

## TRAVELING NITROGEN

Summary	Students play the role of nitrogen atoms traveling through the nitrogen cycle to gain understanding of the varied pathways through the cycle and the relevance of nitrogen to living things.	<p style="text-align: center;"><b>Materials and Supplies</b></p> <p><i>Dice Codes and Reservoir Station Signs</i> (see preparation section below)</p> <p style="text-align: center;">11 dice</p> <p>11 different small rubber stamps and ink pads OR stickers/stamps copied from <i>Stamp Templates</i> (see preparation section below) and glue sticks</p> <p style="text-align: center;"><i>Passport worksheets</i> for each student (final page)</p> <p style="text-align: center;">Pens or pencils</p> <p style="text-align: center;">Ruled paper (for optional assesment)</p>
Source	Windows to the Universe	
Grade Level	5-9	
Time	15 minutes prep time In class: 30-minute plus optional 20 minutes for assessment	
Student Learning Outcomes	Students understand that nitrogen cycles indefinitely through the Earth system Students understand the places that it is found on Earth Students understand that nitrogen is essential for life Students learn that the cycle is nonlinear traveling between living things and physical environment	
National Standards	5-8 Content Standard D: Structure of the Earth System 5-8 Content Standard C: Populations and Ecosystems 9-12 Content Standard C: Interdependence of Organisms 9-12 Content Standard D: Geochemical Cycles Benchmarks: 5A/5 and 5E/2	

### Preparation:

1. Prepare *Dice Codes and Reservoir Station Signs*. If you do not have the signs, you can download and print them from: [http://www.windows2universe.org/teacher\\_resources/n\\_dicecode.pdf](http://www.windows2universe.org/teacher_resources/n_dicecode.pdf)
2. Set up stations around the classroom (or outside). For each station, supply the appropriate reservoir sign and a die. Each station will also need either an inkpad and rubber stamp, or stickers/stamps copied from templates. *Stamp Templates* can be downloaded and printed from: [http://www.windows2universe.org/teacher\\_resources/n\\_stamps.pdf](http://www.windows2universe.org/teacher_resources/n_stamps.pdf).
3. Copy *Passport Worksheets* for all students (final page).

### Directions:

1. Have students read the Windows to the Universe page entitled *The Nitrogen Cycle* (see resource list for URL).
2. Introduce nitrogen. Where is nitrogen found on Earth? Why is it important? Explain that nitrogen travels with the help of bacteria, water, lightning, plants, and animals.
3. Show the nitrogen reservoir signs around the room and explain that these are the places to which nitrogen can travel. These places are called reservoirs.
4. Tell students that for this activity they are each playing the role of a nitrogen atom. They will travel through the nitrogen cycle (i.e., to different stations around the room) based on dice rolls. Tell students that they will each carry a nitrogen passport with them and stamp it (or paste a stamp in it) each time they get to a nitrogen reservoir station. They will then toss the die at the reservoir to determine their next destination. Remind students to note in the passport how they get from one place to another based the roll of the die.

5. Spread students so that there are a few at each station and allow them to start traveling with their passport.
6. After everyone has filled their passport worksheet, discuss as a class:
  - How many stops can you make on your trip?*
  - Will your journey ever end?*
  - Was everyone's journey the same? Why not?*
  - What would happen if a farmer used too much fertilizer? (In this game, that would mean that everyone starts from the fertilizer station at the same time.)*
  - What would happen if we burnt too many fossil fuels?*
  - Livestock farming creates a large amount of animal waste. How would this affect the nitrogen cycle?*

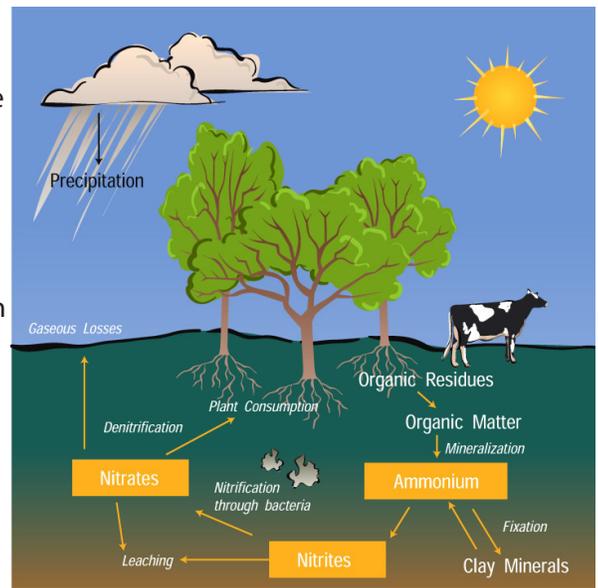
**Assessment:**

- Students write about their trip through the cycle including (1) where they went, and (2) how they got there.
- Show students a diagram of the nitrogen cycle. Ask them to create a diagram documenting only their journey.

**Background Information:**

Nitrogen is an element that is found in both the living portion of our planet and the inorganic parts of the Earth system. The nitrogen cycle is one of the biogeochemical cycles and is very important for ecosystems. Nitrogen cycles slowly, stored in reservoirs such as the atmosphere, living organisms, soils, and oceans along its way.

Most of the nitrogen on Earth is in the atmosphere. Approximately 80% of the molecules in Earth's atmosphere are made of two nitrogen atoms bonded together ( $N_2$ ). All plants and animals need nitrogen to make amino acids, proteins and DNA, but the nitrogen in the atmosphere is not in a form that they can use. The molecules of nitrogen in the atmosphere can become usable for living things when they are broken apart during lightning strikes or fires, by certain types of bacteria, or by bacteria associated with legume plants. Other plants get the nitrogen they need from the soils or water in which they live mostly in the form of inorganic nitrate ( $NO_3^-$ ). Nitrogen is a limiting factor for plant growth. Animals get the nitrogen they need by consuming plants or other animals that contain organic molecules composed partially of nitrogen. When organisms die, their bodies decompose bringing the nitrogen into soil on land or into the oceans. As dead plants and animals decompose, nitrogen is converted into inorganic forms such as ammonium salts ( $NH_4^+$ ) by a process called mineralization. The ammonium salts are absorbed onto clay in the soil and then chemically altered by bacteria into nitrite ( $NO_2^-$ ) and then nitrate ( $NO_3^-$ ). Nitrate is the form commonly used by plants. It is easily dissolved in water and leached from the soil system. Dissolved nitrate can be returned to the atmosphere by certain bacteria in a process called denitrification.



Certain actions of humans are causing changes to the nitrogen cycle and the amount of nitrogen that is stored in reservoirs. The use of nitrogen-rich fertilizers can cause nutrient leading in nearby waterways as nitrates from the fertilizer wash into streams and ponds. The increased nitrate levels cause plants to grow rapidly until they use up the nitrate supply and die. The number of herbivores will increase when the plant supply increases and then the herbivores are left without a food source when the plants die. In this way, changes in nutrient supply will affect the entire food chain. Additionally, humans are altering the nitrogen cycle by burning fossil fuels and forests, which releases various solid forms of nitrogen. Farming also affects the nitrogen cycle. The waste associated with livestock farming releases a large amount of nitrogen into soil and water. In the same way, sewage waste adds nitrogen to soils and water.

**Resources from Windows to the Universe:**

- The Nitrogen Cycle ([www.windows2universe.org/earth/Life/nitrogen\\_cycle.html](http://www.windows2universe.org/earth/Life/nitrogen_cycle.html))
- Climate and Global Change ([www.windows2universe.org/earth/climate/climate.html](http://www.windows2universe.org/earth/climate/climate.html))
- Life ([www.windows2universe.org/earth/Life/life.html](http://www.windows2universe.org/earth/Life/life.html))

