**Common Adaptations of Succulents**

- **Protective Epidermal Barriers**
  - Thick, waxy surface cuticle to limit evaporation
  - Thorns/spines to protect and shade thick stems
  - Toxic compounds to deter predators
  - Silver foliage/fuzzy leaves to reflect sunlight and heat

- **Increased Water Storage System**
  - Broad, fleshy leaves
  - Extensive shallow root system to absorb limited rain
  - Reduced or modified leaves, such as spines
  - Ribbed stem to allow for expansion
  - Thick taproots or caudex (swollen stem or above-ground roots)

- **Modified Photosynthesis Pathway**
  - Nocturnal respiration (Crassulacean Acid Metabolism)
  - Photosynthetic stems
  - Reduced stomata (epidermal pores)

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**Convergent Evolution in Succulent Plants**

What makes a plant succulent? This loose botanical term describes the phenomenon of xerophyte plants that have adapted to their dry environment by developing thickened structures that can store water.

Most horticulturists use the term "succulents" when referring to plants with exceptional water-retaining properties. Succulents can be further broken down into groupings based on how the plant stores this water. Leaf succulents, such as *Aloe vera* or *Echeveria setosa* (called the Mexican woolly rose) store water within plump, broad leaves. Stem succulents, such as *Euphorbia trigona* (also known as the cathedral cactus, though it does not belong to the Cactaceae family and therefore is not a true cactus) or the hedge cactus *Cereus hildmannianus*, are distinctive in their columnar shape and modified leaves, called spines. Caudiciform succulents like *Dioscorea elephantipes*, called elephant’s foot or turtle back plant, possess a caudex, or swollen base that serves as a site of water storage.

Succulent plants are the result of independently evolved plant families that have adapted to arid conditions around the globe via convergent evolution. Convergent evolution occurs when organisms from different evolutionary lineages evolve similar adaptations under comparable environmental conditions. Succulent plants adapted to survive extreme arid conditions, particularly prolonged periods of drought and intense sunlight, by stockpiling rainwater within enlarged water vacuoles inside their cells. These specialized cells within their leaves, stems, or roots collect and hold water, releasing it into the plant when needed.
The Succulent House

In 1901, the structure of what is now known as the Succulent House was rebuilt on the site of the Botanic Garden’s original two-room greenhouse structure. In 2001 the space was renovated to include a rocky center bed filled with large and unique specimens.

Today, the Succulent House functions as a distinct section of the Lyman Conservancy, highlighting a diverse arrangement of succulent plants from across the world.

Commonly referred to as the “Cactus Room”, the Succulent House is home to a variety of succulent plant lineages including and outside of the *Cactaceae* (Cactus) family. Although many of the specimens in this room are not true cacti, all are referred to as succulents. These unique plants represent different genetically distinct families found in many of the world’s harshest ecosystems, yet have similar forms due to convergent evolution. The Succulent House is a truly unique space that continues to represent these diverse and resilient plants.

Hardy Xerophyte Garden

On the south side of the Lyman Conservatory, between the palm house and the pond, is a unique garden of cold-hardy cacti able to brave the harsh New England winters and survive in the frost and snow. Just a quick walk from the indoor Succulent House, the Hardy Xeriscape Garden is home to unique species of *xerophytes*, or plants that have adapted to an arid habitats of the Western Hemisphere.

The garden bed was prepared in 2006 by the first group of Smith Botanic Garden summer interns with guidance from Jeff Rankin, the Gardener and Assistant Curator tasked with managing the Systematics Garden outside of the Lyman Conservancy. A deep layer of gravel was used to line the bed and provide the proper drainage key to winter survival. The Hardy Xerophyte Garden was completed in 2007 when the garden was filled with species native to the Americas.

Designed to complement the indoor cacti collection, this outdoor garden shows plants with structures typical to desert conditions that have adapted to live outdoors year round in Massachusetts with low maintenance and watering requirements.

The Hardy Xerophyte Garden is located just outside of the Lyman Conservatory near the Palm House Entrance.