



## Earth Science Education Activity

# Capillary Action in Soil

**Background:** Water enters soil through precipitation or irrigation, and its movement depends on the properties of the soil. While gravity pulls water downward, water can also move upward through the soil via capillary action. This process is driven by two forces: adhesion (water “sticking to” other surfaces) and cohesion (water molecules “sticking to” each other), which together allow water to move against gravity through the tiny spaces between soil particles. See capillary action for yourself! Take a paper towel and touch the corner to the surface of some water (adding food coloring will make the water movement easier to see). Watch as the water climbs up. This can also be done by placing a stalk of celery in colored water for 24 hours, then observing the vessels in the celery.

Learn more about capillary rise in a short video from Purdue Extension: [Soil Basics: Capillary Rise](#).

**Key Question:** How does water move through different types of soil?

## STANDARDS

**NGSS:** MS-ESS2-1, MS-PS1-4

**SDG 2:** Zero Hunger

**SDG 6:** Clean Water and Sanitation

Learn more about the United Nations Sustainable Development Goals (SDGs) and [explore resources for educators from UNESCO](#).

## MATERIALS

- ◆ three dry soil/sediment samples with different particle sizes: coarse sand, fine sand, silt, clay, and/or a dry soil sample
- ◆ three plastic tubes, such as [these plastic rigid clear tubes](#)
- ◆ magnifying glass or dissecting microscope
- ◆ pantyhose
- ◆ scissors
- ◆ three rubber bands
- ◆ three 100 ml graduated cylinders
- ◆ ruler
- ◆ stopwatch
- ◆ food dye

Acknowledgement: This lesson has been adapted from a soil water lesson from the College of Agricultural Sciences at Oregon State University.



Blue-dyed water moves upward through a narrow glass tube (left) and filter paper (right) due to capillary action.

Credit: Lars Egil Helseth, CC BY SA 3.0



Credit: L. Brase

## PROCEDURE

1. Examine the three samples with a magnifying glass or under a dissecting microscope. Record data about the sizes of the particles of the samples.
2. Cut three 2"x2" squares of pantyhose and stretch them across the bottom of each tube. Secure each with a rubber band.
3. Fill each tube with a different sample. Lightly tap the tubes to settle the sediment, but do not compact it.
4. Fill each graduated cylinder with 20 mL of water.
5. Have the stopwatch ready. Fill each graduated cylinder with 20 mL of water **and add 3 drops of food dye**.
6. Place each soil tube vertically with the bottom end (pantyhose side) submerged in the water and start the timer.
7. Measure and record the height of water rise in each tube at the following intervals: 1 minute, 5 minutes, 10 minutes, and 40 minutes.
8. Optionally, observe again the following day to measure maximum capillary rise.

## ANALYSIS

1. What was the height of capillary rise in each tube at the final measurement? Which soil had the highest rise? The lowest rise?
2. How did the water movement change over time in each tube? Which soil had the greatest change in water height from the first to the last measurement?
3. Based on your particle observations from step 1, draw a close-up diagram of how you think each sample would fill the tube. Then, using arrows and labels, show how you think water moved through each column and explain your thinking.



Copy this tube three times, and add your particle observations for each sample.

4. What does the data suggest about the relationship between sediment size and capillary rise? Use evidence from your measurements to explain why the water traveled higher in some soils than others.
5. What other factors about the sediments (aside from particle size) may have affected water movement? Explain your reasoning.

## SYNTHESIS

How might capillary action help plants get the water they need, even when rain or irrigation is limited? Consider the structure of a plant (e.g., its roots, stem, how it grows in soil) and how water moves from the ground to the plant. Based on your experiment, which type of soil do you think would support plants best in dry conditions, and why? How might different soil textures affect which plants can survive and thrive in various climates or during droughts?

## EXTENSION

Scientists can estimate the size of these pores using the formula:

$$h = \frac{0.15}{r} \text{ or, rearranged: } r = \frac{0.15}{h}$$

Using the final water height ( $h$ , in cm) for each soil sample, calculate the estimated pore radius ( $r$ ) in centimeters.