**ACTIVITY 1: Nitrogen cycle game**

**Introduction** ~10 min

1. Pose question: We know that nitrogen contaminating ground water can be an issue but how does N get into ground water? What are other pools of N? How does nitrogen move between these pools?
2. Hand out worksheet
3. Show the nitrogen pool signs around the room and explain that these are the pools/stores of nitrogen in the environment.
4. Tell students that for this activity they will work in groups to play 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 worksheet with them and record their movement through the stations. They will then toss the die at the pool 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. Do one example dice roll and show how it is recorded using a document cam or other method.
6. Check understanding

**Students play through game**15-20 min

**Post-activity discussion** 5-10 min

Guided discussion questions: How many stops can you make on your trip? Will your journey ever end? Was everyone’s journey the same? Why not?

**ACTIVITY 2: Nitrogen-cycle Diagram Activity** 30-40 min

1. Introduce diagram assignment and pass out instructions
2. Students will work together to create a rough draft diagram of their group’s trip through the nitrogen cycle
3. Form *different* groups to combine information to make a more complete diagram on a piece of poster board students may use the provided station symbols to cut out.
4. Create a diagram on a smart board or white board as a whole class. Have volunteers or a “reporter” from each group contribute.
5. As a group critique diagram and look for errors or gaps

**Guided discussion using diagram** 10-15 min

Possible questions:

* What would happen if a farmer used too much fertilizer? In this game, that would mean that the plants can’t take up all the fertilizer, what are the other options?
* How can humans reduce nitrogen contamination of ground water? Using the nitrogen-cycle identify one pool of nitrogen and one way in nitrogen moves that humans have at least partial control over.
* What would happen if farmers could not use as much N fertilizer?

**Teacher Resources**

## Precision Ag Case Study: <https://www.youtube.com/watch?v=pr_5NLGT9Kk>

Nitrogen in Ag Webinars: http://csanr.wsu.edu/webinars/pnw-ag-and-climate-change/

## References

*Adapted from: UCAR “Nitrogen Cycle Game”*

*http://scied.ucar.edu/activity/nitrogen-cycle-game*

Nitrogen Cycle Game

**Name:**

**Instructions**

In this simulation you are a nitrogen atom. You are going to travel the nitrogen cycle stopping in many locations. For each stop along your journey, remember to record where you went and how you got there.

Here’s an example of how to fill out each stop along the way:

|  |  |  |
| --- | --- | --- |
| Trip | How I traveled: | Where I went: |
| 1 | runoff | Surface water |
| 2 |  |  |

**Your trip log:**

|  |  |  |
| --- | --- | --- |
| Trip | How I traveled: | Where I went: |
| Start |  | Start: |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |
| 6 |  |  |
| 7 |  |  |
| 8 |  |  |
| 9 |  |  |
| 10 |  |  |
| 11 |  |  |
| 12 |  |  |

**Nitrogen Cycle Diagram Activity**

1. Begin by cutting out a label for each of the nitrogen store stations.
2. Now layout your stations in the order you visited them and find an arrangement you like
3. You may have stations you didn’t visit, save them for later
4. Once you have found an arrangement you like glue your nitrogen stores down and begin to add arrows between the stores. Only add arrows in the direction your group moved between stations

|  |  |  |
| --- | --- | --- |
| Atmosphere | Surface Water | Rain Water |
|  |  | Soil |
|  |
|  |
| Groundwater |
| Live Animals | Dead Plants and Animals | Animal Waste |
| Live Plants |  |  |

N2

N2O

NO

Atmosphere

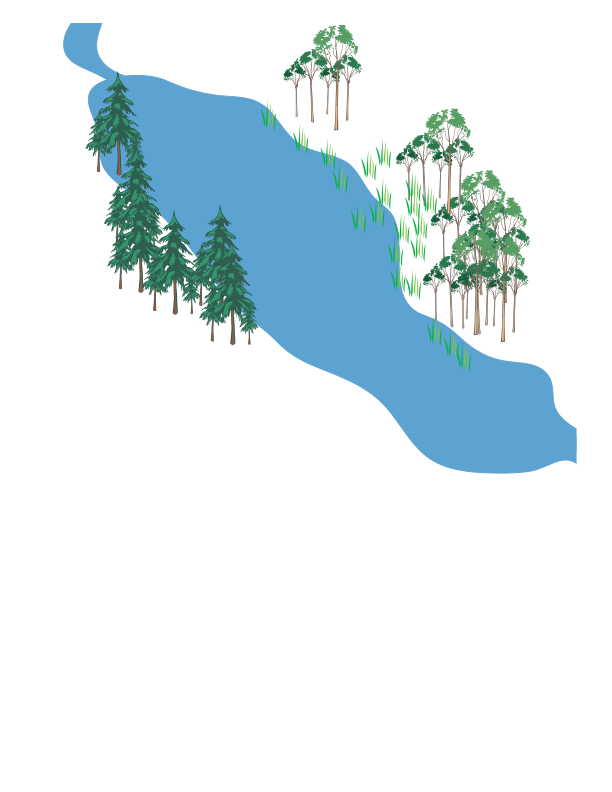
*Write in* ***Atmosphere*** *on your worksheet and then roll the die to see where and* ***how*** *you will travel next!*

**If your die reads: 1 or 2**Lightning strikes! Nitrogen gas is make into a solid and travels to the **soil** via **lightening fixation**

**If your die reads: 3**Blue-green algae and bacteria change you into a solid, bringing you to the **soil** via **bacterial fixation**

**If your die reads: 4**Bacterial symbionts of bean plants extract you from the air and bring you to the **soil** via **symbiotic fixation**

**If your die reads: 5 and 6**Some nitrogen can get into the water in clouds and then fall as **rain** via **bacterial fixation**



NO2-

NO3-

Surface Water

*Write in* ***Surface water*** *on your worksheet and then roll the die to see where and* ***how*** *you will travel next!*

**If your die reads: 1, 2 or 3**

You are just the sort of nitrogen (NO3- or NH4+) that plants need to live. You are now within a **live plant** via **nutrient uptake**

**If your die reads: 4, 5 or 6**You percolate deep underground in the **groundwater** via **percolation.**

NO2-

NO3-

Rain Water

*Write in* ***rain water*** *on your worksheet and then roll the die to see where and* ***how*** *you will travel next!*

**If your die reads: 1**You fall into a lake or stream so now you are part of **surface water** via **precipitation.**

**If your die reads: 2, 3 or 4**You fall on the land and become part of the **soil** via **precipitation**!

**If your die reads: 5 or 6** You rain into the **ocean** via **precipitation**!

NO2-

NO3-

Groundwater

*Write in* ***groundwater*** *on your worksheet and then roll the die to see where and* ***how*** *you will travel next!*

**If your die reads: 1, 2, 3, or 4**

The groundwater you are dissolved within travels and you become part of the **surface water** via **contamination!**

**If your die reads: 5**

The groundwater you are in is taken up by deep roots of **live plants** via **nutrient uptake**!

**If your die reads: 6**

The groundwater you are in evaporates and you are left in the **soil** via **evaporation**!



NO2-

NO3-

NH4+

Fertilizers

*Write in* ***fertilizer*** *on your worksheet and then roll the die to see where and* ***how*** *you will travel next!*

**If your die reads: 1 or 2**You dissolve and wash into the **surface water** via **runoff!**

**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 to live. You are now within a **live plant** via **nutrient uptake!**

NO2-

NO3-

NH4+

Soil

*Write in* ***soil*** *on your worksheet and then roll the die to see where and* ***how*** *you will travel next!*

**If your die reads: 1**

You dissolve and wash into the **groundwater** via **percolation!**

**If your die reads: 2**

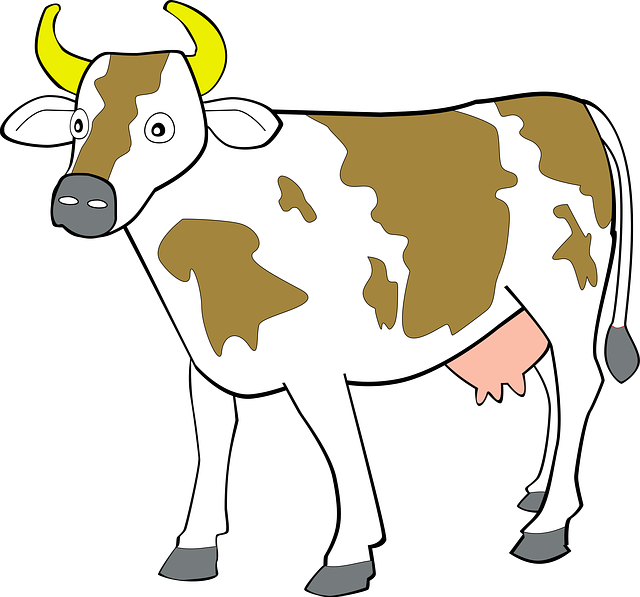
You dissolve and wash into the **surface water** via **runoff!**

**If your die reads: 3 or 4**

You are just the sort of nitrogen that plants need to live. You are now within a **live plant** via **nutrient uptake!**

**If your die reads: 5 or 6**

Bacteria have transformed you into nitrogen gas and you are now part of the **atmosphere** via **nitrification!**



Organic N:

DNA

RNA

Proteins

Live Animals

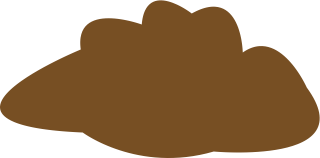
*Write in* ***live animals*** *on your worksheet and then roll the die to see where and* ***how*** *you will travel next!*

**If your die reads: Odd numbers (1, 3, or 5)**

The animal that you are within has 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** via **excretion!**

             Animal Waste

Organic N:

DNA

RNA

Proteins

*Write in* ***animal waste*** *on your worksheet and then roll the die to see where and* ***how*** *you will travel next!*

**If your die reads: 1 or 2**

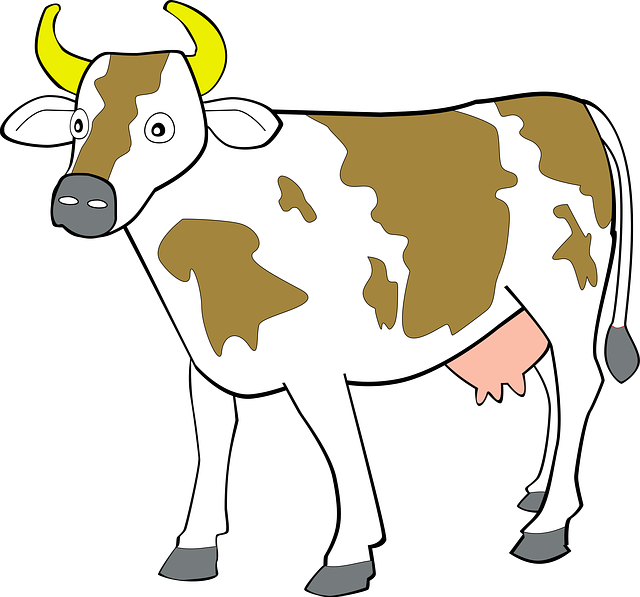
Look out before someone steps in you! Now you are decomposing in the **soil** via **decomposition!**

**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** via **contamination!**



Organic N:

DNA

RNA

Proteins

Dead Plants and Animals

*Write in* ***animal waste*** *on your worksheet and then roll the die to see where and* ***how*** *you will travel next!*

**If your die reads: 1 or 2**

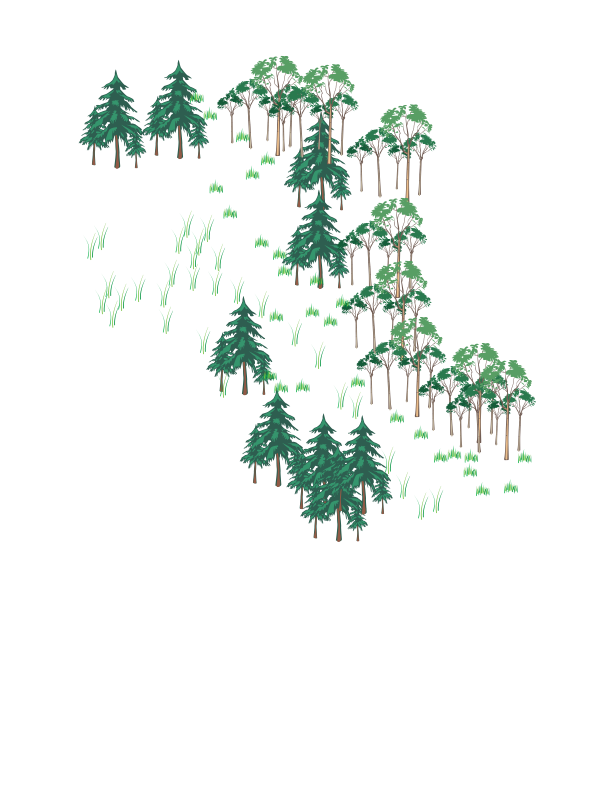
You are decomposed and become part of the **soil.**

**If your die reads: 3 or 4**

You are decomposed and become dissolved in **surface water** via **runoff!**

**If your die reads: 5 or 6**

Forest Fire! The wood you were within is burnt and you have been released into the **atmosphere** via **combustion.**



Organic N:

DNA

RNA

Proteins

Live Plants

*Write in* ***animal waste*** *on your worksheet and then roll the die to see where and* ***how*** *you will travel next!*

**If your die reads: Odd numbers (1, 3, or 5)**The plant that you are within has died. Go to **dead plants and animals.**

**If your die reads: Even numbers (2, 4, or 6)**An animal has eaten the plant that you are within! Go to **live animals** via **herbivory!**

**OPTIONAL ACTIVITY 3:**

**Inquiry Activity:**

**Scientific Literacy/Problem Based Inquiry** 30 min (optional)

Have students read a variety of text/news story/articles (may differentiate based on ability or give the same text to all students) related to nitrogen ground water contamination in their town and globally.

Example Texts:

<http://www2.epa.gov/nutrientpollution/problem>

<http://water.usgs.gov/edu/nitrogen.html>

<http://www.cbf.org/about-the-bay/issues/dead-zones/nitrogen-phosphorus>

<http://www.nbc4i.com/story/29281318/fertilizer-chemicals-blamed-for-water-contamination>

<http://www.wateronline.com/doc/idaho-s-farmers-and-cities-unite-to-clean-waterways-0001>

<http://www.newsweek.com/nutrient-pollution-hurts-fish-study-says-340983>

<http://www.ext.colostate.edu/pubs/crops/00517.html>

<http://www.wnct.com/story/29267414/nitrate-advisory-in-effect-for-areas-of-columbus-water-service>

Have students share different issues related to excess nitrogen with the whole class from their various readings.

**Question (think-pair-share or other):** We have discussed issues related to nitrogen in groundwater. What are the other locations/reservoirs of nitrogen in an ecosystem?

***Define:***

*Reservoirs: a supply, store or source of something (nitrogen in this case).*

*Important stores of N to be sure are covered: gas, plants, in animals, in dead plants and animals, in animal waste, dissolved in water (surface and ground)*