there are too few resources in an area?

| | |
|---|---|
| (A) Populations will double in size immediately. | (B) Populations will stop needing food and water. |
| (C) Every individual will produce more offspring. | (D) Populations may migrate to new areas or even die out. |

Question 5: In the Pika Predicaments investigation , how does the presence of predators (such as foxes) affect the pika population?

| | |
|---|---|
| (A) It limits how large the pika population can grow. | (B) It increases the amount of space available for pikas to make homes. |
| (C) It provides more food and water for the pikas. | (D) It prevents pikas from competing for resources. |

Question 6: How does disease affect the size of a pika population?

| | |
|---|---|
| (A) Disease causes the pika population to grow rapidly. | (B) Disease can reduce the size of a population quickly. |
| (C) Disease has no effect on the size of a population. | (D) Disease increases the carrying capacity of the environment. |

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Question 7: Which of the following is an example of a limiting factor restricting the size of a pika population?

| | |
|---|---|
| (A) Unlimited food and water allowing every pika to survive | (B) The absence of predators in the ecosystem |
| (C) Only a certain number of pikas can make homes due to the amount and types of space available. | (D) Perfect weather conditions with no disease |

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# Q12 : Module 2: Dynamic Ecosystems

## Lesson 1: Resources in Ecosystems

Analyze population data to identify biotic potential and carrying capacity.

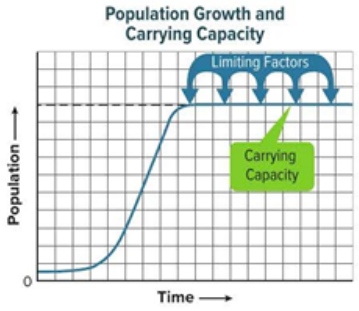
( Page 79 )

Multiple Choice Questions - MCQ

## How big can populations get?

Without limiting factors, populations would keep growing until they reached their biotic potential. **Biotic potential** is the potential growth of a population if it could grow in perfect conditions with no limiting factors.

Almost no population reaches its biotic potential. Instead, it reaches its carrying capacity. **Carrying capacity** is the largest number of individuals of one species that an ecosystem can support over time. For example, in the *Fishy Population Changes* lab, the pond could only support 16 fish before it reached its carrying capacity. The limiting factors of an area determine the area's carrying capacity, as shown in the graph.



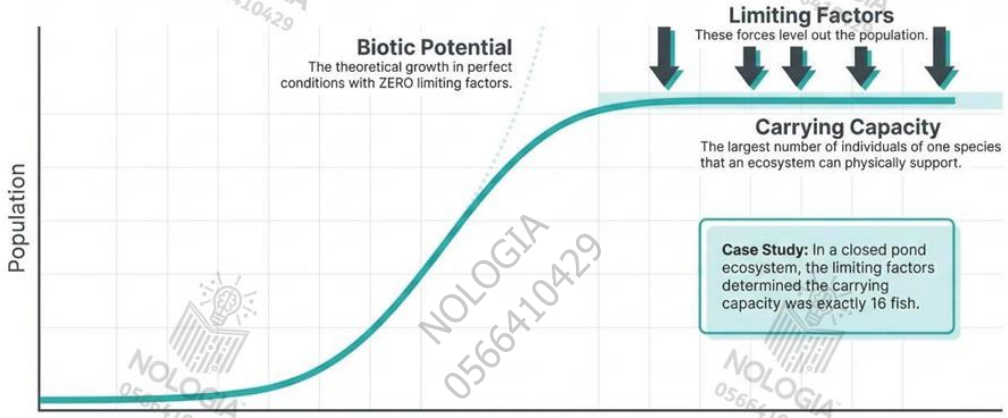

**Overpopulation** Sometimes a population becomes too large for its ecosystem to support. **Overpopulation** is when a population's size grows so large that it causes damage to the environment.

Overpopulation can cause problems for organisms. For example, a population of birds eats spiders. An overpopulation of birds causes the size of the spider population in that community to decrease. Populations of other animals that eat spiders also decrease when the number of spiders decreases.



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## The Limits of Growth: Supply vs. Demand

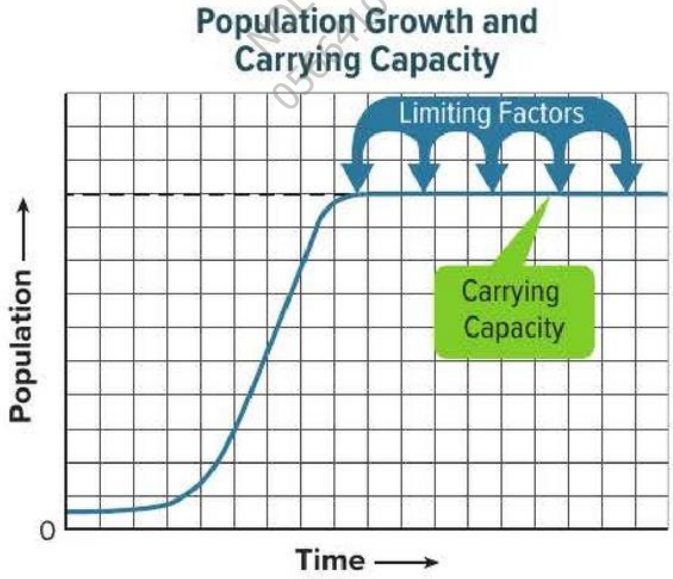





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## Questions :




**Question 1:** How does a line showing biotic potential compare to the carrying capacity curve on the graph?

| | |
|---|---|
| (A) The biotic potential line levels off below carrying capacity due to limiting factors | (B) It continues rising steeply (growth in perfect conditions without limiting factors), while nature restricts growth at carrying capacity |
| (C) Biotic potential is always lower than carrying capacity in every ecosystem | (D) The carrying capacity line drops to zero when conditions are perfect |

**Question 2:** What is biotic potential?

| | |
|---|---|
| (A) The potential growth of a population if it could grow in perfect conditions with no limiting factors | (B) The largest number of individuals of one species that an ecosystem can support over time |
| (C) When a population's size grows so large that it causes damage to the environment | (D) The rapid decrease of a population due to disease and predation |

Question 3: What term describes the largest number of individuals of one species that an ecosystem can support over time?

| | |
|---|---|
| (A) Biotic potential | (B) Carrying capacity |
| (C) Overpopulation | (D) Community size |

Question 4: What determines an area's carrying capacity?

| | |
|---|---|
| (A) The absence of all predators and disease | (B) Perfect conditions with unlimited food and space |
| (C) The limiting factors of the area | (D) The biotic potential of the biosphere |

Question 5: Why does almost no population in nature reach its biotic potential?

| | |
|---|---|
| (A) Because all ecosystems have unlimited food, water, and space. | (B) Because carrying capacity is always higher than biotic potential. |
| (C) Because organisms stop reproducing when conditions are perfect. | (D) Because limiting factors restrict population growth, so the population reaches its carrying capacity instead. |

Question 6: how many fish could the pond support before reaching its carrying capacity?

| | |
|---|---|
| (A) 2 fish | (B) 16 fish |
| (C) 100 fish | (D) 1,000 fish |

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# Q13 : Module 2: Dynamic Ecosystems

## Lesson 2: Interactions Within Ecosystems

Classify relationships based on interactions of organisms.

( Page 94 - 98 )

Multiple Choice Questions - MCQ

After observing the relationships in a coral reef ecosystem, you may have discovered that there are a few different types of symbiotic relationships.

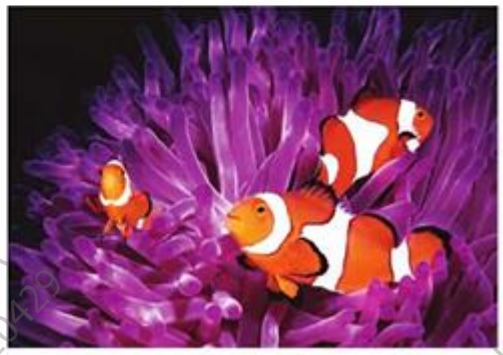


**Commensalism** A symbiotic relationship that benefits one species but does not harm or benefit the other is **commensalism.** Plants called epiphytes (EH puh fites) grow on the trunks of trees and other objects. The roots of an epiphyte anchor it to the object. The plant's nutrients are absorbed from the air. Epiphytes benefit from attaching to tree trunks by getting more living space and sunlight. The trees are neither helped nor harmed by the plants.



**Parasitism** A symbiotic relationship that benefits one species and harms the other is **parasitism.** The species that benefits is the parasite. The species that is harmed is the host. The larvae of the hunting wasp is a parasite. The female wasp, shown in the photo on the left, stings a spider to paralyze it. Then she lays eggs in its body. When the eggs hatch into larvae, they eat the paralyzed spider.

**Mutualism** A symbiotic relationship in which both partners benefit is called **mutualism.** Clownfish and sea anemones live in tropical coral reef communities. The clownfish receives protection from the anemone as the anemone will sting predators of the clownfish. The anemone in turn receives energy from the waste produced by the clownfish. The barbel fish and hippos you learned about earlier also share a mutualistic relationship.





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The oxpeckers are two species of bird found in the savanna of Sub-Saharan Africa. They acquired their name from their habit of perching on top of large African mammals, such as the impala and water buffalo above, as well as zebras, rhinos, and giraffes. The oxpecker feeds exclusively on the ticks and insects that live on these large animals.

The nature of the oxpecker's relationship with large mammals is the subject of ongoing research. Initially, this relationship was thought to be an example of mutualism, where the birds were thought to free the animal of parasites while gaining food in the process. However, oxpeckers have been known to drink the blood of their animal perches. They may even make wounds from ticks much worse by opening them up more. Because of this, elephants have been observed shaking the oxpeckers off after they land.

New evidence suggests that the oxpecker/mammal interaction is sometimes an example of a parasitic relationship. While the large mammals are cleared of parasites, they are sometimes harmed in the process.

**Cooperative Relationships** The leaf-cutter ants in the *Assorted Associations* investigation work together in cooperative relationships for their survival. Together they carry leaves to their nest to be used to grow fungus for food and building. Cooperative relationships can be found in many different populations across the world. For example, elephants cooperate with each other to raise young and watch for predators. Squirrel monkeys benefit in a similar way by living in groups. They cooperate as they hunt for food and watch for danger.



**Predator-Prey Relationships** The osprey catching a fish is an example of a predator-prey relationship. A predator-prey relationship is one in which one organism, the predator, eats another, the prey. Predators help prevent prey populations from growing too large for the carrying capacity of the ecosystem. Predators often capture weak or injured individuals of a prey population. When the weak members of a population are removed, there are more resources available for the remaining members. This helps keep the prey population healthy.

**Competitive Relationships** Organisms that share the same habitat often compete for resources. This is known as a competitive relationship. Competition describes interactions between two or more organisms that need the same resource at the same time. For example, trees compete for sunlight, and the shade from tall trees can slow the growth of younger trees. Wolves compete with ravens for meat from the animals that wolves kill, as shown in the photo above.

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## Symbiosis: The Long-Term Bonds

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Symbiosis is a close, long-term relationship between two species that usually involves an exchange of food or energy.

**[+ / +]**

**Mutualism**
(Both partners benefit)

**[+ / 0]**

**Commensalism**
(One benefits, one is completely unaffected)

**[+ / -]**

**Parasitism**
(One benefits, one is actively harmed)

## Mutualism [+ / +]

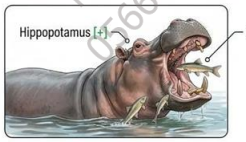
A symbiotic relationship in which both partners benefit.

### Clownfish & Sea Anemone




- **Clownfish [+]:** Receives protection from the anemone's stinging tentacles.
- **Sea Anemone [+]:** Receives energy produced from the clownfish's waste.

### Hippopotamus & Barbel Fish




- **Barbel Fish [+]:** Follows the hippo and gains a steady food source.
- **Hippopotamus [+]:** Has parasites removed and its mouth cleaned.

Bees and beehalm flowers also share this bond—bees [illegible] nectar for honey [+], while the flower achieves pollination [+].

## Commensalism [[+] / 0 ]

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A symbiotic relationship that benefits one species but does not harm or benefit the other.



**Epiphyte Plant [[+]]**
Roots anchor to the object, absorbing nutrients/air. It gains critical living space and sunlight.

**The Tree [0]**
Unaffected. Neither helped nor harmed by the attached plant.

**Cattle Egrets & Cattle.**
Egrets gain a food source [+] by eating insects and worms kicked up by grazing cattle. The cattle are completely unaffected [0].

## Parasitism [+/–]

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A symbiotic relationship that benefits one species (the parasite) and harms the other (the host).



**The Hunting Wasp & Spider**

- The wasp [+] stings and paralyzes the spider, laying eggs inside its body.
- When larvae hatch, they eat the paralyzed spider [-].

**Fleas, Ticks, and Pets:** Fleas and ticks feed off the blood of host cats and dogs, which can cause severe illness in the pet.

## The NOLOGIA Case Study: Friend or Foe?

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The African Oxpecker feeds exclusively on ticks and insects living on large mammals (impala, zebras, rhinos, giraffes).



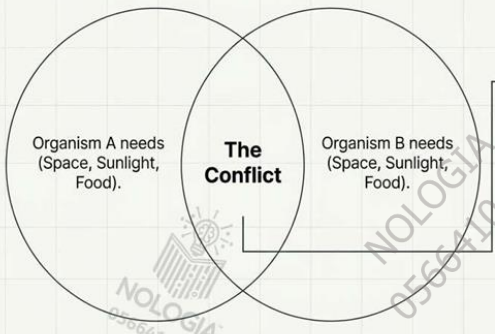
**The Mutualism Hypothesis (+/+)**
Originally, scientists believed birds gained food [+] while freeing mammals from parasites [+].

**The Parasitism Reality (+/-)**
New evidence reveals oxpeckers drink the blood of their perches and intentionally keep wounds open [-]. Elephants have even been observed shaking the birds off after they land.

## Competitive Relationships

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Organisms sharing a habitat fighting for the same limited resources at the exact same time.






- **Example 1 (Flora):** Tall trees casting shade compete with younger trees for vital sunlight.
- **Example 2 (Fauna):** Wolves compete directly with ravens for meat sourced from the animals the wolves have killed.



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## Questions :

**Question 1:** How do the patterns of interactions classify commensalism, parasitism, and mutualism?

| | |
|---|---|
| (A) Epiphytes growing on tree trunks without harming the tree is parasitism | (B) Commensalism (+/0): one benefits, one unaffected (epiphytes/trees); Parasitism (+/-): parasite benefits, host harmed (wasp/spider); Mutualism (+/+): both benefit (clownfish/anemone) |
| (C) Hunting wasp larvae eating a paralyzed spider is commensalism | (D) In commensalism, both interacting species are harmed |

**Question 2:** Why do organisms such as the cleaner shrimp and moray eel (or clownfish and sea anemone) have symbiotic relationships?

| | |
|---|---|
| (A) To exchange food, energy, protection, or living space needed for survival | (B) Only to fight over shelter and destroy their habitat |
| (C) To perform photosynthesis together using sunlight | (D) Symbiotic relationships occur only between nonliving rocks and water |

**Question 3:** What is symbiosis?

| | |
|---|---|
| (A) A close, long-term relationship between two species that usually involves an exchange of food or energy | (B) When members of the same population fight over water in a desert |
| (C) The gradual replacement of a pond with soil and land plants | (D) The process of breaking down glucose in the cytoplasm |



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Question 4: What is commensalism, and which example from the textbook illustrates it?

| | |
|---|---|
| (A) Both partners benefit, such as clownfish and sea anemones | (B) One species benefits and the other is harmed, such as wasp larvae and a spider |
| (C) One species benefits while the other is neither helped nor harmed, such as epiphytes on tree trunks | (D) One organism immediately kills and eats prey, such as an osprey and a fish |

Question 5: what are the species that benefits and the species that is harmed called?

| | |
|---|---|
| (A) The benefiting species is the host; the harmed species is the parasite | (B) The benefiting species is the parasite; the harmed species is the host |
| (C) Both species are called epiphytes | (D) The benefiting species is the producer; the harmed species is the decomposer |

Question 6: A female hunting wasp stings a spider to paralyze it and lays its eggs inside the spider's body so the hatching larvae can eat the spider. This interaction is an example of:

| | |
|---|---|
| (A) Mutualism | (B) Commensalism |
| (C) Cooperation | (D) Parasitism |

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Question 7: What is mutualism?

| | |
|---|---|
| (A) A symbiotic relationship in which both partners benefit | (B) A symbiotic relationship that benefits one species and harms the other |
| (C) A symbiotic relationship that benefits one species and neither helps nor harms the other | (D) A competitive relationship over limited sunlight |

Question 8: How do both the clownfish and the sea anemone benefit from their mutualistic relationship?

| | |
|---|---|
| (A) Clownfish eats the anemone's tentacles; the anemone stings the clownfish | (B) Clownfish gets protection from the stinging anemone; the anemone gets energy from clownfish waste |
| (C) The anemone anchors to tree trunks; the clownfish absorbs nutrients from air | (D) Neither organism receives any benefit from living together |

Question 9: In the mutualistic relationship between the hippopotamus and the barbel fish, what specific benefit does the barbel fish receive?

| | |
|---|---|
| (A) Protection from predators | (B) A steady food source |
| (C) Energy from the hippo's waste | (D) A safe place to lay eggs |

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Question 10: Why is the interaction between cattle egrets and cattle classified as commensalism?

| | |
|---|---|
| (A) Both the egrets and the cattle benefit equally from the interaction. | (B) The egrets gain a food source by eating insects, while the cattle are completely unaffected. |
| (C) The egrets harm the cattle by drinking their blood. | (D) The cattle gain protection while the egrets are unaffected. |

Question 11: what new evidence revealed that the African Oxpecker's relationship with large mammals is actually parasitism rather than mutualism?

| | |
|---|---|
| (A) The birds build nests in the mammals' fur. | (B) The birds only eat ticks and worms kicked up by grazing. |
| (C) The birds drink the blood of their perches and intentionally keep wounds open. | (D) The mammals actively hunt and eat the birds. |

Question 12: How does the material define "Competitive Relationships" between organisms?

| | |
|---|---|
| (A) Organisms working together to find shelter. | (B) Organisms sharing a habitat fighting for the same limited resources at the exact same time. |
| (C) A long-term bond where one species is completely unaffected. | (D) One organism stinging and paralyzing another to lay eggs. |


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Question 13: In the flora example of a competitive relationship, what vital resource do tall trees and younger trees compete for?

| | |
|---|---|
| (A) Soil nutrients | (B) Water |
| (C) Sunlight | (D) Oxygen |

Question 14: In the fauna example provided, which animal do wolves compete directly with for meat sourced from the animals the wolves have killed?

| | |
|---|---|
| (A) Bears | (B) Foxes |
| (C) Ravens | (D) Eagles |

Question 15: How do fleas and ticks interact with host cats and dogs in their parasitic relationship?

| | |
|---|---|
| (A) They clean the host's fur of dead skin. | (B) They feed off the blood of the host, which can cause severe illness. |
| (C) They share the host's food without causing harm. | (D) ey protect the host from other harmful insects. |

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# Q14 : Module 2: Dynamic Ecosystems

## Lesson 2: Interactions Within Ecosystems

Classify relationships based on interactions of organisms.

( Page 98 )

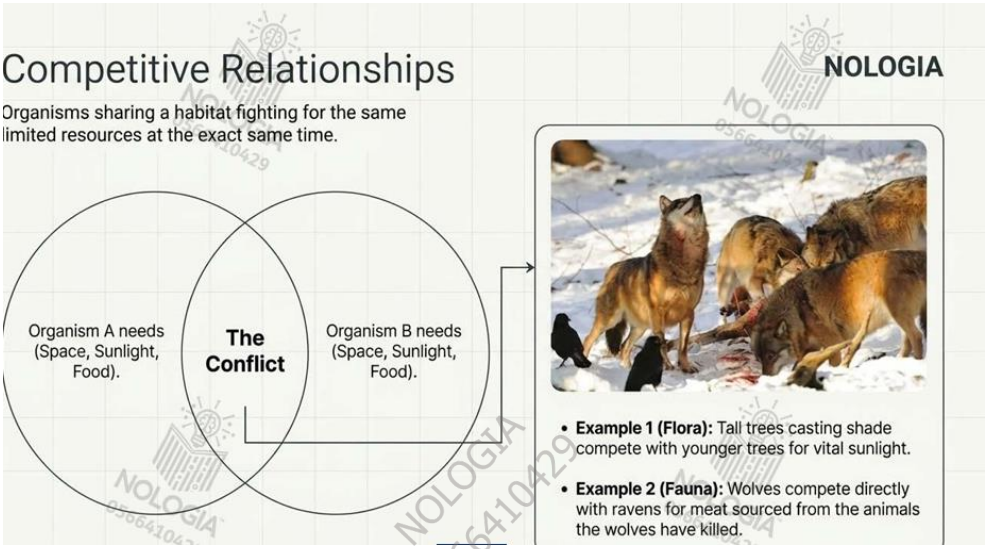
Multiple Choice Questions - MCQ

**Cooperative Relationships** The leaf-cutter ants in the *Assorted Associations* investigation work together in cooperative relationships for their survival. Together they carry leaves to their nest to be used to grow fungus for food and building. Cooperative relationships can be found in many different populations across the world. For example, elephants cooperate with each other to raise young and watch for predators. Squirrel monkeys benefit in a similar way by living in groups. They cooperate as they hunt for food and watch for danger.



**Predator-Prey Relationships** The osprey catching a fish is an example of a predator-prey relationship. A predator-prey relationship is one in which one organism, the predator, eats another, the prey. Predators help prevent prey populations from growing too large for the carrying capacity of the ecosystem. Predators often capture weak or injured individuals of a prey population. When the weak members of a population are removed, there are more resources available for the remaining members. This helps keep the prey population healthy.

**Competitive Relationships** Organisms that share the same habitat often compete for resources. This is known as a competitive relationship. Competition describes interactions between two or more organisms that need the same resource at the same time. For example, trees compete for sunlight, and the shade from tall trees can slow the growth of younger trees. Wolves compete with ravens for meat from the animals that wolves kill, as shown in the photo above.



## Questions :

**Question 1:** In a predator-prey relationship (such as an osprey and a fish), how does the predator benefit and how does predation affect the prey population?

| | |
|---|---|
| (A) Predator eats prey for energy; predation keeps prey within carrying capacity and removes weak/injured individuals | (B) Prey eats the predator, causing the predator population to exceed carrying capacity |
| (C) Predators capture only the strongest prey and leave fewer resources for remaining prey | (D) Neither the predator nor the prey is affected |



**Question 2:** How are cooperative, predator-prey, and competitive relationships explained?

| | |
|---|---|
| (A) Wolves and ravens fighting is cooperation; ants working together is competition | (B) Cooperative: working together for survival (ants, elephants); Predator-prey: predator eats prey (osprey/fish); Competitive: needing the same resource at the same time (wolves/ravens; trees for light) |
| (C) Tall trees shading younger trees is a mutualistic relationship | (D) Predators cause prey populations to grow beyond carrying capacity |

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Question 3: Leaf-cutter ants carrying leaves together to their nest to grow fungus, and elephants working together to raise young and watch for predators, are examples of:

| | |
|---|---|
| (A) Cooperative relationships | (B) Predator-prey relationships |
| (C) Competitive relationships | (D) Parasitic relationships |

Question 4: Squirrel monkeys living in groups to hunt for food and watch for danger is an example of which type of relationship?

| | |
|---|---|
| (A) Cooperative relationship | (B) Predator-prey relationship |
| (C) Competitive relationship | (D) Parasitic relationship |

Question 5: In the relationship where an osprey catches and eats a fish, which organism is the predator and which is the prey?

| | |
|---|---|
| (A) The fish is the predator, and the osprey is the prey. | (B) Both the osprey and the fish are predators. |
| (C) The osprey is the predator, and the fish is the prey. | (D) The osprey is the host, and the fish is the parasite. |

Question 6: How do predators help maintain a healthy prey population in an ecosystem?

| | |
|---|---|
| (A) They cause the prey population to exceed carrying capacity | (B) They keep prey within carrying capacity and capture weak/injured individuals, leaving more resources for healthy prey |
| (C) They provide shelter and sunlight for the prey population | (D) They hunt only the strongest individuals and leave weak ones |



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Question 7: When does competition occur among organisms that share the same habitat?

| | |
|---|---|
| (A) When resources are unlimited and no organisms need the same food | (B) When members of a population work together to raise young |
| (C) When epiphytes grow harmlessly on the trunks of tall trees | (D) When two or more organisms need the same resource at the same time |

Question 8: Why does the shade from tall trees slow the growth of younger trees in a forest?

| | |
|---|---|
| (A) Because tall trees and young trees have a mutualistic relationship | (B) Because tall trees are parasites that feed on the roots of younger trees |
| (C) Because the trees are in a competitive relationship competing for the same resource–sunlight | (D) Because tall trees cooperate with younger trees to protect them from sunlight |

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# Q15 : Module 2: Dynamic Ecosystems

## Lesson 3: Changing Ecosystems

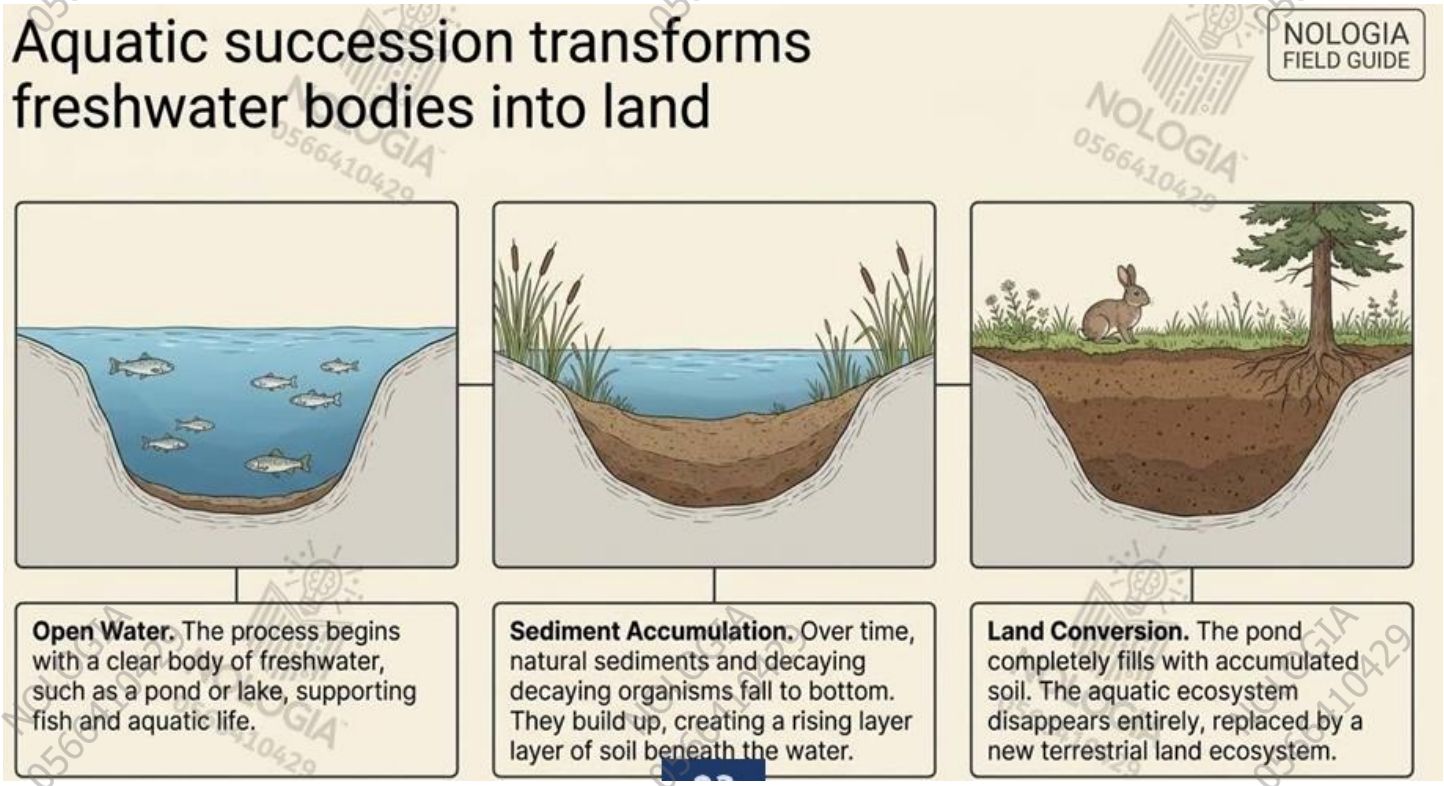
Predict how freshwater ecosystems change with aquatic succession.

( Page 112 )

Multiple Choice Questions - MCQ

ike land ecosystems, freshwater ecosystems change over time in a natural nd predictable process. This process is called aquatic succession. Observe ow freshwater ecosystems change over time.



## Questions :




**Question 1:** How does the buildup of soil during aquatic succession affect a pond or lake ecosystem over time?

| | |
|---|---|
| (A) The pond becomes deeper and turns into an open ocean | (B) Sediments and decaying organisms fill the pond with soil to form a land ecosystem (aquatic populations decrease; land species increase) |
| (C) All soil at the bottom dissolves, leaving bare volcanic rock | (D) The water freezes permanently into a glacier |

**Question 2:** What is the natural and predictable process by which freshwater ecosystems change over time called?

| | |
|---|---|
| (A) Primary volcanic succession | (B) Eutrophication runoff |
| (C) Aquatic succession | (D) Transpiration |

**Question 3:** What does aquatic succession begin with in Stage 1?

| | |
|---|---|
| (A) A body of water such as a pond | (B) A dry desert with sand dunes |
| (C) A mature forest of tall trees | (D) Molten lava flowing over bare rock |

Question 4: In Stage 2 of aquatic succession, what builds up over time to create soil that fills the bottom of the pond or lake?

| | |
|---|---|
| (A) Volcanic ash and molten lava | (B) Sediments and decaying organisms |
| (C) Icebergs and salt water | (D) Plastic quadrats and mist nets |

Question 5: What happens in the final stage (Stage 3) of aquatic succession?

| | |
|---|---|
| (A) The pond becomes twice as deep and fish populations double. | (B) The lake turns into a saltwater ocean. |
| (C) All plants around the pond die out, leaving bare rock. | (D) Eventually the pond or lake fills completely with soil and a land ecosystem develops. |

Question 6: Which sequence correctly shows the order of events during aquatic succession?

| | |
|---|---|
| (A) Pond → Sediments and decaying organisms build up soil on the bottom → Pond fills with soil and a land ecosystem develops | (B) Land ecosystem → Soil erodes → Deep lake forms |
| (C) Molten lava cools into bare rock → Lichens grow → Pond forms | (D) Pond fills with salt water → Coral reef forms → Desert develops |

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Q16 : Module 2: Dynamic Ecosystems

Lesson 3: Changing Ecosystems

Describe the process of ecological succession.

( Page 108 )

Multiple Choice Questions - MCQ

# How do land ecosystems change?

An ecosystem can change over time. Change usually happens so gradually that you might not notice the differences from day to day. Examine the pond community below to observe what changes occur.

## Change in Communities

Examine the two images below. One is labeled *A* and the other is labeled *B*. Imagine community *A* changes and becomes like community *B*.

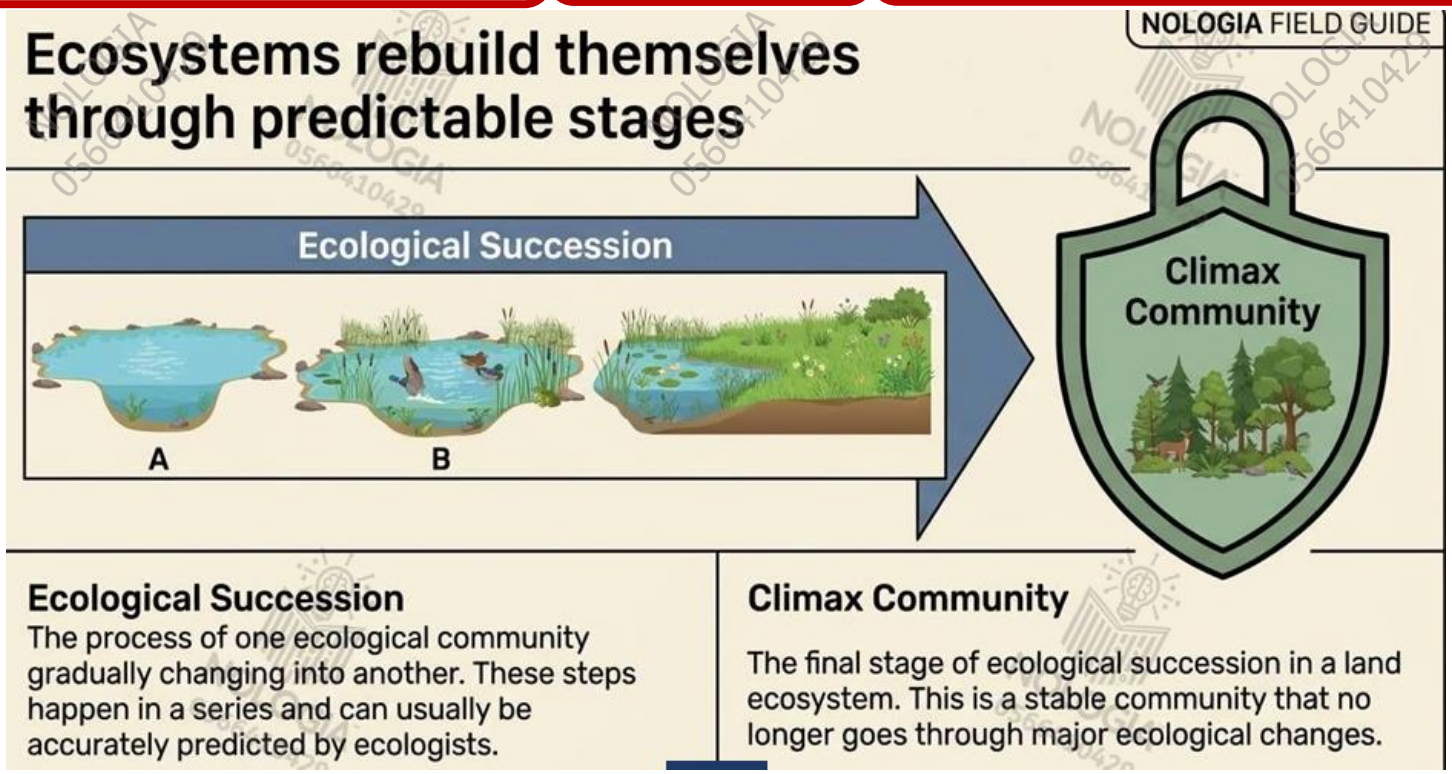


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## Questions :



**Question 1:** How long would it take Community A to become like Community B, and why?

| | |
|---|---|
| (A) Overnight in a single day because ecosystem changes are sudden | (B) Several years (a long time) because ecological succession happens very gradually over time |
| (C) Never, because pond communities cannot change over time | (D) Only a few minutes after a single rainstorm |

Question 2: Summarize the changes that happen as the community changes from A to B.

| | |
|---|---|
| (A) Large trees grow first in the water, and small plants grow last | (B) Small plants, grasses, and reeds grow first, followed by larger plants, providing food and habitats for ducks and frogs |
| (C) All plants and animals disappear, leaving only bare rock | (D) Ducks and frogs arrive first before any plants grow |

Question 3: Why might you not notice changes in an ecosystem from day to day?

| | |
|---|---|
| (A) Because change in an ecosystem usually happens very gradually over time | (B) Because ecosystems never change at any time |
| (C) Because all changes happen only at night | (D) Because large trees grow to full height in a single day |

Question 4: In the Investigation "Change in Communities," the gradual change from pond community A to pond community B is an example of:

| | |
|---|---|
| (A) Extinction | (B) Ecological succession |
| (C) Overexploitation | (D) Cellular respiration |

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**Question 5:** In the "Change in Communities", how does Image A differ from Image B?

| | |
|---|---|
| (A) Image A shows a pond with few plants and animals; Image B shows many reeds, grasses, ducks, and frogs | (B) Image A shows a desert; Image B shows a frozen tundra |
| (C) Image A has many ducks and frogs; Image B has no plants or animals | (D) Both images are completely identical with no changes |

**Question 6:** How long does it take for an ecological community like Community A to change into Community B?

| | |
|---|---|
| (A) A few seconds | (B) One single afternoon |
| (C) Several years (a long time), because ecosystem changes happen gradually | (D) Ecosystems can never change over time |

**Question 7:** Why did more animals such as ducks and frogs appear in Community B?

| | |
|---|---|
| (A) Because all the plants around the pond died out | (B) Because the water in the pond disappeared completely |
| (C) Because volcanic lava flowed into the pond | (D) Because the growth of small and larger plants around the pond provided new food and habitats |

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# Q17 : Module 2: Dynamic Ecosystems

## Lesson 3: Changing Ecosystems

Analyze evidence from ecological succession to identify a climax community.

( Page 109 )

Multiple Choice Questions - MCQ

**Ecological Succession** The change in the pond you just observed is an example of ecological succession. **Ecological succession** is the process of one ecological community gradually changing into another. Ecological succession occurs in a series of steps. These steps can usually be predicted. For example, small plants usually grow first. Larger plants, such as trees, usually grow last. The final stage of ecological succession in a land ecosystem is a **climax community**—a stable community that no longer goes through major ecological changes.

FOLDABLES
Go to the Foldables® library to make a Foldable® that will help you take notes while reading this lesson.

**Primary Succession** Ecological succession in new areas of land with little or no soil or vegetation, such as on a lava flow, a sand dune, or exposed rock, is primary succession. Take a look at how an ecosystem changes after a volcanic eruption.




During a volcanic eruption, molten lava flows over the ground and into the water. After the eruption is over, the lava cools and hardens into bare rock.




Lichen spores carried on the wind settle on the rock. They break down the rock which builds up soil. Lichens add nutrients to the soil as they die and decay.




Airborne spores from mosses and ferns settle onto the thin soil and add to the soil when they die. The soil gradually becomes thick enough to hold water. Insects and other small organisms move into the area.

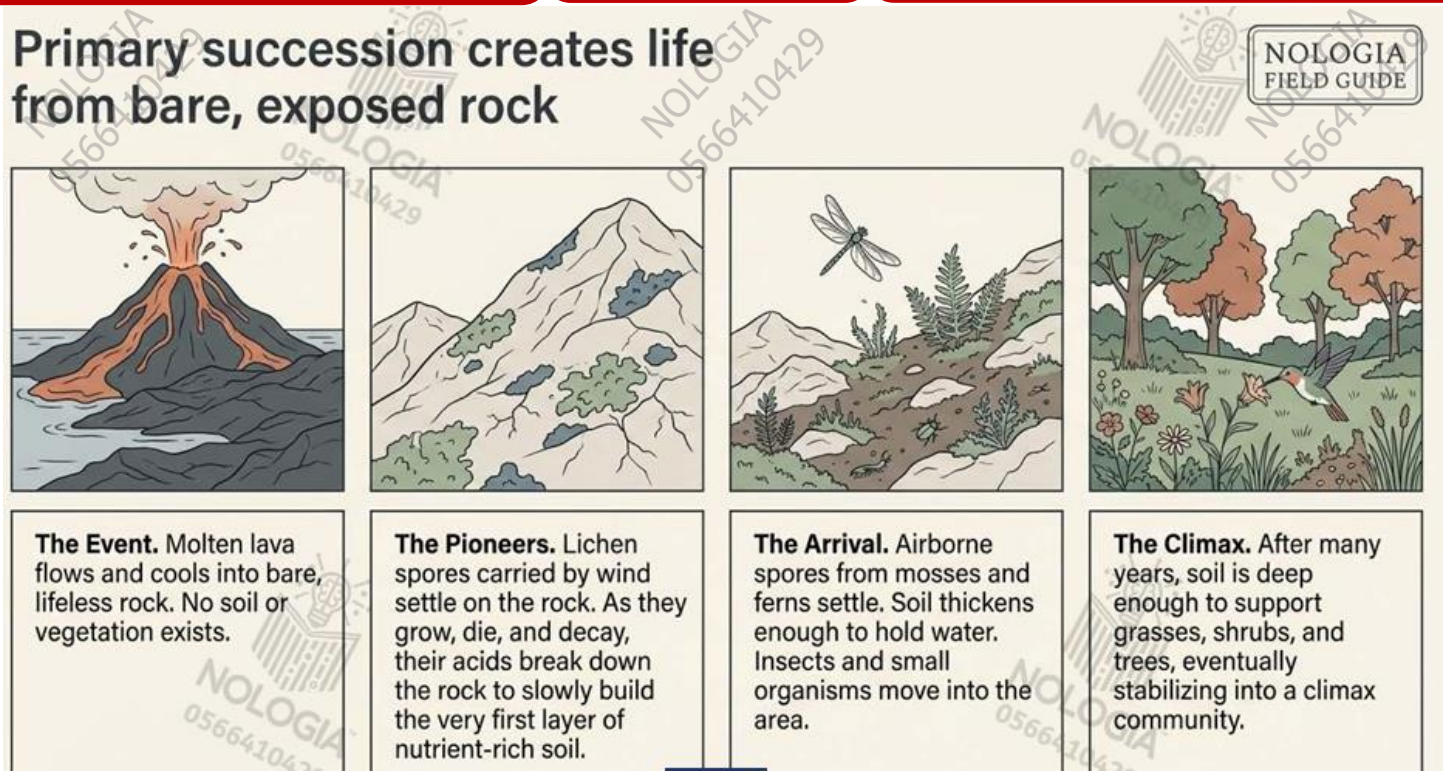



After many years the soil is deep and has enough nutrients for grasses, wildflowers, shrubs, and trees. The new ecosystem provides habitats for many animals. Eventually, a climax community develops.



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## Questions :

**Question 1:** How does evidence from the stages of primary succession identify when a climax community has developed?

| | |
|---|---|
| (A) Stage 1: Bare rock formed right after molten lava cools and hardens | (B) Stage 2: Wind-blown lichen spores breaking down bare rock into thin soil |
| (C) Stage 4: A final, stable community with deep, nutrient-rich soil supporting grasses, shrubs, trees, and animals | (D) Stage 3: Thin soil supporting only mosses, ferns, and small insects |

**Question 2:** What is a climax community?

| | |
|---|---|
| (A) The final, stable stage of succession that no longer goes through major ecological changes | (B) The first stage of succession where molten lava cools into bare rock |
| (C) A temporary community of only lichens and bare rock | (D) An aquatic pond that has just begun to collect sediment |

Question 3: What is primary succession, and where does it occur?

| | |
|---|---|
| (A) Succession in an abandoned farm field with deep, nutrient-rich soil | (B) Succession in new areas with little or no soil or vegetation (lava flow, sand dune, exposed rock) |
| (C) The process of a pond filling with fertilizer runoff | (D) The seasonal loss of leaves by deciduous trees in the fall |

Question 4: In Step 2 of primary succession after a volcanic eruption, how do lichens help start soil formation?

| | |
|---|---|
| (A) Lichens melt the bare rock back into molten lava | (B) Lichens require deep soil and tall trees before they can grow |
| (C) Lichens break down bare rock to build soil and add nutrients when they die and decay | (D) Lichens remove all water and nutrients from the rock |

Question 5: What happens in Step 3 of primary succession when airborne spores from mosses and ferns settle onto the thin soil?

| | |
|---|---|
| (A) The soil disappears and turns back into bare rock | (B) Large beech and maple trees immediately reach full height |
| (C) All insects and small organisms leave the area | (D) They thicken the soil so it holds water, and insects and small organisms move in |

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**Question 6:** What conditions exist in Step 4 of primary succession that allow a climax community to develop?

| | |
|---|---|
| (A) Deep, nutrient-rich soil supports grasses, wildflowers, shrubs, trees, and animals | (B) The ground is covered in hot molten lava with no soil or plants |
| (C) Only wind-blown lichen spores can survive on the exposed rock | (D) The soil is too thin to hold water or support rooted plants |

**Question 7:** Where would primary succession most likely occur?

| | |
|---|---|
| (A) In a New England farm field that was abandoned after growing crops | (B) On bare rock formed from cooled lava after a volcanic eruption |
| (C) In a mature forest of beech and maple trees after a mild rain | (D) In a grassy meadow with deep, nutrient-rich soil |

**Question 8:** Besides a lava flow, which two other examples of areas where primary succession occurs are listed?

| | |
|---|---|
| (A) A sand dune and exposed rock | (B) A plowed farm field and a city park |
| (C) A coral reef and a deep ocean trench | (D) A mature oak forest and a freshwater pond |

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# Q18 : Module 2: Dynamic Ecosystems

## Lesson 3: Changing Ecosystems

Analyze evidence of eutrophication in an aquatic ecosystem.

( Page 115 )

Multiple Choice Questions - MCQ

### Read a Scientific Text

**Eutrophication** Like sediment, decaying organisms fall to the bottom of a pond, a lake, or a wetland, adding nutrients to the water. Runoff from fertilizers used in farming adds even more nutrients to water systems. **Eutrophication** is the process of a body of water becoming nutrient rich. Read about how nutrient pollution and eutrophication can affect an ecosystem.



**CLOSE READING**

**Inspect**

**Read** the passage *Too Much of a Good Thing: Human Activities Overload Ecosystems with Nitrogen.*

**Find Evidence**

**Reread** the passage. Underline words and phrases in which the author discusses nitrogen.

**Make Connections**

**Collaborate** With your partner, evaluate the claim that agricultural activities are responsible for eutrophication.

PRIMARY SOURCE

**Too Much of a Good Thing: Human Activities Overload Ecosystems with Nitrogen**

Humans are overloading ecosystems with nitrogen through the burning of fossil fuels and an increase in nitrogen-producing industrial and agricultural activities, according to a new study. While nitrogen is an element that is essential to life, it is an environmental scourge at high levels.

According to the study, excess nitrogen that is contributed by human activities pollutes fresh waters and coastal zones, and may contribute to climate change. Nevertheless, such ecological damage could be reduced by the adoption of time-honored sustainable practices.

[...]Much of nitrogen fertilizer that is used worldwide is applied inefficiently. As a result, about 60 percent of the nitrogen contained in applied fertilizer is never incorporated into plants and so is free to wash out of root zones, and then pollute rivers, lakes, aquifers and coastal areas through eutrophication.

"While the processes of eutrophication have been recognized for many years, only recently have scientists been able to begin placing the anthropogenic processes in the context of an understanding of the broader biogeochemical cycles of the planet," says Robert Burnap, an NSF program director. This is an important article because it concisely develops this understanding and also provides reasonable predictions regarding the economic and policy dimensions of the problem."

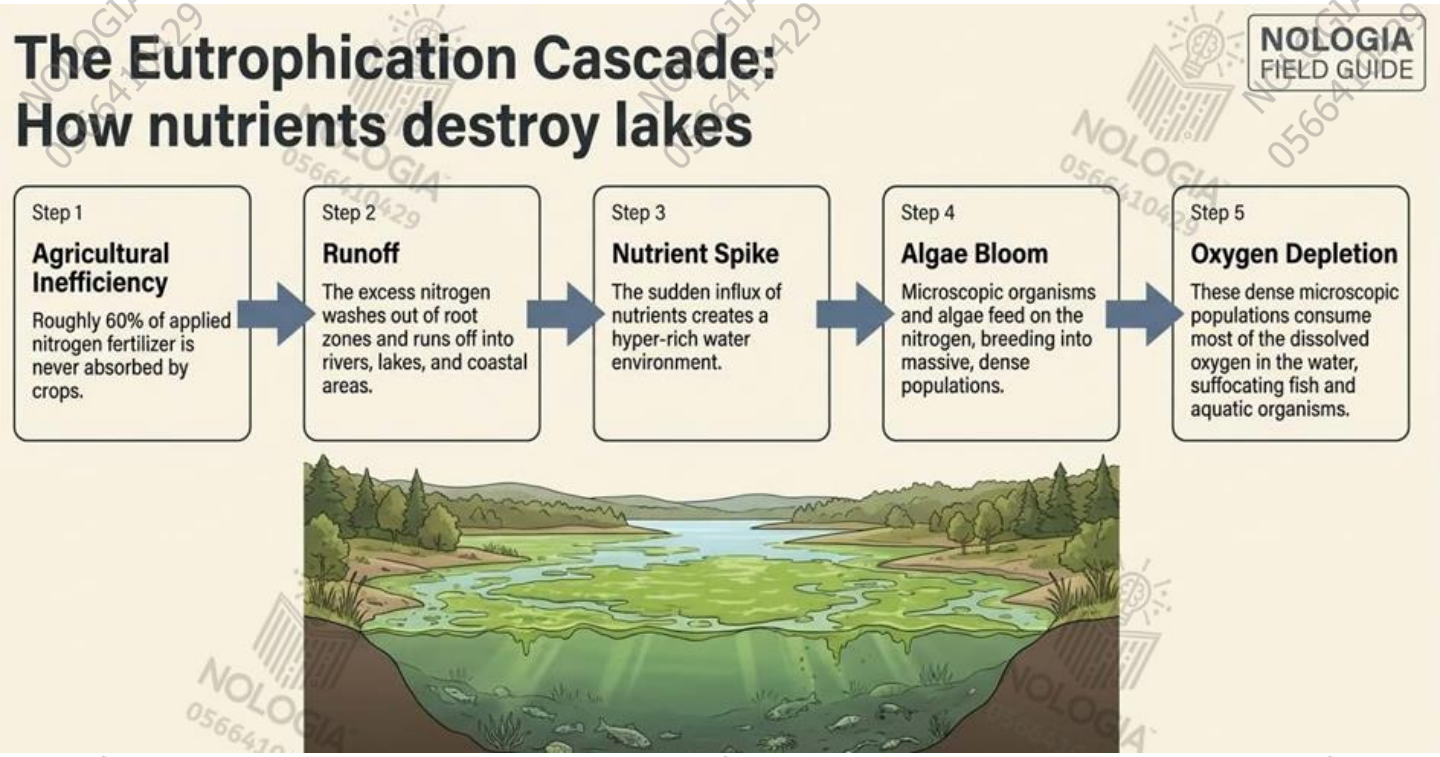
**Source:** National Science Foundation

Eutrophication is a natural part of aquatic succession. However, human activity also contributes to eutrophication. The fertilizers that farmers use on crops and the waste from farm animals can be very high in nutrients. High nutrient levels support large populations of algae and other microscopic organisms. These organisms use most of the dissolved oxygen in water and less oxygen is available for fish and other aquatic organisms.



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## Questions :

Question 1: Why are agricultural activities responsible for eutrophication, and how does it affect fish?

| | |
|---|---|
| (A) High nutrients directly poison fish while increasing dissolved oxygen | (B) Fertilizer runoff (~60% of applied nitrogen) and animal waste cause algal blooms that use up dissolved oxygen needed by fish |
| (C) Fertilizer runoff kills all algae immediately, giving fish extra oxygen | (D) Eutrophication removes all nitrogen and nutrients from the water |

Question 2: How do physical changes to ecosystems, such as forest fires or eutrophication, occur?

| | |
|---|---|
| (A) Through both natural processes (fires, decaying matter) and human activities (fossil fuels, fertilizer/animal waste runoff) | (B) They never occur naturally and are caused only by mist netting |
| (C) Eutrophication is purely man-made and never part of natural aquatic succession | (D) Physical changes only affect nonliving rocks and never affect living populations |

Question 3: What is eutrophication?

| | |
|---|---|
| (A) The process of a body of water becoming nutrient rich | (B) The process of bare rock cooling from molten lava |
| (C) The loss of all nitrogen and nutrients from farm soil | (D) The evaporation of water from a desert ecosystem |

Question 4: Which human activities contribute to overloading water ecosystems with nutrients such as nitrogen?

| | |
|---|---|
| (A) Using mist nets and quadrat sampling in forests | (B) Burning fossil fuels, industry, fertilizer runoff from crops, and farm animal waste |
| (C) Planting native trees to prevent soil erosion | (D) Taking aerial photos of migrating animals |

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Question 5: According to the scientific text "Too Much of a Good Thing," about what percentage of the nitrogen contained in applied fertilizer is never incorporated into plants and washes out of root zones?

| | |
|---|---|
| (A) About 5 percent | (B) About 15 percent |
| (C) About 60 percent | (D) About 100 percent |

Question 6: What happens in a pond or lake when nutrient levels become very high during eutrophication?

| | |
|---|---|
| (A) All algae and microscopic organisms disappear from the water | (B) The water freezes solid at the bottom of the lake |
| (C) Dissolved oxygen levels in the water increase to 100 percent | (D) High nutrient levels support large populations of algae and microscopic organisms |

Question 7: Why do large populations of algae and microscopic organisms harm fish and other aquatic organisms during eutrophication?

| | |
|---|---|
| (A) They use most of the dissolved oxygen in the water, leaving less oxygen for fish | (B) They release too much oxygen into the water for fish to breathe |
| (C) They eat the adult fish directly as top predators | (D) They turn the lake water into salt water |

Q19 : Module 3: Biodiversity in Ecosystems

Lesson 1: Benefits of Biodiversity

Identify methods scientists use to measure biodiversity in an ecosystem.

( Page 142 - 144 )

Multiple Choice Questions - MCQ

# How do scientists measure biodiversity?

How do scientists determine the biodiversity in a given area? The first step is to collect data on the numbers and types of organisms that live there. The method and technology used depends on the types of organisms being counted and the habitat. For example, a scientist may not be able to use the same method or technology to collect data about insects in the rain forest as she would to collect data about the number of fish living around a coral reef.

**Canopy Fogging** Scientists use canopy fogging to collect data about the biodiversity of insects. It is often used in forests. A low dose of insecticide is sprayed up into the top of a tree or trees. The insecticide kills the insects, causing them to fall from the trees. When the insects fall, they are collected in a large screen, a large sheet, or several large funnels. To learn more about biodiversity, scientists study the insects, identify them, and count them.



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**Transect Sampling** Scientists use a transect line to complete transect sampling. A transect line can be a rope, string, or measuring tape that is marked at set intervals, such as every meter or every 2 meters. The transect line is placed in or on the habitat surface and, at every interval, the number of species and individuals are recorded. Transect lines can be used in both terrestrial and aquatic habitats, such as the one in the photo to the right.



**Mist Netting** Fine mesh nets, called mist nets, are used to humanely capture animals in ecosystems. In terrestrial ecosystems, netting is often used to collect data on the biodiversity of bats and birds, as in the photo to the right. A large net is stretched across an area, and when a bat or bird flies into the net, it is removed and examined by scientists. In aquatic ecosystems, fish, shellfish, and other organisms may be captured. After organisms are captured, they are identified, counted, and often tagged and released.



**Aerial Photos** Photos of the ground taken from above, usually from an airplane, are called aerial photos. Aerial photos can be used to count and track species of whales and herds of migrating animals on land, such as moose and caribou. Aerial photos can also be used to assess the biodiversity of trees in temperate forests, but a limitation of the photos is that you can't see the forest floor. The photo to the right is an aerial photo showing walrus cows resting on sea ice.



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**Surveys** An effective way for scientists to learn more about the biodiversity of certain groups of organisms, particularly birds, is by surveying. By analyzing data collected by expert bird watchers, field technicians, and scientists, a big picture of the biodiversity of bird species in an area can be seen. Surveys are usually conducted by people going through a habitat on foot or in a boat and, in the case of birds, using binoculars and a spotting scope to identify and count the number of birds in each species.



**Quadrat Sampling** A quadrat is a known square area that is marked using a pre-made square of plastic or stakes and string. Quadrats can range in size from 1 $m^2$ to 20 $m^2$ and can be used in both aquatic and terrestrial ecosystems. The size of the quadrat used depends on the type of habitat and organisms surveyed. Scientists set down the quadrat and count the number of species and the number of individuals of each species. This is repeated many times throughout the habitat so that the most accurate calculation of biodiversity can be made.



**The Biodiversity Index** After completing surveys, transect samples, or looking at aerial photos, how do scientists use the data they have collected to quantify the biodiversity of an area?

## Calculating Biodiversity

Scientists often use a simple formula called the biodiversity index to calculate the biodiversity of an area.

$$\text{Biodiversity Index} = \frac{\text{Number of species in an area}}{\text{Total number of individuals in the same area}}$$

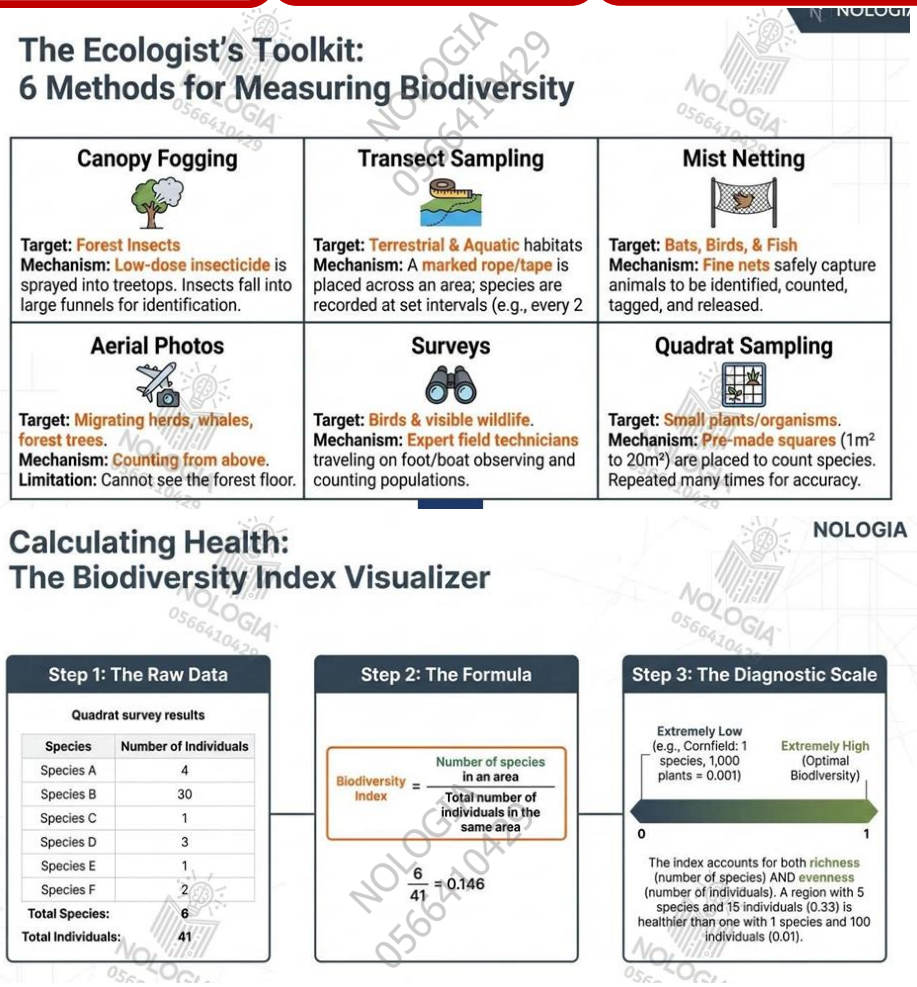
Use the formula and practice calculating the biodiversity index of an ecosystem on the next page.

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## Questions :

**Question 1:** What methods do scientists use to collect data on biodiversity?

| | |
|---|---|
| (A) Canopy fogging (forest insects), transect sampling (marked line), mist netting (bats/birds/fish), aerial photos, surveys, and quadrat sampling (1-20 m² squares) | (B) Canopy fogging uses airplanes to count whales; aerial photos see insects under dense trees |
| (C) Mist nets spray insecticide on birds; quadrat sampling uses binoculars from an airplane | (D) Scientists use the exact same method for every organism and habitat |

Question 2: Using the formula shown, how do scientists calculate the biodiversity index?

| | |
|---|---|
| (A) Total number of individuals × Area in square meters | (B) Number of species in an area ÷ Total number of individuals in the same area |
| (C) Total number of individuals ÷ Number of abiotic factors | (D) Number of quadrats + Number of transect lines |

Question 3: Which method is used in forests by spraying a low dose of insecticide up into the top of a tree so insects fall into screens, sheets, or funnels to be counted?

| | |
|---|---|
| (A) Canopy fogging | (B) Transect sampling |
| (C) Aerial photography | (D) Mist netting |

Question 4: What is a transect line, and how do scientists use it?

| | |
|---|---|
| (A) A fine mesh net stretched between trees to catch flying bats and birds | (B) A rope, string, or tape marked at set intervals (1-2 m) to record species and individuals along a habitat |
| (C) An airplane camera used to photograph migrating caribou from the sky | (D) A chemical spray used to collect insects from the tops of trees |

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**Question 5:** Which organisms can scientists count and track using aerial photos taken from an airplane?

| | |
|---|---|
| (A) Microscopic bacteria and fungi under the soil | (B) Insects hiding beneath the bark on the forest floor |
| (C) Deep-sea worms living on the dark ocean floor | (D) Whales, herds of migrating land animals (moose and caribou), and trees in temperate forests |

**Question 6:** What is a limitation of using aerial photos to assess biodiversity in temperate forests?

| | |
|---|---|
| (A) Aerial photos cannot count large animals like whales or caribou | (B) Airplanes can only fly over aquatic ecosystems |
| (C) You cannot see the forest floor in the photos | (D) Aerial photos require spraying insecticide into the trees |

**Question 7:** How do scientists conduct a biodiversity survey, particularly for birds?

| | |
|---|---|
| (A) Moving through a habitat on foot or boat using binoculars and spotting scopes to count species | (B) Spraying insecticide into the water from a boat |
| (C) Placing 1 $m^2$ plastic squares in the sky | (D) Satellite imaging of the dark ocean floor |

**Question 8:** If a quadrat sample in a meadow has 4 species and a total of 10 individual organisms, what is its biodiversity index?

| | |
|---|---|
| (A) $4 \times 10 = 40$ | (B) $10 \div 4 = 2.5$ |
| (C) $10 - 4 = 6$ | (D) $4 \div 10 = 0.4$ |



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Q20 : Module 3: Biodiversity in Ecosystems

Lesson 1: Benefits of Biodiversity

Use distinct characteristics to identify land biomes.

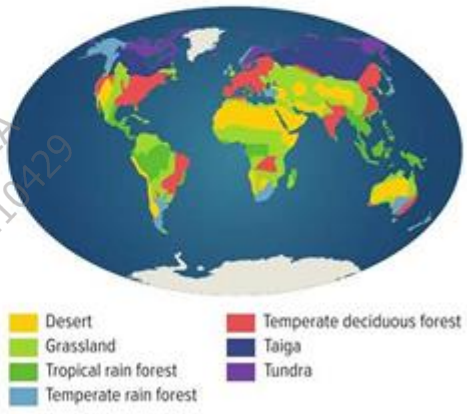
( Page 151 - 154 )

Multiple Choice Questions - MCQ

# How does biodiversity differ between ecosystems?

Different ecosystems contain their own types of plants and animals that live together. Let's explore the different land biomes and aquatic ecosystems on Earth.

**Land Biomes** Earth's continents have many different ecosystems, from deserts to rain forests. Scientists classify similar ecosystems in large geographic areas as biomes. A **biome** is a geographic area on Earth that contains ecosystems with similar biotic and abiotic features. Earth has seven major land biomes, as shown in the image to the right. Areas classified as the same biome have similar climates and organisms. The abiotic factors in each major land biome determine which organisms can live in those ecosystems. Take a look at some of the land biomes on Earth on the next pages.




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**Deserts** A **desert** is a type of biome that receives very little rain.

- Deserts make up roughly one third of Earth's land mass and are Earth's driest ecosystems.
- Precipitation is scarce in a desert, with vegetation having a difficult time growing there.
- Desert dwelling animals, as well as the plants that grow in deserts, have had to adapt to the hot and dry environment in which they live.



**Grasslands** Areas where grasses are the dominant plants are called **grassland** biomes.

- Also called prairies, savannas, and meadows, grasslands are natural carbon sinks.
- Rye grass, buffalo grass, wild oats, and foxtail grow well in these areas.
- Grasslands are rich in invertebrates, as well as birds and mammals.
- Grasses, rushes, and herbs provide lush crops and habitats for the diverse invertebrate community.



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**Tropical Rain Forests** Forests that grow near the equator and experience heavy annual rainfall are called **tropical rain forests**.

- These forests are generally warm and moist.
- With a great number of different plants and animals, tropical rain forests feature a high level of biodiversity.
- Insects make up the largest group of tropical animals. Larger animals include parrots, toucans, snakes, frogs, flying squirrels, fruit bats, monkeys, jaguars, and ocelots.



**Temperate Rain Forests** Tropical rain forest biomes lie near the equator; however, not all rain forests are within the tropics. Regions of Earth between the tropics and the polar circles are **temperate** regions.

- Temperate regions have relatively mild climates with distinct seasons.
- Several biomes are in temperate regions, including rain forests.
- Temperate rain forests are moist ecosystems mostly in coastal areas and are not as warm as tropical rain forests.
- Due to seasonal changes and varied temperatures, temperate rain forests do not feature as much biodiversity as tropical rain forests.



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**Temperate Deciduous Forests** Forests that grow in temperate regions where there is more variation in winter and summer temperatures than in temperate rain forests are called temperate deciduous forests.

- These forests are the most common forest ecosystems in the United States.
- They contain mostly deciduous trees, which lose their leaves in the fall.



**Taiga** A **taiga** (TI guh) is a forest biome consisting mostly of cone-bearing evergreen trees.

- A taiga is also known as a boreal forest and exists only in the northern hemisphere.
- Due to colder temperatures fewer reptiles and amphibians can survive, and there are fewer species of mammals and birds.



**Tundra** A tundra biome is cold, dry, and treeless.

- Most tundra is just south of the North Pole.
- In the tundra, frozen ground makes it difficult for deep-rooted plants to grow.
- The tundra does feature a diverse range of mammalian life; however, reptiles and amphibians are rare.



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## The NOLOGIA Global Land Biome Matrix



| Biome Name | Climate & Abiotic Factors | Key Flora/Fauna | Biodiversity Level |
|---|---|---|---|
| Deserts | Driest ecosystems, scarce precipitation, extreme temperature variations | Adapted drought-resistant plants (succulents, cacti), reptiles, nocturnal animals | Low |
| Grasslands | Prairies/savannas, moderate rainfall, seasonal drought, natural carbon sinks | Rye grass, high invertebrates (insects), large grazing mammals, bison | Medium-High |
| Tropical Rain Forests | Near equator, heavy rain, consistently warm/moist, high humidity | Immense flora/fauna density, dominated dominated by insects, parrots, monkeys, jaguars | Extremely High (Safety Orange text) |
| Temperate Rain Forests | Mild climates, distinct seasons, coastal areas, high precipitation | Tall coniferous trees, smaller mammals, amphibians, deer, bears | High |
| Temperate Deciduous Forests | High summer/winter temperature variation, distinct seasons, sufficient rainfall | Deciduous trees (lose leaves in fall), foxes, squirrels, birds, insects | Medium |
| Taiga (Boreal Forest) | Northern hemisphere, colder temperatures, short growing season, long winters | Cone-bearing evergreens (spruce, fir, pine), fewer reptiles, migratory birds, wolves | Medium-Low |
| Tundra | South of North Pole, cold, dry, permafrost, low precipitation, short summer | Treeless, hardy low-growing plants, mosses, lichens, arctic foxes, caribou, extremely rare reptiles | Low |

## Questions :

**Question 1:** Which statement accurately identifies the key features of Earth's seven major land biomes?

| | |
|---|---|
| (A) Deserts have heavy rainfall near the equator; tropical rain forests are cold, dry, and treeless | (B) Tundra is warm and moist with deciduous trees; grasslands are covered in evergreen trees |
| (C) Deserts (driest); Grasslands (grass-dominated); Tropical rain forests (warm/wet/high biodiversity); Temperate rain forests (coastal/mild); Deciduous (lose leaves in fall); Taiga (evergreens); Tundra (cold/treeless/frozen ground) | (D) Taiga exists only in the southern hemisphere; deciduous trees never lose their leaves |

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Question 2: What is a biome?

| | |
|---|---|
| (A) A geographic area on Earth that contains ecosystems with similar biotic and abiotic features | (B) A single organism living in a small pond |
| (C) A tool used by scientists to count insects in treetops | (D) The process of a body of water becoming nutrient rich |

Question 3: Which land biome makes up roughly one third of Earth's land mass, receives very little rain (scarce precipitation), and is Earth's driest ecosystem?

| | |
|---|---|
| (A) Tropical rain forest | (B) Temperate rain forest |
| (C) Taiga | (D) Desert |

Question 4: Which land biome is also called prairies, savannas, and meadows, acts as an important natural carbon sink, and has grasses (such as rye grass, buffalo grass, wild oats, and foxtail) as its dominant plants?

| | |
|---|---|
| (A) Tundra | (B) Grassland |
| (C) Taiga | (D) Desert |

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Question 5: Which land biome grows near the equator, experiences heavy annual rainfall, is warm and moist, and features a high level of biodiversity where insects make up the largest group of animals?

| | |
|---|---|
| (A) Temperate deciduous forest | (B) Tundra |
| (C) Tropical rain forest | (D) Grassland |

Question 6: How do temperate rain forests differ from tropical rain forests?

| | |
|---|---|
| (A) Temperate rain forests are coastal with mild climates and distinct seasons, and are cooler and less biodiverse | (B) Temperate rain forests grow only on the equator and are much warmer |
| (C) Temperate rain forests are treeless with permanently frozen ground | (D) Temperate rain forests receive almost no rain and are Earth's driest ecosystems |

Question 7: Which forest ecosystems are the most common in the United States, have more variation in winter and summer temperatures, and contain mostly deciduous trees that lose their leaves in the fall?

| | |
|---|---|
| (A) Tropical rain forests | (B) Taiga (boreal forests) |
| (C) Temperate deciduous forests | (D) Grasslands |

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Question 8: Which biome exists only in the northern hemisphere, is also known as a boreal forest, and consists mostly of cone-bearing evergreen trees?

| | |
|---|---|
| (A) Tropical rain forest | (B) Taiga |
| (C) Grassland | (D) Desert |

Question 9: Which land biome is cold, dry, and treeless, is located mostly just south of the North Pole, and has frozen ground that prevents deep-rooted plants from growing?

| | |
|---|---|
| (A) Tropical rain forest | (B) Temperate deciduous forest |
| (C) Grassland | (D) Tundra |

Question 10: What determines which organisms can live in the ecosystems of each major land biome?

| | |
|---|---|
| (A) The abiotic factors in each major land biome | (B) Only the number of mist nets used by scientists |
| (C) Only the size of a single individual organism | (D) Every biome has the exact same abiotic factors |

Question 11: How many major land biomes does Earth have according?

| | |
|---|---|
| (A) Two major land biomes | (B) Four major land biomes |
| (C) Seven major land biomes | (D) Twenty major land biomes |

**Question 12:** Which animals are mentioned on as living in tropical rain forests?

| | |
|---|---|
| (A) Only polar bears, seals, and walruses | (B) Insects (largest group), parrots, toucans, snakes, frogs, flying squirrels, fruit bats, monkeys, jaguars, and ocelots |
| (C) Only desert scorpions and camels | (D) No insects or birds can survive in tropical rain forests |

**Question 13:** Where are temperate regions located on Earth according ?

| | |
|---|---|
| (A) Between the tropics and the polar circles | (B) Directly on the equator only |
| (C) At the very center of the North Pole | (D) Deep on the ocean floor |

**Question 14:** What is a defining characteristic of deciduous trees in a temperate deciduous forest?

| | |
|---|---|
| (A) They bear cones and keep needles all winter | (B) They grow only in frozen ground with no roots |
| (C) They lose their leaves in the fall | (D) They grow only in hot, dry deserts |

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Question 15: Why can fewer reptiles and amphibians survive in the taiga and tundra biomes?

| | |
|---|---|
| (A) Because the taiga and tundra are too hot and humid | (B) Because there is heavy tropical rainfall all year |
| (C) Because deciduous trees block all the air | (D) Due to the colder temperatures in those biomes |

Question 16: Why is it difficult for deep-rooted plants (such as trees) to grow in the tundra?

| | |
|---|---|
| (A) Because the soil is made of hot molten lava | (B) Because the ground is frozen |
| (C) Because there is too much warm tropical rain | (D) Because tall deciduous trees shade the entire tundra |

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# Q21 : Module 1: Matter and Energy in Ecosystems

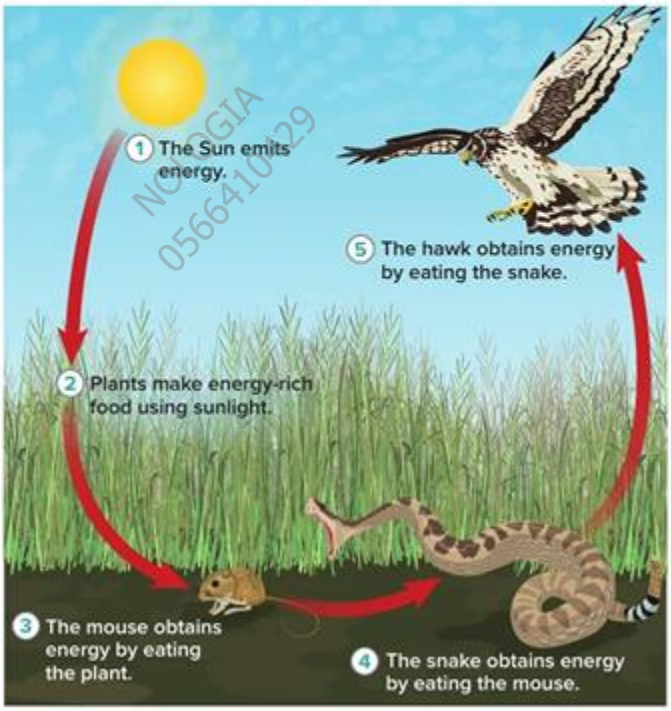
## Lesson 2: Flow of Energy

Analyze food chains, food webs, and energy pyramids to describe how energy flows through the levels of an ecosystem.

( Pages 35 - 38 )

Free Response Questions - FRQ

You just created a food chain. A **food chain,** such as the one shown below, is a simple model that shows how energy moves from the Sun, to a producer, to one or more consumers through feeding relationships. In a food chain, arrows show the transfer of energy. The amount of available energy decreases every time it is transferred from one organism to another. A food chain is helpful when studying certain parts of an ecosystem, but it does not show the whole picture.




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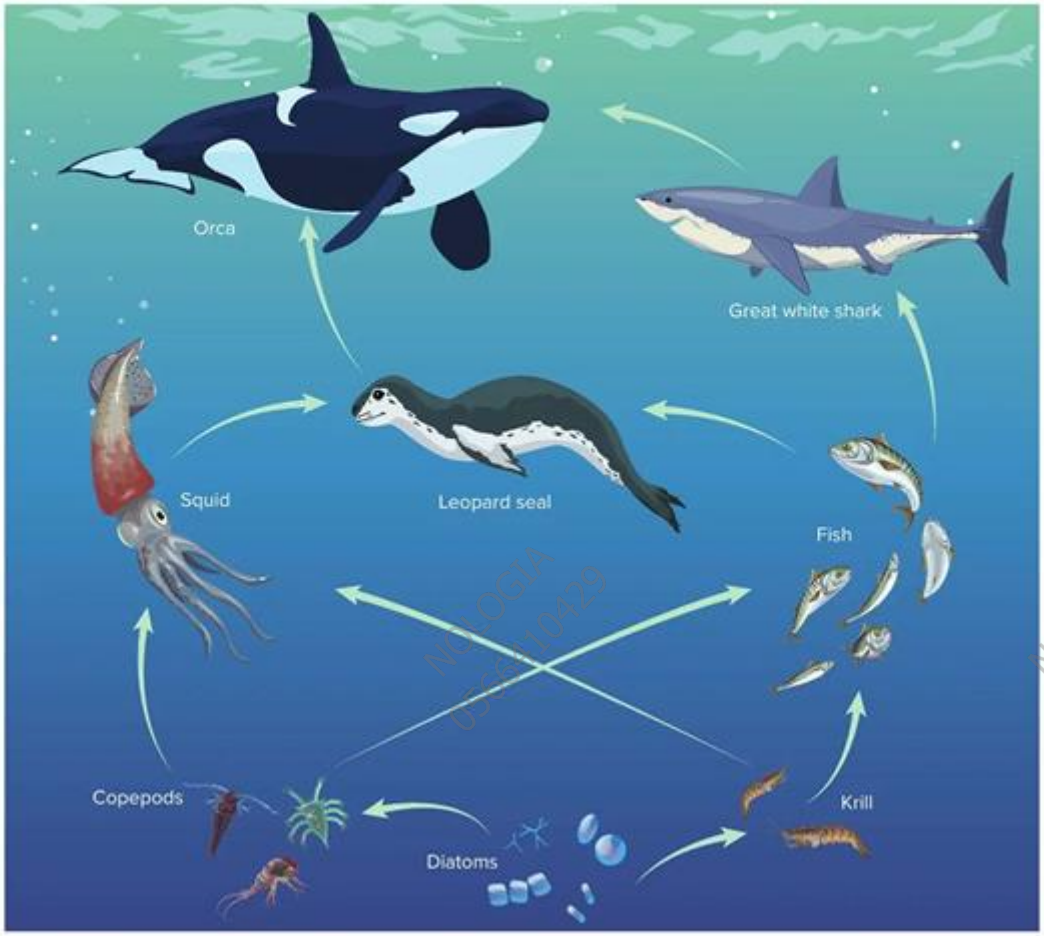


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You just created a food web. Scientists use a model of energy transfer called a **food web**, such as the one shown below, to show how food chains in a community are interconnected. You can think of a food web as many overlapping food chains. Like in a food chain, arrows show how energy flows in a food web. Some organisms in the food web might be part of more than one food chain in that web.



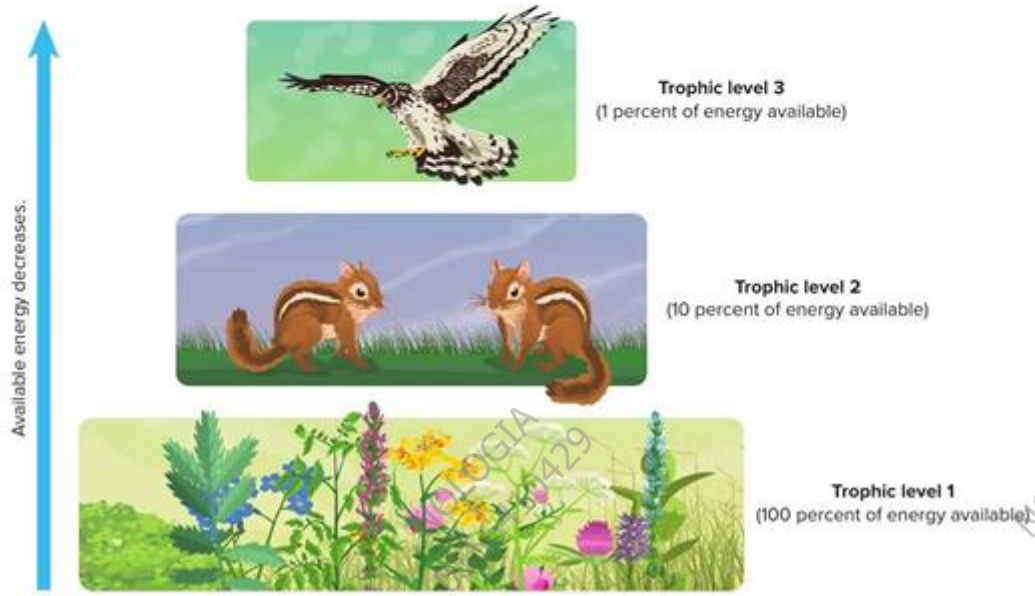

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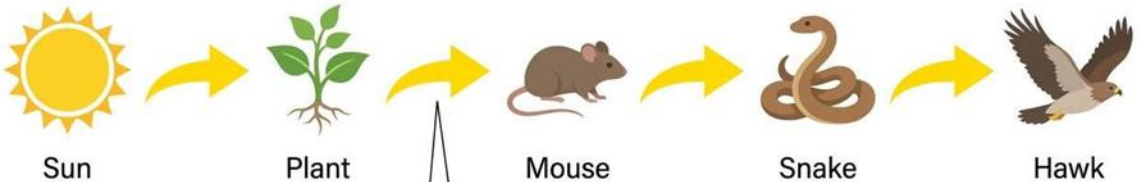
**Energy Pyramid** Food chains and food webs show how energy moves in an ecosystem. However, they do not show how the amount of energy in an ecosystem changes. Scientists use a model called an **energy pyramid,** shown below, to show the amount of energy available in each step of a food chain. The steps of an energy pyramid are also called trophic levels.

Producers make up the trophic level at the bottom of the pyramid. Consumers that eat producers make up the next trophic level. Consumers that eat other consumers make up the highest trophic level. Less energy is available for consumers at each higher trophic level. Only about 10 percent of the energy available at one trophic level transfers on to the next trophic level.




## The Food Chain: A Linear Model of Energy Transfer

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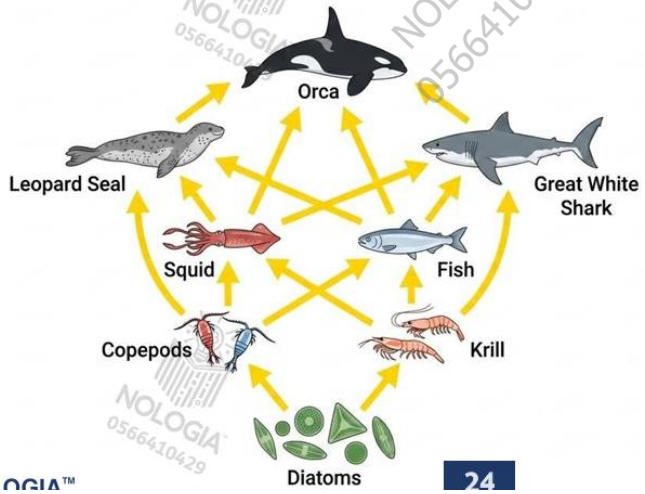

NOLOGIA NOTE: In a food chain, arrows do NOT mean "who eats whom." Arrows show the direction of energy transfer. The energy moves from the plant into the mouse.



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## The Food Web: Interconnected Feeding Relationships




A single food chain **doesn't show the whole picture.**

Scientists use **Food Webs** to model how **energy flows** when organisms are part of **multiple, overlapping food chains.**

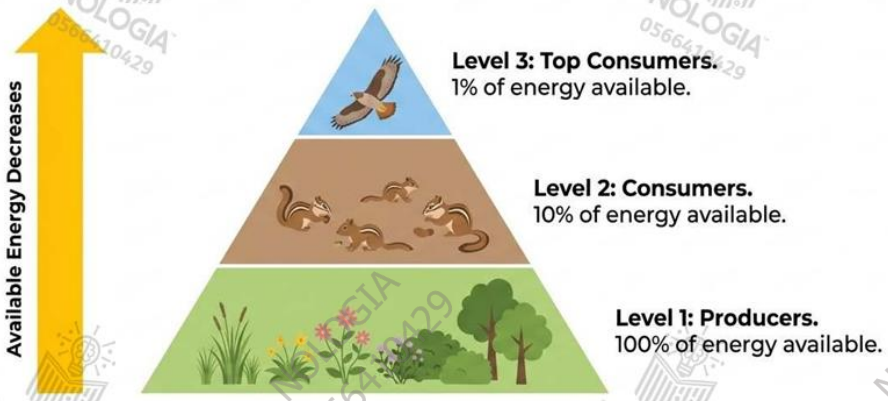
24

## Diagnostic Comparison: Chains vs. Webs

| | Food Chain | Food Web |
|---|---|---|
| Structure | A single, linear path. | A complex, interconnected network. |
| Complexity | Simple model. | Realistic model of an actual community. |
| Organism Roles | An organism occupies only one specific position. | An organism might be part of multiple overlapping chains. |

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## The Energy Pyramid: Trophic Levels and Energy Loss




Only about 10 percent of the energy available at one trophic level transfers to the next. The rest is used for life processes or lost as thermal energy.



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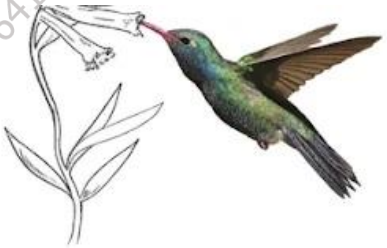
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**Materials**

scissors
glue
yarn
construction paper



**Procedure**

1. Read and complete a lab safety form.
2. On a sheet of paper, make a list of all of the organisms from the previous lab. Note that all of the organisms live in the same community, and there are a variety of producers and consumers.
3. Use scissors to cut out the name of each organism on your list.
4. Glue the names onto a piece of construction paper.
5. Use yarn and glue to connect organisms that have feeding relationships. For example, a piece of yarn would connect a rabbit and grass.
6. Follow your teacher's instructions for proper cleanup.

**Analyze and Conclude**

7. Add the label *Sun* to your model. Which organisms would be connected to the Sun? Why?

The producers, such as plants (e.g., grass, trees, and flowers). Why? Because producers use the Sun's energy to make their own food through photosynthesis. Consumers cannot make food directly from the Sun.

8. Which organisms in your model interact through feeding relationships?

Consumers and producers (e.g., a rabbit eats grass) and consumers with other consumers (e.g., a hawk eats a rabbit, or a fox eats a mouse). These relationships transfer energy throughout the community.



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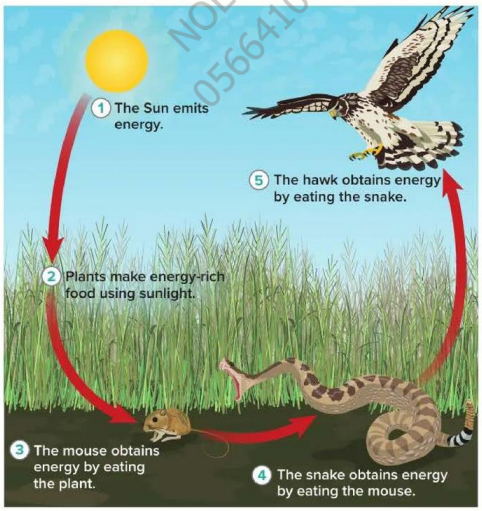
9. Imagine that you removed three organisms from your food web. How would this affect the community?

It would disrupt the food web. Organisms that eat the removed species might starve or have to find other food, while the prey of those removed might overpopulate due to a lack of predators, unbalancing the ecosystem.

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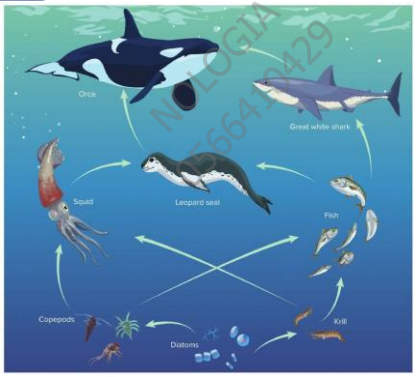
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## Questions :

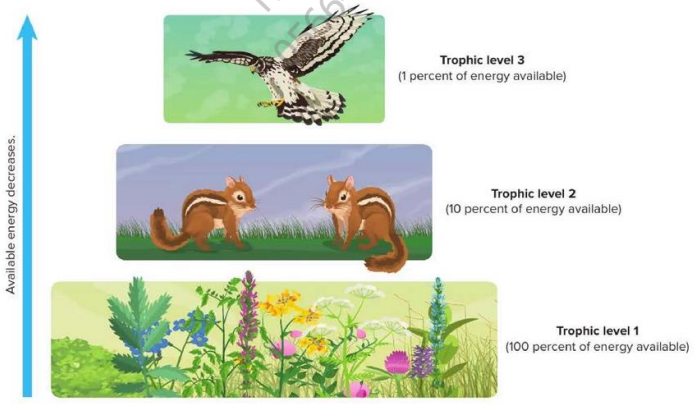



Question 1: Draw a model of a food chain using arrows to model the flow of energy. Label each organism as a producer or consumer, and label each type of consumer.

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Question 2: How does a food web show energy flow in a community, and how would removing three organisms affect the community?




Question 3: How does energy move through an environment across the trophic levels of an energy pyramid?



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Question 4: What is a food chain, and what do the arrows in a food chain show?

Question 5: What happens to the amount of available energy every time it is transferred from one organism to another in a food chain?

Question 6: What is a food web, and how is it related to food chains?

Question 7: which organisms eat krill, and which organisms eat leopard seals?

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Question 8: What is an energy pyramid, and what are its steps called?

Question 9: Describe the organisms and the percentage of available energy at each of the three trophic levels in the energy pyramid.

Question 10: Only about _____ percent of the energy available at one trophic level transfers on to the next trophic level.

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Q22 : Module 2: Dynamic Ecosystems

Lesson 1: Resources in Ecosystems

Explain how resources in an environment affect population and identify the species with large decreases.

( Pages 79 - 80 )

Free Response Questions - FRQ

# How big can populations get?

Without limiting factors, populations would keep growing until they reached their biotic potential. **Biotic potential** is the potential growth of a population if it could grow in perfect conditions with no limiting factors.

Almost no population reaches its biotic potential. Instead, it reaches its carrying capacity. **Carrying capacity** is the largest number of individuals of one species that an ecosystem can support over time. For example, in the *Fishy Population Changes* lab, the pond could only support 16 fish before it reached its carrying capacity. The limiting factors of an area determine the area's carrying capacity, as shown in the graph.




**Overpopulation** Sometimes a population becomes too large for its ecosystem to support. **Overpopulation** is when a population's size grows so large that it causes damage to the environment.

Overpopulation can cause problems for organisms. For example, a population of birds eats spiders. An overpopulation of birds causes the size of the spider population in that community to decrease. Populations of other animals that eat spiders also decrease when the number of spiders decreases.



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**Population Size Decrease** Population size can increase, but it also can decrease. For example, a population of field mice might decrease in size in the winter because there is less food. Natural disasters such as floods, fires, or volcanic eruptions also affect population size. Sometimes, a population's size can decrease to such an extent that it may threaten the entire species. Examine the table to learn about what happens to species that see large decreases in population size.

| | |
|---|---|
| **Extinction** If populations continue to decrease in numbers, they disappear. An extinct species is a species that has died out and no individuals are left. Extinctions can be caused by predation, natural disasters, or damage to the environment. For example, New Zealand was once home to a large, flightless bird called the giant moa. Humans first settled these islands about 700 years ago. They hunted the moa for food. As the size of the human population increased, the size of the moa population decreased. Within 200 years, all the giant moas had been killed and the species became extinct. |  |
|  | **Endangered Species** Mountain gorillas are an example of a species that is endangered. An endangered species is a species whose population is at risk of extinction. There are currently over 16,000 species that are categorized as endangered. Species that are considered critically endangered face an even higher risk of extinction. |
| **Threatened Species** California sea otters almost became extinct in the early 1900s due to overhunting. In 1977, California sea otters were classified as a threatened species—a species at risk, but not yet endangered. Laws were passed to protect the otters and by 2016 there were about 3,200 sea otters. Worldwide, approximately 7,000 species are classified as threatened. |  |

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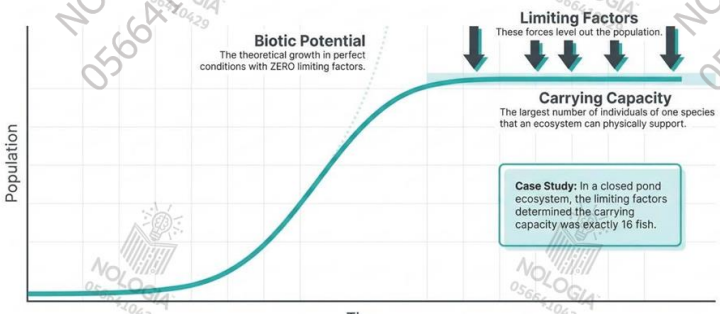
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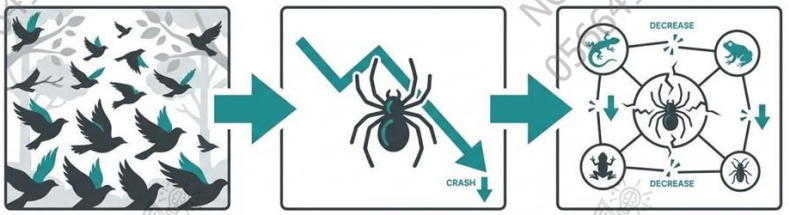
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## The Limits of Growth: Supply vs. Demand




## Breaking the Limits: Overpopulation

**Definition:** Overpopulation occurs when a population's size grows so large that it actively causes damage to the environment.




**Step 1: The Spike**
A population of insect-eating birds grows too large for its ecosystem to sustainably support.

**Step 2: Resource Depletion**
The overpopulated birds eat too many spiders. The spider population completely crashes.

**Step 3: Collateral Damage**
Other animal populations in the community that also rely on eating spiders begin to decrease due to

## Population Decrease: The Downward Spiral

### Pillar 1



**Seasonal Changes**

A population of field mice decreases heavily in winter simply because there is less food available and temperatures drop.

### Pillar 2



**Natural Disasters**

Floods, fires, and volcanic eruptions can instantly alter habitats and drastically reduce population sizes overnight.

### Pillar 3



**Predation & Human Impact**

Overhunting, aggressive habitat destruction, or the introduction of new invasive predators threatening entire species.

## Threat Levels: The Extinction Spectrum

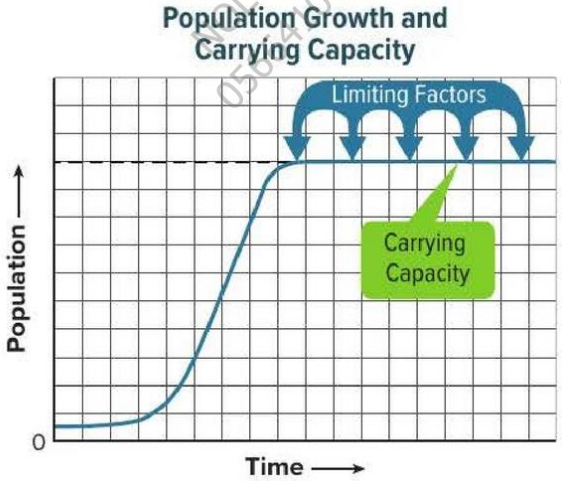
| Status | Definition | Real-World Example | Key Data |
|---|---|---|---|
| Threatened | • A species at risk, but not yet endangered. |  California Sea Otter | • Hunted in early 1900s.<br>• Protected by laws, populations recovered to ~3,200 by 2016. |
| Endangered | • A species whose population is actively at risk of extinction. |  Mountain Gorillas | • Currently over 16,000 different species are globally categorized as endangered. |
| Extinct | • A species that has completely died out; no individuals are left. |  Giant Moa (New Zealand) | • Hunted by early human settlers ~700 years ago. Driven entirely to extinction within 200 years. |



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## Questions :




Question 1: Analyze the graph. Draw/describe a line indicating a population reaching its biotic potential and explain the reasoning.

Question 2: How do limiting factors affect animal populations, and what are the three categories of species with large population decreases?

Question 3: What is overpopulation, and how does an overpopulation of spider-eating birds affect the community?

Question 4: Why might a population of field mice decrease in the winter, and what other events can decrease population size?

Question 5: What is an extinct species, and what caused the extinction of the giant moa in New Zealand?

Question 6: What is an endangered species? Give an example and state how many species are currently categorized as endangered.

Question 7: What is carrying capacity, and what determines it?

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Question 8: What is biotic potential, and why do almost no populations in nature reach it?

Question 9: What are three natural disasters mentioned that can cause a population's size to decrease?

Question 10: Besides natural disasters and less food in winter, what other factors can cause a species to become extinct?

Question 11: Humans settled New Zealand about _____ years ago, and within _____ years all giant moas were killed and the species became extinct.

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# Q23 : Module 2: Dynamic Ecosystems

## Lesson 3: Changing Ecosystems

Analyze models and evidence to explain ecological succession and changes in dynamic equilibrium.

( Pages 109 - 110 , 116 )

Free Response Questions - FRQ

**Ecological Succession** The change in the pond you just observed is an example of ecological succession. **Ecological succession** is the process of one ecological community gradually changing into another. Ecological succession occurs in a series of steps. These steps can usually be predicted. For example, small plants usually grow first. Larger plants, such as trees, usually grow last. The final stage of ecological succession in a land ecosystem is a **climax community**—a stable community that no longer goes through major ecological changes.

FOLDABLES
Go to the Foldables® library to make a Foldable® that will help you take notes while reading this lesson.

**Primary Succession** Ecological succession in new areas of land with little or no soil or vegetation, such as on a lava flow, a sand dune, or exposed rock, is primary succession. Take a look at how an ecosystem changes after a volcanic eruption.




During a volcanic eruption, molten lava flows over the ground and into the water. After the eruption is over, the lava cools and hardens into bare rock.




Lichen spores carried on the wind settle on the rock. They break down the rock which builds up soil. Lichens add nutrients to the soil as they die and decay.




Airborne spores from mosses and ferns settle onto the thin soil and add to the soil when they die. The soil gradually becomes thick enough to hold water. Insects and other small organisms move into the area.




After many years the soil is deep and has enough nutrients for grasses, wildflowers, shrubs, and trees. The new ecosystem provides habitats for many animals. Eventually, a climax community develops.



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## Primary succession creates life from bare, exposed rock

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**The Event.** Molten lava flows and cools into bare, lifeless rock. No soil or vegetation exists.



**The Pioneers.** Lichen spores carried by wind settle on the rock. As they grow, die, and decay, their acids break down the rock to slowly build the very first layer of nutrient-rich soil.

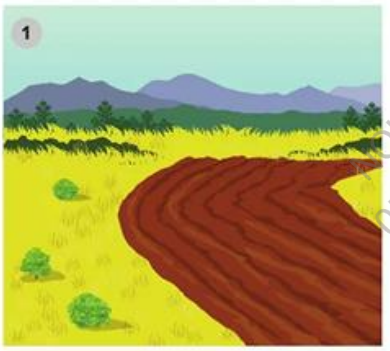


**The Arrival.** Airborne spores from mosses and ferns settle. Soil thickens enough to hold water. Insects and small organisms move into the area.

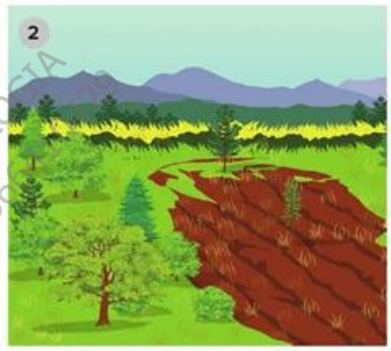


**The Climax.** After many years, soil is deep enough to support grasses, shrubs, and trees, eventually stabilizing into a climax community.

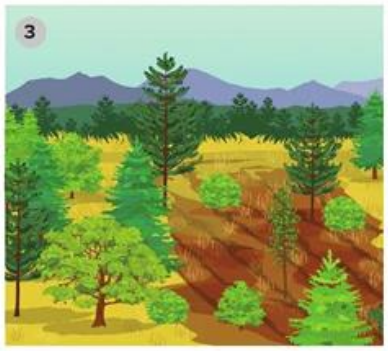
**Secondary Succession** In areas where existing ecosystems have been disturbed or destroyed, secondary succession can occur. One example is forestland in New England that early colonists cleared hundreds of years ago. Some of the cleared land was not planted with crops. This land gradually grew back to a climax forest community of beech and maple trees.




Settlers in New England cleared many acres of forest to create cropland. In places where people stopped planting crops, the forest began to grow back.




Seeds of grasses, wildflowers, and other plants quickly began to sprout and grow. Young shrubs and trees also started growing. These plants provided habitats for insects and other small animals, such as mice.




White pines and poplars were the first trees in the area to grow to their full height. They provided shade and protection to slower growing trees, such as beech and maple.



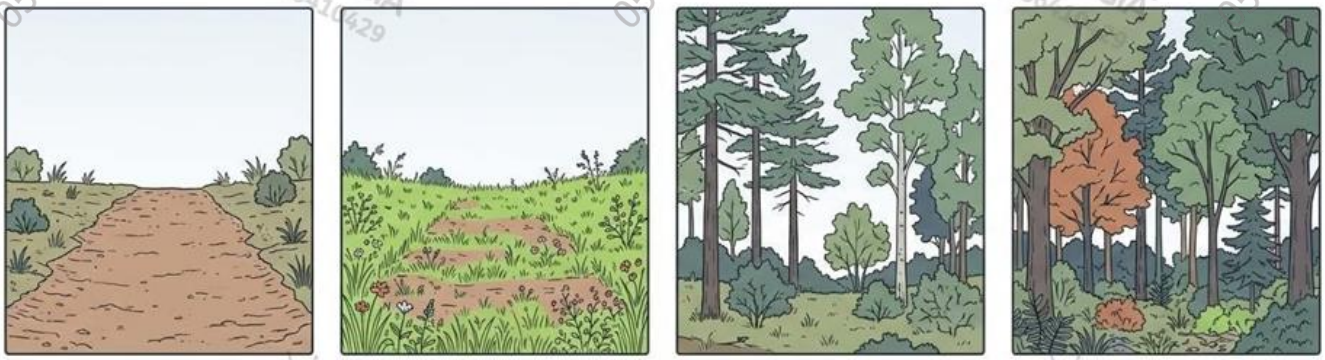

Eventually, a climax community of beech and maple trees developed. As older trees died, new beech and maple seedlings grew and replaced them.

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## Secondary succession restores habitats where soil remains

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**The Disturbance.** Settlers in New England cleared acres of forest for crops. When farming stops, the land is empty but retains its soil.

**Rapid Sprouting.** Seeds of grasses and wildflowers quickly sprout. Young shrubs grow, providing immediate habitat for small animals like mice.

**First Canopy.** Fast-growing trees like white pines and poplars reach full height first, providing necessary shade and protection for slower-growing species.

**The Climax.** Slower-growing beech and maple trees mature, eventually replacing the pines and creating a stable, final climax community.

## Diagnostic Matrix: Comparing succession pathways

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| | Primary Succession | Secondary Succession |
|---|---|---|
| Starting Condition | Bare rock, zero soil, no vegetation | Existing soil, previous ecosystem disturbed |
| Common Triggers | Volcanic eruptions, retreating glaciers, sand dunes | Forest fires, human land clearing, severe storms |
| Pioneer Species | Wind-blown lichen spores | Grasses, weeds, and wildflowers from existing seeds |
| Time to Climax | Very slow - requires soil creation | Much faster - foundation is already built |



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# How do changing ecosystems affect populations?

Populations of organisms depend on resources in their ecosystems for food and shelter. The ecosystem operates under **dynamic equilibrium,** which describes the balance between different parts of the ecosystem. As you have learned, environments change, and the change can last for years. After such a change happens, the balance is lost and individual organisms of a species might not be able to find the resources they need to survive. These changes may disrupt all areas of the ecosystem. Discover how natural disruptions affect ecosystems in the following investigation.

**Effects of Change** Natural disruptions, such as forest fires, floods, volcanic eruptions, and disease, can cause massive amounts of damage to an ecosystem. These sudden changes may make it difficult for organisms to adapt. Some disruptions, like mountain formation, may not happen suddenly but over many years. In some cases, these changes have benefits. Sometimes disturbances control the size of populations or allow new growth of plant life.

## Natural disruptions break equilibrium rapidly

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Events like forest fires, floods, volcanic eruptions, and disease cause sudden massive damage, making it difficult for organisms to adapt.

| The Damage | The Benefit |
| --- | --- |
| Massive habitat loss, forced migration of populations, destruction of food sources. | Disturbance can control overgrown populations and clear canopies to allow sunlight for new plant growth. |

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## Questions :

Question 1: Compare how primary succession and secondary succession gradually form a climax community.

Question 2: Describe what is happening in the image and how it affects the deer population.

Question 3: How do natural changes in ecosystems affect their populations?

Question 4: What is the main difference between where primary succession occurs and where secondary succession occurs?

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Question 5: What is dynamic equilibrium, and what happens when this balance is lost?

Question 6: Give four examples of sudden natural disruptions and one example of a slow disruption.

Question 7: How can natural disturbances sometimes benefit an ecosystem?

Question 8: In Step 2 of primary succession, what role do wind-blown lichen spores play on bare volcanic rock?

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Question 9: In Step 3 of primary succession, how do mosses and ferns change the soil, and what organisms move in?

Question 10: Why did secondary succession occur faster than primary succession in the abandoned New England cropland?

Question 11: In Step 2 of secondary succession , which plants sprouted first and which animals found habitats there?

Question 12: In Step 3 of secondary succession, which trees grew to full height first, and how did they help beech and maple trees?

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# Q24 : Module 3: Biodiversity in Ecosystems

## Lesson 1: Benefits of Biodiversity

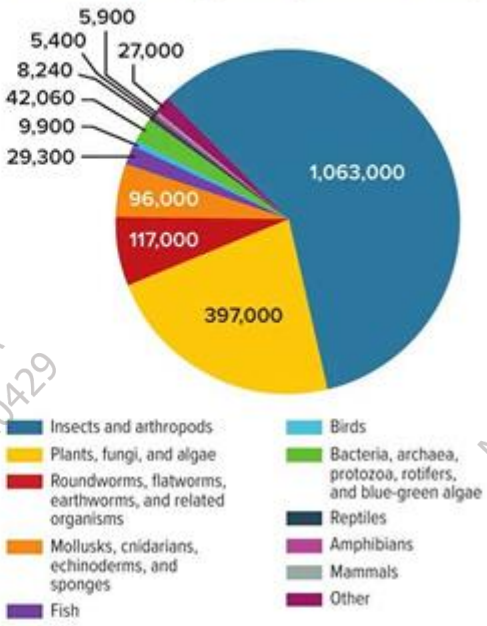
Classify types of biodiversity and identify organisms of the same species.

( Page 141 )

Free Response Questions - FRQ

**Biodiversity** The number and variety of organisms found in a specific region, such as a small pond, a grassy field, a desert, or all of Earth is known as **biodiversity.** The coral reef in the photo on the previous page has high biodiversity because it has many organisms and many different types of organisms. What is the biodiversity of Earth? To date, scientists have identified about 2 million species. A **species** is a group of organisms that have similar traits and are able to produce fertile offspring. A recent estimate of the total number of species on Earth, both known and yet-to-be discovered, is approximately 9 million species. Observe how many of each type of known species exist in the graph to the right.

**Number of Known Species by Taxonomic Group**




**Types of Biodiversity** The variety of genes or inherited traits that are present in a population make up its **genetic diversity.** You can look at your friends and observe all of their different traits, such as eye color, hair texture, and height, to see the genetic variation that exists among humans. The difference in color and patterns on the snails to the right is another example of genetic diversity.

Look at the differences!



Diversity exists within species as well as within an ecological community as a whole. The number of different species and the quantity of each species in an ecological community is called **species diversity.**

Diversity also exists among ecosystems. The variety of ecosystems in the biosphere is called **ecosystem diversity.** Different ecosystems have different abiotic factors that support different types of life.



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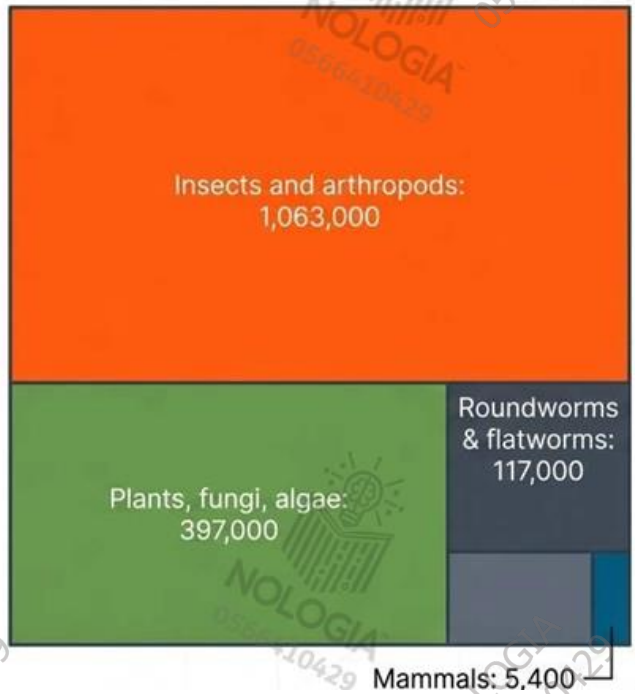
# Defining Biodiversity

The number and variety of organisms found in a specific region, or across all of Earth.

The Global Scale: Scientists estimate approximately **9 million** total species exist. To date, only about **2 million** have been identified.

**Key Term:** A **Species** is a group of organisms with similar traits able to produce fertile offspring.

## Tree-Map




| | | |
|---|---|---|
|  |  |  |
| **Genetic Diversity (Micro)**<br>The variety of genes or inherited traits present within a single population.<br> | **Species Diversity (Meso)**<br>The number of different species, and the quantity of each species, living together within an ecological community. | **Ecosystem Diversity (Macro)**<br>The variety of ecosystems in the biosphere. Different ecosystems possess different abiotic factors (non-living elements) that support completely different types of life. |

## Questions :

Question 1: What type of biodiversity is shown in the High Biodiversity photo (coral reef), and why?

Question 2: Classify the three types of biodiversity and explain how to identify organisms of the same species.

Question 3: What is biodiversity?

Question 4: How do scientists define a species, and how can you identify if two organisms belong to the same species?

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Question 5: To date, scientists have identified about _____ species, and a recent estimate of the total number of species on Earth is approximately _____ species.

Question 6: What is genetic diversity? Give two examples from the text.

Question 8: According to the pie chart "Number of Known Species by Taxonomic Group", which taxonomic group has the largest number of known species, and how many known species does it have?

Question 9: Give four examples of regions mentioned where biodiversity can be measured.

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Question 10: Why do the snails shown represent genetic diversity rather than species diversity?

Question 11: List three examples of inherited traits in humans that illustrate genetic diversity.

Question 12: What two measurements are included in species diversity within an ecological community?

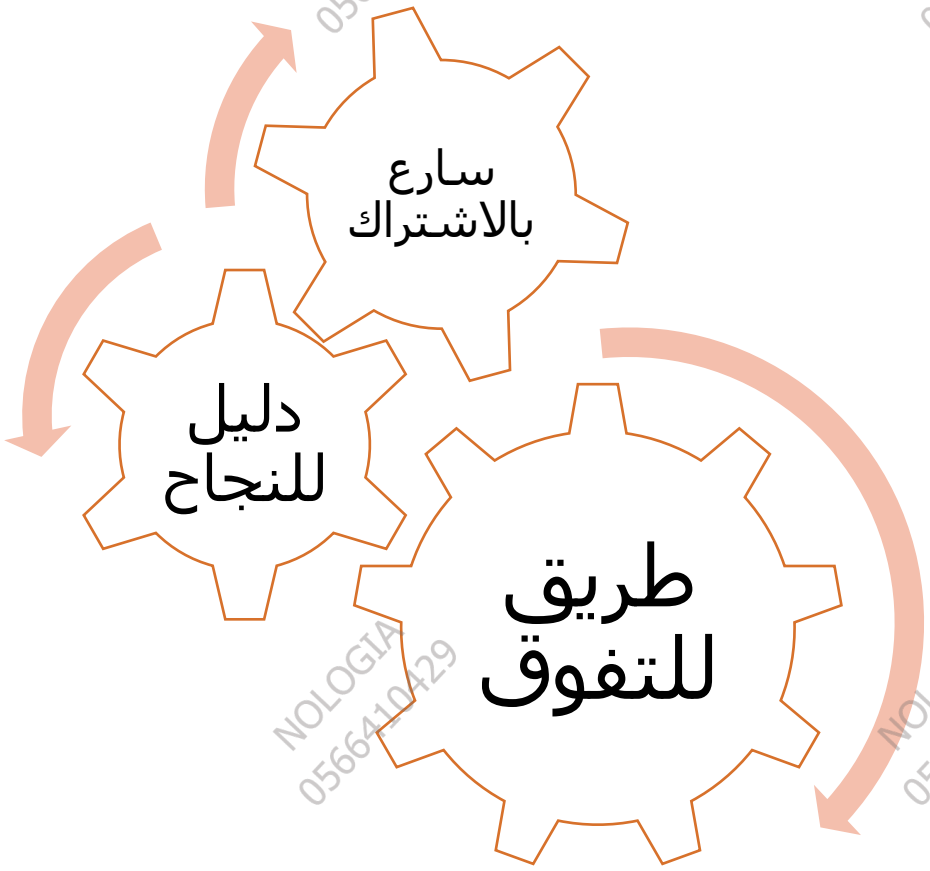
Question 13: The variety of genes in a population is _____ diversity, the number of species in a community is _____ diversity, and the variety of ecosystems in the biosphere is _____ diversity.

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