Introduction to Biology Lab & Class Activity Worksheets

Contents

LAB: The Penny Drop Lab

NAME:_____

DATE:_____

SCIENTIFIC METHOD

The Penny Drop Lab

Introduction: Which side of a penny will hold more drops of water before spilling over on to a paper towel?

OBJECTIVE: In this activity, you will use the scientific method of inquiry to perform a laboratory experiment. The basic parts of the scientific process include the following:

1. Make observations
2. Formulate an hypothesis
3. Test the hypothesis
4. Collect and analyze data
5. Draw a conclusion

Materials:

- Small beaker of distilled water
- Paper towels
- one pipette
- One penny
- Alcohol
- 2 cotton balls
- Rule**r**

PROCEDURE:

1. As you follow the instructions to complete this lab, fill in the steps of the scientific method by writing what you did at each step.

STATE PROBLEM:

_____
_____
_____
_____

RECORD SEVERAL OBSERVATIONS ABOUT THE PENNY:

a. (Sample answers include : civilizations had a number system, a language, honored important people, knowledge about metallurgy and architecture, tools for mining, religion, etc.)

b.

c.

d.

e.

f.

g.

FORMULATE A HYPOTHESIS:

_____
_____
_____
_____

TEST THE HYPOTHESIS – PROCEDURE:

1. Using a paper towel, clean both sides of the penny with alcohol. Why do you think you are doing this?
2. On the lab table, place the penny heads up on a paper towel.
3. Squeeze the bulb of the pipette so that one drop lands on the penny. Record this number in the data table.
4. Wipe the penny dry of water.
5. Repeat steps 1-4 two more times. Record these numbers in the data table.
6. Calculate the mean (average) of the three trials and enter in the data table.
7. Flip the penny to the tails side and repeat steps 3-6.

DATA TABLE:

HEADS	MEAN	TAILS	MEAN
Trial 1		**Trial 1**	
Trial 2		**Trial 2**	
Trial 3		**Trial 3**	

ANALYZE DATA:

HEADS –

TAILS –

GRAPH DATA:

Construct a bar graph using your data collected. Plot the MEAN data for both heads and tails on the same bar graph. Color the bar graph using one color for heads and a different color for tails. Remember to label all parts of your bar graph.

STATE YOUR CONCLUSION:

LAB: Variables- Alka Seltzer Activity

NAME:_____

DATE:_____

Variable: Alka Seltzer Activity

PART 1:

PROCEDURE:

Directions:

Complete the following questions and activities.

Questions and Activities

1. How much time do you think it will take for an Alka Seltzer tablet to dissolve (disappear) when dropped into 150mL of water at room temperature, in ice water, and in hot water? Record predictions in the table below.
2. Take a thermometer and determine the temperature of water at room temperature, in ice water, and in hot water. Using a timing device, test your predictions and enter results in the data table.

	DATA TABLE		
Water Condition	**Water Temperature**	**Predicted Results**	**Tested Results**
ROOM TEMP			
ICE WATER			
HOT WATER			

PART 2:

Directions:

Using graph paper, construct a line graph of tested results.

Questions:

Examine your graph and determine what relationship exists between water temperature and dissolving time.

_____

_____

_____

1. Using your graph, predict the dissolving time for the following temperatures:

a. 45°_____

b. 70°_____

c. 5° _____

PART 3:

A. Directions:

1. When experimenting, it is very important to control as many variables as possible. In scientific experiments there are three types of variables (factors). These are:

   MANIPULATED VARIABLE: Is systematically changed by the investigator
   RESPONDING VARIABLE: Changes as a result of the manipulation
   CONTROLLED VARIABLES: Are factors not allowed to change

B. Questions:

1. **List the variables in Part 1 that were controlled:**
   ____
   ____
   ____
   ____
   ____

2. Identify the manipulated variable.
   ____

3. Identify the responding variable**.____**

Write a statement that shows the relationship between water temperature and dissolving time.

_____
_____
_____
_____
_____

LAB: Shape of Water versus Drop Height

NAME:_____

DATE:_____

SCIENTIFIC METHOD Shape of Water versus Drop Height

INTRODUCTION: If you dribble Kool-Aid while you are standing when you pour it, will it splatter more or less than if you are sitting when you pour it?

OBJECTIVE: In this activity, we will practice using the scientific method while investigating the effect of drop height on the size and shape of water droplet splatters when they land. We will be careful to change only the one item whose effect we will observe. This is called the EXPERIMENTAL VARIABLE. All of the other conditions must be kept completely identical. These conditions are called CONTROLS.

PROCEDURE:

As you follow the instructions to complete the water droplet investigation, fill in the steps of the scientific method by writing what you do at each step.

STATE PROBLEM:

_____
_____
_____
_____

GATHER INFORMATION (Name sources of information.):

a.)_____ b.)_____
c.)_____ d.)_____

MAKE HYPOTHESIS:

EXPERIMENT:

_____
_____
_____
_____

RECORD DATA: Use data table.

FORM CONCLUSION:

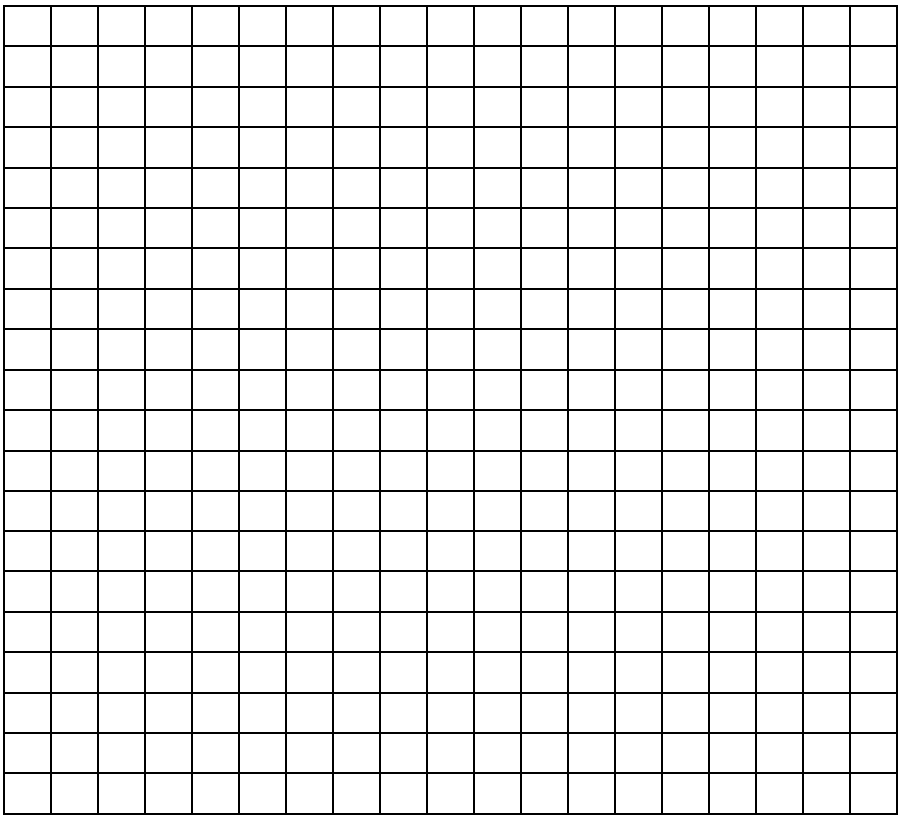
1. Add 2 drops of food coloring to your beaker
2. Add 100 mL of water and mix
3. Partially fill the pipette with colored water
4. Measure the heights listed in the data table using a metric ruler or a meter stick. Position it with one end on the splatter paper and the other end measuring drop height.
5. From each height, drop 3 drops of the colored water in different places on the paper.
6. Measure the diameter of the splatter in millimeters. Record each trial size in the data table. Add the 3 sizes to get a total. Divide by 3 to find the average size of each splatter.
7. Repeat this process for each height.
8. For each drop height, write a description of the splatter in the data table. For example: 'Drop is very round" 'Drop broke apart" 'Drop is surrounded by little splatters"
9. On the graph, construct a bar graph, label the axes, and plot the average splatter versus the drop height.

DATA: DIAMETER OF DROP SPLATTERS (mm)

Drop Height	Trial #1	Trial #2	Trial #3	TOTAL	AVERAGE	DESCRIPTION
5 cm						
10 cm						
20 cm						
40 cm						
80 cm						

SHAPE OF WATER VERSUS DROP HEIGHT

Splatter Size mm



Height - cm

QUESTIONS:

1. How does your conclusion compar
hypothesis?_____
_____
_____

2. Describe two things (controls) that you had to do exactly the same for each trial to make sure you were as accurate as you could
be._____(a)_____
_____
_____(b)_____
_____

3. Why are measurements better than verbal descriptions in reporting scientific data?_____

_____

_____

4. If you need to clean up a small spill area, should you pour your Kool-Aid from a height of two inches or two feet above your beaker?_____

_____

_____Why?_____

_____

LAB: Graphing Review

Purpose of the Exercise:

- To review common types of graphs you will be using this semester in your lab reports.
- To complete two class investigations on Heart Rate and Exercise and Height versus Shoe Size.
- Determine which graph would be best to use for each and create the graphs on graph paper NEATLY and PROFESSIONALLY by hand for your lab report.

Graphs Must Include:

1. **Title:** A brief explanation of the graph's content
2. **Legend (Key):** Tells the person reading the graph what is on the x-axis, y-axis and what data is being represented.
3. **Source:** Tells the person reading the graph where you have found the data being illustrated. You must give credit to your sources if you found the information through research.

X-AXIS:

- The horizontal axis
- Has numbers representing different time periods or names of items being compared
- The INDEPENDENT VARIABLE is plotted on the x-axis
    A. A variable is an object, event, idea, feeling, time period, or any other category you are measuring
    B. The variable that is altered (by the scientist) is called the independent variable
    C. The independent variable is not affected by other factors. For example, if you were investigating the number of jumping jacks people of different ages can do, the ages YOU SELECT for your experiment are the independent variable. The number of jumping jacks a person can do will not change his/her age.

Y-AXIS:

- The vertical axis
- Generally, the y-axis has numbers to represent the measurements (data) you collected
- The DEPENDENT VARIABLE is plotted on the y-axis
    1. The variable(s) that change in response to the independent variable are called dependent variable(s).
    2. The dependent variable is affected by other factors. How many jumping jacks a person can do is affected by how old the person is. Thus, the number of jumping jacks is the dependent variable.

Graphing Exercise #1: <u>Heart Rate Response to Exercise:</u>

"Heart Rate Responses to Exercise": For this exercise, you will be measuring the response of your heart rate to 2 minutes of exercise**. **Do NOT perform this experiment if you have a medical condition that may cause you injury during this exercise!!!**

- Each person in the group will begin by measuring their Resting Heart Rate (RHR) from their Carotid Artery (neck) or Radial Artery (wrist/thumb side) for 15 seconds. (Multiply the number x 4 to get your RHR in beats/minute). This will be the first measurement. Take a few minutes to practice finding and measuring your pulse. *Please note: Use the same artery for each reading for consistent results.
- Then, do jumping jacks for 2 minutes. Immediately after the 2 minutes, check your heart rate again for 15 seconds (Multiply the number x 4 to get your heart rate in beats/minute). This will be your second measurement.
- Measure your heart rate (with the same procedure) every minute thereafter, for 10 minutes.
- You may already be thinking about what may happen to your heart rate during and immediately after doing the jumping jacks. Discuss your group hypothesis. (It may be interesting to collect data from at least two of your group members to compare the results. Are there lab group members that are exercise fanatics and others that are non-athletic? Do you think there would there be a difference in the two graphs??)

What would you expect to happen in this experiment (Your hypothesis)?

_____

_____

Student performing exercise: _____

	Heart Rate in 15 sec (x 4 to get HR in beats/min)
Resting Heart Rate	
Immediately after 2 minutes of Exercise	
1 minute post exercise	
2 minutes post exercise	
3 minutes post exercise	
4 minutes post exercise	
5 minutes post exercise	
6 minutes post exercise	
7 minutes post exercise	
8 minutes post exercise	
9 minutes post exercise	
10 minutes post exercise	

Graph the results from your group on graph paper:

According to the Pre-lab Lecture, which type of graph would be best to use for this experiment? Why?

_____

_____

Which reading will go on the X-axis? Why?

_____

Which reading will go on the Y-axis? Why?

_____

Results: Did your data support your hypothesis (What you thought would happen)?

_____

_____

*Remember to include the parts of the graph: Title and Legend. Remember to make each data point, line, or pie piece, etc.. a different color and/or the data points different shapes to differentiate between the different students in your group. Heart Rate readings are to be graphed in beats/minute.

Graphing Exercise #2: <u>Comparing Height to Shoe Size: ENTIRE CLASS DATA</u>

"Comparing Height to Shoe Size": We will investigate whether there is a relationship between height and shoe size. (Because Male and Female shoe sizes differ, when graphing the results use different colors for Males and Females)

-**Males:** Blue

- **Females:** Pink/Red

<u>MALE DATA</u>

Height in inches	**Shoe Size**

FEMALE DATA

Height in inches	**Shoe Size**

<u>Graph the results from your group on graph paper</u>:

According to the Pre-lab Lecture, which type of graph would be best to use for this experiment? Why?

What are you going to plot on the X-axis? Why?

_____

What are you going to plot on the Y-axis? Why?

_____

Results: After plotting the class data, is there any relationship between Height and Shoe Size? How could you tell if there was a relationship or not?

_____
_____
_____

*Remember to include the parts of the graph: Title and Legend. Remember to make male- blue color and females- pink/red to differentiate between them.

LAB: Shape of Water versus Drop Height

NAME:_____

DATE:_____

SCIENTIFIC METHOD Shape of Water versus Drop Height

INTRODUCTION: If you dribble Kool-Aid while you are standing when you pour it, will it splatter more or less than if you are sitting when you pour it?

OBJECTIVE: In this activity, we will practice using the scientific method while investigating the effect of drop height on the size and shape of water droplet splatters when they land. We will be careful to change only the one item whose effect we will observe. This is called the EXPERIMENTAL VARIABLE. All of the other conditions must be kept completely identical. These conditions are called CONTROLS.

PROCEDURE:

As you follow the instructions to complete the water droplet investigation, fill in the steps of the scientific method by writing what you do at each step.

STATE PROBLEM:

_____
_____
_____
_____

GATHER INFORMATION (Name sources of information.):

a.)_____ b.)_____
c.)_____ d.)_____

MAKE HYPOTHESIS:

EXPERIMENT:

_____
_____
_____
_____

RECORD DATA: Use data table.

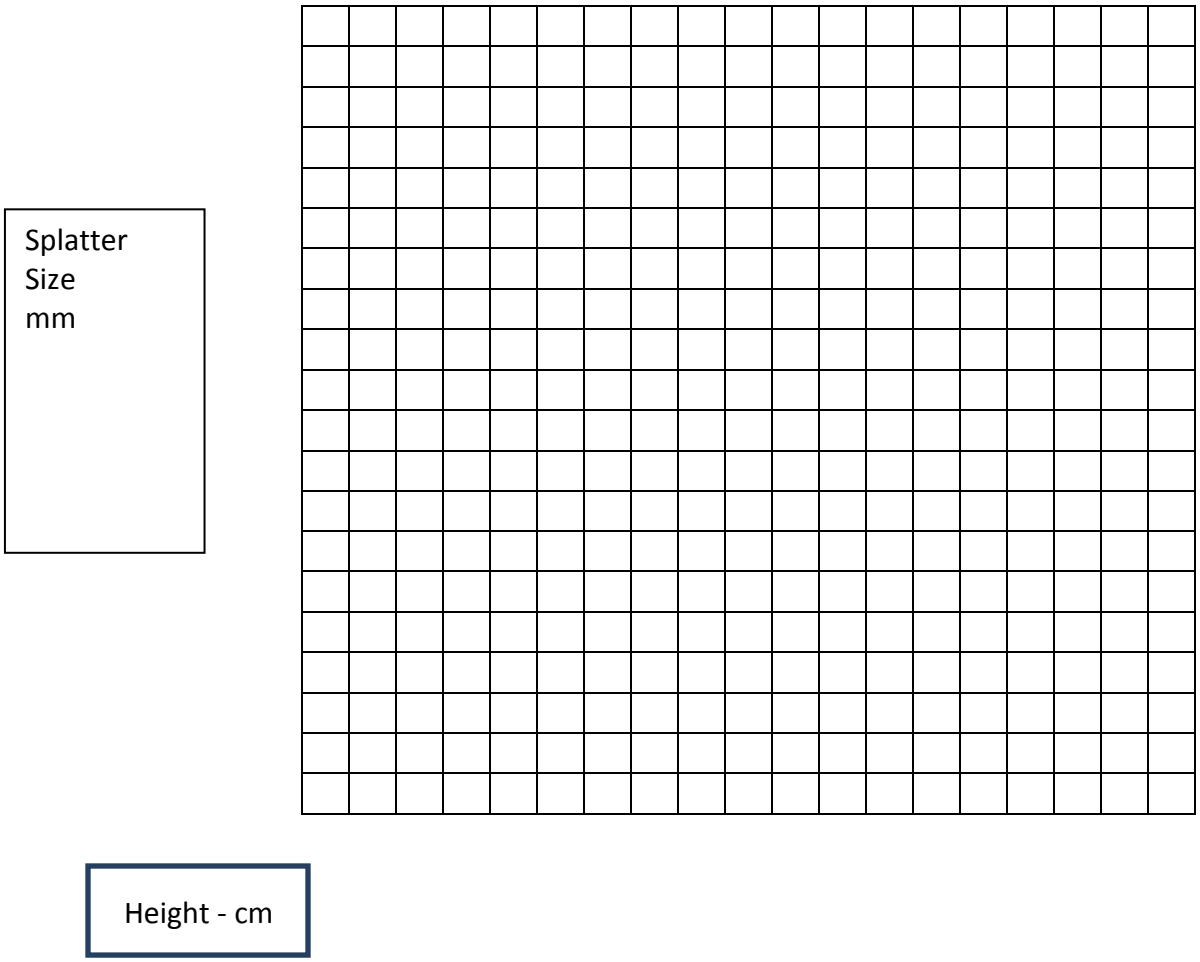
FORM CONCLUSION:

10. Add 2 drops of food coloring to your beaker
11. Add 100 mL of water and mix
12. Partially fill the pipette with colored water
13. Measure the heights listed in the data table using a metric ruler or a meter stick. Position it with one end on the splatter paper and the other end measuring drop height.
14. From each height, drop 3 drops of the colored water in different places on the paper.
15. Measure the diameter of the splatter in millimeters. Record each trial size in the data table. Add the 3 sizes to get a total. Divide by 3 to find the average size of each splatter.
16. Repeat this process for each height.
17. For each drop height, write a description of the splatter in the data table. For example: 'Drop is very round" 'Drop broke apart" 'Drop is surrounded by little splatters"
18. On the graph, construct a bar graph, label the axes, and plot the average splatter versus the drop height.

DATA: DIAMETER OF DROP SPLATTERS (mm)

Drop Height	Trial #1	Trial #2	Trial #3	TOTAL	AVERAGE	DESCRIPTION
5 cm						
10 cm						
20 cm						
40 cm						
80 cm						

SHAPE OF WATER VERSUS DROP HEIGHT



QUESTIONS:

5. How does your conclusion compar
hypothesis?_____
_____
_____

6. Describe two things (controls) that you had to do exactly the same for each trial to make sure you were as accurate as you could
be._____(a)_____
_____
_____(b)_____
_____

7. Why are measurements better than verbal descriptions in reporting scientific data?_____

_____

_____

8. If you need to clean up a small spill area, should you pour your Kool-Aid from a height of two inches or two feet above your beaker?_____

_____

_____Why?_____

_____

LAB: Graphing Review

Purpose of the Exercise:

- To review common types of graphs you will be using this semester in your lab reports.
- To complete two class investigations on Heart Rate and Exercise and Height versus Shoe Size.
- Determine which graph would be best to use for each and create the graphs on graph paper NEATLY and PROFESSIONALLY by hand for your lab report.

Graphs Must Include:

1. **Title:** A brief explanation of the graph's content
2. **Legend (Key):** Tells the person reading the graph what is on the x-axis, y-axis and what data is being represented.
3. **Source:** Tells the person reading the graph where you have found the data being illustrated. You must give credit to your sources if you found the information through research.

X-AXIS:

- The horizontal axis
- Has numbers representing different time periods or names of items being compared
- The INDEPENDENT VARIABLE is plotted on the x-axis
    D. A variable is an object, event, idea, feeling, time period, or any other category you are measuring
    E. The variable that is altered (by the scientist) is called the independent variable
    F. The independent variable is not affected by other factors. For example, if you were investigating the number of jumping jacks people of different ages can do, the ages YOU SELECT for your experiment are the independent variable. The number of jumping jacks a person can do will not change his/her age.

Y-AXIS:

- The vertical axis
- Generally, the y-axis has numbers to represent the measurements (data) you collected
- The DEPENDENT VARIABLE is plotted on the y-axis
    3. The variable(s) that change in response to the independent variable are called dependent variable(s).
    4. The dependent variable is affected by other factors. How many jumping jacks a person can do is affected by how old the person is. Thus, the number of jumping jacks is the dependent variable.

Graphing Exercise #1: <u>Heart Rate Response to Exercise:</u>

"Heart Rate Responses to Exercise": For this exercise, you will be measuring the response of your heart rate to 2 minutes of exercise**. **Do NOT perform this experiment if you have a medical condition that may cause you injury during this exercise!!!**

- Each person in the group will begin by measuring their Resting Heart Rate (RHR) from their Carotid Artery (neck) or Radial Artery (wrist/thumb side) for 15 seconds. (Multiply the number x 4 to get your RHR in beats/minute). This will be the first measurement. Take a few minutes to practice finding and measuring your pulse. *Please note: Use the same artery for each reading for consistent results.
- Then, do jumping jacks for 2 minutes. Immediately after the 2 minutes, check your heart rate again for 15 seconds (Multiply the number x 4 to get your heart rate in beats/minute). This will be your second measurement.
- Measure your heart rate (with the same procedure) every minute thereafter, for 10 minutes.
- You may already be thinking about what may happen to your heart rate during and immediately after doing the jumping jacks. Discuss your group hypothesis. (It may be interesting to collect data from at least two of your group members to compare the results. Are there lab group members that are exercise fanatics and others that are non-athletic? Do you think there would there be a difference in the two graphs??)

What would you expect to happen in this experiment (Your hypothesis)?

_____

_____

Student performing exercise: _____

	Heart Rate in 15 sec (x 4 to get HR in beats/min)
Resting Heart Rate	
Immediately after 2 minutes of Exercise	
1 minute post exercise	
2 minutes post exercise	
3 minutes post exercise	
4 minutes post exercise	
5 minutes post exercise	
6 minutes post exercise	
7 minutes post exercise	
8 minutes post exercise	

9 minutes post exercise	
10 minutes post exercise	

Graph the results from your group on graph paper:

According to the Pre-lab Lecture, which type of graph would be best to use for this experiment? Why?

_____
_____

Which reading will go on the X-axis? Why?

_____

Which reading will go on the Y-axis? Why?

_____

Results: Did your data support your hypothesis (What you thought would happen)?

_____
_____

*Remember to include the parts of the graph: Title and Legend. Remember to make each data point, line, or pie piece, etc.. a different color and/or the data points different shapes to differentiate between the different students in your group. Heart Rate readings are to be graphed in beats/minute.

Graphing Exercise #2: <u>Comparing Height to Shoe Size: ENTIRE CLASS DATA</u>

"Comparing Height to Shoe Size": We will investigate whether there is a relationship between height and shoe size. (Because Male and Female shoe sizes differ, when graphing the results use different colors for Males and Females)

-**Males:** Blue
- **Females:** Pink/Red

<u>MALE DATA</u>

Height in inches	**Shoe Size**

FEMALE DATA

Height in inches	**Shoe Size**

<u>Graph the results from your group on graph paper</u>:

According to the Pre-lab Lecture, which type of graph would be best to use for this experiment? Why?

What are you going to plot on the X-axis? Why?

_____

What are you going to plot on the Y-axis? Why?

_____

Results: After plotting the class data, is there any relationship between Height and Shoe Size? How could you tell if there was a relationship or not?

_____
_____
_____

*Remember to include the parts of the graph: Title and Legend. Remember to make male- blue color and females- pink/red to differentiate between them.

LAB: Using the Compound Microscope

NAME:_____

MICROSCOPE NUMBER_____

DATE_____

The Compound Microscope

Objectives:

- To identify the parts of a compound microscope and their functions
- To demonstrate proper techniques for handling a compound microscope
- To define the terms: parfocal, magnification, resolution, field of view
- To demonstrate the ability to focus on a prepared slide
- To estimate the size of an object in a field

This lab will begin with a discussion of the handling procedures that are used with the compound microscope. Then you will perform several experiments that will allow you more fully to understand the working of your instrument. As you proceed you should answer the questions and fill in the requested information on this worksheet. Be sure to ask your instructor for assistance as needed.

1. Parts of the compound microscope

Obtain a compound and note its number on the front of the lab. As a class we will proceed to identify each of the structures listed below. Refer to the diagram of the microscope as a reference.

A. Support system – arm and base

The entire upper assembly of the microscope is held in an upright position by bar called the arm. The microscope is supported by a square or horsh-shaped base. When carrying your microscope you should hold it by the arm with one hand while supporting it firmly under the base with the other hand.

B. Eyepiece or ocular

The eyepiece or ocular is a set of lenses closest to your eye. Your microscope is binocular which means it has two oculars. These magnify an image by the factor indicated on the side of each eyepiece, usually 10X. If the factor is 10X, the image is magnified ten times by this set of lenses. Locate this number on your ocular and record its value.

Magnification of eyepiece = _____

Notice that the two oculars can be moved closer together or farther apart to match the distance between the user's eyes. Be sure to make this adjustment when you begin to use your microscope.

C. Body tube
The body tube holds the oculars in place.

D. Revolving nosepiece
This circular mechanism is located at the bottom of the body tube. Attached to the revolving nosepiece are several sets of lenses called objective lenses. By rotating the revolving nosepiece, you may select different objectives for use. When rotating the nosepiece be sure the objective lenses clicks securely into position.

Always rotate the nosepiece by holding the outside of the revolving disk – never use the objective lens themselves.

E. Objective lenses
Your microscope should have three objective lenses, each marked with its magnification factor.

4X (scanning objective) –used to initially survey a slide and locate the specimen to be studies

10X (low power objective) – may also be used for initial location of the specimen; used for specimens not requiring greater magnification

40X (high-dry objective) – used for specimens requiring greater magnification; this lens is called "dry" because it does not require the use of oil

Many microscopes also have a 100X or high-oil objective (oil immersion objective); this lens is used for magnification of extremely small specimens such as bacterial cells; it is used with a special microscope oil which is placed on the slide

During lab the term “low power” will be used to refer to the and “high power” will refer to the 40X objective. We will not be using the oil immersion objective. Make sure the scanning lens is now clicked into position on your microscope.

F. Total magnification-enlarging an image of an object

The total magnification of your lens system is obtained by multiplying the power of the objective lens in use by the power of the ocular lens. For example, to calculate the total magnification of you scanning lens:

Magnification of ocular (10X) times magnification of scanning lens (4X) = 40X

Use this equation to complete the chart below:

	Ocular lens	**Objective lens**	**Total Magnification**
Scanning lens	**10X**	**4X**	**40X**
Low power			
High dry power			

Besides enlarging an object, lenses can also detect details of an object. This is called resolution. Resolving power is the ability to see two close points as distinct points. If an instrument has resolving power such that two close points are seen as a single point, no amount of magnification will make it possible to see two distinct points- the single point is merely enlarged. Resolving power of lenses depends on the probe (light for our scopes), the quality and cleanliness of the lenses. The microscopes that we use allow us to resolve points that are 0.25 microns apart.

1mm = 1000 microns (μ)

1μ = 10 angstroms (A)

G. Stage

The specimen is usually mounted on a glass or plastic microscope slide and placed on the platform just below the objective lenses

which is called the stage. The stage has a hole in the center (aperture) so that light can pass through the specimen from below.

Your microscope has a mechanical stage, one that can be moved. This means that you do not have to touch the slide to move it, but rather use the knob to the right of the stage to change the position of the slide. Try moving the stage using the mechanical stage knob.

H. Light

Below the stage is a high-intensity lamp. Light rays travel from this source, up through the hole in the stage, through the specimen then through the objective and ocular lenses to the eye. You turn the light on by using the on/off circular switch located on the lower left side of the base. You also may control the intensity of the light by adjusting this same switch. Be sure to turn off the lamp before you put the scope away.

At this time, plug in your microscope and practice turning the light on and off.

I.Consenser

The condenser is a special lens located between the light and the stage. It serves to focus the light rays onto the specimen.

J. Iris Diaphragm

Light intensity may also be adjusted by changing the opening of the iris diaphragm located under the stage.

Below the front of the stage you will find a small lever that projects from the iris diaphragm. This lever is moved to dilate or constrict the opening of the diaphragm. Locate this lever and move it gently back and forth once or twice while looking through the oculars. Do you see a change in light intensity?

K. Focus adjustment knobs

Your microscope has two focusing knobs – a course adjustment knob and a fine adjustment knob. These knobs are located on the lower part of the arm on both sides of the microscope. When rotated, each of these two knobs adjusts the distance between the stage and the objective lens, allowing you to focus an image of the specimen. The

course adjustment knob changes the distance between the stage and objective lens very quickly, while the fine adjustment knob changes this distance much more gradually. Try slowly rotating each of these focus knobs and observe the degree of movement you produce in the stage.

The course adjustment knob should only be used for initial focusing under scanning or low power.

Focusing under high-dry and high-oil should only involve the fine adjustment knob.

Your microscope is parfocal which means that once you initially focus under one power, the object you are viewing should be in focus (or almost in focus) when you change to another objective lens.

Review what you have learned so far by placing the name of the scope part next to its description.

_____lens located at the superior end of body tube
_____concentrates the beam of light delivered to the specimen
_____used for precise focusing once the initial focusing has been done
_____rotates the objective lens into position
_____used to increase or decrease the amount of light passing through the specimen
_____another name for your 40X objective lens
_____platform on which the slide rests for viewing

Answer the following questions:
If you were viewing a specimen at a total magnification of 450X, and the microscope you were using had a 10X ocular, what would be the power of the objective lens you would be using?_____

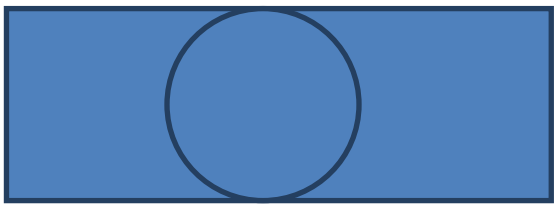
You have been given an unknown slide to examine with your microscope. What lens would you use first?_____

2. Using the Compound Microscope

Now that you are familiar with the parts of your microscope and what each does, you will practice using it to examine several prepared slides.

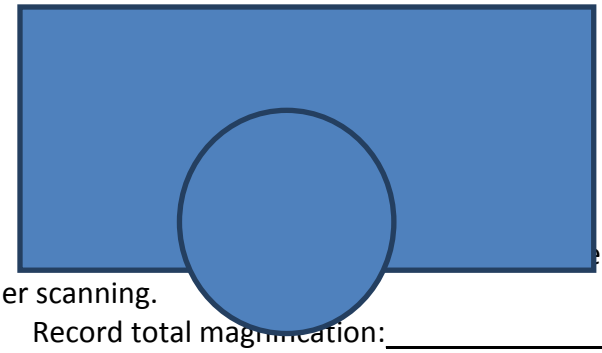
A. Viewing a slide of the letter "e"

1. Obtain a letter "e" slide.
2. Lay the slide on the top of your desk. In the space below, make a sketch of the letter "e" exactly as it is positioned on the slide. (If it is tilted or upside down, draw it exactly that way.)



3. Turn on your microscope light.
   Place the slide on the stage and use the mechanical stage knob to move the letter "e" into the center of the aperature.
4. Adjust the distance between the two oculars to fit the distance between your eyes.
5. Adjust the light intensity with either the light control knob or the iris diaphragm so it is comfortable for viewing.
6. Make sure your scanning lens is in position over the slide. Raise the stage to its highest position using the course adjustment knob while looking at the side of the microscope, not through the ocular. When using the microscope, you should always begin with the stage as close as possible to the objective lens. This means that you will be focusing down and moving farther away from the slide (preventing slide breakage) while you look through the ocular lenses.

7. Use the course adjustment knob to bring the letter “e” into focus.
8. The area you see through your ocular lenses is called the <u>field or field of view.</u>
9. (See next page)

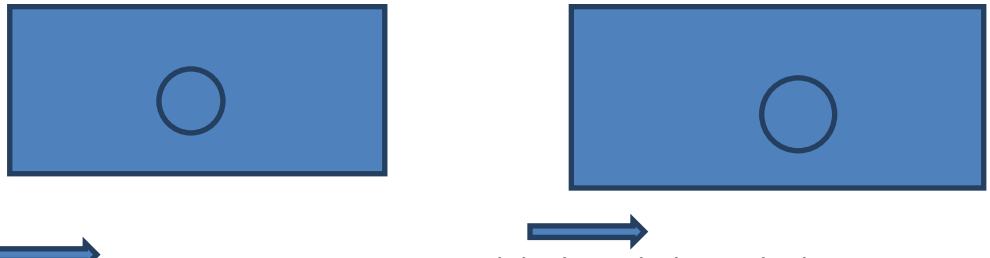


letter “e” as it appears under scanning.

Record total magnification:_____

Describe what has happened to the <u>position</u> of the letter “e” compared to its position when you viewed it on your desktop.

10. If you were to take a slide of the letter “b” and examine it your scanning lens, how would its position change?



scanning

11. As you view your slide through the ocular lenses, use the mechanical stage to move the slide to the right. In which direction does the letter “e” move?_____

    Now use the mechanical stage to move your slide towards you. In which direction does the letter “e” move?_____
12. Position your slide so that the letter “3” is on the far left of your field of view. Change your objective lens from scanning (4X) to low power (10X). <u>DO NOT MOVE THE SLIDE,</u>but look through your oculars to see if you see the letter “e”. Is it visible?_____ Rotate

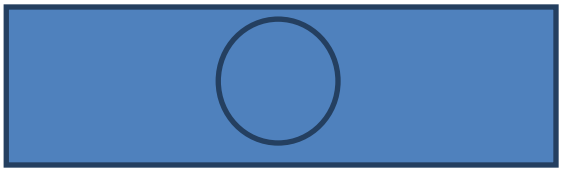
the revolving nosepiece to click the scanning lens back into position. Center the letter "e" in your field of view. Change to the low power objective (10X) and see if the letter is now visible.

As you now realize, it is very important to <u>center the object you are viewing before changing objectives.</u>

What happens to the field of view as you increase magnification> Does it get larger or smaller?_____

13. As you changed from scanning to low power, did the light intensity change?_____How does light intensity change with an increase in magnification? _____Be sure to make adjustments in light intensity as you change lenses.
14. Make a sketch of your field of view with the letter "e" as it appears under low power.

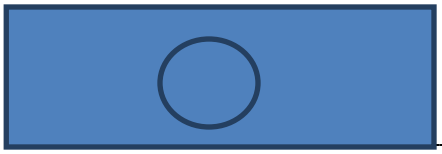
Record Total Magnification___



15. Before changing to your high power objective lens, note the distance between the bottom of your low power lens and the slide as it sits on the stage. This space is called the <u>working distance.</u> Click your high power objective into position and note the working distance. Does the working distance increase or decrease as you go up in magnification?_____
16. Examine the letter "e" under high power (40X). Is the image in focus?_____ _If not, use <u>only the fine adjustment knob</u> to bring the image into focus. Why do you think it is important to use only the fine adjustment knob when working with the high power lens?_____

_____
_____

17. Make a sketch of your field of view with the letter “e” as it appears under high power.



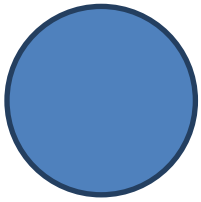
_____
_____

18. Return the letter “e” to the slide box.

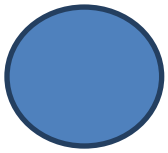
A. <u>Determining Field Diameter</u>

It is often useful to know the approximate size of a specimen you are examining with the microscope. In order to determine its size, it is necessary to know the diameter of your field of view.

1. Obtain a slide with a metric ruler taped to it.
2. Using your <u>scanning objective</u>, position and focus the ruler so that the mm marks run across your field of view.



3. Switch to your low power (10X) objective. Position the ruler so that one of the vertical mm lines is just visible on the far left of the field of view.



The spaces between the vertical lines each is equal to 1 mm. Counting the number of spaces you see, calculate the total diameter across your field of view.
Diameter = _____mm. Since objects viewed through the microscope are usually much smaller than 1 mm, the

(µ) is commonly used to express size. 1 mm = 1,000 (µ) (microns)
What is the diameter of your low power field in µ? _____

4. In order to determine the size of a specimen seen under your high power objective, you will need to know the field size diameter for this lens. It is very difficult to actually measure the diameter, given the magnification of the high power objective. Instead,

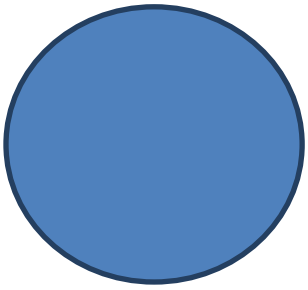
you can use the field diameter of the low power objective to calculate the field diameter of the high power lens using the following equation:
(magnification of low power objective) X (low power field diameter) = (magnification of high power objective) X (high power field diameter)

Solving for the high power field diameter:
High power field diameter = (magnification of low power objective) X (low power field diameter)
_____
Magnification of high power objective

Examining prepared biological specimens

A. Obtain a prepared slide of Amoeba proteus.

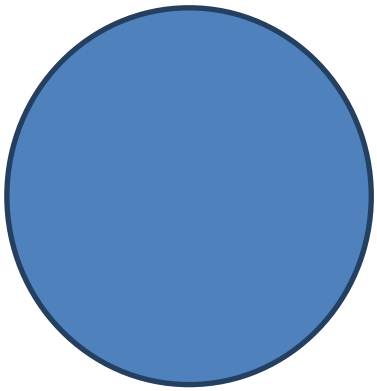
1. Locate a sample under scanning and then under low power and high power.
2. Make a sketch of your specimen under either low or high power.



Total Magnification _____

3. Why do you think the Amoeba are colored?

B. Obtain a prepared slide of frog skin (Rana pipiens)
   1. Locate a sample under scanning and then under low power and high power.
   2. Make a sketch of a group of these cells under either low or high power.



Total magnification_____

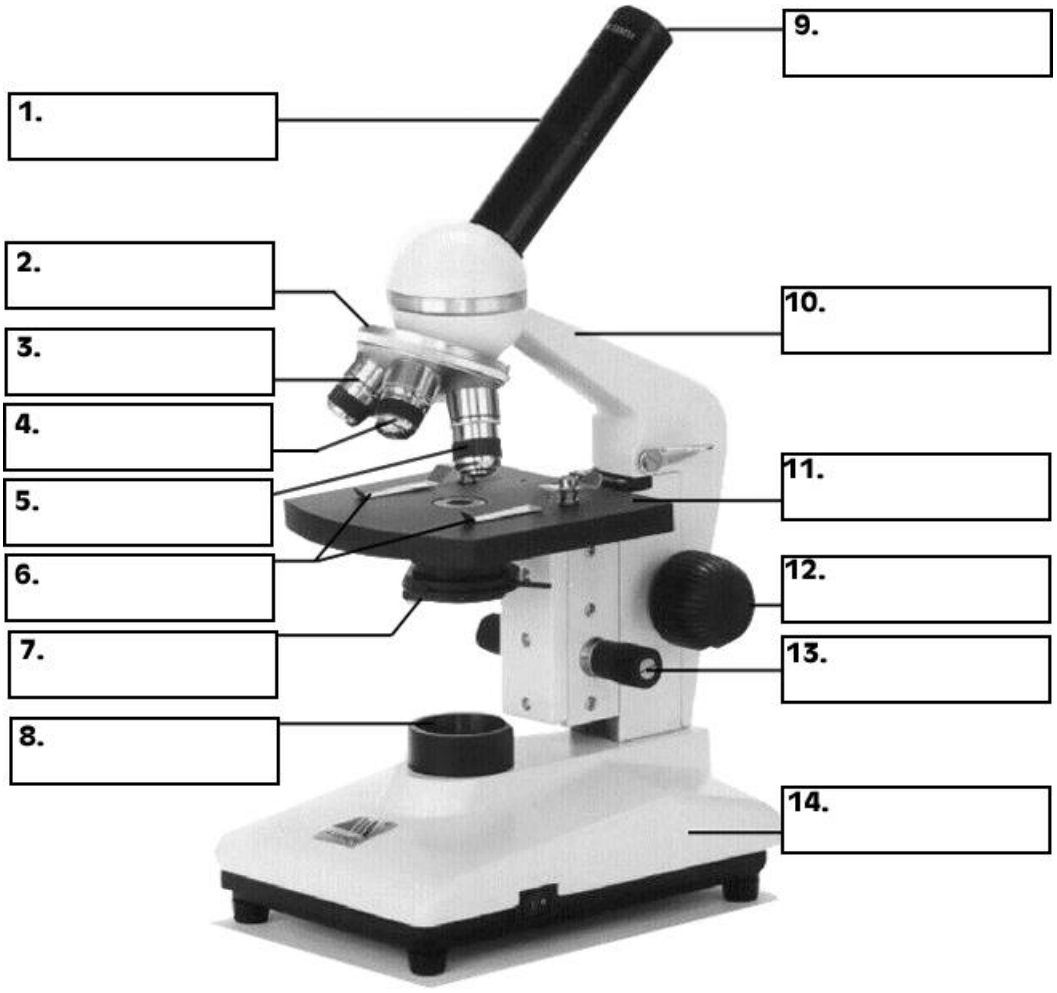
When you are finished:

1. Return the prepared slides to the appropriate box
2. Turn the microscope light off
3. Click the scanning lens into position and raise the stage to its highest position
4. Unplug the scope and wrap the wire around the base of the microscope
5. Cover your microscope and return it to the numbered slot in the cabinet

Assessment:

1. Microscope labeling
2. Microscope parts and functions
3. Microscope questions

Name_____
Microscope Labeling



1. Ocular
2. Objectives
3. Stage
4. Stage clips
5. Diaphragm
6. Course adjustment
7. Fine adjustment
8. Revolving nosepiece
9. Lamp

NAME:
Write the functions of the above microscope parts.

NAME_____

TOPIC

COMPOUND MICROSCOPES

Using a separate piece of paper, answer the following questions about compound microscopes:

1. What is the correct way to transport a compound microscope?
2. What is the set of lenses closest to the eye called?
3. What holds the oculars in place?
4. What is attached to the revolving nosepiece?
5. What is the correct method for rotating the nosepiece of a compound microscope?
6. Name the three objective lenses and tell what the magnification is for each one.
7. How do we find the total magnifications of your lens system?
8. How do you move the mechanical stage on a compound microscope?
9. What is the function of the condenser?

LAB: Exploring Cells

NAME:_____

MICROSCOPE NUMBER_____

DATE_____

Exploring Cells

DATA

1. Identify:
   a. Anton van Leuwenhoek

   b. Robert Hooke

2. Read the following descriptions van Leeuwenhoek wrote about his cabinet and microscope and the "animalcules" he saw.

"I have a very little Cabinet, lacquered black and gilded, that comprehendeth within it five little drawers, wherein lie inclosed 13 long and square little tin cases, which I have covered over with black leather; and in each of these little cases lie two ground magnifying glasses (making 26 in all), every one of them ground by myself, and mounted in silver, and furthermore set in silver, almost all of them in silver that I extracted from the ore, and separated from the gold wherewith it was charged; and therewithal is writ down what object standeth before each little glass.
This little Cabinet with the said magnifying glasses, as I may yet have some use for it, I have committed to my only daughter, bidding her send it to You after my death, in acknowledgement of my gratitude for the honor I have enjoyed and received from Your Excellencies."

On October 4, 1723, Leuwenhoek's daughter, Maria, fulfilled her father's request and delivered the "little Cabinet" to the Royal Society.
Leuwenhoek described his discovery of "animalcules" in a letter dated September 7, 1674, from Delft.

"About two hours distant from this Town there lies an inland lake, called the Berkelse Mere, whose bottom in many places is very marshy, or boggy. Its water is in winter very clear, but at the beginning or in the middle of summer it becomes whitish, and there are then little green clouds floating through it; which, according to the saying of the country folk dwelling thereabout, is caused by the dew, which happens to fall at that time, and which they call ho9ney-dew. This water is abounding with fish, which is very good and savoury. Passing just lately over this lake, at a time when the wind blew pretty hard, and seeing the water as described above, I took up a little of it in a glass phial; and examining this water the next day, I found floating therein divers earthy particles, and some green streaks, spirally

wound serpent-wise, and orderly arranged, after the manner of the copper or tin worms, which distillers use to cool their liquors as they distill over. The whole circumference of each of these streaks was about the thickness of a hair on one's head. Among these there were, besides, very little animalcules, whereof some were roundish, while others, a bit bigger, consisted of an oval. On these last I saw two little legs near the head, and two little fins at the hindmost end of the body. Others were somewhat longer than an oval. These animalcules had divers colours, some being whitish and transparent; others were green and very glittering scales Others again were green in the middle, and before and behind white; others yet were ashen grey. Twas wonderful to see. I judge that some of these little creatures were above a thousand times smaller than the smallest ones I have ever yet seen."

In the above letter, Leeuwenhoek is probably referring to the spirally arranged Spirogyra and the animalcules are probably different kinds of protozoans. He is also referring to Euglena, a green flagellate.

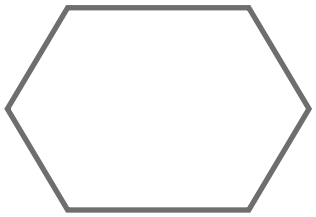
3. Read Robert Hooke's account of his observations of cork.

Robert Hooke, in 1665, wrote in *Micrographia* about his adventures into the unknown – at that time! World of the Microscope. In his writings on "Of the Schema tissue or Texture of Cork, and of the Cells and Pores of Some other such Frothy Bodies," Hooke recounts a most important observation.
"I took a good clear piece od cork, and with a Penknife sharp as keen as a Razor, I cut a piece of it off…then examining it very diligently with a microscope…I could exceedingly perceive it to be all perforated and porous, much like a Honey-Comb in these particulars…in that these pores, or cells, were not very deep, but consisted of a great many little Boxes…For, as to the first, since our Microscope informs us that the substance of Cork is altogether fill'd with Air, and that Air is perfectly enclosed in little Boxes or Cells distinct from one another."

<u>EXPERIMENT</u>

1. Prepare a dry mount of cork, as Hooke did. Diagram and describe the cells you see.

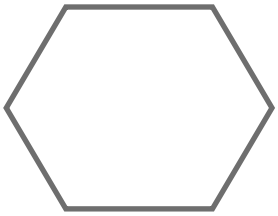
Description



Magnification_____

2. Prepare a wet mount of a piece of your hair. Diagram and descale what you see.

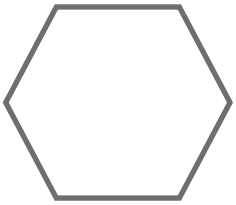
Description



Magnification_____

3. Prepare a wet mount of your cheek cells using the following procedure. Diagram and describe what you see.
    1. Place a drop of water on a slide.
    2. Use a toothpick to scrape some cells from the inside of your cheek. DO NOT RUB SO HARD THAT YOU CUT YOURSELF.
    3. Swirl the tip of your toothpick (with your cheek scrapings) in the water.
    4. Add a drop of iodine to the water and cheek cells.
    5. Carefully add a cover slip.
    6. Examine under low and high power.

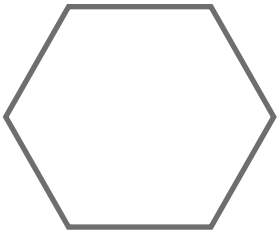
Description



Magnification_____

4. Prepare a wet mount of pond water. Diagram and describe what you see.

Description

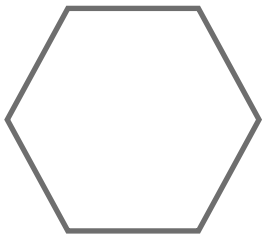


Magnification_____

5. Prepare a wet mount of an onion cell. Diagram and describe what you see.

    1. Place a drop of water on a slide.
    2. Remove a translucent "sheet" of onion from the inside piece of onion.
    3. Carefully place the onion "sheet" into the drop of water. Try not to have any wrinkles.
    4. Observe the slide under low and high power.

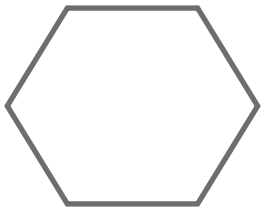
Description



Magnification _____

    5. Carefully lift the coverslip and add 1 drop of iodine to the onion "sheet".
    6. Wait 60 seconds.
    7. Observe the slide under low and high power. Note the differences.
    8. Record your observations.

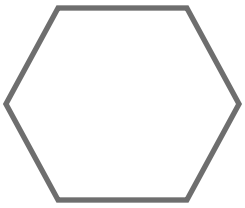
Description



Magnification_____

6. Prepare a wet mount of Spirogyra. Diagram and describe what you see.

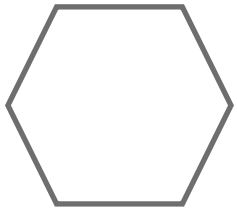
Description
Spirogyra
Green algae
Chloroplasts
Chlorophyll



Magnification_____

7. Prepare a wet mount of Elodea. Diagram and describe what you see.

Elodea
Description
Water plant
Chloroplasts
Chlorophyll



Magnification_____

LAB: Examination of Onion Cells

NAME : _____

MICROSCOPE NUMBER : _____

DATE : _____

Objectives :

- To prepare a wet mount of onion skin
- To stain the skin and identify cell parts
- Draw and label the onion cells under the microscope
- Complete a lab report

Directions for Students:

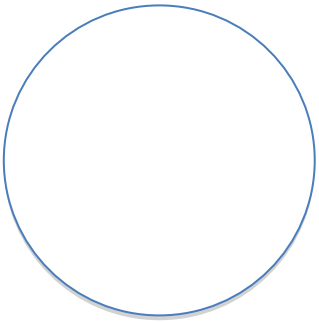
Lab: Examination of Onion Cells

Today you will examine live samples of onion cells. You will observe these cells under low and high power, draw and label the appropriate cell parts which include the nucleus, cell wall and cytoplasm. Answer all the questions below and follow the prescribed format for labeling.

1. Using a scalpel, shave off a very thin section of onion skin. Your sample should be only one to two cells thick.
2. Place the sample on a clean slide, add a drop of water and a cover slip and examine under low and high power. Measure the cell.
3. After you have examined that sample and drawn your diagrams and labels in the spaces provided, obtain another sample of onion skin and place it on a clean slide. This time you will add a drop or two of iodine or methylene blue.
4. Carefully observe the sample under the microscope using low and high power. Diagram and label all the parts visible.

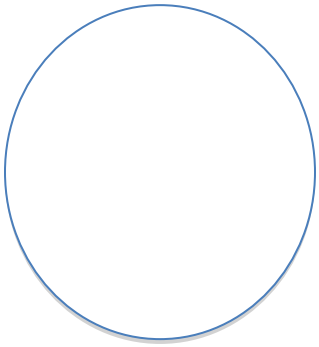
PART I : Preparation of the wet mount using water :

Using your finger nail or scalpel, peel off a very thin section of onion skin (one to two cells thick) and place it on a clean glass slide, add a few drops of water and cover with a cover slip. You will observe your sample under low and high power.



Onion Cells
Low Power

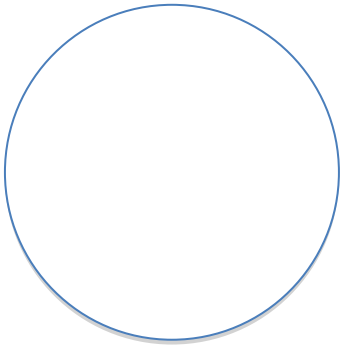
Measurement of onion cell : _____



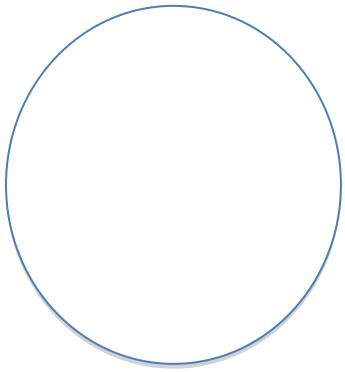
Onion Cells
High Power

PART II : Preparation of the wet mount using dye :

Prepare a new sample of onion skin in the same way you prepared the first. This time you will add a drop of iodine or methylene blue to the sample before placing the cover slip on top.



Onion Cells With Dye
Low Power



Onion Cells With Dye
High Power

OBSERVATIONS :

1. Describe how differently the samples looked with and without the dye.

   _____

   _____

   _____

2. In which kingdom are these cells placed and why?

   _____

   _____

3. Are these cells prokaryotic or eukaryotic? Provide reasons for your answer.

   _____

   _____

4. List the organelles that were possible to see in these samples.

   _____

5. Which organelles were not observable but are known to be present in these cells?

   _____

LAB: Examination of Elodea Cells

NAME : _____

MICROSCOPE NUMBER : _____

DATE : _____

Objectives :

- To prepare a wet mount of an elodea leaf
- To identify cell parts
- Draw and label the elodea cells under the microscope
- Complete a lab report
- To observe cyclosis in elodea cells

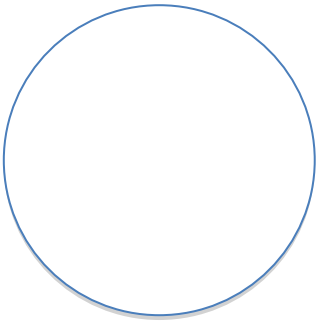
Directions To Students:
Lab : Examination of Elodea Cells

Today you will examine live samples of elodea cells. You will observe these cells under low and high power, draw and label the appropriate cell parts which include the nucleus, cell wall and cytoplasm, vacuole and chloroplasts. Answer all the questions below and follow the prescribed format for labeling.

5. Select a single leaf and place the sample on a clean slide, add a drop of the pond water in which the elodea leaf came, add a cover slip and examine under low and high power.
6. After you have examined that sample and drawn your diagrams and labels in the spaces provided, obtain another sample of elodea and place it on a clean slide. This time you will carefully observe cyclosis of chloroplasts. Cyclosis occurs naturally in plants and is the circular movement of chloroplasts around the exterior of the cell.

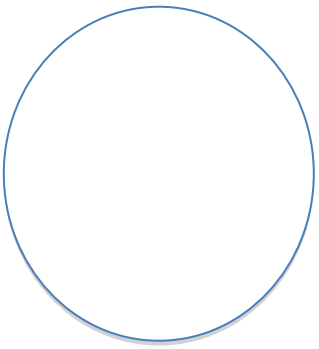
PART I : Preparation of the wet mount using water :

Select a single leaf and place it on a clean glass slide, add a few drops of pond water and cover with a cover slip. You will observe your sample under low and high power.



Elodea Cells
Low Power

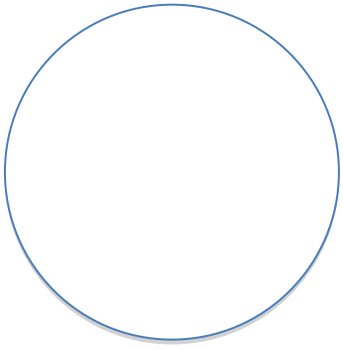
Measurement of elodea cells: _____



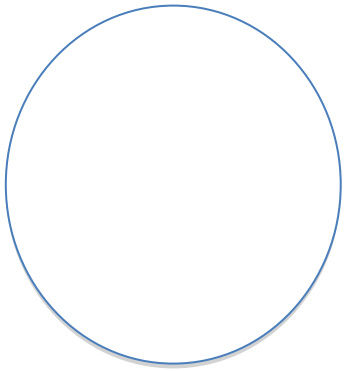
Elodea Cells
High Power

PART II : Observation of Cyclosis :

Prepare a new sample of elodea in the same way you prepared the first.



Cyclosis in Elodea
Low Power



Cyclosis in Elodea
High Power

OBSERVATIONS :

6. Describe how the plant and animals cells you observed differ from each other.

   _____

   _____

   _____

7. In which kingdom are these cells placed and why?

   _____

   _____

8. Are these cells prokaryotic or eukaryotic? Provide reasons for your answer.

   _____

   _____

9. List the organelles that were possible to see in these samples.

   _____

10. Which organelles were not observable but are known to be present in these cells?

    _____

LAB: Measurement of Cell Types

Name: _____

Microscope Number: _____

Date: _____

Directions:
Today your instructor will provide you with various cell types such as animal, plant, protist. You will learn how to measure microscopic objects and convert millimeters to micrometers.

Procedure:
Obtain a microscope and a clear plastic ruler. Place the transparent ruler on the stage of the microscope. Position the ruler in the middle of the viewing range so that it bisects the largest viewing area. Move the ruler so that a whole number (1, 2, 3 etc.) is positioned to the far left side of the viewing area.

More Helpful Information:

Your field of view has the diameter of about 4 mm (millimeters). If you convert millimeters to micrometers, the diameter of the field view equals 4000 micrometers.

1. To determine the cell size on low power, divide 4000 micrometers by the total number of cells that would fit across the circle's diameter. The size of the original cell will be that product. (For example, if 3.5 cells fit across the diameter, then 4000/3.5 = 385 micrometers/cell).
2. To determine the cell size on medium power, divide the field of view (2500 micrometers) by the number of cells lined up end to end or side by side. (For example : 2500 micrometers/10 cells = 250 micrometers/cell.)
3. To determine cell size on high power, divide the field of view length (300 micrometers) by the number of cells lined up end to end or side by side. (For example : 300 micrometers/10 cells = 30 micrometers/cell.)

Now count the number of millimeters from left to right. Estimate to the nearest tenth of a meter within the viewing field. Record this figure:

_____

Multiply your millimeters by 1000 thus converting the measurement to micrometers. A micrometer is one millionth of a meter. Converting to micrometers will allow you to measure cells. Record your answer:

_____

Now place a plant cell slide onto the stage of the microscope and focus. Count the number of cells that can be seen at one time in the field of view. Divide the total amount of micrometers in the field of view by the number of plant cells seen in the slide. This will provide the average size of the cells.

_____

On the following table you will complete a data table which will include :

1. all cell types used
2. the magnification of each slide type
3. a diagram of each cell type

4. the number of cells in a field
5. the diameter of the field of view
6. calculated cell size

	Frog Red Blood Cell	Paramecium	Leaf Cross Section	Elodea	Human Sperm Cell
Magnification					
Diagram of one cell drawn to scale					
# of cells fitting side to side					
Diameter of filed of view					
Calculated cell size. Show work					

Thought Questions:

1. Discuss why it is important to be able to calculate the approximate size of different cells.

2. Research why some cells are larger or smaller than others. What does “surface-volume ratio” mean and what impact does it have on cell size?

CLASS ACTIVITY: Cellular Organelle Group Projects

Group Project Review Group A

The Cell Membrane

Model a cell membrane out of clay. Be sure to include the following parts to the cell membrane:

- Phospholipid Bilayer
- Receptor
- Cholesterol
- Channel Protein (Integral membrane protein)
- Carbohydrate group (Glycosylations)

Be able to answer the following questions:

- What part of the cell membrane is HYDROPHOBIC? HYDROPHILIC?
- What types of molecules can easily pass through the cell membrane without the need for a channel protein?
- What types of molecules need a channel protein to pass through the cell membrane?
- What is the function of a receptor? What binds to the receptor?
- What is the function of cholesterol in a cell membrane?
- What is the function of the glycosylations on the cell membrane?

Group Project Review **Group B**

Nucleus: Protein Synthesis

Model a nucleus out of clay. Be sure to include the following parts of the nucleus:

- Nuclear membrane
- Nuclear pores
- Nucleolus
- Chromatin

Be able to answer the following questions:

- What is the function of the nuclear pores?
- What is the function of the Nucleolus?
- What is chromatin?
- What is the difference between DNA, chromatin and a chromosome?
- What is a gene?
- What is transcription?
- What macromolecule makes up DNA and RNA?
- What are the differences between DNA and RNA?

Group Project Review **Group C**

<u>Endoplasmic Reticulum: Protein Synthesis</u>

Model an ER out of clay. Be sure to include:

- Smooth ER
- Rough ER
- Free Ribosomes

Be able to answer the following questions:

- What is the difference in structure between the Rough ER and Smooth ER?
- What is the function of Ribosomes?
- What is the difference between the proteins made by Free Ribosomes vs. the Ribosomes on the Rough ER? (Hint: Where are those proteins going?)
- What are the functions of the Rough ER?
- What are the functions of the Smooth ER?
- What is translation?
- What is the monomer of a protein?

Group Project Review **Group D**

Golgi Apparatus: Protein Synthesis and Vesicle Transport

Model a simple cell out of clay. Be sure to include:

- A vesicle with a protein to be delivered to the cell membrane or outside the cell coming out of the Golgi Apparatus
- A simple cell membrane (to show exocytosis)
- Vacuole
- Lysosome
- Peroxisome
- Cilia
- Flagellum (Model in the 9 + 2 arrangement)

Be able to answer the following questions:

- What are the functions of the Golgi?
- How is a protein excreted outside the cell? Use the clay to model this.
- What is endocytosis?
- What is the difference between pinocytosis and phagocytosis?

Other organelles: Vacuole, Lysosome & Peroxisomes, Cilia and Flagella

Be able to answer the following questions:

- What is the function of a vacuole?
- What is the function of a lysosome?
- What is the function of a peroxisome?
- What is the function of cilia?
- What is the function of a flagellum?
- What is the structure of a flagellum?

Group Project Review **Group E**

<u>Energy Organelles and the Differences between Plant and Animal Cells</u>

Model a Mitochondrion and a Chloroplast out of clay. Be sure to imclude:

- Outer mitochondrial membrane
- Cristae
- Thylakoid membranes stacked into Grana
- Stroma

Be able to answer the following questions:

- What is the function of the Mitochondria?
- What does the Mitochondria NEED to function? What PRODUCTS do the Mitochondria produce?
- What is the function of the Chloroplast?
- What do Chloroplasts NEED to function? What PRODUCTS do the Chloroplasts produce?
- Do plants have both mitochondria and chloroplasts? Do animals have both mitochondria and chloroplasts?
- Explain how plant and animals cells need each other to be able to survive?
- What is a cell wall? Is it located in Plant or Animal cells?
- What is the function of the vacuole in Plants? How is this different in animal cells?

Group Project Review **Group F**

Cellular Transport

Model a cell membrane out of clay. Be sure to include:

- Phospholipid bilayer
- Channel protein
- Na/K Pump
- Na molecules (one color)
- K molecules (a different color)

Draw on a piece of paper a cell inside of a box representing a red blood cell and the blood. Draw dots to represent Na molecules. Draw a Hypotonic solution, Hypertonic solution and a Isotonic solution. (Hint: Look at your lab notes from last week)

Be able to answer the following questions:

- What is the difference between Active and Passive transport?
- What is Diffusion?
- What is the difference between Simple and Facilitated diffusion? What type of molecules can diffuse by simple diffusion? What type of molecules requires facilitated diffusion?
- What is Osmosis?
- What happens to a cell in a hypotonic solution? A hypertonic solution? An isotonic solution?
- What type of transport is the Na/K pump?

Explain the Na/K pump. Show what happens with your model using the Na and K molecules you modeled. Why is this important in the body

Building A Structure : Cellular Organelle Modeling Group Project

Teacher Name:

Student Name: _____

CATEGORY	4	3	2	1
Construction of Organelle Models - Care Taken	Great care taken in construction process so that the structure is neat, attractive and follows plans accurately.	Construction was careful and accurate for the most part, but 1-2 details could have been refined for a more attractive model.	Construction accurately followed the plans, but 3-4 details could have been refined for a more attractive model.	Construction appears careless or haphazard. Many details need refinement for a strong or attractive model.
Scientific Knowledge of the Organelle Structure	Explanations by all group members indicate a clear and accurate understanding of organelle structure.	Explanations by all group members indicate a relatively accurate understanding of organelle structure.	Explanations by most group members indicate relatively accurate understanding of organelle structure.	Explanations by several members of the group do not illustrate much understanding of organelle structure.
Scientific Knowledge of the Organelle Function(s)	Explanations by all group members indicate a clear and accurate understanding of organelle function.	Explanations by all group members indicate a relatively accurate understanding of organelle function.	Explanations by most group members indicate relatively accurate understanding of organelle function.	Explanations by several members of the group do not illustrate much understanding of organelle function.
Group Questions related to Organelle Model	Group provides written, completed, correct answers to all questions including all details.	Group provides written, completed, correct answers to all questions with 1-2 details missing.	Group provides written, completed answers to all questions with 1 or 2 incorrect answers.	Group provides written, incomplete answers to questions with 3 or 4 incorrect answers.

CLASS ACTIVITY: Cell City Analogy

NAME: _____

DATE: _____

Objectives :

- To draw correct analogies between cell organelles and manufacturing in a typical city

Directions:

Today you will construct a group poster with a sequential drawing that illustrates analogies among cell organelles and manufacturing in a typical city. After the construction of the poster, you and your group will give a presentation to the rest of the class. Your instructor will grade the accuracy of your analogies.

Procedure:

Class Activity: Cell City Analogy

In a far away city called Grant City, the main export and production product is the steel widget. Everyone in the town has something to do with steel widget making and the entire town is designed to build and export widgets. The town hall has the instructions for widget making, widgets come in all shapes and sizes and any citizen of Grant can get the instructions and begin making their own widgets. Widgets are generally produced in small shops around the city, these small shops can be built by the carpenters' union (whose headquarters are in town hall).

After the widget is constructed, they are placed on special carts which can deliver the widget anywhere in the city. In order for a widget to be exported, the carts take the widget to the postal office, where the widgets are packaged and labeled for export. Sometimes widgets don't turn out right, and the "rejects" are sent to the scrap yard where they are broken down for parts or destroyed altogether. The town powers the widget shops and carts from a hydraulic dam that is in the city. The entire city is enclosed by a large wooden fence, only the postal trucks (and citizens with proper passports) are allowed outside the city.

Match the parts of the cell with the parts of a city

1. Mitochondria
2. Ribosomes
3. Nucleus
4. Endoplasmic Reticulum
5. Golgi Apparatus
6. Chloroplast
7. Cell Membrane / cell wall
8. Lysosomes
9. Nucleolus
10. Cytoskeleton
11. Cytoplasm

CLASS ACTIVITY: Respiration and Photosynthesis Group Projects

Group Project Review: Group Project Presentations **Group A**

Oxidation/Reduction

Model a molecule of NADH and $FADH_2$. (Model these electron carriers as "trucks" as we discussed in class. Be sure the "load" or electrons can be removed).

Be able to answer the following questions and include in your presentation:

- List and describe the 3 MAJOR Steps of Aerobic Respiration on the board.
- WRITE HOW MANY ATPs are generated for Eukaryotes and Prokaryotes on the board.
- What is an Oxidation? What happens to the electrons? Is this molecule storing energy or releasing energy?
- What is a Reduction? What happens to the electrons? Is this molecule storing or releasing energy?
- Use your models to show what happens to the electrons with NADH and $FADH_2$ in their Oxidized and Reduced state. In which step are NADH and $FADH_2$ created during AEROBIC RESPIRATION? In which step are they "exchanged" for ATP??
- What is the difference between Kinetic and Potential energy? Give an example of each of these in the body.
- What is Metabolism? What is the difference between Catabolism and Anabolism?

Group Project Review: Group Project Presentations Group B

Mitochondria

Model a Mitochondrion out of clay. Be sure your model includes:

- Outer mitochondrial membrane
- Inner mitochondrial membrane
- Cristae
- The compounds entering the mitochondria
- The compounds produced by the mitochondria
- Model ATP- with 3 P groups that can be removed

Be able to answer the following questions in your presentation of your model:

- What is the FUNCTION of the Mitochondria?
- Do plants have Mitochondria? Do Animals have Mitochondria?
- Describe and point out the following parts on your Mitochondrion model: the Outer Mitochondrial Membrane, the Inner Mitochondrial Membrane, the Intermembrane Space and the Matrix.
- Why is the benefit of having a folded inner mitochondrial membrane and cristae?
- Explain what goes into the Mitochondria and what is produced by the Mitochondria. Use the "ATP" machine model to describe this.
- Define AEROBIC. Are the chemical reactions that occur in the Mitochondria AEROBIC?
- Describe the structure of ATP. What does ATP store? Which type of chemical reaction produces ATP? Which type of chemical reaction breaks down ATP?

Group Project Review: Group Project Presentations **Group C**

Chloroplast

Model a Chloroplast out of clay. Be sure your model includes:

- Thylakoid Membranes
- Grana
- Stroma
- The compounds entering the Chloroplast
- The compounds produced by the Chloroplast

Be able to answer the following questions in your presentation of your model:

- What is the FUNCTION of the Chloroplast?
- Do plants have Chloroplasts? Do animals have Chloroplasts?
- Describe and point out the following parts on your Chloroplast model: Thylakoid Membranes, Grana and Stroma.
- Where is the Chlorophyll located?
- Explain the shape of the Thylakoid membrane and what benefit this gives to the Chloroplast.
- What happens to the Chlorophyll when exposed to sunlight?
- Explain what goes into the Chloroplast and what is produced by the Chloroplast.

Group Project Review: Group Project Presentations **Group D**

Energy and the Differences between Plant and Animal Cells

Use the models of the Mitochondria and the Chloroplasts for your presentation.

Be able to answer the following questions and include in your presentation:

- What is the general OVERALL EQUATION for CELLULAR RESPIRATION? (Write this on the board).
- What is the general OVERALL EQUATION for PHOTOSYNTHESIS? (Write this on the board).
- Do plants have both mitochondria and chloroplasts? Do animals have both mitochondria and chloroplasts?
- Explain how plant and animals cells need each other to be able to survive. (Be sure to include gas exchange and energy transfer between plants and animals). Use the Models of the MITOCHONDRIA and CHLOROPLASTS to SHOW the relationship between ANIMALS and PLANTS. (Physically MOVE the products of one chemical reaction in one of those organelles to enter the next organelle as the REACTANTS of the other reaction and vice versa).
- Explain the difference between an Autotroph and a Heterotroph and relate this to plants and animals.

Building A Structure : Photosynthesis & Respiration Small Group Project

Teacher Name:

Student Name: _____

CATEGORY	4	3	2	1
Construction of Models- Care Taken	Great care taken in the construction process so that the structure is neat and attractive.	Construction was careful and accurate for the most part, but 1-2 details could have been refined for a more attractive product.	Construction accurately followed the plans, but 3-4 details could have been refined for a more attractive product.	Construction appears careless or haphazard. Many details need refinement for a strong or attractive product.
Scientific Knowledge- Model Structure	Explanations by all group members indicate a clear and accurate understanding of the structural parts of their model.	Explanations by all group members indicate a relatively accurate understanding of the structural parts of their model.	Explanations by most group members indicate relatively accurate understanding of the structural parts of their model.	Explanations by several members of the group do not illustrate much understanding of the structural parts of their model.
Scientific Knowledge of Model Function	Explanations by all group members indicate a clear and accurate understanding of the model function(s).	Explanations by all group members indicate a relatively accurate understanding of their model function(s).	Explanations by most group members indicate relatively accurate understanding of their model function(s).	Explanations by several members of the group do not illustrate much understanding of their model function(s).
Group Questions	Group provides written, completed, accurate and clearly answered questions assigned to their group- including all details.	Group provides written, completed and fairly accurate answers to questions assigned to their group- lacking specific details.	Group provides written, completed and fairly accurate answers to questions assigned to their group with 1 - 2 incorrect answers.	Group provides written, incomplete and fairly inaccurate answers to questions assigned to their group with 2 or more incorrect answers.

LAB: Yeast Anaerobic Respiration Lab

Name _____

Date _____

Laboratory Set-Up Form: Bio 120

Lab topic to be covered: Yeast Fermentation

Name:

Date Requested:
Date Needed:
Time Needed:
Room:

Per Table: (6 Tables)

6 Test Tube Holders
48 Small disposable test tubes
6 small Rulers
500 ml Water
500 ml 1% Glucose Solution
500 ml 5% Glucose Solution
500 ml 10% Glucose Solution
6 sets of measuring spoons
48 Mini-balloons
6 packages dry yeast
Oil
Egg
Salt
Vanilla
Cinnamon

Cellular Respiration in Yeast

All living cells, including the cells in your body and the cells in yeast, need energy for cellular processes such as pumping molecules into or out of the cell or synthesizing needed molecules. **ATP** is a special molecule which provides energy in a form that cells can use for cellular processes.

Cellular respiration is the process that cells use to transfer energy from the organic molecules in food to ATP. The following equation summarizes the chemical changes that occur in cellular respiration of the monosaccharide glucose when oxygen is available.

$$C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O + ATP$$

glucose oxygen carbon dioxide gas water energy

The chemical reactions in cellular respiration are similar to the chemical reactions when organic compounds are burned, but of course no ATP is produced. Instead energy is released in the

form of light and heat. The following equation shows the chemical changes that occur when the monosaccharide glucose is burned.

$$C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O + \text{light} + \text{heat}$$

glucose — oxygen gas — carbon dioxide gas — water — energy

What are the similarities between this equation for burning glucose and the equation for cellular respiration of glucose when oxygen is available?

What is the difference between these equations?

There is another important feature of cellular respiration which is not shown in these equations. Cellular respiration involves many small steps; these multiple steps allow the cell to use the energy from each glucose molecule efficiently in order to make as many ATP molecules as possible. The multiple steps of cellular respiration are described in your textbook. Our description will focus on some major steps and how these steps differ, depending on whether oxygen is available or not.

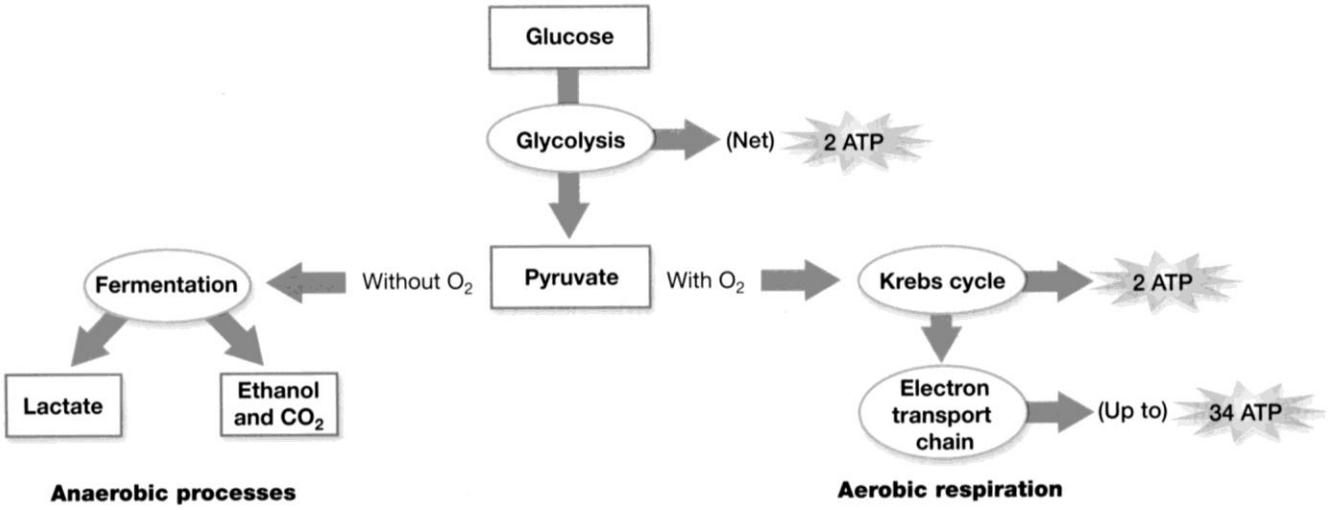
The first major step in cellular respiration is **glycolysis** (see the figure on the top of page 2):

$$1\ \text{glucose} \rightarrow 2\ \text{pyruvate} + 2\ \text{ATP}$$

What happens next depends on whether or not oxygen is available to the cells. When oxygen is available, cells can use the **Krebs cycle** and the **electron transport chain** to make up to 36 ATPs (see the right side of the figure).

$$2\ \text{pyruvate} + 6\ O_2 \rightarrow 6\ CO_2 + 36\ \text{ATP}$$

Cellular respiration that uses O_2 is called **aerobic respiration**. Most of the time, the cells in our bodies use aerobic respiration:



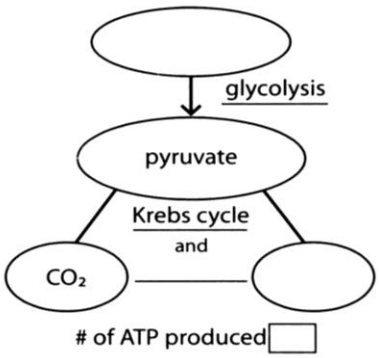
When oxygen is not available, cells use **anaerobic** processes to produce ATP. (The "an" in front of aerobic means "not aerobic".)

Under anaerobic conditions, many cells use a process called **fermentation** to make ATP. As shown in the figure above, there are two types of fermentation: **lactate fermentation** (e.g. in muscles when an animal exercises hard) and **alcoholic fermentation** (e.g. by yeast to make wine and beer).

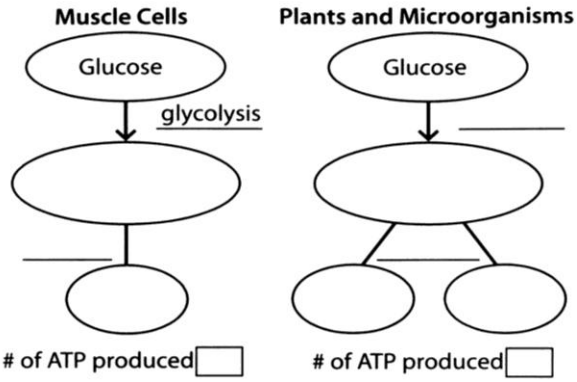
Fermentation has two disadvantages compared to aerobic respiration. Fermentation produces much less ATP than aerobic respiration, and fermentation produces a toxic byproduct (either lactate, which becomes lactic acid, or alcohol). However, fermentation is very useful if oxygen is not available.

Use the above information to complete the figures below. Fill in the ovals with the appropriate molecule. On the blank lines write the name of the appropriate process. In the boxes at the bottom of the figure write how much ATP is made in each pathway.

With Oxygen (Aerobic)



Without Oxygen (Anaerobic)



Humans use **yeast** every day. What is yeast? What are some common uses of yeast?

If you want to make your own bread, you can buy yeast in the grocery store. This yeast consists of little brown grains. The little brown grains of yeast may not seem to be alive, but if you put them in water with sugar, the yeast will carry out cellular respiration and grow.

You can grow yeast in a test tube filled with water and sealed with a balloon. Do you think these growth conditions are aerobic or anaerobic?

Under anaerobic conditions, yeast carries out alcoholic fermentation, so it produces _____ and _____. You can measure the rate of fermentation in yeast by measuring the amount of carbon dioxide gas the yeast produces. Carbon dioxide production can be measured by measuring the depth of the layer of bubbles trapped in foam on top of the yeast solution and also by observing the balloons, which catch the carbon dioxide produced and get bigger.

Part I - Sucrose Concentration

What is sucrose?

Your first experiment will investigate the effect of sucrose concentration on the rate of cellular respiration in yeast. Yeast can convert sucrose into glucose and use it during cellular respiration.

You will design an experiment to answer the question**: Does the concentration of sucrose affect the rate of cellular respiration in yeast?**

Your teacher will provide you with yeast, test tubes, balloons, rulers, and four concentrations of sucrose water: 0% (plain water), 1%, 5% and 10% sucrose.

1. Write a hypothesis that you will test to help you answer the research question.

2. What will be the independent variable in your experiment?

3. What will be the dependent variable in your experiment?

4. What will be the control treatment in your experiment?

What is the purpose of this control treatment?

5. The basic procedure to measure cellular respiration is:
   1) Add 30 mL (2 Tbsp) of the appropriate sucrose solution to each test tube.
   2) Add ¼ tsp of yeast to each test tube.
   3) Put a balloon on the top of each test tube.
   4) With your palm sealing the top, shake each test tube until the yeast is dissolved.
   5) Measure the depth of bubbles produced and observe how the balloons change after 10 minutes and 20 minutes.

   Write <u>your specific procedures</u> here:

6. Complete the first column of these data tables.

	Depth of CO_2 bubbles in:	
Sucrose treatment	10 minutes	20 minutes

	Balloon description	
Sucrose treatment	10 minutes	20 minutes

7. Perform your experiment and record your data in the data tables.

8. Did the yeast produce different amounts of carbon dioxide with different sucrose concentrations?

   Do the results match your hypothesis?

9. Discuss your results with your group. What conclusions concerning the relationship between sucrose concentration and the rate of cellular respiration are supported by your results?

Part II- Yeast and Other Ingredients in Baking Bread

In your second experiment, you will design and carry out an experiment to investigate other variables, besides the concentration of sugar, which may affect the ability of yeast to use that energy source. Yeast is commonly used in baking bread and bread dough usually has other ingredients besides yeast, sugar, water and flour. Some other common ingredients in bread dough are salt, fats (e.g. oil or butter), eggs, and flavoring such as cinnamon. Any of these ingredients could affect the rate of fermentation of the yeast and thus affect the fluffiness of the bread.

You will not actually test how one of these ingredients affects the fluffiness of bread. Instead, you will use the same experimental setup as before (that is, the bottles with yeast mixture, a ruler and balloons) to test the effect of one of these variables on the rate of CO_2 production.

You may choose from these variables for your experiment.

- Cinnamon
- Oil
- Egg
- Salt
- Vanilla

Your group will decide how much of each variable will be used (ex. 1 tsp, ½ tsp, ¼ tsp, etc...)

1. What question will you investigate?

2. Write a hypothesis that you will test to help you answer this question.

3. Plan an experiment to test your hypothesis.

4. What is the independent variable in your experiment?

5. What is the dependent variable in your experiment?

6. What is the control treatment in your experiment? (Hint: You are not testing how sugar affects cellular respiration, so you will want to use 10% sucrose in each of your treatments)

7. What are your procedures?

8. Perform your experiment and collect your data.

	Depth of CO_2 bubbles in:	
Treatment	10 minutes	20 minutes

	Balloon description	
Treatment	10 minutes	20 minutes

9. Did the yeast produce different amounts of carbon dioxide with different treatments? Do the results match your hypothesis?

10. What do your results mean for people who make bread using the ingredient you investigated?

LAB: Photosynthesis

Laboratory Set-Up Form: Bio 120

Lab topic to be covered:Photosynthesis

Name:
Date Requested:

Date Needed:
Time Needed:
Room:

Per Table: (6 Tables)

Basic Materials needed for lab group of 3-4 students:
-Spinach leaves
-4 mm core borer (used to cut holes in cork stoppers, can purchase ones of various sizes, use one about size of paper punch) or paper punch (see web source)
http://www.elbiology.com/labtools/Leafdisk.html

-Syringe (plastic 10+ cc)
-.2 % sodium bicarbonate (baking soda) solution
-Test tube or plastic cup
-Light source
-Thermometer
-Microscope
-Prepared microscope slides of leaf cross sections; plant in sun, plant in shade, desert plant, water lily

Possible extra materials needed depending on variable chosen to test:
-Various wattage's of light bulbs
-Various types of light bulbs (fluorescent, incandescent)
-Colored cellophane (yellow, green, red, blue are typical colors one can purchase)(to change wavelength's of light the plants receive)
-Meter stick
-Baking soda
-Different species of plant (other than spinach)
-Weak acids / weak bases to change the pH of the solution
-Other materials as students design experiments would some substances inhibit photosynthesis? (act as weed killers?)

Thank You!

Designing an experiment to test the rate of photosynthesis

John S Olson
based on "The floating leaf disk assay for Investigating photosynthesis"
http://www.elbiology.com/labtools/Leafdisk.html

Summary
This activity will allow students to measure the rate at which the photosynthesis process occurs. Students will work in small groups to design an experiment with one independent variable and test this variable on spinach leaf disks. The punched out leaf disks will initially sink in a test tube of water but will float as photosynthesis occurs. Students will write a lab report including, hypothesis, experimental design, data collection / analysis, and conclusion (findings). Students will speculate on further investigations that could be done and discuss how the rate at which photosynthesis occurs has vast implications for human survival on the planet.

Learning Goals

This activity is designed for students to:
1) learn that the rate of photosynthesis is influenced by environmental factors that can be quantified
2) understand the equation of photosynthesis and how the structure of a leaf allows for the required gas exchange to occur through the stomata
3) properly design an experiment with one variable, analyze results and report findings to the class
Students will use higher order thinking skills throughout this activity. They will need to use critical thinking to design the experiment and analyze the collected data. They will improve their observing, questioning and communicating skills. The students will need to determine if the question they have chosen to test, is indeed testable. The teacher will guide students to problem solve as they design and modify the experiment to insure only one independent variable is being tested during the experiment.

The students will learn specific concepts during the activity. The students will learn that:
1) the variables of light intensity, temperature, carbon dioxide, light quality all influence the rate of photosynthesis.

2) photosynthesis requires carbon dioxide to furnish the carbon required to make glucose. This carbon dioxide will be supplied by sodium bicarbonate dissolved in the water with the plant leaf disks
3) the stomata opening is controlled by the guard cells and that water, carbon dioxide and oxygen all pass through the stoma openings

4) food production for animals and humans on earth is dependent on plants. By increasing the use of carbon dioxide by plants, it may help slow global climate change. In turn, climate change (warmer in some regions, cooler in other regions) may affect various species of plants

differently.

Context for Use

This 2-3 hour lab activity could be used in high school or college. Ideally, a teacher would have no more than twenty four students to coach through this activity. A student will have prior knowledge as to the equation describing the photosynthetic process as well as having a basic understanding of the scientific method. The lab could be used in a unit on, the scientific method, a photosynthetic unit or in a unit on environmental problems (global climate change and its affect on plants).

Description and Teaching Materials

Introduction:

Teacher and students will review the equation describing photosynthesis. What types of organisms undergo photosynthesis? Discussion will include the ideas that not all plants photosynthesize at the same rate. Brainstorming will bring out possible reasons and variables that would influence photosynthesis. This could include but would not be limited to; plant species, habitat, altitude, depth in water, temperature, carbon dioxide available, water available (desert, tundra, grassland), pH of soil / water

Prepared microscope slides of leaf cross sections will be observed/ drawn. Leaf structures will be named and discussion will relate these structures to the processes of photosynthesis that occur in each. Additional slides of the leaves of a desert plant, water lily, shade plants could be shown/used for comparison and discussion of plant adaptations.

The teacher would now discuss/ review the process of the scientific method. This would be the time to give examples of how some questions scientists raise are not testable. Students should be thinking about the question they will raise about the photosynthesis experiment and if an investigation can be designed to test their question. The teacher can now review what a hypothesis is and how to write a specific, testable hypothesis.

Basic Materials needed for lab group of 3-4 students:

-Spinach leaves

-4 mm core borer (used to cut holes in cork stoppers, can purchase ones of various sizes, use one about size of paper punch) or paper punch (see web source)
http://www.elbiology.com/labtools/Leafdisk.html

-Syringe (plastic 10+ cc)

-.2 % sodium bicarbonate (baking soda) solution

-Test tube or plastic cup
-Light source
-Thermometer
-Microscope
-Prepared microscope slides of leaf cross sections; plant in sun, plant in shade, desert plant, water lily

Possible extra materials needed depending on variable chosen to test:
-Various wattage's of light bulbs
-Various types of light bulbs (fluorescent, incandescent)
-Colored cellophane (yellow, green, red, blue are typical colors one can purchase)(to change wavelength's of light the plants receive)
-Meter stick
-Baking soda
-Different species of plant (other than spinach)
-Weak acids / weak bases to change the pH of the solution
-Other materials as students design experiments would some substances inhibit photosynthesis? (act as weed killers?)

The teacher will now demonstrate to students the basic technique that will be used to measure the rate of photosynthesis. Students can follow along with the directions found in their handout / lab report (see experimental design, steps 1-5 in sample lab report within the assessment section) The main focus of the investigation depends on students knowing how to make the spinach leaf disks and make them sink in water. All students will be guided to use this technique . They can now practice this technique (see experimental design and the following web site http://www.elbiology.com/labtools/Leafdisk.html).

Discuss the process of choosing a variable for the experiment. Pick a testable question to answer when doing the experiment. Give students time to design experiment and do a trial run. Teacher will help coach the students as they finalize / modify the experimental design to include a testable question with only one variable.
The final experimental design will be written out using diagrams /drawings to illustrate the setup.
Students can now plan / design an appropriate data table . (include proper units of measure, titles, all labeling)
Finally, students will complete the experiment, analyze and discuss findings, and report findings to class. Class discussion will connect the lab to world issues; food availability, global climate change.

Teaching Notes and Tips

1) Use fresh spinach leaves, soak them in water overnight at about 4 degrees C. This increases turgor pressure and minimizes "limp" leaves. Use only the firm, dark green areas of the leaf. Avoid major veins or damaged areas.

2) Do not over vacuum the leaf disks. Too little vacuum treatment causes the disks not to sink, too much vacuum treatment may kill the cells.

Assessment

Two rubrics will be used to assess student lab report (sample of report included below) and student participation.

A written exam will be used to determine if a student has met the goals of the activity.

Standards

I History and Nature of Science; Scientific Inquiry

Standard;

Design and conduct a scientific investigation

1) use scientific methods

2) qualitative and quantitative data

3) sources of error

IV.A.5 Processes of photosynthesis in terms of energy flow, reactants, products

PHOTOSYNTHESIS LAB HANDOUT

Student name _____

Rate of Photosynthesis Research

Background: Where in a leaf does photosynthesis mainly occur? How does carbon dioxide get into a leaf? Where / how does oxygen leave a leaf? How does water get into a leaf from the roots?

Obtain a prepared slide of a leaf cross section (x-section). Using 100x make a sketch of what you see.

Use the text book or internet to label the following tissues:

Upper epidermis, lower epidermis, palisade mesophyll, spongy mesophyll, vein (label both xylem and phloem), guard cells, stoma

1) In which of the labeled structures, does most of the photosynthesis occur? (hint; there are more chloroplasts here)

2) Through what structure does carbon dioxide get into the leaves so photosynthesis can occur?

3) What is the function of the guard cells?

4) Of what purpose does the spongy mesophyll serve to the leaf and the process of photosynthesis?

5) Through which of the labeled structures does water get to the leaves from the roots?

6) Through which of the labeled structures are sugars, that are made during photosynthesis, transported to other parts of the plant where they can be used for energy or stored?

7) discuss the variations / adaptations that desert plants, water plants, and plants that grow well in shade have in their leaves that allow them to survive in their particular environments.

Write out a balanced equation for photosynthesis:

Experimental Design

Your table will design an experiment to test how a selected variable affects the rate of photosynthesis. Follow the information below to make "sinking plant disks". You will measure how long it takes (in seconds) for the disks to float as a way to measure the rate of photosynthesis.

Preparation of the leaf disks:

1) Use the cork borer (to cut out the number of disks needed for your experiment).
2) Put disks in a syringe and suck up 5 cc (5 ml) of .2% sodium bicarbonate (baking soda)
3) Put finger over end of syringe, pull back on plunger to about the 35 cc mark (on a 60 cc syringe) and hold this position for 30 seconds. You should see air coming out the sides of the disks. As this is done, the oxygen is being removed from the spongy layer of the leaf and the .2% sodium bicarbonate is entering the spongy layer. This is the source of carbon dioxide needed for the plant to carry out photosynthesis
4) Carefully squirt out the .2% sodium bicarbonate. Suck up about 10 cc's of water. Check to see if the plant disks sink in the water. If they don't, remove the water and try steps 2 and 3 again.
5) Choose the disks that sink. Make sure enough disks are available to properly complete a controlled experiment. They are now ready to be used in your experimental set up. The disks will float when they have produced a measured amount of oxygen through photosynthesis. The time needed for the disks to float is an indirect measure
of the rate of photosynthesis occurring in the leaf disks.

Lab Report Outline: Descriptive title of experiment

The effect of _____ on the rate of photosynthesis.

Purpose / Introduction

Hypothesis; (use if/ then format)

Explain the logic of the stated hypothesis

Sketch of the experimental design used. (the sketch should be specific enough so that the experiment could be reproduced exactly as it was set up; include all measurements, angles, label materials / solutions used, wattage and type of light bulbs, etc.)

Is the data collected qualitative or quantitative data? Discuss.

The independent variable (manipulated) variable in the experiment is

_____

The dependent variable (responding) in the experiment is

_____

How was the experiment controlled?

Data chart: (you design, label and fill in with data)(you must have enough data to make a graph)

Graph of data (obtain a piece of graph paper, make appropriate graph that has a title and is properly labeled, attach graph to this lab report)
Results / discussion / analysis of data:

Findings/Conclusion/ list possible sources of error

Application to World environmental issues: (list ideas generated during brainstorming session)

List new questions that could be researched

LAB: Mitosis

In today's lab, you will observe mitosis in a growing plant root as well as whitefish blastula. The onion root tip is actively dividing and contains cells at different stages of the cell cycle while whitefish blastula is an early stage of embryo development where most of the cells are constantly dividing as well.

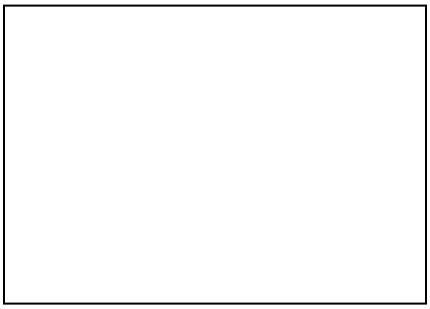
Materials:
Microscope, prepared slides of onion (allium) root tips and whitefish blastula

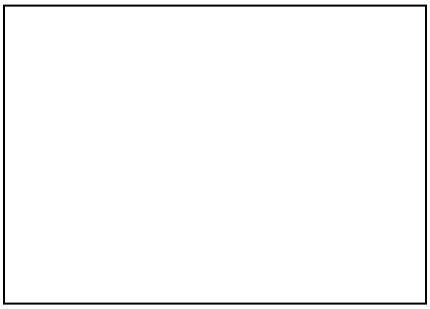
Procedure:
1. Obtain a prepared slide of an onion root tip. Make sure you find the root section first before put the slide on the microscope stage.

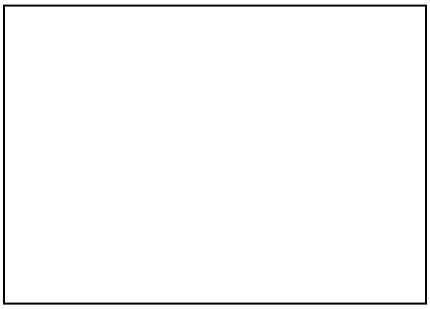
2. After placing the slide on the mechanical stage, apply the scanning lens first, then switch to low-power and essentially high power objective lens to focus.

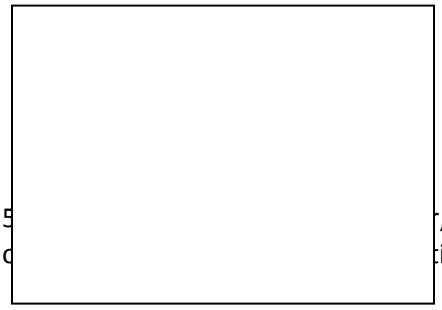
3. At this point, you should see the rectangular onion cells with the nucleus stained. Chromosomes are visible as well as the stages of mitosis.

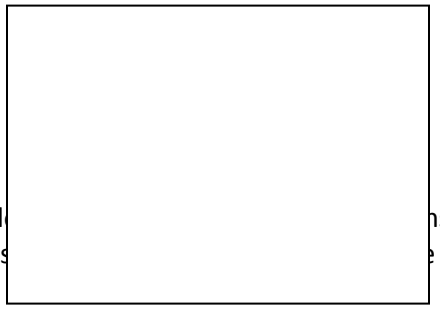
4. Sketch the cell that you observed in the box provided. Make sure you find cells going through various stages of mitosis and put the representative on in the box. After refer to the textbook images and lecture notes, label these images with the correct mitotic stage names.











5 r, d nsibility of counting
c tic s e numbers.

I: Using the following table to record your result.

Total number of cells to be counted: 50

Cell Cycle	**Number of Cells**
Interphase	
Prophase	
Metaphase	
Anaphase	
Telophase	

II. Repeat the experiment with whitefish blastula slide, your roles of counting and recording switch this time.

Total number of cells to be counted: 50

Cell Cycle	**Number of Cells**
Interphase	
Prophase	
Metaphase	
Anaphase	
Telophase	

Analysis & Conclusions:

1. Just taking the onion root tip into consideration, what stage were the majority of the cells in?

2. What percentage of the onion root tip cells was in each stage?

Interphase:

Prophase:

Metaphase:

Anaphase:

Telophase:

3.Explain why interphase takes up the most of the percentage.

LAB: Meiosis

Part I: Please refer to the textbook for the diagram or pictures of STAGES OF MEIOSIS and describe the following stages

MEIOSIS I:

Prophase I:

Metaphase I:

Anaphase I:

Telophase I:

MEIOSIS II:

Prophase II:

Metaphase II:

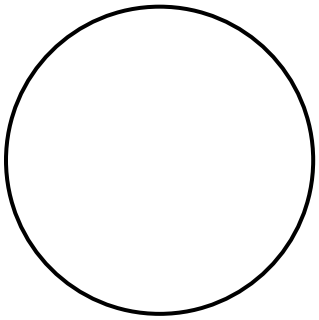
Anaphase II:

Telophase II and Cytokinesis:

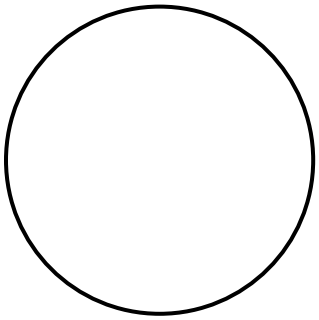
Part II: You are given a cell with 6 chromosomes, using three colored pencils to illustrate the distribution of these 6 chromosomes at various stages of meiosis

MEIOSIS I

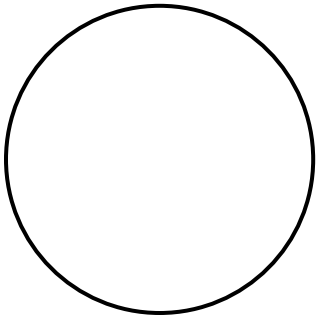
Prophase I



Metaphase I

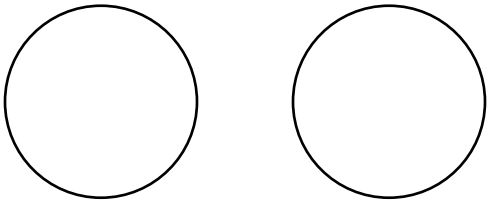


Anaphase I



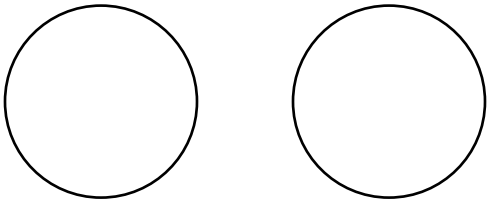
Telophase I and

Cytokinesis

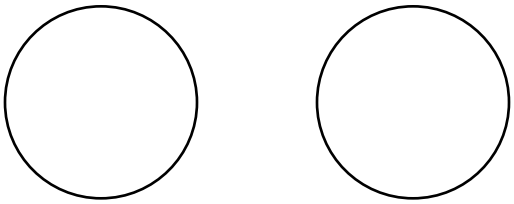


MEIOSIS II

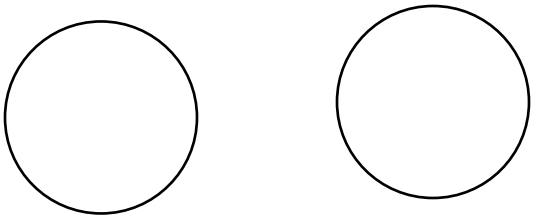
Prophase II



Metaphase II

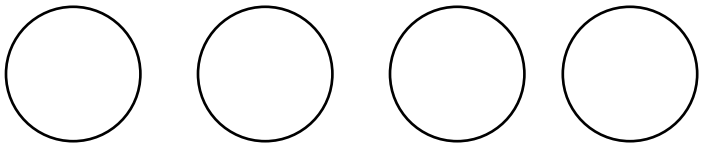


Anaphase II



Telophase II and

Cytokinesis



Part III Generate a detailed list of similarities and differences between mitosis and meiosis.

CLASS ACTIVITY: Opinion Paper on Genetically Modified Foods

Debate: Genetically Modified Food

Background

The advancements in the field of biotechnology have allowed scientists to insert genes into food sources so the altered DNA produces new proteins that lead to new characteristics in the plants. By inserting a gene into a particular plant, the resulting protein may make the plant resistant to insects or resistant to a particular herbicide. The farmers' ability to yield larger crops should greatly improve when these alterations are made. Other genetic modifications can be used to improve the nutritional quality of food.

Many products you buy at the grocery store including corn, beets, canola and soy are probably genetically modified organisms (GMOs for short), but you have no way of knowing unless the manufacturer chooses to label the product. Opponents to genetically modified food fear that future studies may uncover health risks linked to ingesting this altered form of DNA. Others suggest that the use of genetically altered plants may result in the overuse of chemicals to control weeds, and ultimately cause adverse environmental conditions. Currently there are no laws in the United States that mandate the labeling of genetically modified food products.

The **FDA** has assembled a representative group of citizens (our class) to hold a debate on the topic in order to guide their decision on GMOs.

Topic of the Debate

1. Should people be concerned about using (growing or eating) genetically modified foods?
2. Should foods made from GMOs be labeled?
3. Should research and development money be spent on creating GMOs instead of directly sending food aide to starving people?

The Setup

Each of you will have a chance to step into the shoes of the person who is involved with or impacted by the debate over GMOs. **After completing the research phase of this assignment you will construct a two page paper in the form of a personal essay with proper citations that reflects your characters position on the topic questions for the debate.** Your paper should be persuasive and should cover the answers to the topic questions of the debate. Your answers should be supported by research materials but must reflect the point of view and interests of your assigned character. (A Biotech Scientist working for a GMO lab would generally be for the use of this technology while an Agronomist arguing for a return to non-industrial organic farming would be against.)

Available characters:

1. Scientist against Genetically Modified food

2. Scientist working for a Genetically modified food lab
3. Environmental health specialist involved in Genetically Modified Foods
4. Reporter of the local newspaper
5. Scientist studying the habitats of the monarch butterfly
6. Agronomist arguing for organic farming
7. Small business owner if a supermarket with a large produce section
8. Small Family farmer using Genetically modified Seeds
9. Large corporate farmer
10. Parent with small children
11. Banana Farmer from developing nation
12. Pesticide and Fertilizer chemical worker
13. Owner of a hotel on the beach
14. Director of the health department
15. Politician with limited funds and resources for public and environmental health
16. Lawyer representing the union against importation of Genetically modified foods
17. Lawyer representing the US Government on the export of Genetically modified foods
18. A member of the ELF (Earth Liberation Front)

Tips on being persuasive

Setting up a persuasive argument for either a paper or debate can take many different forms. The following outline is simple, yet effective strategy to present and defend a persuasive argument.

1. **Introduction** - Inform the reader/listener about the issue at hand. State the facts that surround the situation.
2. **State your case** - Discuss why your way is the best way. Share evidence and expert opinions supporting your position.
3. **Examine and refute the opposition** - It is vital that you recognize and discredit opposing views. Look for flaws, loopholes, and reasons to reject other suggestions. If there are positive aspects of the opposing view, point them out, but compare them to the overall benefit of your case.
4. **Reconfirm your position** - Now it is time to review the main points of your arguments. Be sure to address any items that may have come while refuting the opposition.
5. **Conclude that your position is superior** - Be confident in your closing that your way, is indeed, the only way based upon all the information just provided.

GMO Character Essay Rubric

Name:_____ Final Score: _____

CATEGORY	Scoring Criteria	Possible Points	Student Evaluation	Teacher Evaluation
Introduction 20 points	A thesis or position statement makes the purpose of the essay clear. *(Statements not begin with: "This essay is about …")*	10		
	Background information is provided to establish the importance of the essay topic. *(Include any definitions of key terms and a short outline of the topic)*	10		
Body 30 points	At least three body paragraphs *(one for each argument)*	10		
	Each argument is supported with scientific fact, not just what you feel. *(Your opinion doesn't matter, unless supported.)*	10		
	Essay information is presented in the student's own words (actually your characters), not "cut and pasted" from your research sources. *(complex terms must be explained)*	10		
Conclusion 20 points	Your position and arguments are summarized. The most important supporting information is restated.	10		
	No new information is introduced	5		
		5		
Overall 30 points	Essay is double spaced using Times New Roman or Arial 12 point on white paper using black ink with 1 inch margins on all edges.	10		
	Works Cited page follows the DHS Style Sheet	10		
	There are no obvious grammar, spelling or punctuation errors.	5		
Score	**Total Points**			

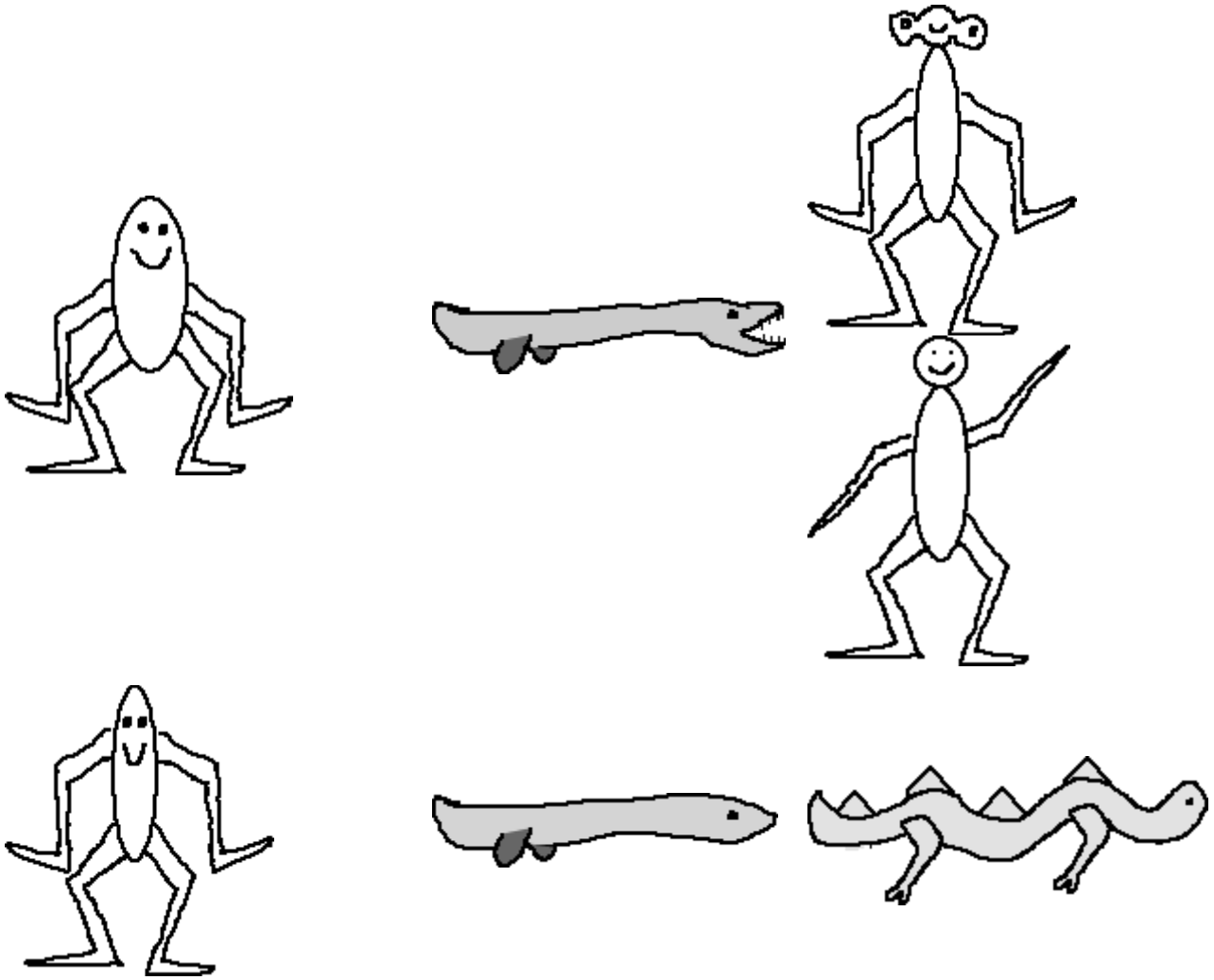
Students are expected to honestly evaluate their own work. If the difference between the student and teachers evaluation is more than 10 points, 5 extra points will be deducted from the final grade score when it is recorded.

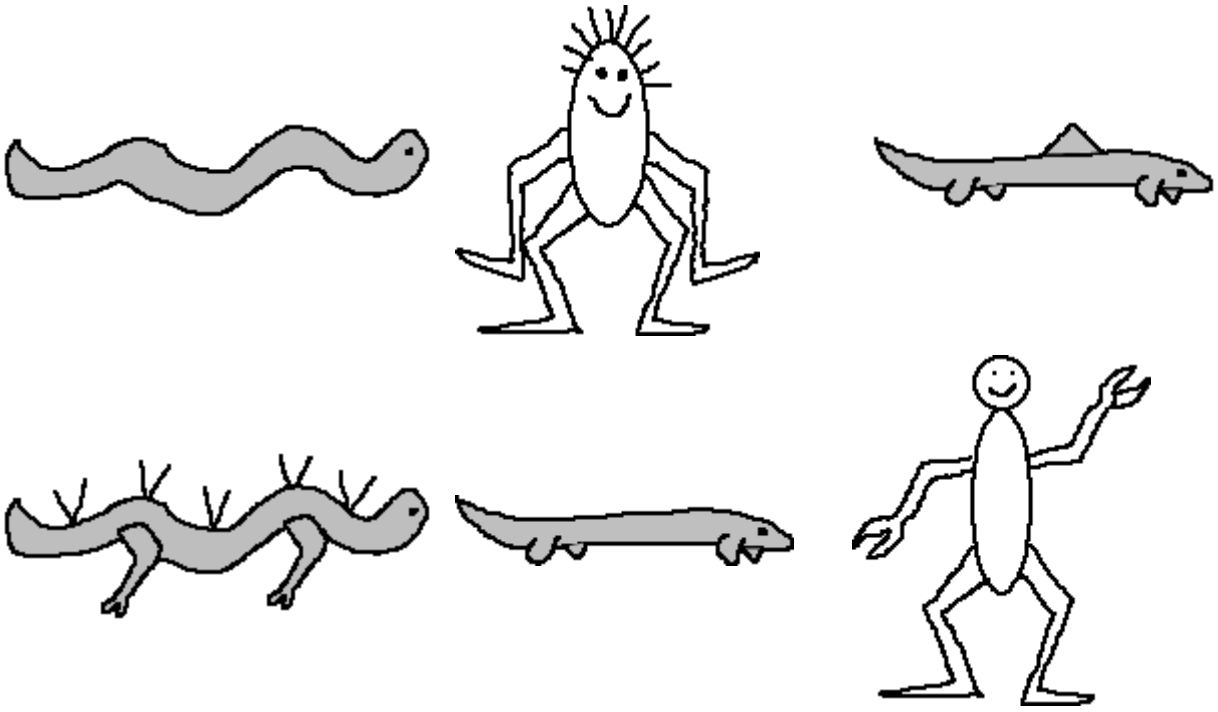
CLASS ACTIVITY: Alien Taxonomy

You are an alien taxonomist. Your job is to classify the aliens found on the planet Bizarro-World. You have noted that there are two main groups of organisms on this planet: a group of humanoid like organisms that live on the land, and a group of fish like organisms that live in the water.

The fish like organisms are photosynthetic and get their food from Bizarro-Sun, the humanoids eat the fish-like organisms.

Because there are so few species, your taxonomic scheme will only use Kingdom, Phylum, Genus and Species. Create a flow chart showing the organisms taxonomic structure, and make up names for the taxa. Give all of the aliens a scientific name. The aliens on Bizarro-World are pictured below, cut them out to help you organize the groups.





CLASS ACTIVITY: Taxonomy, Classification, and Dichotomous Keys

Help! Scientists have discovered quite a few new creatures on planet Pamishan. They need your help to identify and classify them. Use the dichotomous key on the next page to identify these creatures.

1. 	2. 	3. 	4. 	5. 
6. 	7. 	8. 	9. 	10. 
11. 	12. 	13. 	14. 	15. 
16. 	17. 	18. 	19. 	20. 

A Key to New Pamishan Creatures

1. a. The creature has a large wide head.....go to 2
   b. The creature has a small narrow head.....go to 11
2. a. It has 3 eyes .....go to 3
   b. It has 2 eyes .....go to 7
3. a. There is a star in the middle of its chest.....go to 4
   b. There is no star in the middle of its chest .....go to 6
4. a. The creature has hair spikes .....*Broadus hairus*
   b. The creature has no hair spikes.....go to 5
5. a. The bottom of the creature is arch-shaped .....*Broadus archus*
   b. The bottom of the creature is M-shaped .....*Broadus emmus*
6. a. The creature has an arch-shaped bottom .....*Broadus plainus*
   b. The creature has an M-shaped bottom.....*Broadus tritops*
7. a. The creature has hairy spikes .....go to 8
   b. The creature has no spikes.....go to 10
8. a. There is a star in the middle of its body .....*Broadus hairystarus*
   b. The is no star in the middle of its body .....go to 9
9. a. The creature has an arch shaped bottom .....*Broadus hairyemmus*
   b. The creature has an M shaped bottum .....*Broadus kiferus*
10. a. The body is symmetrical .....*Broadus walter*
    b. The body is not symmetrical.....*Broadus anderson*
11. a. The creatrue has no antennae .....go to 12
    b. The creature has antennae .....go to 14
12. a. There are spikes on the face .....*Narrowus wolfus*
    b. There are no spikes on the face .....go to 13
13. a. The creature has no spike anywhere .....*Narrowus blankus*
    b. There are spikes on the right leg .....*Narrowus starboardus*
14. a. The creature has 2 eyes.....go to 15
    b. The creature has 1 eye.....*Narrowus cyclops*
15. a. The creature has a mouth.....go to 16
    b. The creature has no mouth.....go to 17
16. a. There are spikes on the left leg .....*Narrowus portus*
    b. There are no spikes at all .....*Narrowus plainus*
17. a. The creature has spikes .....go to 18
    b. The creature has no spikes .....*Narrowus georginia*
18. a. There are spikes on the head .....go to 19
    b. There are spikes on the right leg.....*Narrowus montanian*
19. a. There are spikes covering the face .....*Narrowus beardus*
    b. There are spikes only on the outside edge of head .....*Narrowus fuzzus*

LAB: Plant Biodiversity

Laboratory Set-Up Form: Bio 120

Lab topic to be covered: Plant Biodiversity

Name: Jessica Bergden

Date Requested:
Date Needed:
Time Needed:
Room:

Per Table: (6 Tables)

6 Plant Field Guides (for Plant Identification)*
*OPTIONAL: Students may bring their Smartphones to photograph plant species or use them for plant identification. Allowing this may depend on instructor.
6 Metersticks
24 small wooden/plastic stakes
String (to mark off plot area)

*This lab can easily be done in MCC Bedford in the field and wooded areas behind Henderson hall. MCC Lowell students may need to take a field trip for this lab to find appropriate plot locations.

Using Plant Surveys to Study Biodiversity: Instructor Guide

Paula Kalinosky
Eastview High School
Apple Valley, MN

Based on an original activity from Bowling Green State University, "Joe's Jungle: Exploring Biodiversity". Online at http://www.ableweb.org/volumes/vol-24/1-waggoner.pdf

Summary

This is an extended field investigation that is intended as launch into several concepts in environmental science including biodiversity, human impacts on natural systems, and energy transfer in ecosystems.

Students will work in small groups of 3-4 students to conduct plant surveys in two study areas, looking and the type and relative proportions (approximate) of each plant found. Students will also make general observations about the conditions at each site (moisture, light level, or other factors they feel are important).

Students will graph the relative frequency of the plants found at each site and compare the composition of the plots by calculating Species Richness (Diversity) and Dominance.

After conducting the survey, student will attempt to identity several plants from each plot using a guide books to determine whether or not the plant types found indicate a difference in growing condition between the two plots.

Students will also generate questions for further study at the plots. (ex. How do the soil types differ? Does the insect community differ? Which plot is has the most biomass? Etc.)

Learning Goals

Student will practice field observation and data collection skills.
Students will practice data analysis by constructing simple frequency graphs and calculating biodiversity indices given an algebraic formula.
Students will write a lab report that synthesizes field observation and document analysis findings.

Skills emphasized:

Data Collection and Observation Skills
Graphing and Data Analysis (qualitative)
Data Analysis (quantitative)
Writing, Critical Thinking, Questioning

Context for Use

This activity has been written for a general education biology or environmental science class. Students should have experience with basic graphing skills and algebraic substitution (algebra I skills). The activity can easily be modified for younger or more advanced students. For example, younger students could skip the Dominance calculations but complete a qualitative analysis for comparing the two plots. Advanced students could additionally consider how to estimate the biomass of each plot. The activity is intended to serve and an introduction to concepts. More in-depth study or practice may be necessary to reach specific learning goals.

The activity requires two study plot areas, fairly distinct in vegetation (ex. a pond, wooded area or a field). Time requirement is one lecture period discussing Biodiversity, Ecology and Species Richness and Dominance and one two hour lab period for data collection. Graphing and plant identification can be done afterwards.

Description and Teaching Materials

Before the Activity – A good opening to this field investigation is a discussion of diversity. Students here this word frequently in regard to social settings, but in biology, it has many applications. Students could brainstorm what the term "biological diversity" means. They may come up with description that indicate genetic diversity, habitat diversity, species diversity – all of which can be seen through the plant survey activity.

The teacher should select two general study plot areas that contain enough plant diversity to make counts interesting, but not overwhelming. Student will work in groups of 2-4 students.

A pre-activity brainstorming session is recommended during which students determine what controls and general methods they will use during the investigation. A class discussion should lead to the following conclusions:

Study plot areas should be the same size
Plants should be counted by the same method in both area
When estimating the number, the same method should be use for both areas
Plants in the field should not be destroyed
The area studied should be disturbed as little as possible during the activity
(Other)

Plot One Data Collection

Field Work
Students work in groups of 3-4 at the first study area. Data collection site should be 1m x 1m or smaller. Each group records the following in the science notebook:

Date
Time
Weather Condition
Plot Location & Description
Data Table with Plant Description and Frequency for each plant type found
Other Observations

Students need not identify plants in the field, but if field books are available, team members can work on this part in the field. If plant identification will happen in the classroom, students should take digital photos, do rubbings, sketches, or collect samples.

(Sample pages in Attachments)

Plot One Graphing and Plant Identification

Students work in their groups to determine the best way to present the plant survey data graphically. (Usually a pie chart or bar graph is best, but other graphical representations are possible). 20-30 minutes

Student use field guides to identify as many plants as they can in the time allotted. If possible, they should note any information about native/non-native status and growing condition requirements. This can be difficult with flowering plants that are not in bloom at the time of collection. (To speed this up, groups could share information by posting sketches or picture on a central whiteboard or bulletin board.)

At the end of the period students should have completed:

1)graphical representation of plant frequencies in study plot one
2)plant identification and information for plot one (at least a few plants)

(Sample graphs in Attachments. Hand drawn may be preferable).

Plot Two Data Collection
Field Work
Students work in groups of 3-4 at the first study area. Data collection site should be 1m x 1m or smaller. Each group records the following in the science notebook:

Date
Time
Weather Condition
Plot Location & Description
Data Table with Plant Description and Frequency for each plant type found
Other Observations

Students need not identify plants in the field, but if field books are available, team members can work on this part in the field. If plant identification will happen in the classroom, students should take digital photos, do rubbings, sketches, or collect samples.

(Sample pages in Attachments)

Plot Two Graphing and Plant Identification

Students work in their groups to determine the best way to present the plant survey data graphically. (Usually a pie chart or bar graph is best, but other graphical representations are possible). 20-30 minutes

Student use field guides to identify as many plants as they can in the time allotted. If possible, they should note any information about native/non-native status and growing condition requirements. This can be difficult with flowering plants that are not in bloom at the time of collection. (To speed this up, groups could share information by posting sketches or picture on a central whiteboard or bulletin board.)

At the end of the period students should have completed:

1)graphical representation of plant frequencies in study plot one
2)plant identification and information for plot one (at least a few plants)

(Sample graphs in Attachments. Hand drawn may be preferable).

Biodiversity Analysis (Dominance and Richness)

Use the page on Biodiversity Calculations or the handout "Joe's Jungle: Exploring Biodiversity" (see teaching notes) to guide students through examples of each of the quantities: Species Richness and Dominance. The goal of the activity is that student will investigate ways of

quantifying data, specifically to answer the question "how biologically diverse are the study areas?"

At the end of the period students should have completed the following in their science notebook:

1)Calculate the Species Richness for each study area and discuss what is indicated by the two values.
2)Calculate the Dominance number for each study area and discuss what is indicated by the two values.

Generating Further Questions for Study

It is important that students consider sources of error in the investigation and generate questions for further investigation of the study plots. Hopefully they may already be questioning whether studying plants only is a valid method of studying biodiversity.

Sample questions: Is the soil different in the two study areas? What kinds of life exist in the soil? How are the insects different in the two areas? What food chains does each area support? Is this area affected by human impact? Etc.

At the end of the investigation each student should at the following to their science notebook/lab report:

1)A list of SEVERAL questions and
2)at least a suggestion for how to improve the investigation.

Teaching Notes and Tips

Lab on Biodiversity Calculation available at: http://www.ableweb.org/volumes/vol-24/1-waggoner.pdf

Keep study areas small, not larger than 1m x 1m. It can be difficult to count plants in dense vegetation. Survey plots should be smaller in very dense vegetation.

Note: Grassy areas can be difficult to study when estimating the number of plants. Students have to grapple with questions about what constitutes one grass plant? How can I count them all? This is a good exercise for brainstorming ways to estimate the total number of plants. Back in the classroom, the class can take a look at what a rhizome is, but for the survey, students can make their own judgment about what constitutes one grass plant and therefore how does one estimate. In this case, the field notes should contain a justification for the estimate.

Assessment

Through the activity students generate a report in their science notebook that includes the following. Although students work in groups, each student must complete a report with all of the following included. Plant identification analysis can be divided among group members. Point values have been attached as a recommendation of how to weight the sections of the report.

Site Observations & Sketches/Rubbings/photos (both sites) (4 pt)
Plant Survey Data (number & types of each plant) (4 pt)
Graph of Plant Frequencies (one for each plot) (4 pt)
Plant Identification List (when possible) (2 pt)
Correlation Analysis (Dominance/Richness Calculations) (4 pt)
Questions for Further Study (2 pt)

Biodiversity Calculations

Species Richness, S = total number of different species found

In the example S = 10 for study plot one

Question for Students – What does species richness indicate? Does the species richness number give a complete picture of the difference between the two study plots? (Species richness is a measure of biodiversity, the higher the number, the greater the biodiversity. So if biodiversity is good, a high number is good. Species richness does not describe the distribution of plants in area studied, just the raw number of types found).

Dominance, D = (total number of organisms) ÷ (the number of the most abundant)

In the example D = 822 plant organisms ÷ 756 short grass plants = 1.09

Questions for Students – What does the dominance number show that is not shown by the species richness number? (Dominance is a way to consider whether or not the different plant types are evenly distributed. In the example, study plot one is dominated by short grass, but in other area, the plants might be more evenly distributed.)

What are the possible values for the dominance number? (The dominance number has to be > 1. If all the plants are one kind, D = 1. If even distributions are desirable, then bigger is better. Student can discuss whether or not that holds true all the time.)

What does a dominance number of 1.0 indicate? (All plants are the same type)

OPTIONAL: BEYOND THE SCOPE OF BIO 120

Sorensen Number, S = $\frac{2c}{(a + b)}$, where a = the number of species in plot 1 (species richness)

b = the number of species in plot 2 (species richness)

c = the number of species in common in plot 1 & 2

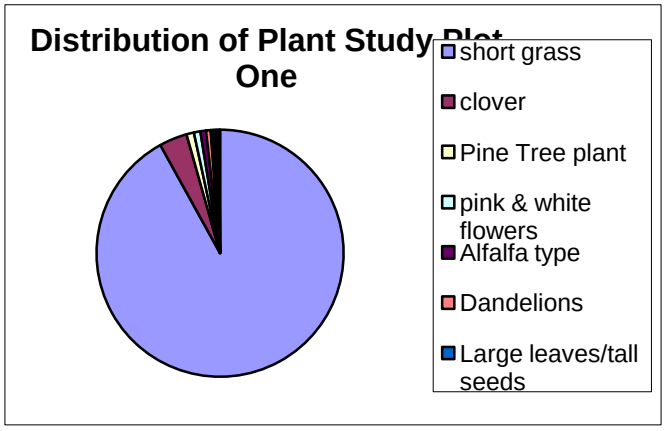
In the example, a = 10. If the second study plot has a species richness of 8, then b = 8. If the two plot have two plants in common then c = 2.

Then S = (2 x 2) ÷ (10 + 8) = 4 ÷ 18 = 0.22

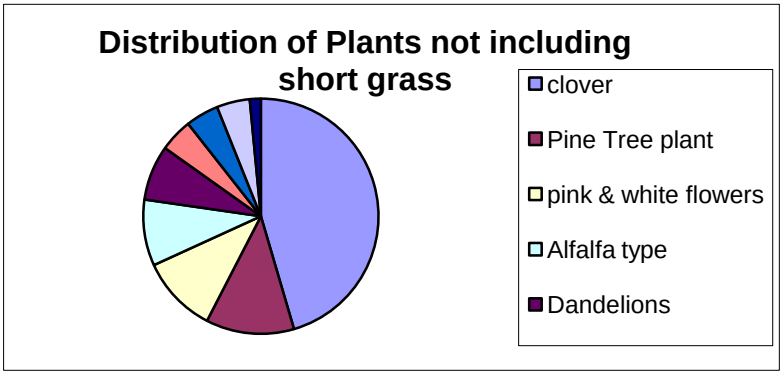
Questions for Students – What does the Sorensen number show that is not shown by the species richness number or dominance number? (The Sorensen number compares to different areas. You can compare two areas by looking at the species richness or the dominance numbers for each, but the Sorensen number gives information about how much the two plots have in common.)

What values for the Sorensen number are possible? (The Sorensen number must fall between 0 and 1. It is zero when there are no species in common, c = 0, and 1 when all species are in common c = (a + b)/2. If the two study plots are within a relatively close distance, as they would be if studied at school, a Sorensen number close to zero represent high habitat diversity).

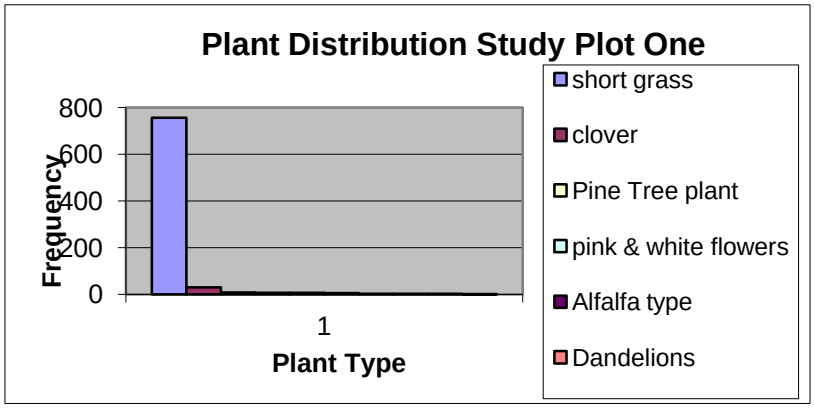
Plant Description	Number
short grass	756
clover	30
Pine Tree plant	8
pink & white flowers	7
Alfalfa type	6
Dandelions	5
Large leaves/tall seeds	3
Large grass plant	3
cauliflower-looking	3
Hairy/Spiky plant	1
Total Individuals	822

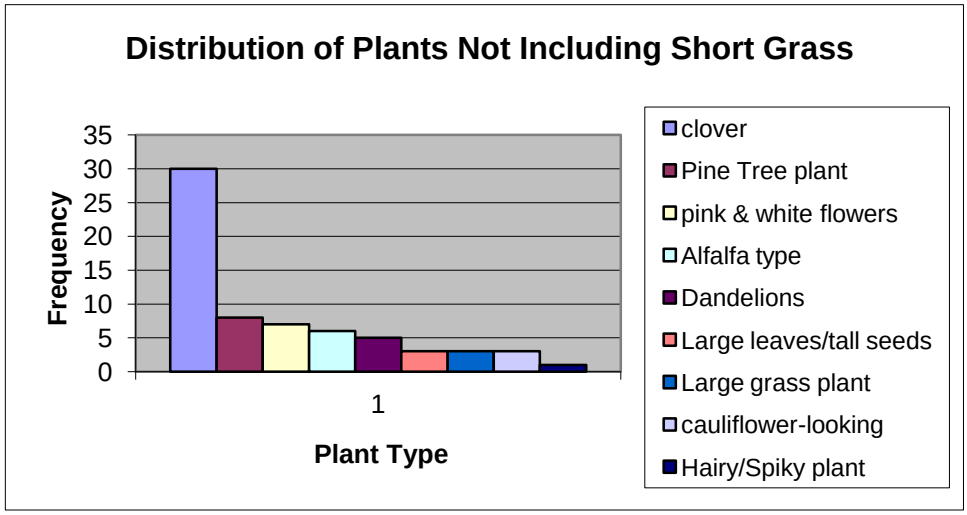


NOTE: Because short grass was so dominant in the study plot, it is difficult to see the relative distribution of other plants. In this graph, short grass has been omitted to show how the frequency of other plants in the plot are



distributed





NOTE: Because short grass was so dominant in the study plot, it is difficult to see the relative distribution of other plants. In this graph, short grass has been omitted to show how the frequency of other plants in the plot are distributed.

CLASS ACTIVITY: Natural Selection

OBJECTIVES: Be able to do the following:

1. Define these terms in writing:
   - natural selection
   - selecting agents
   - evolution
2. Describe why the phenotype of an organism can be important in determining which genes are passed from one generation to the next.
3. Explain how differences in survival, reproductive success, and attractiveness to potential mates can influence how many copies of one's genes are passed from one generation to the next.

Remarks Designed to help students understand the concept of natural selection.

Equipment

- Deck of playing cards
- Ptc paper
- 4 × 8 piece of paper with a word printed on it, such as

  WIND mill
  HEART attack
  SPRINT triathlon
  TREE limb
  SPRING cleaning
  LIGHT Edison
  GIFT birthday
  SHOW boat
  CAT tail

- 10 meter sticks
- Special directions for specific groups of students

Differential Reproductive Rates

SPECIAL DIRECTIONS FOR THE INSTRUCTOR

1. Pairs of the same-colored suits have no offspring.
2. Pairs of different-colored suits, numbers ace through 9, have one offspring.
3. Pairs of different-colored suits with only one member having a number of 10 through king produce
   two offspring.
4. Pairs of different-colored suits with both members having numbers of 10 through king have three offspring.

5. In cases of dispute over mating privileges with particular individuals the individual with the highest value card has priority.

LEK Mating Systems
Special Notes for Females Only

1. Males with caps on are the most desired males. But they can have no more than three mates per year.
2. Males with their caps on backward can not mate.
3. Males without caps can only have one mate per year.
4. Males standing nearest the windows are the most desirable and can have two mates per year.
5. Males with caps on who are standing near the windows can have five mates per year.

Analysis of Results

Differential Survival Rate

1. Identify those individuals in the class who were most successful at producing offspring. What characteristics did they have that allowed them to be successful?
   Those that had good eyesight, could taste ptc, and were able to "find food."

2. Identify those in the class who were the least successful at producing offspring. What characteristics did they have that contributed to their lack of success?
   Those with poor eyesight, who could not taste ptc and who were not able to "find food."

3. Could individuals do anything to improve their chances of reproducing?
   No, all of these items were predetermined by genes or their previous behavior.

Differential Reproduction Analysis

1. Based on the cards they held did all of the people in the class have the same opportunity to reproduce?
   No, some people had superior phenotypes based on the cards (genes) they were dealt.

2. Remember that the cards represented aspects of an individual's phenotype. Could individuals do anything to change their phenotye?
   Yes, those who figured out the rules of the game could choose individuals that would maximize the number of their offspring.

Differential Mate Selection Analysis

1. Were some males more successful than others?
   Yes, those that had preferred characteristics and chose to stand in the correct place.

2. How much of their success was determined by genes?
   Much of their initial success was due to their "genes." They may have enhanced their success later by moving to a more preferred room location.

End-of-Exercise Questions

1. Describe two human characteristics presumed to be determined by genes that would lower a person's reproductive success.
   Many possible answers; hereditary diseases, low mental ability, hereditary deformities.
2. Many eye sight characteristics are inherited (color blindness, astigmatism, near sightedness). Compared to 1000 years ago do you feel these genes are being selected against more or less strongly? Explain your answer.
   They are not being selected against as strongly today because technology allows us to repair malfunctioning visual systems.
3. In many studies observers consider human individuals with symmetrical facial features to be more beautiful than those who have some degree of asymmetry. How might facial symmetry or lack of symmetry affect a person's reproductive success?
   Beauty (attractiveness) may make individuals more successful. Some studies of human sexual behavior suggested that the most beautiful persons have opportunities to mate with more partners.
4. If an organism's reproductive fitness is determined by the genes it inherited, can all individuals have an equal chance of reproducing? Explain your answer.
   No, they did not have any choice about which genes they inherited. You are stuck with what you are dealt.
5. If in a lek mating system the genes that determined the behavior of the females mutated so that they behaved differently, would the same males be successful? Explain your answer.
   No, if the females started to look for different characteristics, those males with the original characteristics would be discriminated against.

CLASS ACTIVITY: Case Studies in Bioethics and the Cost of Medical Treatments

Handout: Bioethics - A Case Study

The Disease:

Hypercholesterolemia is a genetic disease, which causes cholesterol to build up in the arteries. Cholesterol is a type of fat which eventually clogs the arteries, stopping the blood flow leading to heart attacks and strokes. Patients with hypercholesterolemia have a defective gene in which their body does not produce a receptor which breaks down the extra cholesterol. As a result, a large amount of cholesterol stays in the blood and the blood vessels.

Gene therapy can be used by inserting a normal, functioning gene into the liver cells of the patient. The liver will then start making new receptors so the patient can break down the cholesterol in the blood.

The Patient:

Five year-old Lorien Marie Francis has familial or genetic hypercholesterolemia, which may cause heart disease to occur at a young age. Gene therapy could reduce her blood cholesterol and increase her life expectancy. This treatment, however, is very expensive. Lorien's dad, Hank, is a truck driver for Transport Trucking Inc. Hank's insurance has promised to cover 80% of the medical costs. The gene therapy treatment is estimated at $30,000. Hank makes $2,500 a month, but the monthly expenses for the family leave only $100.00 of "extra" money per month.

The Questions and Ethical Issues:

- What is hypercholesterolemia?

- What are the side effects of hypercholesterolemia?

- Do you think Lorien should have the gene therapy? Why?

- Is there any other information you wish you had before making this decision?

- Who should decide whether or not Lorien receives gene therapy (the doctor, the family, the insurance company, the government)? Why?

- Who should pay for the cost of gene therapy?

- What will be the financial burden on the family for this therapy?

- How long would it take the family to pay off their part of the treatment?

- Ultimately this gene therapy might save the insurance company $100,000 in other future medical care costs? Given this information, should the insurance company pay for the entire cost of the therapy?

The issue:

Brendan Kuehne, a 12 year old, is short for his age and has parents that are both short in stature. Brendan wants to be tall. Scientists have developed gene therapy to help people grow taller. This therapy will only work before a child would normally reach his full height. His parents also know that tall stature is a valued trait in our society and would probably make life easier for Brendan and might possibly give him an economic advantage in his adulthood. They don't want Brendan to face some of the difficulties they had growing-up because of his height. Brendan and his parents are aware of products and medical procedures (such as hormones) that can be used to help people change their hair color, shape of their noses, and get rid of wrinkles. Brendan's doctor believes that gene therapy should be used only to improve a person's health.

The Patient:

Brendan's parent's insurance will cover 75% of gene therapy when it is prescribed by a doctor, but none of the costs if the doctor does not think gene therapy is needed to save a life. The cost of the procedure is $12, 000. Brendan's father is an airline pilot and makes $80,000 annually. Brendan's mom is a registered nurse, but she only works part time and makes $20,000. The Kuehne's have very few expenses during the month besides a house payment and utilities and are able to put a large amount of cash into savings every month.

The Questions and Ethical Issues:

- Are there any medical reasons why Brendan should have gene therapy to be taller?

- Is there an ethical difference between plastic surgery and gene therapy when they are performed for cosmetic reasons rather than health reasons?

- Is it ethical for society to allow – or not allow – science to change the genetic structure of an individual?

- Should the Kuehne's pay for Brendan's gene therapy even though the doctor does not think it is medically necessary?

- Given Brendan's age and the fact that there are only a few more years in which to administer the therapy, how much should his wishes be factored in to the decision to use the therapy?

- How much money is the family responsible for paying after the insurance company has paid their 75% (this would be if the treatment was approved by the insurance company)?

- Should cost be a factor in the decision?

- Would your answers change is the Kuehne's made less money – say $25,000 instead of their combined $100,000 income?

LAB: Bioethics Debates

Debate Guidelines:

You will divide into groups of four. Each group will chose a bioethics topic from the list below or provide a topic of your own. As a group you should discuss the issue and decide who will present arguments for and who will present arguments against. Each group will have 20 minutes to debate their topic. The class will be the representative jury for our society and will vote on how we think the issue may best be resolved. Careful and well thought out positions will add to your ability to sway the audience.

Remember that this is an exercise in which there are no right or wrong answers. The issues need to be discussed rationally by all. At the conclusion of the debate, your audience will vote and express society's current view on your topic, based on the arguments that you present. Be ready to back up your statements with specific sources if you are challenged.

Debate Format:
3 minutes of pro presentation
3 minutes of pro presentation
3 minutes of con presentation
3 minutes of con presentation
2 minute pro rebuttal
2 minute con rebuttal
3 minutes audience questions
1 minute audience vote
20 minutes total

Some suggested topics for debate:

- Genetically engineered foods
- Use of Animals in Drug/Cosmetic Testing
- Right to Organ Transplant
- Genetic Testing
- Embryoinc Stem Cells
- Embryonic Screening
- Genetic Screening by Employers
- Fetal Tissue Transplant
- Conservation vs. Economic Interests
- Should the Government be allowed to require vaccination
- Should the Government tell us what to eat
- Reproductive Issues: in vitro fertilization, pre-implant embryonic screening
- Animal Cloning

- Human Cloning

A list of research resources will be provided to the teacher and classmates for each side of the debate.

Prior to the debate you will fill-in the attached rubric to assess your preparedness for the debate.

You will reassess yourself after hearing all the debates to compare your work to your class-mates presentations. Self-assessment rubrics will be handed in to the instructor but will not be graded, except for completion of the assignment.

Follow-up Assignment: Each student will hand in a 1 page paper stating your personal opinion on the topic including back-up facts to reinforce your opinion. The papers are due 1 week after your debate.

Debate Self-Assessment Tool:

Prior to your debate rank yourself on a scale of 1-5, with 1 mean being the lowest score and 5 the highest in the following areas. You will reassess yourself after you have completed your debate and seeing the other teams.

Prior:

1. _____ My viewpoint is clear.
2. _____ I use good strong facts to back-up my view point.
3. _____ I have reviewed my facts and research so I can quickly respond to any questions and give a good rebuttal.
4. _____ I have practiced my debate speech so I am confident in addressing the audience and minimizing my nervousness.

Compared to my classmates:

1. _____ My viewpoint was clear.
2. _____ I had good strong research and many facts to back-up my debate topic.
3. _____ I was quickly able to respond to questions and give a good rebuttal because I had reviewed my research and facts.
4. _____ I was confident in my debate speech and did well compared to my classmates.

DEBATE RUBRIC

Name: _____

Date:_____

Debate topic/position:

_____

	3	2	1
Viewpoint	Viewpoints are clear and organized	Most viewpoints are clear	Viewpoints are unclear and disorganized
Use of facts and examples	Arguments are supported with facts and examples	Most arguments are supported with facts and examples	Arguments lack factual support
Relevance of supporting arguments	All supporting arguments are relevant	Many, but not all supporting arguments are relevant	Few supporting arguments are relevant
Strength of arguments	All arguments are strong and convincing	Some arguments are strong and convincing	All arguments are not convincing
Speaking voice	Voice can always be hear	Voice is heard most of the time	Voice is difficult to hear
Preparation	Student is well prepared	Student needs more preparation	Student is unprepared to defend argument

Total Score:___/18