Science
Life Science
Grade 8
Experimental Design

<u>Overview</u> (For the Teacher)

The life science content presented in this lesson is deliberately simple in order to allow students to focus on the experimental design. An experiment starts with a testable question. There are an infinite number of questions that can be asked about the natural world but many are not testable. For instance, can the sky turn green? If a question is not testable, there is no way to evaluate it.

There must be a reliable method to evaluate the results of a test so you can be sure of the information gained from an investigation. Measurement is an important feature of the scientific process. Numbers are an unambiguous method of communicating test results. Word descriptions, on the other hand, can have many shades of meaning. If an observation is made that an object turned blue, the description is ambiguous. The word "blue" has multiple meanings. You can feel blue or you can turn blue.

On the other hand, if the same object is described as increasing in length by 2.0 cm, there are no other meanings for the description of 2.0 cm. Numbers are a very important method of describing the results of scientific investigations because their meaning is exact.

An experiment is constructed in such a way that leaves no room for doubt about the conclusion. For example, you think light makes plants grow, so you grow some plants in light and compare them to plants grown without light, while leaving **all other conditions constant**. The comparison without the factor being tested is a **control**.

The factor (like light) causing an effect is the **independent (experimental) variable** and usually plotted on the **x-axis**. The condition (like plant growth) that enables us to determine the effect the independent variable has on the organism or object is the **dependent variable(s).** This variable is usually plotted on the **y-axis**. Graphs present measurements of the results of a test in an easy to read format.

PART I DAY 1

Benchmarks

SI-M-A3 Using mathematics and appropriate tools and techniques to gather, analyze and interpret data.

SI-M-A4 Developing descriptions, explanations, and graphs using data.

LS-M-A3 Observing and analyzing the growth and development of selected organisms, including a seed plant, an insect with complete metamorphosis, and an amphibian

SE-M-A2 Demonstrating an understanding of how carrying capacity and limiting factors affect plant and animal populations.

Open *Class Discussion- 15 minutes*

- Group students in pairs.
- Issue the handout, *Life Science Graphs.*
- Ask a student to read aloud the experiment described at the beginning of the activity.
- Ask the following questions to the class.

1. What is being tested?
   [the effect of light on plants]

2. What are the results of the test?
   [plants grow in light and not in the dark]

3. How do you know the results of the test are due to light?
   [because the results of the test were compared to plants grown without light]

4. How were the results of the test described?
   [measurement of the change in plant mass]

5. Why is it important that results are measured and not just given a written description?
   [numbers are more concrete and specific than other forms of description]

6. What kind of graph would be best to present the data? Why?
   [A bar graph would be best because you are comparing the data from different groups.]

Body of Lesson *Activity- 25 Minutes*

Read each activity question to the class. Call on each student group of 2 in turn for the answers. Students may write the answers to the questions on their handouts.

1. An experiment should include a control group and an experimental (test) group. The test group is used to find out if your guess about the experiment outcome is correct. The control group is used for comparison to determine the outcome of the test or experiment. Describe the test group and the control group in the experiment above. What is the difference in the way both groups are treated?

   [Test group- plants are grown in fluorescent light; control group- plants are grown in no light.]

2. The difference in the treatment of the test group and the control group is called the **independent** variable. What is the independent variable in this experiment?

   [fluorescent light]

3. The **dependent** variable is the condition observed to determine the outcome of the experiment. It changes in response to the independent variable. What is the dependent variable in the experiment and how is it measured? Include a possible measuring instrument and the units of measure in your answer.

   [plant growth, plant mass, measured possibly by a triple beam balance, grams- Accept all possible correct answers. Explain to students that we will measure mass because it is the most specific measurable variable that we can use to determine growth.]

4. What factors must be kept constant in this experiment in order to determine the cause of the outcome of the experiment.

   [Amount of water added, watering time, pot size and shape, type and amount of soil, etc.]

5. Write a hypothesis for the experiment. Fill in the blanks below.

The *fluorescent lights* (Independent Variable) will cause *an increase in mass* (Dependent Variable) when applied to *plants* (Organism).

* *Students may say that plant growth will decrease under fluorescent lights. Not all hypotheses are supported by data some are rejected.*

6. Fill in the data table from the information contained in the description of the experiment.

Group	Change in Plant Mass (g)
Test Group	***15***
Control Group	***1***

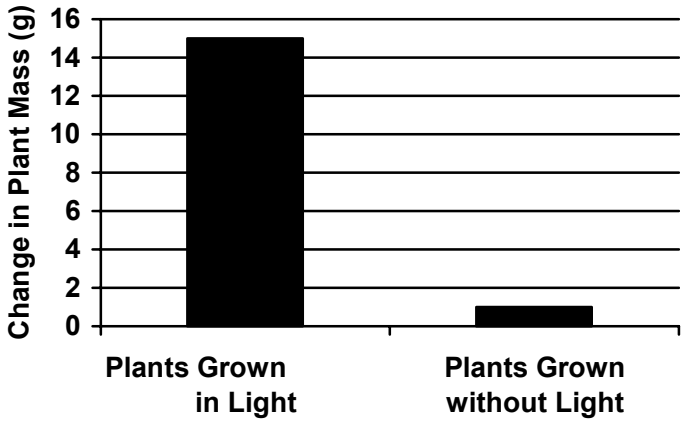
7. The dependent variable is generally plotted on the y-axis of a graph. **Label the**

axis. Include the units of measure in the label. *[Continue with number 8]*

8. A bar graph shows comparisons. **Label the x-axis** where you intend to draw a bar for the **control** and **test** group. Hold up your papers and show your labels.

   [y-axis: Change in plant mass in grams]
   [x-axis: plant grown with light, plants grown with no light]

9. Use the data in table to draw a column to the correct height on the y-axis for the test and control data. Hold up your papers and show your graphs.



10. According to the data, is the hypothesis proven? What evidence supports your statement?

    [Yes; the hypothesis is supported. Plants grown in fluorescent light do increase in mass by 15 grams compared to plants grown without light not significantly increasing in mass.]
    ** Students may say that plant growth decreases with fluorescent lights.*

Close *10 Minutes*

Ask students to keep a science journal. Use student entries to plan future lessons. At the end of the class period ask students to enter the responses to these prompts into their journals:

1. What did you learn today?
2. What questions would you like to ask about the lesson?
3. What would you like to know more about?

Assessment (attached, page 218) *10 Minutes*

Key

1. B
2. C
3. The hypothesis is rejected because yeast grown in glucose produces 22mL of carbon dioxide while yeast grown with no glucose produces no carbon dioxide.

PART II DAY 2

Benchmarks

SI-M-A3 Using mathematics and appropriate tools and techniques to gather, analyze and interpret data.

SI-M-A4 Developing descriptions, explanations, and graphs using data.

LS-M-A4 Explaining the interaction and interdependence of nonliving and living components within ecosystems.

Open *Class Discussion- 15 minutes*

Group students in pairs. Ask a student to read aloud the experiment that appears at the beginning of the activity. Afterwards, ask the following questions to the class.

1. What is being tested?
   [the effect different concentrations of salt on the growth of yeast.]

2. What are the results of the test?
   [as the salt concentration increases yeast growth decreases]

3. How do you know the results of the test are due to salt concentration?
   [because the results of the test were compared to yeast grown without salt]

4. How were the results of the test described?
   [measurements of carbon dioxide volume]

5. What kind of graph would be best to present the data? Why?
   [A line graph would be best because you are comparing the data from different groups.]

Body of Lesson *Activity- 25 Minutes*

- Issue the student handouts for Part II.
- Read each activity question to the class.
- Call on each student group of 2 in turn for the answers.
- Students may write the answers to the questions on their handouts.

1. An experiment should include a control group and an experimental (test) group. The test group is used to find out if your guess about the experiment outcome is correct. The control group is used for comparison to determine the outcome of the test or experiment.

   Describe the test group and the control group in the experiment above. What is the difference in the way both groups are treated?

[test group- yeast grown in different concentrations of salt; control group- yeast grown without salt]

2. The difference in the treatment of the test group and the control group is called the **independent** variable. What is the independent variable in this experiment?

   [the different salt concentrations]

3. The **dependent** variable is the outcome of the experiment, which is caused by the independent variable. What is the dependent variable in the experiment and how is it measured? Include a possible measuring instrument and the units of measure in your answer.

   [carbon dioxide volume in milliliters]

4. What factors must be kept constant in this experiment in order to determine the cause of the outcome of the experiment

   [Amount of water added, watering time, pot size and shape, type and amount of soil, etc.]

5. Write a hypothesis for the experiment. Fill in the blanks below.

Increasing salt concentration (Independent Variable) will cause *a decrease in growth* (Dependent Variable) when applied to *yeast* (Organism).

* Students may say a yeast growth increase with increasing salt concentration.

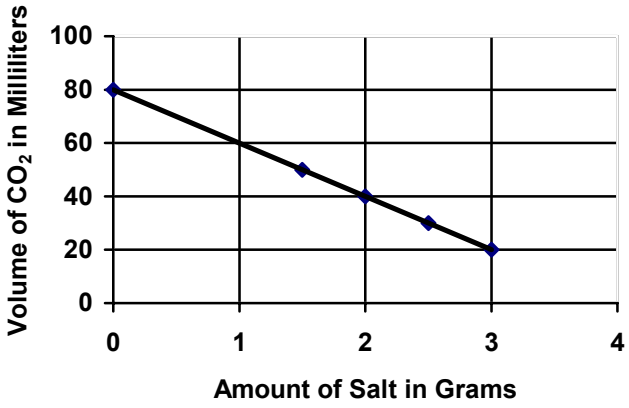
6. Fill in the data table from the information contained in the description of the experiment.

Flask	Amount of Salt (g)	Volume of Carbon Dioxide Gas (mL)
1	***0***	***80***
2	***1.5***	***50***
3	***2.0***	***40***
4	***2.5***	***30***
5	***3.0***	***20***

7. The dependent variable is generally plotted on the y-axis of a graph. The independent variable is generally plotted on the x-axis. **Label each axis**. Include the units of measures in the labels. Hold up your papers and show your labels.

   [y-axis: volume of carbon dioxide gas in milliliters; x-axis: amount of salt in grams]

8. Use the data in table to plot the points on the graph. Hold up your papers and show your graphs.



9. According to the data, is the hypothesis proven? What evidence supports your statement? (2 points)
   [The hypothesis that yeast growth would decrease as salt concentration increases is supported because as salt concentration increased from 1.5 grams to 3 grams, carbon dioxide volume decreased from 50 mL to 20 mL compared to no salt with a volume of 80 mL.]
   ** Students may say a yeast growth increases with increasing salt concentration.*

Close *10 Minutes*

Ask students to keep a science journal. Use student entries to plan future lessons. At the end of the class period ask students to enter the responses to these prompts into their journals:

1. What did you learn today?
2. What questions would you like to ask about the lesson?
3. What would you like to know more about?

Assessment (attached, page 222) *10 Minutes*

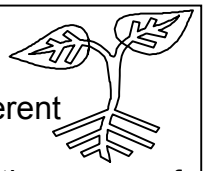
Key

1. C
2. B
3. As x-values increase, y-values increase to 7 cm^2 then gradually decrease, so the hypothesis is not supported.

ACTIVITY SHEETS

Part I: LIFE SCIENCE GRAPHS

The Experiment



Two identical sets of bean plants are germinated from seeds and grown in different environments. The test group is grown under fluorescent lights. The control is grown in total darkness. All other growing conditions are the same for both groups of plants. At the end of 4 weeks both sets of plants are carefully removed from the soil and massed. The beginning mass of the plants in the test group is 5 grams. The mass of the test plants at the end of the experiment is 20 grams. The beginning mass of the plants in the control group is 5 grams. The mass of the control plants at the end of the experiment is 6 grams.

Materials per Student Group
Pencil
Colors

Activity

1. An experiment should include a control group and an experimental (test) group. The test group is used to find out if your guess about the experiment outcome is correct. The control group is used for comparison to determine the outcome of the test or experiment.

   Describe the test group and the control group in the experiment above. What is the difference in the way both groups are treated?

2. The difference in the treatment of the test group and the control group is called the **independent** variable. What is the independent variable in this experiment?

3. The **dependent** variable is the outcome of the experiment, which is caused by the independent variable. What is the dependent variable in the experiment and how is it measured? Include a possible measuring instrument and the units of measure in your answer.

4. What factors must be kept constant in this experiment in order to determine the cause of the outcome of the experiment?

5. Write a hypothesis for the experiment. Fill in the blanks below.

The _____ will cause the
Independent Variable

_____ when applied to a
Dependent Variable

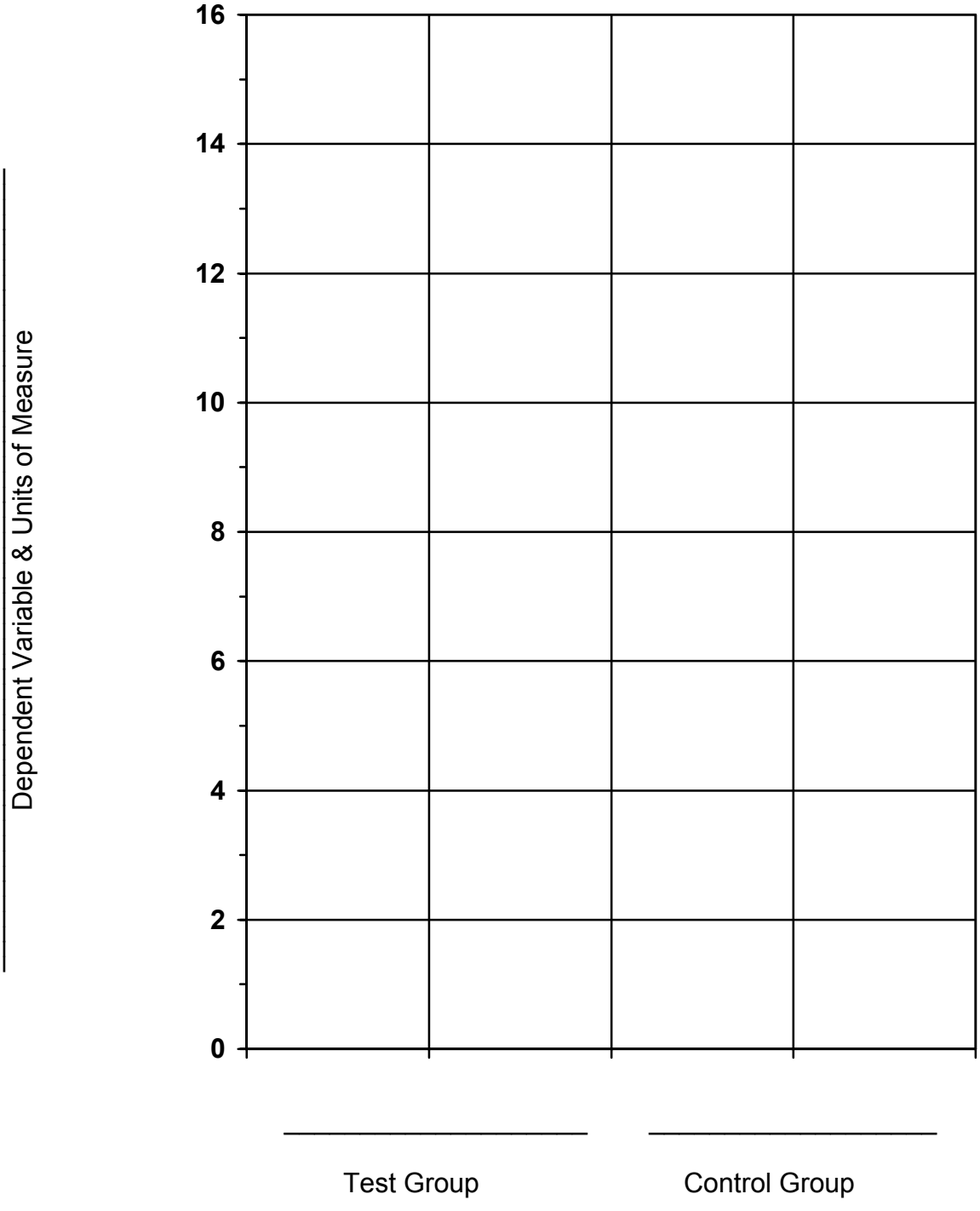
_____.
Object or Organism

6. Fill in the data table from the information contained in the description of the experiment. (2 points)

Group	**Change in Plant Mass (g)**
Test Group	
Control Group	

7. The dependent variable is generally plotted on the y-axis of a graph. Label the axis. Include the units of measure in the label.

8. A bar graph shows comparisons. Label the x-axis where you intend to draw a bar for the control and test group.

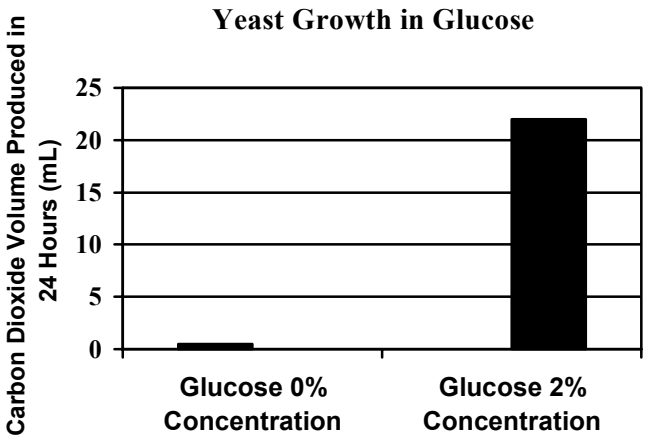


9. Use the data in table to draw a column to the correct height on the y-axis for the test and control data.

10. According to the data, is the hypothesis proven? What evidence supports your statement?

Life Science Graph Assessment

Directions: Use the graph to answer each question below.



1. What is the independent variable indicated by the bar graph above?

   a) Carbon Dioxide Volume
   b) Glucose
   c) Milliliters
   d) Yeast

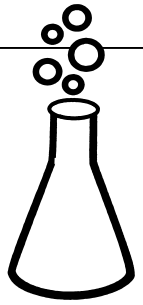
2. How much carbon dioxide was produced in 24 hours by yeast grown in 2% glucose?

   a) 2 mL
   b) 20 mL
   c) 22 mL
   d) 25 mL

3. According to the data, would the hypothesis below be supported or rejected? Discuss the evidence that supports your statement.

Hypothesis: Yeast grown in glucose does not produce carbon dioxide.

Part II: LIFE SCIENCE GRAPHS



The Experiment

Five flasks containing solutions of yeast and nutrients are rigged so the carbon dioxide gas produced by the yeast can be collected and measured. The flasks contain various concentrations of salt in the growing solution. The control flask contains no salt. All other conditions are the same for all flasks. At the end of 24 hours the volume of carbon dioxide gas is measured. Flask #1, containing no salt, produced 80 milliliters of carbon dioxide gas. Flask # 2, containing 1.5 grams of salt, produced 50 milliliters of carbon dioxide. Flask # 3, containing 2 grams of salt, produced 40 milliliters of carbon dioxide. Flask # 4, containing 2.5 grams of salt, produced 30 milliliters of carbon dioxide. Flask # 5, containing 3 grams of salt, produced 20 milliliters of carbon dioxide.

Materials per Student Group
Pencil
Colors

Activity

1. An experiment should include a control group and an experimental (test) group. The test group is used to find out if your guess about the experiment outcome is correct. The control group is used for comparison to determine the outcome of the test or experiment.

   Describe the test group and the control group in the experiment above. What is the difference in the way both groups are treated? (3 points)

2. The difference in the treatment of the test group and the control group is called the **independent** variable. What is the independent variable in this experiment?

3. The **dependent** variable is the outcome of the experiment, which is caused by the independent variable. What is the dependent variable in the experiment and how is it measured? Include a possible measuring instrument and the units of measure in your answer.

4. What factors must be kept constant in this experiment in order to determine the cause of the outcome of the experiment.

5. Write a hypothesis for the experiment. Fill in the blanks below.

The _____ will cause the
Independent Variable

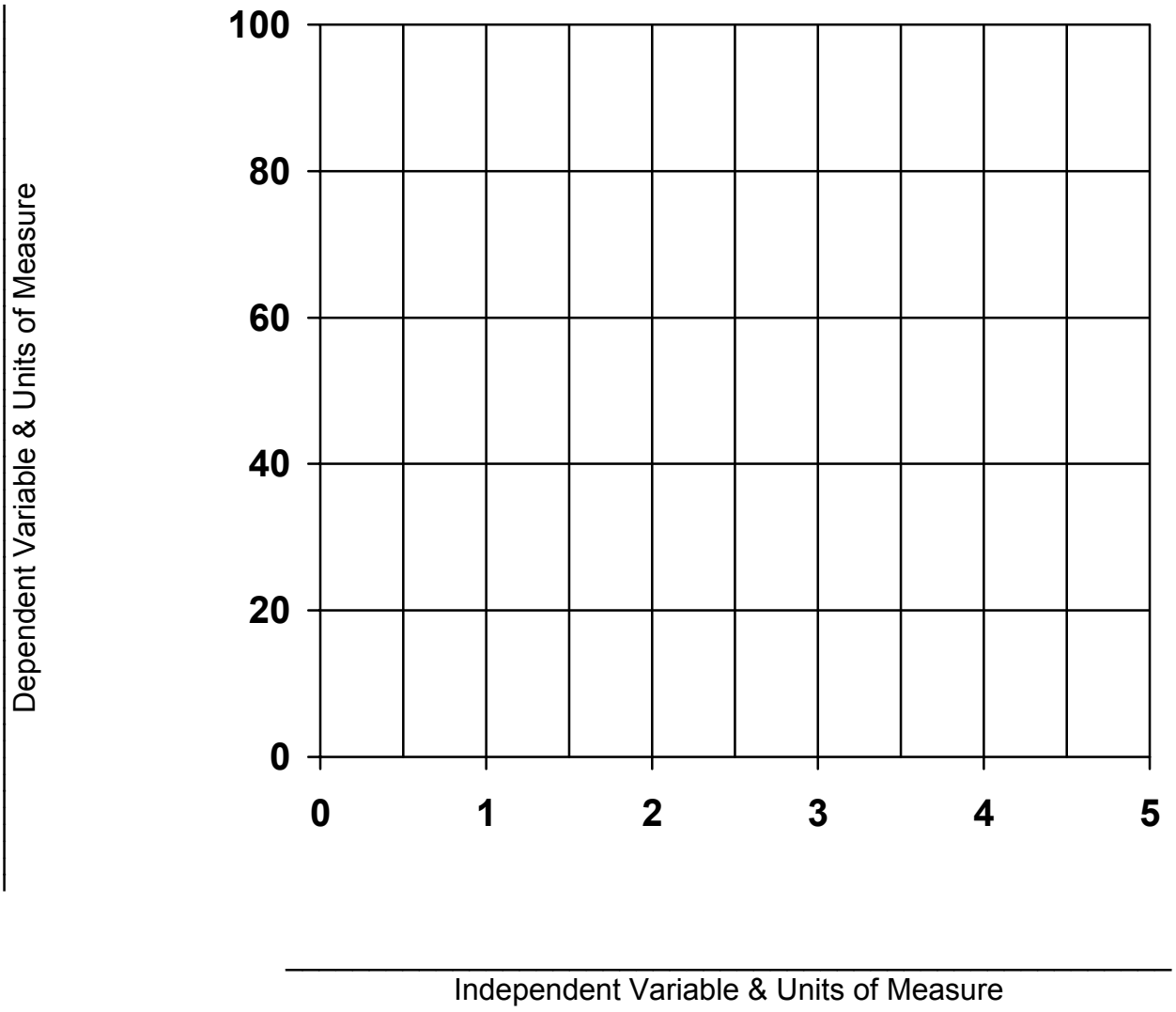
_____ when applied to a
Dependent Variable

_____.
Organism or Object

6. Fill in the data table from the information contained in the description of the experiment. (2 points)

Flask	Amount of Salt (g)	Volume of Carbon Dioxide Gas (mL)
1		
2		
3		
4		
5		

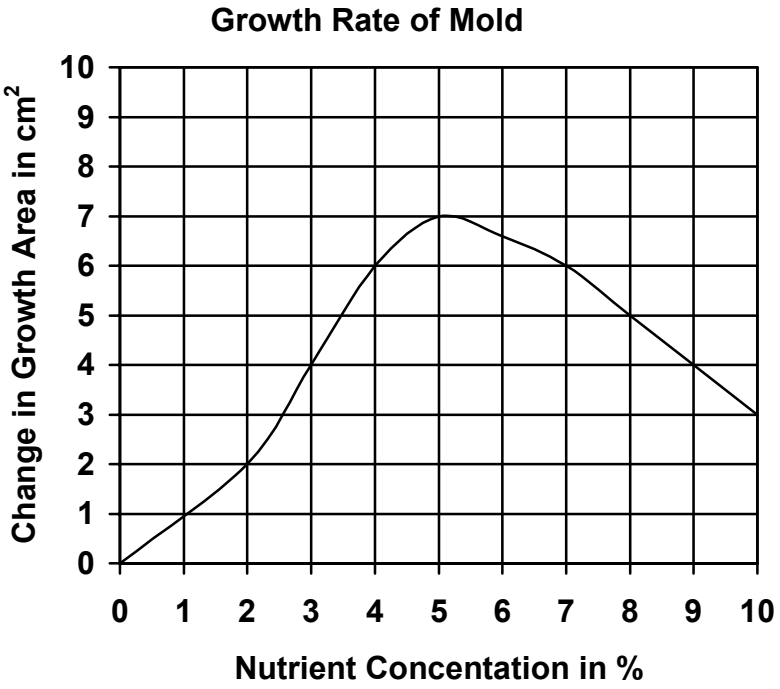
7. The dependent variable is generally plotted on the y-axis of a graph. The independent variable is generally plotted on the x-axis. Label each axis. Include the units of measures in the labels. (4 points)



8. Use the data in table to plot the points on the graph. (2 points)

9. According to the data, is the hypothesis proven? What evidence supports your statement? (2 points)

Life Science Line Graph Assessment



1. What are the units of measure for the dependent variable in the graph above?

   a) %
   b) cm
   c) cm^2
   d) area

2. When the nutrient concentration in 6%, what is the growth area?

   a) 7.0 cm^2
   b) 6.7 cm^2
   c) 6.0 cm^2
   d) 6.1 cm^2

3. As x-values increase, what is happening to y-values? How does this support the hypothesis?

Hypothesis: An increase in nutrient concentration causes an increase in mold growth.