Lab: Möbius Strip

Name ________________________________ Date ________
Period ______

Benchmark:
SC.912.N.1.1 AA: Define a problem based on a specific body of knowledge, for example: biology, chemistry, physics, and earth/space science, and do the following:
- conduct systematic observations,
- pose answers, explanations, or descriptions of events,
- generate explanations that explicate or describe natural phenomena (inferences),
- use appropriate evidence and reasoning to justify these explanations to others,
- communicate results of scientific investigations,
- evaluate the merits of the explanations produced by others.

Background:
In 1858 the Möbius Strip or Möbius Band was discovered by and named after August Ferdinand Möbius, a 19th century German mathematician and astronomer, who was a pioneer in the field of topology. Since their discovery, Möbius strips have been used in a number of applications that exploit their remarkable property: one-sidedness. This characteristic is the result of a closed loop with a half-twist.

List the Steps of the Scientific Method in the space below:

___________________________________________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________

Purpose:
The basis for all scientific investigations is a series of steps that allow scientists to conduct controlled experiments while collecting valid data to test a particular hypothesis. This activity will allow you to practice using the scientific method to hypothesize possible outcomes for a simple experiment.

Materials:
- 60 cm strip of receipt tape
- Pencil
- Tape
- Scissors

Procedure:
1. Bring the ends of a strip of receipt tape (~60 cm long) together to form a circle.
2. Twist one end (by turning it over on top of the other end) and use a piece of scotch tape to hold the two ends together. Be sure the tape spans the entire width of the paper.
3. Your strip should have a half-twist when completed correctly.
4. Hypothesize what might happen if you use your pencil to draw a continuous line down the center of your Möbius strip (pretending the tape holding the ends together is not there). Record your hypothesis in the Data section for Experiment 1 (it has been started for you).
5. **After** you have written your hypothesis, use your pencil to draw a **continuous line** down the center of your Möbius strip. Keep going as far as you can, remember you CAN cross the tape holding the ends together.

6. Record your results and discuss whether your hypothesis was correct or incorrect based on the results of your experiment.

**Experiment 1:**

**Hypothesis:** “If I draw a line down the center of the Möbius strip without lifting my pencil, then

________________________________________________________________________________________

________________________________________________________________________________________

Record your results: _________________________________________________________________

________________________________________________________________________________________

Do your results support or refute your hypothesis? Explain. ________________________________

________________________________________________________________________________________

7. Hypothesize what the Möbius strip would look like if you were to cut along the line you drew in Step 5. Record your hypothesis in the Data section for **Experiment 2.**

8. **After** you have written your hypothesis, use your scissors to cut along the line you drew (down the center of your Möbius strip). Be careful to stay in the center of your strip and **DO NOT CUT FROM THE SIDE.** (Your teacher can demonstrate this for you.)

9. Record your results and discuss whether your hypothesis was correct or incorrect based on the results of your experiment.

**Experiment 2:**

**Hypothesis:** _________________________________________________________________

________________________________________________________________________________________

Record your results: _________________________________________________________________

Do your results support or refute your hypothesis? Explain. ________________________________

________________________________________________________________________________________

10. Hypothesize what might happen if you cut your Möbius strip once more, down the middle of the strip. Record your hypothesis in the Data section for **Experiment 3.**

11. Once you have written your hypothesis, use your scissors to cut down the center of your Möbius strip. Be very careful to stay in the center of your strip and **DO NOT** cut from either side.

12. Record your results and discuss whether your hypothesis was correct or incorrect based on the results of your experiment.
Experiment 3:
Hypothesis: __________________________________________________________

____________________________________________________________________

Record your results: __________________________________________________

____________________________________________________________________

Do your results support or refute your hypothesis? Explain. ______________________

____________________________________________________________________

Analysis:
1. Describe what makes a Möbius strip different than a strip of paper taped in a circle? __________

   ______________________________________________________________________

   ______________________________________________________________________

2. Why is it important to read carefully and follow directions when conducting ANY lab activity? __________

   ______________________________________________________________________

   ______________________________________________________________________

3. Compare your results to someone next to you. Was there anything different? Why? Give examples. __________

   ______________________________________________________________________

   ______________________________________________________________________

4. Did your results in Experiment 2 influence your hypothesis in Experiment 3? How? __________

   ______________________________________________________________________

   ______________________________________________________________________

5. Identify and discuss one “real-life” application for a Möbius strip? (Think industry / science / mechanical, etc.) __________

   ______________________________________________________________________

   ______________________________________________________________________

   ______________________________________________________________________

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Conclusion:
Discuss how scientific thinking can result in scientific bias. Example: How did previous knowledge of Experiment 1 influence your hypothesis for Experiment 2 and 3? Why is it necessary to test a hypothesis many times? __________

   ______________________________________________________________________

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Scientific Method Activity - The Strange Case of Beriberi

Name_________________________________________ Date ____________
Period ____________

Benchmark:

SC.912.N.1.1 AA: Define a problem based on a specific body of knowledge, for example: biology, chemistry, physics, and earth/space science, and do the following:
- conduct systematic observations,
- pose answers, explanations, or descriptions of events,
- generate explanations that explicate or describe natural phenomena (inferences),
- use appropriate evidence and reasoning to justify these explanations to others,
- communicate results of scientific investigations,
- evaluate the merits of the explanations produced by others.

Purpose:
This story is intended to explain how the scientific method has actually been used to solve scientific problems.

Background: Case Study of Beriberi Disease

It is 1897 and people are dying in Java, an island in Indonesia or the Dutch East Indies. They all seemed to share the same hideous symptoms beginning with overall muscle weakness, loss of appetite, and eventually they suffered paralysis and eventually death by heart failure. This disease was called beriberi by the indigenous people. This was a word from their native language that meant “I cannot, I cannot.”

Scientists thought the disease might be caused by bacteria. (After all, since the discovery of bacteria, almost all previously unknown diseases were attributed to a bacterial infection.) They decided to prove that a bacterium was the culprit by conducting an experiment. They used chickens as their trial subject. They injected a group of chickens with the blood from a patient who had beriberi and then to prove that the blood carried the “bacterium that caused the disease” they injected another group of chickens with saline or simple salt solution. Well, both group got beriberi! So back to the starting board they went.

One of the scientists who had been sent to work on this mystery was a Dutch physician and pathologist named Dr. Christiaan Eijkman. One day, as he walked around the hospital compound he observed his surroundings. He noticed that the cook fed every one of the patients the staple diet of the nation polished or white rice. Polished rice is wild, brown rice with the husk or outer layer rubbed off so that its color is white. It was the rice of choice of the middle class of the Indonesian people. He also noticed that the hospital staff fed the chickens (that would eventually be the chicken soup for the patients) wild rice. White rice was more expensive than brown rice, so the chickens were usually fed brown rice. Dr. Eijkman realized that this was an important observation and thought that maybe the wild rice contained something that the white rice did not. So he conducted another experiment. He divided the chickens once again into two separate groups. He fed one group of chickens only white rice and the other group only wild rice. Then he watched and waited.

It turned out that the chickens that had been fed wild rice did not get sick at all, but the chickens that had been fed the polished or white rice became weak, lost their appetite and eventually died from beriberi. Eureka, the case was solved!

As Dr. Eijkman and others continued to research this interesting case, they found that polished rice lacked thiamine, a vitamin necessary for good health. This was actually the first "vital amine" or vitamin to be discovered. It is also called vitamin B1.

We’ve now known for more than a hundred years that brown rice is more nutritious than white rice. But most Asian cultures associate eating white rice with prosperity and eating brown rice with bad luck. Most rice is still milled or polished, both in Asia and elsewhere. In Europe and America both white rice and brown rice are consumed, but mostly white. In fact, some white rice is chemically fortified to add back the B vitamins. In 1929, Eijkman and Hopkins were awarded the Nobel Prize for Physiology or Medicine for this discovery.
**Procedure:**

Fill in the story board with the appropriate descriptions of the steps of the scientific method.

<table>
<thead>
<tr>
<th>What is the problem?</th>
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</table>

<table>
<thead>
<tr>
<th>How did they research the problem?</th>
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<table>
<thead>
<tr>
<th>What is the hypothesis?</th>
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</table>

<table>
<thead>
<tr>
<th>Design the experiment for this hypothesis. (Don’t forget to designate the control group and the experiment group!)</th>
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</table>

<table>
<thead>
<tr>
<th>Did the experiment prove or disprove the hypothesis?</th>
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</table>

<table>
<thead>
<tr>
<th>If proved, what is the conclusion?</th>
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</table>

<table>
<thead>
<tr>
<th>If the experiment <em>did not</em> prove what caused Beriberi, what do you have to do next?</th>
</tr>
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<tbody>
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</table>

<table>
<thead>
<tr>
<th>On a separate sheet of paper, write up your new experiment using the lab writing style that your teacher taught you and attach it.</th>
</tr>
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</table>
Lab: Organic Compounds

Name(s) ________________________________ Date ________
Period_____

Benchmark:
SC.912.L.18.1 AA: Describe the basic molecular structures and primary functions of the four major categories of biological macromolecules.

Background:
What are organic compounds and indicators?
All organic compounds contain carbon, which can bond with many elements, including hydrogen, oxygen, phosphorous, sulfur, and nitrogen. How each organic compound bonds with these elements gives them their unique properties. All living organisms are composed of four major types of organic compounds. The table below lists the most common types of organic compounds found in living organisms. For each type of organic compound, give one example and describe the function of each organic compound.

An indicator is a substance that changes color in the presence of a particular type of molecule. You will learn how to use several indicators to test for the presence of carbohydrates and proteins. You will also use a different type of test for lipids. Name a common indicator that you have used before in science and indicate what it was used to test. ____________________________________________

Purpose:
To demonstrate how different foods can contain one, some, or all four of the organic compounds that are important to cells.

Table 1: Organic Compounds

<table>
<thead>
<tr>
<th>Type of Organic Compound</th>
<th>Example</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lipids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nucleic acids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proteins</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In this lab you will be testing the substances listed in the following table. Predict whether each substance is an organic compound and if so, what type.

Table 2: Predictions

<table>
<thead>
<tr>
<th>Substance</th>
<th>Predict if the substance is a carbohydrate, lipid, protein, or none of these?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetable oil</td>
<td></td>
</tr>
<tr>
<td>Glucose</td>
<td></td>
</tr>
<tr>
<td>Starch from corn or potatoes</td>
<td></td>
</tr>
<tr>
<td>Powdered egg whites</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td></td>
</tr>
</tbody>
</table>
Hypothesis: Read through each procedure and complete the statement.

a) If a substance has a positive filter paper indicator, then ______________________

b) If a substance has a positive Lugol’s solution (iodine) indicator, then ______________________

c) If a substance has a positive Biuret indicator, then ______________________

d) If a substance has a positive Benedict’s indicator, then ______________________

Materials:

- Goggles
- Gloves
- Vegetable oil
- Glucose solution
- Corn/potato starch
- Egg white powder
- Distilled water
- Unknown substance
- Filter paper
- Biuret reagent
- 18 test tubes
- Test tube rack
- Hot water bath
- 9 pipettes

Procedure:

Part A: Testing for Carbohydrates

1. You must wear goggles and gloves for safety.

2. You will use indicators to test for 2 common types of carbohydrates: glucose (a specific type of sugar known as a monosaccharide) and starch (known as a polysaccharide).

3. Obtain 12 test tubes and use masking tape to make 2 labels for each.

4. Label 2 test tubes with each of the following substances: vegetable oil, glucose, starch, egg whites, water, and unknown.

5. For each test tube, using a pipette add 10 drops of the substance indicated on the masking-tape label.

6. Add 2 mL of distilled water to each test tube and swirl the contents to mix the solution.

7. To test for glucose you will use Benedict’s solution as an indicator that changes color in the presence of glucose. Add 4 mL of Benedict’s solution to each of the 6 test tubes.

8. Place the test tubes in a hot water bath (~45°C) for about 5 minutes or until there is a color change. Positive color change may be green to yellow or a brick red color.

9. Which substance do you expect to test positive for glucose? ______________________

10. Which substances do you expect to test negative for glucose? ______________________

11. After observing the color change, record the color for each test tube of Benedict’s solution in Data Table A. Put a plus sign next to those samples testing positive for glucose and a minus sign for those testing negative.

12. To test for starch you will use Lugol’s (iodine) as an indicator. In the presence of starch, iodine will change color from yellow-brown to blue-black. Add 5 drops of iodine solution to each test tube and swirl the contents to mix.

   CAUTION: Be careful when handling iodine; it can stain hands and clothing.

13. In the Data Table A, record the color of the iodine solutions. Put a plus (+) next to those samples testing positive for starch and a minus (-) for those testing negative.

14. Rinse all test tubes thoroughly
**Part B: Testing for Lipids**

1. If a food that contains lipids is put on filter paper, it will leave a spot that lets light through. To test for lipids, divide a piece of a filter paper into 6 equal sections. Label the sections: **vegetable oil, glucose, starch, egg whites, water, and unknown.**

2. On each section of the filter paper, place one to two drops of the substance.

3. With a paper towel, rub off any excess that may stick to the paper. Set the paper aside until the spots appear dry—about 10 to 15 minutes.

4. Which substance do you expect to test positive for lipids? ____________________________

5. Which substance do you expect to test negative for lipids? ____________________________

6. Continue on with the rest of the tests. After all the sections of the filter paper are dry, hold it up to a bright light or window. You will notice that at least one sample has left a spot that lets light through on the filter paper. The spot indicates the presence of lipids.

7. Complete the last column of the **Data Table A.** Put a plus sign for any samples which tested positive for lipids and a minus sign for the samples which tested negative.

**Part C: Testing for Proteins**

1. Label 6 clean test tubes: **vegetable oil, glucose, starch, egg whites, water, and unknown.**

2. Using a pipette add 10 drops of the substance indicated on the label of each test tube.

3. Add 2 mL of distilled water to each test tube and swirl the contents of each to mix.

4. To test for **protein** you will use Biuret reagent as an indicator. Biuret reagent turns from blue to purple in the presence of protein. Add 20 drops of Biuret reagent to each test tube and swirl. **CAUTION:** Biuret reagent contains sodium hydroxide, a strong base. Be very careful not to splash or spill any. If you splash any reagent on yourself, wash it off immediately with water. Call your teacher for assistance.

5. Record the color of each Biuret solution in the **Data Table A.** Put a plus next to those samples testing positive for protein and a minus for those testing negative.

6. Rinse all test tubes thoroughly.

**Data Table A: Organic Compound Tests**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Carbohydrate Tests</th>
<th>Protein Test</th>
<th>Lipid Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Benedicts solution color after heating</td>
<td>Glucose present</td>
<td>Iodine test color</td>
</tr>
<tr>
<td>Vegetable oil</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glucose</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Starch from corn or potatoes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Powdered egg whites</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unknown</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Analysis:

1. Compare your predictions from Table 2 on the first page with your test results in Data Table A. Identify any differences between your test results and your predictions.

____________________________________________________________________________________
____________________________________________________________________________________

2. Did your test for glucose indicate there was glucose in the starch sample?

____________________________________________________________________________________

3. Does that mean that there is no glucose in starch? (Hint: Check your textbook or other reliable source if you do not already know the chemical structure of starch.)

____________________________________________________________________________________

Conclusion:

1. If you found any differences between your hypothesis and your results, what do you think is the reason for these differences? You may want to check with your teacher, your textbook, or the nutritional information to help you interpret your results.

____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

2. Based on your data, which indicator tested positive for the unknown. What organic compound is your unknown? Explain your answer.

____________________________________________________________________________________

3. Suppose the container of distilled water tested positive for one of the organic compounds. How would you interpret this result?

____________________________________________________________________________________

4. Athletes require intense physical training to become bigger, faster, and stronger than their opponent. If you were a member of the varsity football team, which organic compound would be best to assist in repairing your muscles after weightlifting? Explain your answer.

____________________________________________________________________________________

Which organic compound would be best to eat before or during your workout for energy?
5. Select one of your samples and describe the procedure in your own words for each test and summarize your findings.

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Lab: Enzymes and Reaction Rates

Name(s) _________________________________  Date __________  Period _________

Benchmark:
SC.912.L.18.11: Explain the role of enzymes as catalysts that lower the activation energy of biochemical reactions. Identify factors, such as pH and temperature, and their effect on enzyme activity. (Assessed as SC.912.L.18.1 AA)

Background:
Enzymes have 5 important properties that you should know:
1. Enzymes are always proteins.
2. Enzymes are specific in their action.
3. Enzymes are not altered by the reaction.
4. Enzymes are destroyed by heat (denatured).
5. Enzymes are sensitive to pH.

The enzyme catalase speeds up the breakdown of hydrogen peroxide (H₂O₂) into water (H₂O) and oxygen gas (O₂). The reaction is described by the following equation: 2 H₂O₂ → 2 H₂O + O₂

This lab will investigate the role of enzymes related to the concentration of the substrate not the concentration of the enzyme.

Purpose:
To investigate the effect of variations in substrate concentration on rate of reaction.
To investigate the effect of variations in temperature on the rate of reaction.

Hypothesis: Read through the procedure and develop a testable hypothesis.
If hydrogen peroxide is _______________ concentrated, then _____________________________

Materials:
Safety Goggles  Filter paper discs  2 – 250mL beakers (warm & cold)
Yeast Catalase Extract  Forceps/straw/long  Timer
8– Test tubes (25mL)  dissecting needle  Wax pencil/labels
5 – 50mL Beakers  Paper towels  Test tube rack
3.0% Hydrogen peroxide  2 – 25 mL graduated cylinders
Distilled water
pH paper

Teacher Demonstration:
1. Using a hole puncher, punch a small round disc of filter paper.
2. Using forceps place the filter paper disc into a test tube, allowing it to drop to the bottom.
3. Pour 20 mL of hydrogen peroxide solution into the test tube, record the starting time and check disc periodically for any movement up the test tube. Set this off to the side while students begin procedure A.
Procedure:

**Part A:** Effect of hydrogen peroxide concentration on reaction rate.
1. Develop a hypothesis based on the background statement and record it above.
2. Label 5 – 50 mL Beakers: 1, 2, 3, 4, and 5.
3. Prepare hydrogen peroxide solutions in each of the 5 beakers according to **Table 1**.

**Table 1: Solutions preparation:** (Concentration based on 3% Hydrogen Peroxide)

<table>
<thead>
<tr>
<th>Beaker</th>
<th>Concentration</th>
<th>Hydrogen Peroxide</th>
<th>Distilled Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0%</td>
<td>0 mL</td>
<td>20 mL</td>
</tr>
<tr>
<td>2</td>
<td>25%</td>
<td>5 mL</td>
<td>15 mL</td>
</tr>
<tr>
<td>3</td>
<td>50%</td>
<td>10 mL</td>
<td>10 mL</td>
</tr>
<tr>
<td>4</td>
<td>75%</td>
<td>15 mL</td>
<td>5 mL</td>
</tr>
<tr>
<td>5</td>
<td>100%</td>
<td>20 mL</td>
<td>0 mL</td>
</tr>
</tbody>
</table>

4. Label 5 test tubes (to correspond with the beakers): 1, 2, 3, 4, and 5.
5. Label the remaining 2 test tubes: 6 and 7.
6. Use a graduated cylinder to measure 20 mL of 100% hydrogen peroxide into Test Tube #6 and place the test tube into a 250 mL beaker filled with ice-water.
7. Use a graduated cylinder to measure 20 mL of 100% hydrogen peroxide into Test Tube #7 and place the test tube into a 250 mL beaker of 37°C water on a hot plate.
8. Allow both Test Tube #6 and #7 to reach the correct temperature for **Part B**, while you continue with **Part A**.
9. Using a hole puncher, punch out several small round discs from a piece of filter paper.
10. Using forceps, dip a filter paper disc into the beaker of yeast catalase solution, leaving it in the solution for 4 seconds, and then remove it.
11. Place the disc on a paper towel for 4 seconds to remove any excess liquid.
12. Using forceps/straw/long dissecting needle, place the filter paper disc into Test Tube #1, allowing it to drop to the bottom (make sure the disc DOES NOT touch the sides of the test tube).

*Note: The yeast solution contains the catalase enzyme and when the enzyme soaked disc comes into contact with hydrogen peroxide, the reaction results in the formation of oxygen bubbles.*

13. Pour all 20 mL of the 0% hydrogen peroxide solution from Beaker #1 into Test Tube #1 while your partner starts the timer; measure the length of time it takes the oxygen bubbles to carry the disc to the surface of the solution.
14. Record the time in **Data Table 1** in the row that corresponds to your Group #.
15. Repeat steps 9-14 for Test Tubes 2, 3, 4, and 5 and record your data in **Data Table 1**.
16. Report your data to the class according to your teacher’s instructions.
17. Record the data from the other groups in your class in **Data Table 1**.
18. Calculate the average rising time for each of the peroxide solutions with your class data. Record this information in **Data Table 1**.
19. Construct **Bar Graph 1** using the class averages for test tubes #1-5 in **Data Table 1**. Plot the concentration of hydrogen peroxide on the x-axis (independent variable) and rising time on the y-axis (dependent variable).
Procedure
Part B: Effect of Temperature on Reaction Rate
1. Follow steps 10 – 14 in Part A for Test Tube #6 of 100% H₂O₂ that is chilled to ice-water temperature.
2. Record your results in the row for your group in the second to last column of Data Table 1.
3. Follow steps 10 – 14 in Part A for Test Tube #7 of 100% H₂O₂ that is heated in a warm water bath to ~ 37°C (body temperature).
4. Record your results in the row for your group in the last column of Data Table 1.

Data:

Data Table 1 –Rising Time (Class Data)

<table>
<thead>
<tr>
<th>Group #</th>
<th>Test Tube #1 0% H₂O₂ Time (sec)</th>
<th>Test Tube #2 25% H₂O₂ Time (sec)</th>
<th>Test Tube #3 50% H₂O₂ Time (sec)</th>
<th>Test Tube #4 75% H₂O₂ Time (sec)</th>
<th>Test Tube #5 100% H₂O₂ Time (sec) Room Temp</th>
<th>Test Tube #6 100% H₂O₂ Time (sec) Ice Water</th>
<th>Test Tube #7 100% H₂O₂ Time (sec) Warm Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
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<td>Avg. Time</td>
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</tbody>
</table>

Data Analysis:
Bar Graph 1: Concentration H₂O₂ vs. Rising Time (averages)
Construct **Bar Graph 2** using the average time for test tubes # 5, 6 & 7 (100 % Hydrogen Peroxide Solutions) in **Data Table 2** to demonstrate the effects of temperature on enzyme activity. Correctly label each axis of your bar graph, label and include a key for your bars.

**Bar Graph 2:** Temperature H₂O₂ vs. Rising Time (averages)

---

**Analysis:**

1. Identify the control group: BEAKER #: ________What is the role of the control in this experiment? ____________________________________________________________________________________________

2. Using **Bar Graph 2;** Identify the independent variable: ____________________ and dependent variable:_______________________.

**Conclusion:**

1. In a paragraph describe the relationship between the catalase and concentration of hydrogen peroxide solution. Use the results of this experiment to justify your answer. ________________

2. In a paragraph explain why your hypothesis was or was not supported. ________________
3. In a paragraph describe how the temperature of the solution affected the breakdown rate of hydrogen peroxide. Use the results of your experiment to justify your answer.

   ___________________________________________________________
   ___________________________________________________________
   ___________________________________________________________
   ___________________________________________________________
   ___________________________________________________________

Application:

1. A catalyst is a substance that speeds up a reaction but is not consumed in the reaction. Enzymes are biological catalyst. Describe ONE other example of how an enzyme acts as a catalyst in our body.

   ___________________________________________________________
   ___________________________________________________________
   ___________________________________________________________
   ___________________________________________________________
**Effect of Catalase on Hydrogen Peroxide**

**Introduction:**
Metabolism is the sum total of chemical reactions in the body that are necessary to the maintenance of life. Enzymes are biological catalysts that can speed up, and control, chemical reactions that would otherwise virtually never occur at normal body temperature, 37°C. Thousands of chemical reactions are occurring in the human body every moment of life, and each of these reactions is controlled by a particular enzyme. Enzymes are extremely efficient. Some of the chemical reactions that take place in the body produce toxic by-products, which must be quickly degraded or converted. For example, certain reactions in the liver produce hydrogen peroxide, which is extremely poisonous. Under the influence of an enzyme called catalase, the hydrogen peroxide is broken down into water and oxygen. Catalase acts quickly; one molecule of it can deal with six million molecules of hydrogen peroxide in one minute. This same reaction can be catalyzed by iron. However, to achieve the same speed there would need to be about six tons of iron.

Enzymes have five important properties that you should know:

1. **They are always proteins.**
2. **They are specific in their action.** Each enzyme controls one particular reaction, or type of reaction. For example, sucrase degrades sucrose and only sucrose (table sugar).
3. **They are not altered by the reaction.** This means that an enzyme can be used repeatedly. It also means that enzymes appear neither in the reactants nor in the products of a chemical equation.
4. **They are destroyed by heat.** This is because enzymes are proteins, and all proteins are destroyed by heat. Destruction of protein by heat (or under any extreme conditions of pH or salt concentration) is called denaturation.
5. **They are sensitive to pH.** The term pH refers to the degree of acidity or alkalinity of a solution. Most intracellular enzymes work best in neutral conditions, i.e. conditions that are neither acidic nor alkaline.

**Closure Activity:**
Discuss each group’s results with the class as a whole. Make sure to discuss and correct any misconceptions the students have. Write down the WHOLE class’s conclusions on the board and refer back to the hypotheses.

**Extension:**
Time permitting, the students may choose to repeat the experiment with even higher or lower concentrations.

**Teacher Notes:**
Before passing out the labs, have the students think about what processes in the body use enzymes to function. Be sure to discuss as a class the vital enzymes for human digestion such as protease, amylase, lipase, etc.

Review the lab information with the students and, using WHOLE CLASS discussion, have them decide on an individual hypothesis for their lab group, focusing on lower concentration effects and higher concentration effects on the rate of reaction.

Lab suggestions:
- You may want to substitute potatoes and liver puree for the yeast.
- Placing the disc at the bottom of the test tube can be achieved by using a dissection probe, pencil eraser, wooden skewer, et.

Lab Demonstration: Purpose is to show that without an enzyme the breakdown of Hydrogen Peroxide occurs at a much slower rate.

Test tube #5 is used for both bar graphs (concentrations and temperature)
Lab: H₂Olympics

Name(s) _______________________________  Date ________

Period _______

Benchmark:
SC.912.L.18.12: Discuss the special properties of water that contribute to Earth’s suitability as an environment for life: cohesive behavior, ability to moderate temperature, expansion upon freezing, and versatility as a solvent.

Background:
Water exhibits many unique properties that contribute to Earth’s suitability to support life. Aside from being the only substance found in all three states of matter (solid, liquid, and gas), water covers nearly 75% of the earth’s surface and comprises 78% of a human body by mass. The unique properties of cohesion (ability to stick to itself) and adhesion (ability to stick to other substances) create water’s interesting ability to seemingly defy gravity (capillary action), create impenetrable surfaces (surface tension), curve at its edges (meniscus of graduated cylinder), and possess positive and negative ends (polarity).

Purpose:
Investigate water’s properties of adhesion to cohesion through a series of experiments.

EVENT 1 – The Floating Paperclip

Hypothesis: (Can you float a metal paperclip on water?) ________________________________

Materials:
- Paperclip
- Petri Dish
- Water
- Plastic Fork
- Toothpick
- Dish Soap

Procedure:
1. Fill a Petri Dish with tap water.
2. Make a metal paper clip float on the top
3. Make a sketch of the paper clip’s effect on the surface of the water as viewed from the side (profile) in Diagram 1 of the Data Section.
4. After you have shown your teacher the floating paperclip, dip a toothpick into the dish soap and then gently touch the toothpick to the water where the paperclip is floating. Observe.
Data:

**Diagram 1: Floating Paperclip**

Analysis:

1. What property of water was demonstrated by the floating paperclip? _____________________
   __________________________________________________________________________

2. Describe what happened when you added dish soap. ______________________________
   __________________________________________________________________________

3. What property of water did the dish soap change? ________________________________
   __________________________________________________________________________

Application:

1. Water striders are insects that literally can walk on water. Use the knowledge that you gained from your experiment to explain how this is possible. ______________________________
   __________________________________________________________________________
   __________________________________________________________________________

EVENT 2 – Drops on a Penny

**Hypothesis:** (How many drops of fresh water – vs – soapy water? Why?) ____________________________
   __________________________________________________________________________
   __________________________________________________________________________

**Materials:**

- 2 Pennies
- 1 mL Pipette
- Water
- Soapy-water

**Procedure:**

**Part 1:** How much water will fit on a penny?

1. Using a pipette labeled “WATER,” place 1 drop of water on the surface of a clean/dry penny. Make a sketch of the profile (side-view) of that drop in **Diagram 1** of the data section of the lab.

2. Record how many drops of water you can add to the penny before the water spills off. Repeat for two more trials. Record your results in **Data Table 1**.
Part 2: How much soapy-water will fit on a penny?

1. Repeat procedure steps 1 & 2 using a pipette labeled “SOAPY-WATER.” Record your data in Data Table 1.

Data:

Diagram 1: Profile of a drop of water on a penny

![Diagram of a drop of water on a penny]

1 drop of H₂O 1 drop of Soapy-H₂O

Data Table 1 - H₂O Drops on Dry Penny

<table>
<thead>
<tr>
<th></th>
<th># Drops of water</th>
<th># Drops of soapy water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trial 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trial 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Analysis:

1. Is your hypothesis supported by your data? _______ Explain your results in terms of cohesion/adhesion. ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

Application:

1. Explain how detergents function as cleaning agents, considering the cohesion among water molecules.
EVENT 3 – Comparative Drops of H₂O

Hypothesis: (How will the drops appear different?) __________________________________________
__________________________________________________________________________________

Materials:
- 5 cm x 5 cm Square of Waxed Paper
- Glass Microscope Slide
- Water
- 1 mL Pipette

Procedure:
1. **Prediction** – Using Diagram 1 in the Data section, make a sketch of your prediction about what a large drop (made of 5 smaller drops) might look like on a glass slide as compared to on waxed paper.
2. Using a pipette, place 5 drops of water (making one large drop) on both a piece of waxed paper and on a glass microscope slide. (It is important to be sure both the waxed paper and glass slide are dry prior to beginning).
3. Sketch your results in Diagram 2 in the Data section.
4. Using the tip of the pipette, observe what happens when you attempt to push the water around on the surface of the glass slide as compared to the waxed paper.

Data:
**Diagram 1**: Prediction: Profile of a large drop of H₂O

![glass slide](image)

![waxed paper](image)

**Diagram 2**: Results: Profile of a large drop of H₂O

![glass slide](image)

![waxed paper](image)

Analysis:
1. Explain the difference in drop behavior in terms of adhesion and cohesion. __________________
__________________________________________________________________________________

2. Compare what happened when you attempted to push the water around on the surface of the glass slide vs. the surface of waxed paper. ____________________________
__________________________________________________________________________________

Application:
1. What is the purpose of putting wax on automobiles? _________________________

EVENT 4 – The Climbing Property of Water

Hypothesis: (How is water able to get to the top of plants?) _______________________

Materials:
- Plastic Cup
- Graduated Cylinder
- Washable Marker
- Water
- Ruler
- Timer/Clock
- Chromatography Paper or Coffee Filter

Procedure:
1. Using a graduated cylinder, measure 20 mL of water and pour it into a plastic cup.
2. Cut a strip of chromatography paper/coffee filter paper about 2.5 cm wide and 10 cm long.
3. Use a washable marker to draw a line across the width of the filter paper about 2.5 cm from the bottom.
4. Place the filter paper into the cup with water being sure the line you drew is JUST ABOVE the surface of the water.
5. Start your timer when you place the filter into the water and observe for 2 minutes.
6. After 2 minutes, remove the filter paper from the cup and use a ruler to measure the distance the water traveled from your original line to the highest point it reached on the filter strip and record your measurement in Data Table 1.
7. Assuming that the water moves at a constant rate, calculate the distance at which the water climbed the filter paper at 60 sec and 30 sec. Record your answers in Data Table 1.

Data:

Data Table 1 – Water Climbing Filter Paper

<table>
<thead>
<tr>
<th>Time (seconds)</th>
<th>Distance (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>120 (measured)</td>
<td></td>
</tr>
<tr>
<td>60 (calculated)</td>
<td></td>
</tr>
<tr>
<td>30 (calculated)</td>
<td></td>
</tr>
</tbody>
</table>

Analysis:
1. What properties of water were demonstrated by the movement you observed? _______________
Application:
1. Vascular plants have xylem tissue that carries water upward from the roots to every part of the plant. Explain why most vascular plants can grow taller than non-vascular plants.

Conclusion: Discuss the unique properties of water observed during this activity and how they are associated with our natural world.

____________________________________________________________________________

____________________________________________________________________________

____________________________________________________________________________

____________________________________________________________________________
**Benchmark:**
SC.912.L.14.1 AA: Describe the scientific theory of cells (cell theory) and relate the history of its discovery to the process of science.
SC.912.L.14.3 AA: Compare and contrast the general structures of plant and animal cells. Compare and contrast the general structures of prokaryotic and eukaryotic cells. [in different benchmark group]

**Background:**
In the early part of the 19th century, German biologists Schleiden & Schwann (1838-39) realized that all living things, plants and animals, are made of cells. This understanding eventually established the **cell theory**. The 3 basic components of the cell theory are: all living things are made of cells, cells come from existing cells, and cells are the basic unit of organization for all living things.

There are two major divisions of cells: **prokaryotic** (those lacking membrane bound organelles) and **eukaryotic** (those with membrane bound organelles). Bacteria cells are examples of prokaryotic cells, while plant, animal, fungi and protistan cells are examples of eukaryotic cells.

When different types of cells are viewed under a microscope, different cell parts can be seen. Cells from producer organisms (plants) will show parts such as chloroplasts and cell walls. Most consumer organism cells do not have these parts. The microscope enables us to study and locate many cell parts.

**Materials:**
- Compound light microscope
- Onions
- Elodea or other aquatic plant
- Toothpicks
- Slides
- Cover slips
- Prepared slides of human cheek cells
- Dropper bottles containing:
  - Iodine
  - Water

**PART I: ANIMAL CELLS: The Human Cheek Cell**

**Procedure:**
1. Observe prepared slides of human cheek cells.
2. Sketch the cell at low and high power - include magnification. **Label the nucleus, cytoplasm, and cell membrane of a single cell.** Draw your cells to scale.
QUESTIONS:
1. The light microscope used in the lab is not powerful enough to view all organelles in the cheek cell. List 2 organelles that were NOT visible but should have been in the cheek cell.
   a) __________________________   b) __________________________
2. Is the cheek cell a eukaryote or prokaryote? __________________________ How do you know? __________

3. Keep in mind that the mouth is the first site of chemical digestion in a human. Your saliva starts the process of breaking down the food you eat. What macromolecule is present in your saliva that starts the process of digestion?

PART II: Plant Cells:
Part A - Onion Cells
Procedure:
1. Use your fingernail to peel off the thin layer of onion tissue.
2. Place this tissue on the slide and stain it with iodine...add a coverslip.
3. Make sure the tissue DOES NOT fold...it must remain perfectly flat!
4. Observe and draw the cell under low and high power-include magnification. Label the cell wall, nucleus, and cytoplasm.

   ____X

QUESTIONS:
1. Describe the shape of the onion cell: __________________________
2. Are onions plants or animals: __________________________
3. Is a cell wall present? __________________________
4. Describe the shape of the nucleus of the onion cell: __________________________
5. Within what cell part does the nucleus lie? __________________________
6. What is the function of the cell’s nucleus? __________________________
7. Describe the shape of the nucleolus of the onion cell? __________________________
8. Where is the nucleolus found? __________________________
9. What is the function of the nucleolus? __________________________
10. What structure separates the contents of the nucleus from the cytoplasm? __________________________
11. Why where the cells stained? __________________________
Part B - Elodea Cells

Procedure:
1. Prepare a wet mount slide of an Elodea leaflet using water.
2. Observe and draw the cell under low and high power—include magnifications. Label the cell wall, nucleus, chloroplast, and cytoplasm.

Questions:
1. Describe the shape of the Elodea cell: ____________________________
2. Is Elodea a plant or animal? ______ Explain your answer. ______________________
3. What is the function of the chloroplast? ____________________________
4. Are chloroplasts usually present in consumer cells? ______ Explain: ______________________
5. Using prior knowledge, identify the polysaccharide that makes up the cell wall: ______________________

EXTENSION:
1. Add 2 drops of 15% NaCl solution to one edge of ONE of your plant slides.
2. Place the corner of a small piece of paper towel under the opposite edge and draw the NaCl solution under the coverslip.
3. Describe what happens to the cells.
   __________________________________________________________________________
4. Define the term Plasmolysis: ________________________________________________
5. Explain how this process relates to your previous procedure:
   __________________________________________________________________________
6. What property of water is being demonstrated in step 2 of the extension activity?
   __________________________________________________________________________
PART III: ANALYSIS AND CONCLUSION QUESTIONS

Complete this chart. Indicate by using check marks for each structure present in a plant or animal cell.

<table>
<thead>
<tr>
<th></th>
<th>Nucleus</th>
<th>Cell wall</th>
<th>Cytoplasm</th>
<th>Nuclear membrane</th>
<th>Nucleolus</th>
<th>Chloroplasts</th>
<th>Cell membrane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal cell</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant Cell</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Why were no chloroplasts found in the onion cells? (hint: think about where you find onions)
__________________________________________________________________________________
__________________________________________________________________________________

2. Fill out the Venn Diagram below to show the differences and similarities between the plant cells and the animal cells.

CONCLUSION:
1. List the 3 parts of the Cell Theory
__________________________________________________________________________________
__________________________________________________________________________________
__________________________________________________________________________________

2. Match the scientist with his contribution to the cell theory:
   ___ Theodor Schwann  a) Concluded that all cells arise from preexisting cells.
   ___ Matthais Schleiden b) Animal tissues are composed of cells.
   ___ Rudolf Virchow    c) Plant parts are made of cells
3. Give the function of each of the following cell organelles:
   a) Ribosome ________________________________________
   b) Cytoplasm _________________________________________
   c) Mitochondria _______________________________________
   d) Endoplasmic reticulum _________________________________

4. Name two structures found in plant cells but not animal cells:
   a) _________________________  b) _________________________

5. Name three structures found in plant cells AND in animal cells.
   a) _________________________
   b) _________________________
   c) _________________________

6. What structure surrounds the cell membrane (in plants) and gives the cell support.________________________

Label the following diagrams using the word list provided:
Rough E.R.  Chloroplast  Nuclear Membrane  Vacuole  Cell Wall  Nucleus  Cytoplasm
Golgi Body  Centriole  Mitochondria  Lysosome  Smooth E.R.  Ribosome  Nucleolus
Cell Membrane  Chromatin

Diagram 1:

Circle: Diagram 1 is a PLANT or ANIMAL cell because __________________________________________
Diagram 2:

Circle: Diagram 2 is a PLANT or ANIMAL cell because ____________________________________________

__________________________________________
ANSWERS:

QUESTIONS:
1. The light microscope used in the lab is not powerful enough to view all organelles in the cheek cell. List 2 organelles that were NOT visible but should have been in the cheek cell.
ANSWERS CAN INCLUDE: RIBOSOMES, ER, GOLGI, LYSOSOME, NUCLEOLUS

2. Is the cheek cell a eukaryote or prokaryote? __EUKARYOTE__ How do you know? IT HAS A NUCLEUS

3. Keep in mind that the mouth is the first site of chemical digestion in a human. Your saliva starts the process of breaking down the food you eat. What macromolecule is present in your saliva that starts the process of digestion? ENZYMES/PROTEINS

PART II: Plant Cells:
Part A - Onion Cells
Procedure:
1. Use your fingernail to peel off the thin layer of onion tissue.
2. Place this tissue on the slide and stain it with iodine…add a coverslip.
3. Make sure the tissue DOES NOT fold…it must remain perfectly flat!
4. Observe and draw the cell under low and high power-include magnification. Label the cell wall, nucleus, and cytoplasm.

QUESTIONS:
1. Describe the shape of the onion cell:__ RECTANGULAR ___________________________________________________________________
2. Are onions plants or animals:_______ PLANTS ___________________________________________________________________
3. Is a cell wall present? ___________YES ___________________________________________________________________
4. Describe the shape of the nucleus of the onion cell: _____ROUND ___________________________________________________________________
5. Within what cell part does the nucleus lie? NUCLEAR MEMBRANE OR CYTOPLASM
6. What is the function of the cell’s nucleus? COMMAND CENTER/STOREHOUSE FOR DNA
7. Describe the shape of the nucleolus of the onion cell? ___ROUND ___________________________________________________________________
8. Where is the nucleolus found? __________INSIDE NUCLEUS ___________________________________________________________________
9. What is the function of the nucleolus? ______MANUFACTURE RIBOSOMES __
10. What structure separates the contents of the nucleus from the cytoplasm? NUCLEAR MEMBRANE
11. Why where the cells stained? TO MAKE THEM VISIBLE
Part B - Elodea Cells

Procedure:
1. Prepare a wet mount slide of an Elodea leaflet using water.
2. Observe and draw the cell under low and high power—include magnifications. **Label the cell wall, nucleus, chloroplast, and cytoplasm.**

![Cell diagram]

______ X ______ X

Questions:
1. Describe the shape of the Elodea cell: **RECTANGULAR/OVAL**
2. Is Elodea a plant or animal? **PLANT** Explain your answer. **HAS CHLOROPLAST/CELL WALL**
3. What is the function of the chloroplast? **SITES OF PHOTOSYNTHESIS**
4. Are chloroplasts usually present in consumer cells? **NO** Explain: **CONSUMER CELLS DO NOT CARRY OUT PHOTOSYNTHESIS—THEY ARE HETEROTROPHS**
5. Using prior knowledge, identify the polysaccharide that makes up the cell wall: **CELLULOSE**

Extension:
1. Add 2 drops of 15% NaCl solution to one edge of ONE of your plant slides.
2. Place the corner of a small piece of paper towel under the opposite edge and draw the NaCl solution under the coverslip.
3. Describe what happens to the cells. **THE CELL SHRINKS INSIDE THE CELL WALL**
4. Define the term Plasmolysis: **THE PROCESS IN PLANT CELLS WHERE THE CYTOPLASM PULLS AWAY FROM THE CELL WALL DUE TO THE LOSS OF WATER THROUGH OSMOSIS.**
5. Explain how this process relates to your previous procedure: **THE SALT CEATED A HYPERTONIC SITUATION.**
6. What property of water is being demonstrated in step 2 of the extension activity? **ADHESION**
PART III: ANALYSIS AND CONCLUSION QUESTIONS

**Complete this chart.** Indicate by using check marks for each structure present in a plant or animal cell.

<table>
<thead>
<tr>
<th></th>
<th>Nucleus</th>
<th>Cell wall</th>
<th>Cytoplasm</th>
<th>Nuclear membrane</th>
<th>Nucleolus</th>
<th>Chloroplasts</th>
<th>Cell membrane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal cell</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Plant Cell</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

1. Why were no chloroplasts found in the onion cells? (hint: think about where you find onions)
   _______THEY ARE UNDERGROUND AND THE ONION PORTION DOES NOT CARRY OUT PHOTOSYNTHESIS__________

2. Fill out the Venn Diagram below to show the differences and similarities between the plant cells and the animal cells.

![Venn Diagram]

**CONCLUSION:**

1. List the 3 parts of the Cell Theory
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________

2. Match the scientist with his contribution to the cell theory:
   _B__ Theodor Schwann  a) Concluded that all cells arise from preexisting cells.
   _C__ Matthais Schleiden b) Animal tissues are composed of cells.
   _A__ Rudolf Virchow    c) Plant parts are made of cells

3. Give the function of each of the following cell organelles:
   a) Ribosome _______SITES OF PROTEIN SYNTHESIS__________________________
   b) Cytoplasm _______JELLYLIKE SUBSTANCE INSIDE THE CELL MEMBRANE_________
c) Mitochondria **SUPPLY ENERGY TO THE CELL**

d) Endoplasmic reticulum **SERIES OF CANALS THAT AID IN THE PRODUCTION OF PROTEINS AND LIPIDS**

4. Name two structures found in plant cells but not animal cells:
   a) **CELL WALL**
   b) **CHLOROPLASTS**

5. Name three structures found in plant cells **AND** in animal cells. *(THERE ARE SEVERAL CORRECT ANSWERS)*
   a) **CELL MEMBRANE**
   b) **NUCLEUS**
   c) **CYTOPLASM**

6. What structure surrounds the cell membrane (in plants) and gives the cell support. **CELL WALL**

**Label the following diagrams using the word list provided:**

- Rough E.R.
- Chloroplast
- Nuclear Membrane
- Vacuole
- Cell Wall
- Nucleus
- Cytoplasm
- Golgi Body
- Centriole
- Mitochondria
- Lysosome
- Smooth E.R.
- Ribosome
- Nucleolus
- Cell Membrane
- Chromatin

**Diagram 1:**

**DIAGRAM 1 KEY (STARTING AT 12 O’CLOCK AND MOVING CLOCKWISE):** NUCLEOLUS, NUCLEAR MEMBRANE, NUCLEUS, GOLGI BODIES, CELL MEMBRANE, CELL WALL, CYTOPLASM/RIBOSOME, WATER VACUOLE, CHLOROPLAST, CHROMOSOME, RIBOSOME/CYTOPLASM, MITOCHONDRIA

**Circle:** Diagram 1 is a PLANT or ANIMAL cell because **PLANT DUE TO CELL WALL AND LARGE WATER VACUOLE**
Diagram 2:

Circle: Diagram 2 is a PLANT or ANIMAL cell because: **ANIMAL CELL; LACKS A CELL WALL**

**DIAGRAM 2 KEY (STARTING AT 12 O’CLOCK AND MOVING CLOCKWISE):** NUCLEAR MEMBRANE PORE, NUCLEAR MEMBRANE, NUCLEUS, NUCLEOLUS, ROUGH ENDOPLASMIC RETICULUM (ER), GOLGI BODIES, LYSOSOME, RIBOSOME, SMOOTH ER, CYTOPLASM, MITOCHONDRIA, CENTRIOLES, CELL MEMBRANE, CYTOSKELETON, CHROMATIN
Lab: Demonstrating Osmosis Using Potatoes

Benchmark:
SC.912.L.14.2 : Relate structure to function for the components of plant and animal cells. Explain the role of cell membranes as a highly selective barrier (passive and active transport).

Background Questions: (Use your notes or textbook to answer the following questions)
1. Which carbon (organic) compound is most abundant in the potato?

2. Explain what happens during Osmosis? What type of transport is Osmosis?

3. What is a hypertonic solution?

4. What is a hypotonic solution?

5. What is an isotonic solution?

Purpose:
To demonstrate the process of osmosis.

Hypothesis: After reading the procedure state a testable hypothesis.
If ___________________________________, then ___________________________________.

Materials:
Salt (NaCl)  Paper Towel  100 mL Graduated Cylinder
Sugar  Stir Rod  Cylinder
Distilled water  Balance  3 Potato Slices – or
3 – Plastic Cups  Weigh Tray  3 Crinkle-Cut Carrot Slices
Wax Pencil/Marker

Procedure:
1. Use a balance to measure the mass of each potato slice and record your data in Data Table 1.
2. Use a wax pencil or marker to label 3 cups: Cup 1, Cup 2, and Cup 3.
3. Use a 100 mL graduated cylinder to measure 200 mL of distilled into each of the 3 cups.
4. CUP 1- Use the balance to measure 30g of salt and stir until completely dissolved.
5. CUP 2- Use the balance to measure 30g of sugar and stir until completely dissolved.
6. CUP 3- Contains 200 mL of distilled water ONLY.
7. Place one potato slice into each cup and allow it to soak for 30 minutes or overnight.
8. After 30 minutes, remove each potato slice from its cup and blot dry using a paper towel.
9. Use a balance to measure the mass of each potato after soaking and record your data in Data Table 1. (Be careful to record each sample in the correct location – Do not mix them up).
10. Calculate the difference in mass before and mass after and record in **Data Table 1**.
11. Use **Data Table 1** to construct a **BAR GRAPH** showing the initial and final mass for each potato slice. Be sure to include: a **Title**, label each **Axis**, and a **Key** for your bars.

**Data:**

**Data Table 1 – Potato Osmosis**

<table>
<thead>
<tr>
<th>Cup #</th>
<th>Beginning Mass of Potato (g)</th>
<th>Ending Mass of Potato (g)</th>
<th>Change in Mass (g)</th>
<th>% Change in Mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>200mL H₂O + 30g of Salt</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>200mL H₂O + 30g of Sugar</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>200mL H₂O</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Bar Graph of Results**

Title: _____________________________
Analysis:

1. The following formula is used to calculate percentage change:

\[
\text{Percentage Change} = \left( \frac{\text{New Mass} - \text{Original Mass}}{\text{Original Mass}} \right) \times 100\%
\]

2. Calculate the percentage change for each of your samples and record your results in Data Table 1. (SHOW YOUR WORK):

   a. Salt Water:

   b. Sugar Water:

   c. Distilled Water:

3. How do your results compare to the class results? ____________________________________
   ______________________________________________________________________________
   ______________________________________________________________________________

Conclusion:

1. From your data table, identify which solutions were isotonic, hypotonic, and hypertonic solutions in relation to the potato slice?
   ______________________________________________________________________________
   ______________________________________________________________________________
   ______________________________________________________________________________
   ______________________________________________________________________________

2. Does your data support your hypothesis? Use your actual data to support your answer.
   ______________________________________________________________________________
   ______________________________________________________________________________
   ______________________________________________________________________________
3. Identify 2 possible sources of error in your experiment and describe 1 way to correct each of your sources of error: __________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

4. A shipwrecked sailor is stranded on a small desert island with no freshwater to drink. She knows she could last without food for up to one month, but if she didn’t have freshwater to drink she would be dead within one week. Hoping to postpone the inevitable, her thirst drove her to drink the salty seawater. She was dead in 2 days! Why do you think drinking the seawater killed the sailor faster than not drinking any water at all?
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

5. If you were stranded with this sailor, DESCRIBE 2 examples of osmosis that you would encounter on a daily basis: ______________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
Lab: Investigating Photosynthesis

Name(s) ___________________________________ Date __________
Period_________

Benchmarks:
SC.912.L.18.7 as AA: Identify the reactants, products, and basic functions of photosynthesis.
(Assessed as SC.912.L.18.9 AA)

Background:
ALL living organisms carry out the process of cellular respiration: the process in which energy is released from the chemical bonds of glucose. However, ONLY autotrophs carry out the food making process called photosynthesis.

Green plants are examples of autotrophs, meaning they can make their own food in the form of carbohydrates (products) by combining the reactants of carbon dioxide (CO$_2$) and water (H$_2$O) with the aid of solar energy. Oxygen is a fortunate by-product of this process.

Purpose:
To investigate the reactants, products and basic function of photosynthesis.
To investigate the effects of light on the rate of photosynthesis.

Hypothesis:
Read the entire investigation. Then work with your partner to develop a hypothesis for this experiment.
Hypothesis: __________________________________________________________

Materials

| Safety Goggles | 3 Sprigs of Elodea, | Stir Rod |
| 3 – Test Tubes | Evergreen or Pond-weed | Balance |
| Light Source | (stored in water) | Weigh Tray |
| 3 – 250mL Beakers (or cups) | Sodium bicarbonate | Scissors |
| 1 – 1000mL Beaker | (NaHCO$_3$)(baking soda) | Ruler |
| | Tap Water |

Procedure: Products of Photosynthesis

1. Use a weigh-tray and balance to measure 30 grams of Sodium bicarbonate (NaHCO$_3$)
2. Measure 1000 mL of tap water using a 1000 mL beaker.
3. Mix the 30 grams of NaHCO$_3$ into the 1000 mL of water and stir until it dissolves.
4. Pour approximately 200 mL of your solution into each of the 250 mL beakers (or cups).
5. Cut three sprigs of elodea (or other plant), making sure they are equal in length.
6. Label the 3 test tubes: 1, 2, and 3. (Place labels upside down as test-tubes will be flipped.)
7. Place 1 sprig into each test tube, such that the cut end of the sprig is at the open end of the test tube.
8. FILL each test tube (completely, so there is no room for air) with the remainder of your sodium bicarbonate solution (this will provide a source of CO$_2$).
9. Use your thumb to cover the mouth of one of your test tubes, invert it, and place it upside down into the sodium bicarbonate solution in one of the 250 mL beakers. Be careful to only remove your thumb once the mouth of the test tube is completely submerged in the beaker of solution to prevent ANY air from entering the test tube.
10. Gently lower the tube the remainder of the way into the beaker, leaning it against the side of the beaker.
11. If a small amount of air enters the test tube make note of the size of that air bubble on the Data Table. If a large amount of air enters the test tube, remove and repeat 7 – 10.
12. Repeat steps 7 – 10 for test tubes #2 and #3, inverting each into its own 250 mL beaker of solution.
13. Place the test tubes in a vertical position, and measure the height of any gas bubble at the top of the test tube, record on the Data Table.
14. Place test tube #1/beaker under the bright-light source.
15. Place test tube #2/beaker on a counter, in "normal" light.
16. Place test tube #3/beaker in a dark location (or cover).
17. After 24 hours (or during next class) hold each test tube vertically in the beaker and measure the height of the gas bubbles. Record your data on the Data Table.

Data:

<table>
<thead>
<tr>
<th>Test-Tube</th>
<th>Day 1 Measurement of gas bubble</th>
<th>Day 2 Measurement of gas bubble</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Analysis:
1. From what part of the sprig (stem, needle, leaves) did the bubbles emerge? ________________________
2. What gas is being produced in the bubble? ________________________________________________
3. Which test tube produced the largest bubble? _____________________________________________

Conclusion:
1. **Hypothesis:** Was your hypothesis correct or incorrect? Explain your answer in detail referencing how the intensity of light affects the rate of photosynthesis.

   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________

2. **State the reactants and products of photosynthesis:**
   Reactants: ______________________________________________________
   Products: ______________________________________________________

Extension:
1. What effect would different color light have on the rate of photosynthesis? How could you test this?
Lab: Investigating Cellular Respiration and Photosynthesis

Name(s) ___________________________________ Date __________
Period _______

Benchmarks:
SC.912.L.18.9 AA: Explain the interrelated nature of photosynthesis and cellular respiration.
SC.912.L.18.8 as AA: Identify the reactants, products, and basic functions of aerobic and anaerobic cellular respiration. (Assessed as SC.912.L.18.9 AA)

Background:
ALL living organisms carry out the process of cellular respiration: the process in which energy is released from the chemical bonds of glucose. However, ONLY autotrophs carry out the food making process called photosynthesis.

Green plants are examples of autotrophs, meaning they can make their own food in the form of carbohydrates (products) by combining the reactants of carbon dioxide (CO$_2$) and water (H$_2$O) with the aid of solar energy. Oxygen is a fortunate by-product of this process.

To release the energy contained in the bonds of carbohydrate molecules, the chemical reaction of photosynthesis must be reversed in a process called cellular respiration. Because all living things need a constant flow of energy, the process of cellular respiration is always taking place.

In addition to energy production, cellular respiration produces the waste products: carbon dioxide and water; which are the same substances that served as the reactants for photosynthesis.

Indicators: The following can be used as pH indicators:
Phenol Red - changes from red to orange in the presence of carbonic acid.
Bromothymol Blue - changes from blue to green to yellow in the presence of carbonic acid.
Purple cabbage juice - changes from purple to red in the presence of carbonic acid.

The following 2 experiments will demonstrate the relationship between the processes of photosynthesis and respiration. Read through the lab procedure and answer the following questions prior to beginning the lab.

1. What is an acid indicator? ______________________________________________________
____________________________________________________________________________

2. In Part B, why is nothing added to one of the test tubes containing pH indicator? _____________
____________________________________________________________________________

3. What special safety note should you observe when you blow through the straw? ____________
____________________________________________________________________________

Purpose:
To understand the relationship between photosynthesis and respiration.
To observe how respiration occurs under aerobic conditions.

Hypothesis:
Read the entire investigation. Then work with your partner to develop a hypothesis for both Part A and Part B.

1. Hypothesis Part A: _____________________________________________________________
____________________________________________________________________________

____________________________________________________________________________
2. Hypothesis Part B: _____________________________________________________________
____________________________________________________________________________

Materials – Parts A and B:
Safety Goggles
Gloves
Coffee Stir Straw
pH Indicator = Diluted
Phenol Red, Bromothymol
Blue, or Purple Cabbage
Juice
10mL Graduated Cylinder
Test Tube Rack
4 – Test Tubes (15x125mm)
Parafilm or plastic-wrap
Paraffilm or plastic-wrap
Wax Pencil/Marker
10 seedlings (radish/bean sprouts)

1. Be sure to wear your safety goggles throughout this lab.
2. Label the 4 test tubes; 1, 2, 3, and 4.
3. Measure 7 mL of pH indicator into test tube #1 and repeat for test tube #2 (each will be about ½ full).
4. Seal one test tube #1 with parafilm or plastic wrap and place it in your test tube rack. Note its color on the Data Table.
5. Insert a small, coffee stir-straw into test tube #2 and cover temporarily with parafilm.
6. VERY CAREFULLY blow into the straw in test tube #2 until the pH indicator changes color. Be careful to prevent any liquid from bubbling out of the test tube and onto your face or clothes. CAUTION: DO NOT inhale any of the pH indicator.
7. Record the color of the pH indicator in each test tube in the Day 1 column on the Data Table.
8. Cut a 4cm sprig of Elodea (or other available plant) into test tube #2 and cover with parafilm.
9. Place near a bright light source.
10. After 24 hours (or during your next class), observe test tube #1 and #2; record a brief description of the reaction in the "Description" column on the Data Table. Also note the final color of the pH indicator.

Procedure – Part B: Products of Cellular Respiration
1. Measure 4 mL of the same type of pH indicator used in Part A, into test tube #3 and repeat for test tube #4.
2. Cut a cotton-ball in half.
3. Place a half-cotton-ball into test tube #3 so that it is just above the pH indicator and repeat for test tube #4.
4. Place 10 seedlings into test tube #3 and cover with parafilm.
5. Cover test tube #4 with parafilm (no seedlings).
6. Record the color of the pH indicator in test tube #3 and #4 on the Data Table.
7. Place the test tubes in a test-tube rack and place in dark location for 24 hours (or until next class).
8. After 24 hours (or during your next class), observe test tube #3 and #4; record a brief description of the reaction in the "Description" column on the Data Table. Also note the final color of the pH indicator.
Data:

Data Table – Part A & Part B – Observations (pre and post)

<table>
<thead>
<tr>
<th>Test-Tube</th>
<th>Description of Reactions</th>
<th>Color of pH indicator (Day 1)</th>
<th>Color of pH indicator (Day 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Analysis:

1. Describe what caused the color change of the pH indicator when you exhaled into the test tube.

2. After 24 hours, did the color of the pH indicator in test tube #2 change? Explain.

3. After 24 hours, did the color of the pH indicator change in test tube #3? Explain.

4. **Compare / Contrast:** Compare the reaction that occurred in test tube #3 to the reaction that occurred in the test tube #2. How are they similar / different?

5. **Inferring:** Which test tube exhibited the process of respiration? Explain.
6. In part A, which test tube was the control? What is the function of your control?

____________________________________________________________________________
____________________________________________________________________________

Conclusion:

1. **Hypothesis:** Were your hypothesis correct or incorrect? Explain your answer in detail.

____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

2. **Drawing Conclusions:** Why is the process of cellular respiration necessary for all forms of life?

____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

3. Write the formulas for photosynthesis and respiration below:

____________________________________________________________________________
____________________________________________________________________________

In your own words, explain the relationship between the two processes. ________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
Lab: Modeling Probability of Allele Inheritance

Name: ___________________________ Date __________

Period_________

Benchmarks:

SC.912.L.16.2 as AA: Discuss observed inheritance patterns caused by various modes of inheritance, including dominant, recessive, co-dominant, sex-linked, polygenic, and multiple alleles.
(Assessed as SC.912.L.16.1 AA)

Background:
1. What is a trait? __________________________________________

2. Explain the difference between genotype and phenotype. __________________________

3. Differentiate between alleles and genes. ______________________________

4. Differentiate between homozygous and heterozygous. ________________________

5. Create a Punnett Square from 2 heterozygous parents using the alleles B(brown) and b(white).

Purpose:
To predict the genotypic and phenotypic ratios of offspring resulting from the random pairing of gametes.
Calculate the genotypic ratio and phenotypic ratio among the offspring of a monohybrid cross.
**Hypothesis:** Punnett Squares are used to predict possible offspring, use background information to develop your hypothesis.

If your parents are ______________________ then the offspring will be (use ratios) ______________________________________

**Materials:**

- 1 “Mom” brown bag containing: 1 white and 1 brown bean (should be same size, shape, & texture)
- 1 “Dad” brown bag containing: 1 white and 1 brown bean (should be same size, shape, & texture)
- Pencil
- Calculator

**Procedure – Part A: Allele Pairing**

1. Working with a partner, you will model the random pairing of alleles by choosing brown and/or white beans from a bag. The beans will represent the allele for seed color.
   a. **BROWN BEAN** = B – the dominant allele for brown seeds
   b. **WHITE BEAN** = b – the recessive allele for white seeds.
2. Each bag represents a parent. In each bag there is 1 brown bean and 1 white bean. The “MOM” bag contains 2 possible female gametes and the “DAD” bag contains 2 possible male gametes.
3. What is the genotype and phenotype of each parent? ____________________________

4. Decide which partner will represent the Male and which will represent the Female to model a cross between these two parents.
5. Each partner will choose 1 bean from his/her bag (without looking) and place it on the table.
6. The pair of seeds chosen represents the genotype of the first offspring. (Example: Female selects a brown seed (B) and the male selects a brown seed (B), the genotype would be BB)
7. Record the genotypes of the F₁ offspring in Data Table 1
8. Return the beans to their ORIGINAL bags
9. Repeat steps 5 through 8 for a total of 10 times offspring. Record your data in Data Table 1.
10. Based on each offspring’s genotype record each offspring’s phenotype in Data Table 1.

**Procedure – Part B: Calculating Genotypic and Phenotypic Ratios**

1. Using Data Table 1, record genotypes on Data Table 2.
2. Calculate the percentage of each genotype and record your calculations in Data Table 2.
   \[ \% \text{ Genotype} = \left( \frac{\# \text{ of offspring with a given genotype}}{\text{Total number of offspring}} \right) \times 100 \]
3. Record your Genotype % on the white board according to your teacher’s instructions.
4. Using Data Table 1, record phenotypes on Data Table 3.
5. Calculate the percentage of each phenotype and record your calculations in Data Table 3.
   \[ \% \text{ Phenotype} = \left( \frac{\# \text{ of offspring with a given phenotype}}{\text{Total number of offspring}} \right) \times 100 \]
6. Record your Phenotype % on the white board according to your teacher’s instructions.
7. Copy the Class % and Totals after all groups have shared their data.
Data:

Data Table 1 – F₁ Generation:

<table>
<thead>
<tr>
<th>Draw</th>
<th>Allele from Mom</th>
<th>Allele from Dad</th>
<th>F₁ Genotype</th>
<th>F₁ Phenotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
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<tr>
<td>3</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
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<td>6</td>
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<td>7</td>
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<tr>
<td>8</td>
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</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data Table 2 – Genotypic Percentages

<table>
<thead>
<tr>
<th>Genotypes</th>
<th>Total</th>
<th>% of each Genotype</th>
<th>Class Total</th>
<th>Class % of Genotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homozygous Dominant</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heterozygous</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Homozygous Recessive</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total # of offspring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Data Table 3 – Phenotypic Percentages

<table>
<thead>
<tr>
<th>Phenotype</th>
<th>Total</th>
<th>% of each Phenotype</th>
<th>Class Total</th>
<th>Class % of Phenotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Analysis

1. What trait is being studied in this investigation? __________________________

2. With support from your class average data tables which genotype and phenotype would most likely be expressed by the offspring or F₁ generation? __________________________

3. What does each bean represent? ___________________________________________

4. When the beans were selected and paired, what did the pairs represent? ________________

5. What is the probability that your group will have the exact same phenotypic and genotypic ratios as another group in the class? (Explain your answer) __________________________

6. In pea plants, the allele for yellow seeds is dominant over the allele for green seeds. Predict the genotypic ratio of offspring produced by crossing two parent plants that are heterozygous for this trait. Complete the Punnett square below.

   Genotype ratio = ________________

7. According to the Punnett square above, if 60 yellow seeds are randomly produced, how many of those would be heterozygous? __________________________

8. Suppose you found out that brown and white alleles were co-dominant. What would you expect offspring from homozygous brown and homozygous white parents to look like?

   __________________________

   __________________________
9. Suppose you found out that brown and white alleles were incomplete dominance. What would you expect offspring from homozygous brown and homozygous white parents to look like?

__________________________________________________________________________________

Conclusion:
Was your hypothesis supported or refuted (use your data to answer the question)? What are some possible sources of error? How would you improve the design of the activity? ____________________________

__________________________________________________________________________________

__________________________________________________________________________________

__________________________________________________________________________________

__________________________________________________________________________________
Lab: Mitosis and the Cell Cycle

Name ___________________________________  Date __________
Period_______

Benchmark:
SC.912.L.16.14 as AA: Describe the cell cycle, including the process of mitosis. Explain the role of mitosis in the formation of new cells and its importance in maintaining chromosome number during asexual reproduction. (Assessed as SC.912.L.16.17 AA)
SC.912.L.16.8 as AA: Explain the relationship between mutation, cell cycle, and uncontrolled cell growth potentially resulting in cancer. (Assessed as SC.912.L.16.17 AA)

Background:
Cells in a multicellular organism function like the members of a team with each member having a specific job or specialty that works in conjunction with the other members of the team. So how do we become multicellular? This occurs through repeated rounds of cell division.
Cell division can be divided into two stages: 1) Mitosis or nuclear division and 2) cytokinesis or division of the cytoplasm. These processes of a dividing cell however, only constitute a small percentage of the cell cycle. It is during the remainder of the cell cycle called interphase that all of the following processes occur: growth, chromosome synthesis, and routine cellular functions. In this investigation, you will observe the phases of mitosis using prepared slides of onion root tips. Furthermore, you will calculate the percentage of cells in each of the observed phases of mitosis.

1. How are mitosis and cytokinesis different? __________________________________________
   ____________________________________________________________________________

2. What processes occur during interphase of the cell cycle? __________________________
   ____________________________________________________________________________

Purpose:
The student will observe stages of the cell cycle and will calculate the percentage of cells in each phase.

Hypothesis:
If a cell ________________________________________________________________, then it will spend the most time in ________________________________________________.

Materials:
Prepared slides of onion root tip  Compound microscope  Calculator

Procedure – Part A: Diagram the stages of mitosis
1. View the prepared slides of the onion root tip which have been set up.
2. Please use ONLY the fine focus knob. DO NOT move or change anything else on the microscope.
3. After viewing the onion root tips, draw the phases of mitosis in Observation Table and label them with the appropriate names.
Procedure – Part B: Measuring the Time Needed for Mitosis

1. View a prepared slide of an onion root tip on high power.
2. Count the number of cells in the field of view and record your data on the Data Table.
3. Count the number of cells in each phase of mitosis: prophase, metaphase, anaphase, and telophase.
4. Record your findings on the Data Table.
5. To determine the approximate % of cells in each phase in your sample, divide the number of cells in each phase by the total number of cells in the field of view and record your calculations on the Data Table.
6. Convert each decimal number (from step 5) into a percentage by multiplying by100. Record these calculations on the Data Table.

Data:

**Observation Table** – Phases of Mitosis

<table>
<thead>
<tr>
<th>Your Sketch</th>
<th>Name of Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>During this phase the cell increases in size and the DNA is replicated. The chromosomes are dispersed in the nucleus and appear as a network of long threads called chromatin.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>During this phase the chromosomes condense and the nuclear envelope begins to disappear. Chromosomes attach to the spindle at their centromere.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>During this phase the condensed chromosomes move to the spindle equator. The chromosomes are attached to the spindle at their centromere.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Centromere split and the sister chromatids separate and move to opposite poles.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>During this phase the daughter chromosomes arrive at the opposite poles. The nuclear envelope begins to reform.</td>
<td></td>
</tr>
</tbody>
</table>
Data Table – Counting Cells in an Onion Root Tip

Total number of cells in the field of view: _________

<table>
<thead>
<tr>
<th>Phase</th>
<th># Cells in Phase</th>
<th>Number of Cells in Phase</th>
<th>% of cells in each Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total Number of Cells</td>
<td></td>
</tr>
<tr>
<td>Prophase</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metaphase</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anaphase</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Telophase</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Analysis: (Based on your sample)

1. Which phase of mitosis had the greatest percentage of cells? ______________
2. Which phase of mitosis had the least percentage of cells? ______________
3. What percentage of the cells viewed were not undergoing mitosis? ______________
4. Compare your results with two other groups. Were your findings similar? Explain. ______________
   _____________________________________________________________________________
   _____________________________________________________________________________
5. What are the cells doing when they are not undergoing mitosis? ______________
   _____________________________________________________________________________
   _____________________________________________________________________________

Conclusion:

1. Was your hypothesis correct? Use the data to support your answer. ______________
   _____________________________________________________________________________
   _____________________________________________________________________________

2. A radiologist is a doctor who reads x-rays. X-rays are a source of radiation that may cause a mutation in the DNA controlling the cell cycle. If a radiologist is exposed to too much radiation, which leads to an uncontrolled cell cycle, how might this negatively affect the radiologist?
   _____________________________________________________________________________
   _____________________________________________________________________________
   _____________________________________________________________________________