An investigation into the effect of varying the concentration of the substrate hydrogen peroxide on the rate of a reaction catalysed by catalase

Specification references

- *3.1.4.2*

Learning objectives

After completing the worksheet you should be able to:

- carry out enzyme reactions using catalase and different concentrations of hydrogen peroxide
- use the results of the reactions to make conclusions about the rate of reaction and substrate concentration.

Recap

You have carried out an enzyme reaction using catalase and different concentrations of hydrogen peroxide. An enzyme reaction is one of the required practicals that you have to do as part of your Biology A level. You may be asked questions about this practical in your exams. This follow-up sheet aims to prepare you for possible exam questions you may be asked about this practical.

Questions

An experiment was carried out to time how long it takes for all of the substrate to be used up when catalysed with catalase. Two different substrates were used. The results are shown below.

Amounts of substrate / g	Time taken to use all of the liver / s	Time taken to use all of the potato / s
5	69	88
10	60	75
20	24	39
25	16	36
30	16	36

1 Describe and explain the pattern shown by these results. (*5 marks*)

2 Estimate what you would expect the result to be for both substrates at 15 g of substrate. (*2 marks*)

Food test 2 – Benedict's test for non-reducing sugars

Specification references

i 3.1.2

Learning outcomes

After completing the worksheet you should be able to:

ii recall the positive and negative results for the Benedict's test for non-reducing sugars

1 carry out the Benedict's test on a range of food stuffs to identify the presence of a non-reducing sugar.

Recap

You have observed the colour changes that happen when you carry out the Benedict's test on food that contains, or does not contain, non-reducing sugars. This is one of the required skills that you have to have as part of your Biology A Level. You may be asked questions about this practical in your exams. This follow up sheet aims to prepare you for possible exam questions you may be asked about this practical.

Questions

How could you test to see if a food contained non-reducing sugars? (*5 marks*)

Name one molecule that is a non-reducing sugar. (*1 mark*)

An experiment was carried out to test for the presence of sugars and starch in different food. The Benedict's test for reducing sugars and non-reducing sugars and the iodine test was carried out on each food. The results are shown in the table.

Food	Colour change after reducing sugars test	Colour change after non-reducing sugars test	Colour change after iodine test
orange juice	brick red	brick red	orange
milk	green	green	orange
table sugar	blue	brick red	orange
bread	blue	blue	blue–black

a Which food contained non-reducing sugars? (*1 mark*)

b Why did the orange juice turn brick red after the Benedict's test for reducing sugars? (*2 marks*)

c Why does the milk turn green after the Benedict's test for reducing sugars? (*2 marks*)

Permeability: investigating the effect of variation in temperature on the permeability of cell membranes using fresh beetroot

Specification references

- 3.2.3

Learning objectives

After completing the worksheet you should be able to:

- describe the effect of temperature on the permeability of the cell-surface membrane.

Information

The permeability of membranes can be altered in several ways. Temperature is one factor that affects the membrane. As membranes rely on protein molecules to allow molecules to enter and leave the cell through facilitated diffusion, the temperature must not exceed the temperature at which proteins are denatured.

Proteins are denatured when there is a large enough increase in kinetic energy to break hydrogen and ionic bonds. Denatured proteins are not able to function correctly within the membrane and permeability will increase as substances, like the dye in beetroot cells, are able to move more freely out of the cell.

The phospholipids also undergo phase changes at higher temperatures causing the membrane to be more permeable thus allowing the red pigment to move more freely into the water surrounding the beetroot.

A cell membrane will remain fluid as the temperature around it decreases until it reaches a critical temperature at which a membrane solidifies due to its fatty acid composition. At temperatures below this critical point, no dye in the beetroot cell would be able to leak from the cell and would not change the colour of the surrounding water.

Questions

Membranes are found both at the surface of cells and within cells.

1 **a** State **two** functions of membranes **within** cells. (*2 marks*)

b Describe the arrangement and functions of **two** named components of a cell surface membrane. In your answer you should use appropriate technical terms, spelled correctly. (5 *marks*)

2 Which component of a cell membrane becomes more fluid as temperature increases? (*1 mark*)

3 Which component of a cell membrane denatures as temperature increases? (*1 mark*)

4 Liver cells contain membrane-bound organelles called peroxisomes. These organelles contain catalase, an enzyme that breaks down hydrogen peroxide to release oxygen gas.

A student carried out an investigation on catalase using the following procedure:

- two identical sized cubes were cut from a piece of fresh liver
- one cube was frozen overnight and then defrosted
- the other cube was stored in the refrigerator
- both cubes were returned to room temperature and were placed in separate test tubes containing equal volumes of 2% hydrogen peroxide solution.

The student observed that the cube of liver that had been frozen and defrosted, bubbled significantly more than the cube that had been refrigerated.

Suggest an explanation for this result. (*2 marks*)

Identifying the water potential of plant tissue

Specification references

- *3.2.3*

Learning outcomes

After completing the worksheet, you should be able to:

- understand how to produce a dilution series
- draw a calibration curve graph
- use a calibration curve to estimate unknown values.

Recap

You have carried out a serial dilution of a sucrose solution to produce 6 solutions of different concentrations. You then placed potato cylinders in each of your sucrose solutions and calculated the percentage change in mass. Using your data you drew a calibration curve and used this to determine the concentration of sucrose at which there was no percentage change in mass, which enabled you to identify the water potential of the potato tissue.

The practical involved skills relating to Required Practical 3 of your Biology A Level. You may also be asked questions about this practical and the skills it involved in your exams. This follow-up sheet aims to prepare you for possible exam questions that you may be asked about this practical.

Section 1: Serial dilutions

1 1 cm^3 of 1 M sucrose is added to 9 cm^3 of distilled water. What is the concentration of sucrose in the final 10 cm^3 solution?

.... (*1 mark*)

2 1 cm^3 of 1 M sucrose is added to 9 cm^3 of distilled water. The mixture is inverted and 1 cm^3 of the mixture is added to a further 9 cm^3 of distilled water. What is the final concentration?

.... (*1 mark*)

3 A 0.1 M sodium hydroxide solution is made by adding 0.2 cm^3 of sodium hydroxide to 9.8 cm^3 of distilled water. What was the concentration of the *original* sodium hydroxide stock solution?

.... (*1 mark*)

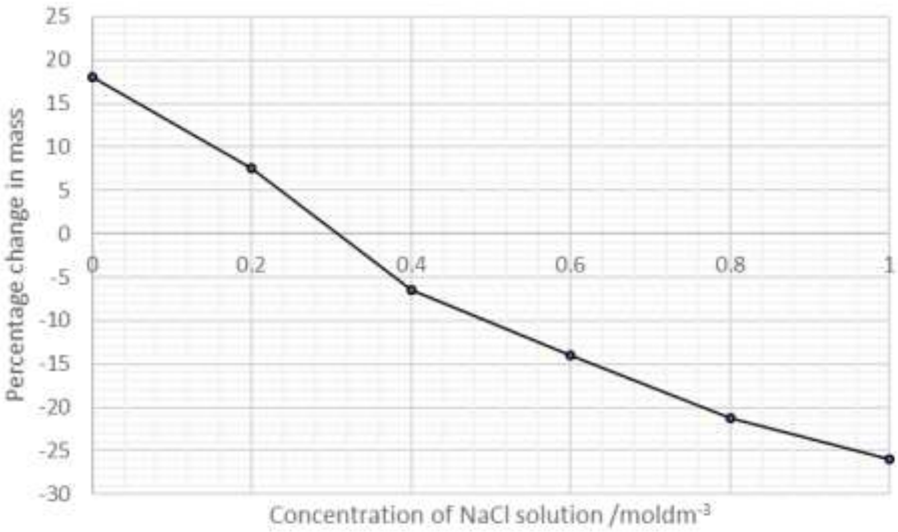
4 0.5 cm^3 of 1.5 M potassium hydroxide is added to 9.5 cm^3 of distilled water, and inverted. 0.5 cm^3 of the mixture is then added to a further 9.5 cm^3 of distilled water. What is the final concentration?

.... (*1 mark*)

Section 2: Calibration curves

The following questions test your ability to read a calibration curve.

Below is a calibration curve for percentage change in mass of discs of beetroot tissue that had been placed in varying concentrations of sodium chloride solution for 2 hours.



1 Using the graph estimate the concentration of sodium chloride solution that would cause the mass of a beetroot disc to increase by 2%.

.... (*1 mark*)

2 Predict the percentage change in mass that would occur if a beetroot disc was placed in a solution of 0.96 mol dm^{-3} sodium chloride.

.... (*1 mark*)

3 What is the difference in percentage change in mass of a beetroot disc placed in a 1.0 mol dm^{-3} solution compared to a 0.1 mol dm^{-3} solution?

.... (*2 marks*)

Calculating mitotic index

Specification reference

- *3.2.2*
- *Maths skill MS 0.3*

Learning outcomes

After completing the worksheet you should be able to:

- use ratios, fractions, and percentages
- calculate mitotic index from stained cell squash preparations.

Introduction

When mitosis is actively occurring in a tissue, such as root tip meristems, it is possible to make stained squashes to see the mitotic stages in individual cells. You may do this as a practical using onion root tips. The mitotic index (MI) is a proportion which is simple to find using the formula:

$$MI = \frac{\text{number of cells with condensed chromosomes}}{\text{total number of cells}} \times 100$$

This will give you a percentage value.

Note that if the multiplication by 100 is not used, the index will be expressed as a simple decimal, e.g. 24% would be expressed as 0.24.

Worked example

Question

In a stained sample of dividing cells, 29 cells were visible in one microscope field of view. Three of these cells had clearly visible chromosomes. What is the MI of the tissue?

Answer

Step 1

Substitute the counted numbers into the formula:

$$MI = \frac{3}{29} \times 100$$

Step 2

Complete the calculation to find the MI:

$(3 \div 29) \times 100 = 10\%$

Questions

1 Calculate MI values for the following: (*4 marks*)

Tissue sample	Number of cells with visible chromosomes	Total number of cells
a	5	30
b	18	26
c	56	245
d	21	145

2 Calculate the MI of the tissue shown in the photograph below. (*2 marks*)

3 Mast Cell Tumours occur in dogs, often causing visible swellings on the skin. The MI of samples taken from these tumours is helpful in predicting likely survival times.

MI (%)	Predicted survival times (months)
0–4	>70
0–48	<2

Biopsy tissue samples taken from tumours on two dogs were examined and microscope cell counts were as follows:

Dog	Biopsy sample	Total number of cells counted	Total number of cells in mitotic stages
Boxer	1	492	369
	2	387	173
	3	426	245
Labrador	1	478	25
	2	429	22
	3	351	11

a Calculate the MI for each sample. (*6 marks*)

b Calculate the mean MI for each dog. Show your working. (*2 marks*)

c Suggest a survival time for the boxer. (*1 mark*)

d Comment on the likely survival of the labrador. (*2 marks*)

Maths skills links to other areas

You will encounter calculations involving this type of maths in several places through the specification, for example in making microscope image magnification, surface area : volume ratio or rate calculations.