

# Cellular Respiration - Midterm Lab Report

BIO100A

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## Section I: Background

Cellular respiration is a process used by cells to break down glucose to produce energy in the form of ATP. One form of cellular respiration is fermentation, which occurs when oxygen is not present or limited. In fermentation, organisms such as yeast convert sugars into carbon dioxide (CO<sub>2</sub>) and ethanol. This process is important because it allows cells to continue producing energy even without oxygen. According to the lab manual, yeast is commonly used in fermentation and plays an important role in food production such as bread and alcohol (National Institutes of Health, 2023). This process allows cells to continue producing energy in low-oxygen conditions (Urry et al., 2020).

In this experiment, the main variables being tested were temperature and sugar concentration. Bottle 1 served as the temperature control comparison because it was kept at room temperature, while bottles 2–5 were placed in a warm water bath. Sugar concentration was also tested by comparing bottles with different sugar amounts. Bottle 6 introduced an additional variable, which was an increased sugar amount of 1.5 teaspoons.

The purpose of this experiment was to determine how temperature and sugar concentration affect the rate of fermentation in yeast. It was predicted that fermentation would occur most effectively in the warm water bath with moderate sugar levels and increased temperature, specifically in bottles 2 and 3. It was also predicted that Bottle 5 would show little to no fermentation due to the absence of sugar.

## Section II: Materials and Methods

This experiment used six identical plastic bottles, active dry yeast, tap water, sugar, balloons, a kitchen pot, and a thermometer. The yeast used was active dry yeast, and tap water was used for all bottles to maintain consistency. The water bath was heated to approximately 110°F, and room temperature was about 73°F.

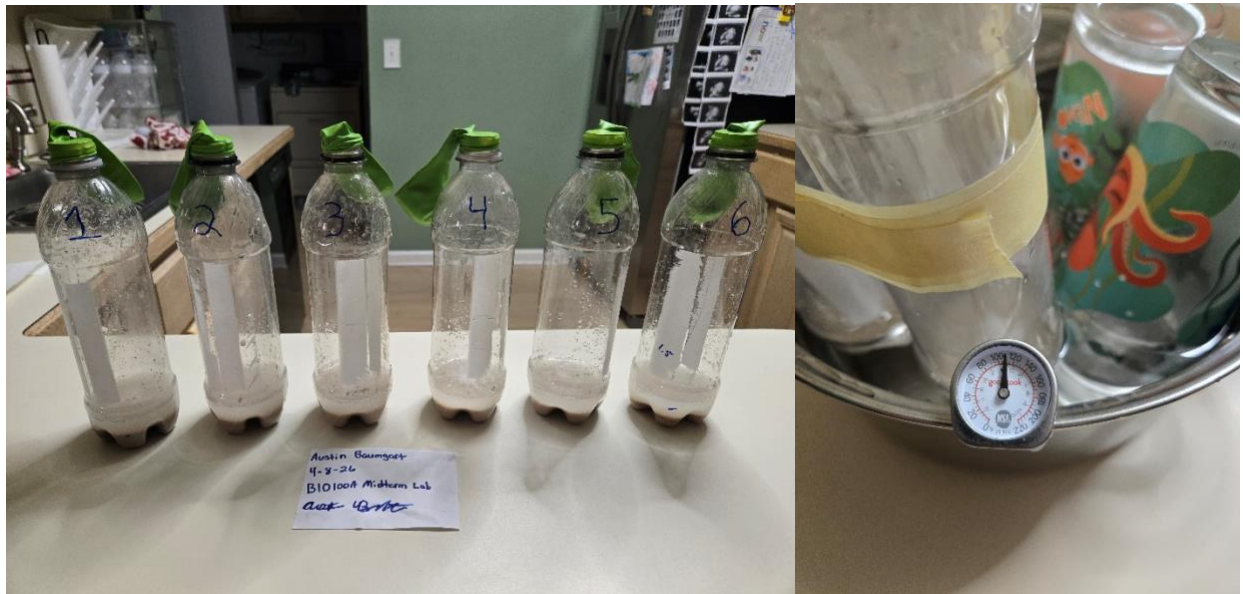
Each bottle was labeled 1 through 6 and filled with 2 teaspoons of yeast and 1/4 cup of water. Sugar amounts were added based on the experimental design, with bottle 6 containing 1.5 teaspoons of sugar as the variable.

Initial yeast heights were measured before placing bottles 2–5 into the warm water bath. Bottle 1 was left at room temperature. The experiment was conducted for approximately 20 minutes while maintaining the water bath temperature between 100–120°F. During the experiment, observations were recorded, and pictures were taken at setup, during the experiment, and at the end.

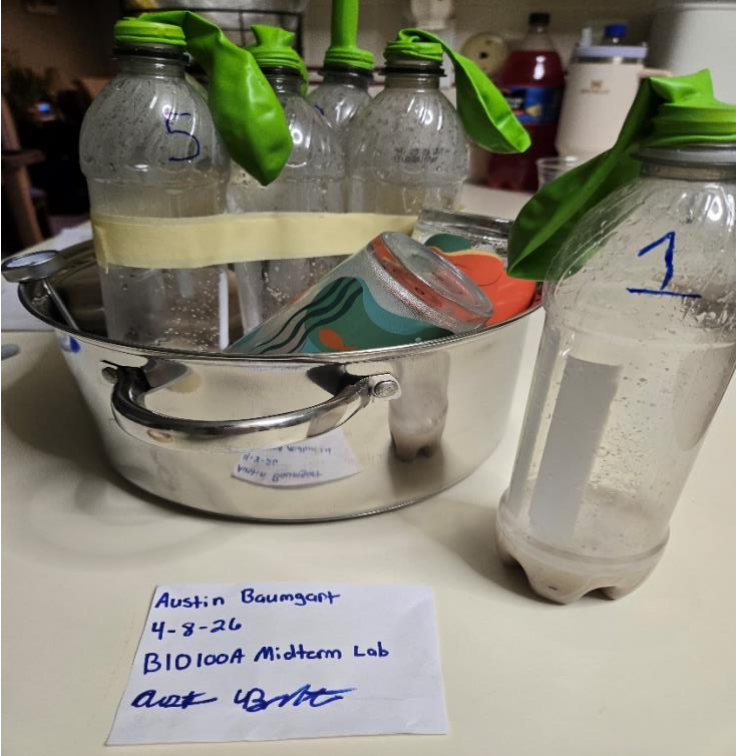
After the experiment, final yeast heights were measured, and balloon sizes were recorded by measuring circumference. These measurements were used to estimate CO<sub>2</sub> production and fermentation activity.

### Report Table #1: Materials

Bottle	Sugar (tsp) or Alternative	Yeast amount (tsp)	Water amount (cup)	Temperature (~110° F)
1	1.00	2	0.25	Room Temp
2	1.00	2	0.25	Water bath
3	1.00	2	0.25	Water bath
4	0.33	2	0.25	Water bath
5	0.00	2	0.25	Water bath
6	1.50	2	0.25	Water bath



# Section III: Results



### Report Table #2: Immediate Observations

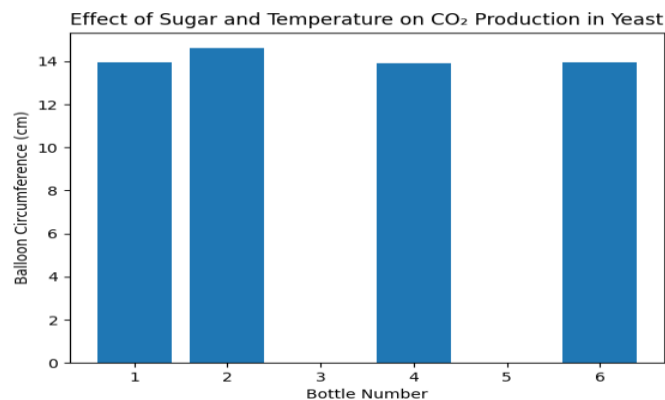
Bottle	Balloon size (L, M, S, no change)	Yeast growth (much, medium, little, none)	Other observations
1	Small	Little	Room temp
2	Large	Much	Largest balloon
3	None	Medium	Balloon had hole
4	Medium	Medium	Normal growth
5	None	Little	No sugar
6	Medium	Medium	Higher sugar

### Report Table #3: Yeast Heights

Bottle	Initial yeast height (cm)	New yeast height (cm)	Change in yeast height (cm)
1	1.84	3.05	1.21
2	1.78	5.97	4.19
3	1.78	6.10	4.32
4	1.82	5.08	3.26
5	1.65	2.92	1.27
6	1.40	4.19	2.79

### Report Table #4: Balloon Measurements and Volumes

Bottle	Circumference (cm)	Top to base	(Top to base/3.14)	$\frac{2}{19} \times C \times C \times R$
1	13.97	2.500	0.80	16.44
2	14.61	2.500	0.80	17.99
3	0	0	0	0
4	13.91	2.500	0.80	16.30
5	0	0	0	0
6	13.97	2.500	0.80	16.44



During the experiment, yeast growth began after about 10 minutes. The temperature of the water bath decreased slightly by about 10°F over the 20-minute period. Bottle 2 showed the greatest balloon expansion, indicating the highest CO<sub>2</sub> production. Bottle 5 showed little to no growth due to the absence of sugar. Bottle 3 had a hole in the balloon, which prevented accurate gas measurement. Bottle 6 showed moderate growth, suggesting that increasing sugar beyond a certain amount may not improve fermentation. This could be due to osmotic stress on yeast cells at higher sugar concentrations. The graph shows that Bottle 2 had the highest CO<sub>2</sub> production, while Bottles 3 and 5 showed little to no gas production due to experimental error and lack of sugar.

## Section IV: Discussion

The increase in balloon size was caused by the production of carbon dioxide gas during fermentation. As yeast breaks down sugar, CO<sub>2</sub> is released and fills the balloon, causing it to expand. Therefore, larger balloons indicate greater fermentation activity. Yeast height increased due to the growth and reproduction of yeast cells, which also reflects fermentation activity. CO<sub>2</sub> production during fermentation causes balloon expansion (Urry et al., 2020).

Temperature had a significant effect on fermentation. Bottle 1, which was kept at room temperature, showed much less growth compared to bottles 2–5 in the warm water bath. This indicates that warmer temperatures increase enzyme activity in yeast, leading to faster fermentation. The production of carbon dioxide is a key indicator of cellular respiration activity (Maxwell & Clay, 2015).

Sugar concentration also affects fermentation. Bottles 2 and 3, which had moderate sugar levels, showed the most growth. Bottle 5, which had no sugar, showed almost no fermentation, confirming that sugar is necessary for the process. Bottle 6, which had increased sugar (1.5 tsp), showed less growth than bottle 2, suggesting that too much sugar may slow fermentation. This suggests that there is an optimal sugar concentration for yeast activity and exceeding that level may reduce efficiency.

The results between bottles 2 and 3 were expected to be similar, but they were not due to a hole in bottle 3's balloon, which allowed gas to escape. This experimental error affected the results. Overall, the results supported the hypothesis that warm temperatures and moderate sugar levels produce the most fermentation. This experiment is important because it demonstrates how environmental factors affect cellular respiration, which has applications in food production and biotechnology. These findings are important because they relate to real-world applications such as baking, brewing, and biofuel production.

## Section V: References

Maxwell, M. R., & Clay, O. (2015). Online BIO100A: Survey of Bioscience Laboratory Manual Part I.

Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., & Reece, J. B. (2020). Campbell Biology (12th ed.). Pearson.

National Institutes of Health. (2023). *Cellular respiration*. <https://www.nih.gov>