

Learning Targets:

- Understand that nitrogen cycles indefinitely through the Earth system.
- Name the places that nitrogen is found on Earth.
- Describe how the cycle travels between living things and the physical environment.
- Understand the role of seaweed in the marine cycle of nitrogen.

Length: 45 - 60 minutes

Key Concepts:

- Nitrogen cycles around and around. It is always recycled and never disappears from our environment.
- Nitrogen doesn't follow the same path all of the time.
- Even though nitrogen is essential for all life, there can still be too much of it sometimes. Seaweeds need a lot of nitrogen to grow, so they take up nitrogen in areas where there is too much.

Essential Questions:

1. Why is nitrogen important?
2. How is nitrogen taken into living organisms?
3. What is the nitrogen cycle?
4. When there is too much nitrogen in the ocean, what role does seaweed take?

Enduring Understandings:

1. Plants and animals use nitrogen to build proteins.
2. Nitrogen cannot be absorbed directly from the air. First, bonds are broken and then bacteria processes nitrogen into nitrates. Then nitrogen is fixed so it can be used.
3. The nitrogen cycle is the process of nitrogen being fixed, then used by plants and animals, and later being returned to the atmosphere to cycle again. Nitrogen takes varied paths in the atmosphere, soil, and waters.
4. Seaweed takes up nitrogen and uses it to grow.

Background for Facilitator:

Nitrogen is an element found in living things such as plants and animals; in dead things such as fallen leaves and dead animals; and in non-living things such as air and water. The nitrogen cycle is very important for ecosystems because it is an important element for ALL life on earth. Nitrogen goes through its cycle slowly, and is stored in the atmosphere, in living organisms, in soils, and in oceans along its way through the cycle. Nitrogen in its gaseous form is unusable to life forms and

must first be converted, or “fixed”, by specialized bacteria so it can be used. Other bacteria do the reverse and return nitrogen to its gaseous form.

In this game, youth will play the role of nitrogen atoms traveling through the nitrogen cycle. They will gain understanding of the varied pathways through the cycle and the relevance of nitrogen to living things. Seaweed picks up nitrogen in a process called nutrient bio extraction. Many plants and animals cannot survive when there is too much nitrogen in the water, but seaweed takes in the nitrogen.

Fun Facts:

- Nitrogen is the seventh most abundant element in the universe.
- Approximately 78% of the atmosphere is nitrogen.
- Nitrogen has no color, odor, or taste.
- Nitrogen is used in fertilizer for farms and gardens.
- The human body contains about 3% nitrogen.

Vocabulary List:

Nitrogen: An important element of the periodic table. It does not have a color or an odor. Nitrogen is essential for growth and reproduction of all living things.

Materials:

- 10 six-sided dice
- 14 Nitrogen Station Signs
- 10 Nitrogen Cycle Passport Datasheets (1 passport per group)
- 15 Nitrogen Necklaces
- 14 Emoji Stamps (a **different** stamp for each game station)
- Pens/Pencils
- Masking Tape
- Paper Towels

Methods:

Engage

1. Introduce this activity by asking youth what types of things they eat on a regular basis. The goal is to determine if they eat one thing all the time or if they eat a variety of foods.
 - a. **Seaweeds produce sugar during photosynthesis, but is that enough for them to survive?**
 - b. **What would happen if humans ate nothing but sugar? Is that good or bad?**
Example to help understanding: **Would you eat candy and pudding for every meal? What if humans ate only broccoli all the time? What would the result be for your overall health?**
 - c. **Seaweeds need a variety of nutrients just like humans need a variety of vitamins and minerals to be healthy.**
2. Explain to the youth that one of the nutrients seaweed needs is called **NITROGEN: Let's learn more about nitrogen. What is nitrogen? A gas in the air. Animals and plants, including seaweed, need it as a nutrient to live. Is it absorbed directly from the air like oxygen? No. Nitrogen must be broken down to nitrates by specialized bacteria. The process of breaking nitrogen down is referred to as “fixing nitrogen.”** Then it

travels through varied paths called a cycle. Let's play a game to see how the nitrogen cycle works and how seaweeds get nitrogen.

3. Point to the nitrogen station signs around the room and explain that these signs represent the places to which nitrogen can travel.
4. Ask for a few volunteers to read aloud how nitrogen travels from station to station.
 - a. **What are the names of the Nitrogen stations around the room?**
 - b. **What are some ways Nitrogen can travel from station to station?** Read a few of the descriptions next to the image of dice.

Explore

5. Ask the youth to work in groups of 2-3 for this game.
6. Give a nitrogen necklace to each person, and tell the youth they will play the role of a nitrogen atom during this game:
 - a. **You will travel as nitrogen atoms with your partners based on the roll of the dice.**
 - b. **You will carry your own dice and a nitrogen passport. You will stamp your passport each time you arrive at a nitrogen station. Every station has a different stamp to help you keep track of where you have been.**
Note: It does not matter which stamp you put at each station!
 - c. **You will also stamp the nitrogen station sign itself to prove that you were there.**
 - d. **Roll the dice and follow the directions on the sign to determine which station you will travel to next.**
 - e. **At the end of the game, you will share your individual journey and we will determine which nitrogen station had the most visitors.**
7. Demonstrate the game by traveling from one station to the next, describing your actions aloud.
8. Direct each group to begin at a different nitrogen station, and record the "start" station on their passport.
9. Walk around to the groups during the game to clarify any questions and remind them to fill out their passports and to stamp the signs.
10. Play the game for approximately 20 minutes, or more if necessary. Repeat the game multiple times if needed to ensure understanding. Repetition may help reinforce key concepts.

Explain

11. When you stop the game, tell youth to remain at the nitrogen station where they ended up and record the number of stamps on each sign.
12. Direct the groups to walk around to empty stations and record the number of stamps on each sign, too. Eventually, all of the stations should be counted between all of the groups.
13. Engage the students in a discussion of their experience:
 - a. **Which nitrogen station was most visited?** (*Note: they will need to compare calculations among groups to answer this question).
 - b. **How many stops did you make on your trip?**

- c. **Was everyone's journey the same? Why or why not? Visual maps can be made by each group and shared with the whole group.**

Elaborate

Let's look more closely at seaweed.

14. Explain that seaweed needs a lot of nitrogen to grow.
 - a. **Nitrogen is an important nutrient for seaweed. Without nitrogen, seaweed couldn't grow.**
 - b. **Oftentimes, seaweed is grown right next to fish farms because the waste from the fish is full of nitrogen.**
15. Explain that fish farming creates a large amount of fish waste.
 - a. **How do you think this affects the nitrogen cycle?**
 - b. **Let's find out by having everyone start from the "Marine Animal Waste" station at the same time.**
16. The nitrogen cycle signs need to be cleaned off. Ask each youth to wipe one sign down with a damp paper towel.
17. Explain that you will now play another round of the game. This time, have all of the groups start at the "Marine Animal Waste" station and roll the dice one group at a time.
18. Direct the youth to record their travel on the back of their passport datasheet.
19. Continue the game for 15 minutes or more.
20. Direct the youth to count the total number of stamps on each station.

Evaluate

21. Engage the youth in a discussion of their experience:
 - a. **What happened when everyone started at the Marine Animal Waste station?**
 - b. **How was this journey different from the first journey?**
 - c. **Where did the nitrogen travel?**
 - d. **Knowing that seaweed uses a lot of nitrogen, how do you think farming seaweed and fish together might benefit the environment?**
 - e. **How do you think growing seaweed can help in areas where there is too much nitrogen?**
 - f. **How do you think humans factor into the nitrogen cycle?** (Youth need to connect humans with farm runoff, fertilizer, accidental forest fires, animal wastes from farms, human wastewater pollution, etc.).

Extension Ideas:

- Discuss the human impacts on the nitrogen cycle (farming, burning fossil fuels, sewage waste, deforestation, marine pollution, etc.). Ask youth to expand upon the nitrogen cycle game to include human impacts, and perhaps suggest solutions to any issues.
- Introduce aquaponics: a system of aquaculture in which the waste produced by farmed fish or other aquatic animals supply nutrients for plants or seaweeds grown hydroponically, which in turn purify the water. Have youth draw and label their own "nitrogen cycle" for an aquaponics system.

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