UBC Geering Up
Engineering Outreach

Closed Terrarium: Sustainability in a Bottle

Subject: Science	**Grade:** 4-8	**Duration:** 1–2 hours to build, plus ongoing observations over several weeks
Lesson Overview	In this lesson, students will build a closed terrarium and use it as a model to explore ecosystems, plant needs, decomposition, water cycling, and sustainability. A terrarium is a self-contained ecosystem that can survive for long periods when built and maintained properly, making it a strong example of sustainability in a small, observable system. Terrariums can also be used for scientific observation and plant propagation, while helping students think about the relationships between living and non-living components in an ecosystem.	

Curriculum Ties (in addition to satisfying multiple core competencies):

Science

- Grade 3: Biodiversity in the local environment
- Grade 4: All living things sense and respond to their environment
- Grade 5: First Peoples concepts of interconnectedness in the environment
- Grade 6: Multicellular organisms rely on internal systems to survive, reproduce, and interact with their environment
- Grade 7: Earth and its climate have changed over geological time

Curricular Competencies

- Questioning and predicting
- Planning and conducting
- Processing and analyzing data and information
- Evaluating
- Communicating

Content Objectives

By the end of this lesson, students will be able to:

- Describe a closed terrarium as a mini-ecosystem with interacting living and non-living components.
- Identify the purpose of key terrarium layers and materials, such as drainage medium, moss, charcoal, soil, and plants.
- Explain how a terrarium models scientific concepts such as the water cycle, decomposition, plant growth, and ecosystem balance.
- Observe and document changes in the terrarium over time using notes, drawings, or data tables.
- Recognize how terrariums connect to sustainability, because they reuse materials, require limited resources, and demonstrate long-term care of living systems.

Materials & Equipment Needed

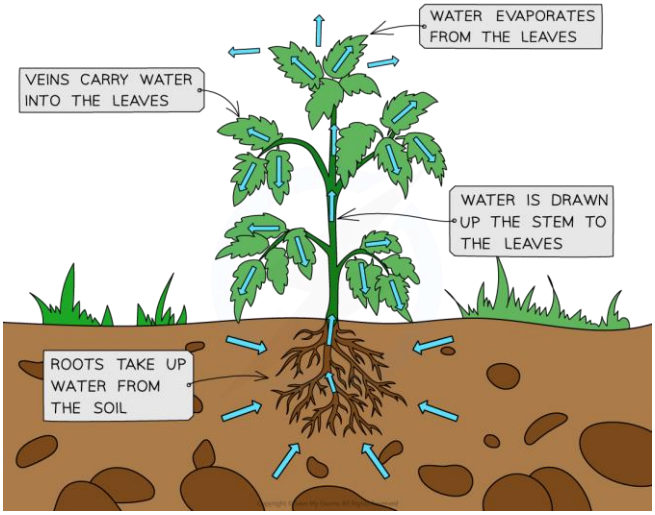
Consumables:	Non-Consumables:
• Small plants suitable for closed terrariums (e.g., ferns, moss, other moisture-loving plants) • Terrarium soil or substrate	• Clear glass jar or container with a lid • Drainage medium such as LECA, gravel, or small pebbles • Spoons or scoops

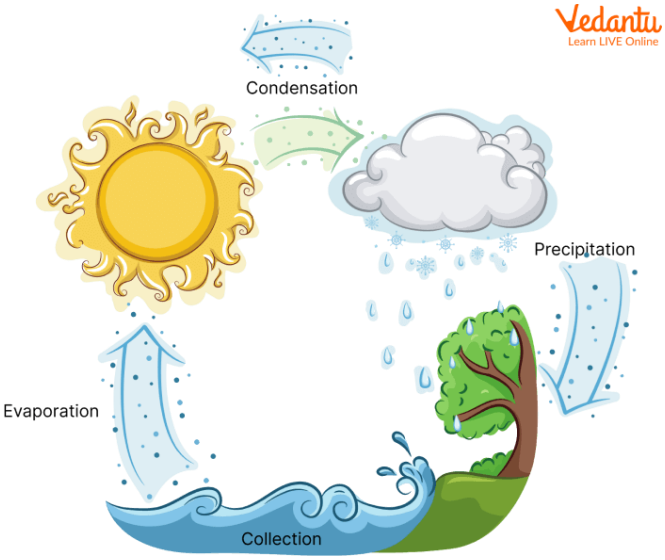
• Dead sphagnum moss • Activated charcoal • Springtails, if available • Small stones, twigs, or other natural hardscape materials • Optional decorative elements	• Spray bottle with water • Observation sheet or science notebook • Optional: magnifying glasses

Important note about moss and natural materials:
If using moss or other natural materials, avoid removing them from parks, forests, trees, lawns, or other living spaces where they play an important ecological role. Moss helps retain moisture, protects soil, and supports small organisms. In some places, collecting moss may also be restricted. Whenever possible, use store-bought moss or reclaimed materials. If students do collect small amounts, they should only take very little from places where removal will not cause damage, such as loose moss from a sidewalk edge, wall, or other non-sensitive surface.

Lesson & Activity

Lesson Stages	**Learning Activities**
Introduction	Begin by asking students: • What does a plant need to survive?





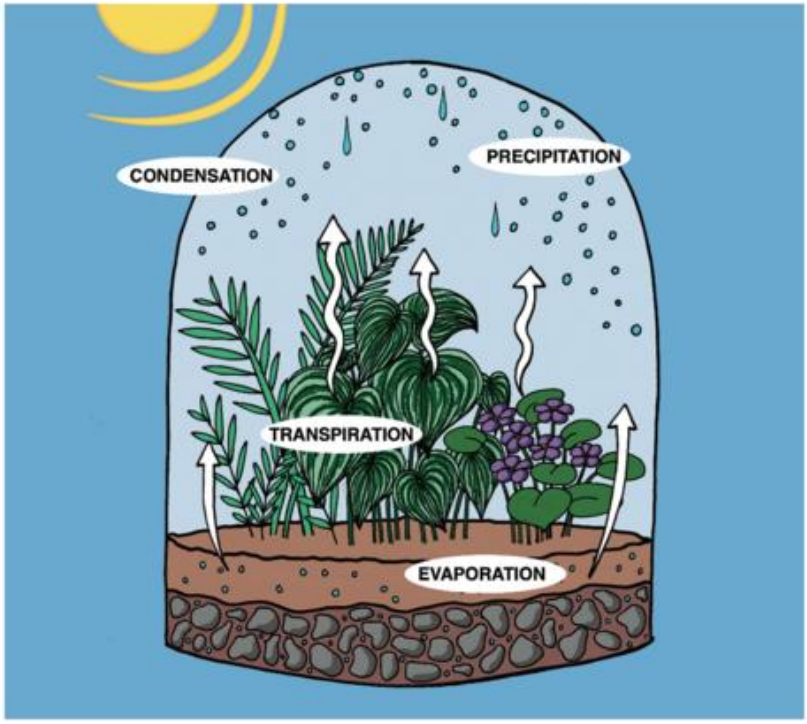
- What happens in an ecosystem when living and non-living things depend on one another?
- Can a garden exist inside a jar?

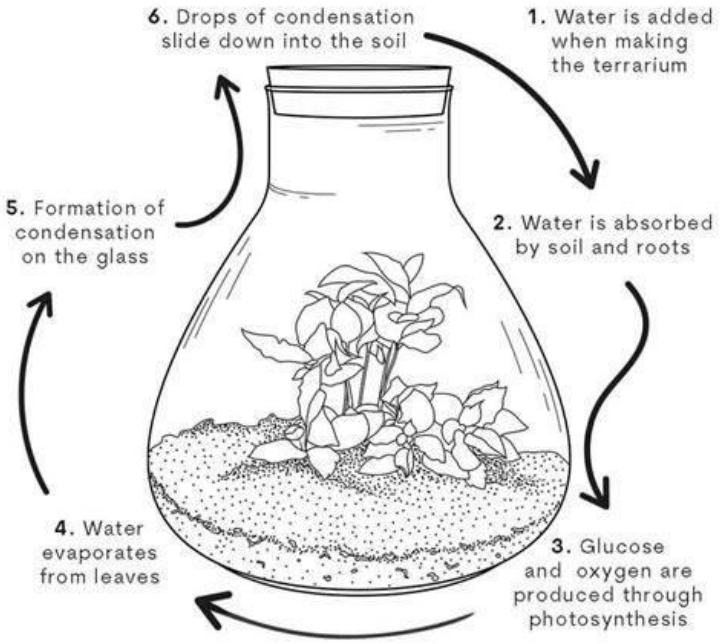
Introduce the idea of a terrarium as a closed tropical ecosystem growing inside a container, almost like a miniature rainforest biome. Explain that, when well maintained, terrariums can survive for years, and some have lasted for decades. They are also useful for scientific observation and plant propagation.

	Resources: • https://www.youtube.com/watch?v=RbbLm5IGIHE • https://www.youtube.com/watch?v=C47NVz8kJDs • https://www.youtube.com/watch?v=GIWy75QPxkI Connect this to sustainability: a terrarium is a system that uses a small amount of material and water, and if built carefully, needs very little maintenance. The source explains that a well-contained terrarium mainly needs enough moisture and indirect sunlight to survive.
Activity	**Part 1: Explore the System** Before building the terrarium, show students all of the materials and invite them to predict what role each one might play in the system. This is a good opportunity to introduce the idea that a terrarium is not just a container with plants, but a mini-ecosystem where each layer has a purpose: Guide students with questions such as: • Why do we need a layer at the bottom for drainage? • What might happen if water stayed around the roots all the time? • Why would charcoal be added to a plant system? • Why is moss useful in a closed terrarium? • Why does a closed terrarium need a lid? • How might tiny organisms, like springtails, help keep the system balanced? Then discuss the function of each material: • Drainage layer (LECA, gravel, or pebbles): This bottom layer collects excess water so the roots do not stay constantly wet. It helps reduce the risk of root rot and keeps the substrate from becoming waterlogged.

	• Sphagnum moss layer: This acts as a barrier between the drainage layer and the soil, helping prevent the soil from falling down into the drainage area while still allowing moisture to move through the system. • Charcoal: A thin layer of charcoal can help reduce odours and limit the growth of mould or bacteria, supporting a healthier closed environment. • Soil or substrate: This provides nutrients, physical support, and space for roots to grow. It is the main growing medium for the plants. • Moss: Moss helps retain moisture, covers exposed soil, and contributes to the humid conditions that many terrarium plants need. It also helps create a more stable and visually cohesive environment. • Plants: The plants are the primary living producers in the terrarium. They use light, water, and carbon dioxide to grow, and they help drive the internal water cycle through transpiration. • Springtails (if used): These tiny organisms act as decomposers. They feed on mould and decaying organic matter, helping keep the ecosystem cleaner and more balanced. • Lid: The lid is what makes the terrarium a mostly closed system. It helps trap moisture inside, allowing water to evaporate, condense on the glass, and return to the soil—creating a small-scale water cycle. You can end this section by asking students: What do you think would happen if we removed one of these layers or elements? That helps reinforce that ecosystems depend on the interaction of many parts, not just one.

Water cycle inside a terrarium:





	Part 2: Explore the System Students will now build their closed terrarium as a layered system. Explain that each layer has a specific role in supporting plant health, moisture balance, and long-term stability. • Choose the container Begin with a clear glass container with a lid. It does not need to be perfectly airtight, but it should hold humidity reliably. Explain that the lid is what allows the terrarium to function as a mostly closed system by trapping moisture and creating a stable microclimate. • Add the drainage layer Add about 1 inch (2 cm) of drainage material, such as LECA or another porous medium, to the bottom of the container. This layer acts as a moisture buffer, giving excess water a place to collect instead of saturating the roots. • Add the barrier layer Place a thin layer of long-fibre sphagnum moss (or mesh, if available) on top of the drainage medium. Its purpose is to keep the drainage layer and substrate separate over time, preventing soil particles from slipping down and reducing the effectiveness of the drainage area. • Add a thin layer of activated charcoal Add a light, even layer of charcoal. Explain that in a closed environment, charcoal helps reduce stagnation, odours, and impurities as water moves through the system. It is not the main structural layer, but it helps support long-term balance. • Add the substrate layer Add enough substrate to support the roots of the plants, usually around 3–4 inches (7–10 cm) depending on the size of the container and plants. Explain that the substrate should hold moisture while still staying loose

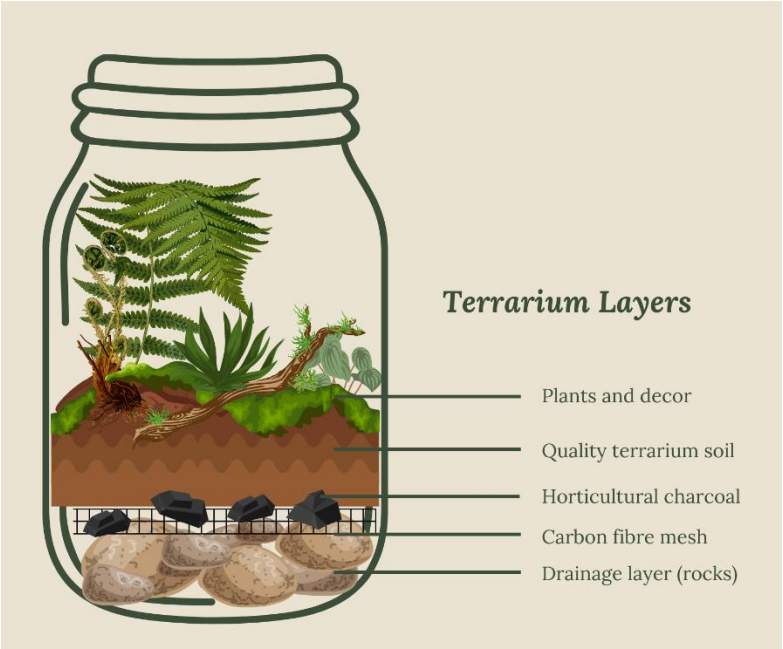
	and airy. You can also slope the substrate slightly from back to front to improve visibility and create a more natural-looking landscape. • Place hardscape elements Add rocks, wood, or other hardscape materials before planting. Explain that these pieces are not only decorative—they help create structure, shape the layout, and can even provide support for roots. Encourage students to place these elements carefully, since moving them later may disturb the plants. • Add the plants Plant compact, humidity-loving species into the substrate. Remind students that closed terrariums work best with plants that enjoy high humidity and indirect light, such as small ferns, tropical mosses, and compact foliage plants. Explain that succulents and cacti are not a good choice because they are adapted to dry conditions and usually rot in sealed systems. • Add moss and surface details Add moss to help cover exposed soil, retain moisture, and create a finished, forest-floor appearance. Students can also add small decorative natural elements if desired. • Lightly moisten the terrarium Add only a small amount of water. The goal is for the substrate to be damp, not saturated. Explain that one of the most common terrarium mistakes is starting with too much water. In a closed system, extra water has nowhere to drain, so it can take a long time to rebalance. • Add springtails, if available If using springtails, add them at this stage. Explain that they act as a cleanup crew, helping break down decaying matter and manage mould as the terrarium matures.

- Seal the container

Place the lid on the terrarium and let the system settle. Explain that once sealed, the terrarium begins recycling its own moisture: water evaporates, condenses on the glass, and returns to the substrate, creating a small internal water cycle.

As students build, pause often to connect each step back to the science. Encourage them to sketch the terrarium layers in their science notebook and label the function of each one. You might also ask:

- Why is drainage important in a sealed system?
- Why do certain plant types work better than others in a closed terrarium?



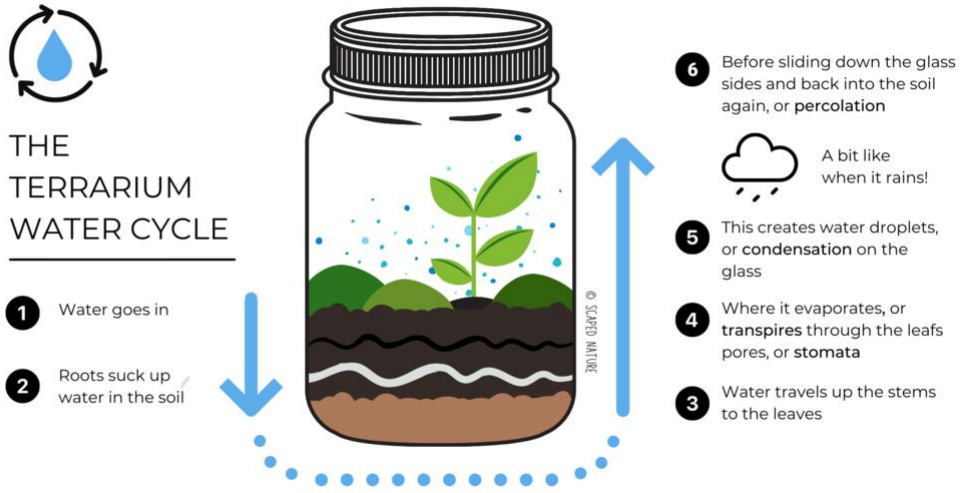
Note: There are many ways to build a closed terrarium, so teachers and students may also want to explore other videos or reference guides before building. Different sources may suggest slightly different layers, plant choices, or care routines. It is a good idea to look at a few

	examples and basic care tips to better understand how to maintain the terrarium over time. **Part 3: Observation and Scientific Follow-Up** Once the terrariums are built and sealed, students begin a terrarium observation log. Explain that they are no longer just "taking care of a plant," but observing how a small, mostly closed ecosystem behaves over time. In a healthy closed terrarium, moisture rises and falls, plants grow gradually, and the system begins to regulate itself through the interactions between plants, substrate, water, microorganisms, and decomposers. Over the next several days or weeks, students can record observations such as: • Condensation patterns on the glass at different times of day • Plant growth (new leaves, root development, changes in size) • Leaf colour and plant health • Moisture levels and whether the substrate appears too wet or too dry • Signs of mould, yellowing, or decay • Changes in moss or hardscape appearance • Activity of springtails, if included Students can collect this information through drawings, labelled diagrams, written notes, simple measurements, or photo comparisons over time. This follow-up can be used to explore several science concepts: • Water cycle: In a closed terrarium, water evaporates from the soil and plant surfaces, condenses on the glass, and returns to the substrate. This makes the terrarium a visible model of evaporation, condensation, and precipitation in a small system.

	• Plant needs: Students can observe how light, moisture, and plant selection affect the success of the system. The source notes that closed terrariums do best in constant indirect sunlight, and that using plants with similar care needs is important for long-term balance. • Ecosystem balance: Students can see how one change, such as too much water or the wrong plant type, can affect the whole system. Overwatering is described in different sources as one of the most common causes of mould and rot, while plant choice strongly affects long-term success. • Decomposition and nutrient cycling: If springtails are present, students can learn how decomposers help break down decaying matter, suppress mould, and return nutrients to the substrate, supporting plant growth over time.
Closure	Bring students together for a final reflection on their terrariums as living systems. Guide the discussion with questions such as: • What makes a terrarium a sustainable system? • Which parts of the terrarium are living, and which are non-living? • Why is each layer important to the overall health of the ecosystem? • What do you predict will happen in your terrarium over the next week? Use this moment to reinforce the idea that small design decisions matter in science. For example, two common terrarium mistakes are overwatering and choosing plants with different care needs, both of which can disrupt the balance of the system. This helps students see that sustainability depends on understanding relationships within an ecosystem and making thoughtful choices from the beginning.

Step Ups & Step Downs	**Step Downs** • Build one terrarium together as a whole-class demonstration instead of having each student or group make their own. • Use a simplified set of materials, and skip optional elements such as springtails if they are not available. • Focus only on identifying the main parts of the terrarium and the basic needs of plants. **Step Ups** • Have students measure and graph plant growth, moisture levels, or condensation patterns over time. • Compare two terrariums under different conditions, such as light level, plant choice, or amount of water. • Ask students to write a short scientific explanation of how the terrarium models the water cycle, ecosystem interactions, and decomposition.

Background Knowledge



A closed terrarium is a sealed glass container designed to grow moisture-loving plants in a stable, humid environment. Once planted and closed, it begins to create its own water cycle: moisture evaporates from the soil and leaves, condenses on the glass, and then returns to the substrate. Because the same water is recycled within the system, a well-built closed terrarium can often go a long time with little or no additional watering.

A successful terrarium depends on a carefully layered structure. A typical build includes a drainage layer (often LECA), a barrier layer such as sphagnum moss or mesh, an optional layer of activated charcoal, and a tropical substrate mix that holds moisture while staying airy. Moss, hardscape, and humidity-loving plants complete the system, and springtails can be added as a small cleanup crew because they feed on mould and decaying matter.

Closed terrariums work best with compact tropical plants that tolerate high humidity, low airflow, and indirect light, such as ferns, vining plants, foliage plants, tropical mosses, and small epiphytes. Plants adapted to dry environments, such as succulents and cacti, are generally poor choices because they tend to rot in sealed systems.
Two of the most common terrarium problems are overwatering and using plants with mismatched care needs. In closed systems, excess water has nowhere to drain, so starting with a lightly moist substrate is usually better than making it too wet. Choosing plants that thrive under similar conditions also helps the terrarium remain stable over time.

Additional Resources

- https://aquifarm.com/closed-ecosystem-terrarium/
- https://iere.org/are-terrariums-self-sustaining/
- https://www.ethicalshift.com/sustainable-living/homemade-terrariums-create-sustainable-mini-indoor-gardens
- https://terrariumtribe.com/closed-terrarium/

- https://www.youtube.com/watch?v=C47NVz8kJDs
- https://www.youtube.com/watch?v=GIWy75QPxkI
- https://www.youtube.com/watch?v=91yxeMhnoxQ