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Lichens

Two students are each designing an experiment to determine if lichens carry out photosynthesis. The teacher provides each student with a sample of a lichen. The students may use any equipment necessary to set up and conduct their experiments. The setups for both the experiments are shown in the diagram.

The setup for Student 1 includes the following:
- a bell jar covered in thick black paper to prevent the light reaching the lichen
- a beaker with a chemical that releases carbon dioxide into the air
- a spray of water on the lichen each day

The setup for Student 2 includes the following:
- a bell jar
- a beaker with a chemical that absorbs carbon dioxide from the air
- a spray of water on the lichen each day
- a light source twelve inches from the top of the bell jar

Because lichens are slow growing, the students will make observations over the course of two weeks to determine whether the lichens are still living. While the students were waiting to make their final conclusion, they researched lichens further and found information relating to lichen growth, survival, and environmental needs.
Lichens: Part Plant and Part Fungus
Lichens are a simple, slow-growing organism that can resemble old blotches of paint on rocks or trees. These organisms are unique in that they are part plant (algae) and part fungus. Scientists have divided lichens into three basic growth forms: crustose, foliose, and fruticose.

Three Types of Lichen

Lichens thrive in wet or damp environments but go dormant, unable to photosynthesize, when water is scarce. Their structure allows them to dry slowly, which helps them survive longer periods of drought and seasonal extremes of cold and heat.

Lichens: In the Tundra
Organisms in a tundra ecosystem rely heavily on lichens as a food source due to lichens’ ability to survive under extreme weather conditions. A tundra food web is shown.
Lichens: Bio-indicator of air pollution

Air pollutants, such as sulfur dioxide, dissolve in rainwater. This can damage the soft, absorbent tissues of lichens, and prevent them from growing. This absorbent nature of lichens makes them natural indicators of air pollution. However, different types of lichen have different sensitivities to air pollution. The table shows how sensitive different types of lichen are to air pollution from sulfur dioxide.

<table>
<thead>
<tr>
<th>Indicator Species Present</th>
<th>Appearance of Lichen</th>
<th>Level of Sulfur Dioxide (SO₄) Tolerated</th>
</tr>
</thead>
<tbody>
<tr>
<td>crustose lichen</td>
<td>crusty blotches</td>
<td>high</td>
</tr>
<tr>
<td>foliose lichen</td>
<td>crusty and leafy</td>
<td>medium</td>
</tr>
<tr>
<td>fruticose lichen</td>
<td>bushlike with branches</td>
<td>low</td>
</tr>
</tbody>
</table>

Because lichen easily absorbs sulfur dioxide, scientists monitor the appearance and size of lichen populations as indicators of air quality. The levels of sulfur concentration have been measured over time and graphed below.
1. Students went hiking in a nature preserve near the Mississippi River. During the hike, they observed lichens growing on tree bark. On one tree, the students observed a large number of crusty blotchy and leafy lichens but very few bushy lichens.

**Part A:** Select the word that completes the sentence:

The level of sulfur dioxide in the air for the area visited by the students is likely **○ high**

**○ medium**

**○ low**

**Part B:** The map shows fine particle air pollution, including sulfur and nitrogen compounds. Select the area on the map where the students would **most likely** find fruticose lichens.
2. **Part A:** Select the word that completes the statement:

The overall trend in sulfur dioxide concentration is

- [ ] increasing
- [ ] decreasing
- [ ] staying the same

**Part B:** Use evidence from the passage to predict how the change in sulfur dioxide levels most likely have impacted the population of each type of lichen. Each answer choice may be used more than once.

<table>
<thead>
<tr>
<th>Lichen Type</th>
<th>Population Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crustose</td>
<td>increase</td>
</tr>
<tr>
<td>Foliose</td>
<td>decrease</td>
</tr>
<tr>
<td>Fruticose</td>
<td>remain constant</td>
</tr>
</tbody>
</table>
3. Based on evidence in the passage, describe how the food web would be affected soon after the caribou hunting season. **Select all statements that apply.**

A. Polar bears will overconsume lemmings and arctic hares.
B. Hawk populations will not be affected by the caribou hunt.
C. Arctic hares and lemmings will compete for the growing lichen supply.
D. Wolves and polar bears will compete for food with fewer caribou available.
E. The producer population will improve with fewer caribou to consume them.
F. Lemming populations will increase due to less competition with caribou for lichens.
4. The table shows weather information for Jefferson City, MO, located near the Missouri River. Missouri is home to several species of lichens due to favorable environmental conditions for lichens throughout most of the year.

<table>
<thead>
<tr>
<th>Month</th>
<th>Jan</th>
<th>Mar</th>
<th>May</th>
<th>Jul</th>
<th>Sep</th>
<th>Nov</th>
</tr>
</thead>
<tbody>
<tr>
<td>minimum temperature (°C)</td>
<td>4.4</td>
<td>13.2</td>
<td>24.4</td>
<td>31.3</td>
<td>26.5</td>
<td>13.2</td>
</tr>
<tr>
<td>maximum temperature (°C)</td>
<td>-6.2</td>
<td>0.7</td>
<td>11.7</td>
<td>20.1</td>
<td>13.9</td>
<td>1.6</td>
</tr>
<tr>
<td>precipitation (millimeters)</td>
<td>48</td>
<td>76</td>
<td>131</td>
<td>109</td>
<td>106</td>
<td>92</td>
</tr>
</tbody>
</table>

Based on the information in the table, during which month are lichens most likely to be dormant?

A. January  
B. May  
C. September  
D. November

5. Which statement best models how lichens move matter and energy through the environment?

A. Carbon dioxide and water provide the elements for the production of sugar and oxygen which are reactants for cellular respiration.  
B. Algae contain chlorophyll within the chloroplasts, which are the site where photosynthesis occurs.  
C. Fungus provide structure and energy for the algae to carry out cellular respiration.  
D. Lichens are producers because the algae can photosynthesize to produce sugar and oxygen for other organisms to begin cellular respiration.
6. Review the model below.

**Part A:** Based on the passage, which investigation design will produce evidence to support the model above?

A. Student 1

B. Student 2

**Part B:** Use evidence from the investigation to support your answer to Part A.