

BOTANY, PLANT PHYSIOLOGY AND PLANT GROWTH

Lesson 9: PLANT NUTRITION

I. LESSON DESCRIPTION

Students contribute to a discussion on the nutritional differences between plants and animals, and then study a reading assignment on seventeen essential plant nutrients. Finally, the students complete a table that synthesizes information from the lesson. *Estimated time requirement for this lesson is 50 minutes.*

Curriculum Standards: Minnesota Academic Standards in Science, Minnesota Department of Education, 5-24-10, Grades 9-12:

- 9.4.1.2.4 “Explain the function and importance of cell organelles for prokaryotic and/or eukaryotic cells as related to the basic cell processes of respiration, photosynthesis, protein synthesis and cell reproduction.”
- 9.4.1.1.1 “Explain how cell processes are influenced by internal and external factors, such as pH and temperature, and how cells and organisms respond to changes in their environment to maintain homeostasis.”

National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards, National Council for Agricultural Education, 2009:

- Plant Systems (PS):
 - PS.02.03.01.a. Identify the essential nutrients for plant growth and development and their major functions.
 - PS.02.03.01.b. Describe nutrient deficiency symptoms and recognize environmental causes of nutrient deficiencies.

Seventeen essential minerals are required for normal physiological processes of plants.

Student Preparation: In advance of this class, students should complete a reading assignment, 09_PlantNutrition_Reading.pdf.

Student Learning Objectives: After completing this class, students will be able to:

- (1) name the 17 elements that form critical links in the chain of plant nutrition,
- (2) explain how plants absorb nutrients, and
- (3) summarize the functions of 6 of the 9 macronutrients.

Instructional Methods: Reading Assignment, Exercise.

II. LESSON PLAN

Introduction

Legend:

Text in normal face - Represents teacher's words.

Text in italic face - Represents suggestions for the teacher.

Interest Approach:

- QUESTION: Bring back to mind what you've learned about photosynthesis. When it comes to food, what is the chief difference between plants and animals?
- ANTICIPATED RESPONSES: *(Students provide opinions, and if the correct answer is not found, counter with this question.)* Think about the source of that food. We use plants as food, but what do plants use as food, and where do they find it?
- ANSWER: One of the major differences between plants and animals is the plant's ability to manufacture its own food. Most plants use light energy to convert carbon dioxide from the air, and water from the soil, into organic compounds for the plants' source of energy; animals, however, must procure *external* supplies of sugars or other compounds as a source of energy. Plants can also synthesize all of their required amino acids and vitamins, while animals must find them in *external* sources. In spite of this divergence, there is an interesting convergence: Both plants and animals share the need for water and certain chemical elements for metabolism, and those elements are the subject of today's lesson.
- QUESTION: If we give a plant some fertilizers – or minerals – or nutrients – or whatever we name them, can we say we're feeding a plant?
- ANTICIPATED RESPONSES: *Entertain a few responses, but resolve the semantics before too long, with the answer below.*
- ANSWER: There's an expression, "We don't feed plants (but plants feed us)." Many people confuse plant nutrition with plant fertilization. Plant nutrition refers to the needs and uses of the basic chemical elements in the plant. Fertilization is the term used when these materials are supplied to the environment around the plant. A lot must happen before a chemical element supplied in a fertilizer can be taken up and used by the plant.

Fertilizers are not plant food! Although it is common practice for many fertilizers to be called plant food, this is a misnomer. Plants produce their own food using water, carbon dioxide and energy from the sun.

- If we intend to understand and improve plant growth, then we have to know which nutrients a plant needs to combine with its self-made food, in order to produce protein, enzymes, vitamins, and other elements essential to plant growth.

Relevancy:

- In this lesson we'll learn about the critical importance of the 17 nutrients that are essential to a plant.

Learning Objectives:

- After attending this class, you will be able:
 - (1) to name the 17 elements that form critical links in the chain of plant nutrition,
 - (2) to explain how plants absorb nutrients, and
 - (3) to summarize the functions of 6 of the 9 macronutrients.
- Now let's move into a study session on these nutrients.

Instructional Methods

Reading Assignment: 10 minutes estimated

- Students can review their reading assignment, 09_PlantNutrition_Reading.pdf.*
- Please review your handout. You'll have 10 minutes.

Exercise: 30 minutes estimated

- Distribute to each student a copy of the exercise, 09_PlantNutrition_Task.pdf.*
- As you studied the lesson you probably noticed that some elements are less likely to be deficient. Place an asterisk before the nutrients that typically are present in sufficient amounts in air, water, and Minnesota soils.
- Then underline the elements without asterisks; levels of the underlined elements will need to be monitored more closely, since the likelihood of deficiency is greater in the underlined elements. Refer to your reading assignment to complete the table. Then follow the three instructions at the bottom of the handout. You'll have 10 minutes.
- Allow time to complete the table, up to 10 minutes. Meanwhile, use the blackboard or whiteboard to recreate the table found in the student handout (not your answer sheet.)*
- What have you found? Which elements should have asterisks? Which elements are underlined? Which element is associated with vegetative growth, and with the cell wall, and with chlorophyll?
- Record all class input on your large diagram, then check that your large diagram matches your answer sheet, 09_PlantNutrition_TaskTEACHER.pdf. If you make any corrections, discuss why.*

Conclusion

- You've completed a valuable synthesis of data from the text. As you observe a deficiency symptom in a plant, and attempt diagnosis, hopefully your detective work will be quicker and easier if you can focus on theories of highest probability. However, always bear in mind that each and every one of the 17 nutrients is essential, and don't rule out the possibility that the missing link in the chain might just be the nutrient that you least suspect.
- Your new insight into the building blocks of plant health will help you build valuable diagnostic skills in maintaining the health of a plant, whether you garden as a hobby, or become a professional nursery grower/professional or landscaper.
- In the next lesson, we'll focus on the *medium* for many of these essential nutrients – the soil.

OPTIONAL ACTIVITIES

- Have the students thoroughly filter “Segment Three – Nutrient Summaries” in the reading assignment and list the various deficiency symptoms for each nutrient. Then take a walk with the students around the property to identify plant parts that show these deficiencies. If leaves are already turning to their autumn hues, or if they have fallen, then you can guide a similar study lab with potted plants that could be brought to class. Alternatively, assign student homework to collect plant parts with various symptoms; however, diagnosis is more thorough when you can study the entire plant and its environment; to compensate, the students can take field notes of the environments where they found the items, and the conditions of the plants.
- Consider doing a soil test. The Soil Testing Laboratory at the University of Minnesota offers soil testing. As a group, follow the instructions on the website to collect samples of soil, mail them in, then evaluate the results as a group when you receive the report. You can use the exercise just to experience the process of a test, or you can add interest by testing the soil in an area where vegetation is particularly luxuriant or problematic. For more information, visit their website at <http://soiltest.cfans.umn.edu/index.htm>.
- Have the students thoroughly filter “Segment Three – Nutrient Summaries” in the reading assignment and list nutrients that tend to leach easily from soils, and those that tend toward little movement.
- Assign the students a research project to explore the process of nitrogen fixation. The self-sufficiency of plants is particularly impressive in this process, since nitrogen-fixing bacteria convert nitrogen from the air into forms of nitrogen used during the synthesis of amino acids and proteins.

RESOURCES

Books:

- *Biology of Plants*, Seventh Edition (December 17, 2004), by Peter H. Raven, Ray F. Evert, Susan E. Eichhorn. Publisher: W. H. Freeman; Hardcover: 944 pages. ISBN: 0716710072
- Comprehensive book on botany.

09_PlantNutrition_LessonPlan.pdf