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FRAMEWORK

MULTIPLE APPROACHES TO DISTANCE EDUCATION FOR TECHNOLOGIAN LEARNERS

Learning Objectives:

- Understand the concept of biogeochemical cycles.
- Identify the different types of biogeochemical cycles.
- Explain the uptakes and cycles of nutrients in the ecosystem.

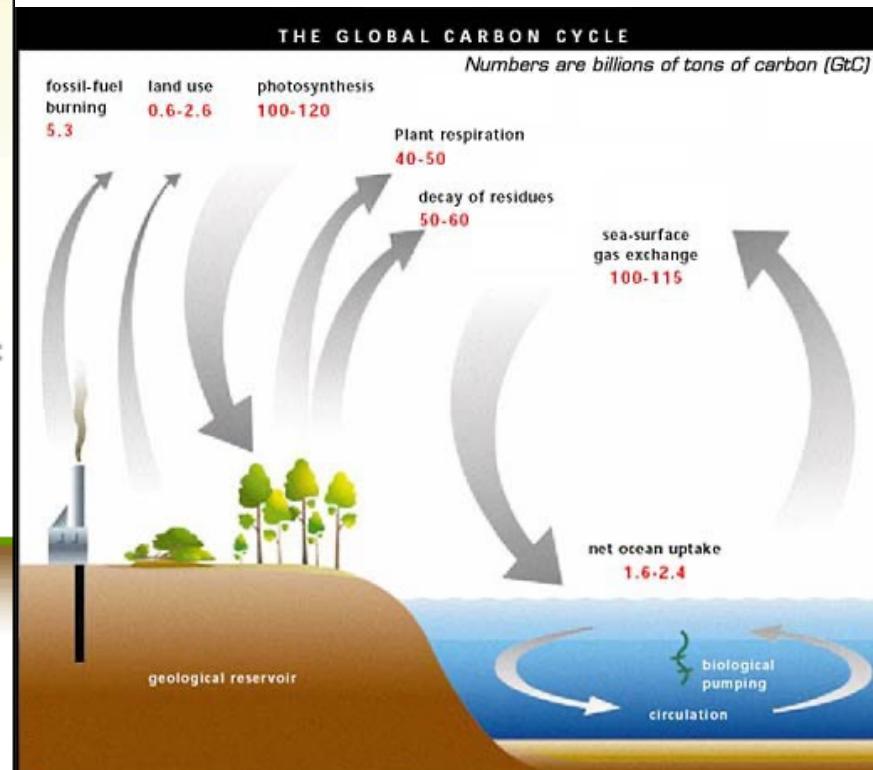
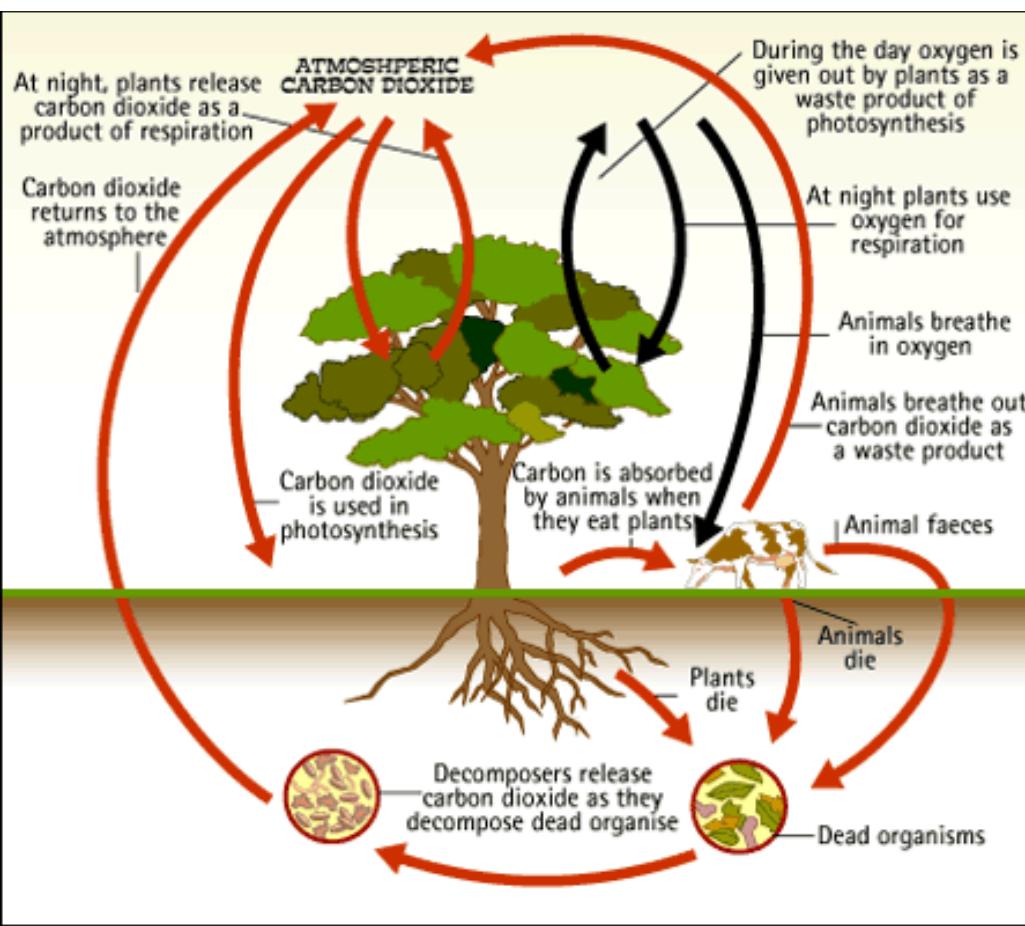


NUTRIENT CYCLES

- **Biogeochemical cycle**
 - path atoms take from the living (biotic) to the non-living (abiotic) world and back again



NUTRIENT CYCLES: ECOSYSTEM TO ECOSPHERE



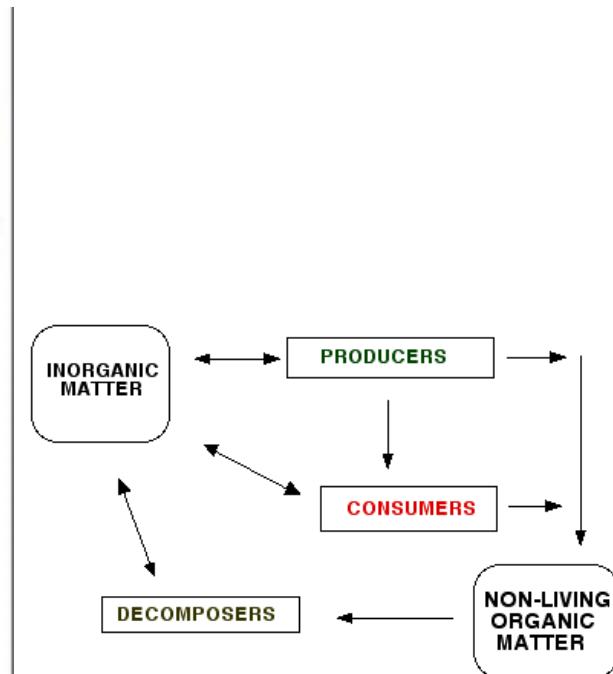
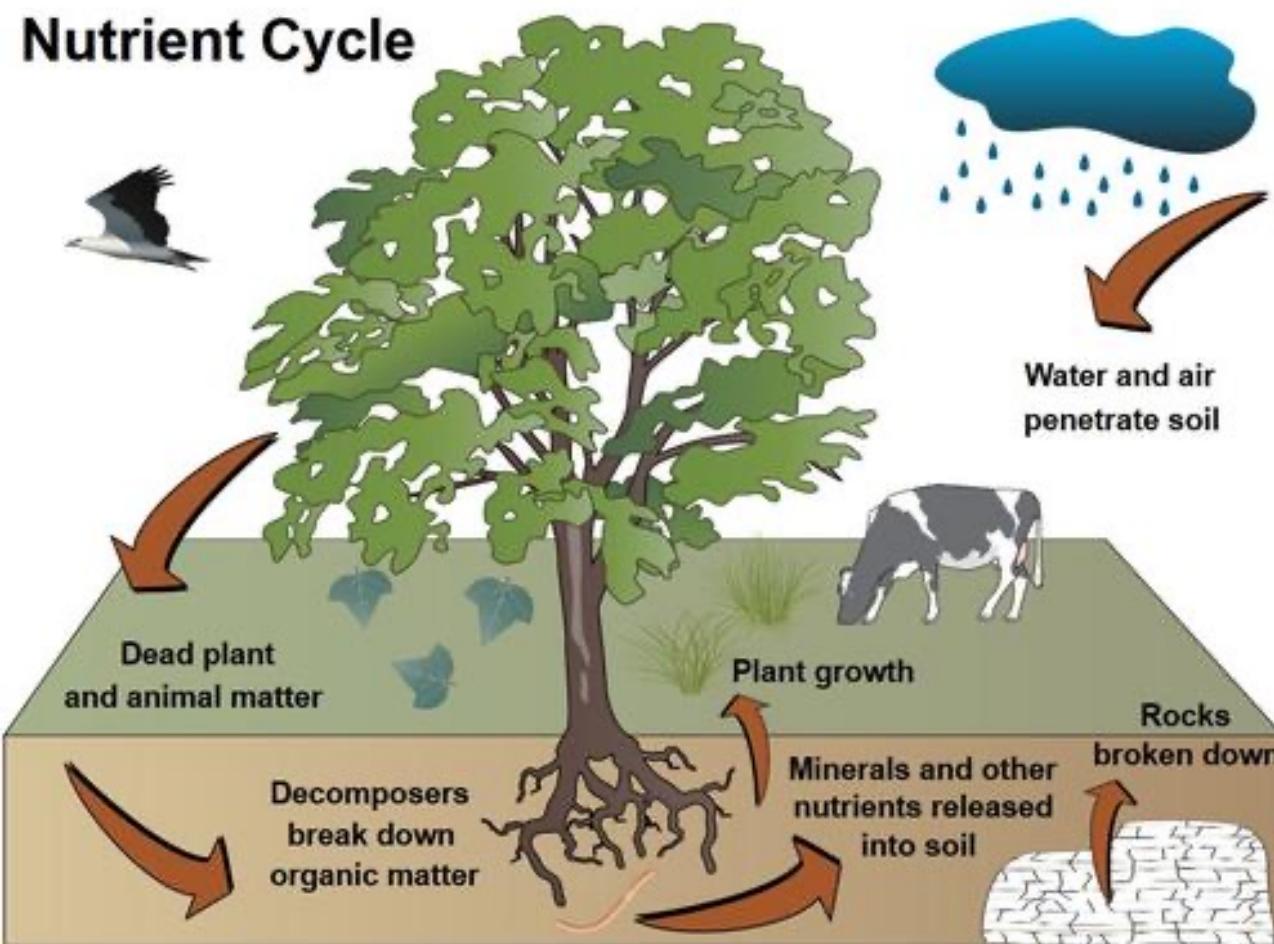
Nutrients: The Elements of Life

O OXYGEN	K POTASSIUM	P PHOSPHORUS
C CARBON	Si SILICON	Cl CHLORINE
H HYDROGEN	Mg MAGNESIUM	Fe IRON
N NITROGEN	S SULFUR	Mn MANGANESE
Ca CALCIUM	Al ALUMINUM	Na SODIUM



NUTRIENT CYCLING IN AN ECOSYSTEM

Nutrient Cycle



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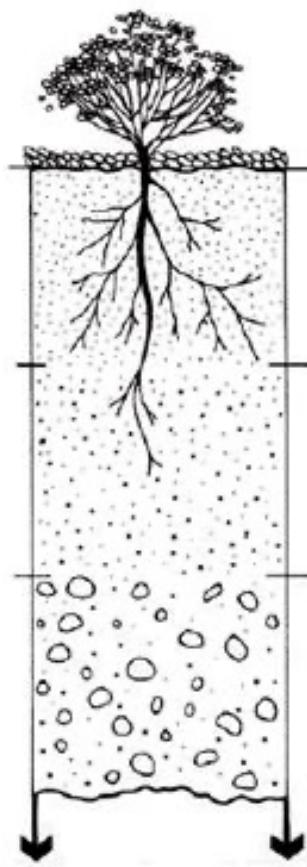
Nutrient Compartments in a Terrestrial Ecosystem

1. organic compartment consists of the living organisms and their detritus
2. available-nutrient compartment consists of nutrients held to surface of soil particles or in solution
3. nutrients held in soils or rocks that are unavailable to living organisms
4. air which can be found in the atmosphere or in the ground



Uptake of Inorganic Nutrients from the Soil

Most plant root activity is in A and B layers. The depth of each layer varies. This profile is typical of mineral soils, as opposed to organic soils found in wetlands and flood plains.

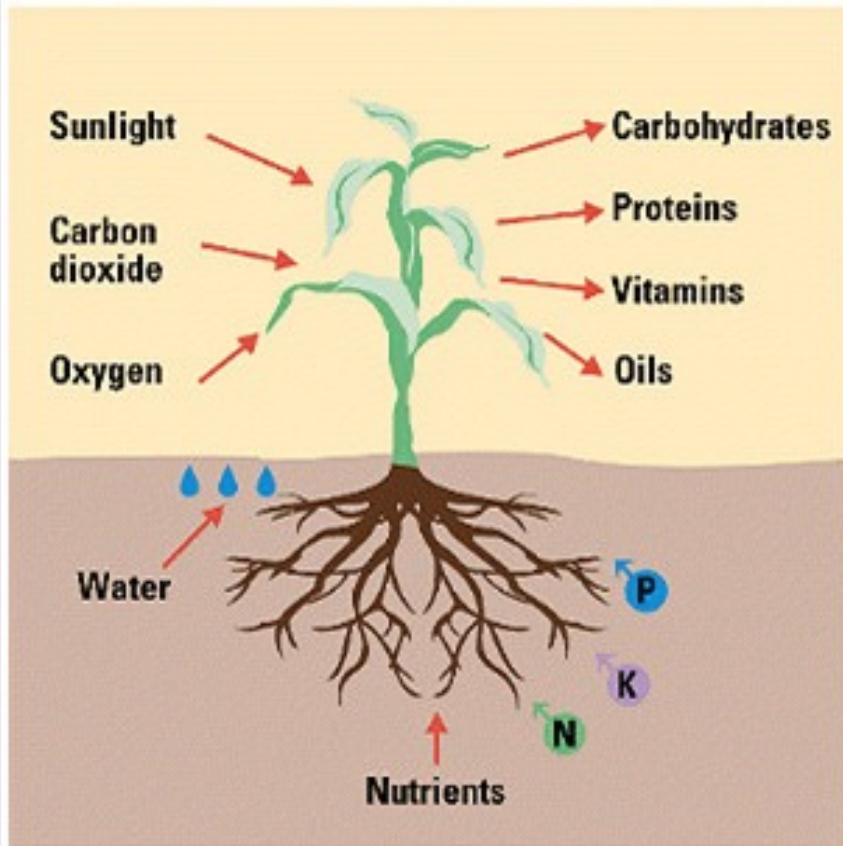


Organic layer

A: Where plants root and where there is the most soil flora and fauna

B: Where leached minerals, silicates and clay accumulate. Little, if any, organic matter

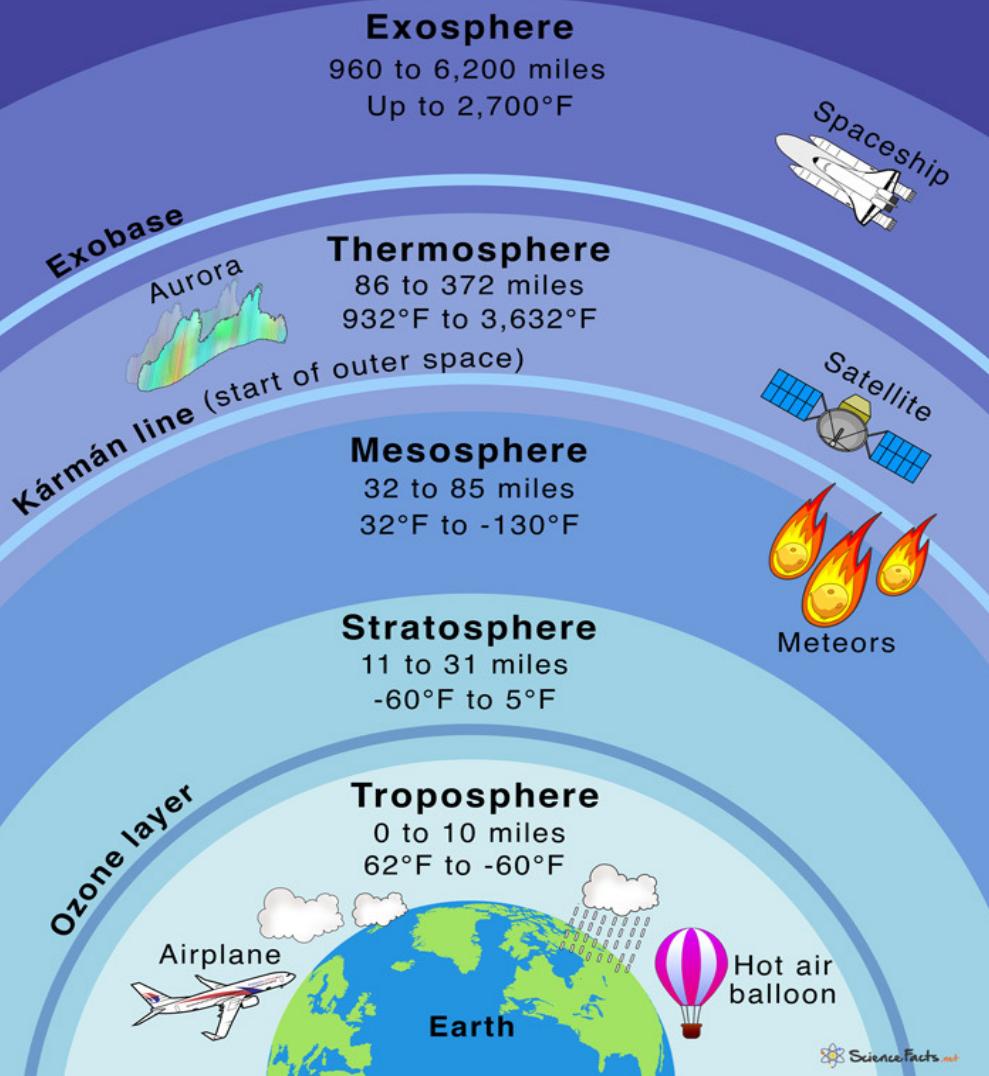
C: Mostly parent material unaffected by the movement of water, minerals and soil particles



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Layers of the Atmosphere



The Atmosphere Is a Source of Inorganic Nutrients

Nitrogen (N_2)

- most abundant gas in the atmosphere about 80% by volume
- entry into and exit from the biota is through bacteria.

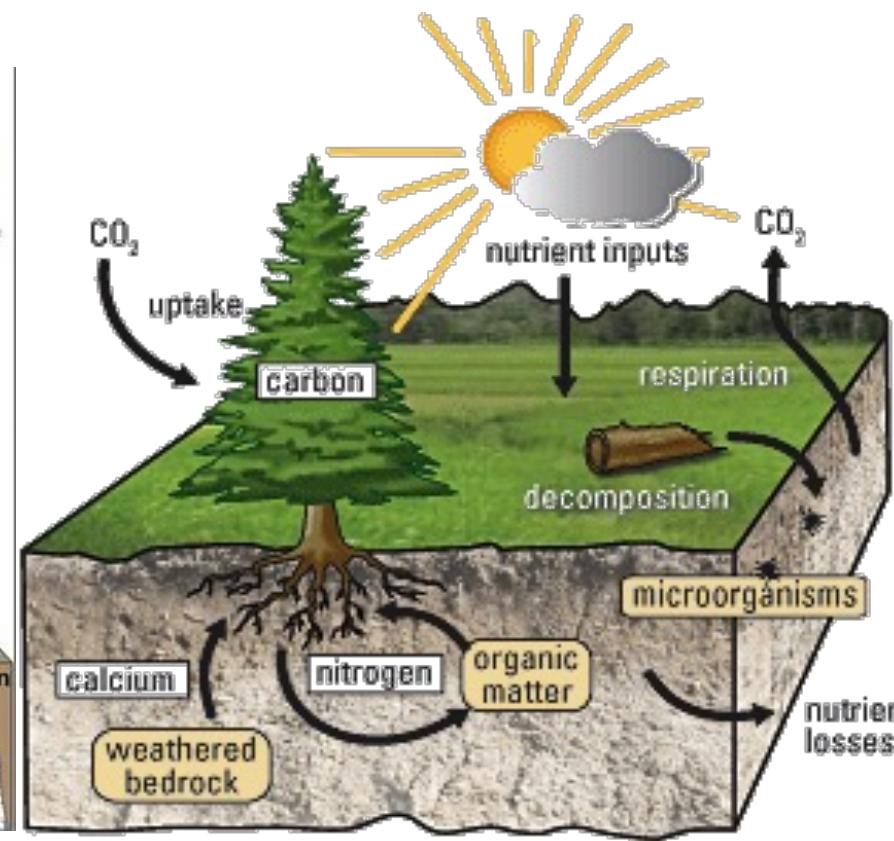
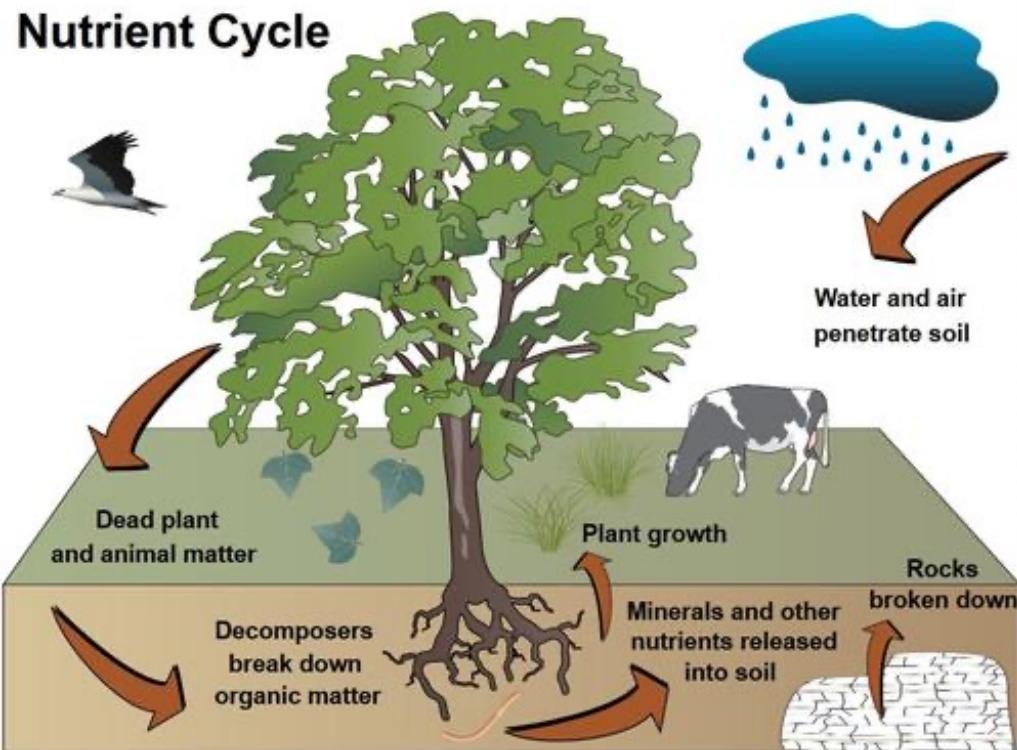


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Processes Nutrients Are Recycled

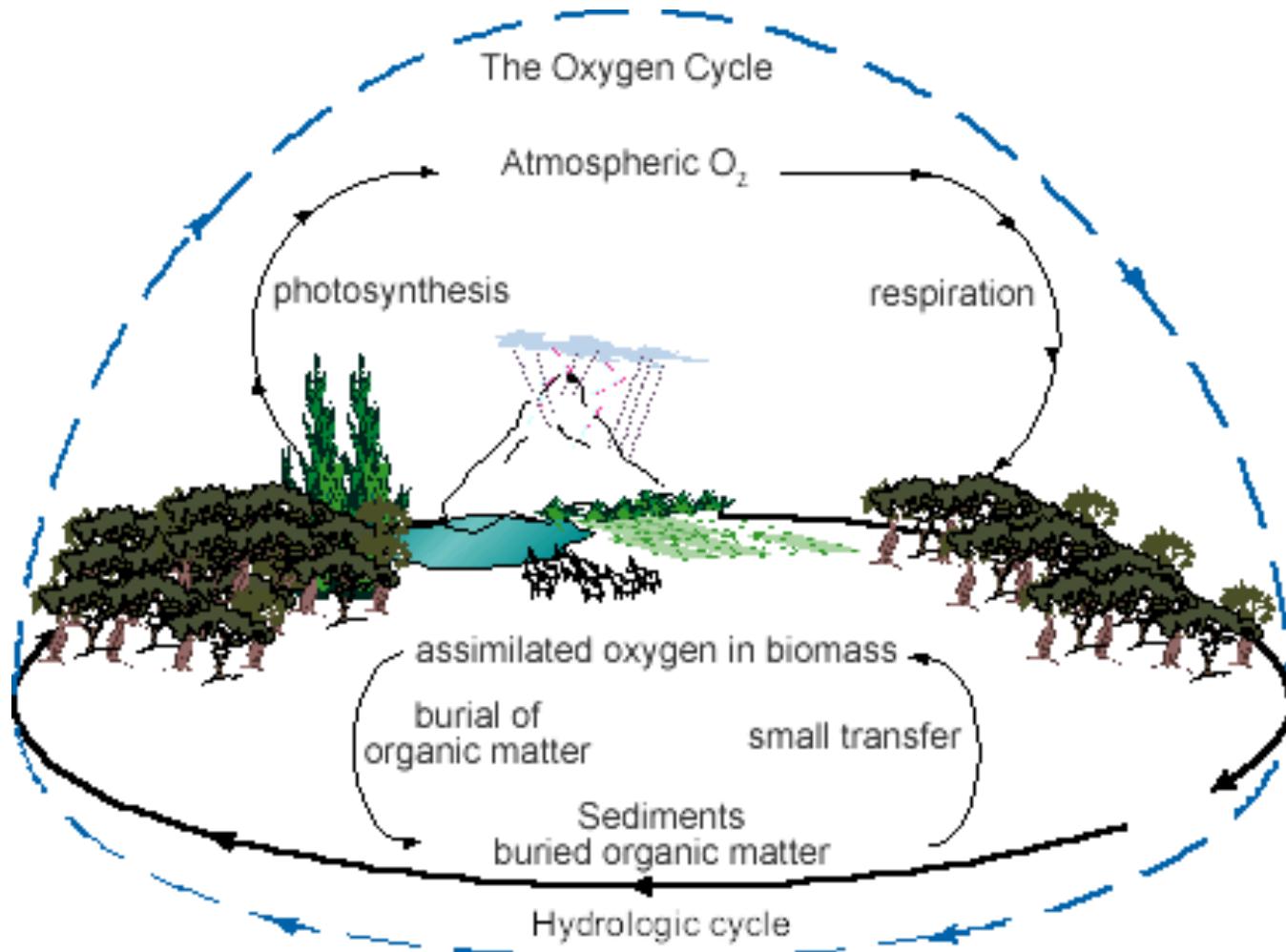
Nutrient Cycle



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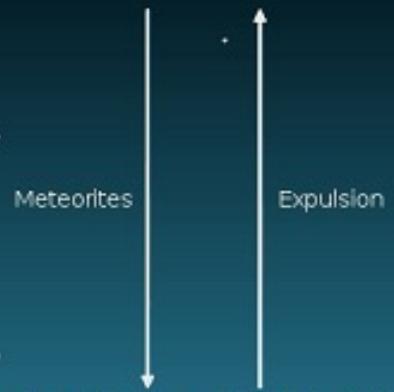
CARBON, HYDROGEN AND OXYGEN CYCLES IN ECOSYSTEMS



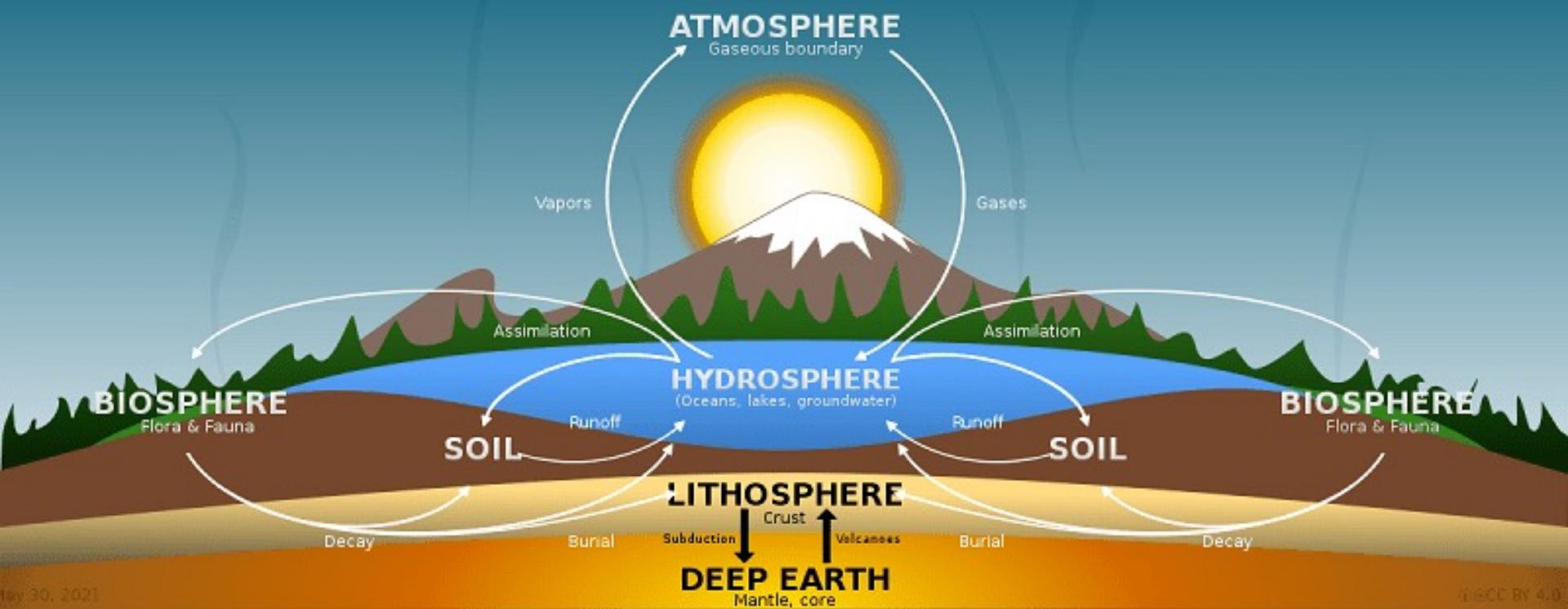
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OUTER SPACE



TYPES OF BIOGEOCHEMICAL CYCLES



- Hydrologic cycle or water cycle
- Gaseous cycle:
 - Oxygen cycle
 - Carbon cycle
 - Nitrogen cycle
- Sedimentary cycle:
 - Sulfur cycle
 - Phosphorous cycle

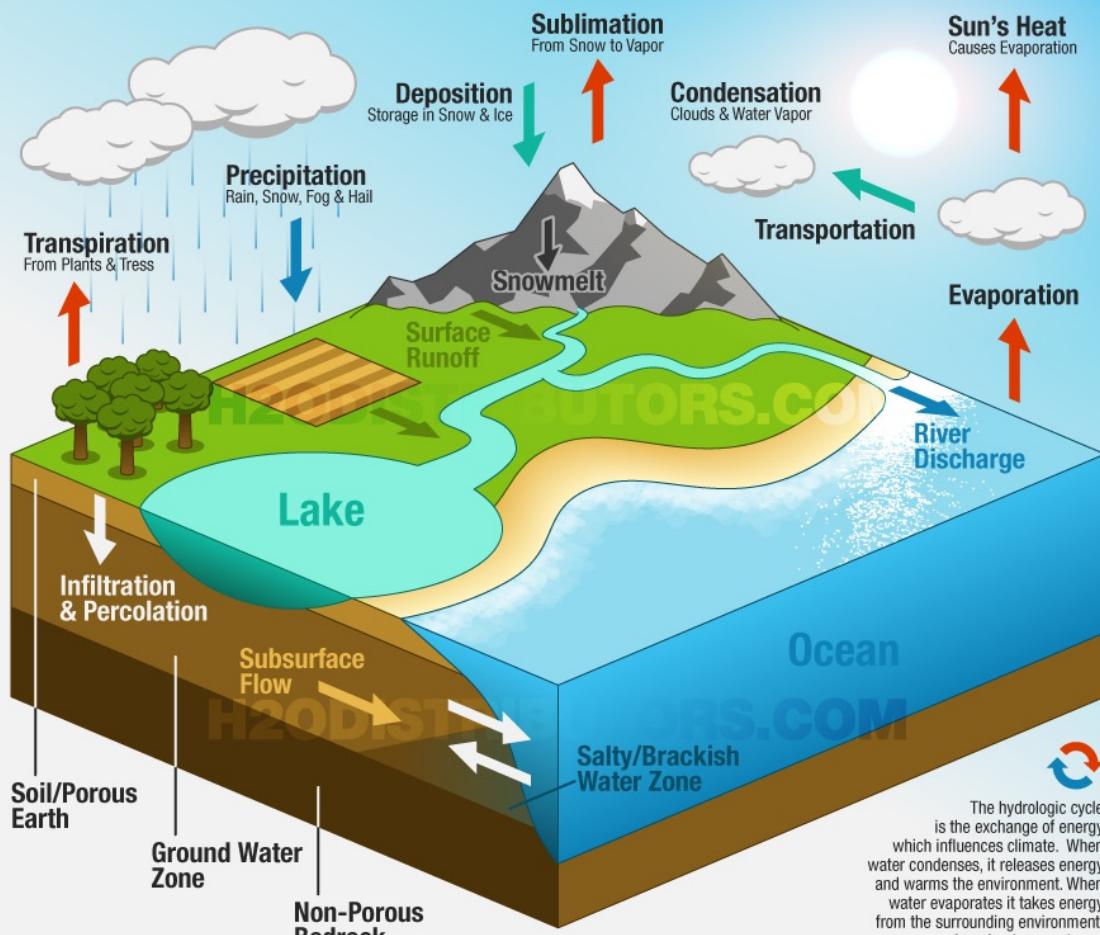


Hydrologic Cycle

The Hydrologic Cycle (also called the Water Cycle) is the continuous movement of water in the air, on the surface of and below the Earth.

Human activities that alter the water cycle:

- Alteration of Atmosphere
- Construction of Dams
- Deforestation and Afforestation
- Water Abstraction from Rivers
- Agriculture
- Industry
- Urbanization



Process Definitions:

Condensation

The transformation of water vapor to liquid water droplets in the air, creating clouds and fog.

Deposition

Also known as desublimation, is a thermodynamic process, a phase transition in which gas (vapor) transforms into solid (ice).

Evaporation

The transformation of water from liquid to gas phases as it moves from the ground or bodies of water into the overlying atmosphere.

Percolation

Water flows horizontally through the soil and rocks under the influence of gravity. Condensed water vapor that falls to the Earth's surface. Most precipitation occurs as rain, but also includes snow, hail, fog drip, graupel, and sleet.

Precipitation

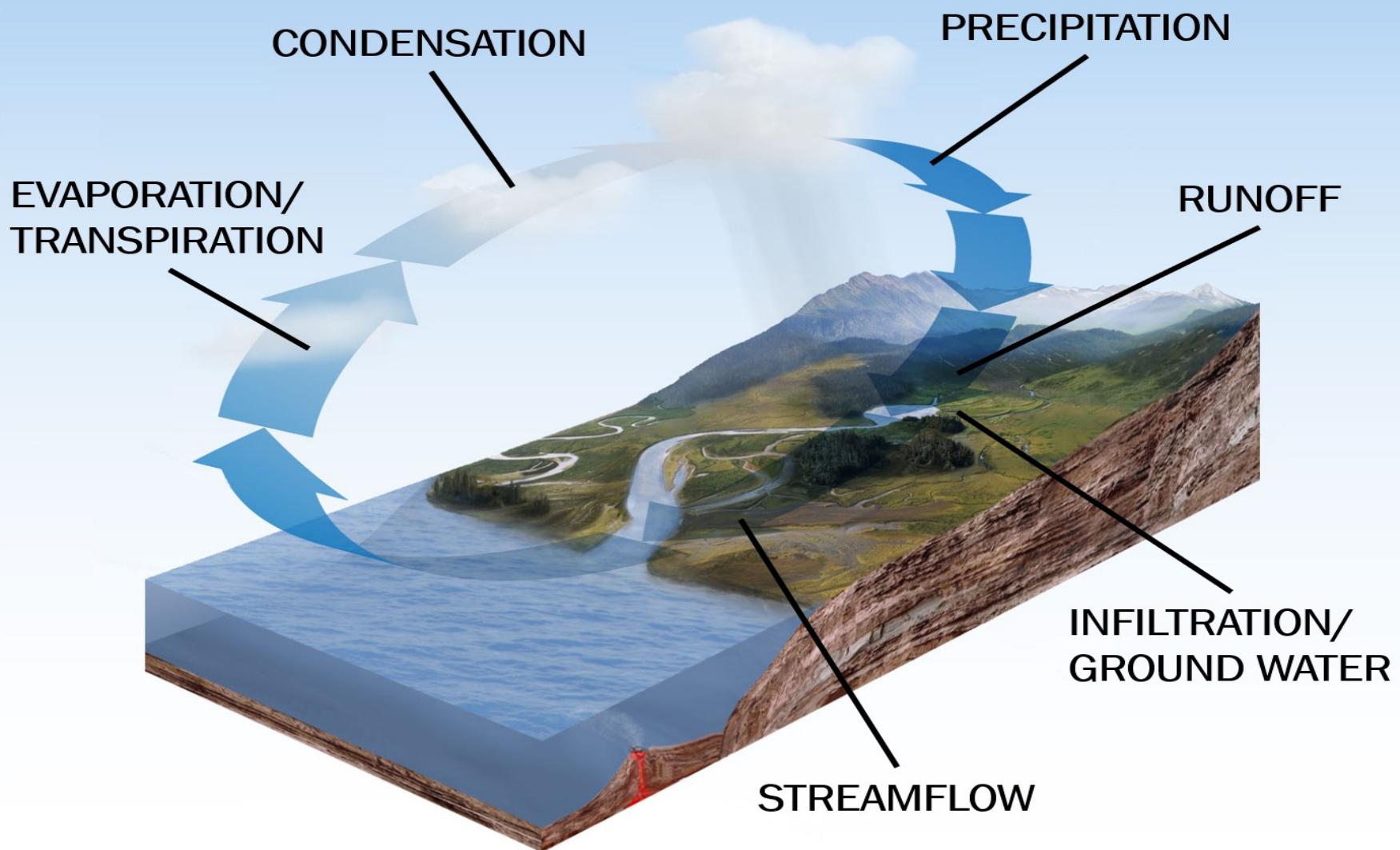
Sublimation

The state change directly from solid water (snow or ice) to water vapor. The release of water vapor from plants and soil into the air. Water vapor is a gas that cannot be seen.

Hydrologic Cycle

- water cycle shapes the land by transporting materials and is essential to most life on Earth.
- water cycle components
 - Evaporation;
 - Transpiration;
 - Condensation;
 - Precipitation and;
 - Runoff





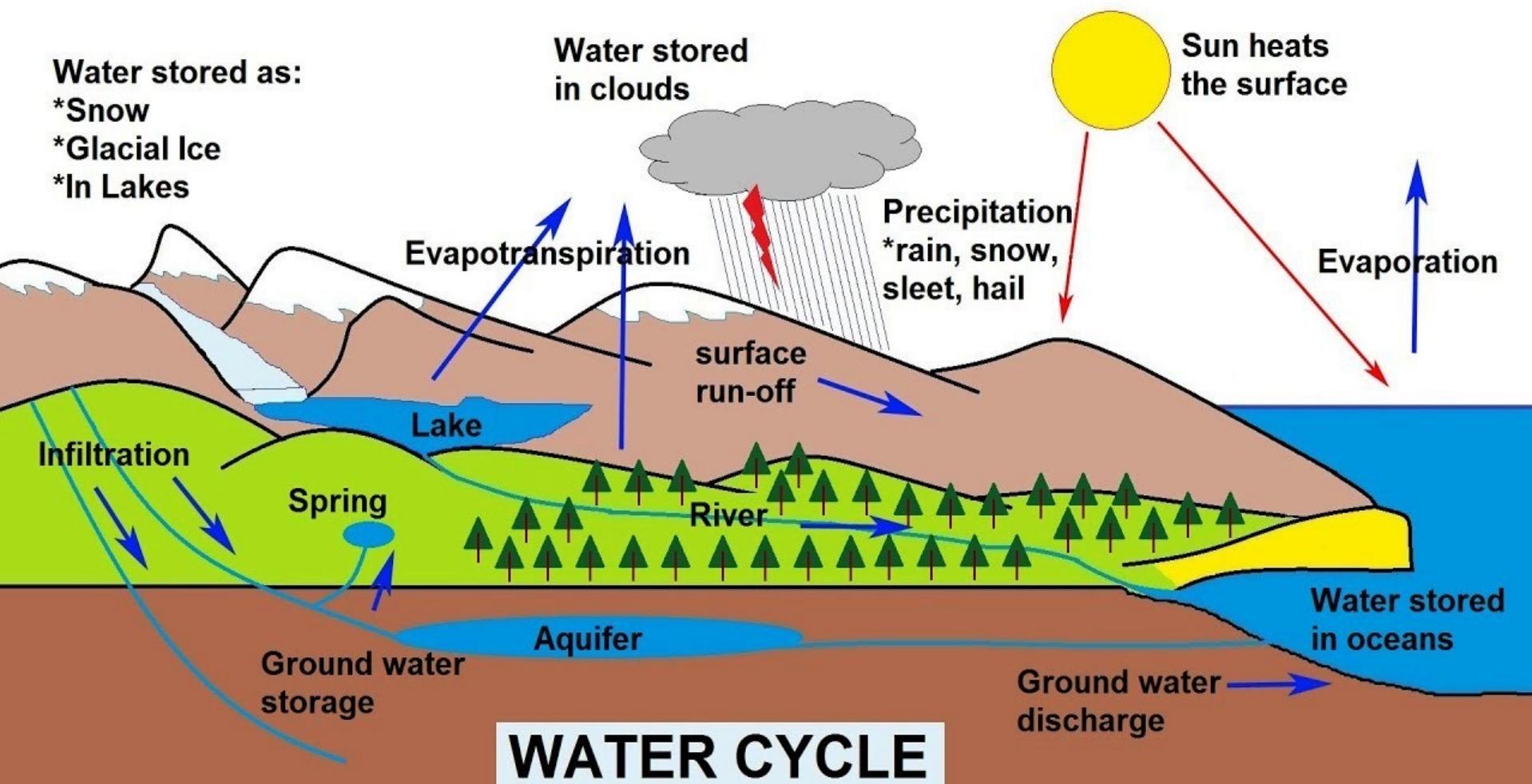
The Water Cycle

Adapted from Wikipedia/Ehud Tal



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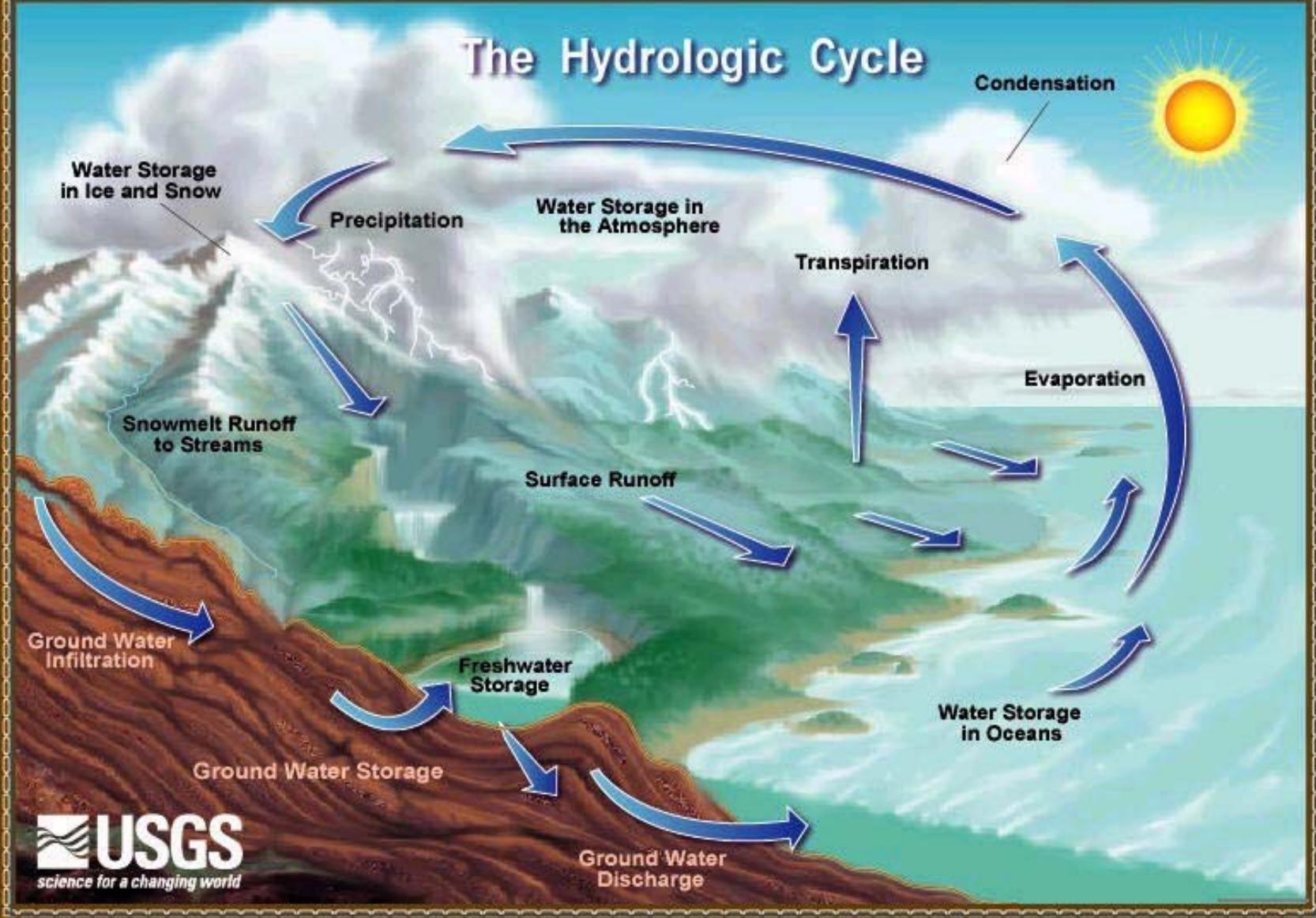
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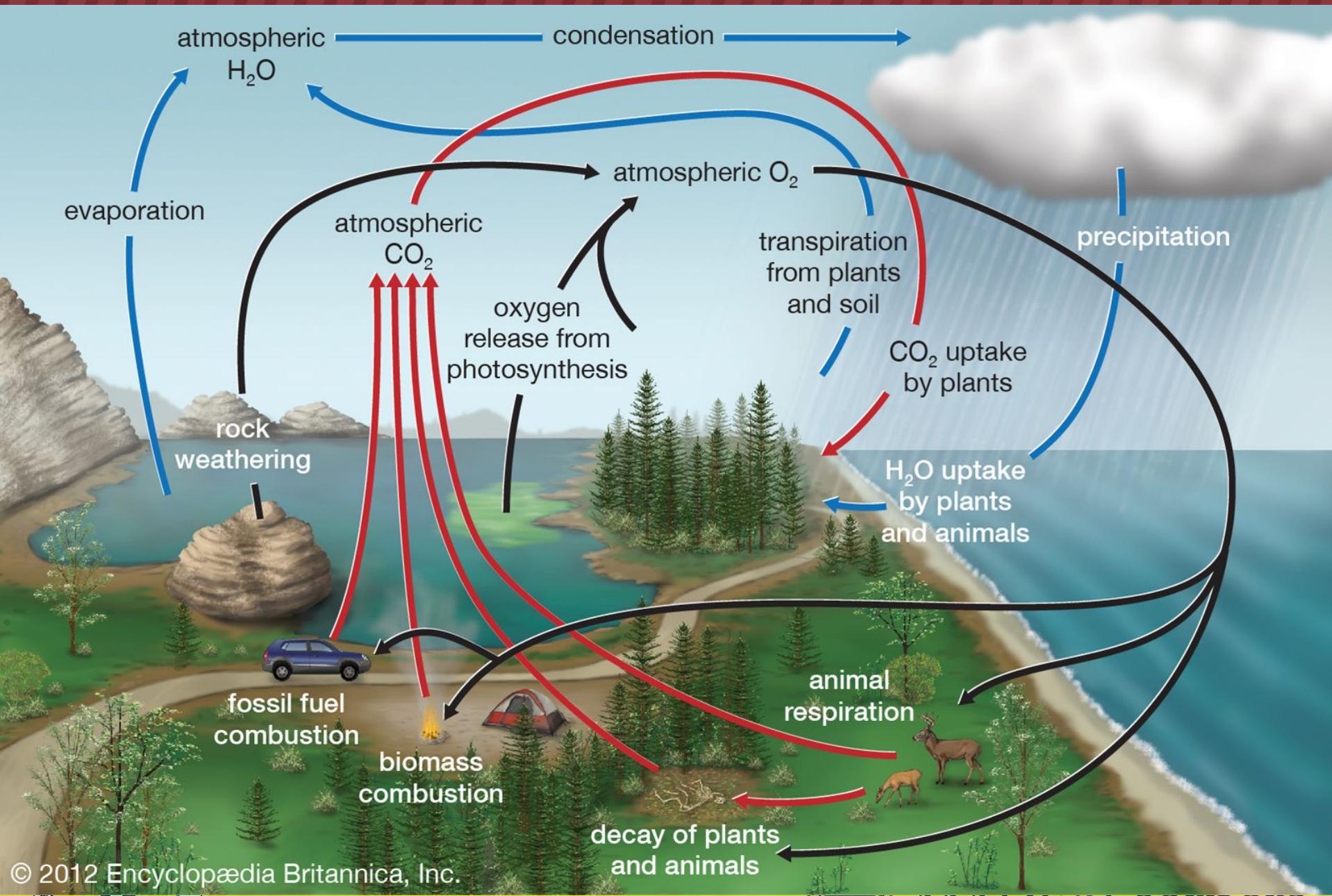
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The Hydrologic Cycle



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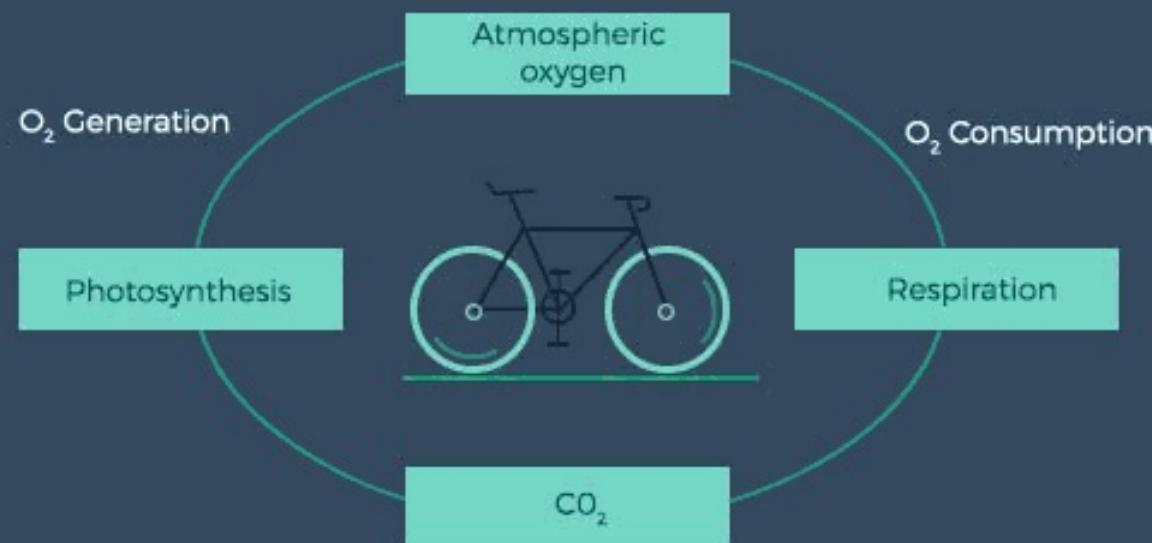


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THE OXYGEN CYCLE

Oxygen is constantly used and created by different processes on planet Earth.



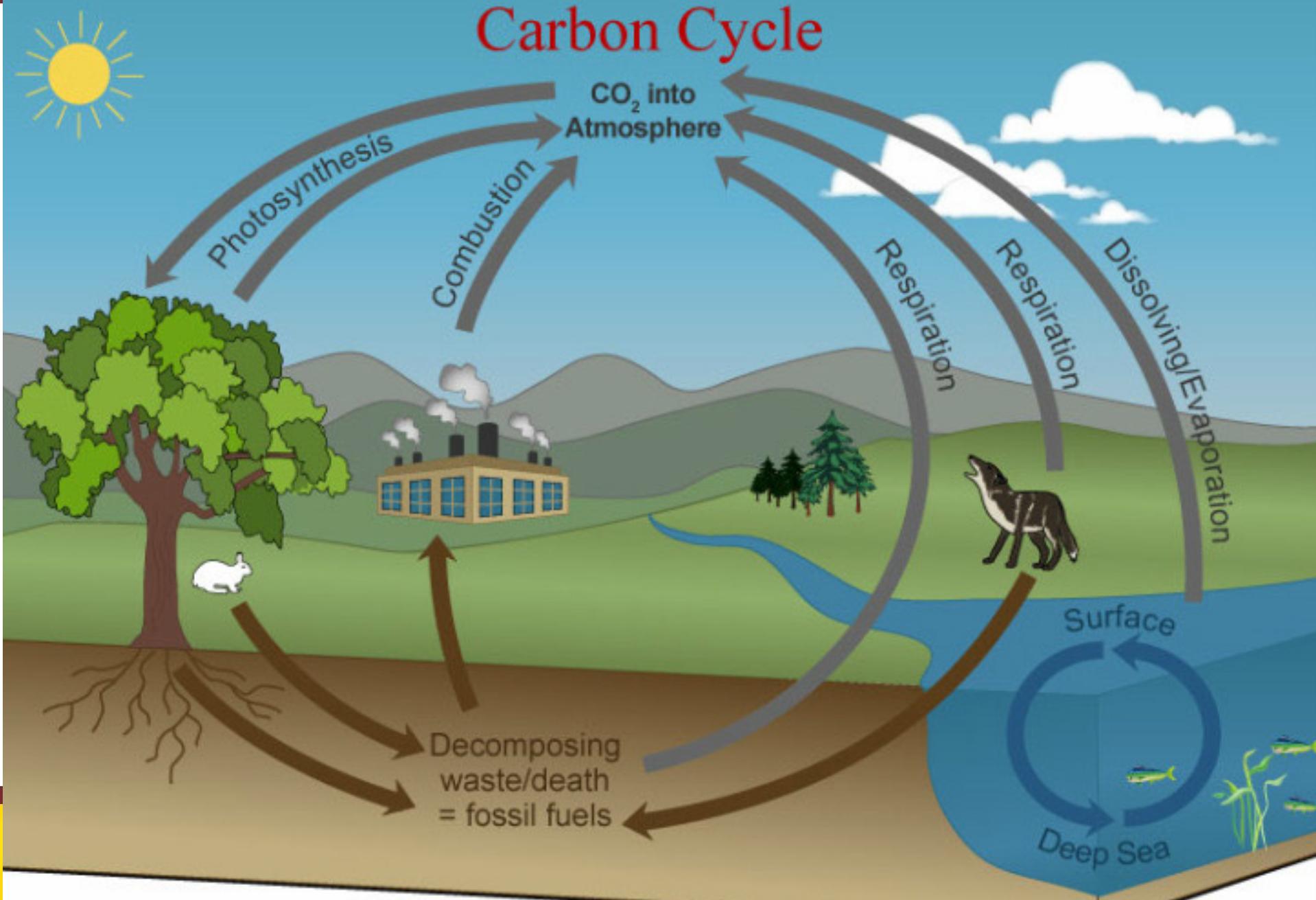
Oxygen Generation

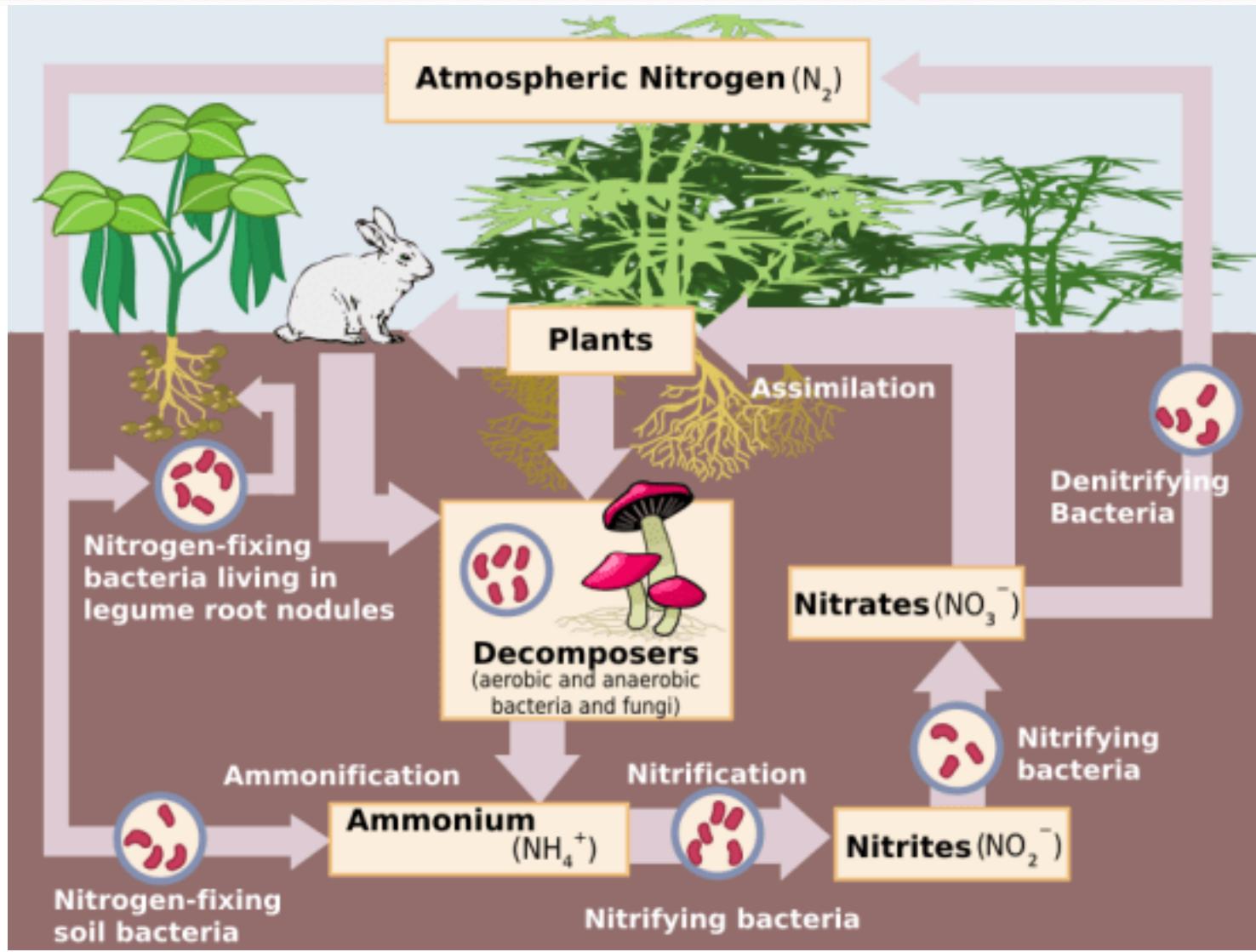
- Plants - via photosynthesis
- Sunlight - via reaction with water vapour

Oxygen Consumption

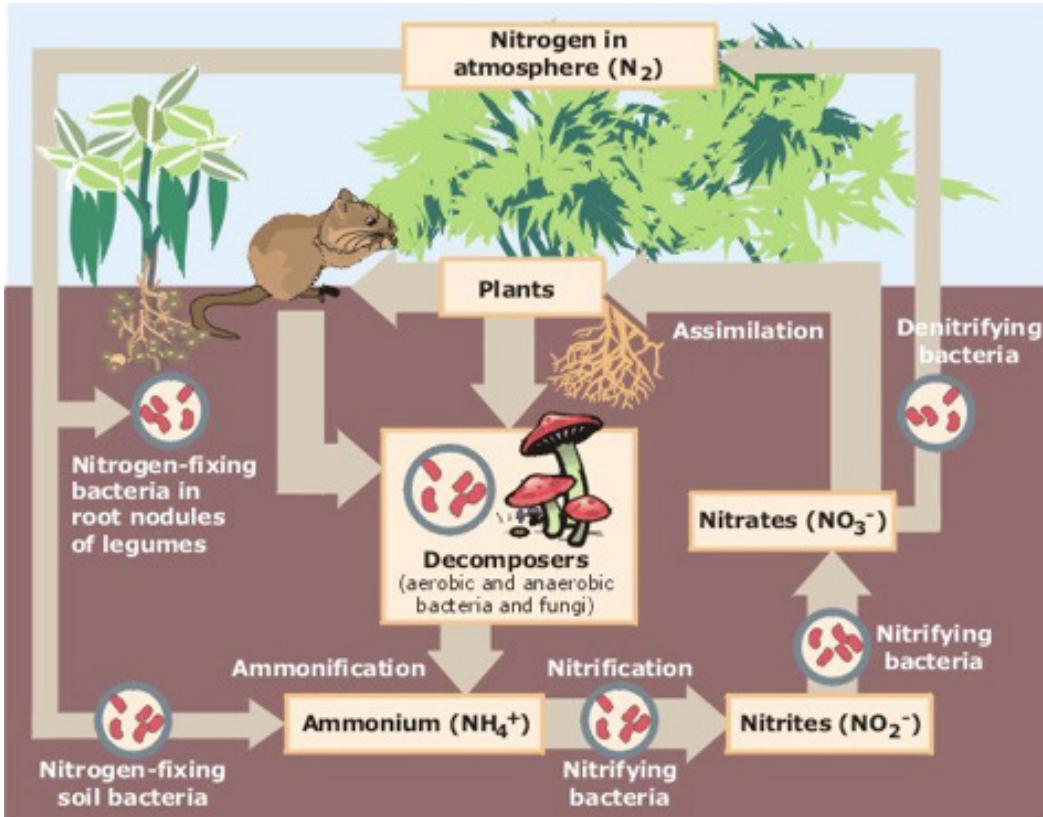
- Respiration
- Decomposition
- Rusting
- Combustion

Carbon Cycle





NITROGEN CYCLE IN ECOSYSTEMS

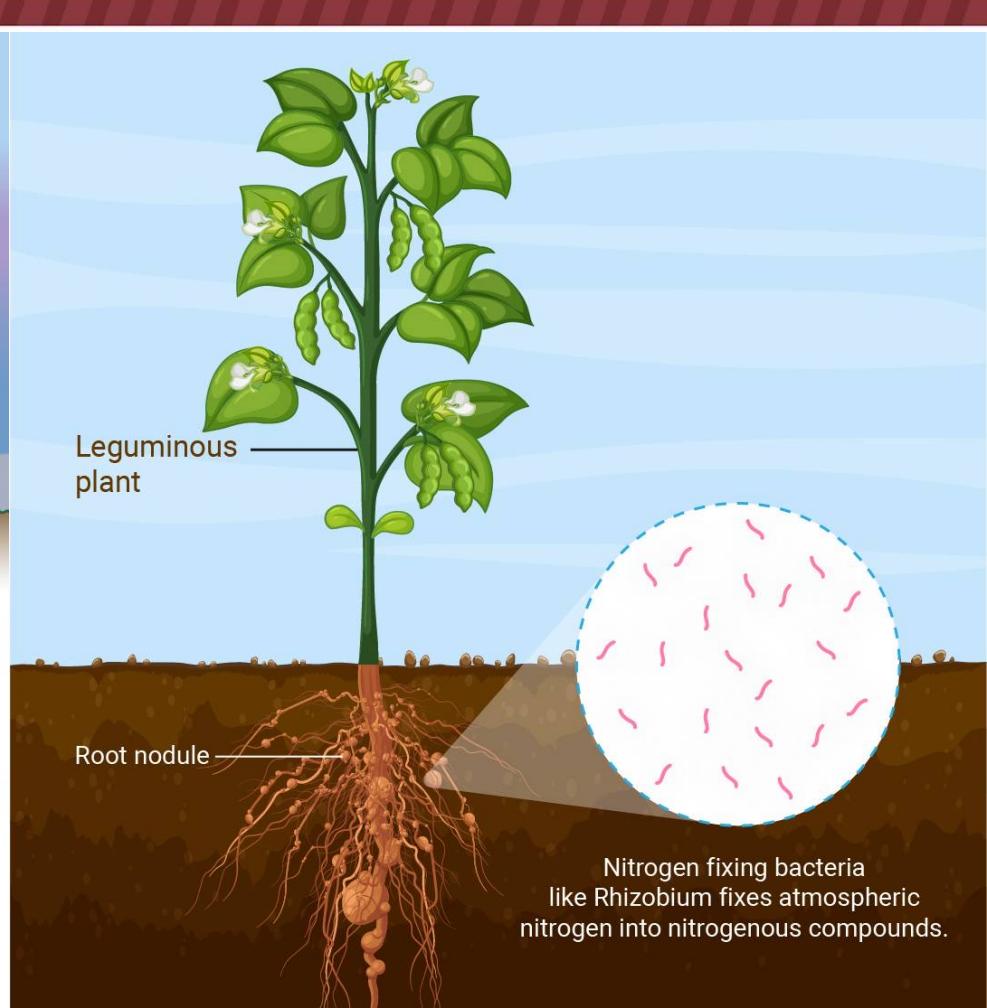
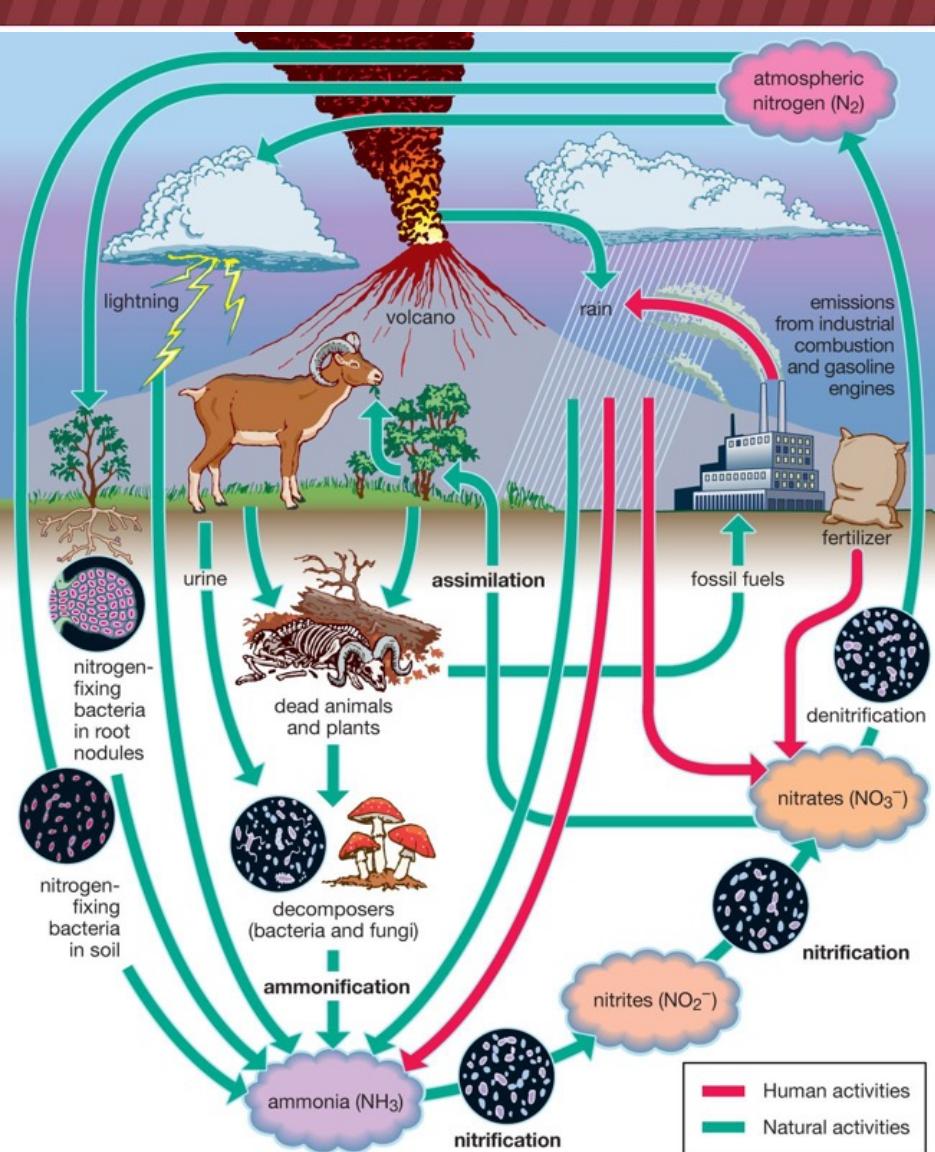


Nitrogen (N_2) makes up 78% of the atmosphere.



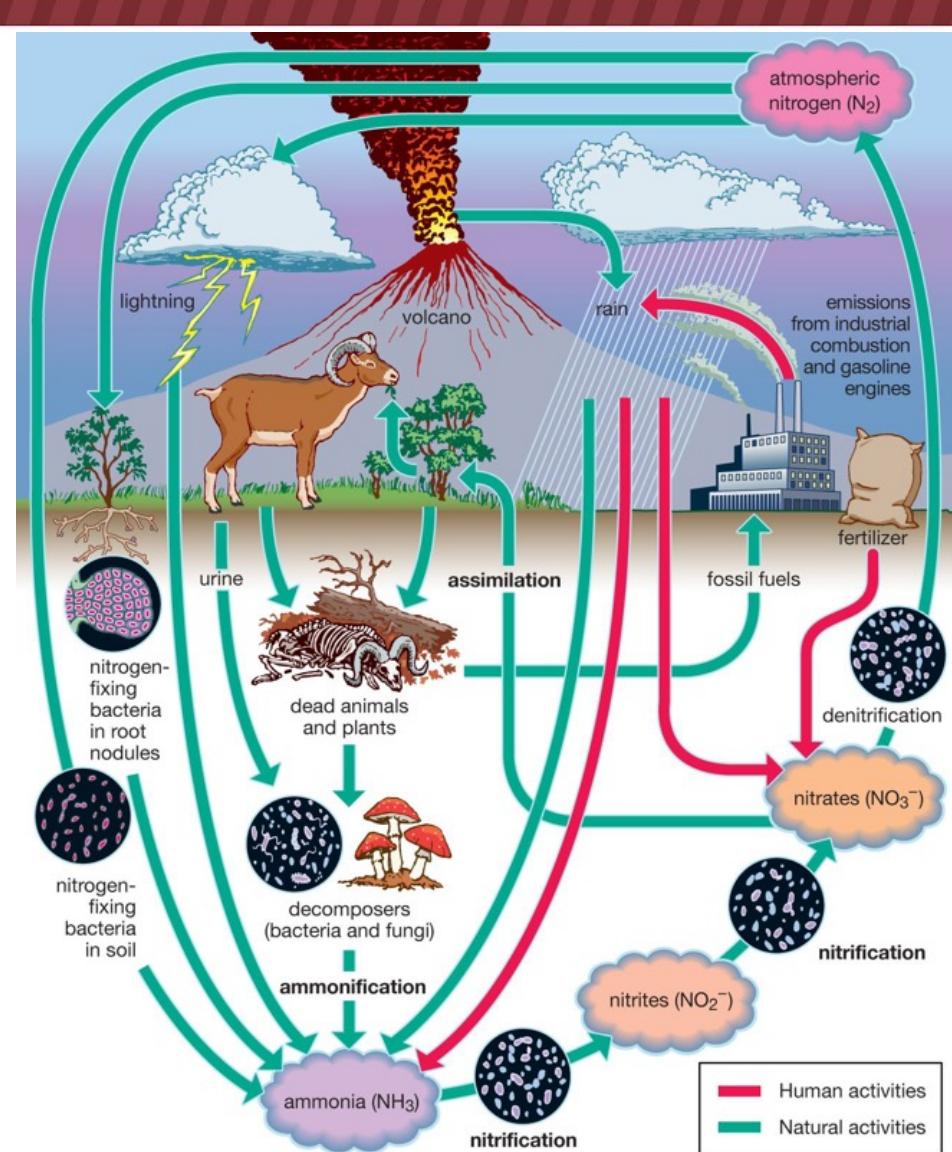
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Rhizobium is a genus of Gram-negative soil bacteria that fix nitrogen.



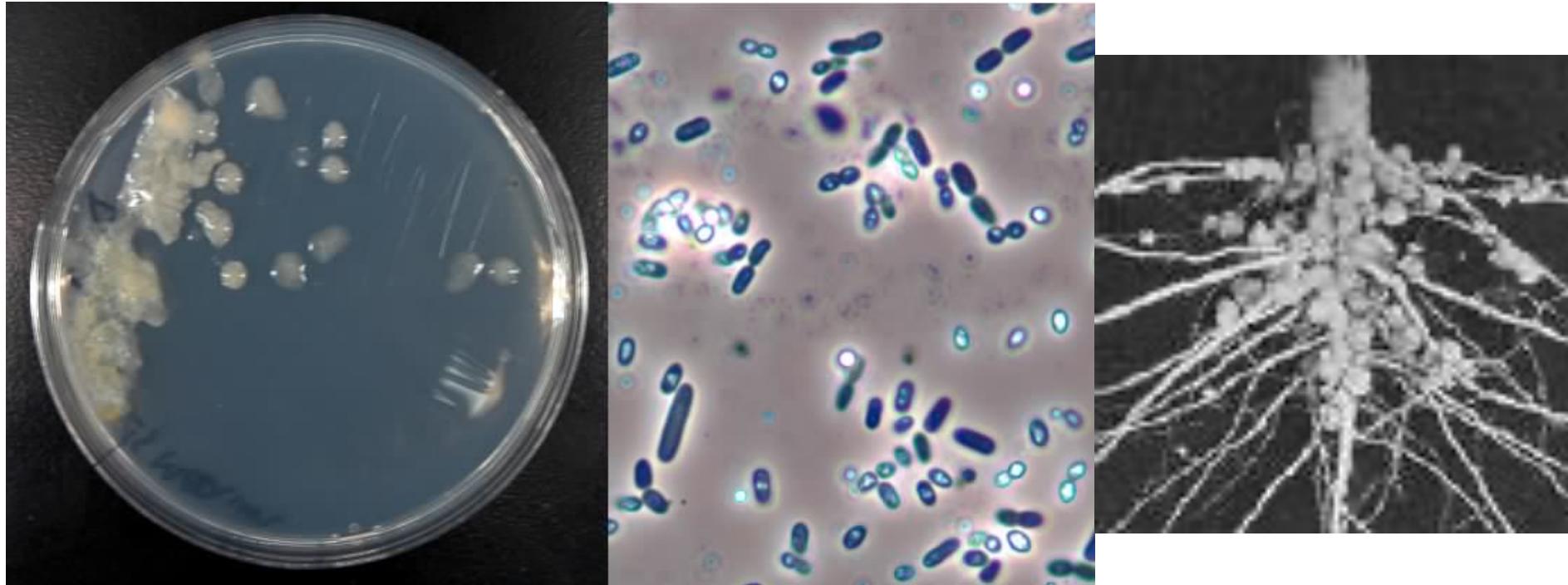


5 Steps:

- Nitrogen fixation (N_2 to NH_3 / NH_4^+ or NO_3^-)**
- Nitrification (NH_3 to NO_3^-)**
- Assimilation (Incorporation of NH_3 and NO_3^- into biological tissues)**
- Ammonification (organic nitrogen compounds to NH_3)**
- Denitrification(NO_3^- to N_2)**



Biological Nitrogen Fixation



Free-living soil bacteria and cyanobacteria (blue-green “algae”) are capable of converting N₂ into ammonia (NH₃) and ammonium (NH₄⁺).



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Learning Activity Assignment:

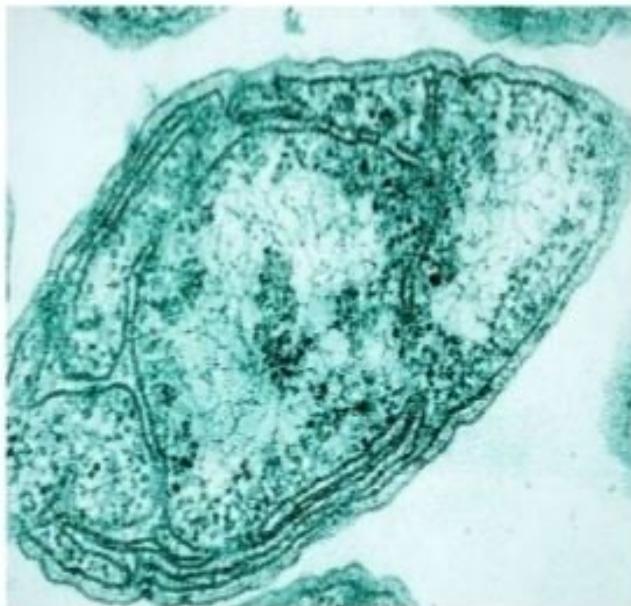
- Explain the difference between gaseous and sedimentary biogeochemical cycles.
- Enumerate at least 3 examples on each classification of biogeochemical cycles.
- Explain how phytoplankton controls the CO₂ emission.



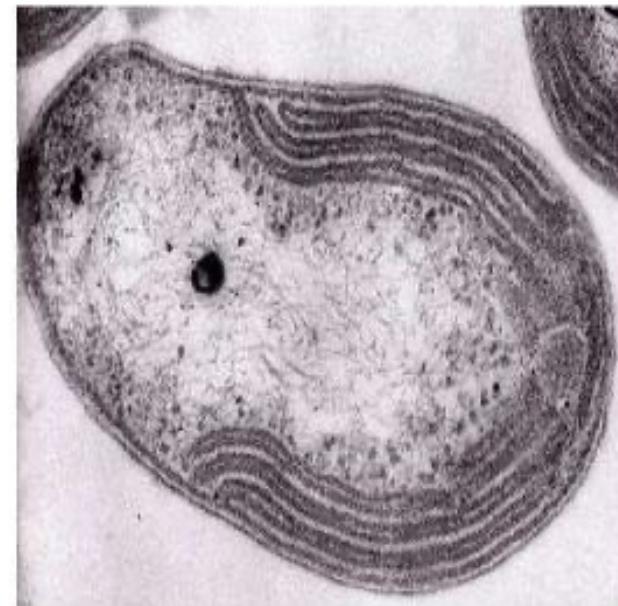
Nitrification

Nitrifying bacteria

13



Nitrosomonas



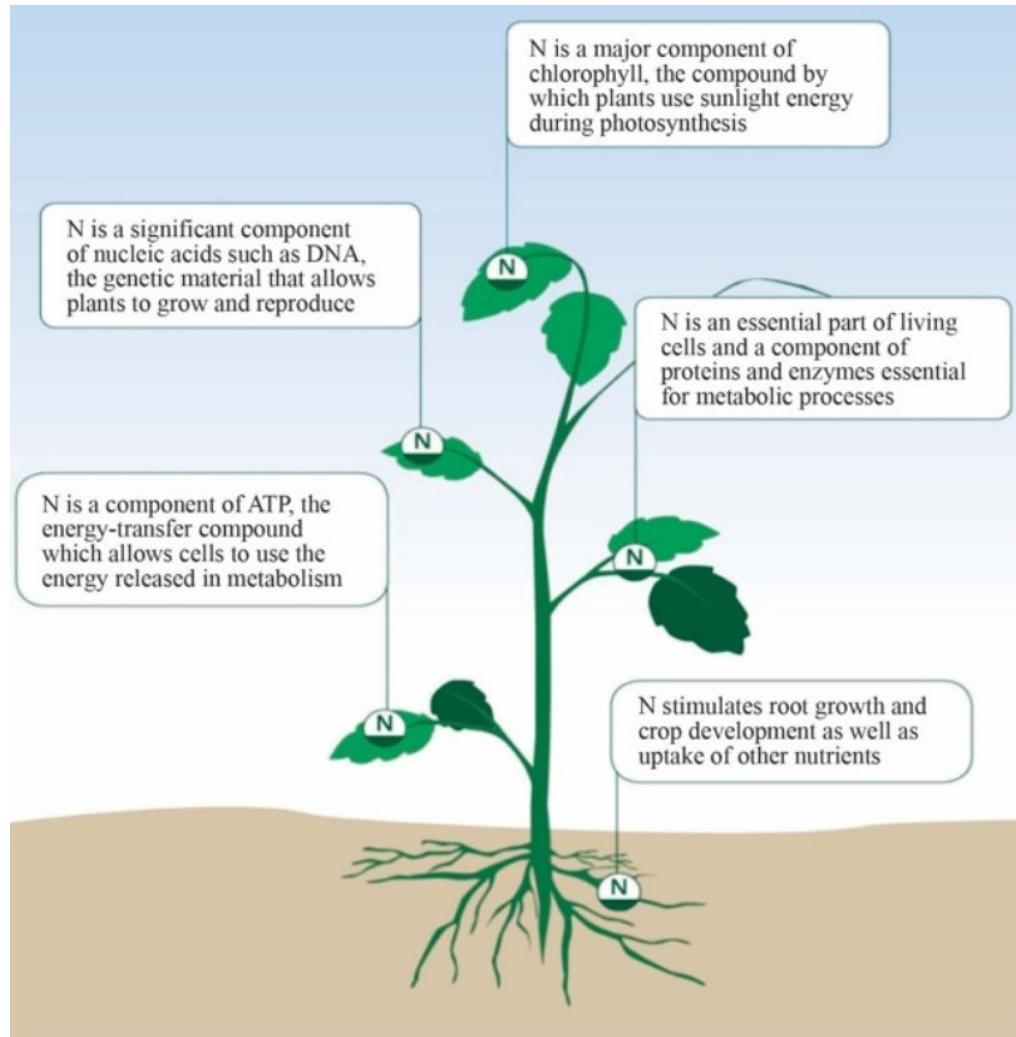
Nitrobacter



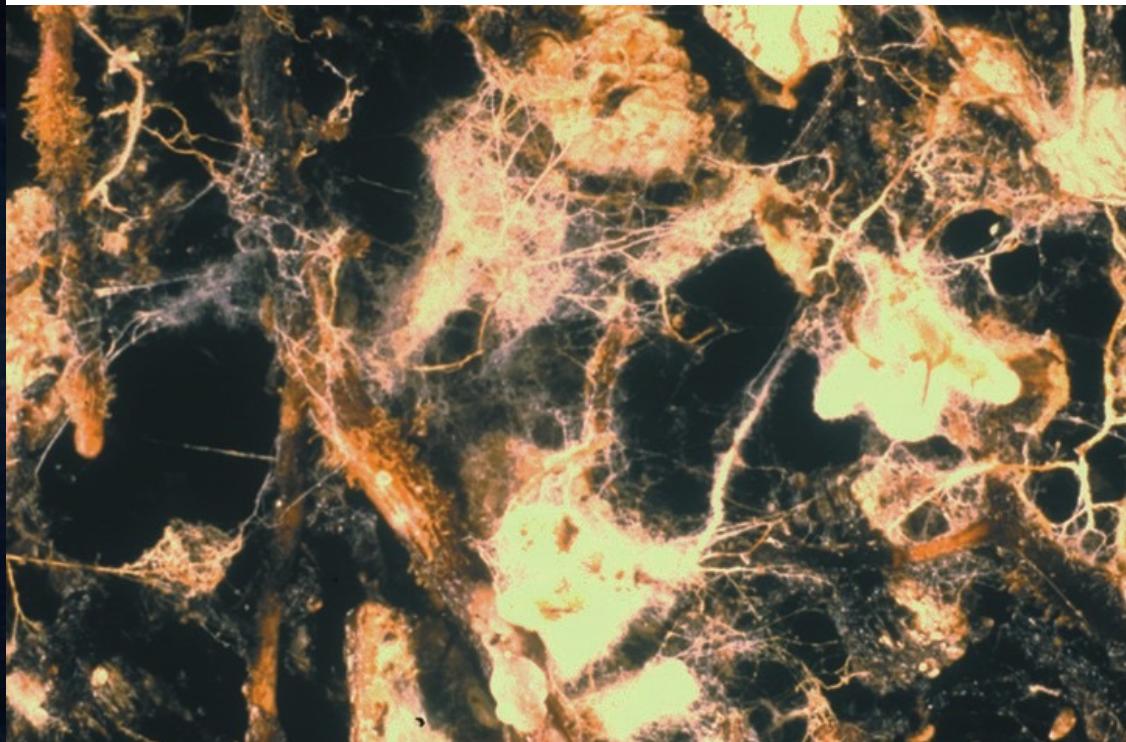
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Uptake of Nitrogen by Plants



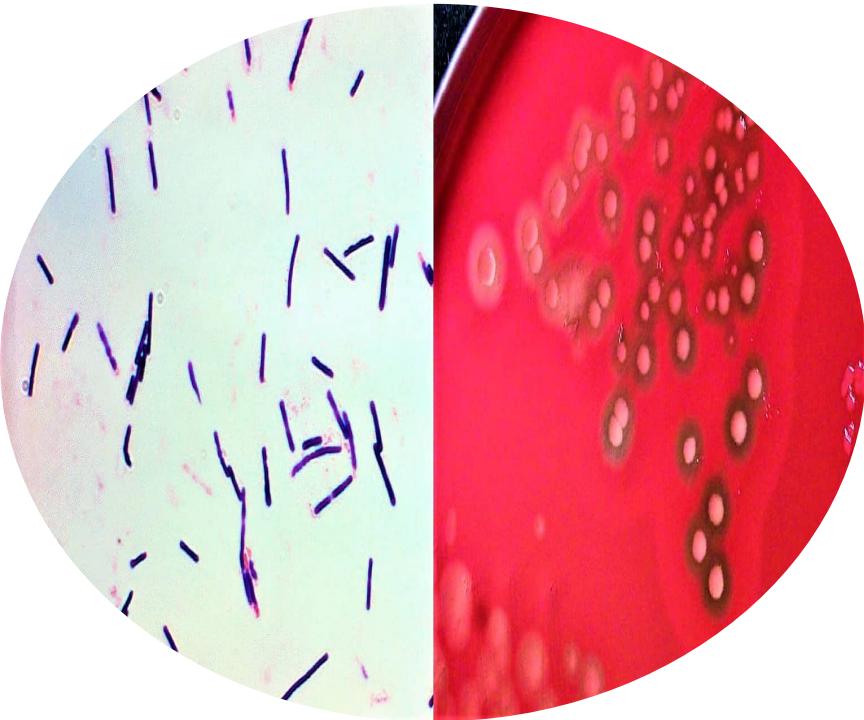
Ammonification



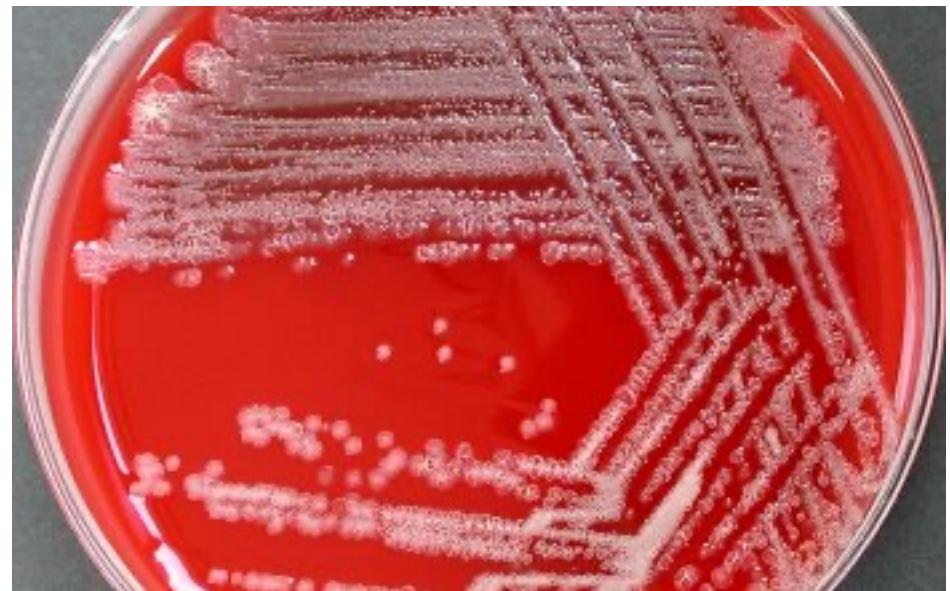
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Denitrification



Clostridium sp.



Pseudomonas stutzeri



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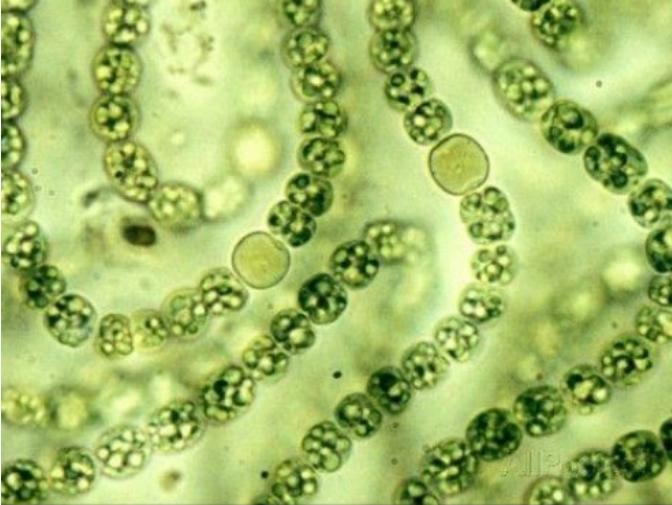
Sources of Nitrogen to the Soil



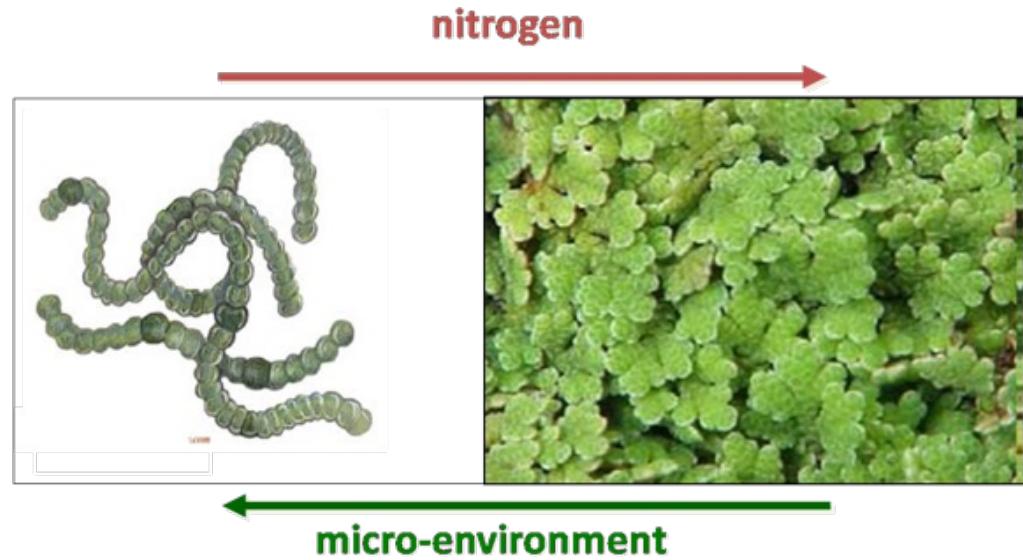
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Biological Sources of Soil Nitrogen

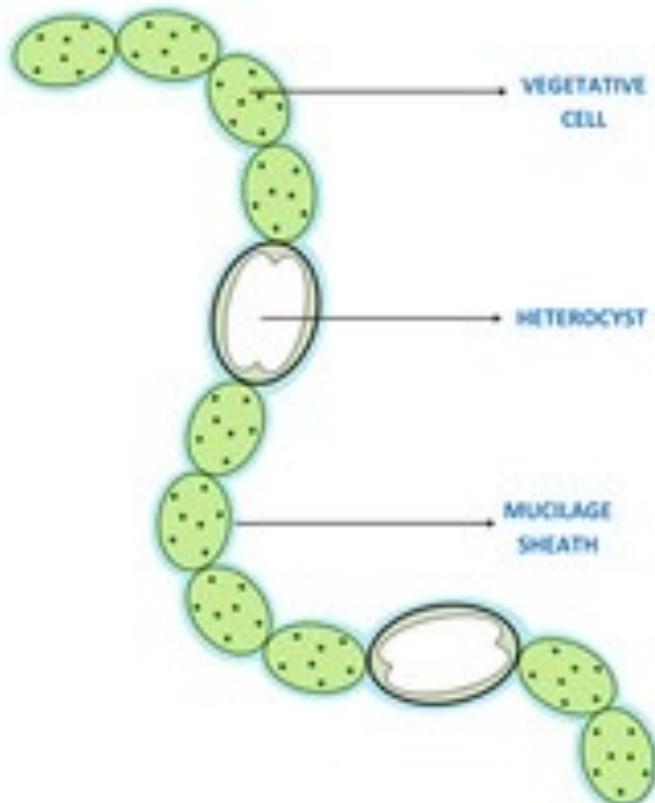


Nostoc sp. – blue - green algae

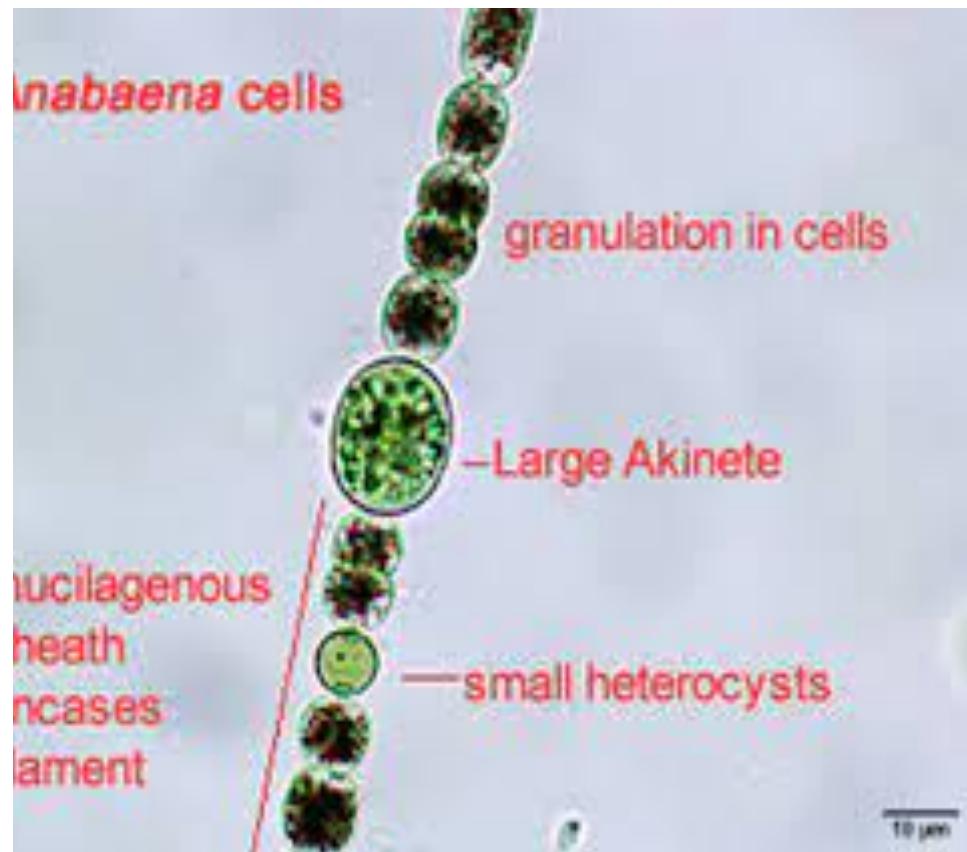


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Nostoc



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Mycorrhizal
colonization also
alter root
exudation



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Atmospheric Sources of Soil Nitrogen



Agricultural Supplements to Soil Nitrogen



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NUTRIENT LOSS IN ECOSYSTEMS I



Experiments at Hubbard Brook



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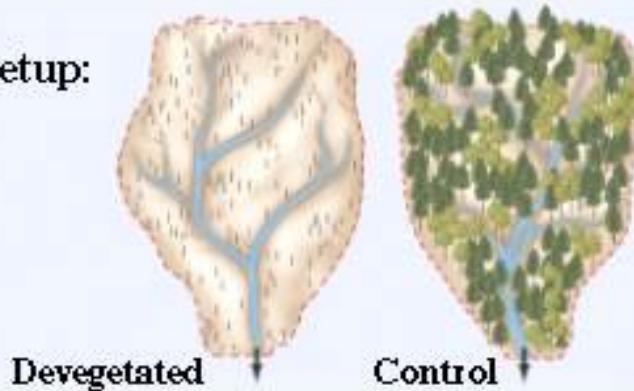
NUTRIENT LOSS IN ECOSYSTEMS II

Question: How does the presence of vegetation affect the rate of nutrient export in an ecosystem?

Hypothesis: Presence of vegetation lowers the rate of nutrient export because it increases soil stability and recycling of nutrients.

Null hypothesis: Presence of vegetation has no effect on the rate of nutrient export.

Experimental setup:



1. Choose two similar watersheds. Document nutrient levels in soil organic matter, plants, and streams.
2. Devegetate one watershed, and leave the other intact.
3. Monitor the amount of dissolved substances in streams.

Prediction: Amount of dissolved substances in stream in unvegetated watershed will be much higher than amount of dissolved substances in stream in control watershed.

Prediction of null hypothesis: No difference will be observed in amount of dissolved substances in the two streams.



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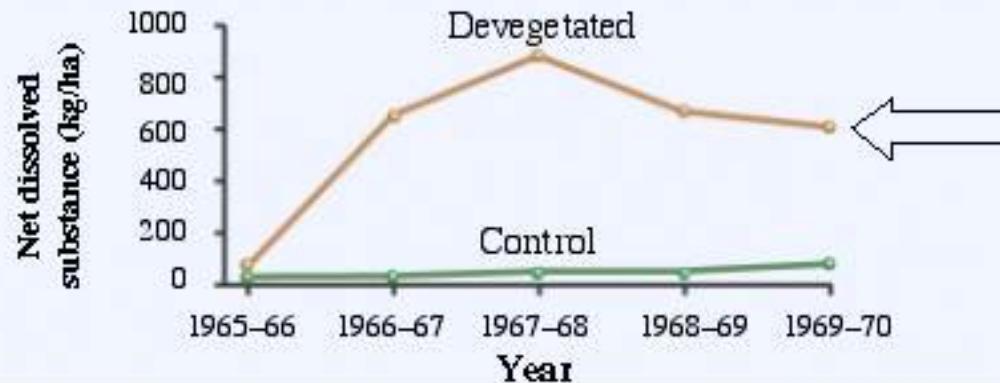
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NUTRIENT LOSS IN ECOSYSTEMS III

Prediction: Amount of dissolved substances in stream in devegetated watershed will be much higher than amount of dissolved substances in stream in control watershed.

Prediction of null hypothesis: No difference will be observed in amount of dissolved substances in the two streams.

Results:

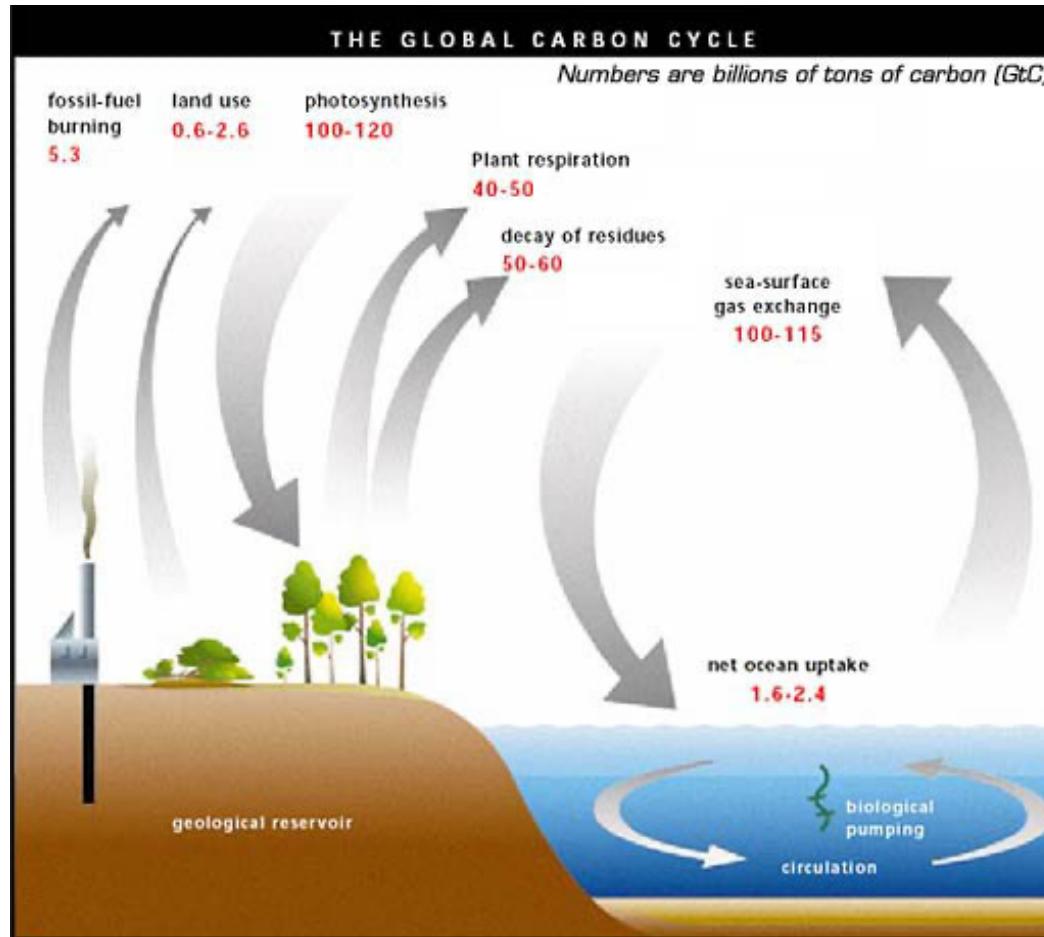


About 10 times more dissolved substances in devegetated watershed than in control watershed

Conclusion: Presence of vegetation limits nutrient loss. Removing vegetation leads to large increases in nutrient export.



GLOBAL NUTRIENT CYCLES



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Sedimentary Cycles

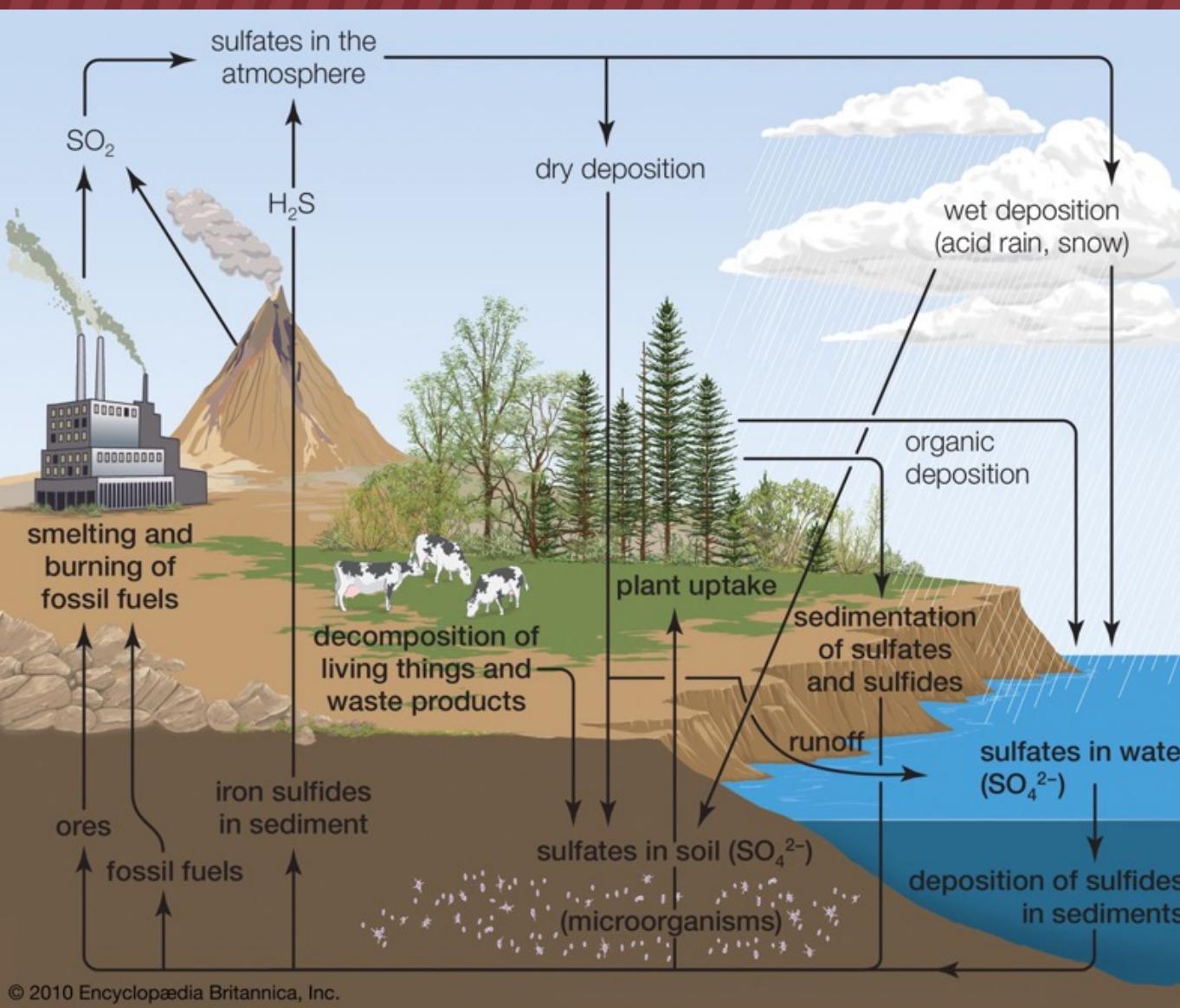
Sulfur Cycle

Phosphorous Cycle



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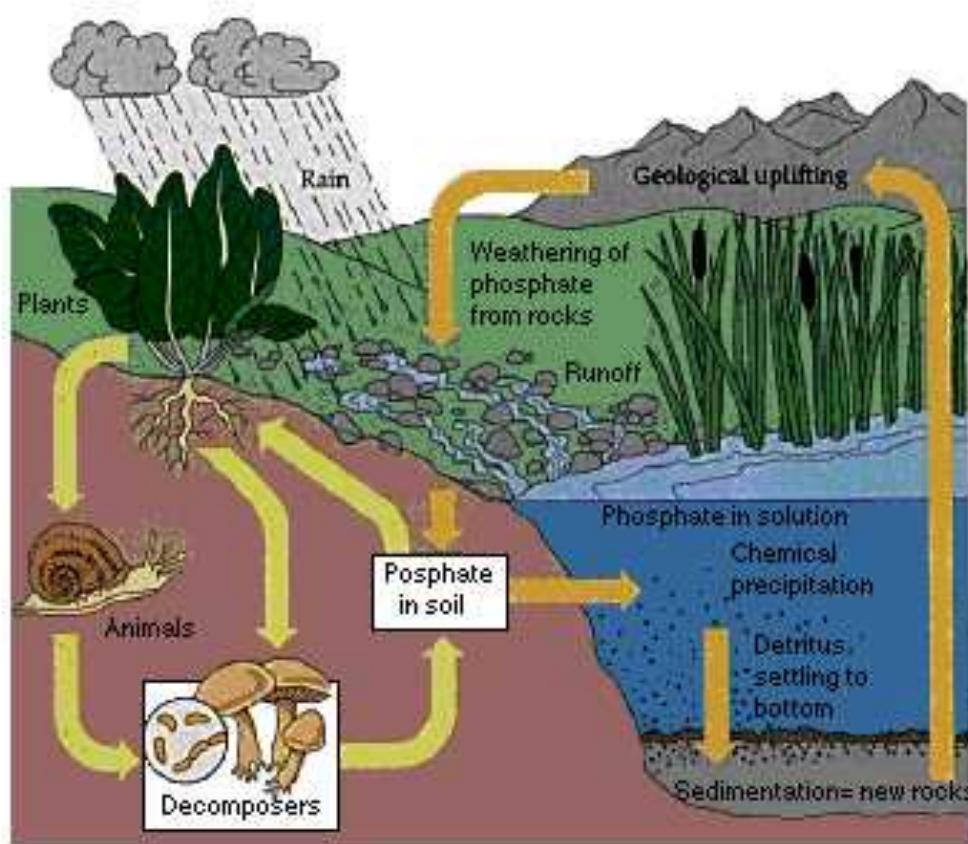


Sulfur Cycle

- Sulfur is released from rocks through weathering, and then assimilated by microbes and plants.



PHOSPHOROUS CYCLE IN ECOSYSTEMS



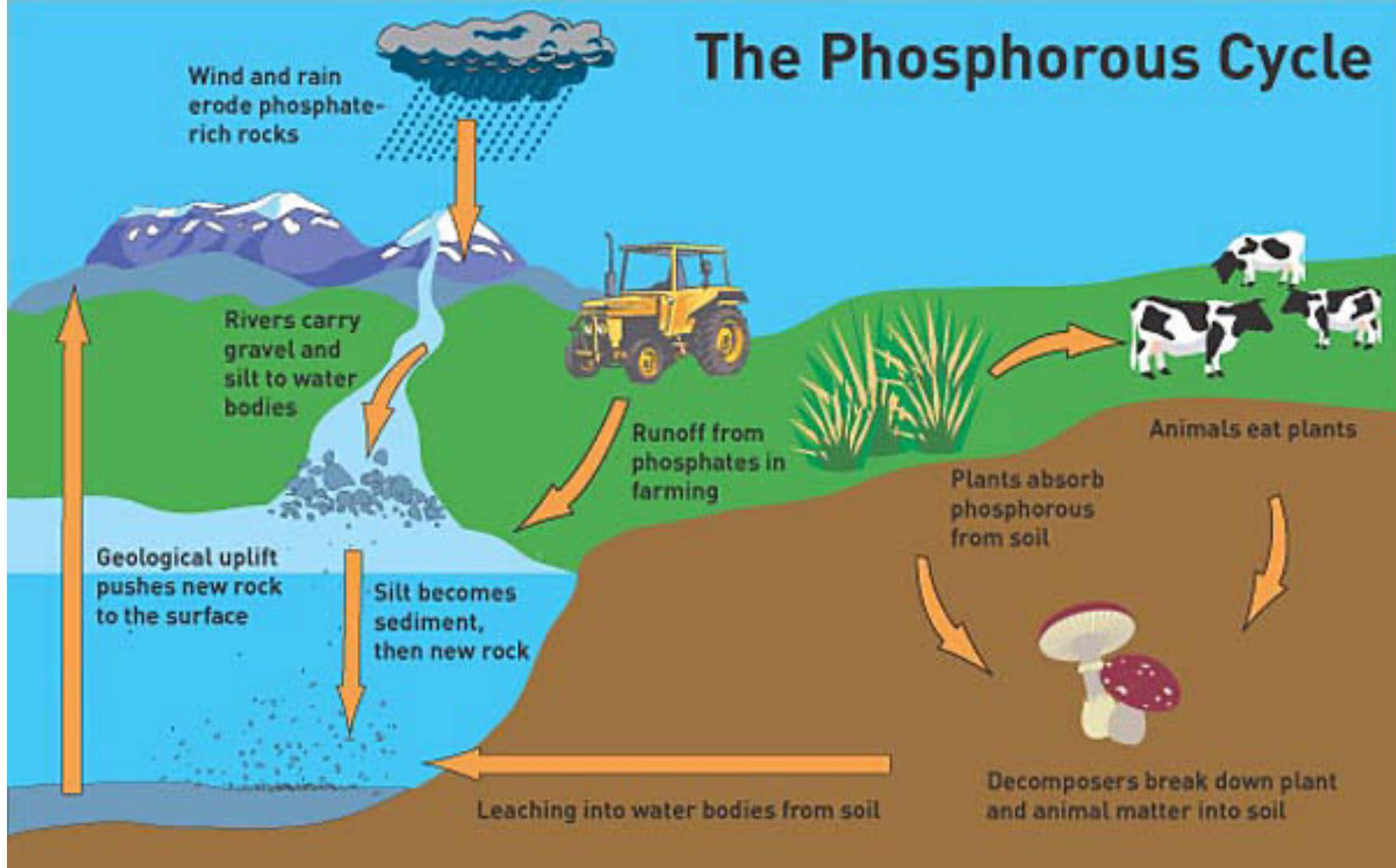
Phosphorus, as phosphate (PO_4^{3-}), is an essential element of life.



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The Phosphorous Cycle



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