Plant Growth and Nutrients

Lesson Plan

Nebraska AFNR Plant Biology:

- Benchmark 1.2: Identify where photosynthesis, respiration, translocation and transpiration influence nutrient cycles.
    - Sample Performance Indicators:
      Identify which plant process is involved in a specific part of a nutrient or water cycle.
      Interpreting results of an experiment relating to these plant processes.

Nebraska Science Standards:

- SC12.3.1: Students will investigate and describe the chemical basis of the growth, development, and maintenance of cells.
- SC12.3.1.a: Identify the complex molecules (carbohydrates, lipids, proteins, nucleic acids) that make up living organisms
- SC12.3.1.b: Identify the form and function of sub-cellular structures that regulate cellular activities
- SC12.3.1.c: Describe the cellular functions of photosynthesis, respiration, cell division, protein synthesis, transport of materials, and energy capture/release

Objectives:

- The student will demonstrate an understanding of photosynthesis.
- The student will understand the structure and function of a plant.
- The student will understand the impact of nutrients on a plant system.

Materials:

Paper, various writing and drawing utensils, Carolina Lab Sheet (optional, 1 per student), clickers (optional), Plant Macronutrient Chart (1 per student), Soybean Plant Parts Worksheet (1 per student)

Additional Enrichment Resources or Source Files:

- Carolina lab sheet: http://www.carolina.com/pdf/activities-articles/leaf-disk-assay-teacher.pdf

Photosynthesis

Students will enter this lesson with varying backgrounds and knowledge pertaining to photosynthesis. Begin with a brief overview and discussion of what they know about photosynthesis. If students have a strong background in photosynthesis, this lab may not be necessary.

Plants have basic needs, all which contribute to growth. We will look at these needs and how they affect plant growth over the next two days.

1. Using the lab outline from Carolina Biological, conduct the lab with the students to demonstrate photosynthesis.
    a. http://www.carolina.com/pdf/activities-articles/leaf-disk-assay-teacher.pdf

2. Use the YouTube video as a resource for the lab. (As with all content on the internet, please preview it prior to viewing with the students.) Note: The lab does not match the video explicitly.
    a. http://www.youtube.com/watch?v=XV9FOErA

3. Have students create a flow chart of photosynthetic reactions, including pictures and descriptions, for an assessment. Be sure to make a clear connection between the growth of plant tissue and the process that results in oxygen production.

Plant Structure & Function

1. Soybeans: Myth or Fact (below)
    a. Students will answer True or False to this set of questions and then self-check the answers on the back. Optional: Clickers may be used for a more interactive experience.
    b. If available, show students a soybean plant before the Prezi and ask them what it is, how it is raised, and what it is used for.

2. Use thinglink.com to create an interactive image of a soybean plant. Have students create a free account and upload an image of a mature soybean plant. Students will label the following parts on the picture and describe the function of that part (roots, leaves, flowers, pods, stem). When finished, students may share with the class, small groups, etc.
    a. Activity alternative: use the worksheet (below): Soybean Plant Parts to label the parts and describe the function.
    b. Link to thinglink teacher key: https://www.thinglink.com/scene/411578975152766976#tlsite
    c. Note: If students are inexperienced with using thinglink.com, provide a demonstration prior to giving the assignment.

Macronutrients

1. Distribute the Plant Nutrients Handout. (below)
2. Have students underline or highlight what each macronutrient contributes to plant growth. Discuss each macronutrient and the primary contributions of each after students are done reading. Students should identify the parts of the soybean plant on the Soybean Plant worksheet and describe the function of each macronutrient on the worksheet.
    a. Optional Extension Questions: Which nutrients are most important and why? What happens when a plant is deficient in a specific nutrient? What is a nutrient deficiency? What happens when a plant has too much of a specific nutrient? How does this affect us?

b. Optional Independent Study: Given the six macronutrients, students will research the results of each macronutrient deficiency.

3. Distribute the Soybean Plant Parts Worksheet (below). Have students draw and color the other half of the soybean plant deficient in all six nutrients on the worksheet. Students describe each nutrient deficiency and how it affects the plant on the worksheet. Students may enjoy sharing their drawings with the class. This might also give students the opportunity to learn from each other after completing the assignment.

4. Soybean Production
   a. Show students the Prezi, http://prezi.com/piroxfi-f8em/? utm_campaign=share&utm_medium=-copy&rc=ex0share which highlights the steps in soybean production and includes information about nitrogen fixation.
   b. Assessment: Have students draw or write the steps of soybean production. Allow students to be creative. They might create a poster, song, model, visual, or other product for this assignment. Students will present these to the class.

Soybeans: Myth or Fact - soybean production and products

(with clickers if available)

1. The soybean, also known as the soya bean, is a legume native to East Asia.
2. During the Civil War, soybeans were used in place of coffee because real coffee was scarce.
3. One acre of soybeans can produce 32,650 crayons.
4. Soy ink is used in about 45 percent of America's daily newspapers that circulate more than fifteen hundred copies per run.
5. US farmers first grew soybeans as cattle feed.
6. Forty gallons of soy-diesel can be produced from one acre of soybeans (about 35 bushels).
7. Soymilk is a soy food that contains soy proteins that help reduce cholesterol levels and prevent heart disease.
8. The Shedd Aquarium in Chicago was the first building in Illinois to install a soy-based roof.
9. Using 12% soy flour and 88% all-purpose flour instead of 100% all-purpose flour increases the protein content by 25%.
10. Soybeans are called the "Cow of China" because it is an excellent source of potassium.
11. 90% of the biodiesel currently produced in the United States is soy biodiesel.

Answer Key:

1. True
2. True
3. False - One acre of soybeans can produce 82,368 crayons.
4. False - Soy ink is used in over 95 percent of America's daily newspapers that circulate more than fifteen hundred copies per run.
5. True
6. False - 50 gallons
7. True
8. True
9. False - 40%
10. False – calcium
11. True

Sources:

Oklahoma 4-H http://oklahoma4h.okstate.edu/aitc/lessons/extras/facts/soybean.html
National Soybean Research Lab http://www.nsrl.uiuc.edu/aboutsoy/question.html
Ohio Soybean Association http://www.soyohio.org/aws/OHSOY/pt/sp/osa_industryoverview

Plant Nutrients

Sixteen chemical elements are known to be important to a plant's growth and survival. The sixteen chemical elements are divided into two main groups: non-mineral and mineral.

The **Non-Mineral Nutrients** are **hydrogen (H), oxygen (O), & carbon (C).** These nutrients are found in the air and water. In a process called **photosynthesis**, plants use **energy from the sun** to change **carbon dioxide** (CO2 - carbon and oxygen) and **water** (H2O- hydrogen and oxygen) into starches and sugars. These starches and sugars are the plant's food. **Photosynthesis** means "making things with light". Since plants get carbon, hydrogen, and oxygen from the air and water, there is little farmers and gardeners can do to control how much of these nutrients a plant can use.

Mineral Nutrients

The **13 mineral nutrients**, which come from the soil, are dissolved in water and absorbed through a plant's roots. There are not always enough of these nutrients in the soil for a plant to grow healthy. This is why many farmers and gardeners use fertilizers to add the nutrients to the soil.
The mineral nutrients are divided into two groups: macronutrients and micronutrients. Macronutrients can be broken into two more groups: **primary and secondary nutrients**.
The **primary nutrients** are **nitrogen (N), phosphorus (P), and potassium (K)**. These major nutrients usually are lacking from the soil first because plants use large amounts for their growth and survival.
The **secondary nutrients** are **calcium (Ca), magnesium (Mg), and sulfur (S).** There are usually enough of these nutrients in the soil so fertilization is not always needed. Also, large amounts of Calcium and Magnesium are added when lime is applied to acidic soils. Sulfur is usually found in sufficient amounts from the slow decomposition of soil organic matter, an important reason for not throwing out grass clippings and leaves.

Micronutrients are those elements essential for plant growth which are needed in only very small (micro) quantities . These elements are sometimes called minor elements or trace elements, but use of the term micronutrient is encouraged by the American Society of Agronomy and the Soil Science Society of America. The micronutrients are **boron (B),copper (Cu), iron (Fe), chloride (Cl), manganese (Mn),molybdenum (Mo) and zinc (Zn)**. Recycling organic matter such as grass clippings and tree leaves is an excellent way of providing micronutrients (as well as macronutrients) to growing plants.

Macronutrients

Nitrogen (N)
- Nitrogen is a part of all living cells and is a necessary part of all proteins, enzymes and metabolic processes involved in the synthesis and transfer of energy.
- Nitrogen is a part of chlorophyll, the green pigment of the plant that is responsible for photosynthesis.
- Helps plants with rapid growth, increasing seed and fruit production and improving the quality of leaf and forage crops.
- Nitrogen often comes from fertilizer application and from the air (legumes get their N from the atmosphere, water or rainfall contributes very little nitrogen)

Phosphorus (P)
- Like nitrogen, phosphorus (P) is an essential part of the process of photosynthesis.
- Involved in the formation of all oils, sugars, starches, etc.
- Helps with the transformation of solar energy into chemical energy; proper plant maturation; withstanding stress.
- Effects rapid growth.
- Encourages blooming and root growth.
- Phosphorus often comes from fertilizer, bone meal, and superphosphate.

Potassium (K)
- Potassium is absorbed by plants in larger amounts than any other mineral element except nitrogen and, in some cases, calcium.
- Helps in the building of protein, photosynthesis, fruit quality and reduction of diseases.
- Potassium is supplied to plants by soil minerals, organic materials, and fertilizer.

Calcium (Ca)
- Calcium, an essential part of plant cell wall structure, provides for normal transport and retention of other elements as well as strength in the plant. It is also thought to counteract the effect of alkali salts and organic acids within a plant.
- Sources of calcium are dolomitic lime, gypsum, and superphosphate.

Magnesium (Mg)
- Magnesium is part of the chlorophyll in all green plants and essential for photosynthesis. It also helps activate many plant enzymes needed for growth.
- Soil minerals, organic material, fertilizers, and dolomitic limestone are sources of magnesium for plants.

Sulfur (S)
- Essential plant food for production of protein.
- Promotes activity and development of enzymes and vitamins.
- Helps in chlorophyll formation.
- Improves root growth and seed production.
- Helps with vigorous plant growth and resistance to cold.
- Sulfur may be supplied to the soil from rainwater. It is also added in some fertilizers as an impurity, especially the lower grade fertilizers. The use of gypsum also increases soil sulfur levels.

Soil

In general, most plants grow by absorbing nutrients from the soil. Their ability to do this depends on the nature of the soil. Depending on its location, a soil contains some combination of sand, silt, clay, and organic matter. The makeup of a soil (soil texture) and its acidity (pH) determine the extent to which nutrients are available to plants.

Soil Texture (the amount of sand, silt, clay, and organic matter in the soil)
Soil texture affects how well nutrients and water are retained in the soil. Clays and organic soils hold nutrients and water much better than sandy soils. As water drains from sandy soils, it often carries nutrients along with it. This condition is called leaching. When nutrients leach into the soil, they are not available for plants to use.
An ideal soil contains equivalent portions of sand, silt, clay, and organic matter. Soils across North Carolina vary in their texture and nutrient content, which makes some soils more productive than others. Sometimes, the nutrients that plants need occur naturally in the soil. Other times, they must be added to the soil as lime or fertilizer.

Soil pH (a measure of the acidity or alkalinity of the soil)

- Soil pH is one of the most important soil properties that affects the availability of nutrients
    - Macronutrients tend to be less available in soils with low pH.
    - Micronutrients tend to be less available in soils with high pH.
- **Lime** can be added to the soil to make it less sour (acid) and also supplies calcium and magnesium for plants to use. Lime also raises the pH to the desired range of 6.0 to 6.5.
- In this pH range, nutrients are more readily available to plants, and microbial populations in the soil increase. **Microbes** convert nitrogen and sulfur to forms that plants can use. Lime also enhances the physical properties of the soil that promote water and air movement. It is a good idea to have your soil tested. If you do, you will get a report that explains how much lime and fertilizer your crop needs.

Soybean Plant Parts

1. Label the following parts: roots, leaves, flowers, pods, stem.
2. Describe the function of each part.