Exploring Plant Nutrients Widget
Teacher's Guide

Directions: Allow students to explore the *Exploring Plant Nutrients* widget at http://www.thescienceofsoil.com/. Students should examine the variables, water, sunlight, and nutrients by clicking on the hotspots (dots) that show how the variable functions within the plant. Then, students can use the bottom slider to examine what a plant looks like with too much or too little of a variable. Use the widget to fill in the blanks and answer the questions below.

1. Nutrients enter the root cells through both **diffusion** and **active transport**. Roots absorb water and nutrients from the soil through tiny hairs.

2. Plants transport water from the roots to the rest of the plant using **xylem tissue**. The **xylem** is made of dead cells that form long, empty tubes that let water pass through. Water moves upward through the xylem using water's properties of cohesion and surface tension.

3. The plant loses water through evaporation in the leaves. As some water evaporates, the attraction between water molecules results in additional water molecules pulled into the leaves to replace the water lost to the air. This process is called **transpiration** and drives water from the roots, through the stem, up to the leaves.

Extend the Learning!
See Nutrients for Life Foundation's *Nourishing the Planet in the 21st Century* free middle school curriculum, Lesson 3 "Plant-Soil Interactions" for more labs and lessons on these concepts.

4. Phloem: The phloem tissue transports **sap**. Phloem tissue is made of living cells called sieve cells.

5. The pressure-flow hypothesis is one likely explanation for how sugars move through the phloem. According to this hypothesis, the cells of the phloem actively transport sugar molecules into their interior. Water flows in due to a process where fluid moves from an area of high concentration to low concentration through a **semi-permeable membrane**.

6. Without water, describe the effects on the plant's stem and leaves. Answers will vary. Example: **Without water, the stem begins to dry out. Growth is stunted, because it is harder to move nutrients around, and the plant begins to brown and go limp. Without water, growth is stunted, and leaves wilt, curl, and yellow. Water is also a reactant for the photosynthesis reaction. If it is not present in the leaves, the plant will not be able to make the sugar it needs to live and grow.**

7. Without enough water, describe the kernels of a corn. Answers will vary. Example: **Without enough water, the kernels of a corn plant dry out and will not grow.**

8. Which of the following is NOT an effect of excessive water:
    a. Decreased air pockets needed for the root system to breath.
    b. Diseases, especially root rot.
    c. White roots.
    d. Roots will be unable to absorb the nutrients the plants need from the soil.

9. Unhealthy roots caused by excess water affect the whole plant. List three effects of unhealthy roots caused by excess water. Answer should include any three of the following: **causing fungal infections, stalk rot, lightweight kernels, and reduced nutritional value among other things. Dark, wet-looking spots will develop.**

Sun:

10. Summarize photosynthesis process. Answers will vary. Example: **Photosynthesis takes place mainly in the leaves of the plant. Leaves use energy from sunlight and chlorophyll (the pigment that makes plants look green) to convert CO_2 and water (H_2O) to sugar. Carbon dioxide enters the leaves through tiny holes called stomata. Plants transport food from the leaves to the rest of the plant using the phloem. Leaves will change their position in accordance with the light to capture as much of the energy from sunlight as possible.**

11. Without sunlight, the stems of the plant will appear **lanky or spindly, caused by the excessive lengthening of cells.**

12. Without enough sunlight, chlorophyll— the light sensitive molecule necessary for photosynthesis— will not develop. What are the effects of chlorophyll not developing? Answers will vary. Example: **The plant will appear pale overall, its growth will be stunted, and the entire plant will weakens. There will be a greater distance between the leaves of the plant due to the lengthening of the stem.**

13. What do kernels of corn contain? Answers will vary. Example: **Kernels of corn contain a seed for a new plant and some sugar for the plant to use as it begins growing.**

14. Too much sunlight damages leaves and can penetrate cells, causing damage to the plant's genes and often resulting in cell death. If the plant takes in too much energy, **the evaporation process** from the leaves takes place more quickly, possibly using up water faster than the roots can take it in.

15. Too much sunlight can damage **the genetic material** in leaves, killing cells.

16. With too much sun, the entire plant will weaken and droop, because its cells contain **too little water** and **lose rigidity**.

Nutrients:

17. In non-agricultural ecosystems, **dead plants and animals** return nutrients to the soil when they decay, providing essential elements for new life.

18. When farmers harvest crops, they take away many necessary nutrients from the ecosystem. Fertilizers are used to **restore the nutrient balance to depleted agricultural soil** so the next set of crop plants will have enough nutrients and essential elements for healthy growth.

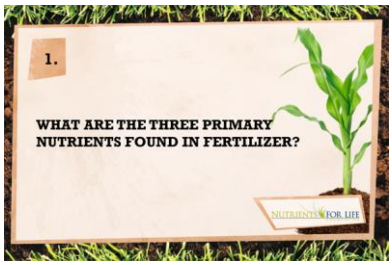
19. List three plants that store starch in their roots. **Onions, carrots, potatoes, and beets are examples of plants that store starch in their roots.**

20. The more extensive the plant's root system is, the better it can **absorb** and **store nutrients.**

21. Describe how decomposing organic matter releases nutrients into the soil. Answers will vary. Example: **Microbes break down that material into water-soluble forms that the plant's roots can absorb.**

22. The earth's atmosphere contains about 80% nitrogen gas; plants **cannot** use this form of nitrogen.

Reinforce these soil nutrient concepts with Nutrients for Life Foundation's set of flashcards.



Request these and other free materials on www.nutrientsforlife.org.

23. When a plant is lacking a specific nutrient, it will not grow properly and will show physical signs particular to that **nutrient deficiency**.

24. Nitrogen is also part of the **chlorophyll**, the green pigment of plants that helps the photosynthesis reaction take place. Thus, without enough nitrogen, plant leaves turn yellow.

25. Without nitrogen for the cell's DNA and proteins, all of these occur **except:**
    a. **excessive flowering**
    b. cell division slows
    c. the plant's stalk weakens
    d. it will no longer stand upright
    e. the kernels may fall off

26. Nutrient toxicity occurs when **too much of a nutrient is present.**

27. Describe what happens if plants are exposed to more nutrients than they can absorb. Answers will vary. Example: **If plants are exposed to more nutrients than they can absorb, the excess nutrients can pollute rivers, streams, lakes, and oceans.**