The Nitrogen Cycle

Nitrogen is another essential nutrient. It is in all amino acids, is incorporated into proteins, and is present in the bases that make up nucleic acids (DNA and RNA).

The majority of the atmosphere (78%) is made up of nitrogen (in the form of nitrogen gas, N_2), making it the largest source of nitrogen on Earth. Unfortunately, nitrogen gas is largely useless to living organisms.

Nitrogen Fixation

Before living organisms can make use of nitrogen, it must be converted into a useable form. The process by which nitrogen is converted to useable forms (and back) is called the **nitrogen cycle**.

Nitrogen gas is converted to useable forms primarily by two processes:

1. Nitrogen Fixation
    - converts nitrogen gas (N_2) into ammonia (NH_3)
    - mostly done by bacteria in the soil

2. Nitrification
    - converts ammonia (NH_3) into nitrates (NO_3^-) or nitrites (NO_2^-)
    - mostly done by soil bacteria

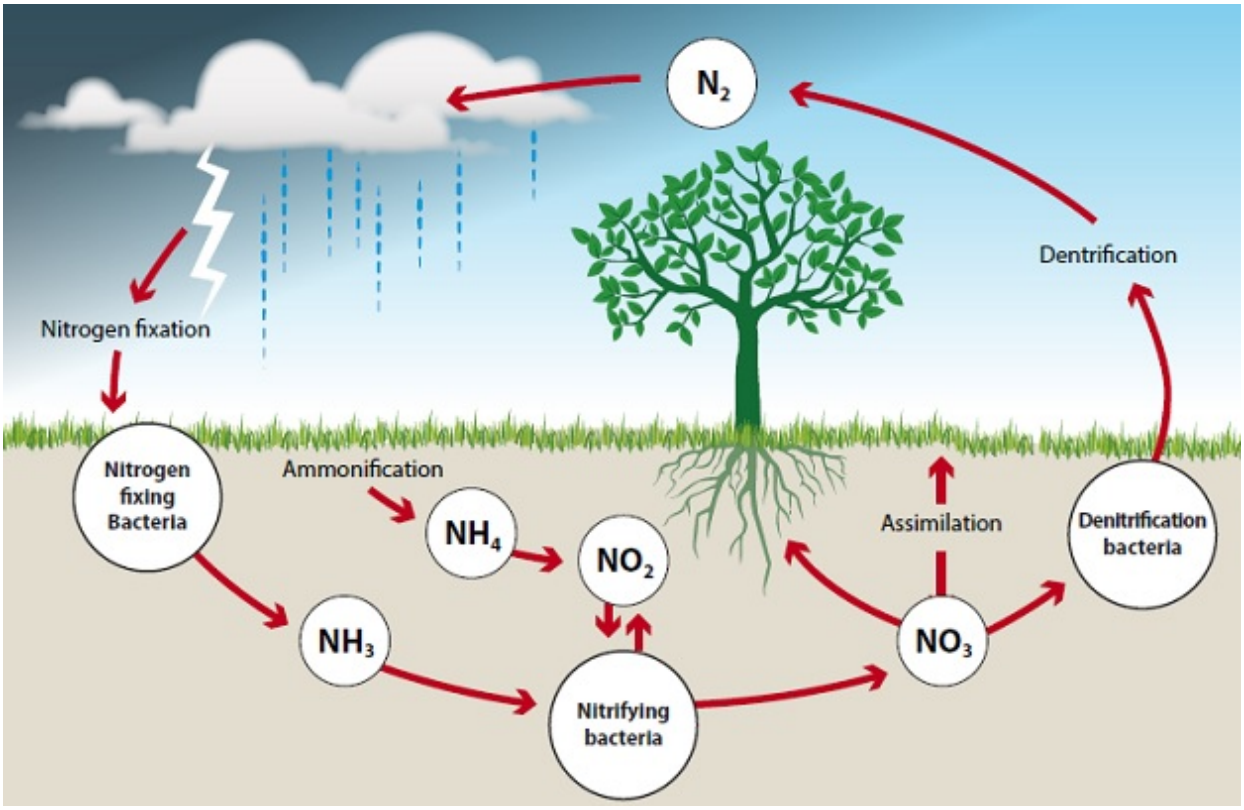
Nitrates and nitrites are useable forms of nitrogen that can be absorbed by plants (called **assimilation**) or consumed by animals in order to build organic compounds (e.g. amino acids).

Note: Nitrogen fixation can also occur in industrial processes, and in lightning strikes. Also, burning fossil fuels releases nitrates and nitrites.

Denitrification

Denitrification is the conversion of nitrates/nitrites back into nitrogen gas. The nitrogen gas is then free to return to the atmosphere, thus completing the nitrogen cycle. This process is also mostly done by soil bacteria.

The diagram below shows the nitrogen cycle.



Under normal conditions, the amount of nitrogen being removed from the atmosphere and the amount of nitrogen being returned to the atmosphere are the same. This means the amount of nitrogen in the atmosphere usually remains constant.

Disturbing the Nitrogen Cycle

Humans add nitrogen to the environment in two major ways:

1. Agricultural Processes
    - plants need nitrogen to grow
    - farmers use nitrogen-based fertilizers on soil to improve crop yield

2. Burning Fossil Fuels
    - fossil fuels contain nitrogen
    - burning them releases nitrogen into the atmosphere

Effects on Soil

Too much nitrogen in the soil turns the soil acidic. Acidic soil:

- damages the roots of plants
- dissolves toxic metals (that are then absorbed by plants)
- can wash from soil into bodies of water

Effects on the Atmosphere

Too much nitrogen in the atmosphere results in acid rain. When acid rain falls to Earth, it can harm a variety of organisms:

- acid rain raises the acidity of lakes, which can kill fish, birds, amphibians, and other organisms
- acid rain damages the waxy covering on some plant leaves, exposing the leaves to disease
- acid rain leaches nutrients from soil, hindering plant growth

Effects on Water

Extra nitrogen enters bodies of water in a number of ways:

- fertilizer runoff from farms
- acid rain
- sewage systems (solid waste contains nitrogen)

Too much nitrogen in water can cause an explosion of plant growth. This has several consequences:

- too many plants at the surface block sunlight from penetrating to deeper water
- plants living deeper down can't carry out photosynthesis and start to die out
- less oxygen is being produced in deeper water
- fish start to die due to lack of oxygen

Increased nitrogen in water can also have a direct impact on humans. Nitrogen in the form of nitrates reduces the ability of blood to carry oxygen (this is known as anemia). So, if your drinking water contains too many nitrates, it may increase your risk of anemia. This is more of a problem in rural communities where water is not treated before being used.

Worksheet

1. Where is most of the nitrogen on Earth located? _____

2. What two processes are responsible for converting nitrogen into useable forms? _____

3. How do animals obtain usable nitrogen? _____

4. What is denitrification? _____

5. Livestock farming creates large amounts of animal waste. How would this affect the nitrogen cycle? _____

6. What would happen if a framer used too much fertilizer? What adverse affects can this have on the environment? Be specific! _____

7. How can burning fossil fuels affect the nitrogen cycle? _____