

Amazing Adaptations of Succulents

Overview: From aloes to echeverias to cacti, the popularity of succulent plants for indoor gardens is on the rise. In addition to being interesting and adorable, these fascinating botanical specimens provide opportunities to teach students about plant adaptations.

Grade Level/Range: 4th – 6th Grade

Objective: Students will explore the characteristics of succulent plants to learn about ways living organisms adapt to survive in their native environments.

Time: 45 minutes

Materials:

- Examples of succulent plants (common plants readily available from garden centers include jade plant, aloe, echeveria, cacti, haworthia, sedum, and kalanchoe)
- Examples of non-succulent plants (many options, including houseplants such as philodendron and ivy and vegetable plants such as peppers)
- Microscopes (optional)

Background Information

Succulent is a very broad term used to group plants that have fleshy stems and leaves designed to store extra water. Most succulents are native to environments with limited water availability and rainfall, such as deserts. They are also found in regions with very rocky soil that lack the ability to retain a consistent supply of water. Cacti are probably the most widely recognized succulents. Other common examples include jade plants, aloes, echeveria, haworthia, sedum, and kalanchoe.

There are a few exceptions to the typical description and in fact there are some succulents that live in fairly humid environments. For example, air plants and some types of [bromeliads](#) are considered succulents. They live in trees in the rainforest (pretty much the exact opposite of a desert climate); however, because they do not have roots in the ground, water availability can be challenging, and so they also must rely on their adapted ability to store water to survive.

Adaptations of Succulent Plants

Some of the common physical characteristics of succulents that help them store and use water efficiently include:

- Fleshy roots, stems and leaves that have tissues adapted to store extra water beyond what they need for their immediate needs.



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- A shape that allows the leaves and/or stems to swell when filled with water, and shrink when that water is used by the plant.
- Leaves with a rounded shape. Because water loss is influenced by the amount of surface area exposed to air, a rounded shape (compared to a flat leaf) minimizes the surface area relative to its mass. Some succulents, such as certain cacti, don't have leaves at all; instead, their stems contain chlorophyll and perform photosynthesis.
- A waxy leaf and stem coating. A waxy surface acts like a sealant to protect the plant from a dry environment and decrease water loss. Hairs and thorns are also thought to help deflect air movement around leaves which can help decrease water loss.
- Shallow roots. Shallow roots allow plants to soak up water from near the surface soil surface. This is helpful in environments where rainfall is scarce or comes in short bursts that may not be deeply absorbed.
- Stomata that open during the night rather than during the day.



The accordion-like folds of a barrel cactus allow it to expand as roots absorb water when it is available, and to contract when the plant uses that water during dry spells.

Specialized Photosynthesis

Stomata are the tiny openings on leaves through which plants take in the air they need for photosynthesis. Additionally, it is through their stomata that plants release the extra oxygen, which is a by-product of photosynthesis. While the stomata are open, plants also lose water through the combined processes of transpiration and evaporation.

Learn more: Photosynthesis 101 <https://kidsgardening.org/garden-how-to-photosynthesis-101/>

Since plants need sunlight to complete the process of photosynthesis, most plants open their stomata during the day to take in the air that they need. Daytime conditions (sunlight and higher temperatures) also contribute to an increase in the loss of water through transpiration and evaporation. To decrease water loss, many succulents have developed the special ability to open their stomata at night. They are able to take in the air they need for photosynthesis and then store it until it can be used in the daytime. The nighttime opening of stomata and highly specialized storage system for the components needed for photosynthesis are an important way they decrease the amount of water they lose through transpiration.

Growing Succulents Indoors

The adaptations of succulent plants that they have developed to help them survive their native environments also come in handy when we use them for indoor gardens. Due to modern-day heating and cooling systems, most indoor environments

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are drier than outdoor conditions, and succulents are designed to decrease water loss in dry air. Their water efficiency can also mean less watering is needed (although that will vary widely due not only to conditions, but also factors such as the type, size, and age of the plant) which potentially can decrease the amount of care needed. That said, some succulents struggle with the low light levels found in many indoor locations. The addition of artificial lights such as grow lights can be beneficial. Also, because succulents are adapted to low-water conditions, well-drained soil is a must, and overwatering is a common problem.

Laying the Groundwork

1. Introduce your students to stomata and the job they do for plants. They are small openings in plant leaves that open and close to allow for:
 - air to be brought into the leaf for photosynthesis
 - extra oxygen produced through photosynthesis to be released
 - water brought up from the plant roots to be released through the processes of transpiration and evaporation
2. If you have a microscope available to you, look for stomata on leaf samples. The stomata are typically found in greater numbers on the undersides of the leaves and on the outside layer of the leaf. To be able to see them under a microscope, try folding the leaf in half and then tearing it, which may give you a thinner sample to look through.

The California Academy of Sciences also offers suggestions for using clear nail polish and tape to try and separate the stomata off of your leaf for viewing. Instructions for this method can be found at: <https://www.calacademy.org/educators/lesson-plans/stomata-printing-microscope-investigation>.

3. If you do not have microscopes available, you can check out the video Travel Deep Inside a Leaf also from the California Academy of Sciences: <https://www.youtube.com/watch?v=Bf-RFPaZeAM>.
4. Explain to students that stomata usually open during the day, but there are some plants that open their stomata at night instead. Ask them why some plants might do that? If they need some prompting, ask them to think about how much they sweat on a hot day. Do they sweat more in the sun during the day or in the darkness at night? Explain that some plants open their stomata at night to decrease water loss. Share additional details from the background information as grade level appropriate.

Exploration

1. Help students further explore the adaptations of succulents by giving them the chance for hands-on observation of one or more samples of succulent plants compared to non-succulent plants. Succulent plants are readily available in the indoor plant sections at garden centers and even in the floral departments of some grocery stores. Good examples include jade plant, aloe, echeveria, cacti, haworthia, sedum, and kalanchoe.

Although you can use about any kind of non-succulent plant for comparison, annual bedding plants (such as petunias and coleus) and/or grasses may be the easiest and most inexpensive options.

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2. Depending on the number of students in your classes, you may want to divide kids into small groups for observations to keep the number of plant samples needed low. Alternately, if you are able to find larger sample plants, you may also be able to break off some individual leaves for student observation without permanently damaging the parent plant. You can use our Plant Adaptation Observation Worksheet to help guide their exploration.
3. After giving them time to explore on their own, discuss observations as a group highlighting the common characteristics of succulents mentioned in the Background Information.

Making Connections

Based on your observations, summarize all of the different adaptations of succulent plants and how they help the plants survive tough conditions. Beyond their own survival, why might it be important for our planet to have plants that can grow in challenging ecosystems. What are some of the benefits plants bring to their environment? Some possible answers may include: stabilizing soil, adding oxygen/removing carbon dioxide from the air and providing food and shelter for animals.

Branching Out

Science: Make new plants from old. Teach student about asexual propagation techniques using succulent plants. Check out [Grow Succulent Plants from Leaves](#) for more information <link to your new garden activity>.

Science: In addition to being adapted to store water, many succulents also have features, such as spines or thorns, hairs, to help protect them from hungry and thirsty animals. Some plants even contain poisonous compounds. Find some examples of succulent plants with strong defense systems to share with your class.

Art: Learn about Kokedama. Kokedama is a Japanese technique of growing plants on a moss-covered ball. Succulents are a common choice of plant materials for this type of art. Check out the [How to Make a Kokedama](#) from the Missouri Botanical Garden or [DIY Kokedama](#) from the Brooklyn Botanic Garden for more details.

Link to Standards:

4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.



A saguaro cactus towers over neighboring plants.

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