THE NITROGEN CYCLE

Earth is a closed ecosystem with regards to matter. All of the atoms in Earth’s ecosystem (Earth and its atmosphere) have been here since Earth formed, and they always will be in the future. They can be rearranged into different combinations and forms, but they cannot enter or leave. We can demonstrate this by following the path of certain elements as they pass through living systems. One important element to keep track of is nitrogen. Nitrogen (N) is an essential component of DNA, RNA and proteins, the building blocks of life. All organisms must have nitrogen to live and grow.

Although the majority of the air we breathe is made up of nitrogen gas (N2), most of the nitrogen in the atmosphere is unavailable for use by organisms. Organisms cannot break the strong triple bond between the two N atoms in molecules of nitrogen gas so they are unable to use it to build new molecules. Animals obtain nitrogen by eating plants, but plants must somehow obtain nitrogen from their environment. To be usable to plants, N2 must first be converted to more a chemically available form such as ammonium (NH4+) or nitrate (NO3-). However, this kind of biologically available nitrogen is often in short supply in natural ecosystems, so it is often a limiting factor in the growth of plants.

Microorganisms, particularly bacteria, are the key players in transforming nitrogen into biologically useful forms. On land, certain bacteria (known as “nitrogen fixing” bacteria) are able to convert atmospheric nitrogen gas (N2) directly into the kinds of nitrogen compounds that plants can use. These bacteria often form symbiotic relationships with host plants, especially legumes (e.g., beans, peas, and clover), living in nodules on their roots. Other species of bacteria break down animal waste and bodies of dead organisms into various nutrients, including usable nitrogen which is then absorbed by plants. Similarly, in marine and aquatic ecosystems different species of bacteria rearrange nitrogen waste products of animals and dead bodies of organisms in various ways that ultimately make them available to plants. This also prevents waste products from building up to toxic levels in the water.