The Nature of Science

What strategies are involved in solving a science problem?

Scientists try to understand the world around us by making careful observations. These observations often present problems. In order to solve these problems, scientists sometimes use a scientific method.

A scientific method is an orderly process that usually includes a series of steps similar to these:
1. Determine the problem. State what you want to find out.
2. Make a hypothesis. State the prediction that you want to test.
3. Test the hypothesis. State what steps you will take to design an experiment to test your hypothesis. Complete the experiment. Make observations. Record what happened during your experiment.
4. Analyze the results. Explain any patterns you see. Organize your observations and data into a usable form.
5. Draw conclusions. Describe what your observations and data indicate about your hypothesis. Decide whether or not your hypothesis is supported. If not, determine why your hypothesis is not supported and propose a new hypothesis.

In this Virtual Lab you will use a scientific method to determine how to create the most efficient compost pile.

Compost is decomposed matter that is used as fertilizer or as mulch (material put around plants to help them retain water). Compost is made by combining four basic ingredients: green materials, such as grass clippings, green leaves, and vegetable and fruit scraps; brown materials such as dried grass and leaves, twigs, straw, and sawdust; air; and water. In addition to being good for plants, compost is good for the environment because it makes use of materials that otherwise would go to waste.

Objectives:
- Apply a variety of strategies in order to solve a science problem.
- Identify factors that affect the efficiency of a compost pile.

Virtual Lab Procedures:
1. Examine the problem: Consider the four ingredients necessary to make compost - green material (nitrogen-rich materials like grass clippings, kitchen scraps), brown material (carbon-rich materials like dried leaves, straw, wood chips, etc...), water, and oxygen.
2. Make a hypothesis: Make a testable prediction about how the efficiency of a compost pile would be affected by varying the ratio of green to brown material, the amount of water added, and the number of times a compost pile is turned (to supply oxygen).
3. Test your hypothesis: Click and drag the Brown to Green Balance bar, the Water Concentration bar, and the Number of Turns bar to the position you want to test. Click the Calendar. Click the Table button and record the combinations you tested and the resulting Efficiency Meter reading.
4. Click the Reset button and test other combinations in the same way. Record your results in the Table.
5. Analyze your data: Use the Table to analyze your data about the efficiency of the compost pile.
Background Research:

**What is Composting and Compost?**

*Composting* is the controlled decomposition of organic materials by microorganisms.

*Compost* is partially decomposed organic matter.

*Humus* is completely decomposed organic matter.

*Mulch* is organic or inorganic materials spread in a layer on the soil surface.

**Benefits and Uses of Compost**

Compost offers many benefits to the landscape and garden. For example, compost:

- Improves soil tilth condition, and structure;
- Increases the soil's ability to hold water and nutrients;
- Supports living soil organisms;
- Helps dissolve mineral forms of nutrients;
- Buffers soil from chemical imbalances;
- May provide biological control of certain soil pests; and
- Helps return organic materials to the soil, and keeps them out of landfills and waterways.

Compost can be used as a mulch, a liquid "fertilizer", or incorporated into the soil or potting mixes.

**What Can Be Composted?**

The basic rule for backyard composting is that you can compost:

*Anything that was once a plant!*

**Greens and Browns**

Backyard Composting is primarily a biological process so you must feed your *microorganisms* to keep them happy. Microbes need both carbon (C) and nitrogen (N), food sources to function. All materials contain both C and N. The ratio of carbon to nitrogen within a material is called the carbon to nitrogen ratio (C:N).

Materials with favorable proportions of carbon and nitrogen (C:N) offer the decomposer microorganisms a "complete meal".

**"Greens" - Nitrogen Sources**

Materials that are a good source of nitrogen are called "Greens" and are characterized as having a low C:N ratio (C:N ratio less than 30:1) and are generally high in moisture and fast to decompose. Examples of "greens" include manure, inorganic fertilizer, vegetable kitchen scraps, green leaves, and grass clippings. Not all "greens" are green in color. For example, coffee grounds are a nitrogen source.

**"Browns" - Carbon Source**

Materials that are high in carbon relative to nitrogen are called "Browns", and are generally dry and slow to decompose. They are generally brownish or darker in color. Examples of "browns" include: straw, leaves, chipped branches and tree trimmings, paper, and sawdust. Browns decompose at low temperatures unless combined with a source of nitrogen.

**"Greens and Browns"**

<table>
<thead>
<tr>
<th>Green Materials</th>
<th>Brown Materials</th>
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<tbody>
<tr>
<td>Fast to decompose</td>
<td>Slow to decompose</td>
</tr>
<tr>
<td>Nitrogen provides the microbes with the raw element of proteins to build their bodies and reproduce.</td>
<td>Carbon is the energy source for the microbes that help break down the materials.</td>
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<tr>
<td>examples: manure, kitchen waste, grass clippings, inorganic nitrogen rich fertilizers.</td>
<td>examples: leaves, wood chips, straw, sawdust.</td>
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</table>

Nature of Science Virtual Lab - Lab Sheet

Research Summary:
Problem:
What makes the most efficient compost components (green materials, brown materials, water, oxygen)?

Research: Summarize the source material provided.

Hypothesis:
If different amounts of green and brown materials are combined with water in a compost pile that is turned to provide oxygen to the pile, then a combination of _____ percent green materials, _____ percent brown materials, and _____ percent water with _____ number of turns to supply oxygen during the month will create the most efficient compost pile.

Variables:
Independent: different amounts of components
Dependent: efficiency rating
Constants: same location, same time of year, same duration for testing amounts (one month), same turning tool,

Procedures:
1. Gather materials: virtual lab link, lab sheet, pencil.
2. Click and drag the Brown to Green Balance bar, the Water Concentration bar, and the Number of Turns bar to the amounts shown in the Compost Components data table.
3. Click on the calendar in the lower right hand corner to test the setting amounts for the month duration. Record the Efficiency Rating.
4. Click the Reset button and test other combinations in the same way. Record your results in the data table.
5. Choose your own combinations of components and fill in the rest of the data table.

<table>
<thead>
<tr>
<th>Compost Components</th>
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<tbody>
<tr>
<td>Green Materials (%)</td>
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### Compost Components

<table>
<thead>
<tr>
<th>Green Materials (%)</th>
<th>Brown Materials (%)</th>
<th>Water Concentration (%)</th>
<th>Number of Turns per Month</th>
<th>Efficiency Rating (High, Medium, Low)</th>
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**Observations** (general statements of patterns and things you observed during the experiment):

**Conclusion:**
In this virtual lab various amounts of green material, brown material, water and oxygen were added to a compost pile to evaluate the efficiency of generating usable compost material. The hypothesis made before this experiment **was wasn’t** supported by the data from this experiment. The most efficient compost pile included the combination of materials in the following amounts:

____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

To further test/evaluate this problem, scientists should ___________________________________
Virtual Lab Evaluation:

1. How might the results of this experiment be communicated to others?

2. What are some errors that may have occurred during this experiment?

3. How could the experiment be improved? (Be specific)

4. How might the data collected in this virtual lab be applied to the real world?