

Traveling Nitrogen

Unit: Cycles
Lesson: 2

Materials & Preparation

Time:

- Preparation: 15 min
- Teaching: 30 min
- Assessment: 20 min

Materials for Class

- 11 Dice
- Dice Codes (see p. 4-5)
- Signs with station names (see Advanced Preparation)
- 11 small rubber stamps
- 11 ink pads

Materials for Students:

- *Passport Student Page*
- Pen or pencil
- Lined paper

National Science Standards

- Life Science: Content Standard C (Populations and Ecosystems)
- Earth and Space: Content Standard D (Structure of the Earth System)

Learning Goals

Students will

- Learn that nitrogen cycles indefinitely through the Earth system and will understand the places that it is found on Earth.
- Understand that nitrogen is essential for living things.
- Learn that the cycle is complex and nonlinear traveling between organisms and the physical environment.

What Students Do in this Lesson

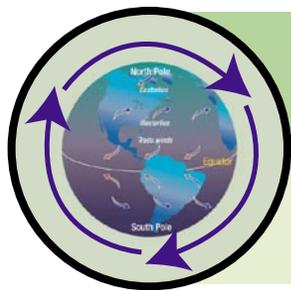
Students play the role of nitrogen atoms traveling through the nitrogen cycle to gain understanding of the varied pathways through the cycle and the relevance of nitrogen to living things.

Source

Windows to the Universe www.windows.ucar.edu

Key Concepts

- Nitrogen is an element that is found in both the living portion of our planet and the inorganic parts of the Earth system.
- Nitrogen cycles ceaselessly through the Earth system.
- Nitrogen atoms do not always take the same path through the system. There are many potential routes.
- There are many ways that humans cause modifications to the nitrogen cycle (including use of fertilizers, burning of fossil fuels, and livestock farming).



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Advanced Preparation

- Make large reservoir signs for: *atmosphere, surface water, rainwater, groundwater, fertilizers, soils, ocean, animal waste, dead plants and animals, live plants, live animals.*
- Print *Dice Codes* (p. 4-5) for reservoir stations and cut apart.
- Set up stations around the classroom (or outside). For each station, supply the appropriate reservoir sign, dice codes, a die, inepad, and stamp.
- Go around the room with the Key to Stamps sheet and stamp each reservoir so that you know which stamp corresponds with which reservoir.
- Copy *Passport Student Page* for all students.

Introducing the Lesson

- Have students read the Windows to the Universe page entitled *The Nitrogen Cycle* (http://www.windows.ucar.edu/tour/link=/earth/Life/nitrogen_cycle.html).
- Introduce nitrogen. Survey student knowledge. *Where is nitrogen found on Earth? Does it move from place to place or stay still? Why is it important?* Explain that nitrogen travels with the help of bacteria, water, lightning, plants and animals and that the class is going to discover how nitrogen travels.

Facilitating the Lesson

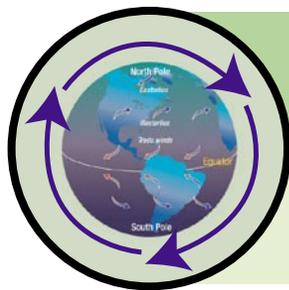
1. Show the nitrogen reservoir signs around the room and explain that these are the places to which nitrogen can travel. These places are called reservoirs.
2. Tell students that for this activity they are each playing the role of a nitrogen atom. They will travel through the nitrogen cycle (i.e., to different stations around the room) based on rolling dice. Tell students that they will each carry a nitrogen passport with them and stamp it each time they get to a nitrogen reservoir station. Then toss the die at the reservoir to find out what your next destination will be. Write a note in the passport to indicate how you are getting from one place to another based on what the die says.
3. Spread students so that there are 2 or three at each station and allow them to start traveling with their *Passport Student Page* by rolling the die at their stations.
4. Once all student have travelled enough times to fill in their entire Student Page, facilitate a group discussion of where they went and how they got there.

Summarizing and Reflecting

Discussion questions:

- *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 started 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?*

Have students write a paragraph about their trip through the nitrogen cycle. Include information about (1) where they went, and (2) how they got to each destination.



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Background Information

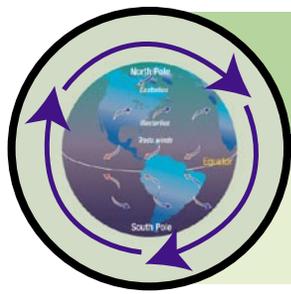
Nitrogen is an element that is found in both the living portion of our planet and the inorganic parts of the Earth system. The nitrogen cycle is one of the biogeochemical cycles and is very important for ecosystems. Nitrogen moves slowly through the cycle and is stored in reservoirs such as the atmosphere,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

Additional Resources

- Project LEARN: Cycles of the Earth and Atmosphere
<http://www.ucar.edu/learn/>
- Windows to the Universe: The Nitrogen Cycle
<http://www.windows.ucar.edu/tour/link=/earth/Atmosphere/overview.html>



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DICE CODES

1. Print the dice code pages (p.4-5 of this lesson).
2. Cut each reservoir apart on the dotted lines.
3. Place dice codes at appropriate reservoir stations ?(see Advanced Preparation for more information)

You've arrived at the: **Atmosphere**

Potential routes from here:

- If your die reads 1 or 2: Lightning strikes! Nitrogen gas is made into a solid and travels to the soil!
- If your die reads 3 or 4: Blue green algae and bacteria convert you into a solid bringing you to the soil!
- If your die reads 5 or 6: Bean plants extract you from the air and bring you to the soil!

You've arrived at the: **Surface water**

Potential routes from here:

- If your die reads 1 or 2: You are just the sort of nitrogen that plants need. You are now in a live plant!
- If your die reads 3 or 4: You travel through the rivers and streams to the ocean!
- If your die reads 5 or 6: You percolate deep underground in the groundwater!

You've arrived at: **Rainwater**

Potential routes from here:

- If your die reads 1: You fall into a lake or stream so now you are part of surface water.
- If your die reads 2 or 3: You fall on the land and become part of the soil!
- If your die reads 4: You percolate deep underground in the groundwater!
- If your die reads 5 or 6: You rain into the ocean!

You've arrived at: **Groundwater**

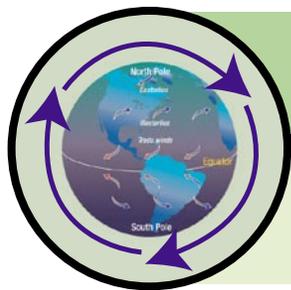
Potential routes from here:

- If your die reads Odd numbers (1, 3, or 5): The groundwater you are dissolved within travels and you become part of the surface water!
- If your die reads Even numbers (2, 4, or 6): The groundwater you are dissolved within travels and you become part of the ocean!

You've arrived at: **Fertilizers**

Potential routes from here:

- If your die reads 1 or 2: You dissolve and wash into the surface water!
- If your die reads 3 or 4: You become part of the soil!
- If your die reads 5 or 6: You are just the sort of nitrogen that plants need. You are now in a live plant!



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You've arrived at: **Soils**

Potential routes from here:

- If your die reads 1: You dissolve and wash into the groundwater!
 - If your die reads 2: You dissolve and wash into the surface water!
 - If your die reads 3 or 4: You are just the sort of nitrogen that plants need. You are now in a live plant!
 - If your die reads 5 or 6: Bacteria transformed you into nitrogen gas. You are now in the atmosphere!
-

You've arrived at the: **Ocean**

Potential routes from here:

- If your die reads 1: Look out! Water is on the move! You have washed into the groundwater!
 - If your die reads 2 or 3: You are just the sort of nitrogen that plants need. You are now in a live plant!
 - If your die reads 4, 5, or 6: Bacteria have transformed you into nitrogen gas and you are now part of the atmosphere!
-

You've arrived at: **Live animals**

Potential routes from here:

- If your die reads Odd numbers (1, 3, or 5): The animal that you are within died. Go to dead plants and animals.
 - If your die reads Even numbers (2, 4, or 6): Congratulations! The animal that you were within has excreted and you are in its waste. Go to animal waste!
-

You've arrived at: **Animal waste**

Potential routes from here:

- If your die reads 1 or 2: Look out before someone steps in you! Now you decompose in the soil!
 - If your die reads 3 or 4: A farm supply company has picked you up and made you into fertilizer!
 - If your die reads 5 or 6: What's that in the water? You have dissolved into surface water!
-

You've arrived at: **Dead plants and animals**

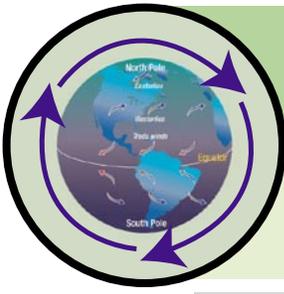
Potential routes from here:

- If your die reads 1 or 2: You are decomposed and become part of the soil!
 - If your die reads 3: You are decomposed and become dissolved in surface water!
 - If your die reads 4: You are decomposed and become dissolved in the ocean!
 - If your die reads 5 or 6: Fire! The wood you were within burns. You are released in the atmosphere.
-

You've arrived at: **Live plants**

Potential routes from here:

- If your die reads Odd numbers (1, 3, or 5): The plant you are in died. Go to dead plants and animals.
- If your die reads Even numbers (2, 4, or 6): An animal has eaten the plant you are in! Go to live animals.



CLIMATE DISCOVERY STUDENT PAGES

NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

Traveling Nitrogen

Name _____
Date _____ Class _____

1. Fill out your start location in the space below.
2. Roll the die at your start location to find out where to go next. Write the "Where I'm going" and "How I'm getting there" information in the Trip #1 box (as in the example at the right).
3. Head to that location and stamp the Trip#1 box. Then, roll the die at that location to find out where to go next.

Trip#1:Where I'm going: Surface Water	How I'm getting there: Fertilizer washed into stream
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Stamp

Start Location: _____

Trip#1:Where I'm going: _____	How I'm getting there: _____
Stamp above	

Trip#6:Where I'm going: _____	How I'm getting there: _____
Stamp above	

Trip#2:Where I'm going: _____	How I'm getting there: _____
Stamp above	

Trip#7:Where I'm going: _____	How I'm getting there: _____
Stamp above	

Trip#3:Where I'm going: _____	How I'm getting there: _____
Stamp above	

Trip#8:Where I'm going: _____	How I'm getting there: _____
Stamp above	

Trip#4:Where I'm going: _____	How I'm getting there: _____
Stamp above	

Trip#9:Where I'm going: _____	How I'm getting there: _____
Stamp above	

Trip#5:Where I'm going: _____	How I'm getting there: _____
Stamp above	

Trip#10:Where I'm going: _____	How I'm getting there: _____
Stamp above	