LAB WORKSHEET: YEAST RESPIRATION & FERMENTATION

GED Science / Biology Practical Investigation

Student Name: _____ **Date:** _____ **Class/Period:** _____

Background Information:

Baker's yeast (*Saccharomyces cerevisiae*) is a single-celled fungus that can produce energy through two cellular pathways. In the presence of oxygen, yeast undergoes **aerobic cellular respiration**. When oxygen is depleted or absent, yeast switches to **anaerobic respiration (alcoholic fermentation)**.

> **Aerobic Respiration:** $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + Energy\ (36–38\ ATP)$
> **Alcoholic Fermentation:** $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2 + Energy\ (2\ ATP)$

1. SCIENTIFIC OBJECTIVE & HYPOTHESES

Formulate testable predictions for each setup before beginning the experiment.

Setup A (Yeast + Warm Water, No Sugar):

Setup B (Yeast + Warm Water + Sugar, Aerobic to Anaerobic transition):

Setup C (Yeast + Warm Water + Sugar + Oil Layer, Strict Anaerobic):

2. EXPERIMENTAL VARIABLES IDENTIFICATION

Complete the variables table based on the lab setup.

Variable Type	Identification in this Experiment
Independent Variable *(What you intentionally change)*	
Dependent Variable(s) *(What you measure or observe)*	
Control Variables *(What you keep constant)*	1. 2. 3.
Negative Control Setup *(Baseline comparison group)*	

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Safety & Handling Note: Keep water temperature between 38°C – 43°C (100°F – 110°F). Water that is too hot will kill the yeast cells. Wear safety goggles when securing balloons over bottle openings.

3. EXPERIMENTAL PROCEDURE

1. Label three clean, clear 500 mL plastic bottles: **A**, **B**, and **C**.
2. Pour 1 cup (240 mL) of warm water into each bottle.
3. Add 1 packet (approx. 7g) of active dry yeast to each bottle and swirl gently to mix.
4. Add 2 tablespoons of sugar to **Bottle B** and **Bottle C** only. Do NOT add sugar to Bottle A.
5. Immediately pour a thin layer (approx. ¼ inch) of vegetable oil directly on top of the liquid in **Bottle C**. Do not shake Bottle C after adding oil.
6. Leave Bottle B open to the air for 10 minutes before capping with a balloon. Secure balloons tightly over the mouth of all three bottles. Record observations at 0, 15, 30, and 45 minutes.

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4. OBSERVATION & DATA COLLECTION CHART

Record qualitative observations (balloon inflation, bubbling/foaming, visual appearance) and measure balloon circumference using a string and ruler.

Bottle / Condition	0 Min	15 Min	30 Min	45 Min & Odor Check
Bottle A (Yeast + Water)				**Circumference:** ____ cm **Odor:**
Bottle B (Yeast + Water + Sugar)				**Circumference:** ____ cm **Odor:**
Bottle C (Yeast + Water + Sugar + Oil)				**Circumference:** ____ cm **Odor:**

5. DISCUSSION & ANALYSIS QUESTIONS

Q1. Evidence of Cellular Activity: Which bottle(s) showed active inflation of the balloon? What specific gas was produced to cause this expansion, and what cellular organelle in yeast is primarily responsible for aerobic respiration?

Q2. Role of Substrate: Why did Bottle A experience little to no balloon inflation compared to Bottles B and C? What fundamental biological concept does this demonstrate regarding energy production?

Q3. Distinguishing Respiration from Fermentation: Describe the odor observed when unhooking the balloon from Bottle C at the end of 45 minutes. How does this chemical byproduct confirm that *alcoholic fermentation* occurred rather than aerobic respiration alone?

Q4. Effect of the Oil Barrier: Explain the specific role of the vegetable oil layer added to Bottle C. How did blocking environmental oxygen alter the metabolic pathway used by the yeast?

Q5. Energy Efficiency Analysis: Aerobic respiration yields approximately 36 to 38 ATP molecules per glucose molecule, whereas alcoholic fermentation yields only 2 ATP. Based on this information, why do organisms prefer aerobic respiration when oxygen is readily available?

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Q6. Gas Verification Test (Extension): If you were to bubble the gas collected from Bottle B or C into a test tube containing *limewater* (calcium hydroxide), what chemical change would you expect to see, and why?

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