

15

P

Phosphorus

30.9738

(Ne) $3s^2 3p^3$


280

44.1

1.82

STUFF
THEY DON'T
WANT YOU
TO KNOW™

PHOSPHORUS INFO

1. The phosphorus element has the atomic number 15
 2. The symbol of element is P
 3. It's atomic weight is 31
 4. It has 15 protons
 5. It has 15 electrons
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- A close-up photograph of a lit matchstick. The matchstick is positioned vertically, with its red-tipped head at the bottom. A bright, intense orange and yellow flame is visible, extending upwards from the head. The background is dark, making the flame stand out prominently.

Interesting Facts

- **Phosphorous is a non-metal**
- **It is essential for the body's energy transport molecules and for holding DNA and RNA molecules together**
- **Many non-metals are absolutely essential for body functioning like nitrogen, oxygen, sulfur, etc.**

PHOSPHORUS



A multivalent pnictogen, phosphorus as a mineral is almost **always present in its maximally oxidised state, as inorganic phosphate rocks.**

Elemental phosphorus exists in two major forms—**white phosphorus** and **red phosphorus**—but due to its high reactivity, phosphorus is never found as a free element on Earth.

In nature, Phosphorus exists in form of **phosphate.**

PHOSPHORUS USES

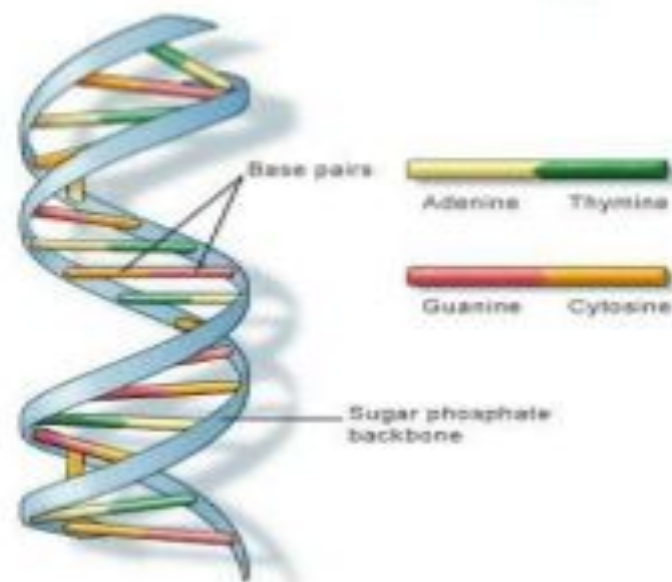


White Phosphorus is used in some explosives, including rockets. This caused an uproar because of safety concerns.

Red Phosphorus is used in match heads. You can see the texture of a match head next to the matches.



Fertilizer; Phosphorus is known for being essential to DNA and to a lesser extent fertilizer





Why do we need our phosphorus?

- Strong bones
- Strong teeth
- Nucleus in our cells: production of DNA
- 85% of phosphorus found in the teeth and bones
- It is inside the tissue of
- Help reduce muscle pain
- It is needed for growth

Foods High in Phosphorus

Meat



Fast Food

Cheese



Milk



Seeds



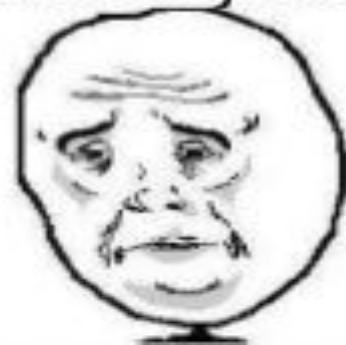
Canned Fish



Cola

WHEN WE DON'T GET ENOUGH

- If you have a phosphorus deficiency in your body, there are a number of side effects that could take place. You can have trouble with your bones and can become more susceptible to breaking bones in your body. You can have bone pain, fatigue, weakness in different areas of the body and even anxiety as a result of not taking enough phosphorus. But you also need to be sure that you're not getting too much phosphorus. If you eat a lot of junk food, you may be taking in too much phosphorus every day, and this could affect your calcium levels.





Early stage of P deficiency.

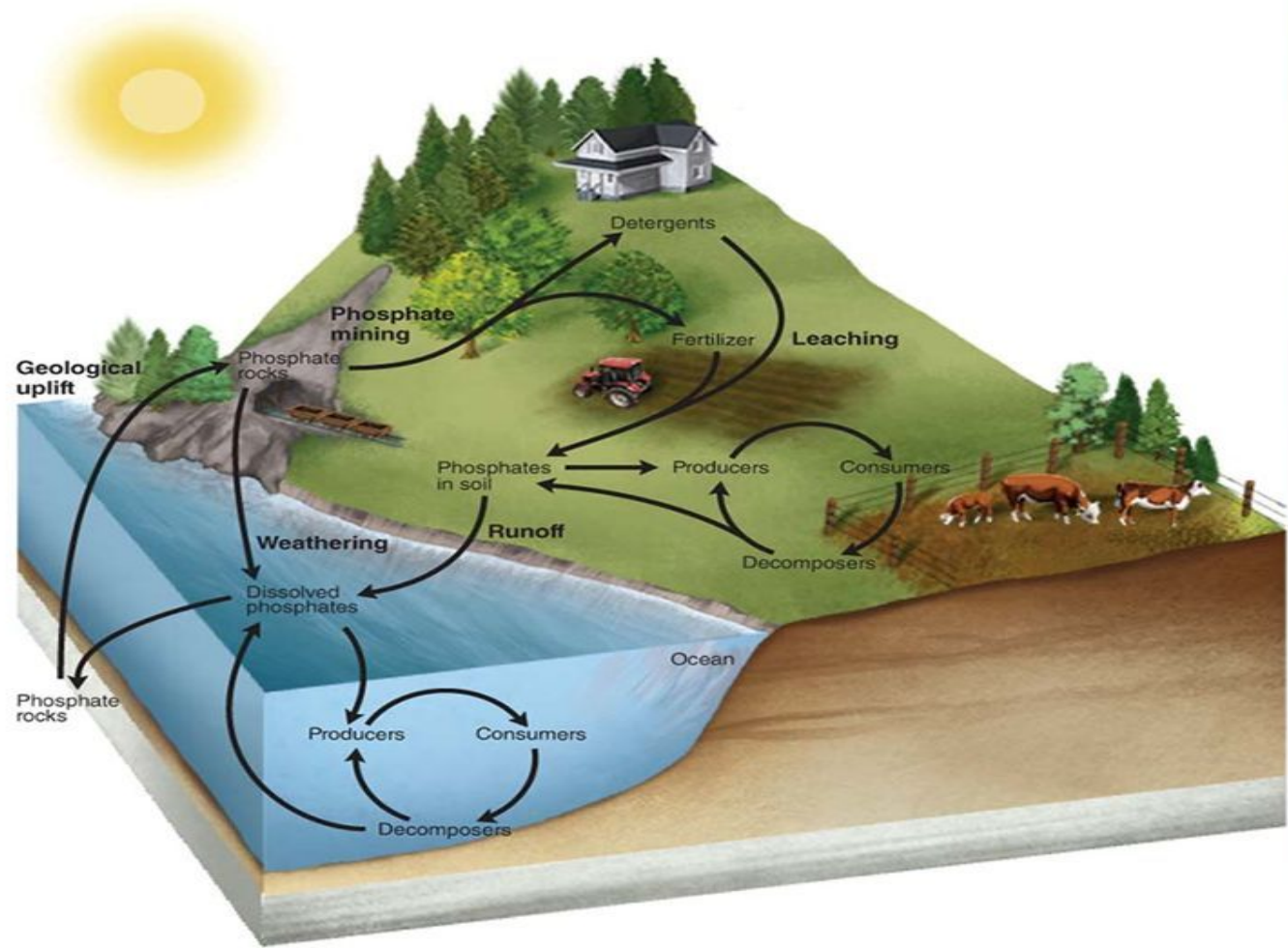


Progression of P deficiency.



Later stage of P deficiency.

The Phosphorus Cycle



The phosphorus cycle. The phosphorus cycle begins with the weathering or mining of phosphate rocks and use of phosphate fertilizer, which releases phosphorus into the soil and water. This phosphorus can be used by producers and subsequently moves through the food web. In water, phosphorus can precipitate out of solution and form sediments, which over time are transformed into new phosphate rocks.


Figure 7.4
Environmental Science for AP[®], Second Edition
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More Facts.....

- **Oxygen, carbon and nitrogen cycles include gases in the atmosphere. The phosphorous cycle is an example a non-metal cycle that does not have a gas as part of its cycle.**

Introduction

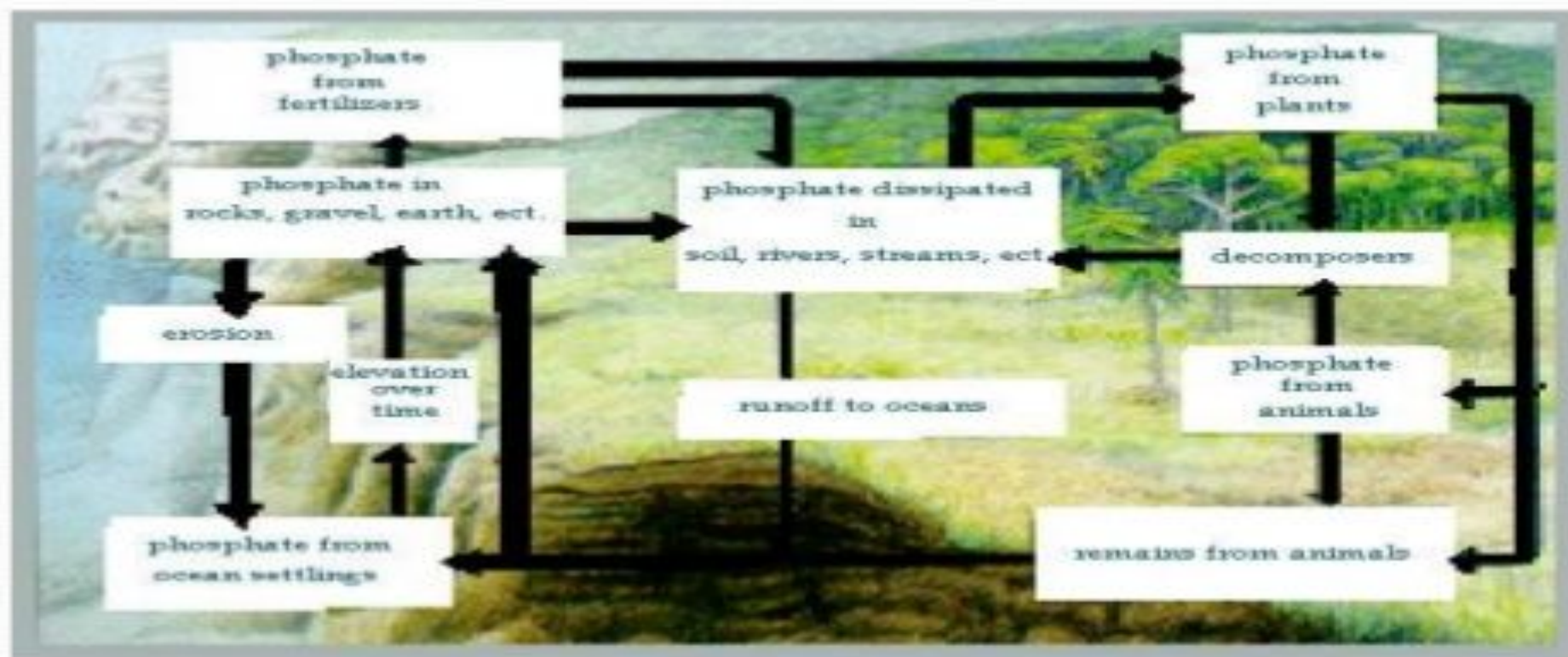
- The **phosphorus cycle** is the movement of phosphorus from the environment to organisms and then back to the environment.
- The phosphorus cycle may also be referred to as the *mineral cycle or sedimentary cycle*.
- Unlike the other cycles, phosphorus **cannot** be found in air in the gaseous state.
- The phosphorus cycle is the **SLOWEST** cycle.
- The atmosphere does not play a significant role in the movement of phosphorus, because phosphorus and phosphorus-based compounds are usually solids at the typical ranges of temperature and pressure found on Earth.
- On the land, phosphorus (chemical symbol, P) gradually becomes less available to plants over thousands of years, because it is slowly lost in runoff.

- 
- Low concentration of P in soils reduces plant growth, and slows soil microbial growth.
 - Soil microorganisms act as both sinks and sources of available P in the biogeochemical cycle.
 - Locally, transformations of P are chemical, biological and microbiological: the major long-term transfers in the global cycle, however, are driven by tectonic movements in geologic time.
 - Humans have caused major changes to the global P cycle through shipping of P minerals, and use of P fertilizer, and also the shipping of food from farms to cities, where it is lost as effluent.

- Phosphate salts that are released from rocks through weathering usually dissolve in soil water and will be absorbed by plants.
- Animals absorb phosphates by eating plants or plant-eating animals.
- When animals and plants die, phosphates will return to the soils or oceans again during decomposition.
- After that, phosphorus will end up in sediments or rock formations again, remaining there for millions of years. Eventually, phosphorus is released again through weathering and the cycle starts over.

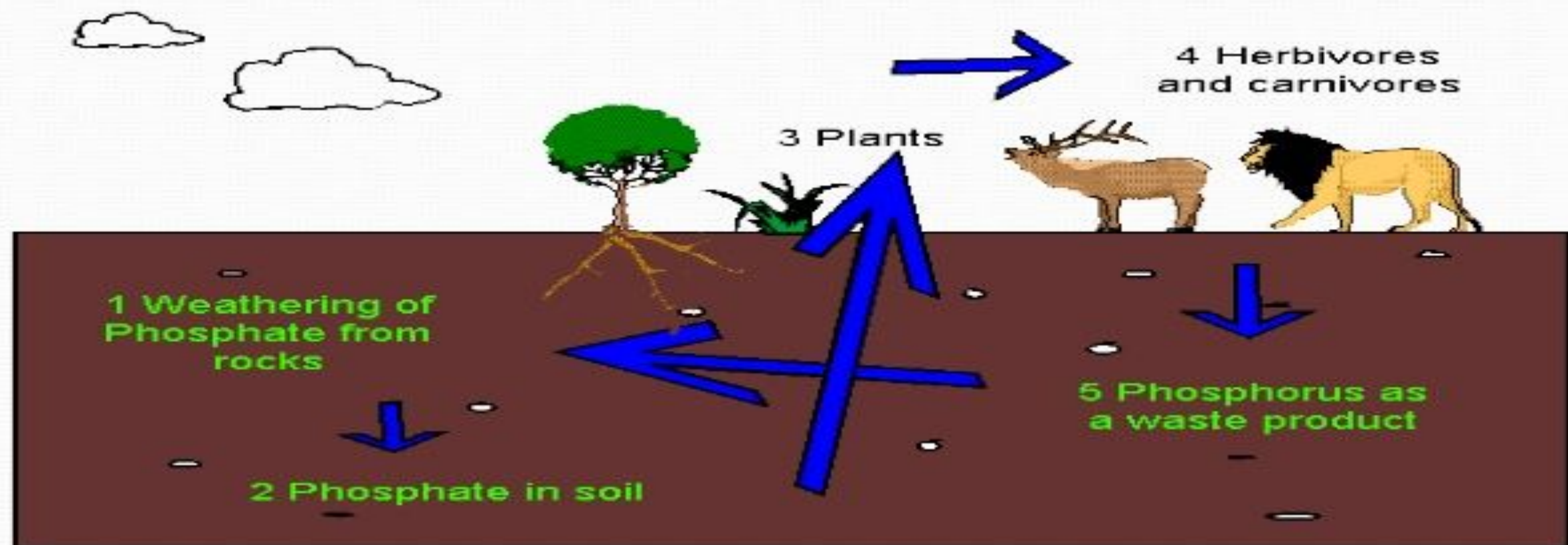
A GLOBAL VIEW OF THE PHOSPHORUS CYCLE

The phosphorus cycle occurs when phosphorus moves from land to sediments in the seas and then back to land again. The main storage for phosphorus is in the earth's crust. On land, phosphorus is usually found in the form of phosphates. By the process of weathering and erosion, phosphates enter rivers and streams that transport them to the ocean. Once in the ocean, the phosphorus accumulates on continental shelves in the form of insoluble deposits. After millions of years, the crustal plates rise from the sea floor and expose the phosphates on land. After more time, weathering will release them from rock and the cycle's geochemical phase begins again.



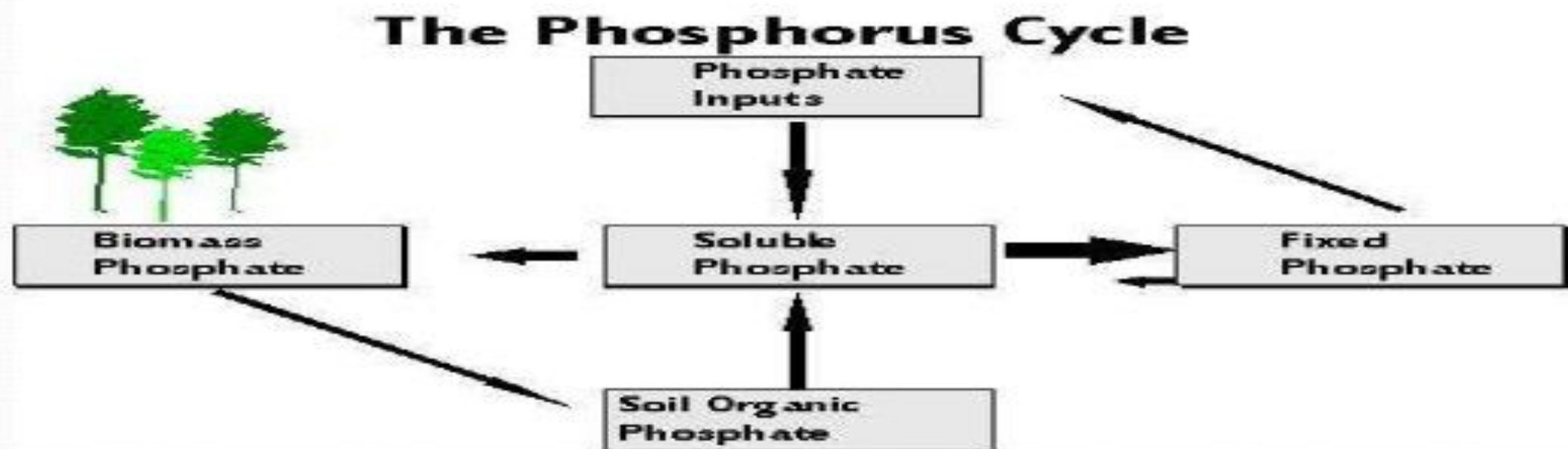
AN ECOSYSTEM VIEW OF THE PHOSPHORUS CYCLE

The ecosystem phase of the phosphorus cycle moves faster than the sediment phase. All organisms require phosphorus for synthesizing phospholipids, NADPH, ATP, nucleic acids, and other compounds. Plants absorb phosphorus very quickly, and then herbivores get phosphorus by eat plants. Then carnivores get phosphorus by eating herbivores. Eventually both of these organisms will excrete phosphorus as a waste. This decomposition will release phosphorus into the soil. Plants absorb the phosphorus from the soil and they recycle it within the ecosystem.

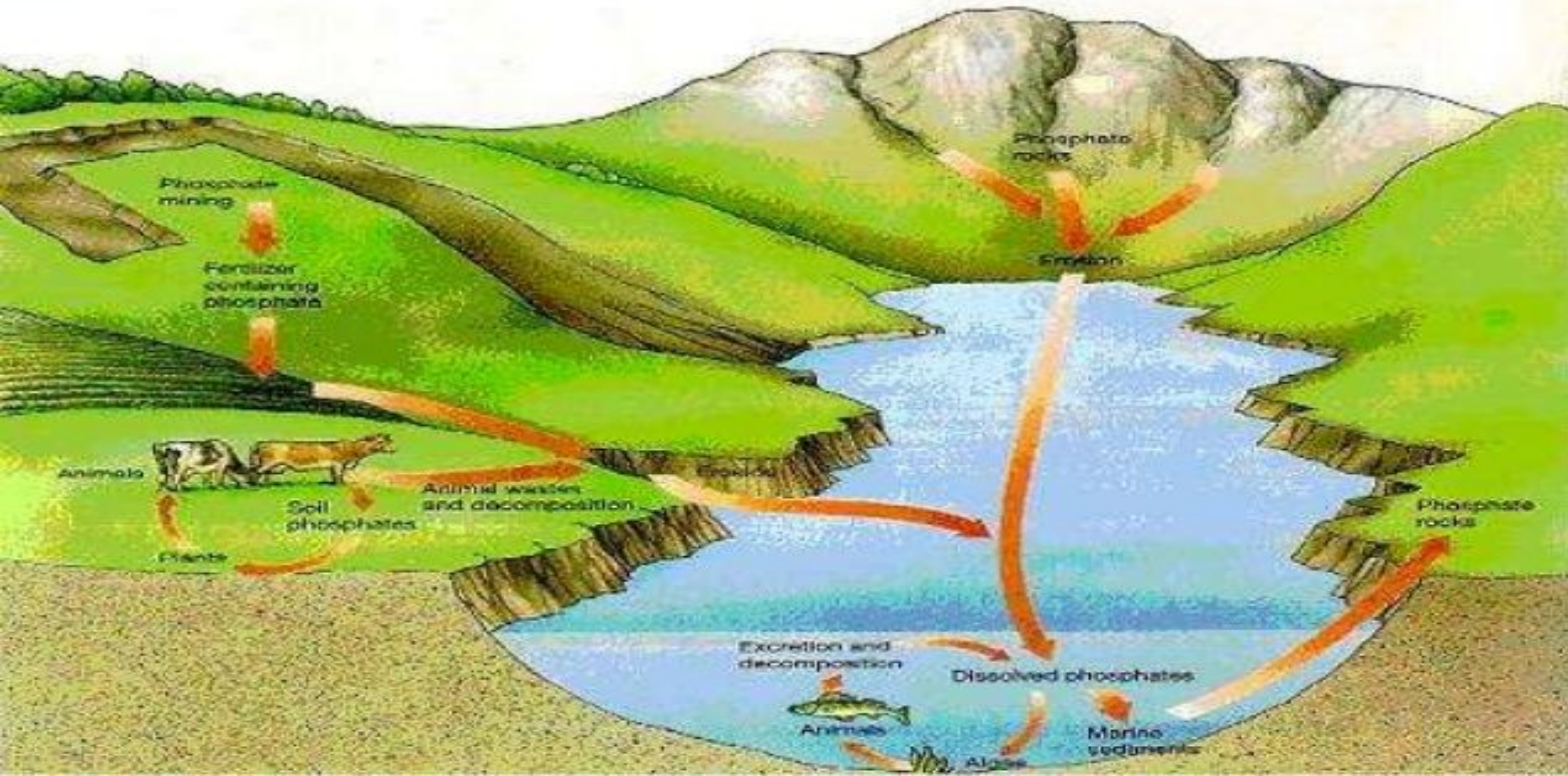


A SOIL-BASED VIEW OF THE PHOSPHORUS CYCLE

Initially, phosphate weathers from rocks. The small losses in a terrestrial system caused by leaching through the action of rain are balanced in the gains from weathering rocks. In soil, phosphate is absorbed on clay surfaces and organic matter particles and becomes incorporated (immobilized). Plants dissolve ionized forms of phosphate. Herbivores obtain phosphorus by eating plants, and carnivores by eating herbivores. Herbivores and carnivores excrete phosphorus as a waste product in urine and feces. Phosphorus is released back to the soil when plants or animal matter decomposes and the cycle repeats.



Phosphorous Cycle



Form of existence in nature

- *Unlike the other cycles, there is no volatile phosphorus-containing product to return phosphorus to the atmosphere in the way carbon dioxide, nitrogen gas, and sulfur dioxide are returned.*
- *Therefore, phosphorus tends to accumulate in the seas. It can be retrieved by mining the above-ground sediments of ancient seas, mostly as deposits of calcium phosphate.*
- *Seabirds also mine phosphorus from the sea by eating phosphorus-containing fish and depositing it as guano (bird droppings).*
- *Certain small islands inhabited by such birds have long been mined for these deposits as a source of phosphorus for fertilizers.*

Microbiological importance of phosphorous

- Phosphorus is a macronutrient necessary to all living cells. It is an important component of adenosine triphosphate (ATP), nucleic acids (DNA and RNA), and phospholipids in cell membranes.
- It may be stored in intracellular volutin granules as polyphosphates in both prokaryotes and eukaryotes.
- It is a limiting nutrient for algal growth in lakes. The average concentration of total phosphorus (inorganic and organic forms) in wastewater is in the range 10–20 mg/L.
- The major transformations of phosphorus in aquatic environments are described below :
 - Mineralization
 - Assimilation.
 - Precipitation of Phosphorus Compounds.
 - Microbial Solubilization of Insoluble Forms of Phosphorus.

Mineralization :

- Organic phosphorus compounds (e.g., phytin, inositol phosphates, nucleic acids, phospholipids) are mineralized to orthophosphate by a wide range of microorganisms that include bacteria (e.g., *B. subtilis*, *Arthrobacter*), actinomycetes (e.g., *Streptomyces*), and fungi (e.g., *Aspergillus*, *Penicillium*).
- Phosphatases are the enzymes responsible for degradation of phosphorus compounds.

Assimilation :

- Microorganisms assimilate phosphorus, which enters in the composition of several macromolecules in the cell.
- Some microorganisms have the ability to store phosphorus as polyphosphates in special granules

Precipitation of Phosphorus Compounds:

- The solubility of orthophosphate is controlled by the pH of the aquatic environment and by the presence of Ca^{2+} , Mg^{2+} , Fe^{3+} and Al^{3+} .
- When precipitation occurs, there is formation of insoluble compounds such as hydroxyapatite ($\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$), vivianite $\text{Fe}_3(\text{PO}_4)_2 \cdot 8\text{H}_2\text{O}$ or variscite $\text{AlPO}_4 \cdot 2\text{H}_2\text{O}$.

Any questions?



