Earth's Hydrosphere: It's All About Water!

Grades 6-8

Vetted by Riverside County Office of Education-STEM

Why Is This Important?

"Water is essential for life as we know it. It is present throughout the Solar System and was part of the Earth from its formation. The source of the water was the same as the source of the Earth's rock: the cloud of particles which condensed in the origin of the solar system."

--Kpedia

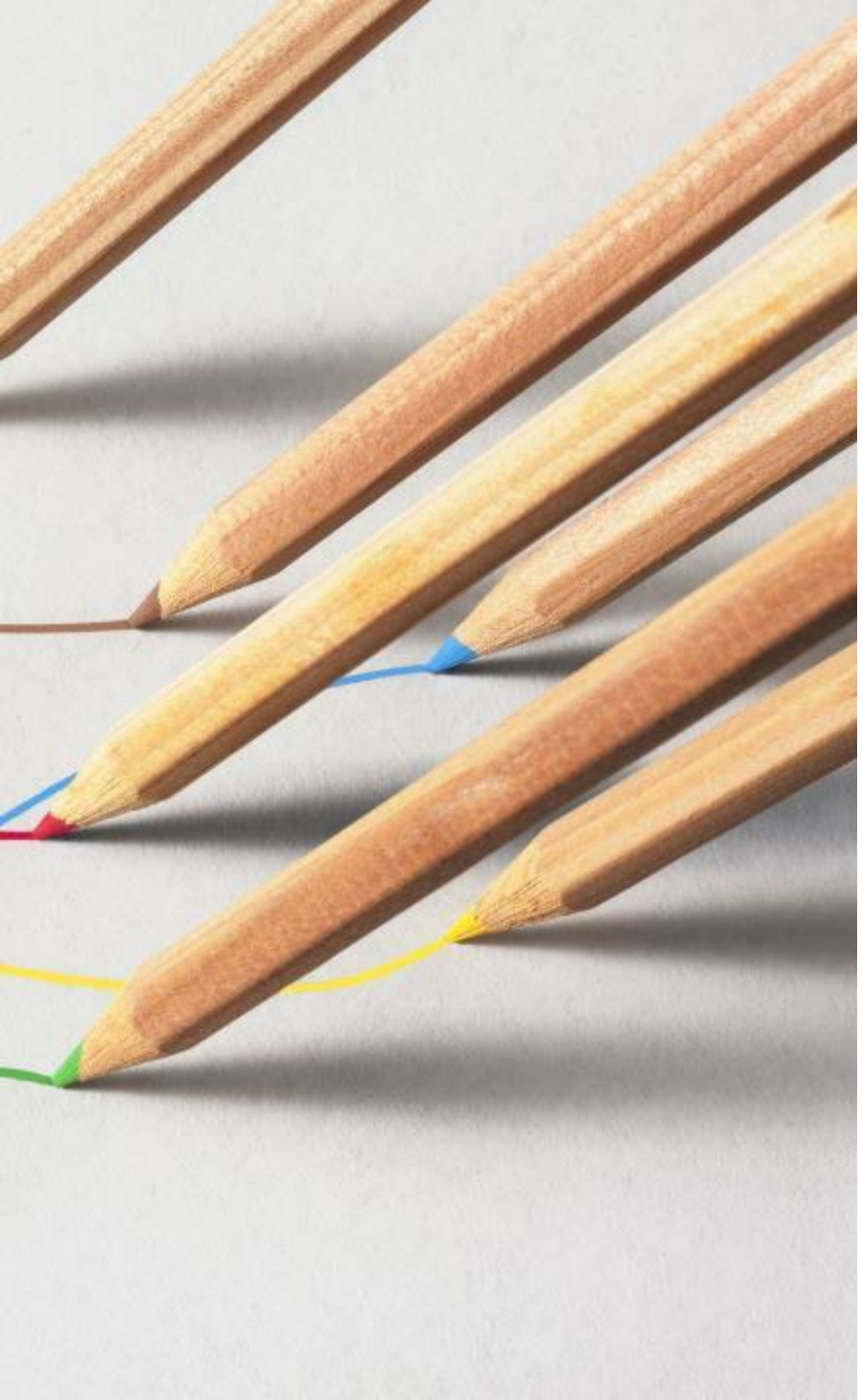
Learning Goals

Students will learn:

- The components of the hydrologic (water) cycle.
- The relationship between plant functions and the hydrologic cycle.
- And the effects of weather on plant functions.

Anchor Phenomena: Water Cycle

Teachers: For best viewing results show in full screen mode.



Develop a Model To Describe the Phenomena

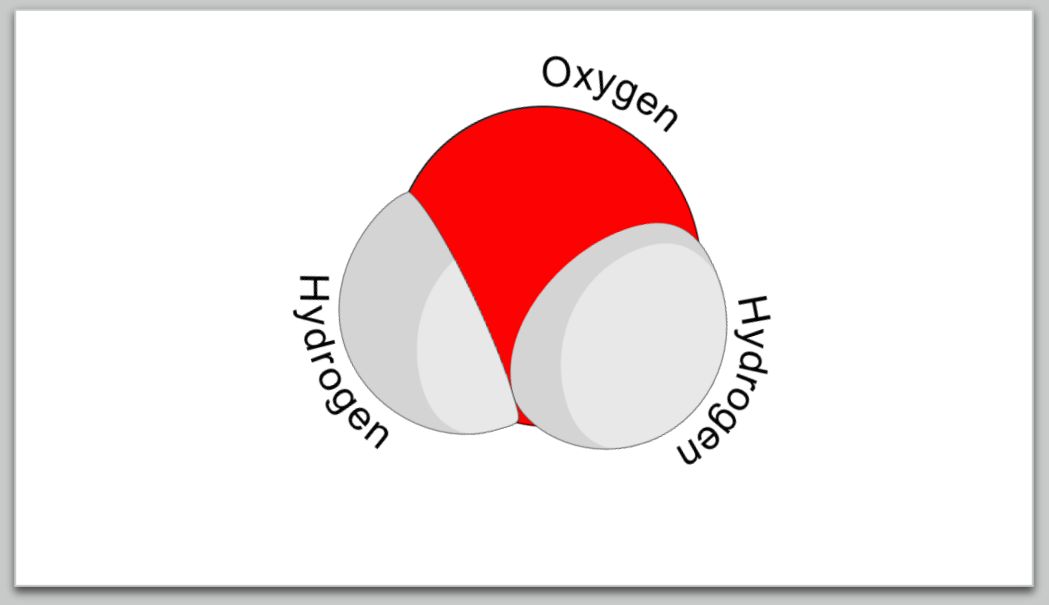
Draw a diagram demonstrating the phenomena of water cycling through Earth's systems. Include both observable and unobservable details.

- Label all important parts of the diagram.
- Use arrows to show how all parts interact.
- Write an explanation describing this phenomena.

Lesson 1: *What is the Hydrologic Cycle?*

First-What is Water?

- Water is a molecule made of two hydrogen atoms and one oxygen atom. Its chemical formula is H_2O.
- Water is a **fluid** which means it can move easily and change its shape.
- Like other liquids, water has a **surface tension**, which means the surface of a water droplet will hold the droplet together in a ball shape.
- Water is the only chemical substance on Earth that can exist naturally in **three states of matter**:
  - Solid
  - Liquid
  - Gas

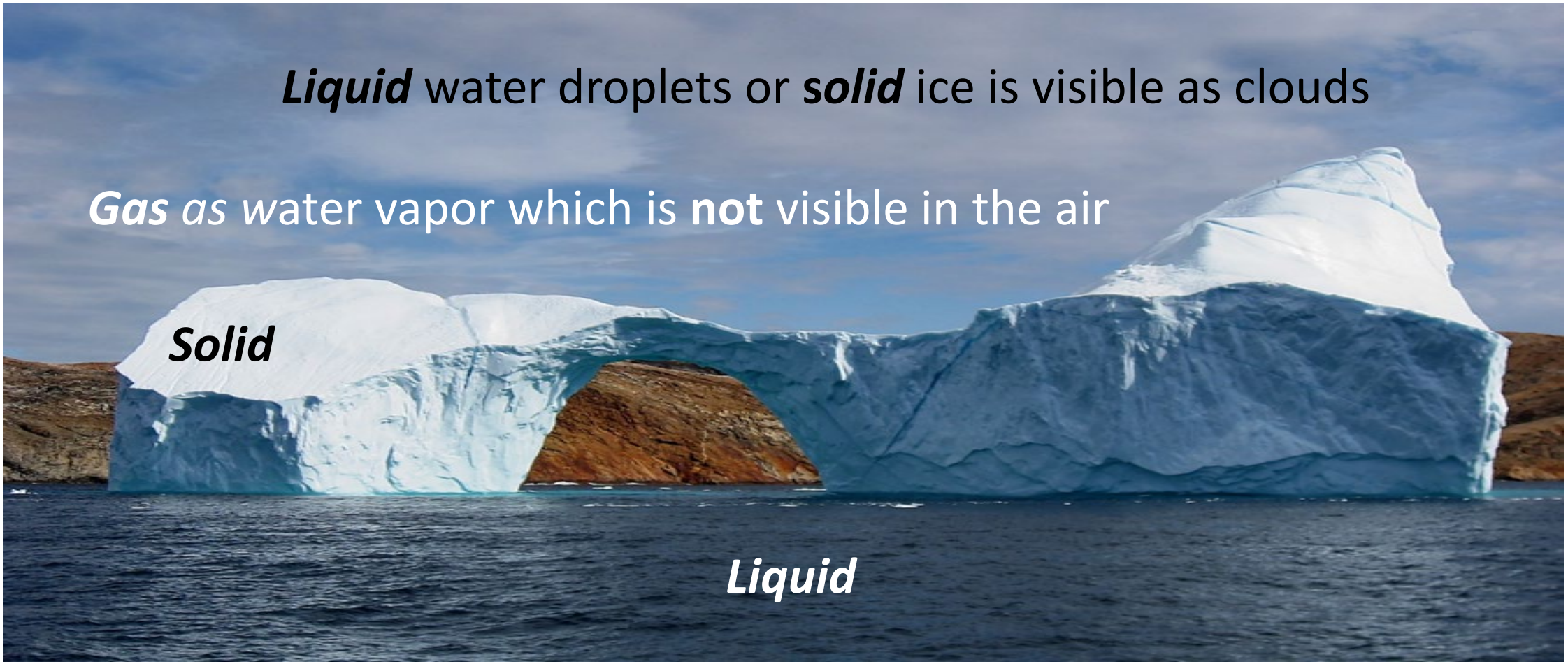


Can You Identify the Three States of Water?

In this picture:

- What is the solid form of water?
- What is the liquid form of water?
- What is the gas form of water?

Three States of Water *Identified*



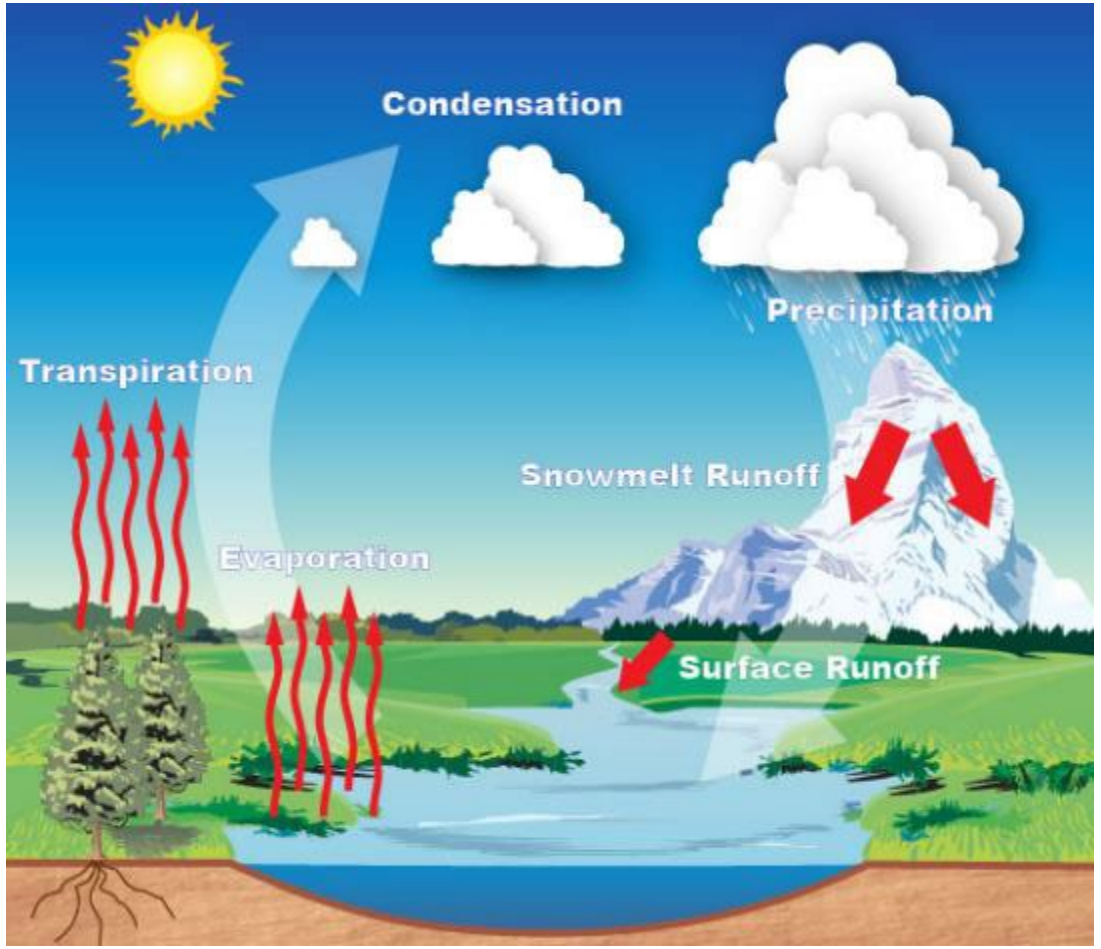
Earth's Hydrosphere

***Hydro* is the Greek word for water. The hydrosphere contains all the solid, liquid, and gaseous water of the planet. It ranges from 10 to 20 kilometers in thickness.**

- The hydrosphere extends from Earth's surface downward several kilometers into the **lithosphere** and upward about 12 kilometers into the **atmosphere**.
- The **water cycle** is used as a model to demonstrate the hydrosphere.

The Hydrologic (Water) Cycle

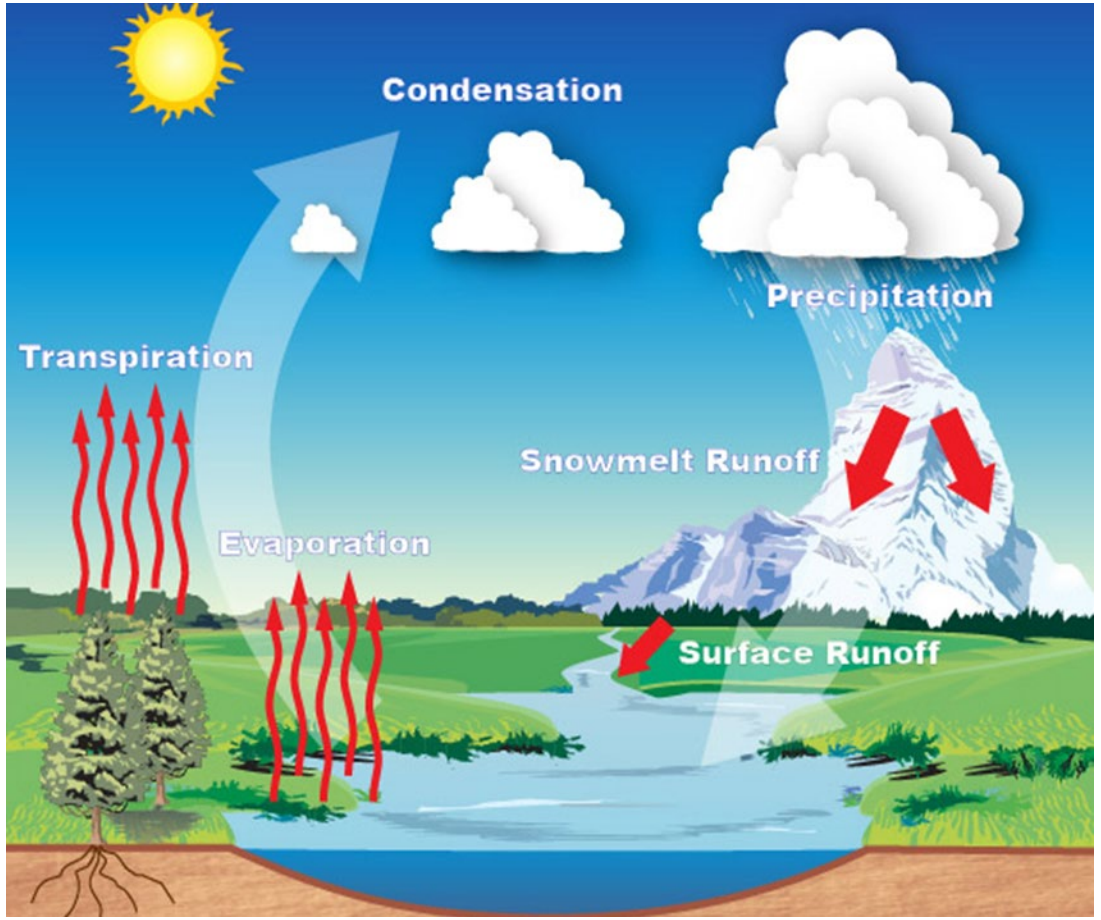
- The hydrologic - or water - cycle is the *continuous movement* of water between the lithosphere and the atmosphere.
- Energy from the sun and the pull of gravity **drive this continual movement**.
- In its three states (solid, liquid, and gas), water ties together the major parts of the Earth's **climate system** which is the air, clouds, ocean, lakes, plant vegetation, snowpack, and glaciers.



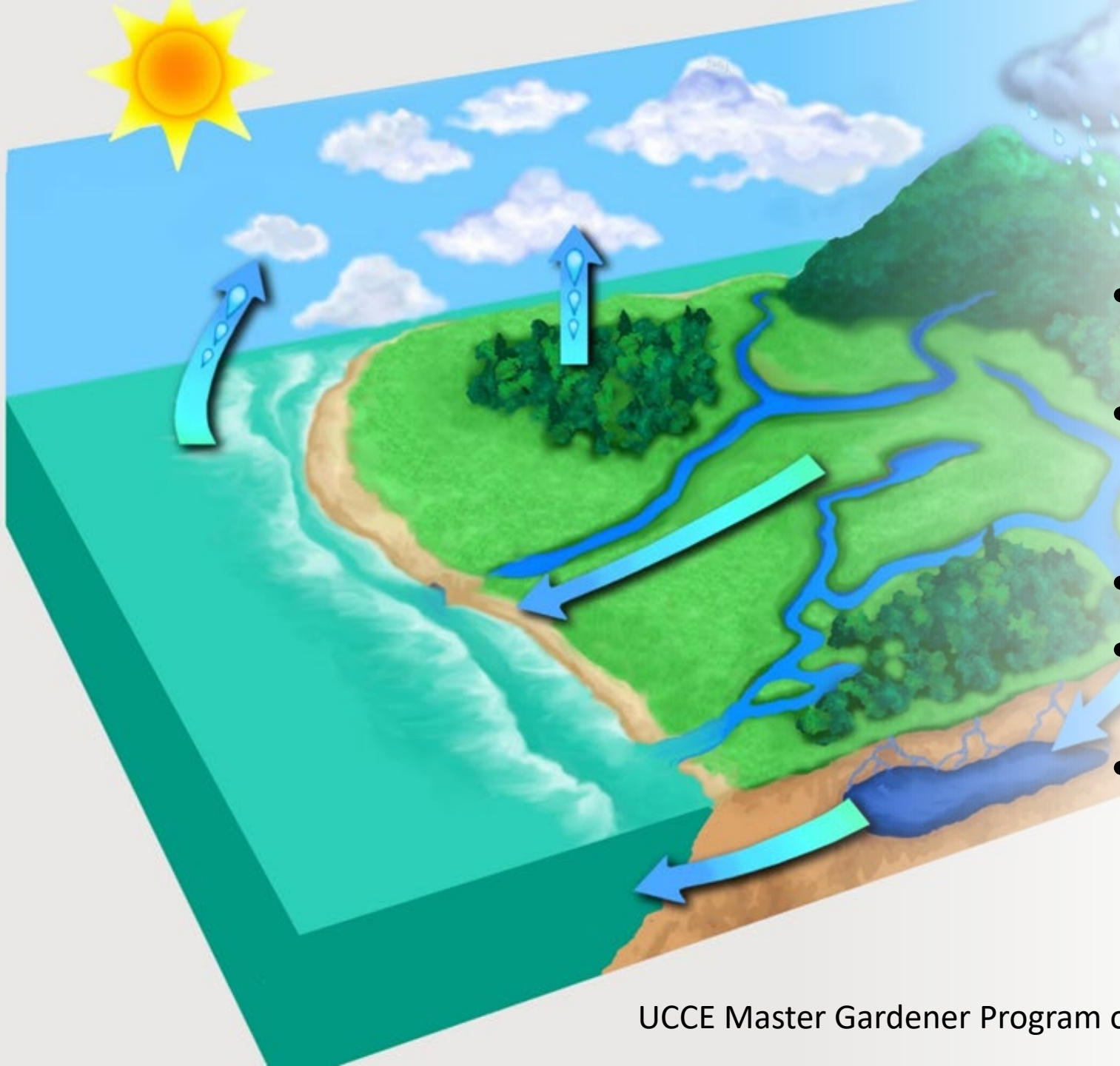
A Closer Look at the Hydrologic Cycle

The National Weather Service calls this model the "basic water cycle".

- **Evaporation** of water vapor from water and soil.
- **Transpiration** of water vapor from plant vegetation.
- **Condensation** of water droplets into forming clouds.
- **Precipitation** of rain, sleet, or snow.
- **Runoff** from snowmelt, and surface runoff from both snowmelt and rain.



Video: Water Cycle



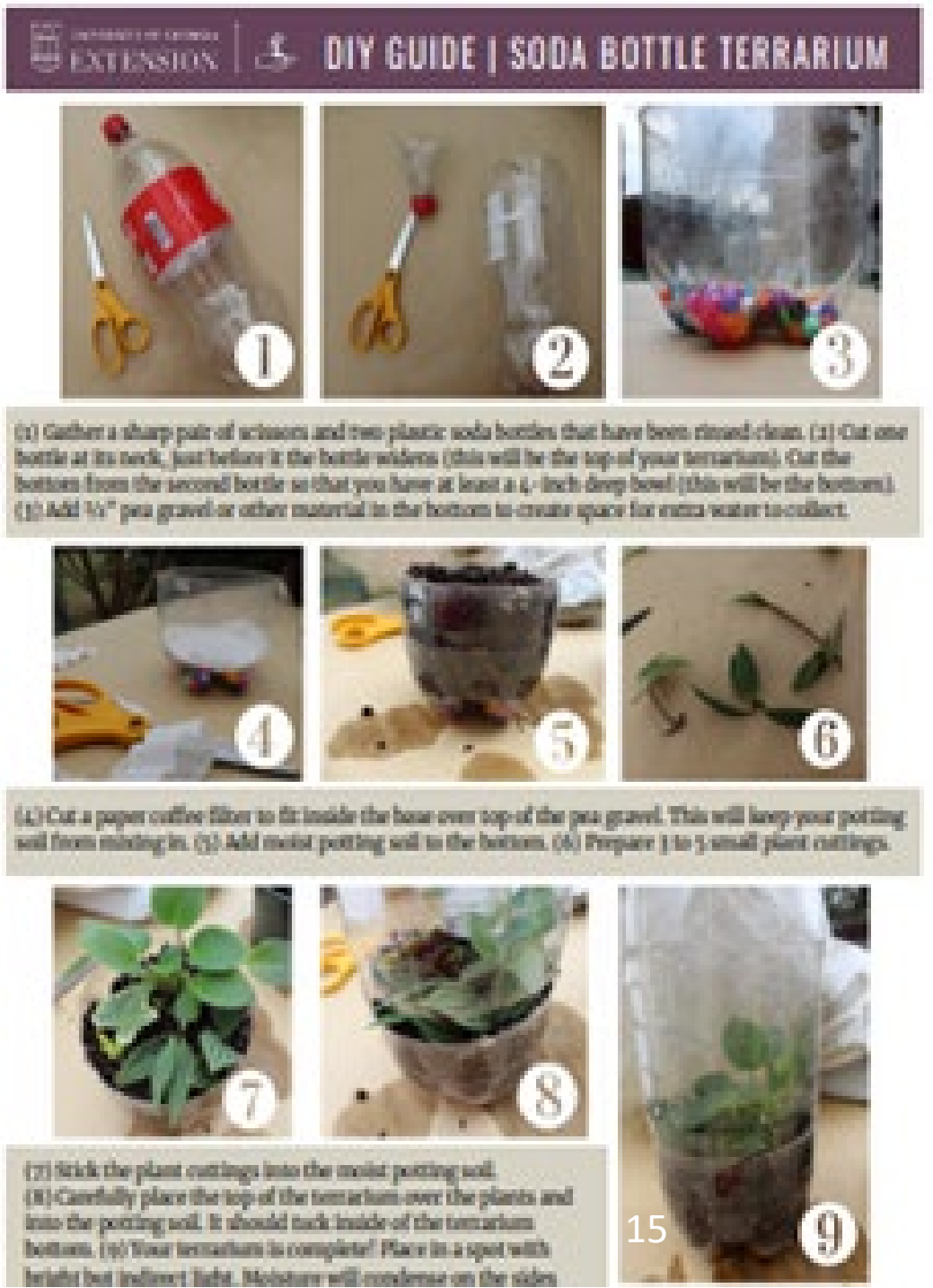
Check for Understanding

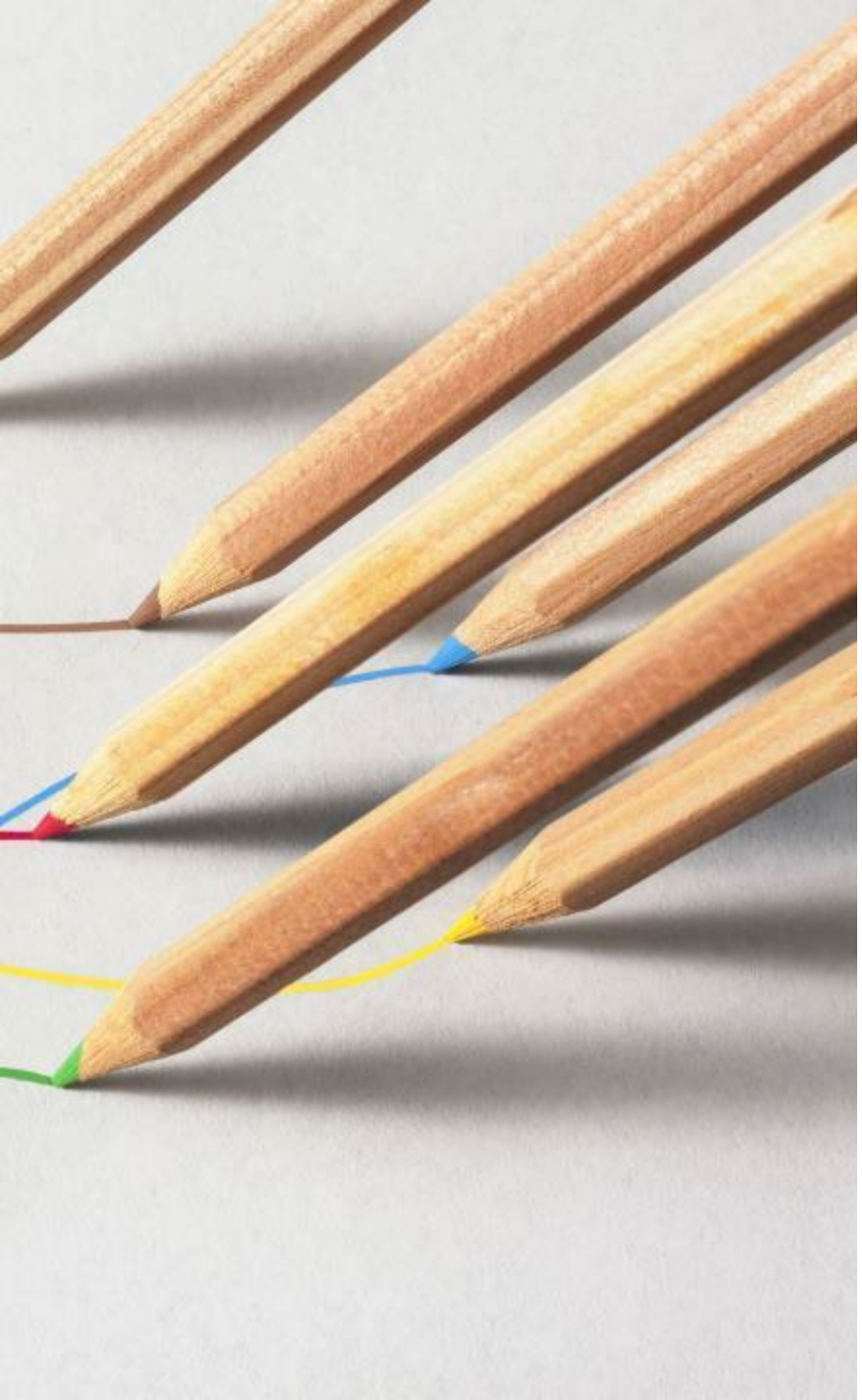
- What does surface tension allow water to do?
- What are the three states of water? Give an example of water in one of its states.
- What is the Hydrosphere?
- What drives the movement of water through the hydrologic cycle?
- Describe one of the components of the movement of water through the cycle.

Phenomena in the Garden: *Make a Garden Terrarium*

A terrarium is a model of the water cycle.

- Using simple supplies, students individually or in small groups, can construct their own small hydrosphere to observe the water cycle.
- Click on the link for step-by-step Master Gardener guidance: DIY: Soda Bottle Terrarium





Develop a Model To Describe the Phenomena

Revise or draw a new model of water cycling through Earth's systems that reflects what you have learned about this phenomena.

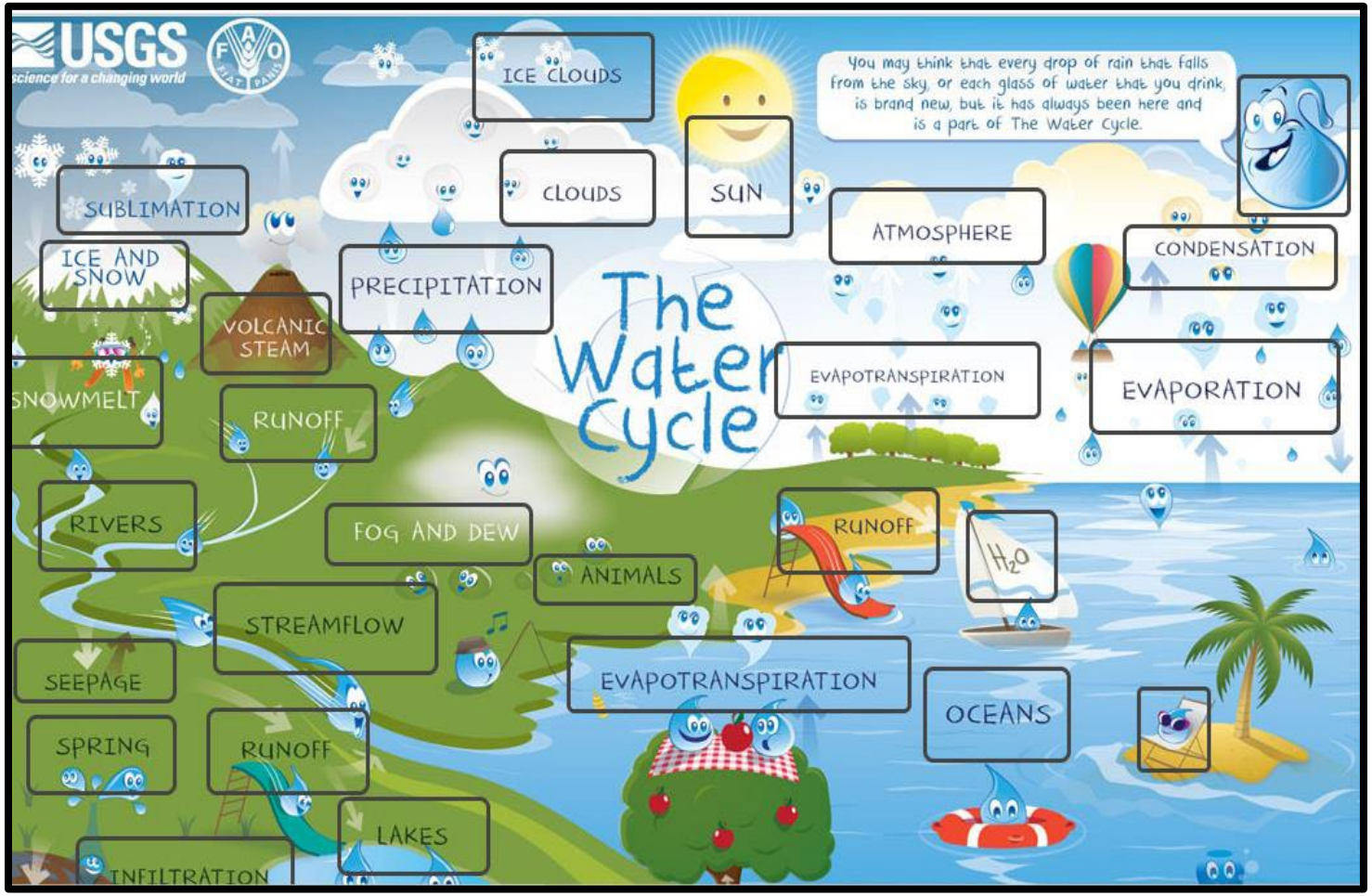
- Label all important parts of the diagram.
- Use arrows to show how all parts interact.
- Write an explanation describing this phenomena.

Extend Your Thinking:

Explore the Hydrologic Cycle in More Detail

The water cycle is about water recycling! Every drop of water has already been part of the hydrologic cycle.

- Click on the link : [Water Cycle Activity]
- Hover over a topic to learn more detail about this cycle.
- Add information you've learned to your water cycle model.



Lesson 2

A Closer Look at the Role of Plants in the Hydrologic Cycle

Why is Water So Important to Plants?

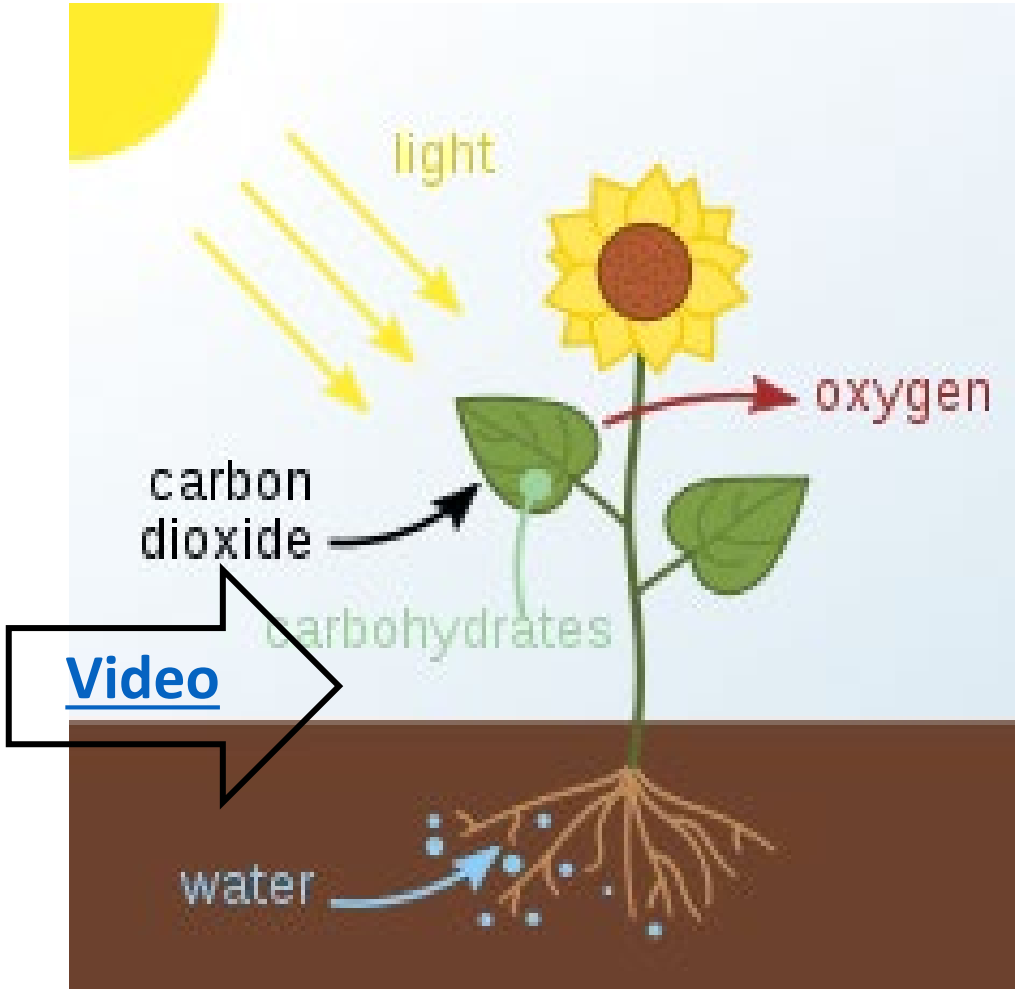
Most plants are composed of 90% water. Water is used by plants in four essential ways:

- Photosynthesis
- Structure
- Translocation
- Transpiration

Understanding Photosynthesis

Photosynthesis is the process by which plants produce the energy they need to survive and grow. Water is essential for this process.

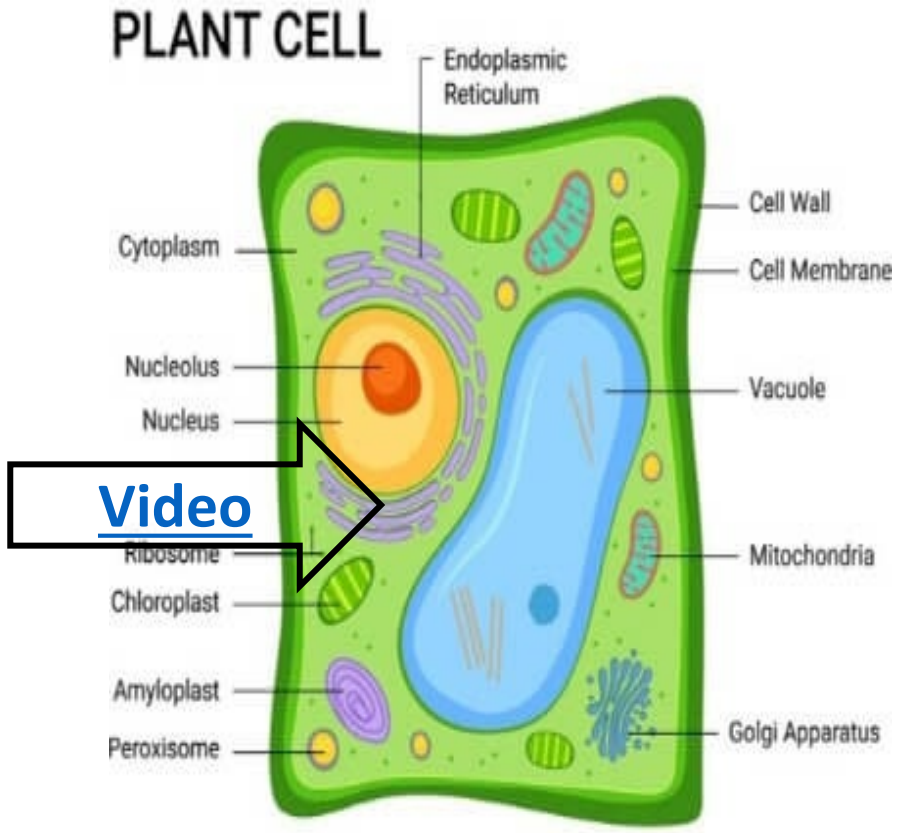
- Photosynthesis uses the energy from the sun to create energy (food) in the form of sugars (carbohydrates).
- For the molecules of sugar to form they need carbon dioxide which they absorb from the air, and hydrogen from the **water** in the plant.



Understanding Plant Structure

Plants do not have a skeleton. Instead, plant structure comes from the pressure of the water in their cells which enables them to grow and maintain rigidity.

- Within each cell is the **vacuole**, a space filled with **water** that ensures the cell maintains its shape.
- If the plant receives enough water, the vacuole keeps the cell walls at the right pressure and gives the plant its strength.

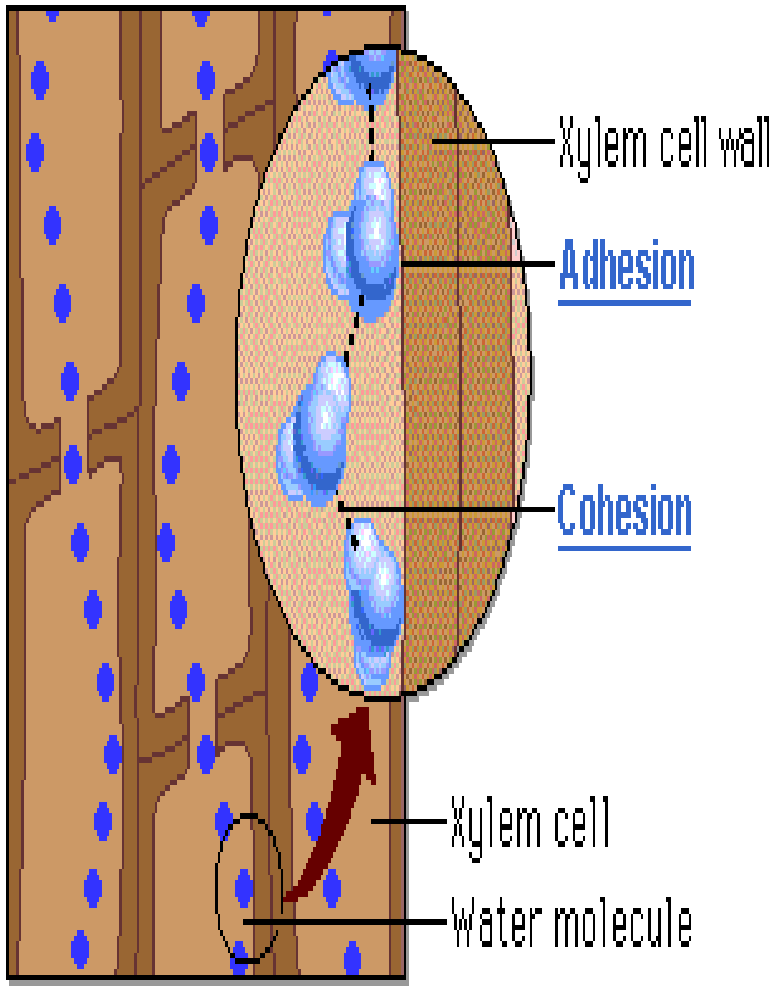


Understanding Translocation

The movement of water through the parts of a plant is called translocation.

The plant absorbs nutrients in a solution form; so adequate water in the soil is essential for good plant growth.

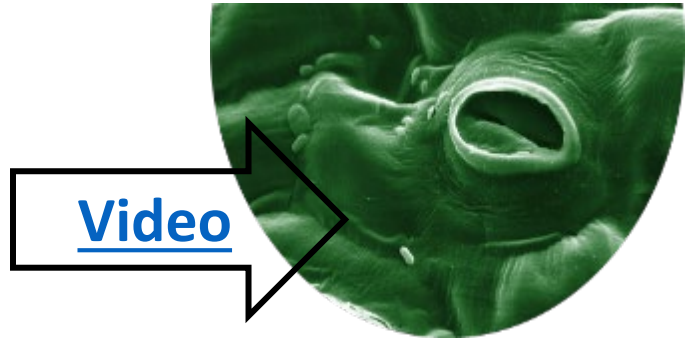
- Soil nutrients are taken up by the roots in a **water** solution and moved by a process called **capillary action.**
- Capillary action takes place in the plant's **xylem** system, in long hollow chains of dead xylem cells.

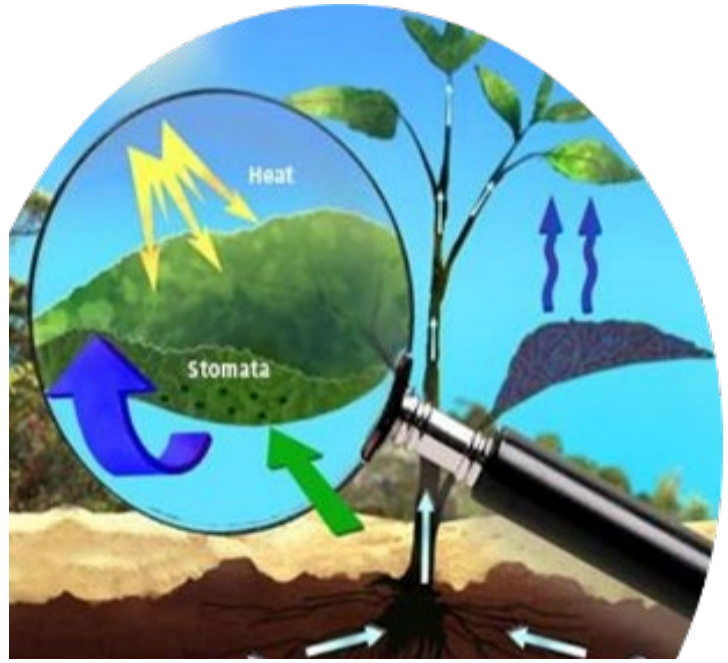


Understanding Transpiration

The driving force behind water movement in plants is evaporation through the leaves, which provides a suction force pulling water up the plant's "plumbing" system. Because water is evaporating from a living surface (a plant), it is called transpiration.

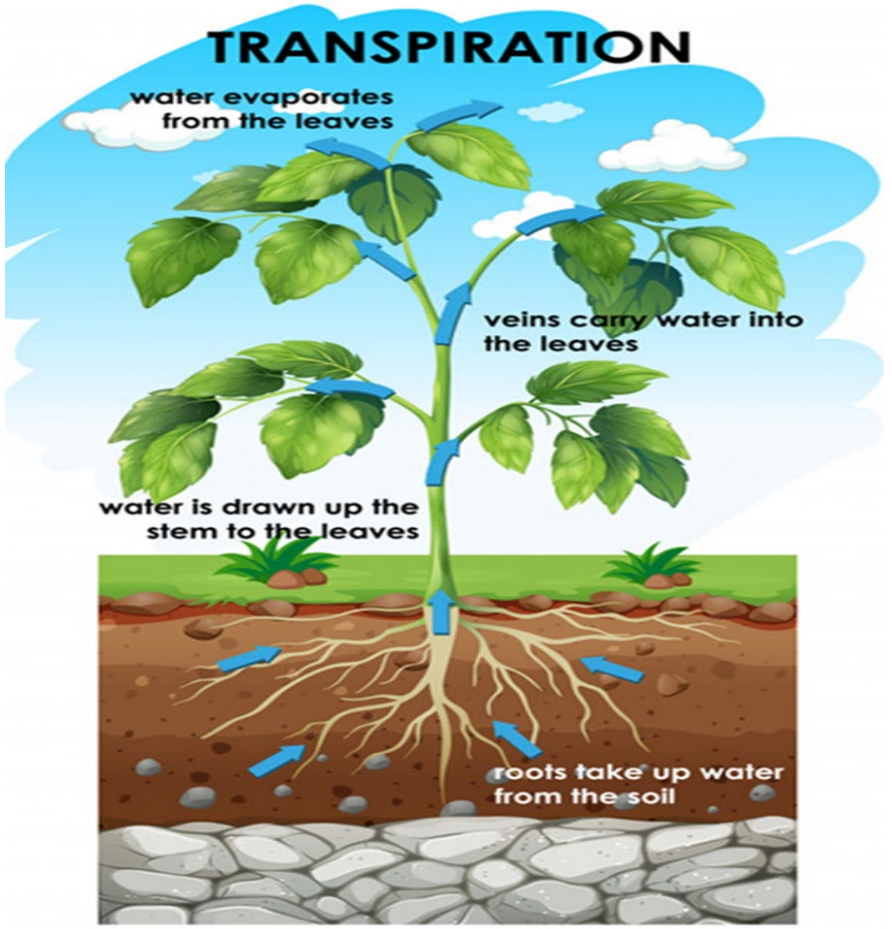
- Water is absorbed by roots from the soil and transported as a liquid to the leaves via the xylem.
- In the leaves, small pores called stomata allow water to escape as a vapor.
- Of all the **water** absorbed by plants, less than 5% remains in the plant for growth!





Why Do Plants Transpire?

- **Water uptake:** Although less than 5% of the water taken up by roots remains in the plant, that water is vital for plant structure and function.
- **Accessing nutrients from the soil:** The water that enters the root contains dissolved nutrients vital to plant growth. Transpiration enhances nutrient uptake into plants.



Why Do Plants Transpire? *Continued*

- **Carbon dioxide entry:** Open stomata allow water vapor to leave the leaf but also allow carbon dioxide to enter which is essential for the process of photosynthesis.
- **Evaporative cooling:** Energy is released as water evaporates or converts from a liquid to a gas from the leaf pores.

Transpiration is a Critical Process for Plants and the Hydrologic Cycle

Transpiration provides about 10% of the water vapor being cycled through the Hydrosphere.

- Watch this video demonstrating the movement of water through a tree and into the atmosphere.

How Do Trees Transport Water from Roots to Leaves? | California Academy of Sciences

Check For Understanding

- What percent of the Earth's water is fresh-not salty?
- Where is most freshwater located that is available to plants?
- Most plants are composed of what percent water?
- Describe one essential way plants use water to survive.
- What is the role of stomata?
- What percent of all water vapor comes from plants?

Phenomena In the Garden: *Plant Transpiration*

Place a "do not disturb" sign in front of your experiment. Image credit: NASA/JPL-Caltech | + Expand image

- Tie a clear plastic bag around a plant or branch with leaves. Use a rubber band or twist tie.
- As a **control**, set up a second empty bag nearby.
- After 30 minutes observe both for evidence of moisture.
- Optional: Leave the bags out overnight or for several hours. Remove the bags and measure the amount of liquid collected.

Introduce **variables** into this experiment:

- ❖ Different types of plants with different leaf sizes
- ❖ Plants in the sun versus shade
- ❖ Plants at night versus daytime

Develop a Model To Describe the Phenomena

Revise or draw a new model of water cycling through Earth's systems to reflect what you have learned about this phenomena.

- Label all important parts of the diagram.
- Use arrows to show how all parts interact.
- Write an explanation describing this phenomena.

Extend Your Thinking:

Watch the video: A River in the Sky

As you watch this video take notes answering the following questions:

- How may gallons of water can a rainforest tree "pump" each day to be released as water vapor?
- What do these trees release to help make clouds?
- During what season do the trees transpire more?
- What is the "river in the sky"?

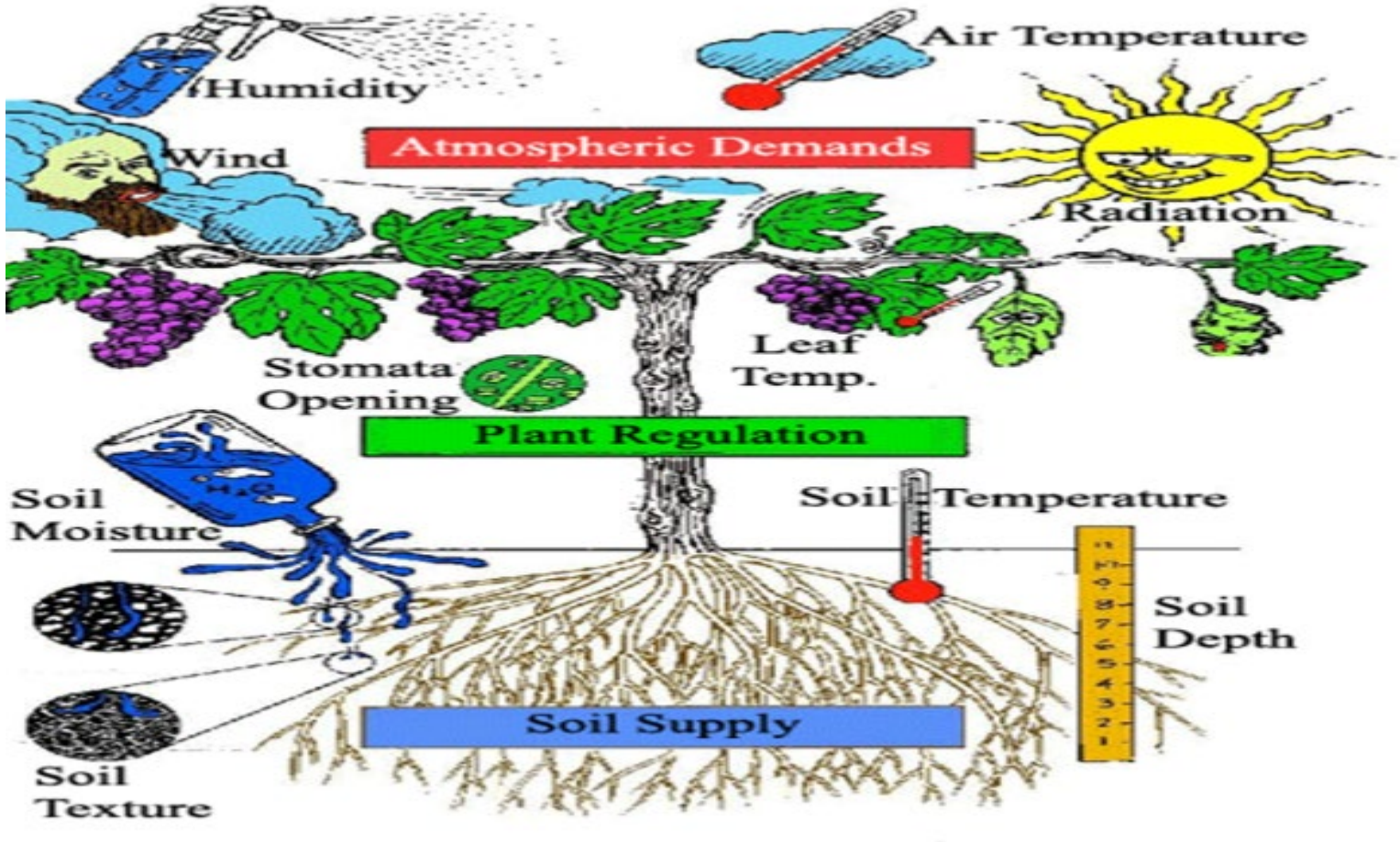
Dr. Nobre says that the trees affect the weather and make their own rain. Update your model to show how rainforest trees do this.

Lesson 3: Weather and Water in the Garden

The Amount of Water a Plant Needs is Affected By Weather Conditions

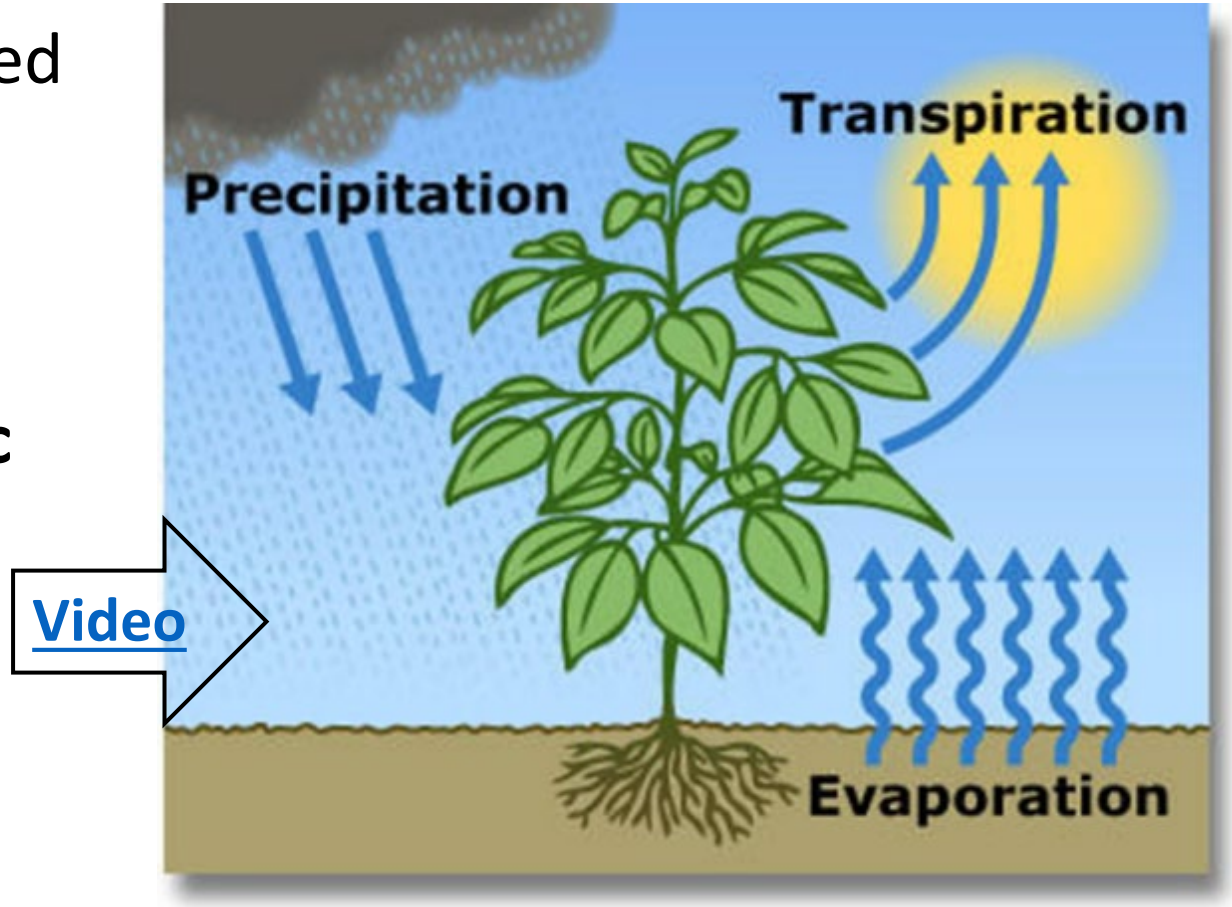
These are also called meteorologic conditions:

- Solar Radiation
- Temperature
- Relative Humidity
- Wind speed



Understanding Evapotranspiration

- Evapotranspiration is the combined process of e*vaporation* of water from the soil and *transpiration* of water from the plant.
- **One or more of the meteorologic conditions will affect the *rate* of evapotranspiration**.



Video

Evapotranspiration Affects the Amount of Water a Plant Needs

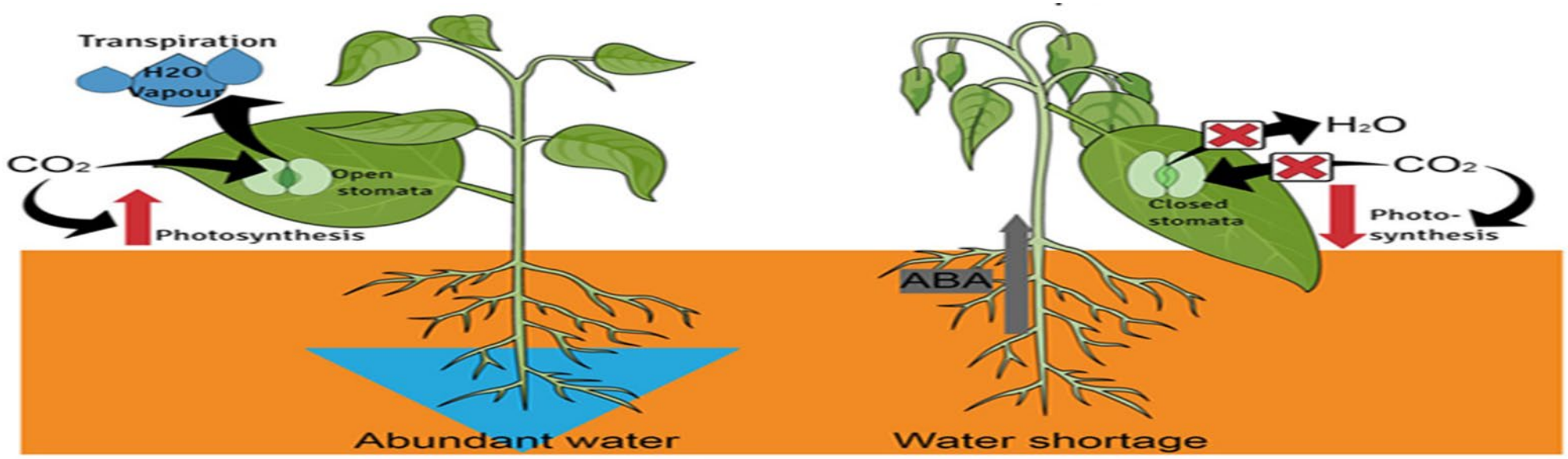
The rate of water use varies depending on the type of plant.

- However, for normal growth most plant species require replacement of a large portion of water lost.
- The highest rate of plant water use occurs in midsummer, the lowest rate in midwinter.

Without Adequate Water a Plant Will Wilt and Could Die

When the soil of a plant runs low on available water:

- The water chains in the xylem become thinner and thinner.
- The vacuoles can no longer keep the cell walls at the right pressure and the plant begins to wilt.



Managing a Plant's Rate of Water Use: *Minimize Soil Evaporation*

Watering:

- Water in the *cooler morning hours* when the sun is not directly overhead, the temperature is cooler, and it is usually less windy.

Mulching:

- *Insulate the soil* with mulch.
- Mulches should be kept 4-6 inches away from plant stems to avoid "trunk" diseases.
- Spread at a depth of 2-4 inches for maximum insulating benefits.

Managing a Plant's Rate of Water Use: *Maintain Healthy Plant Structure and Function*

New Plantings

- New plantings *require more frequent watering* than established plants.
- *Maintain moist soil* around recent transplants and seedlings.
- *Maintain a moist seed bed* through seed germination.

Established Plants

- Most landscape plants and grasses *can be maintained with less water.*
- Many established plants will show some wilting mid-day during the hottest months. *That may not mean they need additional water.* Insert your pointer finger into the soil near the root zone at a depth of 2-3 inches. If it is moist at that depth, your established plant does not need additional water.

More Tips for Maintaining *Healthy Plant Structure and Function*

- Create **hydrozones**. This means placing plants with *similar water requirements* together in a planting bed where they will receive the correct amount of water to meet their needs.
- For example, shallow-rooted vegetables will *need more frequent watering* than more deeply rooted crops.

Video: Evapotranspiration

As you watch this video listen carefully for the answers to the following questions:

- During a growing season when does moisture in the soil evaporate the most? Explain why.
- Why is evapotranspiration important to the water cycle?

Check For Understanding

- Name one meteorologic condition that affects a plant's water needs.
- What is evapotranspiration?
- Why is it important to manage a plant's water use?
- Describe one strategy for managing a plant's rate of water use.
- Which strategy helps reduce the amount of moisture evaporating from the soil?

Phenomena in the Garden: *Evaporation*
Measuring Your Soil's Moisture Level

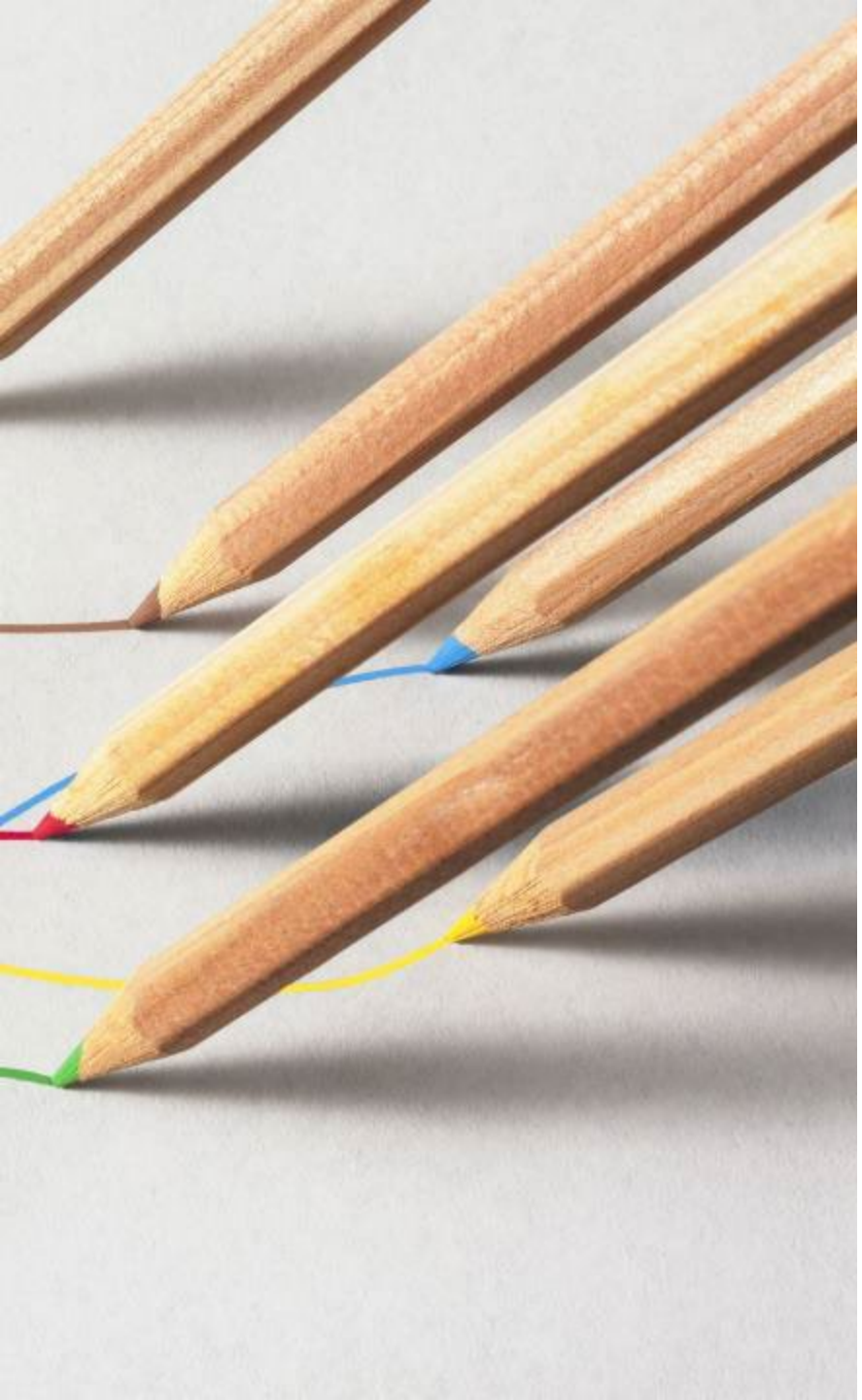
3 Ways To Check Your Soil Moisture - Garden Quickie Episode 75

Watch this video which provides an overview on three simple methods for testing the moisture level of soil.

- Use one or more of these methods to evaluate the moisture level of a garden bed.
- For an accurate assessment of the overall bed, test the moisture level in five or more areas.

Introduce variables into your garden bed assessment:

- Areas covered with mulch versus bare soil.
- Moisture level in the morning versus afternoon.



Create a Final Model To Describe the Phenomena

- **Draw a new model of water cycling through Earth's systems that reflects what you have learned about this phenomena.**
- Label all important parts of the diagram.
- Use arrows to show how all parts interact.
- Write an explanation describing this phenomena.

Extend Your Thinking: *SMAP Part 1*
Measuring Soil Moisture From Space

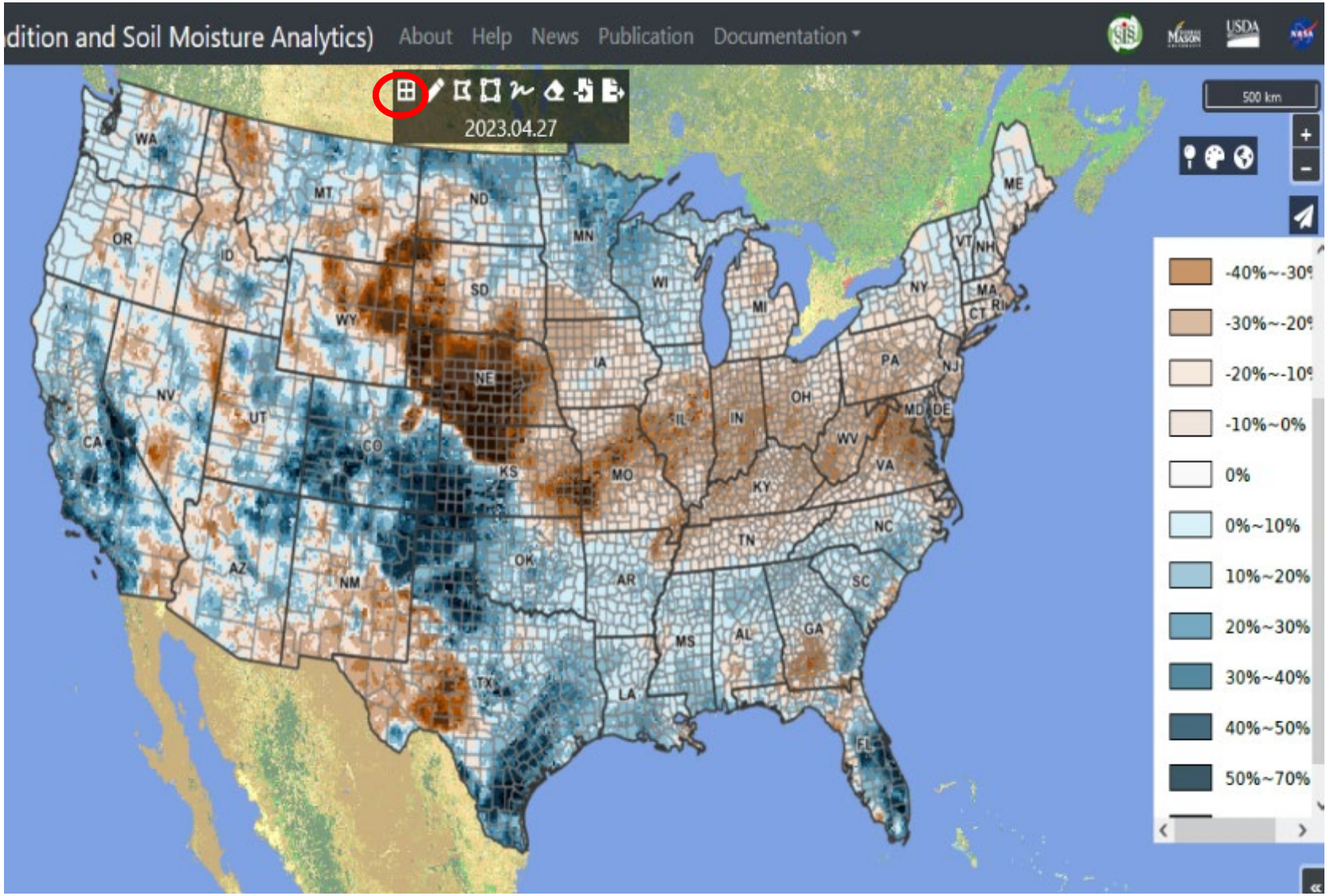
Real World: What Is Soil Moisture?

Scientists have developed a satellite called SMAP that can measure soil moisture from space.

As you watch this NASA video take notes answering the following:

- What does SMAP stand for?
- Give an example of how the SMAP data is used.
- Why are the SMAP measurements important?

Extend Your Thinking: SMAP Part 2



Real-time SMAP data is available to the public.

- Click on **Crop Conditions and Soil Analytics** to see recent percent of soil moisture measurements for the United States.
- Click on the circled image to get data specific to your state and county.
- How might this information influence your planting and watering schedule?

Next Generation Science Standards

MS-ESS2.C: The Roles of Water in Earth's Surface Processes

▪ Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land.

▪ Global movements of water and its changes in form are propelled by sunlight and gravity.

MS-LS1.A: Structure and Function▪ Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell.

MS-LS1.B: Genetic factors as well as local conditions affect the growth of the adult plant.

MS-LS1.C: Organization for Matter and Energy Flow in Organisms ▪ Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use.

Next Generation Science Standards

Science and Engineering Practices:

- Develop and use a model to describe phenomena. (MS-ESS2-1),(MS-ESS2-6)
- Develop a model to describe unobservable mechanisms. (MS-ESS2-4)

Crosscutting Concepts

- Systems and Models: Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. (MS-ESS2-6)

- Energy and Matter: Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter.(MS-ESS2-4)
- Cause and Effect: Phenomena may have more than one cause, and some cause-and-effect relationships in systems can only be described using probability. (MS-LS1-4),(MS- LS1-5)

Career Technical Education Pathway Standards
Agriculture and Natural Resources

G3.0 Understand plant physiology and growth principles.

- G3.1 Investigate plant systems, nutrient transportation, and energy storage
- G3.4 Research the factors that influence plant growth, including water, nutrients, light, soil, air, and climate.

Resources

- California Master Gardener Handbook; Pettinger, 2015
- DIY: Soda Bottle Terrarium; University of Georgia Extension
- The Hydrologic Cycle; National Oceanic and Atmospheric Administration
- SMAP; Jet Propulsion Laboratory
- Transpiration Demo; NASA-Jet Propulsion Laboratory Classroom Activities
- Water Cycle; National Geographic Resource Library
- Water Cycle; Climate Change, and How it Effects California's Ecosystems; Oct. 10, 2021, blog by Flo Pucci:; UCCE Master Gardeners of San Joaquin County
- Water Science School; US Geological Survey
- Water World; National Geographic Resource Library

Resources

- **Images:** Creative Commons, Kiddle; nassgeo.csiss.gmu.edu; NASA; National Oceanic and Atmospheric Organization; Stock; USGS; UCANR; Wikipedia
- **Videos:** PBS Learning Media; Dan the Weather Man; Crash Course Kids; 2 Minute Classroom; Webekeit; WatchKnowLearn.Org; California Academy of Sciences; Weather Wise; The Ripe Tomato Farms; NASA

Master Gardeners

The University of California Cooperative Extension (UCCE) Master Gardener Program (MGP) is an educational program designed to teach and effectively extend information to address home gardening and non-commercial horticulture needs in California.

UCCE is the outreach arm of UC's division of Agriculture and Natural Resources (ANR). Master Gardener volunteers (MG volunteers) promote the application of basic environmentally appropriate horticultural practices through UCCE-organized educational programs that transfer research-based knowledge and information.

University of California
Agriculture and Natural Resources
UCCE Master Gardener Program

Gardening Questions?

Email the UCCE Master Gardeners of Riverside County

- Email Helpline: anrmgriverside@ucanr.edu
- School Gardens: mgschoolgardens@gmail.com

Website Resources

- Riverside Master Gardeners Website

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