



CRITICAL THINKING ACTIVITY: LIVING IN THE NITROGEN CYCLE

TEACHING NOTES: This is a hands-on activity that will help students understand the nitrogen cycle and the organisms that take part in it. Student will need to have an understanding of covalent bonds and the Octet Rule prior to attempting this activity. If time permits, once the cycle is completed, students can switch roles. It would be advisable to give them some practice with simple molecular building kits as well.

OBJECTIVE: Students will:

- ✓ Understand how nitrogen cycles through the Earth system;
- ✓ Comprehend the role played by different organisms in the cycle;
- ✓ Build chemical models for each step in the nitrogen cycle;
- ✓ Understand the First Law of Thermodynamics;
- ✓ Role-play the 5 steps of the nitrogen cycle.

MATERIALS:

- ✚ Several molecular model kits
- ✚ Kit Directions for each kit
- ✚ Paper and pencil
- ✚ **Student Sheets 1-4**

PROCEDURE:

1. Create instruction cards for each group of students.
2. Organize students in groups.
3. When the role-playing part of the activity is completed, instruct students to complete one of the tasks in the **ANALYSIS and CONCLUSIONS** section by relying on the reading selection and what they observed during the role-play activity.

Teacher Sheet 2

GROUP 1: Atmosphere people (2 students)- Your group is going to build 4 nitrogen gas molecules. The formula for nitrogen gas is N_2 . Take 2 nitrogen elements (use blue or red with 4 prongs coming out) and put them together with 4 white “bond” sticks. One N_2 = 1 nitrogen molecule. You will need to make 4 of them and then take them to the nitrifying bacteria group. They will “fix” them into nitrites and nitrates for the legumes.

Group 2: Nitrifying Bacteria (4 students)- The nitrogen people will bring you the nitrogen gas, N_2 , that you “breathe” in because you have been turned into nitrifying bacteria. Take the N_2 and turn it into molecules known as NO_2 Nitrite and NO_3 Nitrate. Because animals cannot take in nitrogen gas and use it to make amino acids, bacteria (you) do this for them. As nitrifying bacteria you are the foundation of all life! You will take the 4 N_2 molecules the atmosphere people bring you and make 2, NO_2 , Nitrite molecules and 2, NO_3 , Nitrate molecules. These are the molecules that the legumes (bean plants) can take in and use to make amino acids. Take 1, 4-prong nitrogen and connect it to oxygen elements (using the white bonds) for NO_2 , and make 2 of these. Then take one nitrogen and connect it to 3 oxygen elements for NO_3 Nitrate. Make 2 of these also. When you are done take these molecules to the Legume people.

Group 3: Legume People (8 students): You are the mediator between the nitrifying bacteria and all other life on Earth. You will receive the nitrites and nitrates from the bacteria people. You will take these molecules and make amino acids. Amino acids are the building blocks of protein, which make up your hair, skin, enzymes, fingernails, etc. Follow the directions on the sheet in front of you to make 4 amino acids (Each pair of students should make 1 amino acid.). Use the molecules you are given from the atmosphere people and the molecules made for you on your lab table (that in real life would have come from the soil that you, as plants, are growing in...such as CO_2 (carbon dioxide) and $C_6H_{12}O_6$ (glucose and carbohydrates)). Once you complete your amino acids take them to the Cow people. The Cow people will make them into proteins/muscle... that eventually humans will eat, digest and turn into the proteins that they need.

Teacher Sheet 3

Group 4: Cow/herbivore People (2 students): You are the “assimilators”- the cows grazing on alfalfa, which is a type of legume which has bacteria on its roots which “fixes” NO_2 , Nitrite molecules and NO_3 , nitrate molecules. The Legumes take the nitrites and nitrates and “fix” them into amino acids, a long protein. Create the molecules according to the instructions in front of you. Proteins should be about 30% of your diet. Once you complete your protein, you will “die.....” lay down on the table. The decomposing/denitrifying bacteria will come by and “decompose” you and your proteins and your other organic molecules that make up your cow body...returning them to the atmosphere and soil.

Group 5: Denitrifying Bacteria (8 people): You are the decomposers of the Earth. Without you all life would be smothered in a pile of waste that would never break down and be recycled. You are decomposing a cow’s organic molecules or proteins. So, you will hydrolyze these proteins and turn them back into : (4) N_2 Nitrogen gas and (2) CO_2 carbon dioxide, (2) $\text{C}_6\text{H}_{12}\text{O}_6$ glucose/carbohydrates. Any leftover elements in real life would be used to make other molecules, in this case you just leave them on the lab table. Basically, you have completed most of the nitrogen cycle and have manipulated the 1st Law of Thermodynamics: Matter/energy is not created or destroyed; it is simply transferred into other molecules/matter/energy.