Lesson 3 | Case Study

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Case Study

Directions: Use what you know about variables to complete this concept map.

1. _____________

2. _____________

3. _____________

4. _____________

5. _____________

A variable

which is the

which affects the

can be a(n)

which is the

independent variable

that can affect the outcome of a(n)
Case Study

The Iceman’s Last Journey

1. In the year ________________, two hikers discovered the remains of a man in a melting ________________ between Austria and Italy.

2. The ________________ found near the body, including ________________ made of deerskin and stuffed with grass, suggested that the body was not of a person from any recent time.

3. Scientists designed a(n) ________________ experiment to try to identify the body.

4. To design a controlled experiment, scientists identify ________________ that might affect the ________________ of the experiment.
   a. Any factor that can have more than one value is called a(n) ________________.
   b. A controlled experiment has ________________ different kinds of variables.
   c. The ________________ variable is the factor that is being tested; it is changed by the investigator to observe how it affects a dependent variable.
   d. The ________________ variable is the factor that is observed or measured during a controlled experiment.
   e. A controlled experiment has ________________ groups.
   f. A(n) ________________ group is used to study how a change in the independent variable affects the ________________ variable.
   g. In the ________________ group, the ________________ variable is not changed, but otherwise this group is the same as the experimental group.

5. Using ________________ dating, scientists figured out that the body found in the ice, nicknamed the Iceman, lived about ________________ years ago; one of the first ________________ about the Iceman was that he died in the autumn and was quickly buried and frozen.
Lesson Outline continued

6. Samples of __________________________ (burned wood) found near the Iceman’s body were from trees that grew at lower __________________________ than the discovery site; for this reason, scientists hypothesized that shortly before the Iceman died, he had been at places that were __________________________ in elevation.

7. A scientist ran an experiment on a tiny sample of material from the Iceman’s __________________________, where he found edible __________________________ material, including einkorn.

8. The scientist found that pollen grains had been in the Iceman’s stomach for a(n) __________________________ time before the man died because they had not been digested; the scientist identified the pollen as being from a tree that grows at __________________________ elevation than the discovery site.
   a. The scientist hypothesized that his sample from the Iceman was __________________________ and that the grains of pollen came from near the scientist’s __________________________.
   b. He ran an experiment in which the __________________________ was a sterile slide that included the same saline solution and equipment the scientist used with the Iceman’s sample, without the sample itself.
   c. The control did not have any __________________________, so the grains had been swallowed by the Iceman.

9. The pollen grains found in the Iceman were __________________________, so the scientist concluded that the Iceman died during the __________________________ season of the pollen grains.

10. By studying more grain samples from the Iceman, the scientist inferred where the Iceman traveled during the last period of __________________________ hours of his life.

11. The Iceman is thought to have traveled from a high region down to a valley, where he was injured with a(n) __________________________ that was found in his shoulder, at which point he retreated back to a higher elevation, where he eventually __________________________.
**Case Study**

**Directions:** On the line before each definition, write the letter of the term that matches it correctly. Each term is used only once.

1. the factor that is changed by the investigator to observe how it affects a dependent variable
   - A. variable
   - B. independent variable
   - C. dependent variable
   - D. control group
   - E. experimental group

2. any factor that can have more than one value
   - A. variable
   - B. independent variable
   - C. dependent variable
   - D. control group
   - E. experimental group

3. the factor that a scientist observes or measures during an experiment
   - A. variable
   - B. independent variable
   - C. dependent variable
   - D. control group
   - E. experimental group

4. The effects of changing the independent variable are observed and recorded for this.
   - A. variable
   - B. independent variable
   - C. dependent variable
   - D. control group
   - E. experimental group

5. This contains the same factors as the experimental group, but the independent variable is not changed.
   - A. variable
   - B. independent variable
   - C. dependent variable
   - D. control group
   - E. experimental group
Case Study

Directions: On the line before each statement, write the letter of the correct answer.

1. In ______, two hikers discovered a human body in a melting glacier on the border of Austria and Italy.
   A. 1891
   B. 1919
   C. 1991

2. ______ often begin when someone asks a question about something that is observed in nature.
   A. Variable
   B. Hypotheses
   C. Scientific investigations

3. The Iceman lived about ______ years ago.
   A. 4,000
   B. 5,300
   C. 10,000

4. Because the Iceman’s body was extremely well preserved, Professor Spindler concluded that it was covered by snow shortly after the man died and that he had died in the ______.
   A. fall
   B. spring
   C. winter

5. ______ is common in scientific research.
   A. Error
   B. Failure
   C. Success

6. By examining the ______ of the Iceman’s digestive tract, Professor Oeggl was able to reconstruct the Iceman’s last journey.
   A. lining
   B. contents
   C. temperature
Text-Analysis Activity: Revising Hypotheses

A hypothesis is a statement of explanation for an observation that can be tested by scientific investigations. If a hypothesis is supported by an investigation, it will be retested to ensure consistency. If a hypothesis is not supported by the investigation, the results can be used to revise the hypothesis before it is tested again.

Directions: Read each scenario and answer the questions that follow.

Jennie and LaMonte wondered when the most students missed school during the school year because of illness. Their hypothesis was that the most students miss school because of illness in September, because students have recently returned to school and bring illnesses that spread from person to person. They looked up the school records for the past ten years and found that the greatest number of students missed school due to illness in the month of February.

1. In your own words, describe Jennie and LaMonte’s original hypothesis.

2. Using the information they learned from the school records, write a revised hypothesis.

Last year, Vidal and Mia observed that birds ate the berries at the bottom of the bushes in the schoolyard first. After all the lower berries were gone, the birds worked their way up the bushes, finally eating the berries at the top. Vidal and Mia hypothesized that the birds ate the lower berries first because they ripened first, so the birds were attracted to their red color. To test their hypothesis, they used a nontoxic, odorless, flavorless, edible red dye to color all of the berries on three bushes. They left three other bushes untouched. They observed that the birds ate the lower berries on all the bushes, even on the untouched bushes.

3. In your own words, describe Vidal and Mia’s original hypothesis.

4. Using the information from Vidal and Mia’s investigation, write a revised hypothesis.
Case Study

Directions: Use your textbook to respond to each statement.

1. Variables can be classified as independent or dependent.
   
   Compare and contrast independent variables and dependent variables.

2. Controlled experiments include two groups. One group is called the experimental group, and the other is called the control group.
   
   Explain how the experimental group and the control group differ.

3. Scientific investigations have greatly increased our knowledge of many subjects, including the way people lived thousands of years ago.
   
   Describe one observation that was part of the Iceman investigation. Tell what questions resulted from the observation and how those questions were investigated.

4. Scientific investigations usually include error analysis. This helps scientists understand factors that might affect their results.
   
   Identify the kinds of information scientists might find in an error analysis. Use the Iceman investigation as an example.
Case Study

Key Concept  How are independent variables and dependent variables related?

Directions: On the line before each statement, write the letter of the correct answer.

_____ 1. When scientists design a controlled experiment, they have to identify factors that can affect the _____ of an experiment.
   A. outcome  
   B. prediction  
   C. independent variable  

_____ 2. A variable is any factor that can have more than _____ value(s).
   A. one  
   B. two  
   C. three  

_____ 3. In controlled experiments, there are two kinds of _____.
   A. variables  
   B. outcomes  
   C. hypotheses  

_____ 4. The independent variable is the factor that is changed by the investigator to _____ how it affects a dependent variable.
   A. predict  
   B. change  
   C. observe  

_____ 5. The _____ is the factor that a scientist observes or measures during an experiment.
   A. control group  
   B. dependent variable  
   C. independent variable  

_____ 6. When the _____ variable is changed, it causes the _____ variable to change.
   A. new, old  
   B. dependent, independent  
   C. independent, dependent
Key Concept Builder

Case Study

Key Concept  How are independent variables and dependent variables related?

Directions: On the line before each statement, write the letter of the term that matches it correctly. Some terms will be used more than once.

1. A controlled experiment has two groups, _____ and _____.
   - A. the independent variable
   - B. the experimental group
   - C. the control group

2. The effects of changing the independent variable are observed and recorded for _____.
   - A. the independent variable
   - B. the experimental group
   - C. the control group

3. The control group contains the same factors as the experimental group, but _____ is not changed.
   - A. the independent variable
   - B. the experimental group
   - C. the control group

4. Without _____, it is difficult to know if your experimental observations result from the variable you are testing or another variable.

Directions: Respond to each statement on the lines provided.

5. Describe how independent and dependent variables are related.

6. Explain why a control group is important to a controlled experiment.
Case Study

Key Concept  How is scientific inquiry used in a real-life scientific investigation?

Directions: Use the map to answer each question or respond to each statement on the lines provided.

1. **Explain** how the Iceman’s digestive tract allowed Professor Oeggl to reconstruct the Iceman’s last journey.

   ________________________________________________________________

   ________________________________________________________________

   ________________________________________________________________

   ________________________________________________________________

   ________________________________________________________________

2. Considering how fast pollen digests in a person’s stomach, about how long do you think it took the Iceman to reach his final destination? Explain.

   ________________________________________________________________

   ________________________________________________________________

   ________________________________________________________________

   ________________________________________________________________

   ________________________________________________________________
**Case Study**

**Key Concept** How is scientific inquiry used in a real-life scientific investigation?

**Directions:** Write three or four paragraphs explaining the Iceman case study. In your writing, be sure to outline each part of the experiment including early conclusions, observations, hypotheses, experiments, error analysis, interpretation, inferences, and conclusions. Support your writing with details.
Some people think that bats are cute, some are afraid of them, and some researchers study them. In a landmark study published in the journal *Science*, researchers describe the independent and dependent variables in an experiment focused on the ability of birds and bats to protect plants from insect damage in a natural forest ecosystem.

**What Scientists Already Know**

In a previous study (#1), the researchers found that bats prey on plant-eating insects to a greater extent than had previously been estimated. Caterpillars, katydids, beetles, and other insects devour tropical plant leaves. Plants defend themselves directly by producing tough leaves and toxic chemicals, but another key factor in plant survival is the role of insect predators such as birds and bats.

In another study (#2) that addressed pest control by birds and bats, researchers excluded large insect eaters by placing netting enclosures over entire plants, leaving the nets in place day and night. In this way, they measured the combined effect on damage to plant leaves by birds and bats by eliminating their access to the plants. The independent variable was access to the plants, and the dependent variable was the amount of damage to plant leaves.

**Plan and Results of the Study**

In the current study (#3), the goal was to find out whether there was a difference between the insect-control effects of bats compared to birds. Because birds actively hunt insects during daylight and bats hunt insects at night, the design of this experiment separated the insect-control effects of bats and birds by placing netting enclosures over five common tropical plant species only at night or only by day. A group of control plants were left uncovered. The results of this experiment are listed in the table below.

<table>
<thead>
<tr>
<th>Insect-Control Effects of Bats and Birds</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Experimental Plant Groups</strong></td>
</tr>
<tr>
<td>------------------------------------------</td>
</tr>
<tr>
<td>Control plants – uncovered</td>
</tr>
<tr>
<td>Group A plants – covered by day</td>
</tr>
<tr>
<td>Group B plants – covered by night</td>
</tr>
</tbody>
</table>

**Applying Critical-Thinking Skills**

**Directions:** Respond to each statement.

1. **Formulate** a conclusion based on the results of this study (#3).
2. **Identify** the independent and dependent variables in the current study (#3).
**Earth System Variables**

A controlled experiment is designed to answer a question and is constructed using an independent variable and a dependent variable. Data is collected about changes in the dependent variable as it changes according to the investigator’s change of the independent variable.

An example of an independent variable in a natural system is the lines of latitude that form imaginary horizontal rings around the axis of the Earth. Earth temperature is a variable that is generally dependent on the location relative to the lines of latitude. Because the region near the equator receives the most concentrated energy from the Sun, it is generally warm throughout the year; the regions near the North and South Pole are cold and ice-bound even in summer because they receive much less solar energy. As the lines of latitude progress from the equator toward the poles, therefore, average temperatures become cooler and cooler at the latitudes that are farther and farther away from the equator.

Latitude is not the only variable that affects Earth’s temperatures, however. Although average temperature is a variable dependent on latitude, it does not change steadily as the latitude changes because other geographic variables such as winds, ocean effects, and altitude also affect atmospheric temperatures in any given region.

1. Plot each of the following pairs of locations on a world map:
   - San Francisco, California; St. Louis, Missouri
   - Portland, Oregon; Vladivostok, Russia
   - Paris, France; St. John’s, Newfoundland
   - Mt. Everest in the Himalayas; Tampa, Florida

2. For each location pair, research the following:
   (a) the approximate latitude
   (b) the average annual and seasonal temperatures
   (c) geographic variables that cause differences in their temperatures even though they are at the same latitude

3. Construct a table that shows the latitude of each location pair, the temperature differences, and the geographic variables that cause those differences.
Inferring from Indirect Evidence

In the case study about the Iceman, you learned how scientists used evidence found in or near the body to learn how the Iceman might have lived and what he ate. In this investigation, you will use similar indirect evidence to learn more about an owl.

An owl pellet is a ball of fur and feathers that contains bones, teeth, and other undigested parts of animals eaten by the owl. Owls and other birds, such as hawks and eagles, swallow their prey whole. Stomach acids digest the soft parts of the food. Skeletons and body coverings are not digested and form a ball. When the owl coughs up the ball, it might fall to the ground. Feathers, straw, or leaves often stick to the moist ball when it strikes the ground.

Ask a Question
What kinds of information can I learn about an owl by analyzing an owl pellet?

Materials
owl pellet    forceps
bone identification chart magnifying lens
dissecting needle
Also needed: toothpicks, small brush, metric ruler, paper plate

Safety

Make Observations

☐ 1. Read and complete a lab safety form.

☐ 2. Carefully measure the length, the width, and the mass of your pellet.
   ☐ Write the data below.

☐ 3. Gently examine the outside of the pellet using a magnifying lens.
   ☐ Do you see any sign of fur or feathers?

☐ What other substances can you identify? Record your observations.
4. Use a dissecting needle, toothpicks, and forceps to gently pull apart the pellet. Try to avoid breaking any of the tiny bones.
   - Spread out the parts on a paper plate.

5. Use the bone identification chart to identify each of the bones and other materials found in your pellet.
   - Make a mark in the table below for each part you identify.

### Bone Identification Chart

<table>
<thead>
<tr>
<th>Bone</th>
<th>Animal</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skull</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jaw</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shoulder blade</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forelimb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hindlimb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hip/pelvis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rib</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertebrae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insect parts</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Lab Tips
- When using your forceps, squeeze the sides very lightly so that you don’t crush fragile bones.
- Use the brush to clean each bone. Try rotating the bones as you match them to the chart.
- Lay the bones on the matching box on the chart as you separate them. Then count them when you are finished.

### Analyze and Conclude
6. **Assemble** the bones you find into a skeleton. You may need to locate pictures of rodents, shrews, moles, and birds.
7. **Discuss** with your teammates why parts of an animal skeleton might be missing.
Lab A continued

8. **Write** a report that includes your data and conclusions about the owl’s diet.

9. **Identify Cause and Effect** Is every bone you found in the pellet necessarily from the owl’s prey? 

   - Why or why not?

10. **Analyze** What conclusions can you reach about the diet of the particular owl from which your pellet came?

   - Can you extend this conclusion to the diets of all owls? 
   - Why or why not?

11. **The Big Idea** How did the scientific inquiry you used in the investigation compare to those used by the scientists studying the Iceman? In what ways were they the same?

   - In what ways were they different?

**Communicate Your Results**

Compare your results with those of several other teams. Discuss any evidence to support that the owl pellets did or did not come from the same area.
Inferring from Indirect Evidence

In the case study about the Iceman, you learned how scientists used evidence found in or near the body to learn how the Iceman might have lived and what he ate. In this investigation, you will use similar indirect evidence to learn more about an owl.

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Ask a Question
What kinds of information can I learn about an owl by analyzing an owl pellet?

Materials
owl pellet
bone identification chart
dissecting needle
forceps
magnifying lens

Also needed: toothpicks, small brush, metric ruler, paper plate

Safety

Make Observations
1. Read and complete a lab safety form.

2. Carefully measure the length, the width, and the mass of your pellet. Write the data below.

3. Gently examine the outside of the pellet using a magnifying lens. Do you see any sign of fur or feathers? What other substances can you identify? Record your observations.
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7. **Discuss** with your teammates why parts of an animal skeleton might be missing.

8. **Write** a report that includes your data and conclusions about the owl’s diet.
9. Identify Cause and Effect  Is every bone you found in the pellet necessarily from the owl’s prey? Why or why not?

10. Analyze  What conclusions can you reach about the diet of the particular owl from which your pellet came? Can you extend this conclusion to the diets of all owls? Why or why not?

11. The Big Idea  How did the scientific inquiry you used in the investigation compare to those used by the scientists studying the Iceman? In what ways were they the same? In what ways were they different?

Communicate Your Results
Compare your results with those of several other teams. Discuss any evidence to support that the owl pellets did or did not come from the same area.

Put your data on the board. Use the class data to determine a mean, median, mode, and range for each type of bone.
Design an Owl Investigation

**Directions:** Use the information and data from the Lab Inferring from Indirect Evidence to perform this lab.

You have learned that scientists use scientific methods to design and carry out investigations and that sometimes scientists must make inferences based upon evidence they have gathered. You also learned that owls regurgitate pellets that contain the food parts that they could not digest. In Lab B, you investigated owl pellets and made inferences about the owl and its diet. Now, research a species of owl that is found near where you live and use scientific methods to design an investigation that could accurately determine the diet of that species of owl.

Please note that you must complete Lab B before beginning Lab C. Also, have your teacher approve your design and safety procedures before beginning your experiment.
Chapter Key Concepts Builder

Methods of Science

End-of-Chapter Practice

Directions: Work with a group to stage a play that outlines the last few days of the Iceman’s life.

Begin by reviewing the following information about the Iceman.

<table>
<thead>
<tr>
<th>Where did the Iceman most likely live?</th>
<th>What was most likely the Iceman’s last meal?</th>
<th>Where did the Iceman last journey to?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Now, use these details to consider what the Iceman’s life might have been like. Consider his family, friends, and way of life.

Next, write a play. Include the scientific conclusions drawn about the Iceman’s last journey and base your creative inventions on facts, inferences, and hypotheses. Make sure each member of your group is assigned a part in the play. Remember to express yourself clearly and precisely and to incorporate spelling and grammatical rules.

Now practice your play. Think about:

<table>
<thead>
<tr>
<th>Ideas for organizing your play:</th>
<th>The materials you will need:</th>
<th>Your individual responsibilities:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</table>

After you have practiced your play, present it to the class.