



EARTH'S SPHERES



The Earth is made up of four main physical spheres that interact with each other and support life.

GEOSPHERE

(Land Sphere)



It includes the solid part of the Earth such as rocks, mountains, soil and minerals.



ATMOSPHERE

(Air Sphere)



It is the envelope of gases (mainly nitrogen and oxygen) surrounding the Earth.



HYDROSPHERE

(Water Sphere)



It includes all the water on Earth in liquid, solid and gaseous forms such as oceans, rivers, lakes, groundwater, ice and water vapour.



CRYOSPHERE

(Ice Sphere)



It includes all frozen water on Earth such as glaciers, ice caps, sea ice, snow and permafrost.



BIOSPHERE

(Life Sphere)



It includes all living organisms (plants, animals and microorganisms) and the regions of Earth where life exists.



KEY POINT



These spheres are interconnected and interdependent.
A change in one sphere affects the others.

Geosphere + **Hydrosphere** + **Cryosphere** + **Atmosphere** + **Biosphere**
= A balanced Earth system

SOLAR RADIATION & UNEVEN HEATING

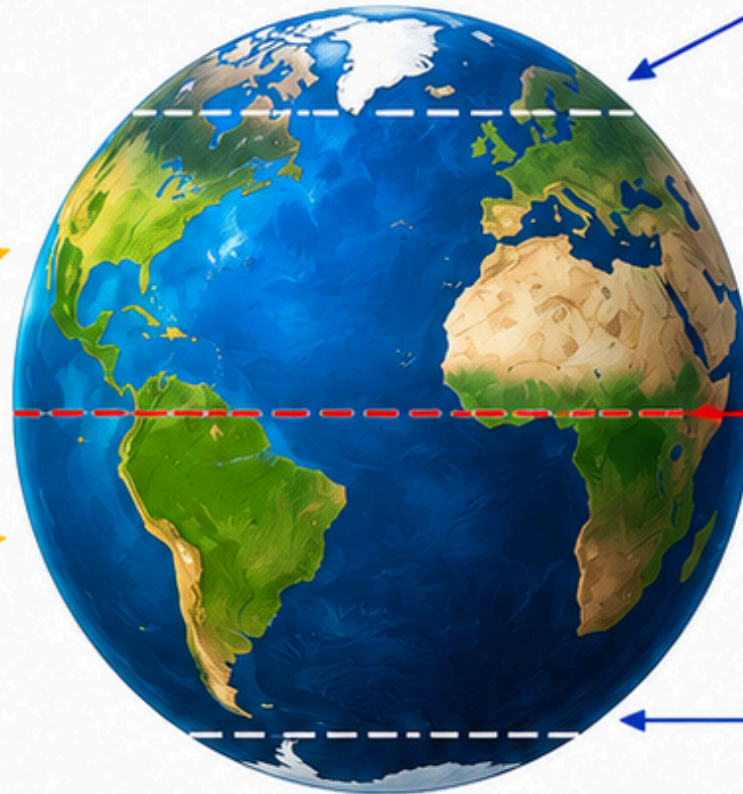
The Sun is the primary source of energy for the Earth. However, solar energy is received in different amounts at different places, leading to uneven heating of the Earth's surface.

1. SOLAR RADIATION

The Sun emits energy in the form of electromagnetic waves. When these waves reach the Earth, they are called **solar radiation**.



Solar Radiation



Low Angle (Poles)

Sun's rays fall at a low angle. Energy is spread over a larger area and passes through more atmosphere.
→ **Less heating**

High Angle (Equator)

Sun's rays fall almost perpendicular. Energy is concentrated on a smaller area and passes through less atmosphere.
→ **More heating**

Low Angle (Poles)

Sun's rays fall at a low angle. Energy is spread over a larger area and passes through more atmosphere.
→ **Less heating**

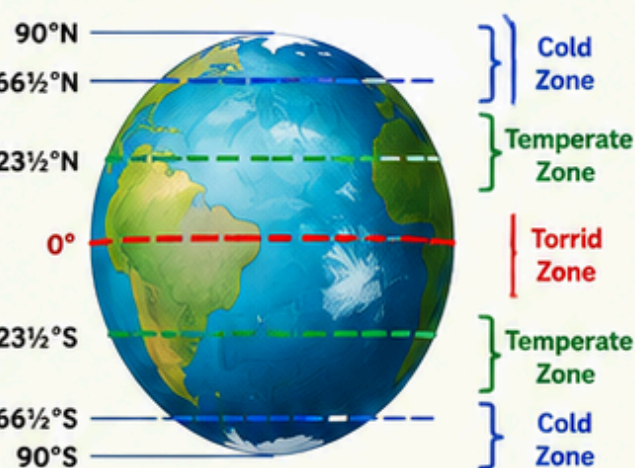
2. UNEVEN HEATING OF THE EARTH

Because of the spherical shape of the Earth and its tilt, solar energy is not distributed equally. This causes differences in temperature from place to place.

A. DIFFERENT LATITUDES

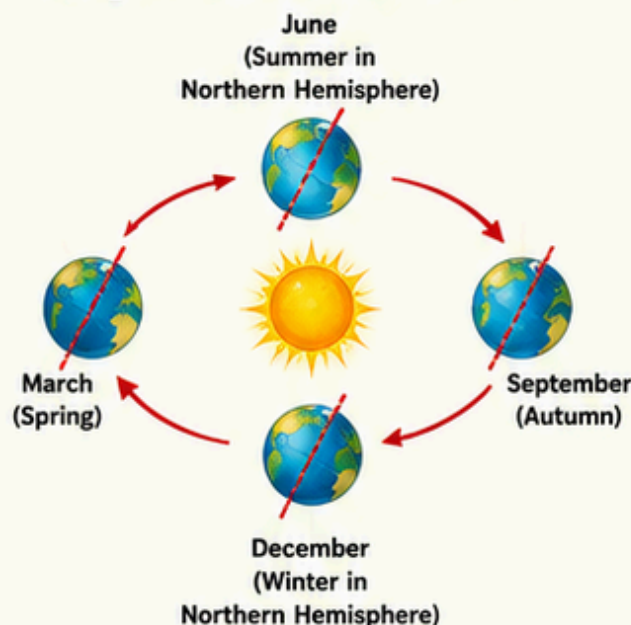
Places near the Equator receive more direct sunlight and are warmer.

Places near the Poles receive less direct sunlight and are colder.



B. DIFFERENT SEASONS

Due to the tilt of the Earth on its axis ($23\frac{1}{2}^\circ$), a place receives more direct sunlight in summer and less in winter.



C. DIFFERENT DISTRIBUTION OF LAND AND WATER

Land heats up and cools down faster than water. Coastal areas have a moderate climate, while interiors experience extreme temperatures.



LAND
Heats up fast
Cools down fast
(Extreme temperature)



WATER
Heats up slow
Cools down slow
(Moderate temperature)

KEY POINTS

- Solar energy is the main source of heat for the Earth.
- The Earth's spherical shape and its tilt cause uneven heating.
- Uneven heating leads to differences in temperature, climate, winds, ocean currents and seasons.



GREENHOUSE EFFECT

The greenhouse effect is a natural process in which gases in the Earth's atmosphere trap some of the Sun's heat. This keeps the Earth warm enough to support life.

1. INCOMING SOLAR RADIATION

Sunlight passes through the atmosphere.

Most of it reaches the Earth's surface and warms it.

2. OUTGOING HEAT RADIATION

The Earth's surface emits heat energy (infrared radiation) back toward the atmosphere.

3. HEAT TRAPPED BY GREENHOUSE GASES

Greenhouse gases trap some of this heat and prevent it from escaping into space.

This causes the lower atmosphere and Earth's surface to stay warm.

ATMOSPHERE

EARTH

The Earth's surface absorbs solar energy and heats up.

MAJOR GREENHOUSE GASES

- Water Vapour (H_2O)
- Carbon Dioxide (CO_2)
- Methane (CH_4)
- Nitrous Oxide (N_2O)
- Ozone (O_3)



NATURAL GREENHOUSE EFFECT (GOOD)

Keeps the average temperature of the Earth around $15^{\circ}C$ instead of $-18^{\circ}C$. This natural warming makes life possible.



With natural greenhouse effect, Earth remains warm and habitable.



ENHANCED GREENHOUSE EFFECT (BAD)

Human activities increase greenhouse gases, trapping more heat than necessary. This leads to global warming and climate change.



More greenhouse gases
→ More heat trapped
→ Rise in global temperature
→ Melting ice
→ Extreme weather
→ Climate change

KEY POINTS



- Greenhouse effect is a natural process that keeps Earth warm.
- It occurs when greenhouse gases trap heat in the atmosphere.
- It is essential for life, but too much of it due to human activities is harmful.
- We must reduce greenhouse gas emissions to keep our planet safe.



VALLEY BREEZE

Valley breeze is a local wind that blows **during the day** in mountain valleys. It flows from the valley floor up the slopes.

HOW IT HAPPENS

1 Sun heats the valley floor faster.

The sun's rays warm the valley floor more quickly than the mountain slopes.

2 Warm air rises.

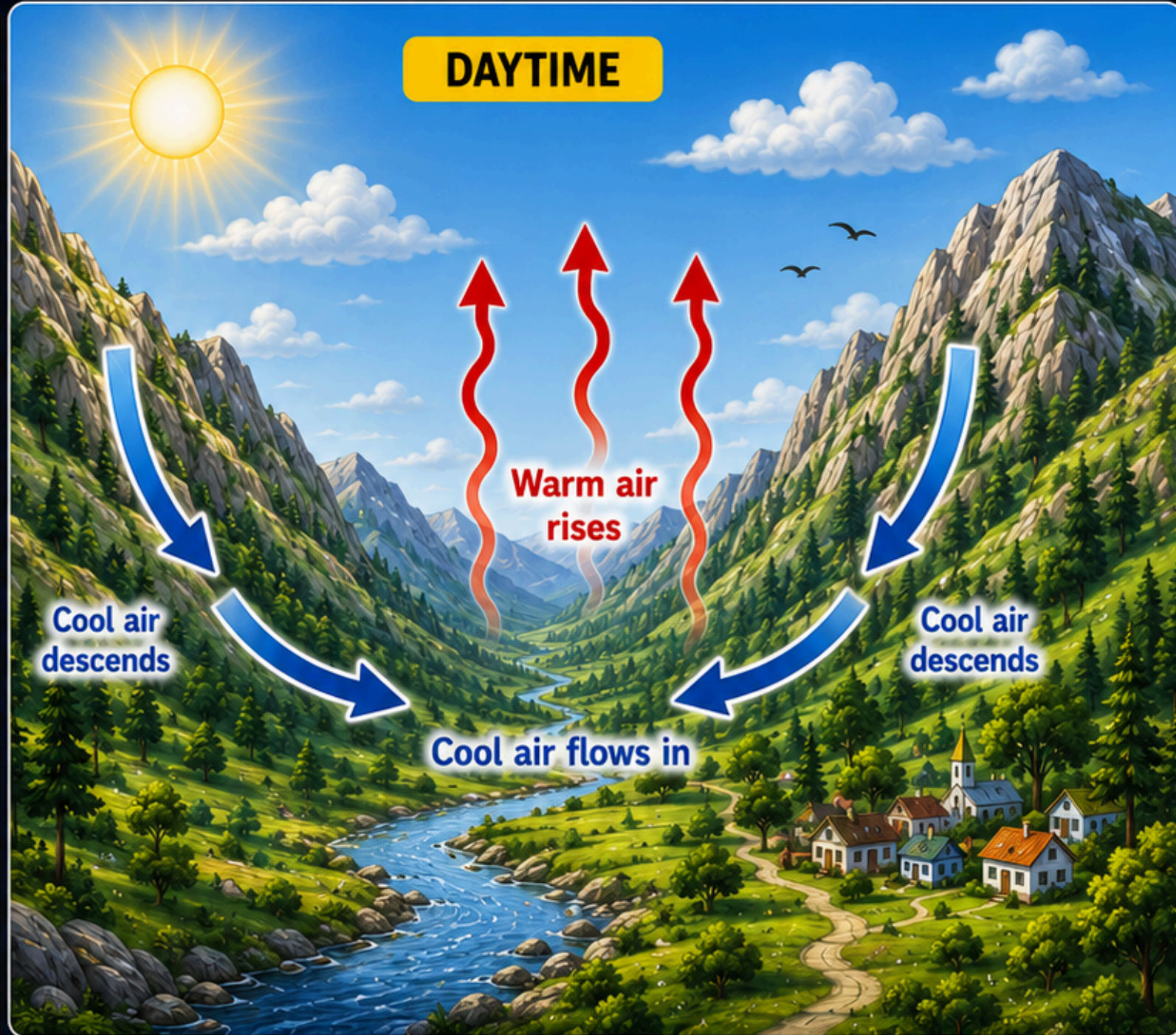
The warm air over the valley floor becomes light and rises upward.

3 Cool air moves in.

Cooler, denser air from the surrounding mountains moves down the slopes toward the valley.

4 Valley breeze blows.

This cool air flows along the valley floor and up the mountain slopes, replacing the rising warm air.



During the day, the valley floor is warmer than the mountain slopes. Cool air from the mountains flows into the valley and up the slopes.

This is called a valley breeze.



KEY POINTS



- ✓ Valley breeze blows during the day.
- ✓ Warm air rises from the valley floor.
- ✓ Cool air moves from the mountains into the valley and up the slopes.
- ✓ It helps moderate the temperature in mountain valleys.

EXAMPLE

In the Himalayas and other mountain regions, valley breeze occurs on clear, sunny days. It makes the daytime weather pleasant in the valley.





MOUNTAIN BREEZE



Mountain breeze is a local wind that blows **during the night** in mountain regions. It flows from the mountain slopes down to the valley.

HOW IT HAPPENS

1 Land cools at night.

After sunset, the mountain slopes cool faster than the valley floor by losing heat quickly.



2 Cool air forms on the slopes.

The cool air near the mountain slopes becomes cold, dense and heavy.



3 Cool air moves down.

The dense cool air flows down the mountain slopes toward the valley.

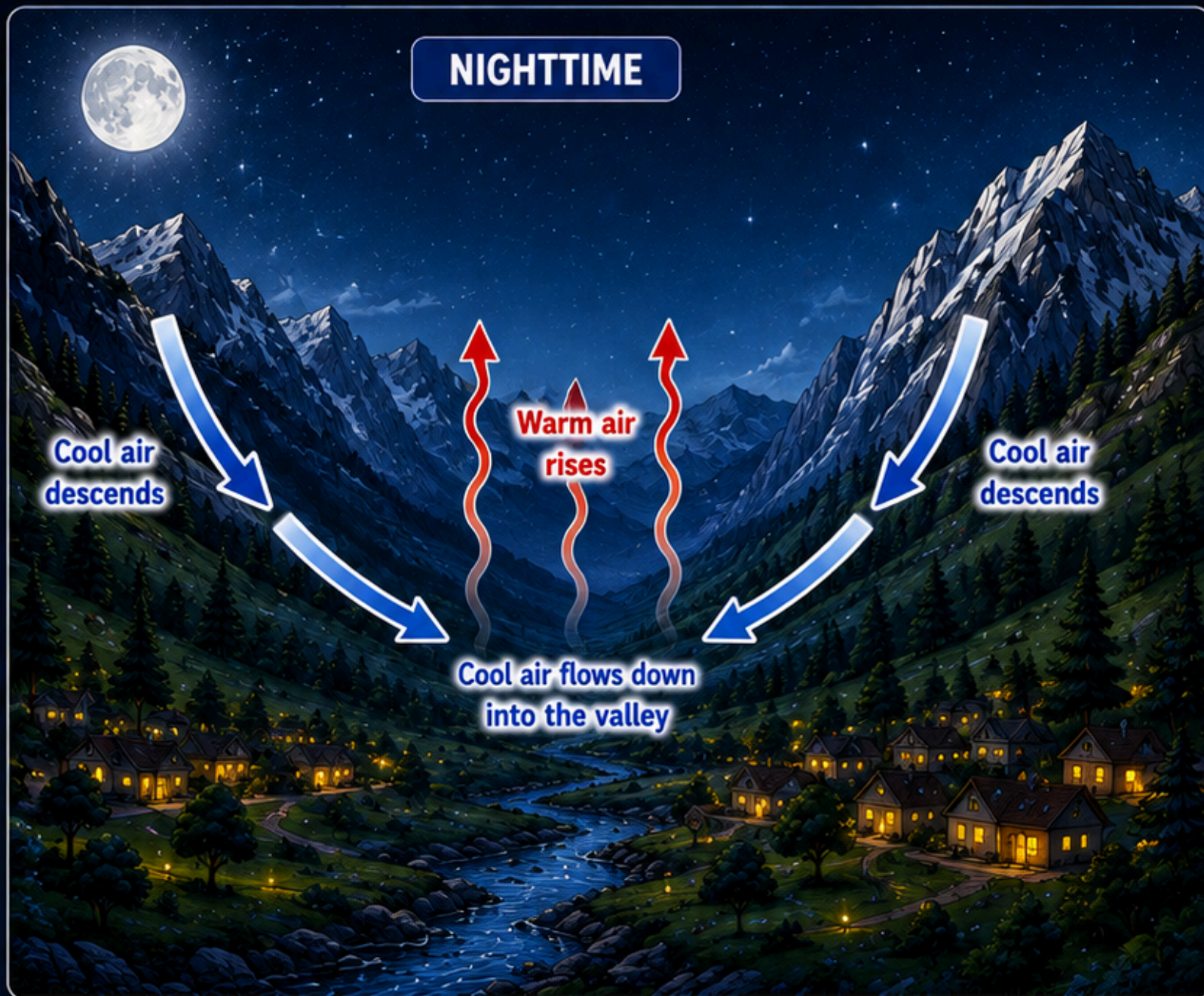


4 Mountain breeze blows.

This cool air spreads across the valley floor, replacing the rising warm air.



NIGHTTIME



During the night, the mountain slopes cool faster than the valley. Cool, dense air flows down the slopes into the valley. This is called a **mountain breeze**.



KEY POINTS



- ✓ Mountain breeze blows during the night.
- ✓ Mountain slopes cool faster than the valley floor at night.
- ✓ Cool, dense air moves down the slopes into the valley.
- ✓ Warm air from the valley rises up.
- ✓ It brings cool and pleasant weather at night in mountain regions.

EXAMPLE

In the Himalayas and other mountain regions, mountain breeze occurs on clear, calm nights. It makes the night time weather cool and comfortable.



GLOBAL OCEAN CURRENTS

Ocean currents are continuous, directed movements of seawater driven by **winds, Earth's rotation** and differences in **water temperature and salinity**.

TYPES OF OCEAN CURRENTS

→ **WARM CURRENTS**
Flow from low latitudes toward high latitudes. They carry warm water.

→ **COLD CURRENTS**
Flow from high latitudes toward low latitudes. They carry cold water.

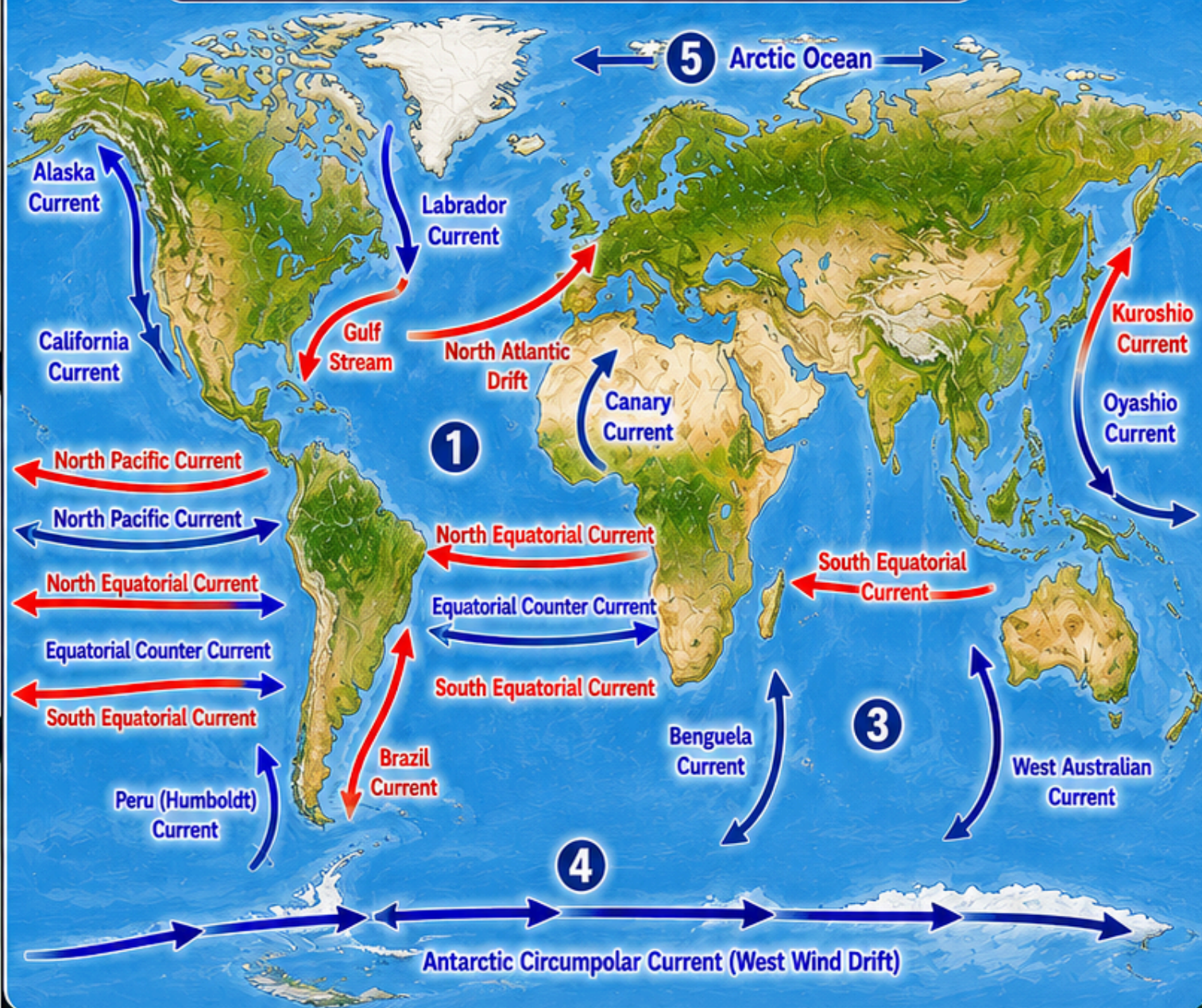
MAJOR OCEAN BASINS

- 1 Pacific Ocean
- 2 Atlantic Ocean
- 3 Indian Ocean
- 4 Southern Ocean
- 5 Arctic Ocean

WHY ARE OCEAN CURRENTS IMPORTANT?

-  They regulate Earth's climate by redistributing heat.
-  They influence weather and rainfall.
-  They support marine life and fisheries.
-  They help in navigation and reduce travel time.

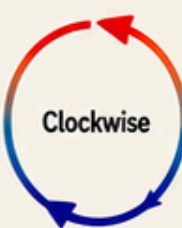
MAJOR OCEAN CURRENTS OF THE WORLD



OCEAN GYRES

Most ocean currents form large circular patterns called gyres.

NORTH PACIFIC GYRE



Clockwise

SOUTH PACIFIC GYRE



Anticlockwise

NORTH ATLANTIC GYRE



Clockwise

SOUTH ATLANTIC GYRE



Anticlockwise

INDIAN OCEAN GYRE



Anticlockwise

KEY POINTS



Warm currents move poleward from the equator and warm the climate.



Cold currents move equatorward from the poles and cool the climate.



Currents are shaped by winds, Earth's rotation and differences in water density.



They play a vital role in climate, marine life and human activities.



WATER CYCLE



The water cycle is the **continuous movement** of water on, above, and below the surface of the Earth.

5 MAIN STEPS

1 EVAPORATION



Sun heats the water in oceans, lakes and rivers and turns it into water vapour, which rises into the air.

2 TRANSPIRATION



Plants release water vapour into the air through tiny openings in their leaves.

3 CONDENSATION



Water vapour rises, cools down and turns into tiny water droplets, forming clouds.

4 PRECIPITATION

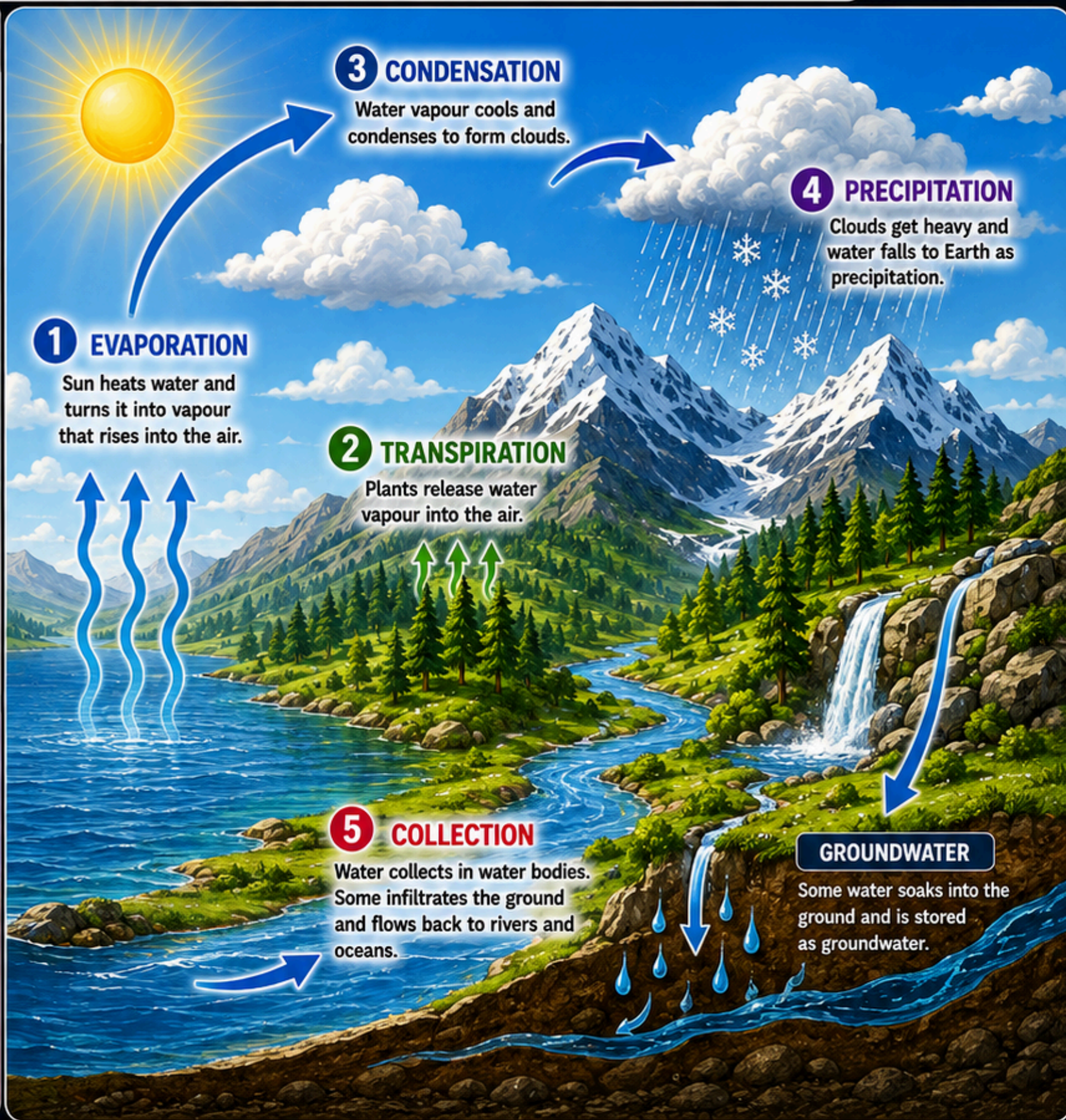


When the cloud droplets become heavy, they fall to Earth as rain, snow, sleet or hail.

5 COLLECTION



Water collects in rivers, lakes and oceans. Some water soaks into the ground and becomes groundwater. The cycle then begins again.



IMPORTANCE OF THE WATER CYCLE



Provides fresh water for drinking, agriculture and industry.



Supports all living organisms on Earth.



Helps maintain the balance of our climate.



It is a natural cycle that keeps our planet life-sustaining.

THE CYCLE NEVER STOPS!

The sun's energy keeps the water cycle moving, ensuring there is always water for life on Earth.



NITROGEN CYCLE

The **nitrogen cycle** is the natural process that converts nitrogen in the atmosphere into forms that **living things can use**, and then returns it to the atmosphere.

5 MAIN STEPS

1 NITROGEN FIXATION



Atmospheric nitrogen (N_2) is converted into ammonia (NH_3) or other usable forms by bacteria, lightning or human activities.



Nitrogen-fixing bacteria in soil and root nodules

2 ASSIMILATION



Plants absorb ammonia or nitrate from the soil and use it to make proteins and other important compounds.

3 AMMONIFICATION



Decomposers break down dead plants, animals and waste products, converting organic nitrogen into ammonia (NH_3).

4 NITRIFICATION



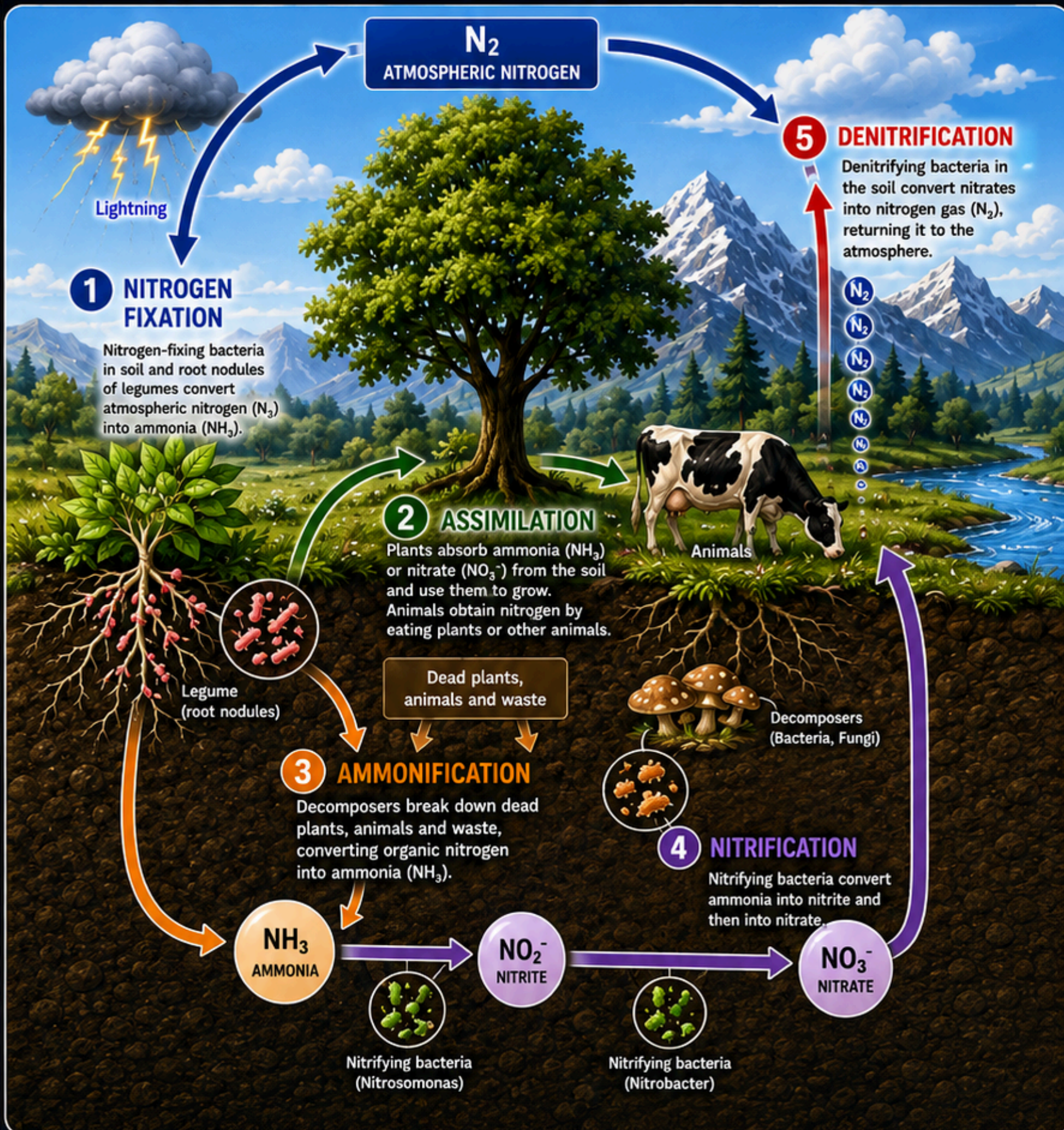
Bacteria convert ammonia (NH_3) into nitrite (NO_2^-) and then into nitrate (NO_3^-), which plants can absorb.



5 DENITRIFICATION



Denitrifying bacteria convert nitrates in the soil into nitrogen gas (N_2) which is released into the atmosphere.



WHY IS THE NITROGEN CYCLE IMPORTANT?



- Nitrogen is essential for proteins, DNA, RNA and chlorophyll.
- It helps plants grow and supports all living organisms.
- It maintains soil fertility and ecosystem balance.
- It ensures the continuous availability of nitrogen in usable forms.

INTERESTING FACTS



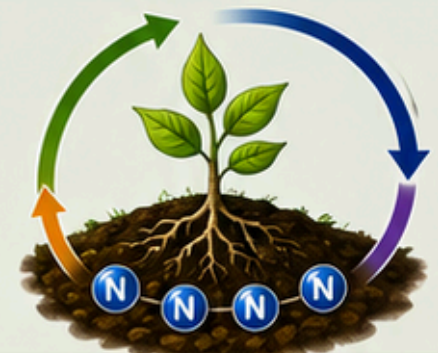
About 78% of the Earth's atmosphere is nitrogen gas (N_2).



Nitrogen-fixing bacteria in legumes reduce the need for fertilizers.



Human activities like industrial fertilizer use also affect the nitrogen cycle.



→ Nitrogen inputs into the system

→ Nitrogen movement in living things

→ Conversion in the soil

→ Return of nitrogen to the atmosphere



The nitrogen cycle keeps Earth's ecosystems healthy by **recycling nitrogen** between the environment and living things.



CARBON CYCLE



The **carbon cycle** is the natural process through which carbon moves between the atmosphere, living organisms, oceans and the Earth.

6 MAIN STEPS

1 PHOTOSYNTHESIS



Plants absorb carbon dioxide (CO_2) from the atmosphere and use sunlight to convert it into food.

2 RESPIRATION



Plants, animals and microorganisms release carbon dioxide (CO_2) back into the atmosphere through respiration.

3 DECOMPOSITION



When plants and animals die, decomposers break down the dead matter and release carbon dioxide (CO_2) into the soil and air.

4 OCEAN EXCHANGE



Oceans absorb carbon dioxide (CO_2) from the atmosphere. Marine organisms use it to build their shells and skeletons.

5 FOSSIL FUELS

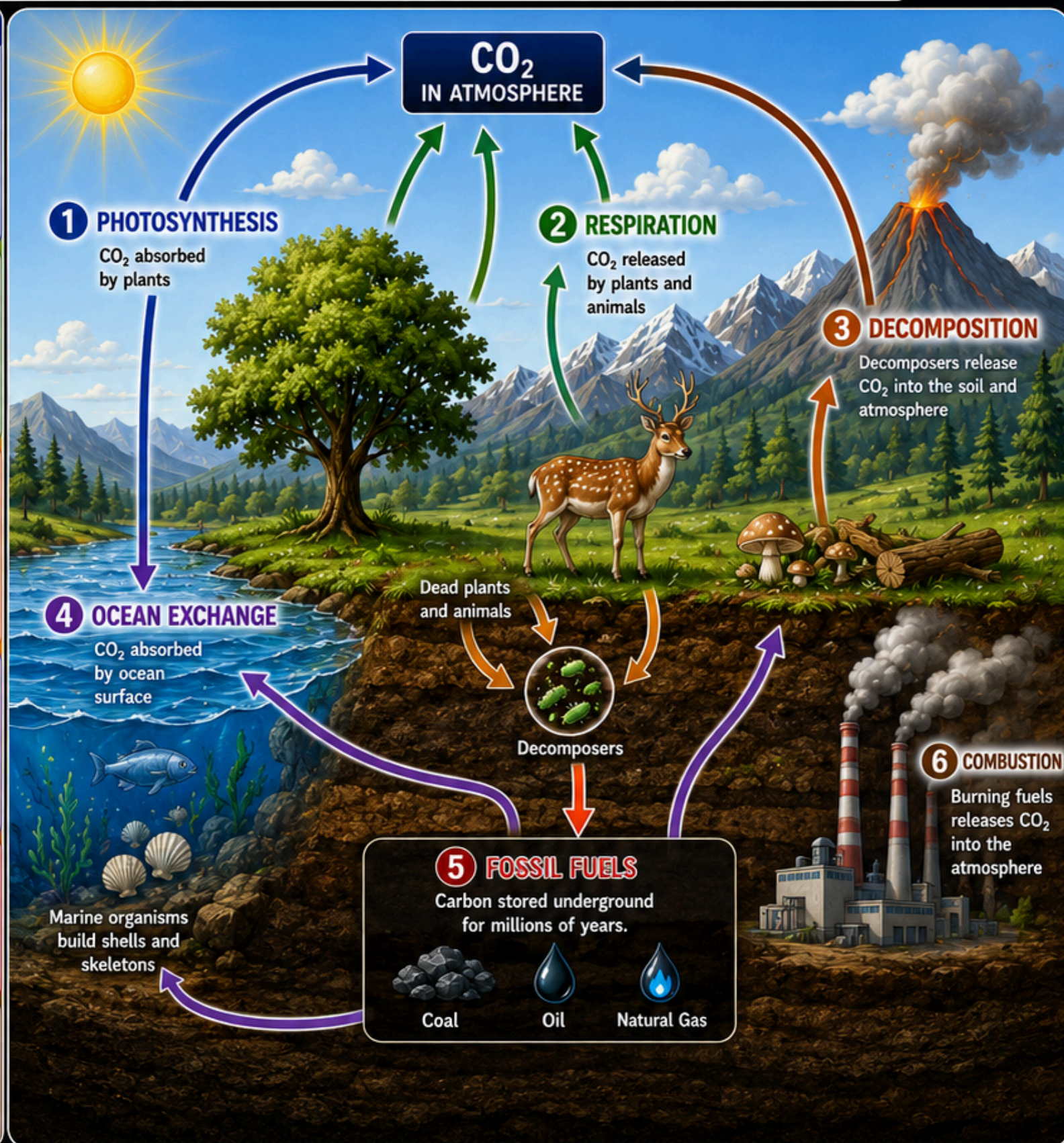


Some carbon is stored underground for millions of years and forms fossil fuels like coal, oil and natural gas.

6 COMBUSTION



Burning fossil fuels, wood and other organic materials releases carbon dioxide (CO_2) into the atmosphere.



WHY IS THE CARBON CYCLE IMPORTANT?



It helps regulate Earth's climate and temperature.



It supports life by providing the carbon needed for growth and energy.



It maintains the balance of carbon in air, water, soil and living things.



It recycles carbon between the environment and living organisms.

CARBON STORES

Carbon is stored in different places called carbon reservoirs.



• Atmosphere (CO_2 gas)



• Oceans



• Living Organisms



• Soils



• Rocks and Sediments

• Fossil Fuels

DID YOU KNOW?



Plants remove about 10 billion tons of carbon dioxide (CO_2) from the air every year.



Oceans store more carbon than the atmosphere and all land plants combined.



Human activities have increased the amount of CO_2 in the atmosphere since the Industrial Revolution.



The carbon cycle is a continuous cycle that connects all forms of life and the environment.

Carbon enters the system

Carbon moves through living and non-living things

Carbon is stored in soil, ocean or rocks

Carbon returns to the atmosphere as CO_2



KEELING CURVE



The Keeling Curve shows the continuous rise in **atmospheric carbon dioxide (CO₂)** levels measured **at Mauna Loa Observatory, Hawaii** since 1958.

WHAT IS THE KEELING CURVE?

It is a graph that shows the monthly average concentration of CO₂ in Earth's atmosphere.



Measured at Mauna Loa Observatory, Hawaii (3,397 m above sea level) by **Dr. Charles David Keeling** and his team.

WHY MAUNA LOA?



High altitude and remote location.

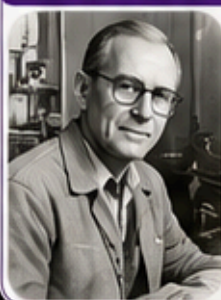


Above most local pollution sources.



Represents background atmosphere for the Northern Hemisphere.

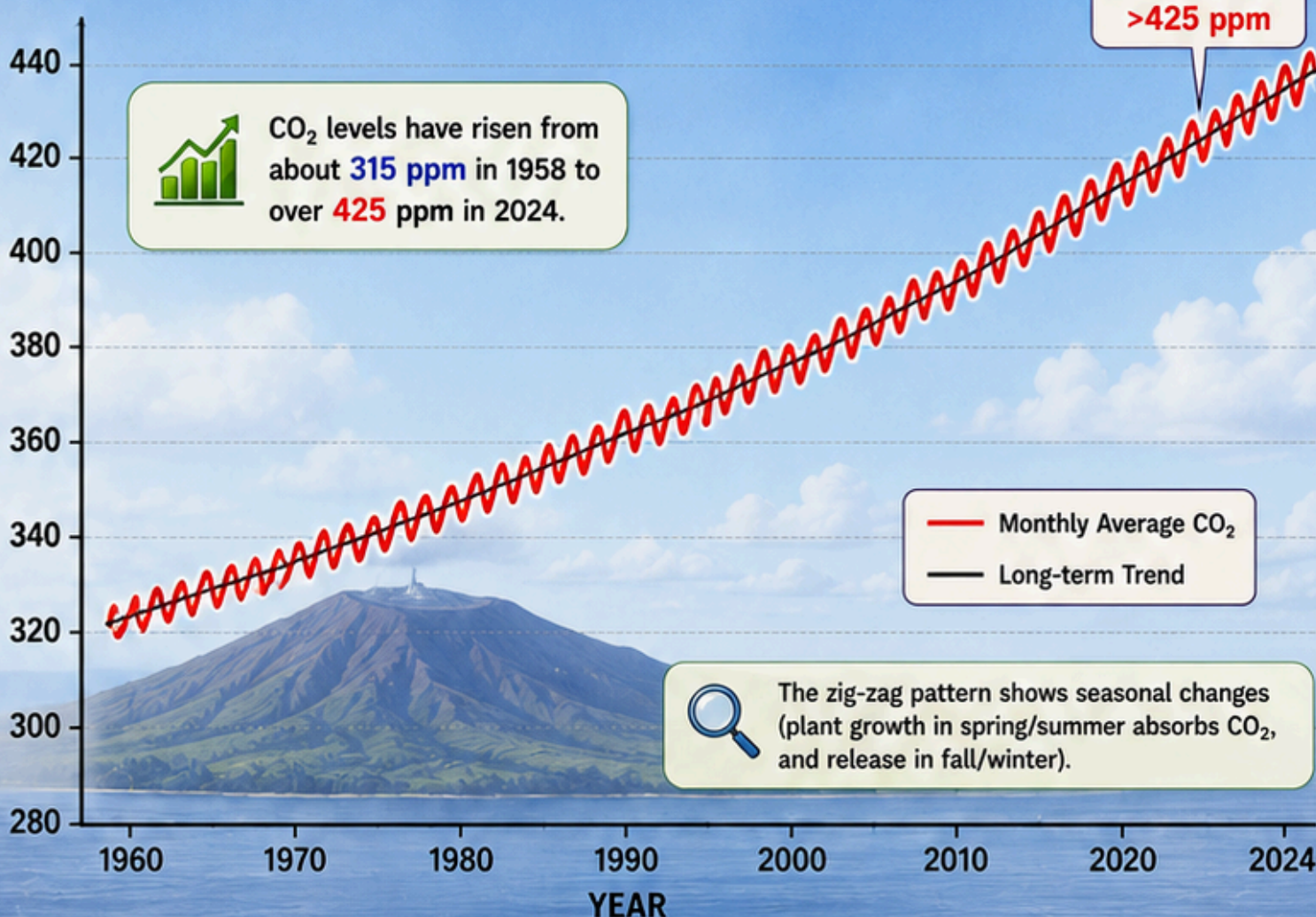
ABOUT DR. C. D. KEELING



Charles David Keeling began CO₂ measurements in 1958. His lifelong work has been crucial in understanding climate change.

ATMOSPHERIC CO₂ CONCENTRATION AT MAUNA LOA

CO₂ CONCENTRATION (parts per million)



KEY MILESTONES

1958

Measurements begin at Mauna Loa.
~315 ppm

1980

CO₂ levels cross 340 ppm

2000

CO₂ levels cross 370 ppm

2013

CO₂ levels cross 400 ppm

2024

CO₂ levels exceed 425 ppm

WHY IS THE KEELING CURVE IMPORTANT?



Provides the longest continuous record of atmospheric CO₂.



Strong evidence that human activities are increasing greenhouse gases.



Helps scientists understand and predict climate change.



Crucial for developing climate policies and solutions.

MAIN SOURCE OF RISING CO₂



Burning fossil fuels (coal, oil, natural gas)



Transportation



Deforestation



Industrial processes



THE TAKEAWAY



The Keeling Curve is a clear and powerful reminder that our planet is warming due to **rising CO₂**. The faster we act, the better the future we build.



Small changes today, a **better tomorrow.**

Measure. Understand. Act.



EUTROPHICATION

Eutrophication is the process in which water bodies become overly enriched with **nutrients**, causing **excessive growth of algae** and aquatic plants, and **depleting oxygen** in the water.

MAIN CAUSES

AGRICULTURAL RUNOFF



Fertilizers and manure from farms wash into water bodies during rain.

SEWAGE & WASTEWATER



Untreated or partially treated sewage adds excess nutrients to the water.

DETERGENTS



Phosphates in detergents enter water bodies through household wastewater.

URBAN RUNOFF



Rain washes oil, chemicals, and other pollutants into lakes and rivers.

THE PROCESS

1 NUTRIENT ENRICHMENT

Excess nutrients (nitrogen & phosphorus) enter the water.



2 ALGAL BLOOM

Nutrients cause rapid growth of algae and aquatic plants.



3 LIGHT BLOCKED

Thick algal growth blocks sunlight from reaching underwater plants.



4 PLANT DIE-OFF

Underwater plants die due to lack of light.



5 OXYGEN DEPLETION

Decomposers break down dead matter, using up oxygen. Fish and other aquatic life die.



EFFECTS OF EUTROPHICATION

OXYGEN DEPLETION



Low oxygen levels create "dead zones" where aquatic life cannot survive.

LOSS OF BIODIVERSITY



Fish, invertebrates, and plants die, reducing biodiversity in the ecosystem.

HARMFUL ALGAL BLOOMS



Some algal blooms produce toxins that are harmful to animals and humans.

WATER QUALITY DECLINE



Water becomes foul-smelling, cloudy, and unpleasant for recreation or drinking.

ECONOMIC IMPACT



Affects fishing, tourism, and increases the cost of water treatment.

HOW TO PREVENT IT?



Use fertilizers wisely and in the right amount.



Treat sewage and wastewater before releasing it.



Use phosphate-free detergents.



Protect natural buffers like plants and wetlands along shorelines.



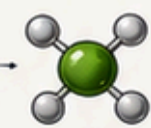
Reduce runoff by using rain gardens, permeable pavements, and green infrastructure.

NUTRIENTS THAT CAUSE EUTROPHICATION

N

NITROGEN

From fertilizers, animal waste, sewage, and decomposition of organic matter.



P

PHOSPHORUS

From fertilizers, detergents, sewage, and soil erosion.



DID YOU KNOW?



Just a small increase in nutrients can cause huge algal blooms.



Eutrophication is now affecting lakes, rivers, estuaries, and even coastal oceans worldwide.



It is one of the leading causes of water quality impairment.

EXAMPLES AROUND THE WORLD

• Lake Erie (USA/Canada)

Severe algal blooms in the 1960s and 1970s led to the "Great Lakes Crisis".



• Baltic Sea (Europe)

Large "dead zones" occur every summer due to nutrient pollution.



• Vembanad Lake (India)

Eutrophication has reduced water quality and affected fisheries and livelihoods.



Healthy **water**, healthy **life**! Let's work together to keep our water bodies **clean** and **balanced**.



REDUCE POLLUTION



PROTECT NATURE



SAVE OUR FUTURE