

# LIFE IN A BOTTLE



GRADES 9-12

# LIFE IN A BOTTLE

## SNC - Plant Farley LESSON PLAN

**Lesson Title:** Life in a Bottle - A Micro-ecosystem Study

**Lesson Description:** Students will apply concepts related to ecology, environmental science, and biology by establishing and maintaining aquatic micro-ecosystems in gallon jars. The exercise is designed to reinforce previously studied concepts and skills such as microscopy, use of dichotomous keys, taxonomy, energy flow, etc. The exercise requires a field trip to establish the micro-ecosystems. The project is a long-term effort that will require weeks to months to complete. The teacher should modify the complexity of the project to suit the class needs and time availability.

**Grade Level:** 9-12 (modify as needed for each grade level)

**Subject Area(s):** Ecology, Environmental Science, Life Science, Biology

**Objectives:** Students will:

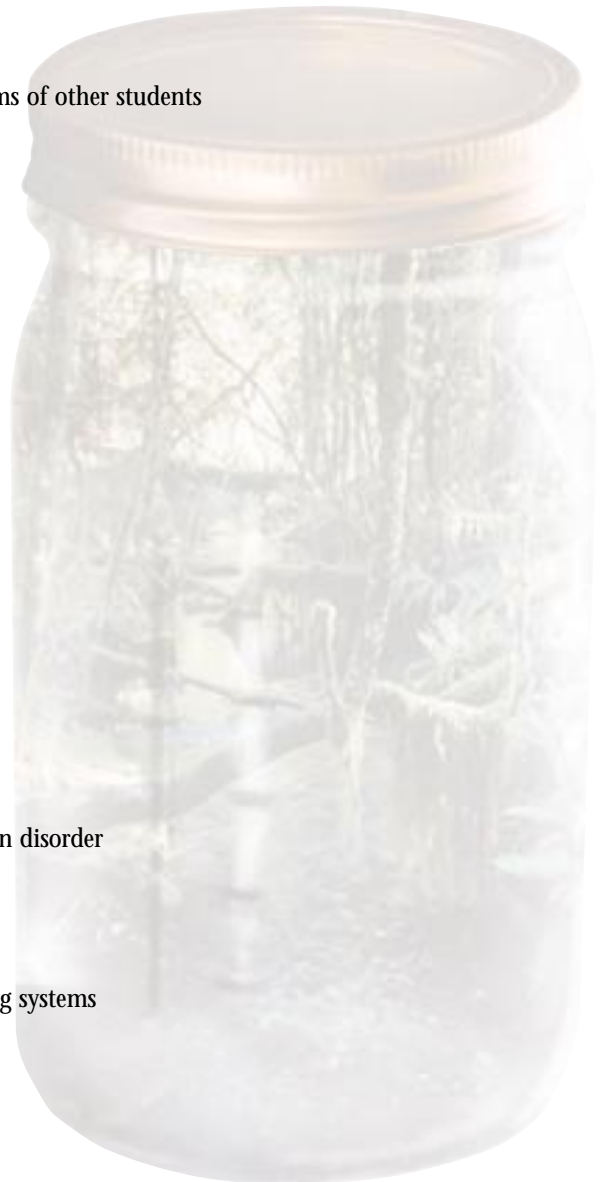
- construct an aquatic micro-ecosystem
- observe and monitor water conditions
- collect and classify life forms from the micro-ecosystems
- compare water conditions and life forms with those of the ecosystems of other students
- analyze and discuss observations and data with other students
- relate findings to principles of ecology, biology, and limnology

**Materials:**

- gallon jars with lids
- pond water sources
- duct tape (or Parafilm)
- water test kits (such as Lomotte)
- stereomicroscopes/compound microscopes
- microslides/coverslips
- Petri dishes
- pencils, colored pencils
- drawing paper (unruled)
- dichotomous keys (to ID protozoa, algae, etc.)/field guides
- thermometers (alcohol)
- activity sheets/journals

**Correlations (NSES):**

- Content Standard A - Science as Inquiry
  - develop abilities to do scientific inquiry
  - develop understandings about scientific inquiry
- Content Standard B - Physical Science
  - develop an understanding of conservation of energy and increase in disorder
  - develop an understanding of transfer of energy
- Content Standard C - Life Science
  - develop an understanding of the cell
  - develop understanding of interdependence of organisms
  - develop understanding of matter, energy, and organization in living systems
  - develop an understanding of the behavior of organisms



### Correlations (NSES) continued:

- Content Standard F - Science in Personal and Social Perspectives
  - develop an understanding of population growth
  - develop an understanding of natural resources
  - develop an understanding of environmental quality

### Curriculum Integration:

- Mathematics (measurements)
- Language Arts (written and oral communications)
- Other science disciplines

### Process Skills:

- Observation
- Comparison
- Collection of data
- Measurement
- Counting
- Research
- Inference
- Investigation/experimentation
- Interpretation/assessment of data
- Analysis of data
- Description of findings
- Communication of ideas
- Construction of model
- Group/cooperative learning
- Written/oral communication

### Background Information:

- Main ideas
  - Principles related to ecology such as:
    - principles of taxonomy
    - basic principles of ecology such as population/community characteristics/dynamics
    - biological diversity/species interaction
    - energy flow in an ecosystem
    - limnology
  - Principles related to biology such as:
    - cell structure
    - use of dichotomous keys
- Secondary ideas
  - Review of laboratory skills such as:
    - use of the stereomicroscope
    - pH scale
    - use of metric (SI) measurement
  - Measurement of temperature, various temperature scales

### Teacher Activities:

- Assemble/organize all materials needed for activity.
- Set up field trip to local ponds, creeks, drainage ditches, etc. to obtain water samples.
- Present background material to students.
- Depending on the size of the class, the teacher should divide the class into groups of 3-5 students. Each group will construct its own micro-ecosystem in a gallon jar. Each student in the group should have specific tasks in the exercise. For example, one student should be responsible for recording data, another measuring pH, another measuring temperature, etc.
- Issue instructions to students regarding experiment.
- Distribute Activity Sheets to students and give instructions on how to complete them.
- Show students a previously constructed aquatic micro-ecosystem.
- Stress lab safety. (broken glass hazard, etc.).
- Monitor/assist students as needed during exercises.
- Stress to students that this is a long-term project that will require periodic measurements and will be monitored for weeks or even months.
- Issue instructions regarding how students are to keep journals and when/what information must be entered.

### Student Activities:

- Listen to background information given by teacher.
- Obtain all materials needed to complete the exercise (refer to Activity Sheet).
- Record preliminary data on Activity Sheets.
- Construct micro-ecosystems as directed in Activity Sheets.
- Observe, record, and enter data in journals as directed by teacher.
- Interpret/analyze data and share it with other students.
- Participate in discussions regarding findings/predictions.

### Evaluation:

- Student journals
- Direct observation
- Oral reports from students

### Extension/Enrichment:

- Have students compare life forms in their micro-ecosystems to those of other classes/groups.
- Have students modify the environmental conditions of their micro-ecosystems via artificial manipulations (e.g., heat lamps, introduction of chemicals, introduction of new species, etc.).
- Do advanced species studies such as microbiological cultures/identification of bacteria within the micro-ecosystems.
- Have students swap micro-ecosystems and validate the findings of the other group.
- Combine two different micro-ecosystems and observe/study results.
- Take additional field trips to ponds, wetlands, etc.; show students examples of various aquatic ecosystems (e.g. a eutrophic system, an oligotrophic system, etc.).

### Safety Considerations:

- Use alcohol filled thermometers rather than mercury.
- Sample from healthy water sources (e.g. do not sample highly polluted sources or those known to have high coliform counts).
- Caution students to handle glass equipment with care to prevent breakage.
- Do not allow students with cuts or open wounds to obtain samples.
- Insist that students wash their hands with soap and hot water after working with their micro-ecosystems.
- Caution students against placing their hands in their mouth, nose or eyes while working with their ecosystems.
- Review use of water testing kits with students; caution them about possible dangers of working with reagents contained in the kits.

# LIFE IN A BOTTLE

## ACTIVITY SHEET ONE

(READ THIS ENTIRE SHEET BEFORE BEGINNING THE EXERCISE)

### Introduction

In this lab activity, you will use gallon jars to construct and maintain aquatic micro-ecosystems. The exercise is a long-term project and will last several weeks or even months. You will be required to make many observations and monitor your ecosystem very carefully. You will enter all your data in a journal as instructed by your teacher. You may be asked to submit written and oral reports regarding your findings/observations on a periodic basis. You will not be able to perform all the observations/tests required in a single lab session. Your teacher will guide you as to which tests to perform during each lab session.

The initial set-up of your aquatic ecosystem requires a field trip to local water sources such as a pond, lake, creek, or stream. There you will obtain water, pond bottom, and life forms from a single source for your group's ecosystem.

Hopefully, you will be able to see examples of ecological principles and concepts discussed prior to the laboratory exercise. Follow the directions on this Activity Sheet and record your data carefully and accurately.

### Procedure

Obtain the following materials as directed by your instructor:

- One gallon jar with lid (one per lab group)
- Duct tape
- Thermometer - BE CAREFUL!!!
- Water test kit (one per lab group)
- Stereomicroscopes/compound microscopes
- Microscope slides and coverslips
- Petri dishes
- Unruled paper for drawings
- Pencils/colored pencils for drawings
- Various field guides/dichotomous keys/texts
- Journals

- You may visit several different aquatic ecosystems (rivers, lakes, ponds, etc.) but you will sample only one. If you visit a single site, do not collect your sample from the same place in the site as other groups in your class. For instance, if one group collects from the north end of a pond, your group should collect from the south end.
- Prior to collecting a sample to establish your ecosystem, make the following measurements/observations and record the data in your journals: area of site where collection will be made (e.g., north side), approximate water depth at site of collection, water temperature at site, sunlight conditions at sample site (e.g. shade, partial shade, etc.), water movement at site (e.g., slow water flow, no movement, etc.), local vegetation near collection site (e.g., grasses, cattails, reeds, etc.). After making such observations, use your water test kits to test the water conditions at the collection site. Record the results of the various tests performed (e.g., pH, dissolved oxygen, nitrates, density, etc.).
- To obtain your sample, scoop mud, sand, rock and/or other materials from the bottom of the pond (or other ecosystem) and carefully place it in the bottom of your gallon jar. You should have three to five inches of this bottom material in your jar.
- From the same area from which you collected the bottom material, obtain enough water to fill the jar to about one inch from the top. Place the lid on the jar and seal it with the duct tape.
- Try to keep your new micro-ecosystem still and allow it settle down on the trip back to school.

### Procedure (continued)

- When you arrive back at school, your teacher will help you decide where to place your new aquatic micro-ecosystem. It should be a place that will receive a limited amount of sunlight and be at a temperature that is not too cold or too hot. Label your ecosystem with the names of students in your group and the date and place of collection.
- Make an entry into your journal about what life forms you expect to find in your new ecosystems and how your ecosystem may change over the next several weeks.
- Over the next several days, use the microscopes, field guides, and keys to study the life forms in your new micro-ecosystems and identify as many life forms as you can. Make drawings of each life form identified and place them in your journal.
- Use the test kits to monitor the water conditions/characteristics of your ecosystem on a periodic basis and record results in your journal.
- Study the water and soil of your ecosystem each week to determine how life forms are changing. Make new identifications and drawings as needed.
- Analyze your data and compare it with the findings of other groups.
- Answer the questions below and place these Activity Sheets in your journal.

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## ACTIVITY SHEET TWO

1. What life forms do you expect to find in your micro-ecosystem?
2. Identify the biotic (living) and abiotic (non-living) parts of your ecosystem. How do you think they are related?
3. Nothing but sunlight enters your ecosystem after you seal it with the duct tape. Describe how the projected path of energy flows through your ecosystem. Use diagrams as needed.
4. Predict what processes you expect to occur within your ecosystem.
5. Write a description of what changes you expect will occur within your ecosystem. Include a projected timeframe for such changes.
6. Discuss the Carbon Cycle and Nitrogen Cycle and how they relate to your particular micro-ecosystem. Include diagrams as needed.