PREDICT

- What do you think will happen if you place a drop of water in the center of the toothpick flower?
- Why do you think this will occur?

OBSERVE

- What happened to the toothpicks?
- Where did the water go?
- How did this compare with what you predicted?
- Draw the "before" and "after" diagrams of the toothpicks in your journals.

Part 2
What If?

Ask the group to share questions that might have arisen as they conducted the "Toothpick Flowers" activity. Invite them to think of other questions they would like to explore. Some possibilities are:

- Will the results of the experiment differ if you use rounded toothpicks instead of flat toothpicks?
- 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?
- If you use another liquid, would you get the same results?

Feel free to try these other investigations or ones that are suggested by the students. Invite students to share their questions and results with the class and record them in their student journals. Ask students to record their observations 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.

- What happened to the paper flowers?
- What variables did you test?
- How did this investigation remind you of the color blooming carnation and celery activity?
- What surprised you?
- What variables did you test?
- What new questions do you have?

The "Why" and The "How"
Capillary action is how trees and plants get water to travel upward against gravity. All trees and roots have tube-like capillaries called "xylem" (zi-lem). Water molecules like to stick together and to the inside walls of the tree's capillaries, so they rise up the tubes against the force of gravity. Capillary action is how water travels from the roots of a plant to its leaves. Water eventually evaporates (changes from liquid to gas) from the leaves in a process called transpiration.

This investigation illustrated capillary action. The water traveled through the capillaries in the paper flower causing the petals to swell and open. Capillary action was also the force that caused water to be absorbed by the toothpicks. This resulted in the toothpicks straightening, which changed the shape of the toothpicks from a flower to a star. The water molecules stick or adhere to the paper flower and the toothpicks. This adhesive force worked with surface tension to pull water through the paper flower and the toothpicks.

Curriculum Match-Up

- Have students tie-dye shirts to see capillary action happen before their eyes.
- Experiment with white paper towels to see which liquids travel the farthest and fastest, and does the print on the paper towel effect the absorption rate.
- Graph the speeds or distances for the different liquids or different colored water.
- Diagram the path of water as it flows through a tree or plant by capillary action.

References:
www.ed.gov/pubs/parents/Science/celery.html
www.stevespanglerscience.com/experiment/00000144

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Moving On Up: Capillary Action II

Learning Objectives

Students will:

1. Explain why water climbs or travels through certain materials.
2. Investigate the process of capillary action using different materials.
3. Select variables to test during the capillary action experiments.

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Vocabulary Ventures

adhesion
capillary
capillary action
cohesion
gravity
meniscus
surface tension

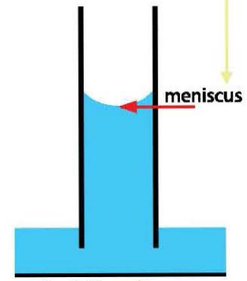
Note: This introduction is repeated from the previous lesson plan on capillary action.

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? All of these have 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 tree roots, 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).**

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 attraction between water molecules at the surface causes water to pull or curve itself inward, forming a concave or bowl shape (like the letter C) called a **meniscus**. Surface tension keeps the surface of the water together inside the tube. When the surface of the water is pulled through the capillary, cohesion helps pull all of the water molecules through the capillary as well.



liquid traveling up through a tube

Capillary action is limited by **gravity** and the size of the capillaries. 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 Investigations

Investigation 1: *This investigation has two parts.*
Organize and set up materials: 5 minutes
Introduce the lesson: 5 minutes
Conduct the investigation: 10 minutes
Student journaling/group reflection: 10 minutes
Total estimated time: 30 minutes

Investigation 2: *This investigation has two parts.*
Organize and set up materials: 5 minutes
Introduce the lesson: 5 minutes
Conduct the investigation: 15 minutes
Student journaling/group reflection: 10 minutes
Total estimated time: 35 minutes

Investigation 1: Paper Blooms

Materials

For groups of three or four
Student journals and writing tools

Investigation 1
Part 1
- ½ liter water bottle
- Flower template (See Appendix)
- Pie tins
- Notebook paper
- Scissors
- Food coloring
- Sponges for clean-up

Part 2
- Bottles of other liquids (Salty water, soapy water, cold water, hot water, white vinegar, Karo syrup, baby oil, isopropyl alcohol, seltzer water)
- Various kinds of paper

Investigation 2
Part 1
- ½ liter water bottle
- Different colors of food coloring
- 16 oz plastic cups
- Flat toothpicks
- Sponges for clean-up
- Straw or eye dropper

Part 2
- Rounded toothpicks
- Bottles of other liquids (the same liquids used in Investigation 1)

Part 1
Unfurling Flowers

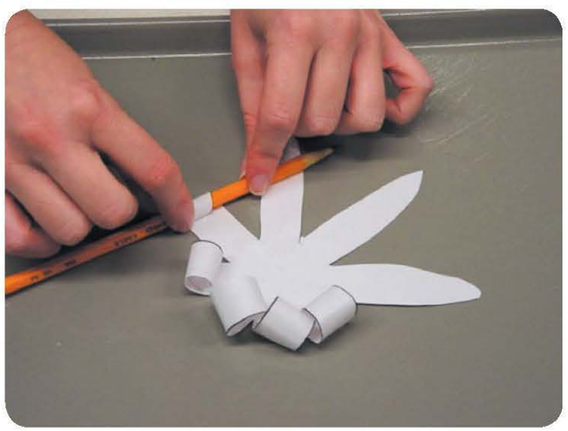
GET READY!

Explain to students that they will be conducting another experiment about capillary action, this one involving paper flowers. Review any relevant concepts/vocabulary from previous investigations, specifically Unit 1, Lesson 8, "Colorizing Carnations".

TIP
Gather all necessary materials prior to the start of the activity. Prepare salty and soapy water solutions in advance. Prepare flower templates for Part 1. Flower templates must have distinct petals that are clearly separated, not layered or overlapping. This makes it easy for the petals to unfurl during the experiment.

PROCEDURE

1. Have students fill their pie tins halfway with water and add two drops of food coloring.
2. Next, have students use the flower template to trace a flower on notebook paper and cut it out.
3. Students should use a pencil to roll up the petals so that it looks as if the flower is closed.
4. Explain that the students will place the paper flower into the water, but first, invite them to make and record their predictions.



curling paper flower petals

PREDICT

- What will happen when the flower is placed into the water? Why?
- Where do you think the water will go?

OBSERVE

After placing the flower in the pie tin of water, ask students to make observations and discuss them with their partner or group.
- What happened to the flower when it was placed in the pie tin?
- What did you observe about the water?
- Where did the water go?

Part 2
What If?

Ask the group to share questions that might have arisen as they conducted the first part of this investigation, "Unfurling Flowers." Invite students to think of other questions they would like to explore. Some possibilities are:
- Would you get the same results if you used different quantities of water or different amounts of food coloring?
- What if you used soapy water? Salty water? Cold water? Hot water?
- If we used another liquid, would you get the same results?
- What about other variables such as different types of paper for the flowers and different size flowers?

Feel free to try these other investigations or ones that are suggested by the students. Invite students to share their questions and results with the class and record them in their student journals.

Investigation 2: Toothpick Tricks

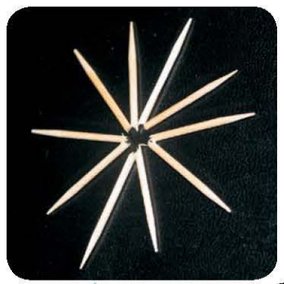
Part 1
Toothpick Flowers

GET READY!

Explain to students that you will be conducting another experiment about capillary action, this one involving toothpicks. Review any relevant concepts/vocabulary from previous investigations.

PROCEDURE

1. Have students prepare their colored water in the 16 oz cups by pouring water into the cups and adding several drops of food coloring to the water.
2. Invite students to bend five flat toothpicks in half without breaking them, so that each one is in the shape of a "V".
3. Students should then arrange the five toothpicks on a waterproof surface with the base of the V's touching, to resemble a flower.
4. Students should place the ends of their straws into the colored water. Holding a finger over the other end of the straw, they should then lift the straw out of the water.
5. Inform students that they will be placing the water into the center of the toothpick flower, but before they do, they should make some predictions.



flower (before)

star (after)