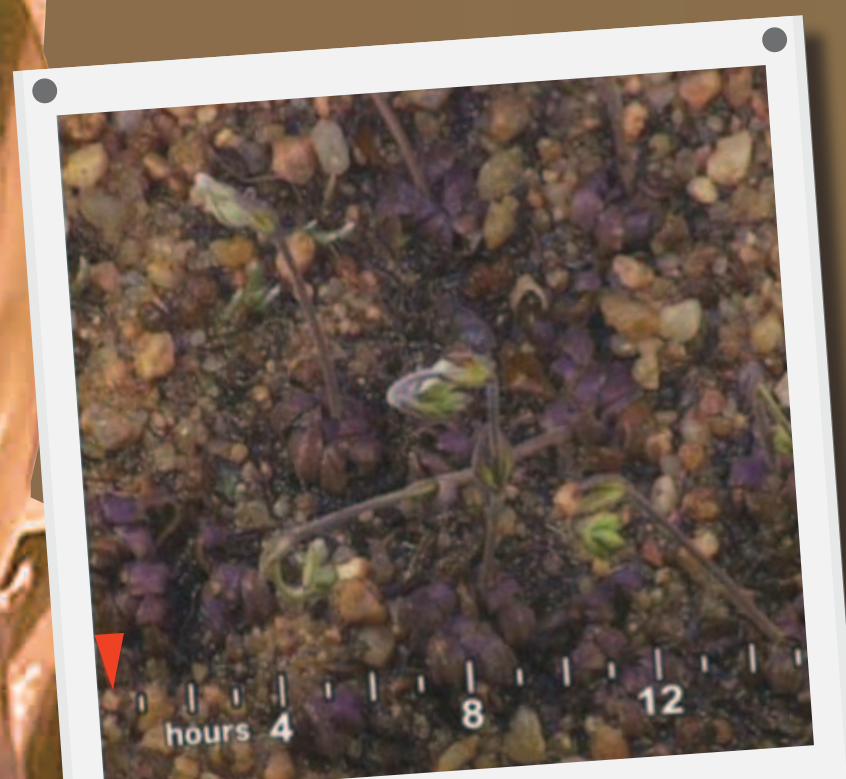




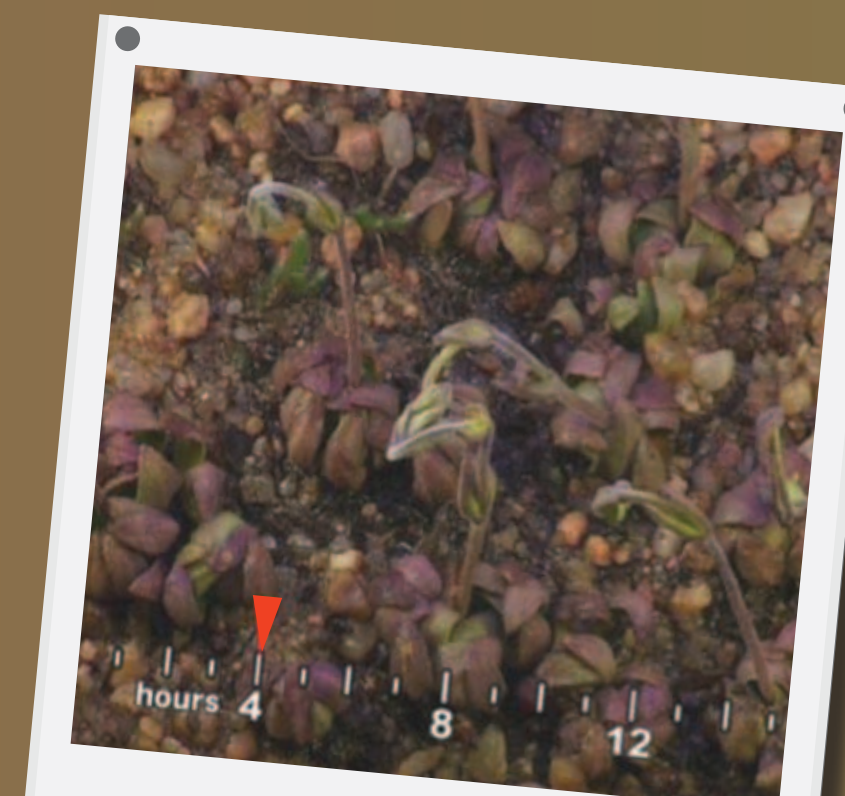
DROUGHT TOLERANT CROPS

Like most plants, agricultural crops are selected to resist losing water during a drought so they can survive and produce seeds which people and animals can then use or eat. However, when the drought goes on for too long, the resistance mechanisms fail and the crops die.

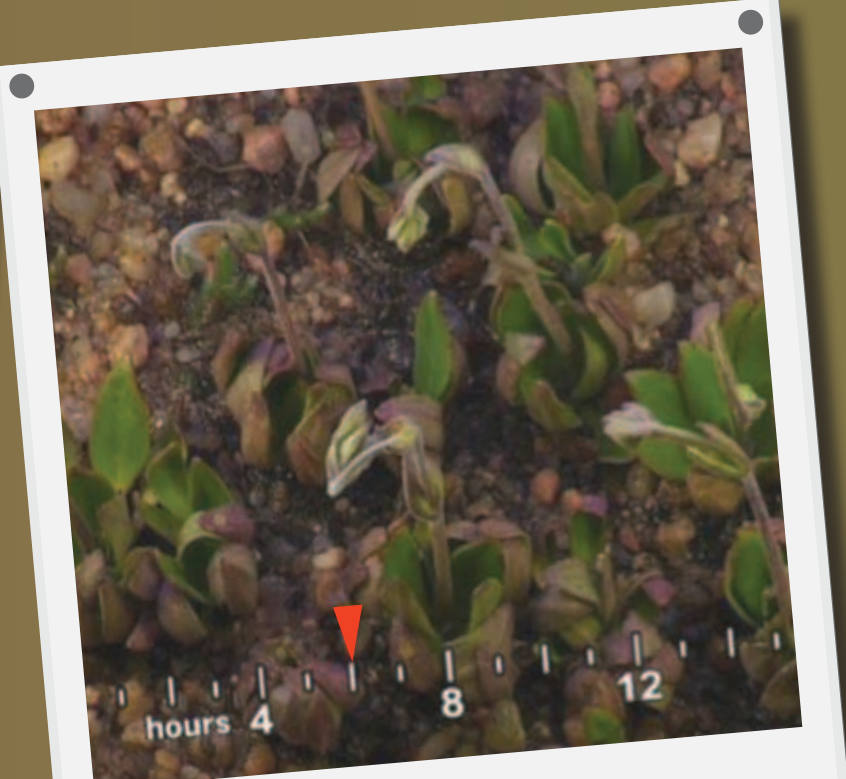
A group of plants called **resurrection plants** can lose almost all of their water (up to 95%) and survive! Below are some resurrection plants (called *Craterostigma wilmsii*), rehydrating after being dried. These **resurrection plants** are being studied so we can understand how they protect themselves against the damage caused by extreme water loss.



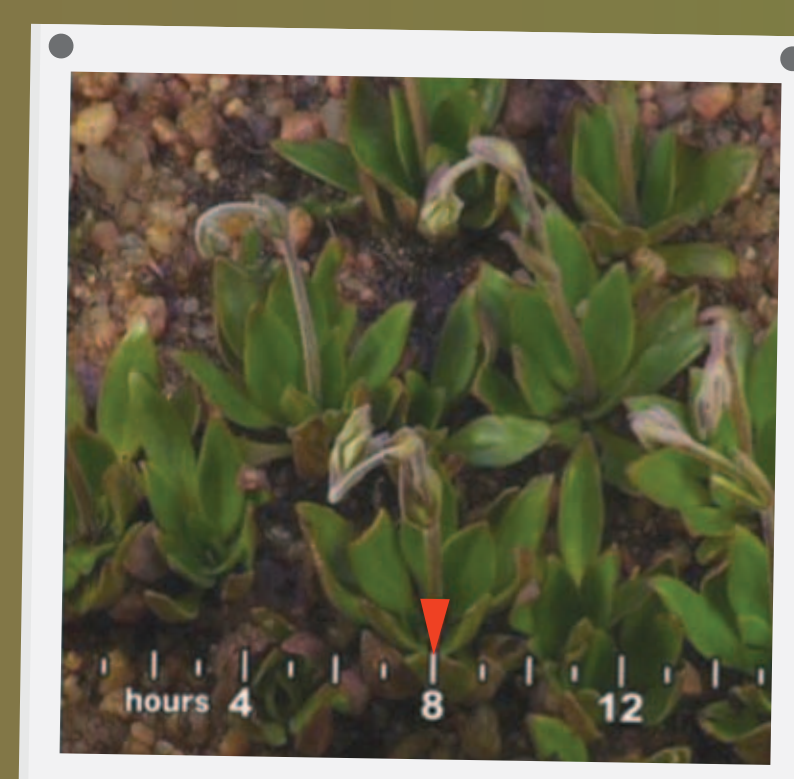
Craterostigma wilmsii, shortly after it has been watered.



4 Hours after the plant has been watered.



After only 6 hours, green leaves are clearly showing.



After 8 hours, nearly all its leaves are green.



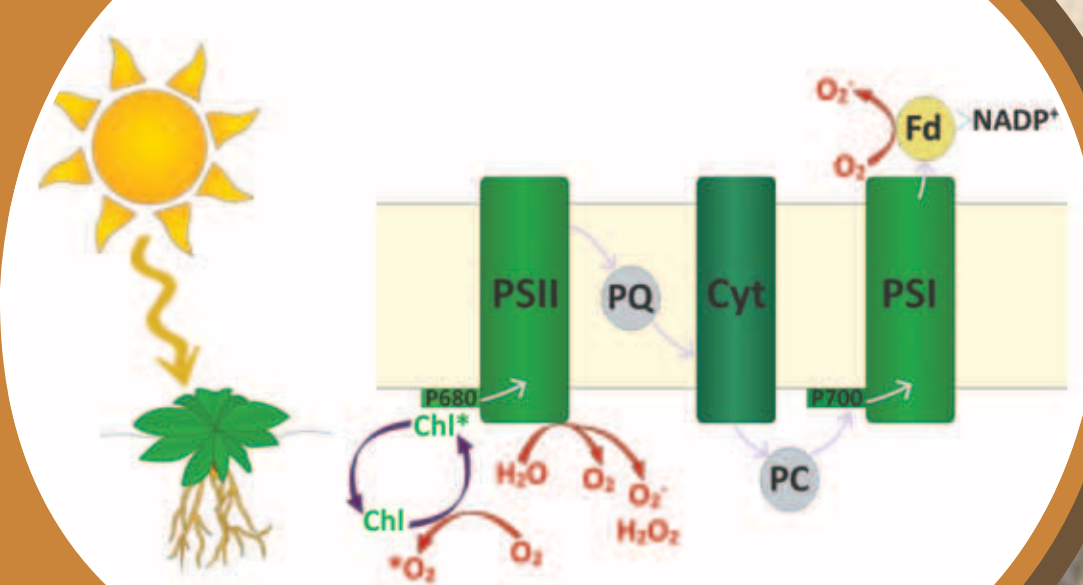
The plant has been fully restored 18 hours after it was watered.

PROBLEMS

LIGHT STRESS

No water + Photosynthesis = Free Radicals

Even when there is no water, **chlorophyll** still absorbs light & **photosynthesis** carries on. This leads to the formation of **free radicals** which cause a lot of damage in cells.



LOSS OF FIRMNESS

When cells lose water, the vacuole shrinks.

Without the pressure exerted by a firm vacuole, the cell contents can "collapse" and the cell membrane can tear. This damage is likely to lead to **cell death**.



DNA / ENZYME DAMAGE

With **water loss**, the normal solutes of the cell become concentrated.

This, combined with the free radicals formed because of light stress, leads to the **destruction of DNA and enzymes** that are vital to the cell.



SOLUTIONS

ANTIOXIDANTS & SUNBLOCK

Resurrection plants manufacture **antioxidants** to fight the free radicals.

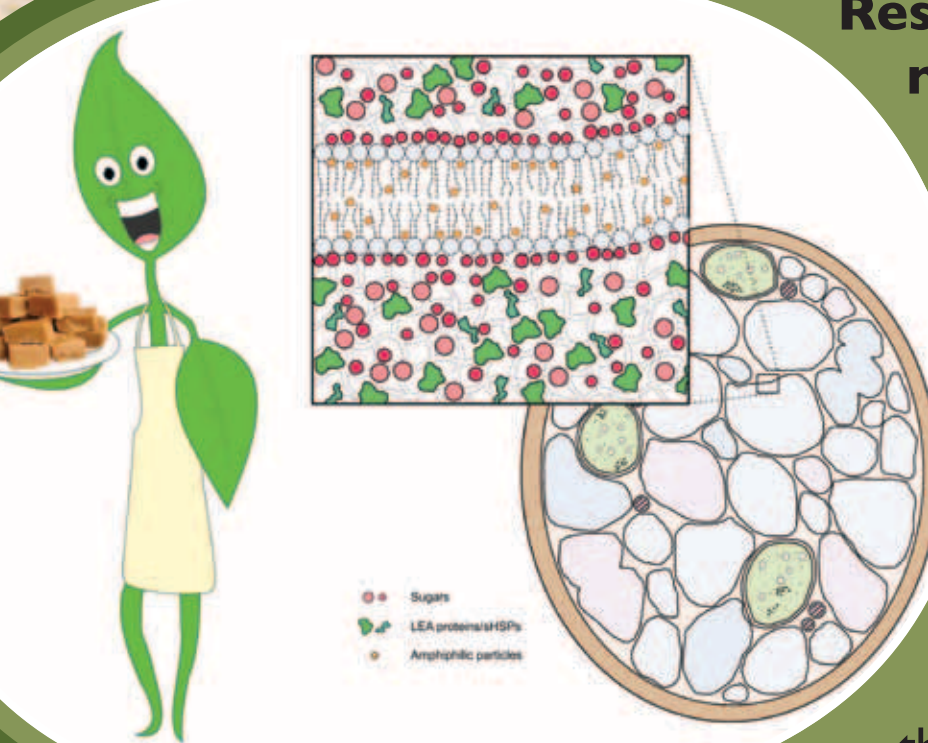
They also produce "**sunblock**" – pigments that hide the chlorophyll to stop it absorbing light.



WATER REPLACEMENT

Resurrection plants make "fudge"!

They accumulate sugar, proteins, amino acids, organic acids & deep eutectic solvents (which keep solutions liquid at low temps) which replace the water that has been lost from the cell. This "fudge" stops membranes from breaking and "freezes" the cell so there is less damage.



PROTECTANTS

Resurrection plants also manufacture other substances like specialized proteins that help other proteins, enzymes and DNA to stay intact when water is lost.

The "fudge" of sugars also helps to **stop damage** and **protect the molecular structure** of the cell.



Ultimately, scientists aim to breed these solutions into crops to make them more drought tolerant. We can identify the genes responsible and use them to transform the crop plants. A more drought tolerant crop will help farmers produce food and seed.