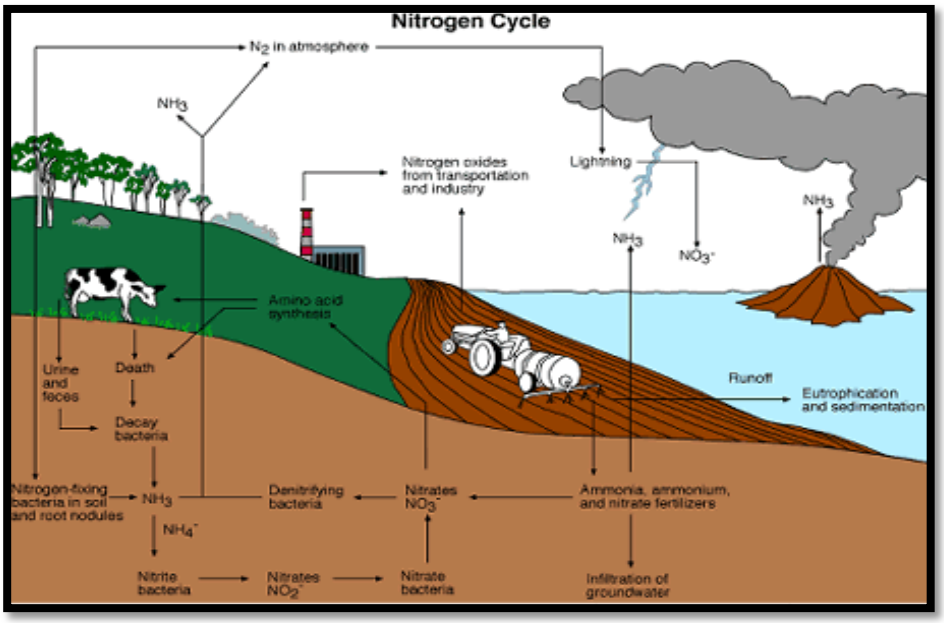
Student Sheet 1

CRITICAL THINKING ACTIVITY: LIVING IN THE NITROGEN CYCLE

About 78% of the Earth's atmosphere is "free" nitrogen (N_2) gas produced by biological and chemical processes within the biosphere and not combined with other elements. All living things need nitrogen to build ***amino acids***, a kind of protein, as well as RNA and DNA. It is also needed to make chlorophyll in plants, which plants use in photosynthesis to make their food and energy. However, nitrogen is an ***inert*** or non-reactive substance and cannot be used in its free form by most living things. They can only use nitrogen that is already in compound form.

For nitrogen to be used by different life forms on Earth, it must be "fixed" or changed into different ***states***. Nitrogen in the atmosphere, or air, is ***N_2***. Other important states of nitrogen include ***Nitrates (NO_3), Nitrites (NO_2),*** and ***Ammonium (NH_4)***.

The ***nitrogen cycle*** describes how nitrogen moves between plants, animals, bacteria, the atmosphere and the soil. The most important part of the cycle is ***bacteria***. Bacteria help the nitrogen change between states so it can be used.



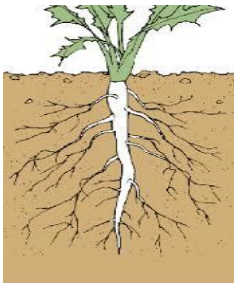
When nitrogen is absorbed by the soil, different types of bacteria help it to change state so that it can be absorbed by plants. Animals then get their nitrogen from the plants.

Student Sheet 2

STEPS IN THE NITROGEN CYCLE

- **Fixation**-This is the first step in the process of making nitrogen usable by plants. Lightning can change atmospheric nitrogen into a ***nitrate***, a useable form, but most fixation is done by specialized ***bacteria*** that change nitrogen into ***ammonium.***

- **Nitrification** - This is the process by which ammonium gets changed into ***nitrates*** by bacteria. Nitrates are what the plants can then absorb.



- **Assimilation** - This is how plants get nitrogen. They absorb nitrates from the soil into their roots. Then the nitrogen gets used in amino acids, nucleic acids, and chlorophyll.

- **Ammonification** - This is part of the decaying process. When a plant or animal dies, decomposers like fungi and bacteria turn the nitrogen back into ammonium so it can reenter the nitrogen cycle.

- **Denitrification** - Extra nitrogen in the soil gets put back out into the air. There are special bacteria that perform this task as well.

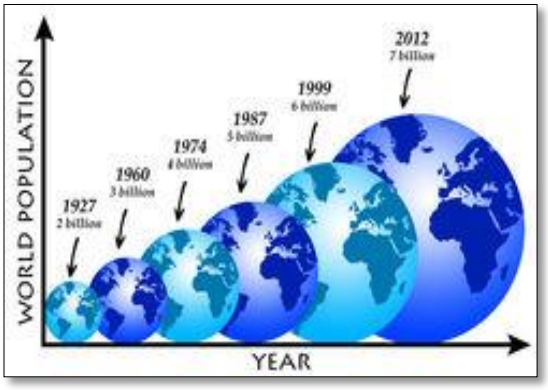
Human activity has changed the cycle by adding nitrogen into the soil with fertilizers as well as through other activities that put more nitrous oxide gas into the atmosphere.

Student Sheet 3

HOW HAVE HUMANS CHANGED THE NITROGEN CYCLE?

Like the Earth's other biogeochemical cycles, the nitrogen cycle circulates nitrogen compounds cycle through the air, water systems, and soil. But unlike water, these compounds are being pumped into the environment in ever increasing amounts. As a result, humans are altering the natural nitrogen cycle, causing serious impacts on biodiversity, global warming, water quality, human health, and even the rate of population growth in developing nations.

During the past century, human population has skyrocketed and increasing the demand for food, living and farming space and energy. To satisfy the needs of more people, both developed and developing countries have produced more and more reactive nitrogen.



Farmers have learned to increase the yield of their farms just by adding nitrogen fertilizers to the soil-the more fertilizer, the bigger the crop yield and the more profit. In addition, in many areas, large-scale cultivation of nitrogen-fixing crops like beans, clover and peas has increased the global supply even more.

The burning of biomass—the use of wood for fuel and the clearing of forests and grasslands for more farms, as well as the draining wetlands and adds to the human contribution.

Student Sheet 4

Fossil fuel combustion also contributes to the reactive nitrogen overload. It's not just agriculture that's changing the nitrogen cycle; urbanization is doing it in a big way. Cities are full of people and people like cars. The keys get turned, the cars start, the emissions go up into the air and what comes down is somebody else's problem. Cars release ***nitrogen oxides*** - the collective term for NO and NO_2. By fixing atmospheric nitrogen and releasing reactive nitrogen that otherwise would be stored indefinitely in fuels, fossil fuel combustion contributes about 20 Tg of reactive nitrogen globally each year.

ANALYSIS/CONCLUSIONS

1. Create an original visual presentation of the nitrogen cycling process using the information you acquired from the reading and the role-playing activity.
    - Be sure to label all contributors and the 5 steps in the correct order.
    - Be sure that your visual is clear and could be easily understood by students in another grade level or class with less experience.
    - Be prepared to answer any questions from classmates.

2. Imagine that you are a nitrogen molecule. Write a story about the journey you take as you travel through the nitrogen cycle. Include the following in your story:
    - A description of your trip through the cycle including (1) where you went, and (2) how you got there;
    - A description of why your journey will never end;
    - Include as many of the following terms in your story as well:

Nitrogen	Atmosphere	Bacteria	"Fixing"
Consumers	Producer	Decomposition	Fertilizer
Manure	Runoff		