www.scienceinschool.org

Martian habitats in the classroom: testing *Artemia*

Activity 2 answer sheet

Why is the bottle washed before the experiment, and why is detergent avoided during cleaning?

Washing the bottle removes dust, dirt, potential contaminants, as well as any remaining traces of the soft drink. Detergent is avoided because even small residues can harm microorganisms (algae and decomposers) and brine shrimp.

What is the purpose of adding sand and crushed shells?

The sand and crushed shells simulate the sediment layer of a shallow aquatic habitat, providing a microhabitat for decomposer microorganisms, which are responsible for breaking down waste and recycling nutrients in the ecosystem.

Why do we use sea salt?

Artemia are marine organisms, so adding sea salt creates the proper salinity for their survival. Correct salinity is also essential for algae growth and maintaining a balanced micro-ecosystem. If the salinity is too low or too high, the *Artemia* may become stressed or die, and algae may fail to grow, disrupting the food supply and nutrient cycling within the bottle ecosystem.

Why are algae essential in both the bottle ecosystem and a future Martian habitat?

Algae act as primary producers, using sunlight and carbon dioxide to produce organic matter through photosynthesis. In both the bottle ecosystem and a future Martian habitat, they could provide oxygen, form the base of the food web and help recycle carbon dioxide produced by animals.

Why must water levels and environmental conditions be carefully monitored in this model ecosystem, and how does this relate to future habitats on Mars?

Water volume, salinity, temperature and light must be monitored because changes in them can affect algal growth and the survival, behaviour and distribution of *Artemia*. Keeping these conditions stable makes observations more reliable and reflects the need to carefully manage environmental conditions in future Martian habitats to sustain stable biological systems.

Why do we add liquid fertiliser at the beginning of the experiment, and why can the dose be reduced later?

Liquid fertiliser is added mainly during the first two weeks to provide mineral salts that support early algal growth. Once a photosynthetic community is established, the dose can be reduced to encourage the system's progressive self-sustainability and to investigate whether nutrient recycling can help maintain life in the bottle ecosystem over time.

Why is the cap left loose or off?

Leaving the cap loose allows gas exchange, enabling oxygen to enter and carbon dioxide to escape. This helps maintain suitable conditions inside the bottle, preventing oxygen depletion and other imbalances that would negatively affect *Artemia* survival.

Why do we roll the bottle once a week?

Gently rolling the bottle each week helps circulate nutrients, prevents the sediment from compacting, stops algae from accumulating on the walls so light can reach the water, and improves the distribution of oxygen and carbon dioxide.

Why are different sizes of brine shrimp added?

Brine shrimp of different sizes and ages are added to represent natural population diversity and allow students to observe differences in growth, movement, feeding behaviour and use of space within the bottle ecosystem.

How do the geosphere, atmosphere, biosphere and hydrosphere interact in the bottle ecosystem?

In the bottle ecosystem, the geosphere is represented by the sand, crushed shells, and dissolved mineral salts, providing habitat and essential nutrients. The atmosphere is the air above the water, allowing gas exchange for oxygen and carbon dioxide. The hydrosphere is the water itself, where the brine shrimp swim and algae grow. The biosphere includes all living organisms: algae, brine shrimp, and decomposers. These spheres interact continuously: nutrients from the geosphere dissolve in the water (hydrosphere), algae (biosphere) perform photosynthesis using carbon dioxide from the air (atmosphere) and mineral salts (geosphere) dissolved in water, and decomposers break down organic matter from waste and dead organisms into inorganic minerals, which are then reused by the algae, keeping the ecosystem balanced.

Can a bottle ecosystem be considered a model of a Martian life-support system? Why or why not?

The bottle ecosystem is a simplified model that demonstrates key processes found in life-support systems, such as energy flow, nutrient recycling and interactions between producers and consumers. However, real Martian habitats would be far more complex, requiring additional technologies to regulate temperature, atmospheric composition, water purification and food production. Nevertheless, the bottle ecosystem provides a useful way to explore the biological principles that support sustainable life-support systems.