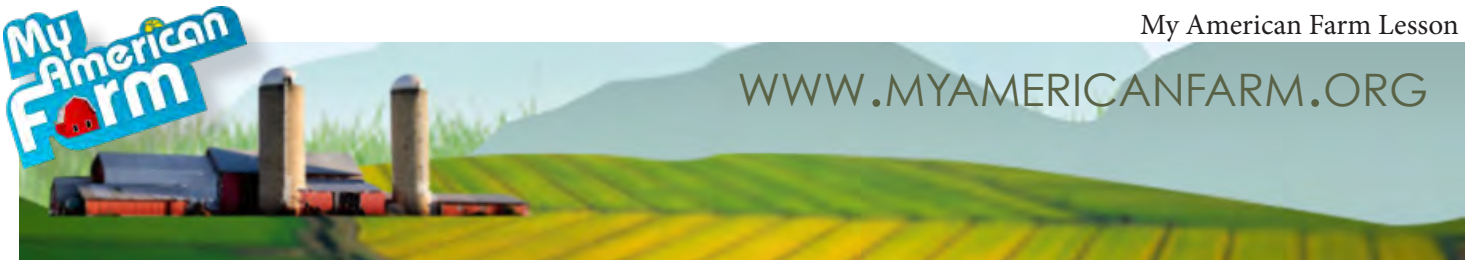


Peanuts and Nitrogen

Lesson Snapshot

Related "My American Farm" Game

"Operation Peanut Butter" available at www.myamericanfarm.org

Grade Levels

- 3rd - 5th grade

Content Areas

- Science

Standards

Next Generation Science Standards Grades 3-5

5-LS2-1: Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment

5-PS3-1: Use models to describe energy in food that was once from the sun

5-LS1-1: Support argument that plants get material they need for growth chiefly from air and water (not the soil)

5-LS2: Ecosystems: Interactions, Energy and Dynamics

Objectives

By the end of this activity, the students will be able to:

- Recall that all animals need plants to live
- Recognize that all plants and animals need nitrogen to live (among other things)
- Recall that peanut plants are a good host for bacteria that fixes nitrogen into a consumable form

Materials

- Writing utensil/student
- "Nitrogen Cycle Diagram" handout/student
- "Element Handout" 1 set/10 students
- "Nitrogen Deficient Plants" presentation or "Nitrogen Deficient Plants-single page"
- "Nitrogen Cycle Demonstration" cut-outs, 1/class
- White Board/Chalk Board
- Photos of peanut plants, their roots, and Rhizobium bacteria
- (Optional) Peanut plant with roots to show students what Rhizobium looks like

Preparation

- Print student handouts
- Print and cut appropriate amount of "Element Handout"
  Appropriate Ratio per 10 students:
  7 Nitrogen
  2 Oxygen
  1 Carbon Dioxide/other
- Print and cut "Nitrogen Cycle Demonstration" cutouts.
- Either prepare PowerPoint® presentation "Nitrogen Deficient Plants" or print a color copy of "Nitrogen Deficient Plants" single page (in color, 1/2-3 students)
- Visit My American Farm online (www.myamericanfarm.org) to preview the "Operation Peanut Butter" game.
- Review the lesson. There are a couple of places where you will see an asterisk (*). These are areas where you can choose to modify the lesson. To determine if you need to make these modifications, ask:
  - » How much time would you like to allocate for the activity?
  - » How would you like students to demonstrate what they've learned?

Background Information For Instructor

Brush-up on your knowledge

Key Facts

- All living things require the following elements to survive: C (carbon), H (hydrogen), O (oxygen), and N (nitrogen). For this lesson, the focus will be on nitrogen.
- Nitrogen exists as a gas in the atmosphere. (Nitrogen makes up about 79% of the gases in our atmosphere, oxygen makes up close to 20% and carbon dioxide/hydrogen and other

gases make up the remaining 1%)

- Neither plants nor animals can utilize atmospheric nitrogen. The following is a high-level view of the nitrogen cycle:
  - Bacteria on the roots of certain plants convert the nitrogen to a form which plants can utilize. *(This is where the peanut plant, or more specifically, the bacteria that lives on the roots of the plant, comes into play.)*
  - Plants convert this form of nitrogen into organic nitrogen that animals obtain by eating plants
  - When animals die, their bodies are broken down by different bacteria in the soil. The bacteria converts the organic nitrogen back into atmospheric oxygen. (This is actually a multi-step process utilizing different types of bacteria along the way.)

Introduction

Set Context for the Activity

Step 1: Introduce Elements Needed by All Living Things

- On the board, write Carbon, Hydrogen, Oxygen, and Nitrogen
- Ask students to turn to a partner or two and share if they know what any of the four things are or what they have in common? (Responses will vary greatly by age.)
- Ask a few students to share what they know with the class
- Acknowledge answers and highlight/clarify the following facts about C, H, O, N
  1. Plants and animals need all four of these things to survive.
  2. All four of these things can be found in our air (we just can't see them). They are other places too, which we'll learn about soon.

*Step 2 (option a): What's in the Air?

- Handout an element card to each student ensuring that the ratio of C/H/others:O's:N's are accurate
  - *for every 10 students: 1 C/H/others:2 O's:7 N's*
- Set Context for demonstration: *"Each of you are now one of the gases that are in the air."*
- Give directions for demonstration. *"We're going to countdown from three to one. When we get to one, hold up your card and look around the room to see what you notice."*
- As students are looking around, mention the following questions. (With older students, these could be rhetorical and they could sit down and write their observations with less guidance. With younger students you might want to answer questions as you go, capturing information on the board.)
  1. *What do you see?*
  2. *What is there the most of?*
  3. *How many of there of each N, C, H, O?* (This might be an opportunity to talk about percentages if age appropriate.)
- Follow-up by highlighting that over 70% (in fact 78%) of our air is made up of Nitrogen gas.
- Transition: *Let's learn a little more about Nitrogen!*

*Step 2 (option b): What's in the Air?

- Show pictures of nitrogen deficient plants
- As students are viewing pictures, mention the following questions and discuss.What do you see?
  1. *What do the plants in the pictures have in common? How are they different from healthy plants?* (Answers will vary-Yellowish leaves, small/thin leaves, fewer leaves, drop leaves early. Shoots of plants might be smaller and a more reddish color.)
- Wrap up by making the point that all living things need nitrogen and that there is lots of nitrogen in our atmosphere.
- Transition: *Let's learn a little more about nitrogen!*

Body

Main Content

Step 3: The Nitrogen Cycle

- Write the following question on the board: "What do peanut plants have to do with nitrogen?"
- Introduce the question and solicit answers if you wish.
- Handout *"Nitrogen Cycle Diagram"* to each student
- Lead a Discussion about the Nitrogen Cycle
  - Refer to beginning of lesson where you pointed out that all living things need carbon, hydrogen, oxygen and nitrogen.
  - Introduce the problem with nitrogen: plants and animals need nitrogen, but they can't use the

nitrogen that is in the air--it has to be "fixed" or changed a little first

- Announce and share content: *This is where the plants, including peanut plants, come in handy!*
- Reference live peanut plant with roots exposed and/or use photos for reference
  - *Some plants, including peanuts have special bacteria on their roots* (point to the nodules on roots).
    - Ask students to draw some bacteria nodules on the peanut roots of their handout. (*The bacteria is called Rhizobium. Share if appropriate for age group.)*
- Walk students through worksheet by having them add arrows. Allow for inquiry.
  - Draw arrow from nitrogen in air to the bacteria on the roots of the peanut plant
  - Draw arrow from the roots of the peanut plant to the peanut plant
  - Draw arrow from peanut plant to animal
  - Draw arrow from animal to decomposing bacteria in the soil
  - Draw arrow from decomposing bacteria back to atmospheric nitrogen to complete the cycle
- If needed, talk students through the cycle, allowing for questions
- Ask students to talk the cycle through with a partner then swap roles. If appropriate, repeat with another partner.

- Return to question on board and solicit answers: "What do peanut plants have to do with nitrogen?"
  - Key take away here is that they have special bacteria on their roots that fix nitrogen so plants can utilize it.
  - Another point would be that the peanuts and plant itself provide nitrogen to animals.

Step 4: Simple Cycle Demonstration

- Select 5 volunteers and distribute appropriate materials to each
  - **1. Atmosphere:** Large Yellow Circles (*representing atmospheric nitrogen)*
  - **2. Nitrogen Fixing Bacteria on Peanut Plant Roots (Rhizobium):** Small Brown Circles (*representing ammonia when placed on the yellow circle)*
  - **3. Peanut Plant:** Small Green Squares (*representing organic nitrogen when placed on the yellow circle)*
  - **4. Animal (your choice):** Small Red Triangles (*representing ammonia/waste when placed on the yellow circle)*
  - **5. Decomposing Bacteria:** No extra supplies needed *(these bacteria will remove the red triangles/converting the waste back into atmospheric nitrogen)*
- Help students walk through the demonstration. *(See "Nitrogen Cycle Demo" reference page for visual)*
  1. Atmosphere student will pass the yellow circle to the Nitrogen fixing bacteria
     - Nitrogen fixing bacteria will add a brown circle to the Nitrogen
  2. Nitrogen fixing bacteria will pass to the plant
     - Peanut plant will remove brown circle and add green square to yellow cirlcle
  3. Peanut plant will pass to the animal
     - Animal will remove green square and add red triangle
  4. Animal will pass to the decomposing bacteria
     - Decomposing Bacteria will remove the red triangle
  5. Decomposing bacteria will pass the plain yellow circle back to the Atmosphere
- Repeat demonstration a couple of times and ask students to point to the corresponding steps on their "*Nitrogen Cycle Diagram*"

Step 5: Play the Game

- At this point you may elect to have students play "Operation Peanut Butter", available at myamericanfarm.org. Students can work individually or in pairs.
- Inform students they will be jumping into a fun game that takes a closer look at the journey peanuts take to get from the field to our tables.

*You may choose to have students play this game before you arrive, after you have left, or at home with adult permission.

*The game is supported by audio. You may wish to secure headphones for students, or play the game as a class while displaying on a large screen.

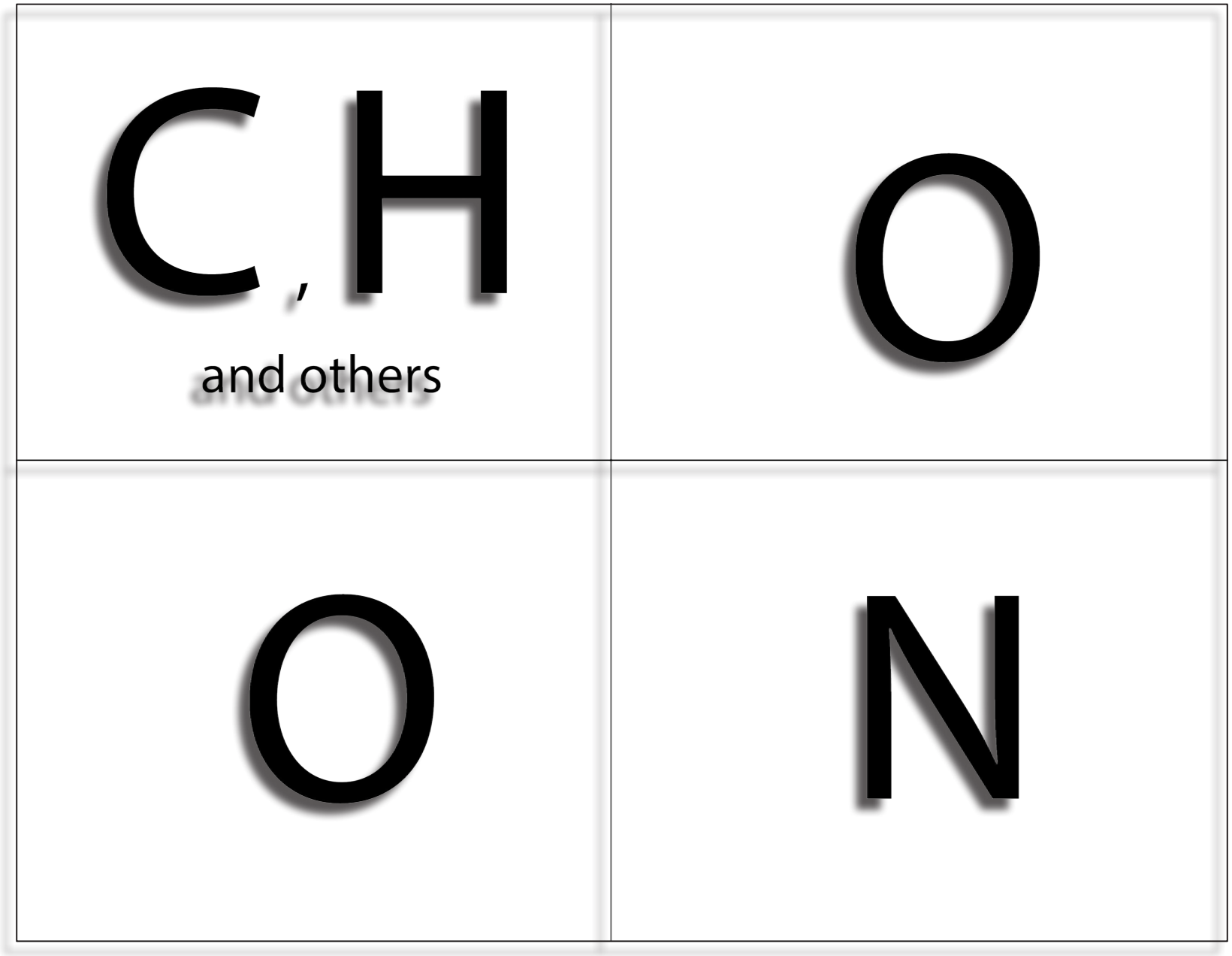
Wrap Up

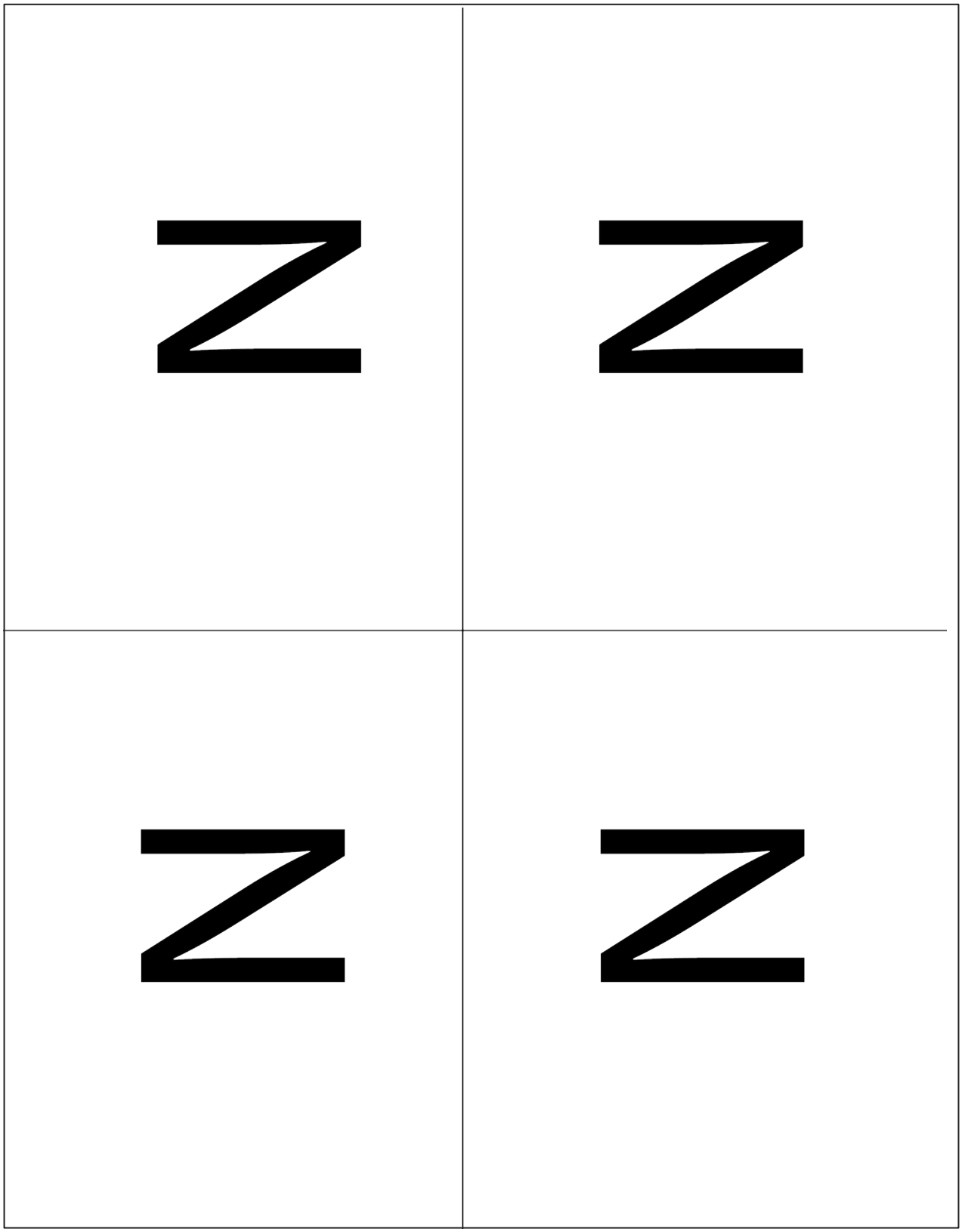
Review, Assess, Challenge

Step 5: What have you learned?

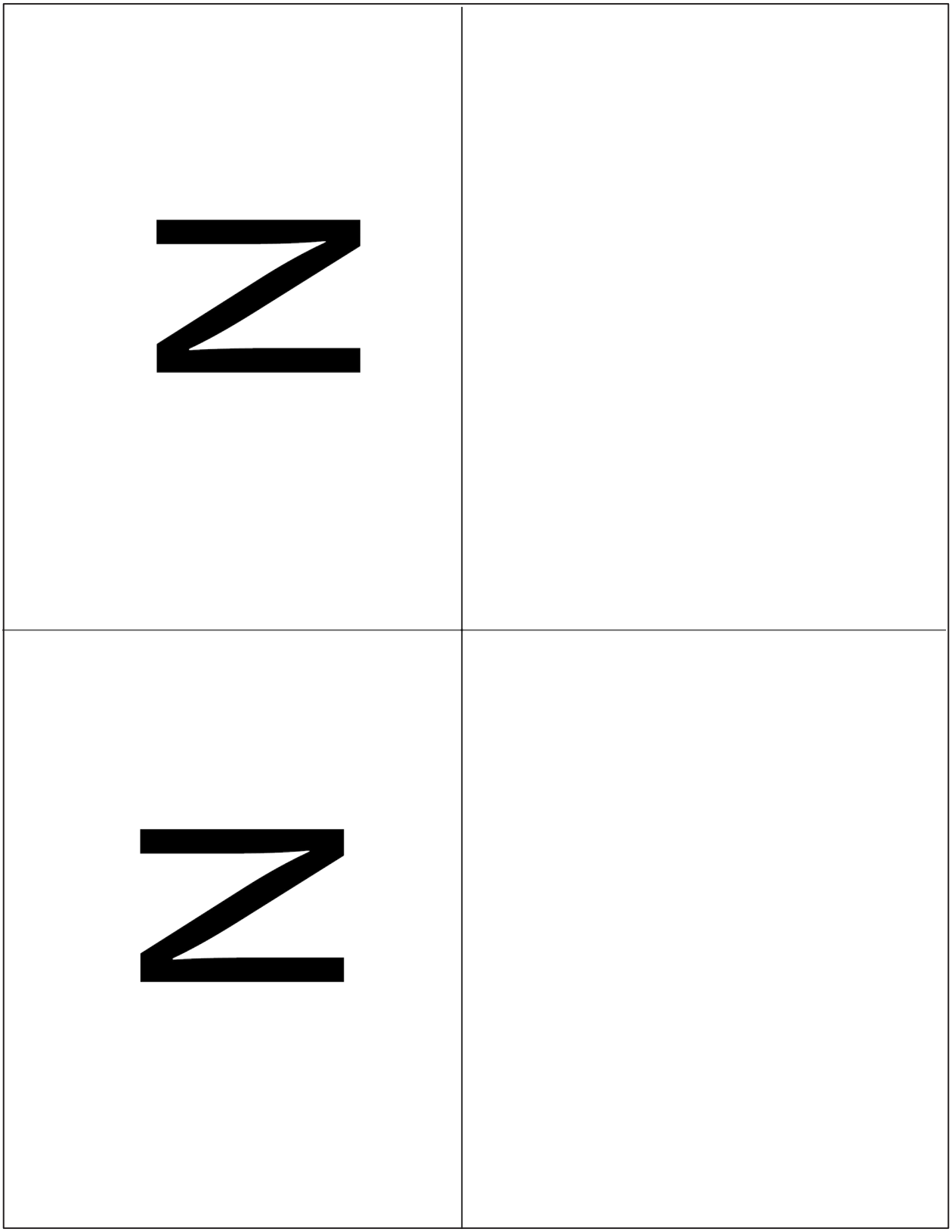
- Ask students to pair up and take turns describing the flow of nitrogen in the nitrogen cycle.

Teaching Notes





"Element Handout"



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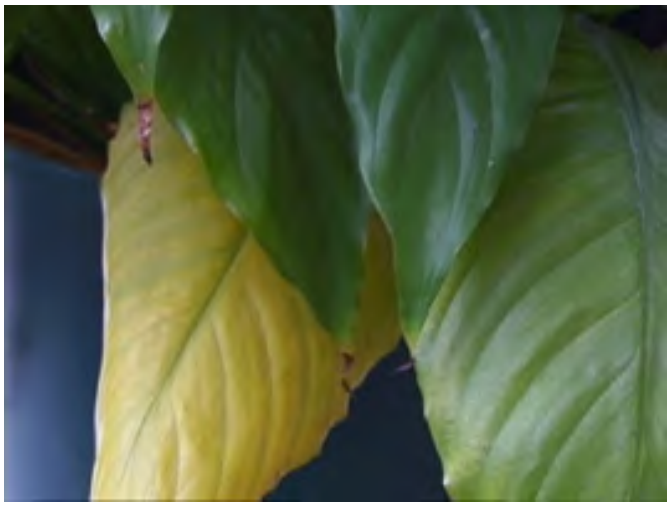
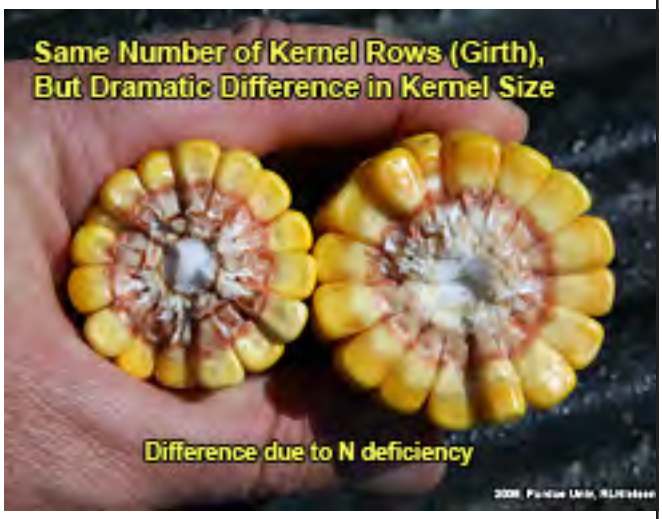
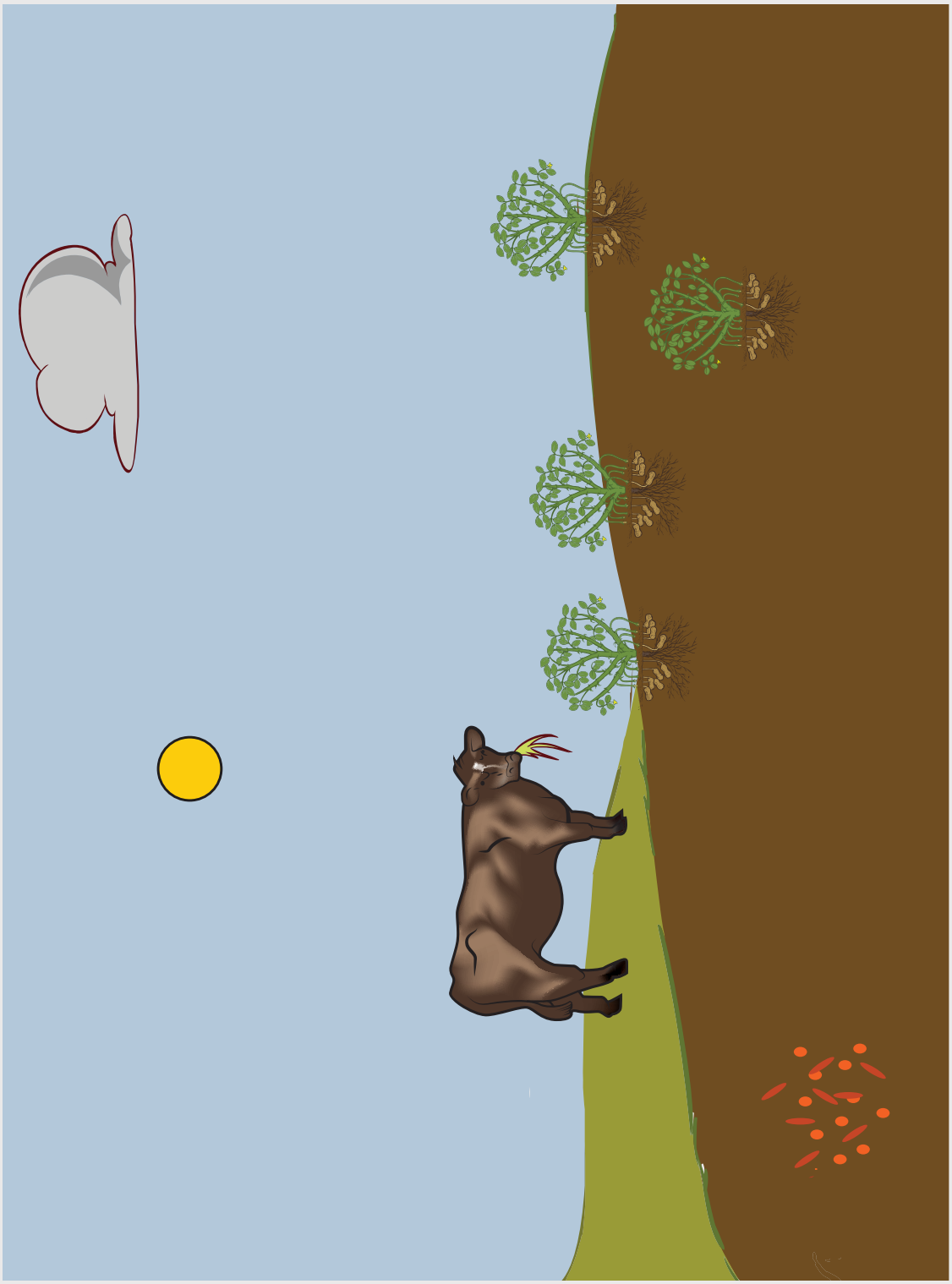
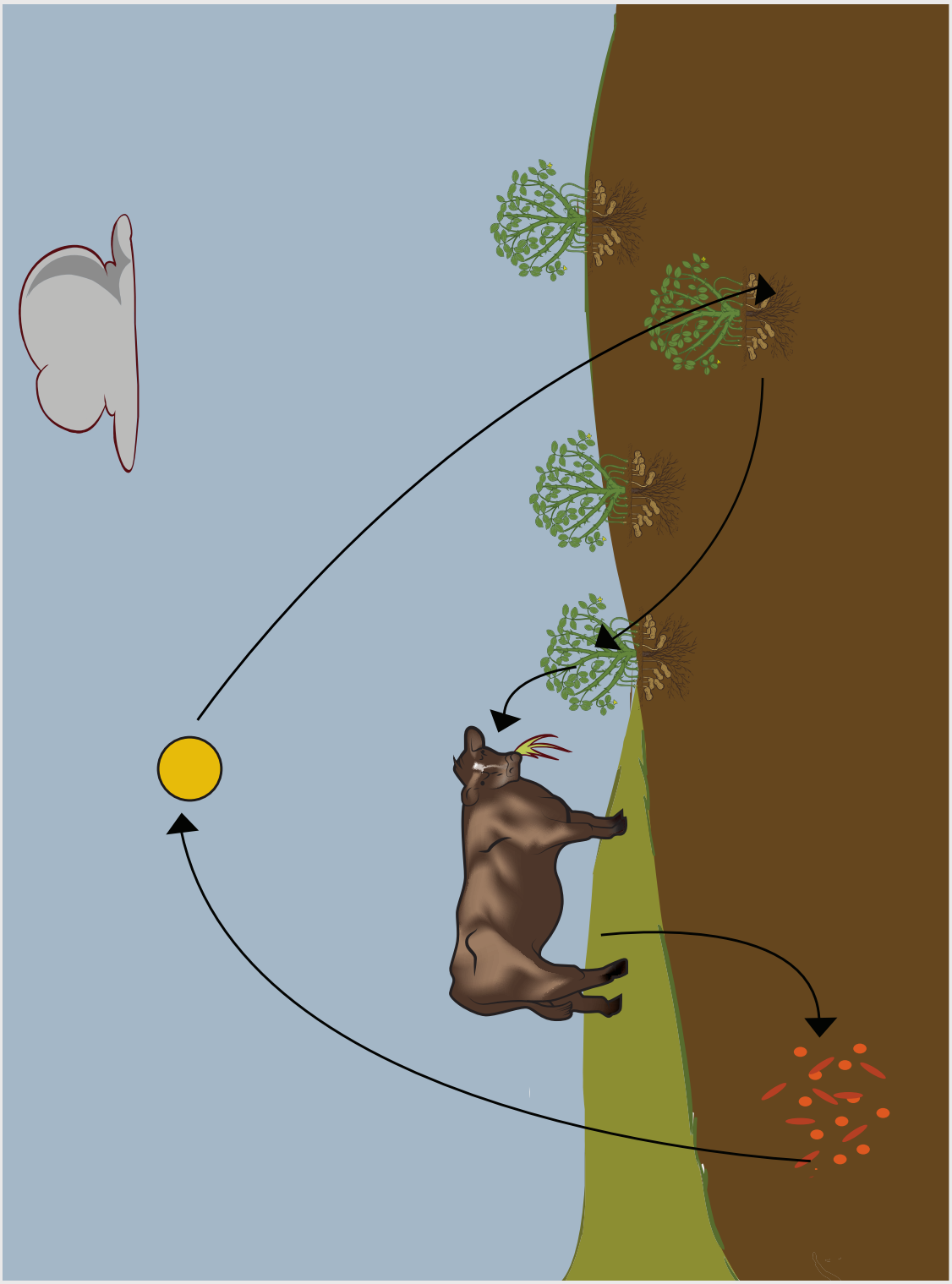


Colorado State Extension--http://www.ext.colostate.edu/mg/gardennotes/231.html#N



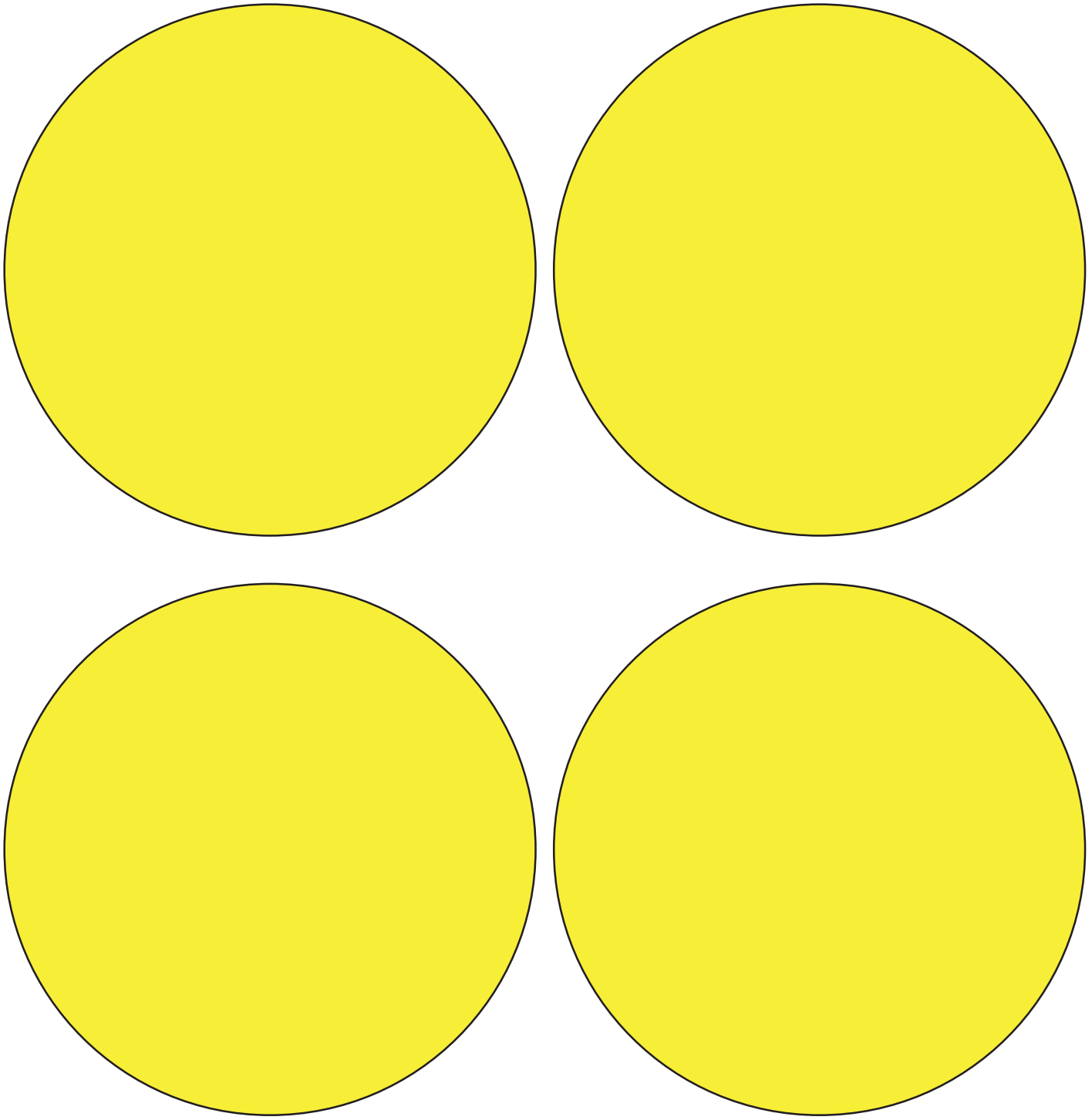
Purdue Department of Agronomy--https://www.agry.purdue.edu/ext/corn/news/timeless/CornRespLateSeasonN.html





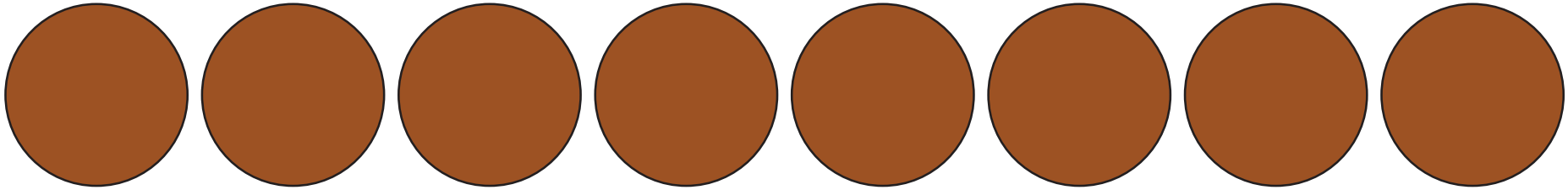
Handout yellow circles to Atmosphere

1: Atmosphere will pass yellow circle to Nitrogen Fixing Bacteria on roots of Peanut Plant



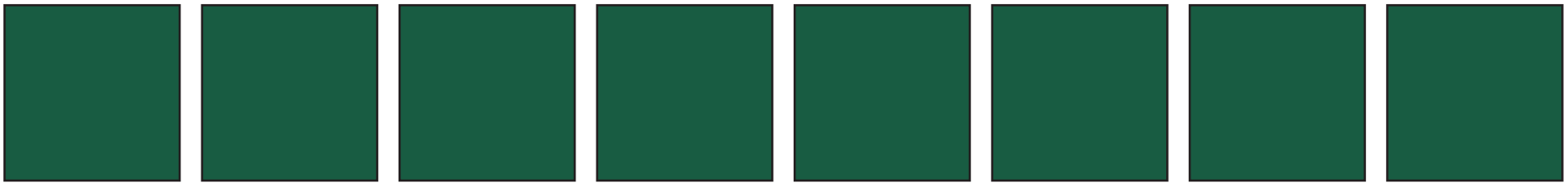
Handout brown circles to bacteria on peanut plant roots

2: Nitrogen fixation *the bacteria (Rhizobium) on the roots of the peanut plant will add brown circle to the large yellow circle*



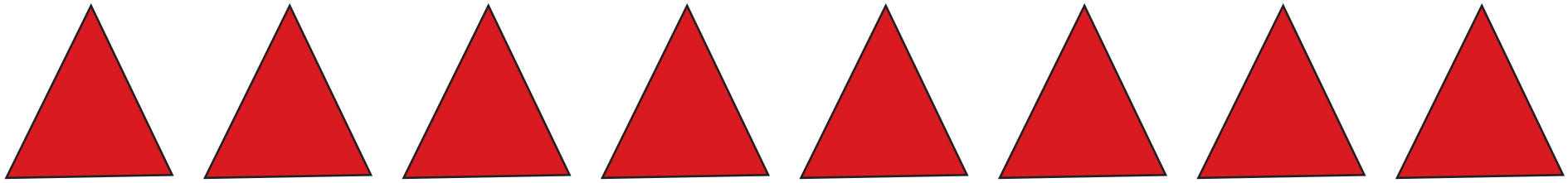
Handout green squares to peanut plant

3: Nitrogen assimilation *the peanut plant (or any plant) removes the circle and replaces with square and passes to the animal*



Handout out red triangles to the decomposing bacteria

4: Nitrification and Denitrification *the peanut plant (or any plant) removes the circle and replaces with square and passes to the animal*



5: Nitrification and Denitrification *the Decomposing Bacterial removes the red triangle and return the plain yellow circle to the atmosphere*