



Wonderful, Wonderful Water - Transpiration

Total time ~50 minutes

Overview

Apply the concepts of water movement and chemistry to transpiration in plants. Students will learn about transpiration: the process of water leaving the leaves of the plant. Students will also learn how water travels from the roots of the plant up to the leaves. They will learn about the transpiration rate and what affects this rate.

Objectives:

After this lesson students will be able to:

- **Review** the concepts of water movement learned in chemistry
- **Explain** what transpiration is
- **Identify** the 4 factors that influence the transpiration rate
- **Describe** the 2 properties of water: adhesion and cohesion

Vocabulary:

- Cohesion
 - Water molecules sticking to each other
- Adhesion
 - Water molecules sticking to things other than water
- Transpiration
 - Water evaporation from the exposed parts of plants
 - Exposed parts: plant stem and leaf
- Transpiration Stream
 - As water leaves the plant through the leaves water from other parts of the plant
- Transpiration Rate
 - How fast water leaves the plants
- Evaporation
 - Water turning from a liquid into a gas in the form of water vapor

Materials

- Ziploc bag **OR**
- Clear plastic bag **AND**
- string

Preparation

1. Find a plant
2. Cover a portion of the plant with the clear plastic bag or Ziploc bag
3. Make sure not to crush any of the leaves of the plant
4. Observe the bag as water from the leaves begins to fog up the bag

Garden Activity

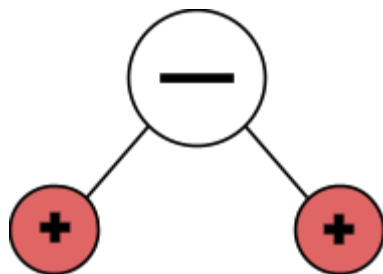
1. Done in the beginning (be sure to have bags in different conditions so students can compare at the end after learning about the factors)
2. Students will take clear plastic bags and string or a ziploc bag and go out to the garden
3. They will choose a plant and place the bag over a bunch of leaves
4. Then students will seal the bag with string or zip the bag closed
5. By the end of the lesson student should observe that the bag has condensation, indicating that water has left the leaves via transpiration

Warm Up

1. At their tables students discuss with each other how water moves up plants. How does water move up if gravity pulls everything down? What is pulling the water up? How does water travel all the way up from the roots to the leaves?
 - a. They should also discuss evaporation and come up with a definition
2. Have students share the ideas they came up with to the class

Understanding Water

1. At their tables have students discuss rain on a window. What do they see? How does the water behave? What does the rain look like?
 - a. The main focus would be for students to identify that water forms droplets and that the droplets stay together
 - b. Also that droplets can combine to form bigger droplets
2. Water sticks to other objects that are not water → **adhesion**
 - a. Example of rain on the window
 - b. The water is staying on the window
 - c. Does not slide down immediately, some rain droplets fall down slower than others
3. Now we will observe that water sticks to itself → **cohesion**
4. Each water molecule is like a magnet
 - a. Each molecule has a positive and negative end
 - b. Since water molecules are like magnets they'll stick together



5. Water Faucet vs Sand Bucket

- a. When water comes from the faucet it comes out in a stream all together. Why?
 - i. Due to cohesion the water comes out together in a stream
- b. When pouring sand the sand comes out separately in grains, NOT sticking together
 - i. There is NO cohesion between the sand particles
- c. Used to show properties of cohesion
- d. Use diagram [here](#)

Cohesion and Adhesion Activity with a Paper Towel

1. Give the students at each table the materials
 - a. A cup (preferably clear)
 - b. 1 inch in width strip of paper towel
 - c. Water based food coloring (not necessary, but will be easier for visualization)
2. Pour water into the cup, about halfway
3. Mix the food coloring into the water, the color is not important as this is for visualization of the water moving
4. While holding one end of the paper towel students will place the strip of paper towel into the water, they will continue to hold the dry end above the water
5. Students will watch the water move up the strip of paper towel, this will happen very quickly
6. Question to the students: Using **cohesion** and **adhesion** come up with a explanation as to what you just witnessed with paper towel
7. **Explanation**
 - a. Water sticks to the paper towel through adhesion and also moves up the paper towel by adhesion. Cohesion is acting when the water moves up together and not separately. Remember cohesion and adhesion are always present!
 - b. Exception: adhesion won't be present on extremely water repellent materials. If students mention how water is repelled by an umbrella this is not completely true as you still have to shake the umbrella to completely rid it of water, therefore adhesion is still present.
 - i. Only explain b if a student asks

Helpful Diagrams

Link to the diagrams can be found [here](#)

Transpiration

1. [Transpiration Video](#)

- a. On the slideshow the video can start at 1:22 since the beginning info is not relevant to this lesson.
2. Show diagram of the 4 factors (increasing v. decreasing)
3. What is the adhesion in the xylem and what is the cohesion in the xylem?
 - a. Use the diagram in this [slideshow](#)
 - b. Explanation
 - i. Adhesion is the water molecules sticking to wall of the xylem, which is a tube
 - ii. Cohesion is the water molecules sticking together and pulling each other up

The 4 Factors that affect Transpiration Rate Game

1. This will be similar to a bingo game
 - a. Instead of numbers the squares will either say “transpiration rate decreases” or “transpiration rate increases”
2. The teacher will call out various situations listed below
 - a. A sunny day
 - b. A windy day
 - c. It is raining
 - d. It is night time
 - e. a cloudy day
 - f. When you walk outside your clothes start sticking to your skin
 - g. A summer day
 - h. Noon
 - i. There is no wind
 - j. There are no clouds in the sky
 - k. A winter day
 - l. This plant is in the shade
 - m. There is no wind
 - n. The weather has been very dry
 - o. Teacher can also make up their own situations as long as they can match it up with an explanation to how transpiration rate changes
3. At each table students will be able to discuss what the answer is and the first table to raise their hand will need to given an explanation into why they chose either “transpiration rate decreases” or “transpiration rate increases”
4. If the table is correct they will be able to fill in one square
5. If the table is incorrect, the teacher will choose another table until one table gives a correct explanation
 - a. Explanations are listed at the end of this section

6. The game is complete when a table gets a bingo
7. If there is a prize then maybe connect it to the snack at the end
8. Correct explanations
 - a. Temperature
 - i. If temperature \uparrow then transpiration rate will also \uparrow because rising temperature makes evaporation faster \rightarrow transpiration rate increase
 - ii. The opposite will be true where if the temperature is lower, then evaporation will be slower \rightarrow transpiration rate decrease
 - b. Light intensity
 - i. If light is more intense then photosynthesis is happening more \rightarrow more water is made \rightarrow more water need to be released \rightarrow transpiration rate increases
 - ii. Low light intensity means less photosynthesis \rightarrow less water \rightarrow less water to evaporate \rightarrow transpiration rate decreases
 - c. Air flow (might be confusing)
 - i. More air blowing water away \rightarrow less water around the leaf \rightarrow water from inside will want to move to the outside \rightarrow transpiration rate increases
 - ii. No or less wind outside \rightarrow no water being blown away from around the leaf \rightarrow water inside the leaf will not want to move outside the leaf since there's too much water outside already \rightarrow transpiration rate decreases
 - iii. Might be helpful to say that in nature molecules will always want to move from a crowded place to a less crowded place
 - d. Humidity
 - i. More humid \rightarrow more water molecules in the air around the leaf \rightarrow water inside the leaf will not want to move outside the leaf since there's too much water outside already \rightarrow transpiration rate decreases
 - ii. Less humid \rightarrow less water molecules in the air outside the leaf \rightarrow water inside the leaf will want to move out since there is not a lot of water in the air outside of the leaf \rightarrow transpiration rate increases
9. Bingo Cards can be found [here](#)
 - a. Ignore the first two pages of instructions, they are not applicable to this game.

4. Closing Activity/Snack

This [recipe](#) will be used for the snack. Be sure to let students observe the spinach being stir fried so they can see the water leaking out. This shows that leaves hold water.

5. Student Reflection Questions:

1. Water is arguably the most important liquid to life. Thinking about cohesion and adhesion, do those two properties of water have any effect for humans?
2. Are there any other substances that have similar properties to water? How are they the same or different compared to water?
3. When water transpired it leaves the plant in a gas form, how did the water go from a liquid in the plant to a gas in the air?

6. Assessment Questions:

1. What is it called when water sticks to itself?
 - a. Prohesion
 - b. Cohesion**
 - c. Selfhesion
 - d. Adhesion
2. What factor does NOT affect the rate of transpiration?
 - a. humidity
 - b. Light intensity
 - c. Soil pH**
 - d. Temperature