

# Botanical Engineering

**Pre-visit**

As a follow up to your trip to Missouri Botanical Garden, each of your students is to receive a portion of duckweed in a small container. Using the hypothetical story on the next page, inform students that they are now engineers preparing for a long term exploratory spaceflight. Their challenge is to design a growing setup for duckweed to supplement the rations and atmospheric recycling on this space flight . Prior to the challenge as a pre-visit lesson, provide students with time to research the specific needs of duckweed. If time is limited, feel free to provide students with the key points below.

**KEY POINT:** DUCKWEED needs the following to grow:

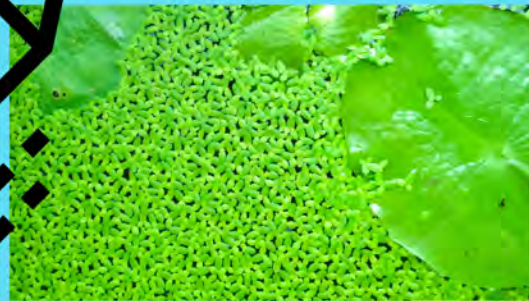
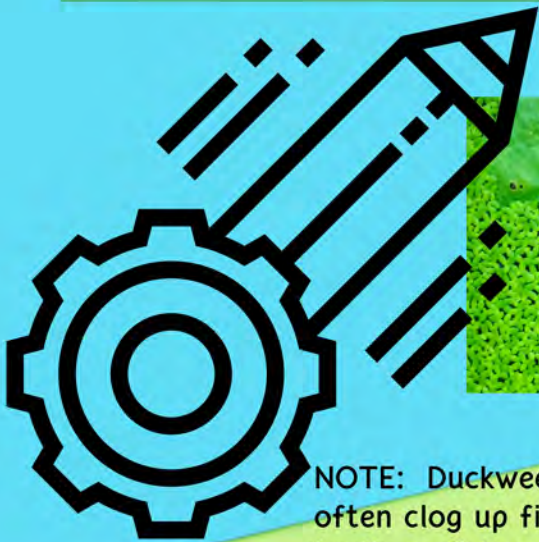
- adequate space
- high light nutrients
- CO<sub>2</sub> (from air)
- distilled water

**KEY POINT:** DUCKWEED does not like the chemicals in tap water.

Rainwater, pond water, distilled, or even just water that has “rested” overnight is better.

Chlorine and fluoride from the tap will off gas over time, but should not be fed directly to these plants. Duckweed is often found partnered with a cyanobacteria algae that grows on its roots and assists in absorbing nutrients. Perfectly clear water may be more stressful for both than water which is a bit murky. Small pond organisms like snails, amphipods, insect larvae, may appear in starter samples or be added later as part of the mini ecosystem. Duckweed cleans water itself, it doesn't need a sterile setup and acquires nutrients better with the right kind of “biotic soup”.

**NOTE:** Duckweed is often considered to be a nuisance in aquariums and ponds because the tiny plants often clog up filters and fountains, Underwater plants are shaded out by a water surface totally covered by it, or fish may aggressively consume it down to nothing. Students should be advised not to add their duckweed sample to class or home aquariums without permission from supervising adults first.



# STORY:

## Post-visit

Students are now engineers on earth providing logistics support for an interplanetary mission to Mars. During the return flight, an eight month journey, an object is detected from earth that appears to be exhibiting a strange, perhaps artificial trajectory. The Mars mission is in the best position to intercept and investigate, but the lengthened trip will tax the crew's reserves of food and the capacity of the ship's air scrubbers. In order to provide extra rations and breathable air, a fast growing, nutritious plant will need to be grown reliably in a small setup. The best plant, currently on board as part of an experiment on cosmic radiation exposure, is **DUCKWEED**.



Students can brainstorm and sketch potential design solutions or variations to keep the duckweed alive. They can select a design to implement as "proof of concept" to see if they are able to keep the duckweed alive.

Students should experiment with sun exposure, temperature, and how often water is refreshed. Bleached leaves are a sign of stress, but it will be up to the students to determine what needs to be fixed. Under ideal conditions, duckweed can double in volume every ten days so we recommend a scaled up enclosure both to provide room and make slight fluctuations in conditions a smaller proportion of the whole setup. (A simple fishbowl is a good place to start.)

During the process, if students duckweed does not survive their design, they may borrow starters from those who have more success further down the line in order to try again. Students should be encouraged to repeat the design and implementation process to fix any issues that may have been observed as to why the duckweed did not survive. It may even be advisable to have one or more classroom setups for this purpose.

Encourage students to learn from their mistakes and share successes like a real scientific community!

# CHALLENGE:



Students are tasked with engineering an indoor environment setup for supporting and propagating their duckweed.

**Key Point:** *A duckweed colony can survive for a long time if all needs are met.*

 **MISSOURI BOTANICAL GARDEN**

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