WJEC England Biology A Level

SP C1 03: Investigation into factors affecting respiration in yeast

Practical notes

Introduction

Respiration is a series of **enzyme-controlled** reactions that release energy in the form of **ATP** from the **breakdown** of **organic compounds** (e.g. glucose).

Aerobic respiration take place when there is a **plentiful supply** of **oxygen**:

glucose + oxygen → carbon dioxide + water (+ ATP)

The rate of production of **carbon dioxide** can be used as an **indicator** of the **rate of respiration**.

The rate of respiration is influenced by different **factors** (e.g. temperature, pH, nutrient availability). The effect of each of these factors can be determined by changing **one variable only**, and observing its effect on the rate of reaction.

In this practical, we will determine the effect of **temperature** on the **rate of respiration** in **yeast**.

Equipment

- 100 g dm^{-3} yeast
- 0.4 mol dm^{-3} sucrose solution
- 20 cm^3 syringe
- Glass rod
- Water baths: 20, 30, 40, 50 and 60°C
- Thermometer
- Weight
- Permanent marker
- Stopwatch

Risk assessment

Hazard	Risk	Precaution	Emergency
Broken glass	Cuts	Keep glassware away from the edge of the desk	Dispose of broken glassware carefully; elevate cuts and apply pressure; do not remove glass from cuts; seek medical assistance
Boiling water	Scalding	Handle boiling water with care; use tongs to transfer boiling tubes; wear safety goggles	Run burn under cold water; seek medical assistance

Water bath	Electric shock	Ensure hands are dry before plugging in/ unplugging the water bath	Seek medical assistance
Yeast	Allergic reaction	Handle yeast in a suspension form; use non-latex disposable gloves	Seek medical assistance

Method

1. Set up **five** water baths of varying temperatures: 20, 30, 40, 50 and 60°C
2. Take the yeast suspension and **stir** using a **glass rod**
3. Using a **20 cm^3 syringe** take up **5 cm^3 yeast suspension**
4. Take up **10 cm^3 sucrose solution** into the **same** syringe
5. Draw the plunger of the syringe back until it is close to the barrel end. Invert to gently **mix** the contents.
6. Place the syringe into the water bath **horizontally**. *Ensure that the nozzle (which is off-centred) is on the side of the syringe close to the surface of the water.*
7. Allow to **equilibrate** for 5 minutes
8. Wait until gas bubbles begin to be expelled from the nozzle at regular intervals. Start a **stopwatch** and count the **number of bubbles** released in **one minute**. Record your results (see below).
9. Repeat steps 1 to 8 for the four other temperatures
10. **Repeat** the method a further two times to obtain **three repeats** for each temperature

Variables

Independent variable

The variable that is **changed**
i.e. temperature

Dependent variable

The variable being **measured** whose value depends on the independent variable
i.e. the number of bubbles released in **one minute**

Controlled variables

The variables that are kept **constant** during the experiment:

- Concentration of yeast suspension
  100 g dm^{-3} yeast suspension used throughout
- Concentration of sucrose solution
  0.4 mol dm^{-3} sucrose solution used throughout
- Volume of yeast suspension
  20 cm^3 syringe used to measure 5 cm^3 of 100 g dm^{-3} yeast suspension
- Volume of sucrose suspension
  20 cm^3 syringe used to measure 10 cm^3 of 0.4 mol dm^{-3} sucrose solution
- Period of time over which the bubbles are counted
  Bubbles counted for a period of one minute (timed using a stopwatch)

Results

Temperature (°C)	Number of bubbles counted in one minute			
	Repeat 1	Repeat 2	Repeat 3	Mean
20				
30				
40				

50				
60				

The **mean number of bubbles** is **proportional** to the **rate of reaction**.

A **graph** of the **mean number of bubbles** against **temperature** can be plotted and the trend observed.

Conclusion

As **temperature increases**, the rate of respiration **initially** increases:

- Enzymes in the yeast suspension have more **kinetic energy**
- **Random movement** of molecules increases
- Probability of a **successful** collision increases
- More **enzyme-substrate complexes** form
- Rate of respiration **increases**

However, **beyond the optimum** temperature, the rate of respiration decreases:

- Increasing vibrations **break bonds** in the enzymes' tertiary structure
- Active sites change shape
- Enzymes **denature**
- Rate of respiration **decreases**