The National Orthodox School Shmaisani

IB Foundation Years (9 & 10) Lab Report

1) Writing a fully focused research question

- Must include the range of the independent variable with units
- Must include the dependent variable
- Method of measuring the dependent variable

What is the effect of temperature (0,25,40) in degrees Celsius)) on the permeability of beetroot cell membranes, as measured by the diffusion of beetroot pigment (in absorbance units) from the cells into a surrounding solution over time, and quantified using a color meter?

what is the effect of ----------(IV) what range will you be uisng ---------- on the -----DV----------measured by ----------(write the method and the units)----------?

2) Scientific background

- Research your independent variable
- Research its effect on your dependent variable
- Research the method of measuring the dependent variable
- Include citation

  - Effect of Temperature on Beetroot Membrane - Abstract/Aim The aim of this experiment is to look at - Studocu
  - The Effect of Temperature on Cell Membranes - Snab Biology
  - ChatGPT Open AI
  - Core practical 5: Investigate the effect of temperature on membrane permeability

The temperature of the water bath serves as the independent variable in this experiment, and it has a direct effect on the permeability of beetroot cell membranes. Studies have shown that temperature can disrupt the structure and fluidity of cell membranes, leading to increased

Citations/References:

permeability. As temperature rises, the phospholipid bilayer of the cell membrane becomes more fluid, allowing for easier movement of molecules across the membrane . This increased fluidity results in the formation of gaps or spaces within the membrane, making it more permeable to molecules. The diffusion of betalain pigment out of beetroot cells is a reliable indicator of membrane permeability. As the cell membranes become more permeable due to the influence of temperature, betalain molecules can diffuse more easily out of the cells and into the surrounding solution. Measuring the percentage transmission of light through the solution using a colorimeter allows for the quantification of this diffusion process. By examining the effect of temperature on membrane permeability and measuring betalain diffusion, this experiment provides valuable insights into the relationship between temperature and the permeability of beetroot cell membranes.

3) **Hypothesis:** Outline a hypothesis to predict the outcome of the experiment and explain it using logical scientific *reasoning (what do you think is going to happen*

> If the temperature (IV) increases, then the permeability of beetroot cell membranes (DV) will increase as well, resulting in greater diffusion of beetroot pigment into the surrounding solution over time, as measured by a color meter.

Scientific explanation for hypothesis (This is the explanation to the previous hypothesis. Why do you think that your hypothesis is correct? Explain it in detail with reasons and causes. You may also find research at this point if allowed).

Because:

The permeability of cell membranes is influenced by temperature due to its impact on the structure and fluidity of the phospholipid bilayer. Cell membranes are composed of a phospholipid bilayer, with hydrophilic heads facing outward and hydrophobic tails facing inward, creating a hydrophobic interior. As the temperature increases, phospholipid molecules gain more kinetic energy, resulting in enhanced fluidity and the formation of gaps within the membrane. These changes increase the permeability of the membrane by providing pathways for molecules to move across. In beetroot cells, the increased permeability at higher temperatures allows for the diffusion of betalain pigment molecules out of the cells and into the surrounding solution. The concentration of betalain in the solution rises, causing a decrease in the percentage transmission of light through the solution as measured by a colorimeter. This phenomenon occurs because the fluidity and gaps in the phospholipid bilayer facilitate the movement and diffusion of the betalain pigment, ultimately resulting in a greater release of pigment into the solution.

4) Manipulating the variables:

What is your independent variable ?

- What are the units ?
- How will it be changed stating the instruments that you will be using
- Will you be doing a control experiment ?
- Why did you choose this range ?

The independent variable in this hypothesis is temperature, measured in degrees Celsius. The temperature will be changed using a water bath and a thermometer to control and monitor the temperature of the beetroot samples. The dependent variable is the permeability of beetroot cell membranes, which will be measured by the diffusion of betacyanin pigment in absorbance units from the cells into a surrounding solution over time, and quantified using a color meter. The experiment will include a control using beetroot samples at room temperature to establish a baseline for the amount of betacyanin pigment that is naturally released from the cells without any external manipulation. The range of temperature to be tested will depend on the specific experimental design, but a common range is between 0°C and 40°C, which allows for the observation of a linear relationship between temperature and membrane permeability up to a certain point, beyond which the membrane becomes irreversibly damaged.

Discuss your dependent variable [the method of measurements + units + time frame]

The dependent variable in this experiment is the permeability of beetroot cell membranes, which will be measured by the diffusion of betacyanin pigment in absorbance units from the cells into a surrounding solution over time, and quantified using a color meter. Absorbance units are a measure of the amount of light absorbed by a solution, which is directly proportional to the concentration of the absorbing substance. The color meter will measure the absorbance of the solution at regular intervals over a specified time frame, allowing for the quantification of the amount of betacyanin pigment that has leaked out of the cells and into the surrounding solution. The time frame will depend on the specific experimental design, in our case 5 minutes, depending on the rate of pigment diffusion and the range of temperatures being tested.

Controlled Variable	**How will you keep this controlled? Stating the values and the equipment that you will be using**	**How could it affect your results if not controlled?**
Time in the water bath	Set a fixed duration of 5 minutes for each test tube in the water bath. Use a timer or stopwatch to ensure accurate timing. You can also have a separate timer for each test tube to manage the time precisely	If the time in the water bath is not consistent for all samples, it can lead to variations in the degree of pigment diffusion. Longer exposure times may result in greater pigment diffusion, while shorter times may lead to incomplete diffusion. Inconsistent exposure

		times can introduce bias and affect the comparison between different temperature conditions.
Source of light for colorimeter	Use a standardized light source for the colorimeter readings. If the colorimeter has a built-in light source, ensure it remains consistent throughout the experiment. If an external light source is required, such as a lamp, use the same lamp for all measurements. Position the lamp at a fixed distance from the colorimeter and maintain the same angle and intensity of light for each reading	The source of light for the colorimeter should remain constant throughout the experiment. If different light sources are used or if there are fluctuations in the intensity or color of the light, it can lead to inconsistencies in the readings. Inaccurate or inconsistent light conditions can introduce errors in measuring the percentage transmission and affect the reliability of the results.
Type of beetroot	Use beetroot from the same batch or variety to ensure consistency. This means selecting beetroots that are sourced from the same supplier or from the same package. If possible, use beetroots of similar size to minimize variability in pigment concentration. Keep the beetroots stored under the same conditions until they are used in the experiment	If different types or batches of beetroot are used, they may have varying concentrations of betalain pigment. This can introduce variability in the initial pigment content, which can affect the results. Inconsistencies in the beetroot used can lead to differences in the baseline levels of pigment transmission, making it difficult to isolate the impact of temperature on pigment diffusion.

5) **Materials and Method**:

State your materials [number needed + units] (Be descriptive, example: 10cm^3 graduated cylinder) include the uncertainties for each piece of apparatus

- water baths pre-set at required temperatures
- thermometer
- distilled water

- syringe
- large beetroot
- cork borer 3cm
- ruler
- white tile
- knife
- 10 cm° syringe
- pipette
- test tubes
- colorimeter
- four cuvettes
- labels or pens for labeling
- forceps
- crushed ice

Method : What are the steps of the investigation?

o State step by step your method [must be clear and easy to follow]
o **Draw and annotate a diagram or add an annotated photo in the space (** This annotated (labeled) diagram of your equipment set up.
o State the number of trials per increment of the independent variable

1. Prepare three water baths pre-set to a range of temperatures between 0 °C, 25 °C, 40 °C.
2. Use a syringe to add 10 cm3 of distilled water to eight test tubes. Label each test tube with a temperature from the pre-set range.
3. Place each tube in the water bath set to the corresponding temperature for 5 minutes.
4. Check the temperature of each bath is correct using a thermometer. It is unlikely to be exactly the desired temperature. Record the actual temperature and use this in your table and graph.
5. Cut three beetroot cylinders using a cork borer. Using a knife, ruler and white tile, trim them all to the same length (3 cm). Wash the cylinders thoroughly with water until the water runs clear and pat dry gently with a paper towel.
6. Add one beetroot cylinder to each of the eight tubes and leave in the water bath for 5 minutes.
7. Shake the tubes once. Working quickly, use forceps to remove the cylinders carefully from each tube. Discard the cylinders, keeping the supernatant liquid. It may be easier to decant the liquid into clean test tubes.
8. Set the colorimeter to a blue/green filter and percentage transmission. Zero the colorimeter using a blank cuvette filled with distilled water.

9. Transfer liquid from each test tube in turn into a colorimeter cuvette, place into the colorimeter and read the percentage transmission reading, recording your results in a suitable table.
10. Plot a graph of transmission against temperature.

6) Safety, Ethical and Environmental issues

Safety issues:

- Sharp objects: Be cautious when using tools like the cork borer and knife to avoid accidental cuts. Wear protective gloves and handle equipment carefully.
- Heat hazards: High-temperature water baths can cause burns or scalds. Use heat-resistant gloves and proper protective clothing to prevent injuries.
- Chemical hazards: Handle all chemicals safely, following lab guidelines and using appropriate protective gear like gloves and goggles.

Ethical issues:

- Respect for living organisms: Handle beetroot ethically and consider the well-being of the plants used in the experiment.
- Informed consent: Obtain necessary permissions or consents if required for sourcing beetroot or when there are ethical considerations.

Environmental issues:

- Water usage: Conserve water by using only the required amount for the experiment, such as preparing water baths and washing beetroot.
- Waste disposal: Follow proper waste disposal practices for used beetroot cylinders and any chemical waste, adhering to local regulations.
- Energy consumption: Use equipment efficiently, turning off when not in use and utilizing energy-saving settings, to reduce energy consumption.

7) Results

Add a table for qualitative results e.g. Variation within the organism/biological material being dealt with; Color, texture, shape, size, heat changes; Anything you notice that might affect results.

Temperature (°C)	Color of Solution	Texture of Beetroot	Shape of Beetroot	Heat Change
0	Pale	Firm	Cylindrical	No change
25	Light pink	Firm	Cylindrical	No change
40	Dark Pink	Softened	Slightly swollen	Slight warming

Table 1: Qualitative Observations of Beetroot Characteristics at Different Temperatures

Raw Data

- Construct a table to add your raw data , add a fully detailed title to your table .
- Label your table (table 1, table 2…)
- Add suitable heading s with units and uncertainties to your table.
- Unify your decimal points

Temperature in °C	Absorbance from colorimeter in %

Table 2: Raw Data for the Effect of Temperature on Absorbance of Beetroot Pigment

Processed data

- Justify the reason for data processing

- Add screenshots from excel to provide evidence for your work, or provide a sample calculation.
- Construct a table to add your results
- Add a title for your table and label it
- Unify your decimal points

Data processing is crucial to organize and make sense of the raw data collected. It allows for effective analysis, interpretation, and presentation of the data, enabling researchers to derive meaningful insights and draw valid conclusions.

Temperature in °C	Absorbance from colorimeter in %
0	49
25	45
40	46

Table 3: Effect of Temperature on Absorbance of Beetroot Pigment