Ecology and Biodiversity

Ecology

- **Ecology** is the study of the relationships between all organisms and their environment.
- An **ecosystem** is a self-sustaining collection of organisms and their environment.
- The **biosphere** is the largest ecosystem of all. It consists of the thin layer of the earth's surface where all organisms live.

Ecosystems

- Ecosystems consist of three levels of life:
  - **Species** - the sheer variety of species on Earth
  - **Ecosystems** - the environments where the species evolve and live
    - A **community** - which refers to the organisms that live in a particular place such as a forest (residents of a neighborhood).
    - A **habitat** - refers to the physical location of a community (neighborhood).
  - **Genetic diversity-** all the variety of genes within a species (and ecosystem)

Components of an Ecosystem

- Nonliving components of an ecosystem are called **abiotic factors**.
  - Examples: sunlight, chemistry of soils, slope of land, temperature
- Living components of an ecosystem are called **biotic factors**.
  - Examples: all living organisms - plants, animals, protists, bacteria…
  - Interactions of biotic factors include **predation & symbiosis.**

Biodiversity

- **Biodiversity** refers to the number and variety of species on Earth.
- The number of known species on Earth is about **1.6 million**, most of which are insects.
  - This differs from the actual number of species on Earth, which may be closer to 13 million.

Importance of Biodiversity

- **Biodiversity** does more than provide a variety of products and resources
  - it also keeps the planet **livable** for us and for all other species.
- **Biodiversity** helps:
  - **maintain the atmosphere**
  - **keep the soil fertile**
  - **purify water**
  - **and generally keep the world running smoothly**
- We have the power to destroy species and ecosystems, so humans have a **moral obligation** to be careful stewards of the Earth.

Loss of Biodiversity

- We can not afford to be careless with our natural resources. We share the environment with other organisms in a complex network.
- Each species has a role or **niche** to play in its ecosystem.
  - If one species disappears from an ecosystem, the ecosystem changes.
- **Keystone species** are species that are so important to the functioning of an ecosystem that if they disappear the ecosystem falls apart.
  - Example: Sea Otters in California
- To understand the role people are playing in biodiversity loss, it helps to think of something called the **HIPPO dilemma**. This term doesn't refer to hippopotamuses, rather it is an acronym for the **main threats to biodiversity.**

HIPPO Dilemma

- **H**abitat loss
- **I**ntroduced species
- **P**opulation growth
- **P**ollution
- **O**ver-consumption

- **Habitat loss** - the destruction of habitats is the number one cause of **species extinction**.
- **Introduced species - Nonnative or Exotic species** are species that are not native to a particular region. These species can threaten native species, which have no natural defenses against them.
  - Example: Birds in Guam
- **Population growth** -There are **6 billion humans** living on Earth
  - Earth's population of human beings is **increasing** at a rate of about **222,000 people each day**.
  - This is changing the environment dramatically and causing other species to become extinct at an accelerated rate.
  - Humans take up more and more space and deplete more resources than any other species.

- **Pollution** - The more resources our population consumes, the more pollution we're likely to create.
  - Pollution's effects can be obvious, such as an oil spill, or not so visually obvious, such as insecticides that can cause reproductive failure in fish, birds, and mammals (like DDT).
- **Over-consumption** - Population growth alone doesn't account for the increasing consumption of natural resources that is largely responsible for biodiversity's decline.
  - Patterns of **affluence and poverty** also have a huge impact.
    - For example, those of us living in affluent, **industrialized nations**, such as the US, consume a disproportionate amount of the Earth's fossil fuels, forest, and other natural resources. People struggling to survive in **less-industrialized nations** often have little choice but to overuse the few resources available to them.

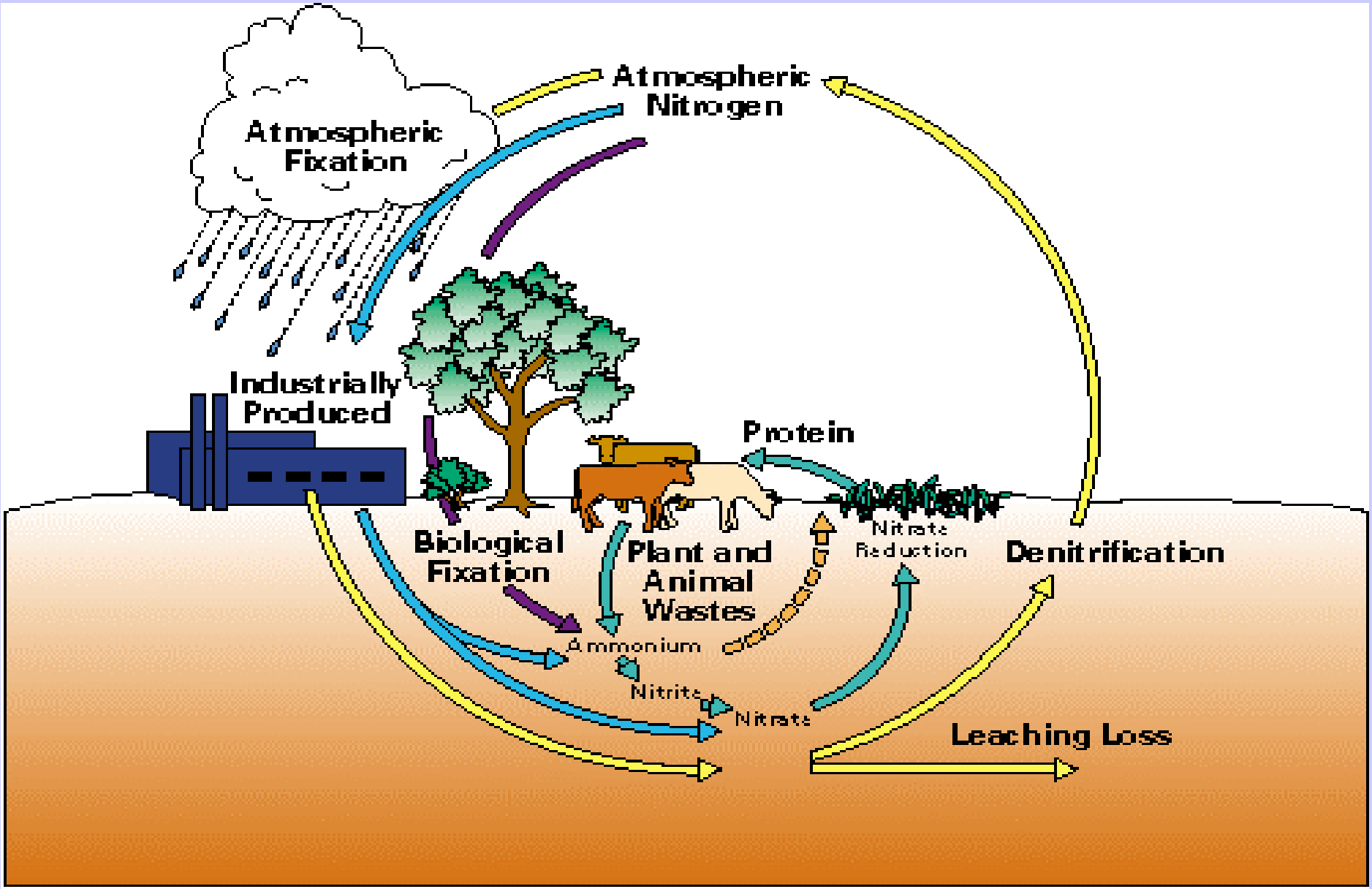
- **Extinction** occurs when the last individual of a species dies.
- **Mass extinction** is the extinction of many species during a relatively short period of time.
    - Example: Dinosaurs
    - These are often caused by a change in climate.
  - Many scientists believe that we are living in a mass extinction, and that by the year 2100, 25% or more of all species of plants and animals that were on Earth in 1900 will have become extinct.
    - This will be caused by the action of human beings.

How do organisms in ecosystems obtain adequate amounts of the minerals and other inorganic substances they need?

- **Nutrients**, like calcium, nitrogen, iron and potassium circulate within an ecosystem.
- **Rainfall** helps minerals get **absorbed** into plants.
- Other organisms eat the plants, and the nutrients are cycled through the **food chain**.

Nitrogen Cycle

- **Nitrogen** is a component of proteins and nucleic acids.
- **Nitrogen gas** (N_2) cannot be absorbed directly from the atmosphere by organisms.
  - It has to be converted to **ammonia**, NH_3.
  - The process of changing N_2 to NH_3 is called **nitrogen fixation**.
    - This is accomplished through the action of **bacteria**.
    - Bacteria have an enzyme that is strong enough to break the chemical bond between the 2 nitrogen atoms. This allows the nitrogen to bond with hydrogen and form ammonia.
    - Ammonia is absorbed by plants
- Since **animals** cannot absorb nitrogen from the soil, they must **obtain nitrogen by eating plants or other animals**.
- When animals and plants die, the nitrogen in its body is **released by decomposers**.
  - Animal wastes, such as dung and urine, as well as plant material are decomposed and return nitrogen to the soil.

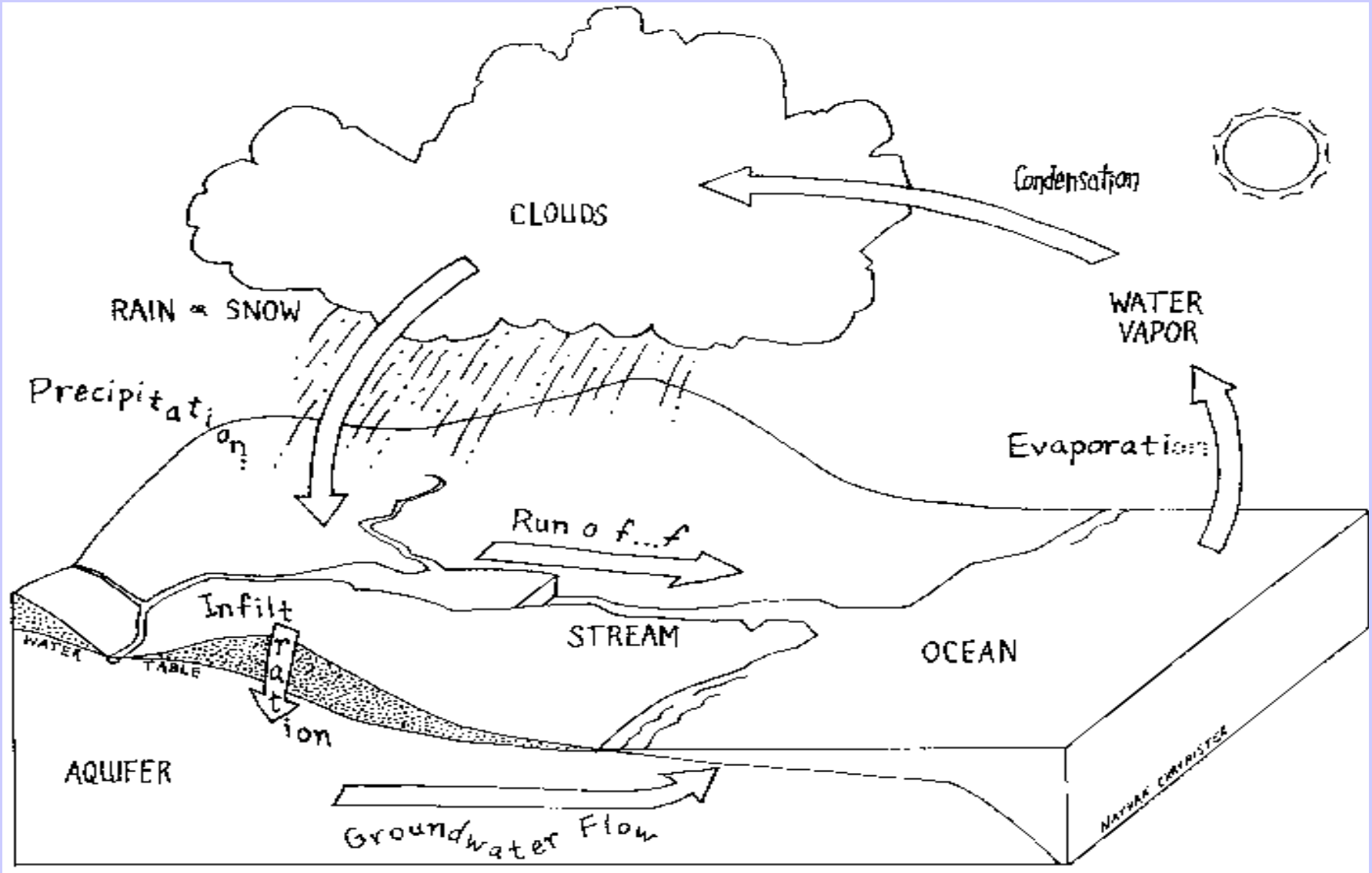


The Nitrogen Cycle

Water Cycle

- The **availability of water** determines the **diversity of organisms** in an ecosystem.
- Plants absorb much of the water that is **precipitated**.
  - **Precipitation** is rain, snow, hail, sleet, etc.
- Plants also **transpire** (release) water through their leaves.
  - The process is called **transpiration**.
- When trees are cut, water is not absorbed and it will runoff into streams and rivers, eventually making its way back to the ocean.
  - This impacts the water cycle, the nutrient cycle, and soil cycles.

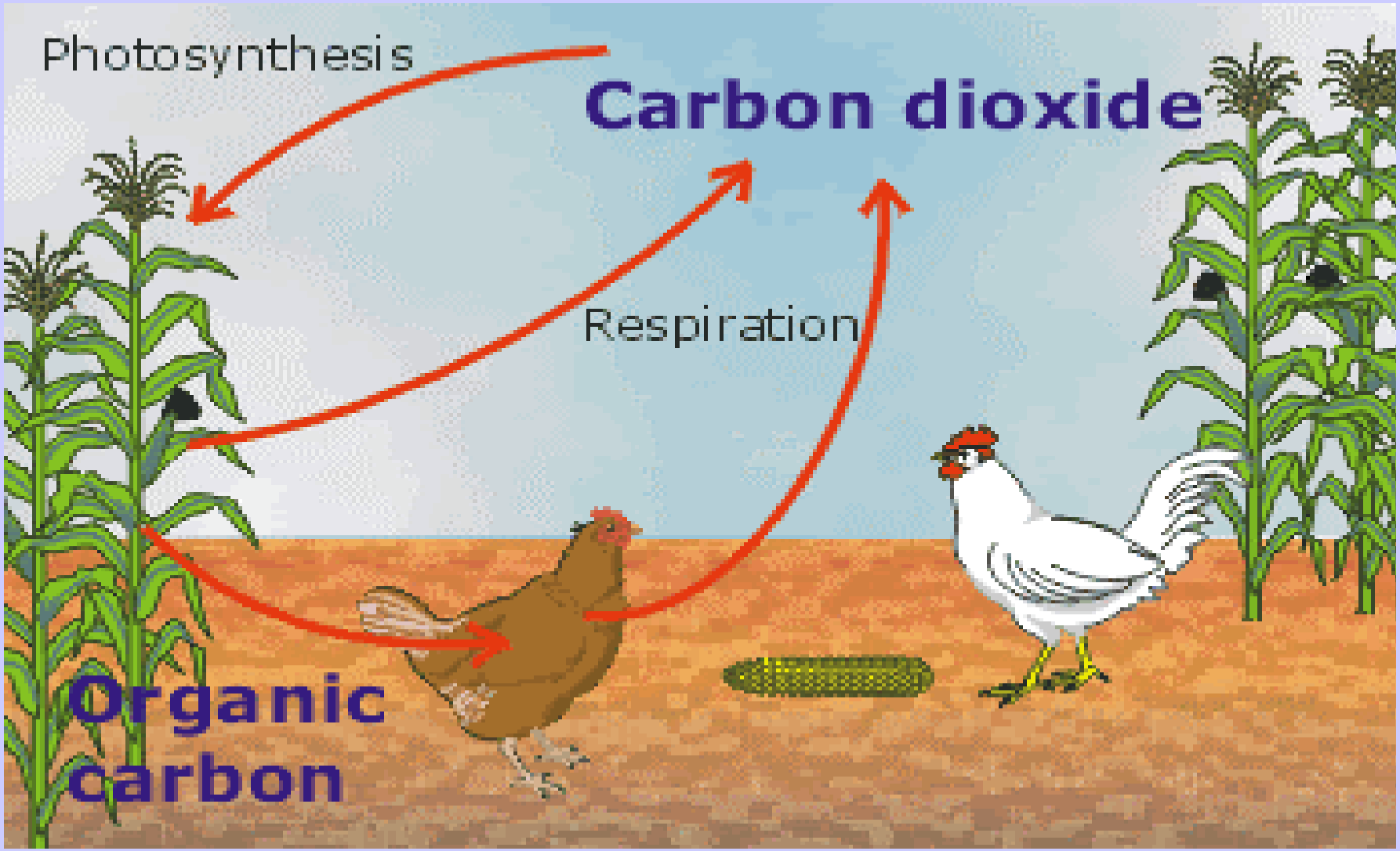
The Water Cycle



Carbon Cycle

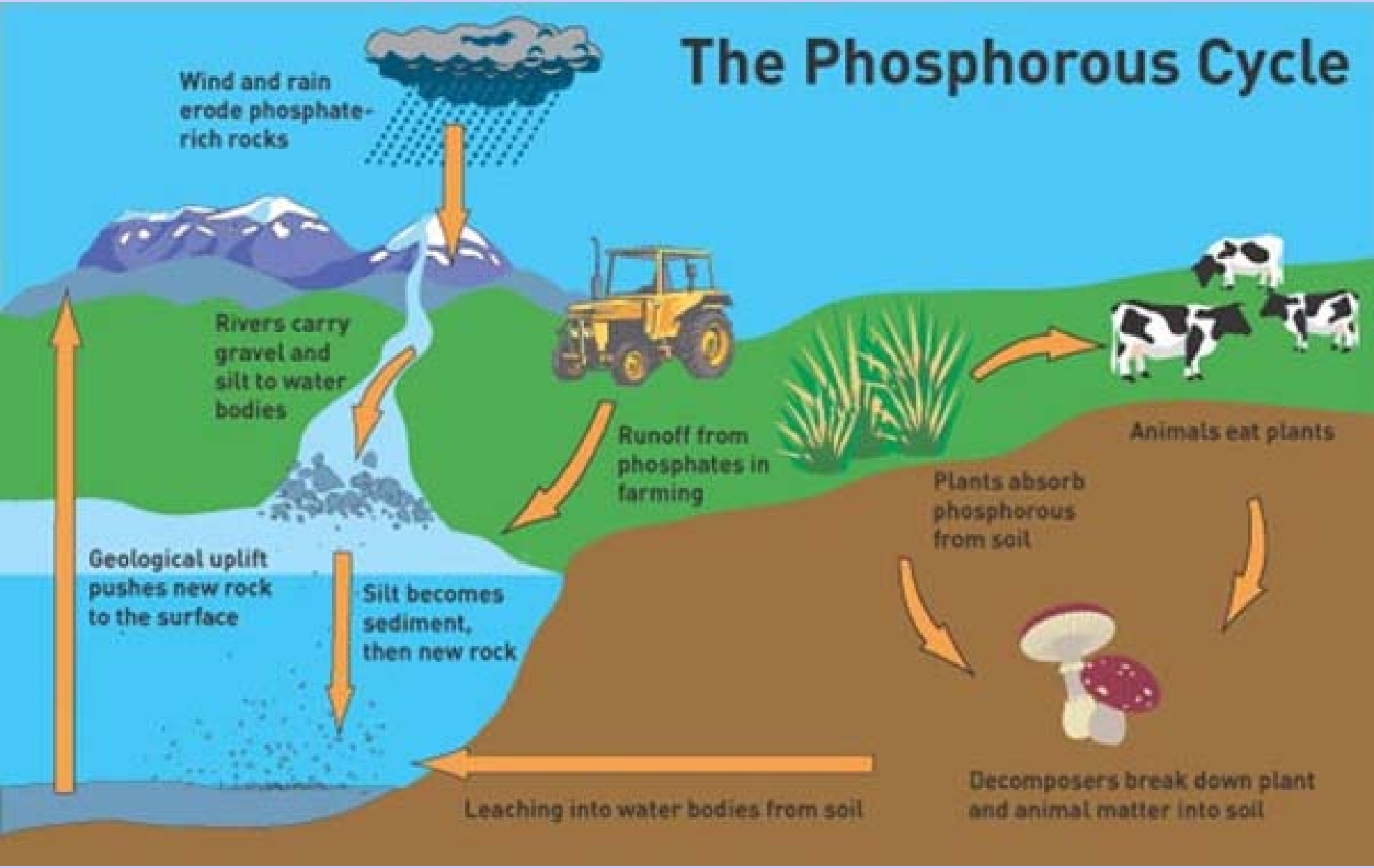
- Like water, carbon cycles between the living and non-living environment.
- Carbon is absorbed by plants as **CO_2**.
- Produces, such as plants use **carbon dioxide** to make other organic molecules in a process called **photosynthesis**.
- **Consumers** obtain energy-rich molecules that contain carbon by eating plants or other animals.
  - As these molecules breakdown, CO_2 is produced and released in a process called **respiration**.

The Carbon Cycle



The Phosphorus Cycle

- Organisms require **phosphorus** as major ingredients of **DNA, cell membranes**, and energy storing molecules (**ATP**).
- The weathering of **rocks** gradually adds **phosphate** to the soil.
- **Producers** (plants) use this phosphate found in the soil.
- **Consumers** (animals) get phosphorus by eating the producers.
- Phosphate is returned to the soil through consumer excretion and by the action of decomposers on dead organisms and organic waste.


The Phosphorous Cycle
Wind and rain erode phosphate-rich rocks
Rivers carry gravel and silt to water bodies
Runoff from phosphates in farming
Animals eat plants
Plants absorb phosphorous from soil
Geological uplift pushes new rock to the surface
Silt becomes sediment, then new rock
Leaching into water bodies from soil
Decomposers break down plant and animal matter into soil