Transport in Plants

Objectives

- Become familiar and be able to recognize the different types of cells found in the plant's vascular tissue.
- Be able to describe root pressure and transpiration and discuss their contributions to water transport
- Be aware of some of the environmental influences on transpiration
- Know the difference between macronutrients and micro nutrients and be able to use a key to determine a nutrient deficiency

Introduction

All the cells of a plant require water and essential minerals for their survival and growth. This includes the cells at the very top of the plant. In some trees, this may be in excess of 100 m above the ground. Clearly, plants require an efficient mechanism to transport water and dissolved minerals from the soil throughout the plant's body.

In this laboratory exercise, you will investigate the mechanisms used by plants for water transport and how some environmental variables might influence the rate at which this fluid is moved.

Go to the Transport in Plants simulation within the Plants section of the BiologyOne DVD to complete these activities.

Activity 25.1
Vascular Tissue

Water and dissolved minerals are primarily transported up the plant through the xylem tissue. Sugars, dissolved in water are transport from the leaves through the plant's phloem tissue. These are several types of xylem and phloem cells that support these activities. Here you will examine some of these.

Types of xylem tissues:
Tracheid Cells - These are elongate cells with thick, lignified secondary cell walls. Their primary function is to transport water and minerals up the plant from the roots. Because of their thick walls, tracheid cells also help support the plant. These cells are dead at maturity.

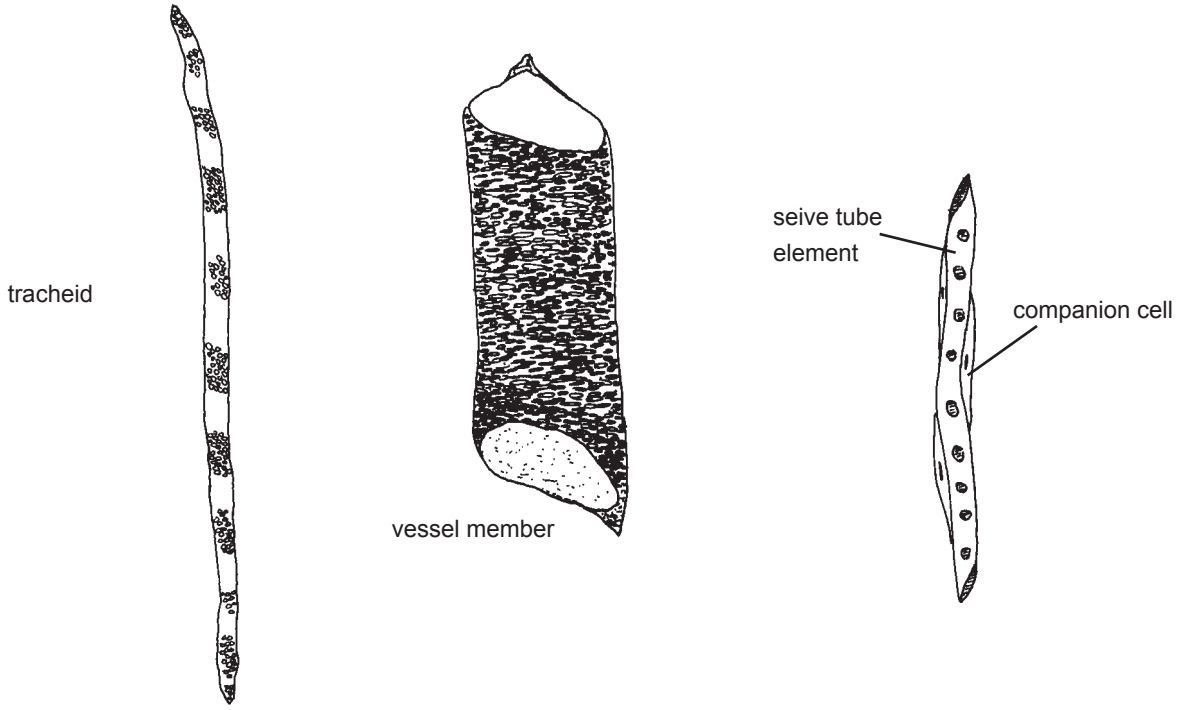
Vessel Member Cells - Like tracheid cells these cells have thick, lignified secondary cell walls, act as a means of water and mineral transport in the plant, and provide structural support. Vessel members differ from tracheids in that the cells are shorter but have a greater diameter. These cells also have perforations at their ends, connecting end to end to create a long tube within the plant. Vessel members are dead at maturity.

Types of phloem tissues:
Sieve Tube Element Cells - These are elongate cells with walls which are somewhat thicker than those found in parenchyma cells but are not lignified. The cell walls are perforated by clusters of pores which allow material to move from one sieve tube element to another. A pore cluster is referred to as a sieve plate or a sieve area. These cells function in transporting food (carbohydrates produced by photosynthesis) throughout the plant. The sieve tube element cells retail their cytoplasm when mature but the nucleus of the cell degenerates.

Companion Cells - These cells are closely associated with the sieve tube element cells. The cells are smaller and have thinner cell walls. These cells apparently assume the role of controlling the sieve tube element once the sieve tube element has lost its nucleus.

Make your own drawing of xylem cells and phloem cells in the Results Section.

Xylem and Phloem Cells



Activity 25.2
Root Pressure

One of the functions of roots is the absorption of water and minerals from the soil. The root can also move water from the root up the plant. The mechanism plant roots use to move water is called root pressure. In this process, water moves from the soil into the root's vascular tissue by osmotic pressure. Since the water cannot be compressed, it is forced up the stem through the xylem tissues. This force can be so great that it forces water out from the strands of vascular tissue along the margins of leaves. Water forces out this way is termed guttation.

In this simulation you have two ways to measure root pressure, the actual pressure produced by this process and the volume of water moved by this process. In the simulation, click on one of the buttons to measure either pressure or volume. You can return to this screen to select the other measure later.

When measuring pressure, what is the final pressure created by the root pressure in this plant? Record your observations in the Results Section.

When measuring volume, how much water is moved up the stem by root pressure over 12 hours? Twenty four hours? Record your observations in the Results Section.

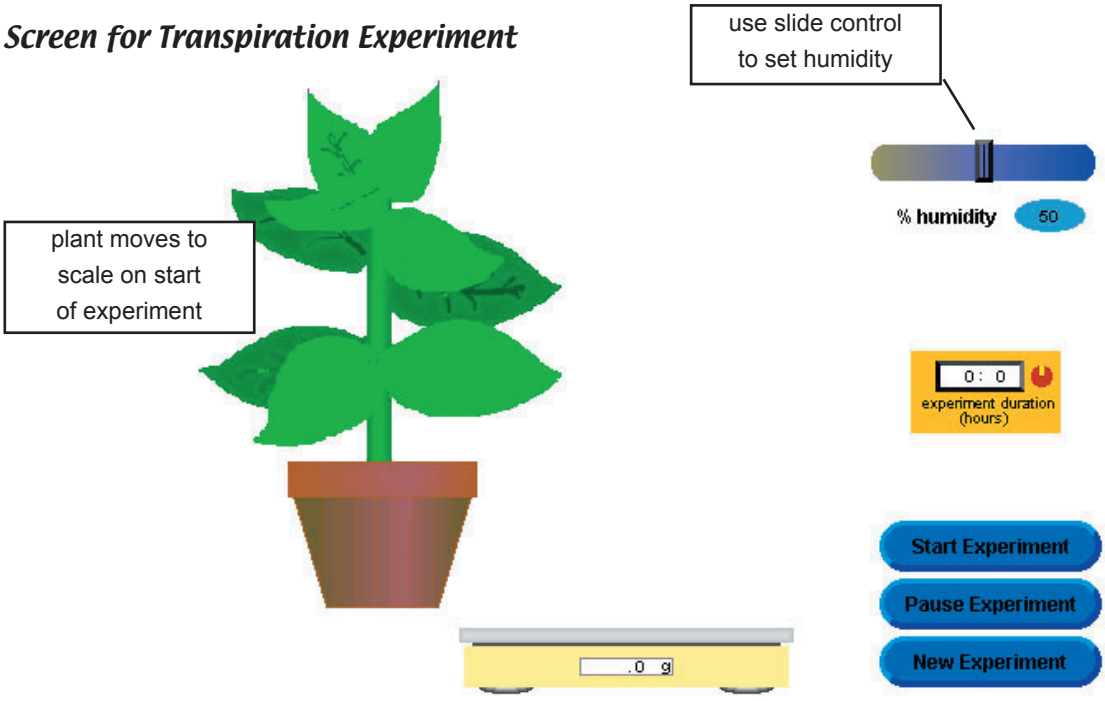
Activity 25.3
Transpiration

While root pressure is one process plants use to move water up the stem, this process cannot move water high enough or fast enough to account for all the water movement observed in plants. A second method, perhaps a more important method, plants use to move water is the transpiration/cohesion process. Here, water evaporates through the stomata of the leaves, the process called transpiration, creating a pull on the water column in the plant. So this way the water is pulled rather than pushed up the plant.

The effectiveness of this method depends on the rate of transpiration. Transpiration rates are greatly influenced by environmental factors such as relative humidity and wind. In this simulation you will measure the transpiration loss of water from a plant at different humidity levels.

Before starting this experiment, first use the slider control in the upper right to set the relative humidity to 25%. Then click on the start experiment button to move the plant onto the scale. Immediately pause the experiment. You will be measuring the loss of water via transpiration by the change in the weight of the plant. Record the initial plant weight at

Screen for Transpiration Experiment



time 0 (within the first few minutes of simulation time) in the Results Section.

Restart the experiment by clicking the start or pause button again. In the Results Section, record the plants weight at 4, 8, 12, 16, 20 and 24 hours. Graph your results for water loss at 25% relative humidity.

Repeat this experiment at 75% relative humidity.

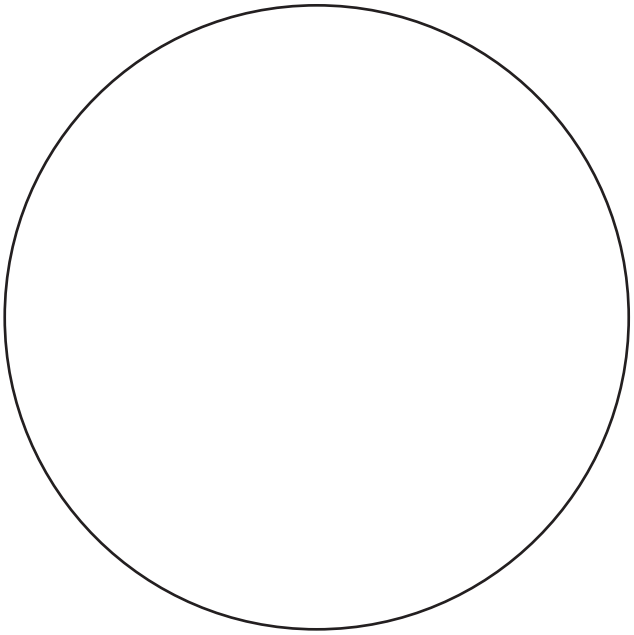
How does humidity influence water loss due to transpiration?

Lab Exercise **25**

Name _____

Results Section

Activity 25.1
Vascular Tissue



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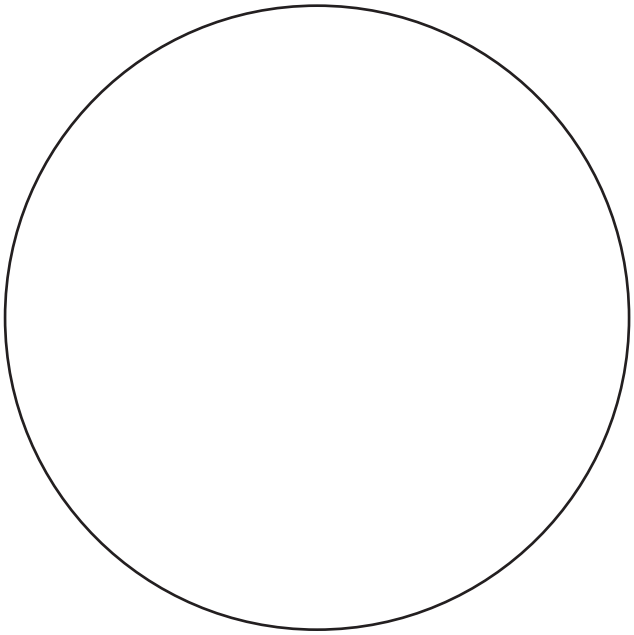

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object

Activity 25.2
Root Pressure

Maximum Root Pressure: _____

Water Volume after 12 hours: _____

Water Volume after 24 hours: _____

Activity 25.3
Transpiration

% humidity: _____

Hours	Plant Wt. (g)	Total Water Loss (g)
0	_____	_____
4	_____	_____
8	_____	_____
12	_____	_____
16	_____	_____
20	_____	_____
24	_____	_____

% humidity: _____

Hours	Plant Wt. (g)	Total Water Loss (g)
0	_____	_____
4	_____	_____
8	_____	_____
12	_____	_____
16	_____	_____
20	_____	_____
24	_____	_____