Part 2
What If?

Ask students: If you could change one thing about this investigation to learn something new, what would you try? When we change one part of an experiment to see how it affects our results, this change is known as a variable. Use the chart in your journal to record your ideas about what might happen if you change some of the variables. Some possibilities are:

- Will you get the same results if you use different quantities of water or different amounts of food coloring?
- What if you use soapy water? Salty water? Cold water? Hot water?
- Will it make a difference if you use slightly wilted carnations or celery?
- What if you tried a different type of plant?
- If you use another liquid, will you get the same results?

We encourage you to try these variables or other ideas suggested by the students. Invite students to share their questions and results with the group and record their findings in the chart in their student journals.

WRAP-UP

To wrap-up the investigation, bring your students together for a group discussion to help them understand why and how they achieved their results. It is important to share results so that everyone has a clear picture of what happened. To help you facilitate the discussion, review the explanation in "The Why and The How" using the Group Discussion questions as a guide.

Group Discussion
Explain to students that scientists learn from each other through discussion, and they build upon the work of others to make new discoveries. Just as scientists come to conclusions based on the findings of their experiments, they will now come together as a group to share their results and make conclusions about the investigations they've conducted. Have students record their final results and the explanation in their journals.

References:
www.ed.gov/pubs/parents/Science/celery.html
www.stevespanglerscience.com/experiment/00000144
Toothpick star in Water, water everywhere and not a drop to spare! New Jersey Academy for Aquatic Sciences.

Group Discussion
- Did you get similar results for the celery and carnations?
- Were there different results for different lengths of carnations or celery?
- Where do you think the water goes once it gets to the top of the plant?
- What did you learn about water from this experiment?
- Did everyone have the same results?
- What did you like about this investigation?
- What variables did you try?
- What surprised you?

The "Why" and The "How"
This investigation illustrates the property of water known as capillary action. Capillary action is how trees and plants get water to travel upwards from their roots to their leaves and flowers. All trees and plants have tube-like capillaries called "xylem" (zi-lem). Water molecules like to stick together and to the inside walls of plant capillaries, so they rise up in the tubes until they reach the top of the plant. Water eventually evaporates (changes from a liquid to a gas) from the leaves and petals of the plant by a process known as transpiration.

In this investigation, the colored water climbed up through the narrow capillaries of the celery and carnations. As the colored water moved upwards it outlined the path of the capillaries in each plant's stem/stalk, leaves and petals, resulting in a change of color.

Curriculum Match-Up

- Graph the distances the water traveled in the celery and carnations for a particular time period.
- Create a graph for the time it took for the water to travel all the way up the celery and carnations.
- Graph the speeds or distances for different colored water.
- Repeat the experiment using other materials such as cotton string. What do you observe?

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Moving On Up: Capillary Action I

Learning Objectives

Students will:

1. Explain why water travels through certain materials by capillary action.
2. Investigate how water can travel through the capillaries of different materials.
3. Test variables during the capillary action experiments.

Vocabulary Ventures

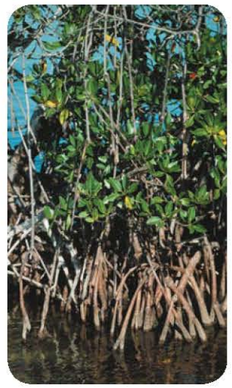
adhesion
capillary
capillary action
cohesion
gravity
meniscus
surface tension

Have you ever wondered how water gets from the roots of a tree to its leaves, or why paper towels are able to soak up a soggy spill? It has to do with the property of water known as **capillary action**.

Capillary action is water's ability to move through the narrow tube-like spaces, known as capillaries, within a porous or spongy material. Capillary action even allows water to climb upwards against the force of gravity. This is how water is able to travel from the roots to the leaves of a tall tree.

Plants absorb water from the soil through their roots. When water enters the soil and reaches the roots of the tree, water molecules are attracted to the molecules in the root. This process is known as **adhesion**, and it happens when water molecules are attracted to molecules in other substances. This attraction causes the water molecules to move closer to the root molecules and be drawn through the narrow **capillary** tubes inside the plant. For capillary action to occur, the attraction between the water molecules and the tree molecules (adhesion) must be stronger than the mutual attraction between all water molecules (cohesion).

Water's **surface tension**, the property of water which causes an invisible "skin" to form on the surface of water, also has an important role in capillary action. Inside a capillary, the surface of water forms a concave shape (like the letter C) called a **meniscus**. This is because the force ad adhesion causes surface water molecules near the capillary walls to move through the capillary first. As these molecules move, surface tension keeps the surface of the water together and causes it to form a bowl shape. The water molecules beneath the surface tag along due to cohesion.


mangrove tree with exposed roots

Capillary action is limited by **gravity** and the size of the capillaries or tubes. Water will stop moving upwards through a capillary once it is unable to overcome the force of gravity. The size of a capillary also determines how high the water can go. The thinner the capillary tube, the higher up capillary action will pull the water. Capillary action can draw water up into a tree over 300 feet tall!

Time Needed to Conduct Investigation
This investigation has two parts.
Organize and set up materials: 10 minutes
Introduce the lesson: 10 minutes
Conduct the investigation: 20 - 30 minutes
Student journaling/group reflection: 10 minutes
Total estimated time: 50 - 60 minutes

Investigation: Colorizing Carnations

Materials

For groups of three or four
Student journals and writing tools

Part 1
- ½ liter water bottle with tap water
- 200 mL beakers or measuring cups to hold plants
- 3 Fresh stalks of celery with leaves (cut to the same length)
- 3 Fresh white carnations with leaves (cut to the same length)
- Red or blue food coloring
- Sponges for clean-up
- Clock or watch
- Calendar

Part 2
- Rulers
- Magnifying lenses
- Other types of plants with leaves
- Bottles of other liquids (Salty water, soapy water, cold water, hot water, white vinegar, Karo syrup, baby oil, isopropyl alcohol, seltzer water)

Part 1
Color Me Happy

TIP
This activity will take several days to complete. Fresh carnations and celery should be purchased NO SOONER THAN THE DAY BEFORE the lesson is done to prevent them from drying out. Refrigerate the celery and keep the carnations in water to prevent wilting. Have your students help with the prep work.

TIP
Just prior to the start of the lesson make a fresh cut on the carnation and the celery. To make a fresh cut, hold the celery stalks and carnation stems under running water. As you are doing this, cut off the bottom ends of the celery and a bottom portion of the stems of the carnations at an angle using scissors. Cut a number of different lengths of celery and carnations.

GET READY!

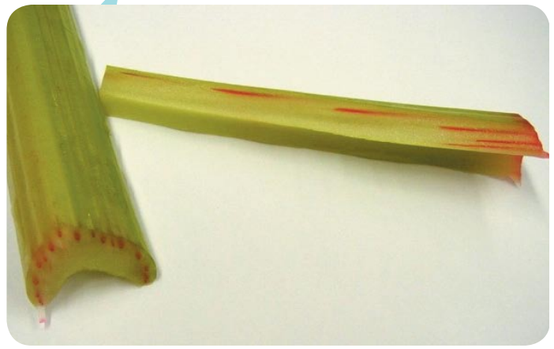
Inform the class that they will do an experiment to understand how a paper towel can soak up a spill, or how water gets from the roots to the leaves of a tree. Review any relevant concepts/vocabulary from previous investigations.

PROCEDURE

1. Have students measure out 75 mL of water.
2. Next, have the students place 20 drops of blue or red food coloring into the beakers or measuring cups. Students should observe what happens after they added the food coloring to the water. Students should record the amount of water and number of drops in their student journals.
3. Have students place the celery stalks and carnations in each of the cups and set them aside. As an option, students can split some of the carnation stems down the middle, keeping them attached to the flower, and placing each half in a different colored container of water.
4. Students should record in their student journals the date and what time it is when they place the carnations and celery in the water.

TIP
Capillary action can sometimes take a few days to occur in these plants, so you may want to prepare final samples in advance of the investigation to show students.

split carnation set-up



celery vessels with food coloring

PREDICT

- What do you think will happen to the celery and the carnations as they sit in the colored water? How did you come to that conclusion?
- What do you think will happen to the split carnations?
- Do you think there will be a difference between the results for the carnations and the celery? Why, or why not?

OBSERVE

Ask students to record their observations in the student journals as they conduct the investigation.
- Do you think there will be a difference between different lengths of celery or carnations?
- Do you think that there will be different results for different colors?

TIP
After a few days, invite students to observe what happened to their celery stalks and carnations. If a visible result has not yet occurred, let students observe the prepared samples.

Students can set up additional celery stalks and carnations and record the results in hour/day-long increments, measuring how far the water traveled at each interval.

- What do you observe about the stem/stalk of the plants? Pick up the carnation/celery and examine the bottom of the stem where it was cut. Diagram what you observe.
- What do you notice about the petals and leaves? How do they look under magnifying lenses? Diagram what you observe.
- Examine the carnations and celery each day and record your observations.
- Measure and record how high the food coloring traveled.