

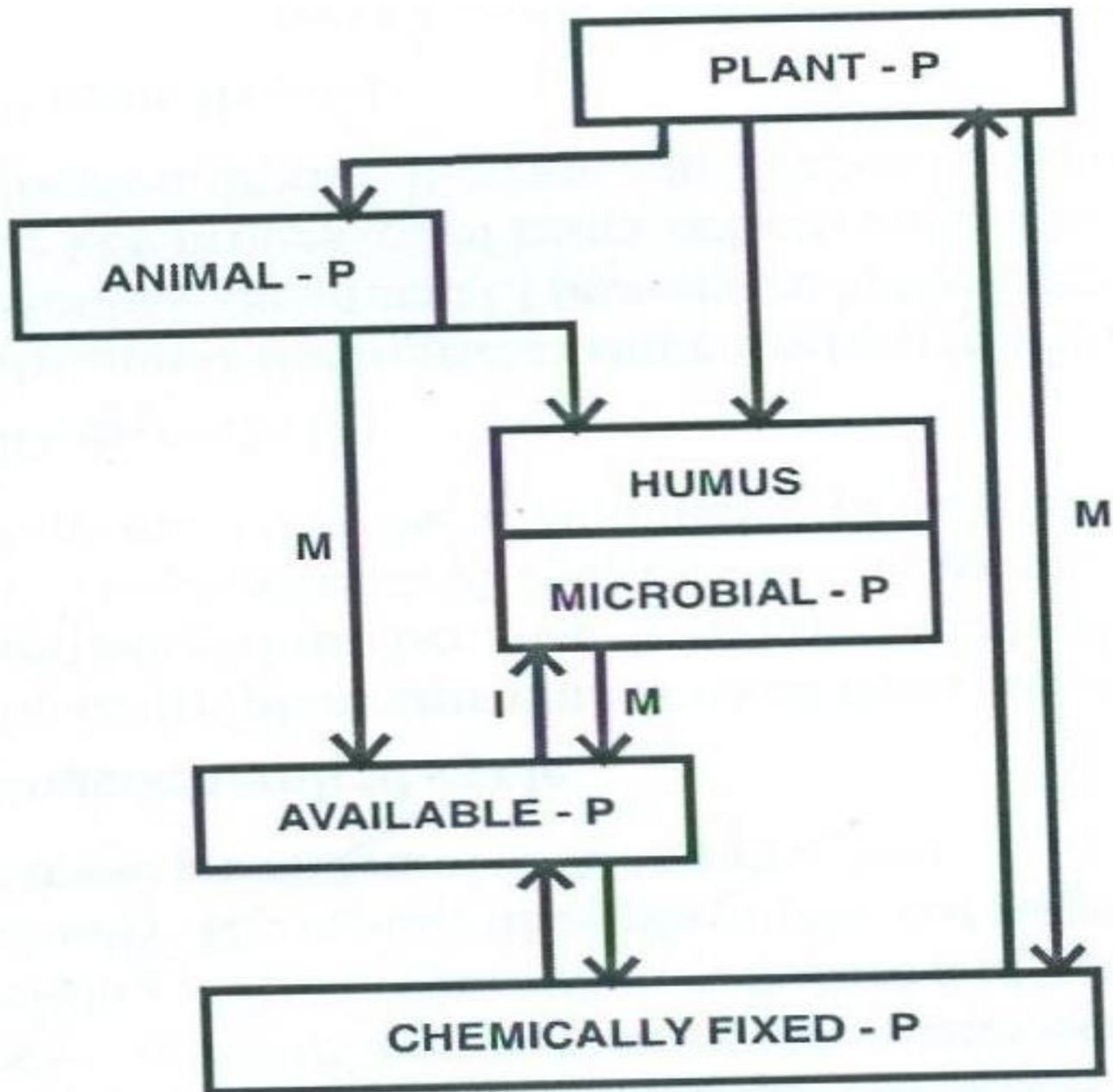
Aquatic Microbiology

Nutrient cycles: Phosphorus, iron and manganese cycles

Phosphorus cycle

- Phosphorus : Mineral nutrient required for plants, animals and microorganisms.
- Microorganisms play a key role:
 - (i) altering its solubility,
 - ii) mineralization of organic phosphate into inorganic phosphate,
 - (iii) oxidation and reduction of phosphorus compounds.
- Uptake of phosphate ions utilized for the synthesis of organic phosphates within the cell, thus a fraction immobilized.
- Upon death of plants , organic phosphate is rapidly released by enzymatic hydrolysis. Phosphate becomes limiting factor.

- The availability of phosphates therefore depends on the degree of solubilization of insoluble phosphates by various organic and inorganic acids produced by microorganisms.
- Soil microorganisms, fungi produce these acids and solubilize insoluble phosphates - available to the plants.
- *Bacillus, Pseudomonas, Micrococcus, Aspergillus, Penicillium* and *Fusarium*.



I - Immobilization; M - Mineralization

Iron cycle

- Iron is an important limiting nutrient for plants, which use it to produce chlorophyll.
- Photosynthesis depends on adequate iron supply. Plants assimilate iron from the soil into their roots.
- Animals consume plants and use the iron to produce hemoglobin, the oxygen transports protein found in red blood cells.
- When animals die, decomposing bacteria return iron to the soil.
- The marine iron cycle is very similar to the terrestrial iron cycle, except that phytoplankton and cyanobacteria assimilate iron.

- Iron fertilization has been studied as a method for sequestering carbon.
- Scientists have hoped that by adding iron to the ocean, plankton might be able to sequester the excess CO₂ responsible for climate change.
- However, there is concern about the long term effects of this strategy.
- Iron (Fe) follows a geochemical cycle like many other nutrients.
- Iron is typically released into the soil or into the ocean through the weathering of rocks or through volcanic eruptions.

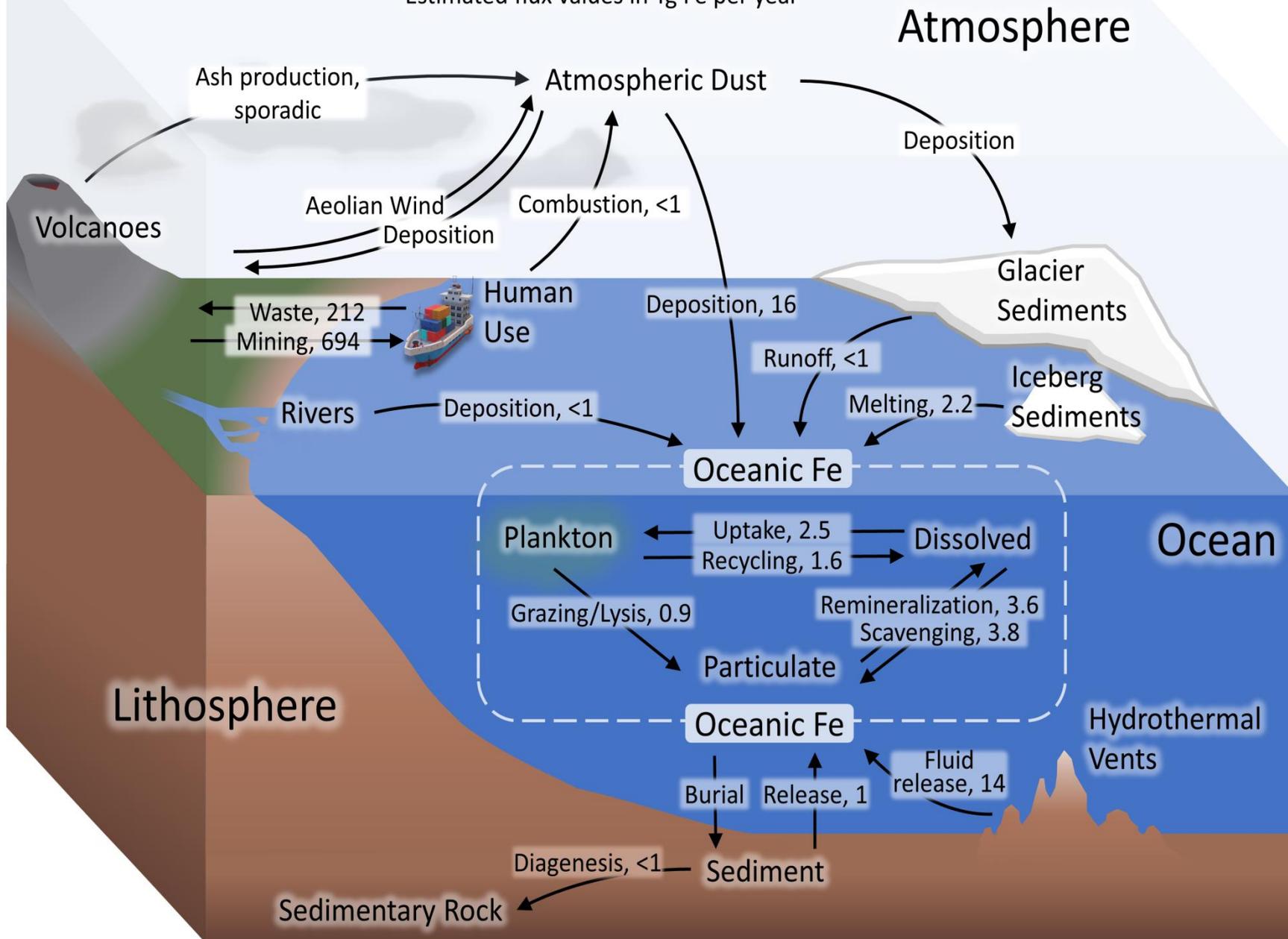
- **The Terrestrial Iron Cycle:**

- In terrestrial ecosystems, plants first absorb iron through their roots from the soil. Iron is required to produce chlorophyll, and plants require sufficient iron to perform photosynthesis.
- Animals acquire iron when they consume plants, and iron is utilized by vertebrates in hemoglobin, the oxygen-binding protein found in red blood cells.
- Animals lacking in iron often become anemic and cannot transmit adequate oxygen.
- Bacteria then release iron back into the soil when they decompose animal tissue

- The Marine Iron Cycle: The oceanic iron cycle is similar to the terrestrial iron cycle, except that the primary producers that absorb iron are typically phytoplankton or cyanobacteria.
- Iron is then assimilated by consumers when they eat the bacteria or plankton.
- The role of iron in ocean ecosystems was first discovered when English biologist Joseph Hart noticed “desolate zones,” which are regions that lacked plankton but were rich in nutrients.
- He hypothesized that iron was the limiting nutrient in these areas.
- In the past three decades there has been research into using iron fertilization to promote algal growth in the world’s oceans.

Global Iron Cycle

Estimated flux values in Tg Fe per year



Manganese cycle

- **Manganese** is a chemical element with the symbol **Mn** and atomic number 25.
- It is not found as a free element in nature; it is often found in minerals in combination with iron.
- In biology, manganese(II) ions function as cofactors for a large variety of enzymes with many functions. Manganese enzymes are particularly essential in detoxification of superoxide free radicals in organisms that must deal with elemental oxygen.

- Manganese also functions in the oxygen-evolving complex of photosynthetic plants.
- While the element is a required trace mineral for all known living organisms, it also acts as a neurotoxin in larger amounts.
- Especially through inhalation, it can cause manganism, a condition in mammals leading to neurological damage that is sometimes irreversible.

Manganese Cycle

