Module 3: Cell Biology - Structure and Function
Topic 4 Application: Gummy Bear Membrane Scientific Investigation

Before you begin the scientific investigation, make sure to download the *Gummy Bear Membrane Scientific Investigation Report*. As you complete this scientific investigation, fill in any needed information on the report template. If you need more information about each section of the report, please visit the Developmental Module.

Introduction

The cell membrane is an important protective structure for the cell. The membrane helps maintain homeostasis by controlling what enters and leaves the cell. Substances are transported in and out of the cell because of the needs of the cell, as well as the solute concentrations both inside and outside of the cell. Depending on these concentrations, cellular transport either happens spontaneously, or it is facilitated by an input of energy from the cell.

In this investigation, you will observe the effect that different solutions have on a gummy bear submerged in the solution. The gummy bear will be submerged in plain water, a salt/water solution, and a sugar/water solution. Gummy bears are candies made of gelatin, starch, and sugar.

Objectives

In this scientific investigation, you will:

- investigate the movement of water in different solution concentrations; and
- investigate the effect different solution concentrations have on the size of the gummy bear.

Hypothesis

Using the **Procedure and Data Collection** section, read through the procedural information for this scientific investigation. Based on your understanding of the procedure, develop your own hypotheses which describe your expected results. You should consider the following question: How will soaking gummy bears in each of the different solutes change the sizes of the gummy bears? Record your hypotheses in the **Hypothesis** section of your *Gummy Bear Membrane Scientific Investigation Report*.

Equipment and Materials

- Apron
- Granulated sugar (1 cup)
- Gummy bears (6)
- Index cards or paper and pen
- Measuring cup with metric (mL) measures or a graduated cylinder
- Measuring cup with 1 cup measure
- Metric ruler
- Petri dishes or small bowls (6)
- Roll of paper towels
- Rubber gloves
- Safety goggles
- Saucepan
- Slotted spoon
- Stove top or burner
- Table salt (2 cups)

- Tap water or 1 gallon jug of water

Safety Precautions

This scientific investigation requires the use of a stove top and boiling water. Make sure to conduct this scientific investigation under the supervision of an adult AND in a properly ventilated area. In addition, make sure to use all safety apparel and equipment as advised in the **Procedure and Data Collection** section.

Procedure and Data Collection

The **Procedure and Data Collection** section for this scientific investigation is divided into five different parts that take place over three days. Make sure to complete each part of the investigation in the order that it is presented to you. In addition, make sure that you record the data in the appropriate table in **Data** area on the *Gummy Bear Membrane Scientific Investigation Report*.

Measurement of Gummy Bears

Throughout this scientific investigation, you will be required to measure the volume of gummy bears. Since gummy bears are irregularly shaped objects, you should use the technique outlined below. In order to measure the volume of the gummy bear in millimeters, use the following measuring technique and multiply (L x W x H):

- Length (L): Measure along the back from the feet to the ears.
- Width (W): Measure along the bottom from the outside of the left foot to the outside of the right foot.
- Height (H): Measure along the arm from the stomach of the bear to the back of the bear.

Day One - Part 1

For this part of the scientific investigation, you will need the following equipment and materials:

- Gummy bears (3)
- Measuring cup with metric (mL) measures or a graduated cylinder
- Metric ruler
- Petri dishes or bowls (3)

1. Gather your materials.
2. Measure the volume of each dry gummy bear, and record the volumes in the Initial Volume column of "Data Table 1" in the **Data** section of your *Gummy Bear Membrane Scientific Investigation Report*.
3. Measure 50 mL of plain tap water into each of the three petri dishes or bowls.
4. Place one gummy bear in the water of each petri dish or bowl, and do not disturb them for 24 hours. Make sure to label these gummy bears as **PLAIN WATER**.

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Topic 4 Application: Gummy Bear Membrane Scientific Investigation

Day One - Part 2

For this part of the scientific investigation, you will need the following equipment and materials:

- Apron
- Granulated sugar (1 cup)
- Gummy bears (3)
- Measuring cup with metric (mL) measures or a graduated cylinder
- Measuring cup with 1 cup measure
- Metric ruler
- Petri dishes or bowls (3)
- Rubber gloves
- Safety goggles
- Saucepan
- Stove top or burner

1. Gather your materials.
2. Measure the volume of each dry gummy bear and record the volumes in the Initial Volume column of "Data Table 2" in the **Data** section of your *Gummy Bear Membrane Scientific Investigation Report*.
3. Put on your apron, gloves, and safety goggles.
4. Pour 500 mL of tap water into a saucepan, and heat it on the stove until it begins to boil. Remove the pan from the heat source, and turn off the heat source.
5. Measure 1 cup of granulated sugar.
6. Pour the sugar into the hot water immediately. Stir the mixture until the sugar is dissolved.
7. Allow sugar/water solution to cool.
8. Measure and pour 50 mL of the sugar/water solution into each of the petri dishes or bowls.
9. Place one gummy bear in the sugar/water solution of each petri dish or bowl, and do not disturb them for 24 hours. Make sure to label these gummy bears as **SUGAR/WATER SOLUTION**.

Day Two – Part 3

For this part of the scientific investigation, you will need the following equipment and materials:

- Apron
- Gummy bears (3) soaked in tap water for 24 hours
- Measuring cup with metric (mL) measures or a graduated cylinder
- Measuring cup with 1 cup measure
- Metric ruler
- Petri dishes or bowls (3)
- Rubber gloves
- Safety goggles
- Saucepan
- Stove top or burner
- Table salt (1 cup)

1. Use the slotted spoon to carefully remove each gummy bear from each bowl of tap water from Part I, and place them on the counter or another hard surface.
2. Make careful observations about the color of both the gummy bear and water in the bowls. Record your observations in the Volume and Observations After 24 Hours in Tap Water column of "Data Table 1" in the **Data** section of your *Gummy Bear Membrane Scientific Investigation Report.*
3. Carefully measure the volume of each gummy bear, and record the volumes in the Volume and Observations After 24 Hours in Tap Water column of "Data Table 1" in the **Data** section of your *Gummy Bear Membrane Scientific Investigation Report*.
4. Place each gummy bear carefully in a separate dry, empty bowl.
5. Put on your apron, gloves, and safety goggles.
6. Pour 500 mL of tap water into a saucepan, and heat it on the stove until it begins to boil. Remove the pan from the heat source, and turn off the heat source.
7. Measure 1 cup of table salt.
8. Pour the salt into the hot water immediately. Stir the mixture until the salt is dissolved.
9. Allow salt/water solution to cool.
10. Measure and pour 50 mL of the salt/water solution over the bears in each of the petri dishes or bowls.
11. Do not disturb them for 24 hours. Make sure to label these gummy bears as **PART 1 SALT/WATER SOLUTION**.

Day Two – Part 4

For this part of the scientific investigation, you will need the following equipment and materials:

- Apron
- Gummy bears (3) soaked in sugar/water solution for 24 hours
- Measuring cup with metric (mL) measures or a graduated cylinder
- Measuring cup with 1 cup measure
- Metric ruler
- Petri dishes or bowls (3)
- Rubber gloves
- Safety goggles
- Saucepan
- Stove top or burner
- Table salt (1 cup)

1. Use the slotted spoon to carefully remove each gummy bear from each bowl of sugar/water solution from Part 2 and place them on the counter or another hard surface.
2. Make careful observations about the color of both the gummy bear and water in the bowls and record your observations in the Volume and Observations After 24 Hours in Sugar/Water Solution column of "Data Table 2" in the **Data** section of your *Gummy Bear Membrane Scientific Investigation Report*.
3. Carefully measure the volume of each gummy bear, and record the volumes in the Volume and Observations After 24 Hours in Sugar/Water Solution column of "Data Table 2" in the **Data** section of your *Gummy Bear Membrane Scientific Investigation Report*.
4. Place each gummy bear carefully in a separate dry, empty bowl.
5. Put on your apron, gloves, and safety goggles.

6. Pour 500 mL of tap water into a saucepan, and heat it on the stove until it begins to boil. Remove the pan from the heat source, and turn off the heat source.
7. Measure 1 cup of table salt.
8. Pour the salt into the hot water immediately. Stir the mixture until the salt is dissolved.
9. Allow salt/water solution to cool.
10. Measure and pour 50 mL of the salt/water solution over the bears in each of the petri dishes or bowls.
11. Do not disturb them for 24 hours. Make sure to label these gummy bears as **PART 2 SALT/WATER SOLUTION**.

Once you have completed Parts 3 and 4, answer questions 1-5 in the Data Analysis section of your Gummy Bear Membrane Scientific Investigation Report.

Day Three – Part 5

For this part of the scientific investigation, you will need the following equipment and materials:

- Gummy bears (6) soaked in salt/water solution for 24 hours
- Slotted spoon
- Metric ruler

1. Using the slotted spoon, carefully remove each gummy bear from each bowl of salt/water solution from Part 3 and Part 4 of the scientific investigation and place them on the counter or another hard surface.
2. Make careful observations about the color of both the gummy bear and water in the bowls and record your observations in the Volume and Observations After 24 Hours in Salt/Water Solution column of the appropriate data table in the **Data** section of your *Gummy Bear Membrane Scientific Investigation Report.*
3. Carefully measure the volume of each gummy bear and record the volumes in the Volume and Observations After 24 Hours in Salt/Water Solution column of the appropriate data table in the **Data** section of your *Gummy Bear Membrane Scientific Investigation Report*.

Once you have completed Part 5, answer questions 6-10 in the Data Analysis section of your Gummy Bear Membrane Scientific Investigation Report.

Data

Use the data tables provided in the **Data** section of the *Gummy Bear Membrane Scientific Investigation Report* to record your data from this scientific investigation. The data tables are also shown below:

Data Table 1

Gummy Bear	Initial Volume (mm^3)	Volume/Observations After 24 Hours in Tap Water (mm^3)	Volume/Observations After 24 Hours in Salt/Water Solution (mm^3)
1			
2			

3			

Data Table 2

Gummy Bear	Initial Volume (mm^3)	Volume/Observations After 24 Hours in Sugar/Water Solution (mm^3)	Volume/Observations After 24 Hours in Salt/Water Solution (mm^3)
1			
2			
3			

Data Analysis

In the **Data Analysis** section of the *Gummy Bear Membrane Scientific Investigation Report*, provide responses to the following questions:

1. After the gummy bears soaked in plain tap water for 24 hours, what observations did you make about the color of the gummy bears and the color of the water?
2. After the gummy bears soaked in the sugar water solution for 24 hours, what observations did you make about the color of the gummy bears and the color of the water?
3. What happened to the volume of the bears in both the tap water and the sugar water solutions? In what direction did the water move?
4. What type of solution was the plain tap water?
5. What type of solution was the sugar water solution?
6. After the gummy bears soaked in salt water for 24 hours, what observations did you make about the color of the gummy bears and the color of the water?
7. Which gummy bears, if any, had the greater change of volume, the bears originally soaked in tap water and then salt water? Or the bears originally soaked in sugar water solution and then salt water?
8. For each set of bears, what type of solution was the salt water solution? In what direction did the water move?
9. If you had soaked a dry gummy bear in the salt water solution, what would have happened to the volume of the gummy bear?
10. What is the independent variable in this investigation? What is the dependent variable in this investigation?

Conclusion

Using the Conclusion section of the Gummy Bear Membrane Scientific Investigation Report, compose three to four sentences describing an overall conclusion based on your data. Were your hypotheses true or false, and how do you know? Use the data and notes that you collected from your investigation to form your conclusion. Make sure that you include information that you gained from data analysis to support your conclusion.

Experimental Sources of Error

On your Gummy Bear Membrane Scientific Investigation Report, provide responses to the following questions: Are there any sources of error? If so, what are they, and what could be done to minimize error?

Once you have completed the Properties of Water Scientific Investigation Report, please submit your work to the dropbox.