5.7.10 Nutrient cycling

As the earth is essentially a closed system with respect to matter, we can say that *all matter on earth cycles*. Every matter that is used by living organisms passes between the biotic and abiotic components of the biosphere. *Nutrient cycling* is the movement (or cycling) of matter through the system. In general, we can subdivide the system into: atmosphere, hydrosphere, lithosphere and biosphere. By matter we mean elements (such as carbon, nitrogen, oxygen) or molecules (water). The movement of matter between these parts of the system is generally termed as a *biogeochemical cycle*.

Gaseous and sedimentary nutrient cycles

In *gaseous nutrient* cycles, the atmosphere constitutes a major reservoir of the element that exists in a gaseous phase. Such cycles show little or no permanent change in the distribution and abundance of the element. Carbon and nitrogen are prime representatives of biogeochemical cycles with a prominent gaseous phase.

In a *sedimentary cycle*, the major reservoir is the lithosphere from which the elements are released largely by weathering. The sedimentary cycles, exemplified by phosphorus, sulfur, iodine, and most of the other biologically important elements, have a tendency to stagnate. In such cycles, a portion of the supply may accumulate in large quantities, as in the deep ocean sediment, and thereby become inaccessible to organisms and to continual cycling. Some of the elements that are characterized by sedimentary cycles do have a gaseous phase, sulfur and iodine being among them, but these phases are insignificant in that there is no large gaseous reservoir.

Carbon cycle

Photosynthesis and respiration are the two opposing processes that drive the global carbon cycle. It is predominantly a gaseous cycle, with CO_2 as the main vehicle of flux between the atmosphere, hydrosphere and biota. Terrestrial plants use atmospheric CO_2 as their carbon source for photosynthesis, whereas aquatic plants use dissolved carbonates (i.e. carbon from the hydrosphere).

In addition, carbon finds its way into inland waters and oceans as bicarbonate resulting from the weathering of calcium-rich rocks such as limestone and chalk. Respiration by plants, animals and microorganisms releases the carbon locked in photosynthetic products back to the atmospheric and hydrospheric carbon compartments.

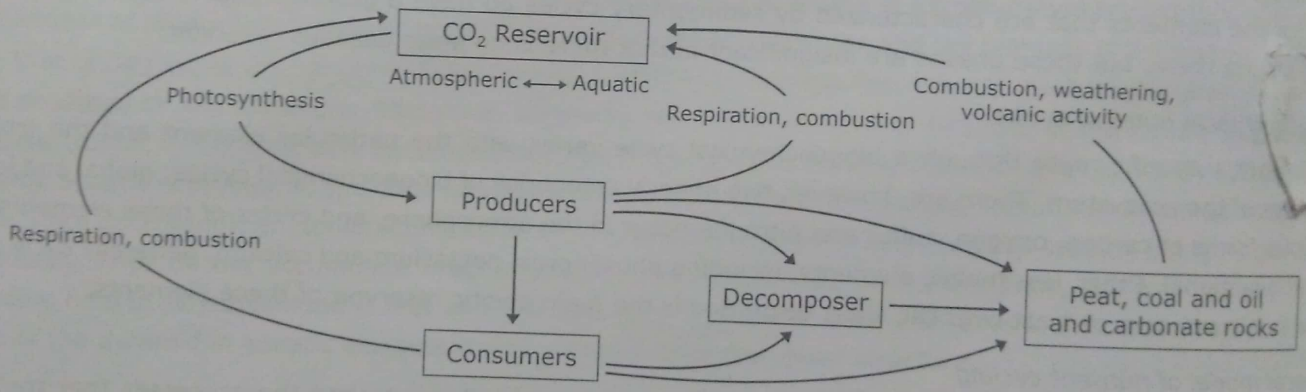

Figure 5.14 Carbon cycle

Nitrogen cycle

The atmospheric phase is predominant in the global nitrogen cycle. In nitrogen cycle, nitrogen is converted between its various chemical forms. This transformation can be carried out by both biological and non-biological processes. The important processes in the nitrogen cycle include nitrogen fixation, ammonification, nitrification, and denitrification. *Nitrogen fixation* involves the conversion of N_2 by bacteria to ammonium ions. Atmospheric nitrogen is also fixed by lightning discharges during storms and reaches the ground as nitric acid dissolved in rainwater, but only about 3–4% of fixed nitrogen derives from this pathway. *Ammonification* involves decomposition of organic nitrogen to ammonium ions. In *nitrification*, ammonium ion is converted to nitrite and nitrate by nitrifying bacteria. *Denitrification* is the reduction of nitrates into nitrogen gas. This process is performed by bacterial species such as *Pseudomonas* and *Clostridium* in anaerobic conditions.

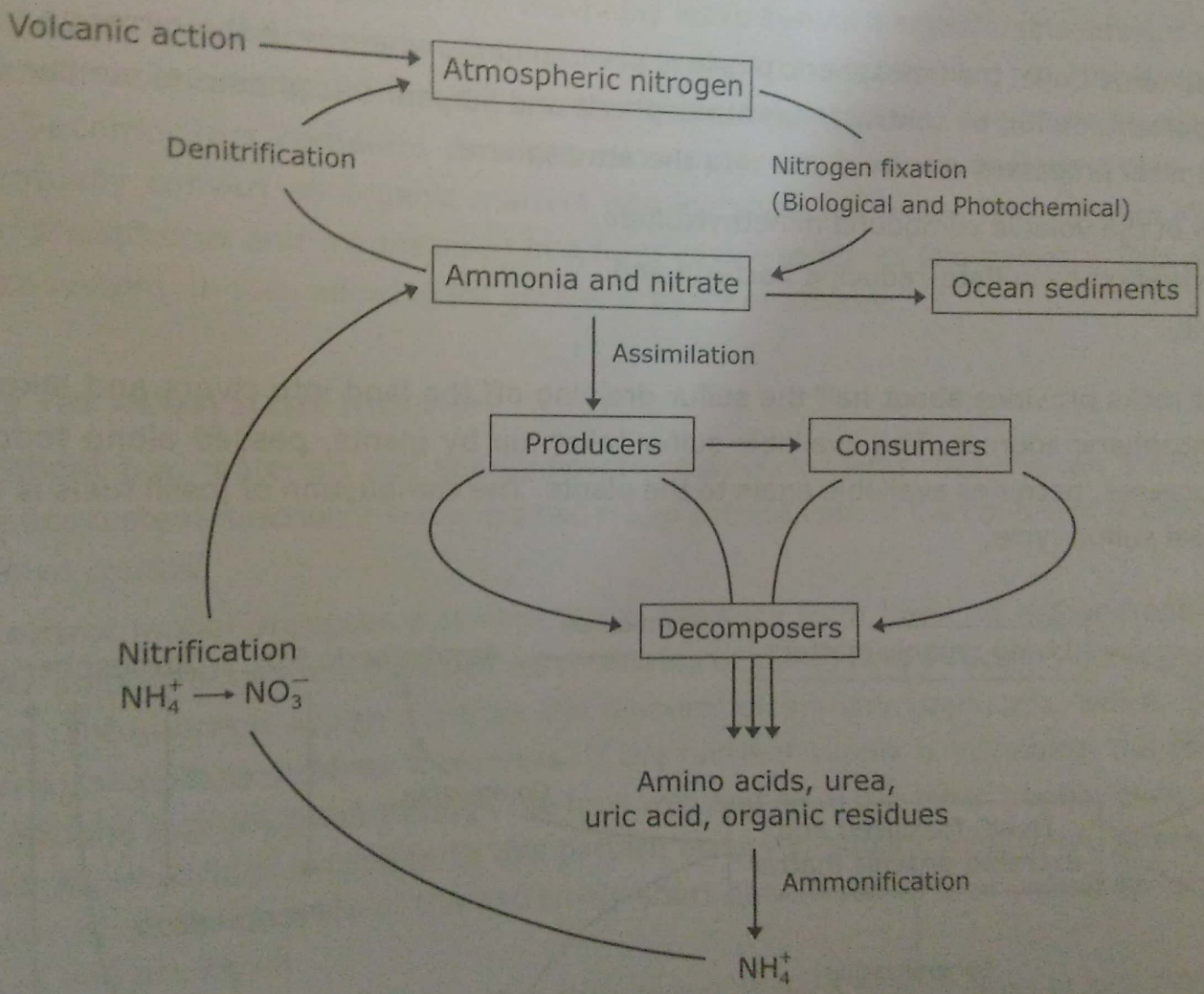

Figure 5.15 Nitrogen cycle.

Phosphorus cycle

The principal stocks of phosphorus occur in rocks and ocean sediments and in dissolved form in rivers, lakes and ocean water. Weathering of rocks gradually adds phosphorus to soil; some leaches into groundwater and surface water and may eventually reach the sea. The phosphorus cycle may be described as an 'open' cycle because of the general tendency for mineral phosphorus to be carried from the land to the oceans. A typical phosphorus atom, released from the rocks by chemical weathering, may enter and cycle within the terrestrial community for years, or centuries before it is carried via groundwater into a stream, where it takes part in the nutrient spiraling.

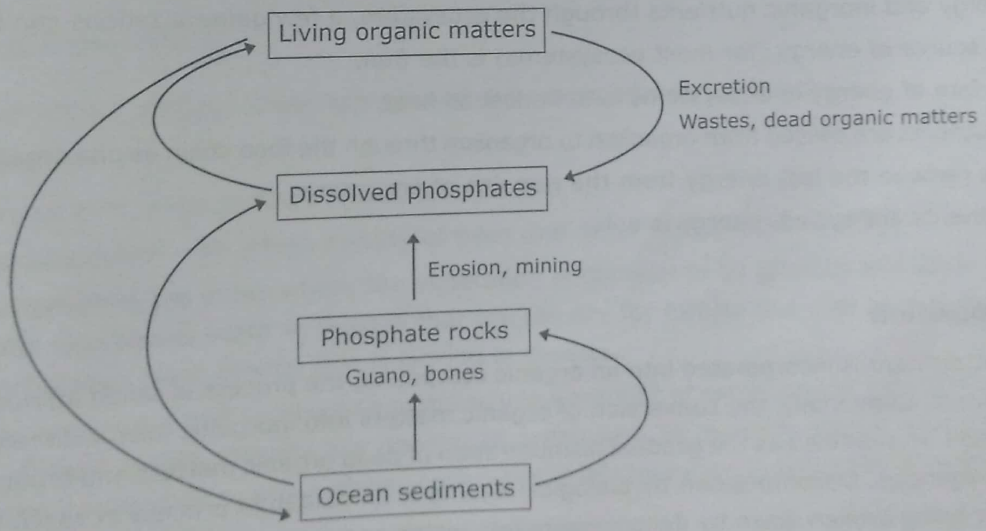

Figure 5.16 Phosphorous cycle.