**HUMAN BIOLOGY YEAR 11 ATAR**

**UNIT 1**

**ASSESSMENT: SCIENCE INQUIRY**

**TASK WEIGHTING 6%**

**Factors Affecting Enzyme Functioning – The Decomposition of Hydrogen Peroxide**

**Background information**

Hydrogen peroxide is a chemical made naturally in the body. Enzymes breaking down certain amino acids and fatty acids make significant amounts of hydrogen peroxide. In addition to enzymes that produce hydrogen peroxide as part of their normal catalytic cycle, many enzymes that undergo oxidation and reduction make hydrogen peroxide and other reactive oxygen species (this happens quite a bit in the mitochondria).

The white blood cells also produce very large amounts of hydrogen peroxide along with other substances (household bleach!) to kill the germs. **Hydrogen peroxide** (**H2O2**) is also a by-product of **respiration** and is made in all living cells.

**Hydrogen peroxide** is harmful and must be removed as soon as it is produced in the cell. Hydrogen peroxide can initiate chemical chain reactions within a cell that can damage DNA and proteins. Long term exposure to hydrogen peroxide can lead to conditions such as cataracts and vascular disease. Since hydrogen peroxide can be damaging to normal tissue, these enzymes that produce hydrogen peroxide are kept inside specialized organelles inside cells called peroxisomes.

The peroxisomes also contain large amounts of catalase to break down the hydrogen peroxide before it can escape. The biological enzyme catalase decomposes hydrogen peroxide into water and oxygen and therefore renders it harmless to the body.

Not all enzymes are made by the body. In industry many chemical enzymes or catalysts are used to perform catabolic reactions just like naturally occurring enzymes. Iron (III) Nitrate is a catabolic chemical often called a chemical catalyst.

**Part A: Individual activity (5 marks)**

Follow the step by step instructions laid out below to investigate the decomposition of hydrogen peroxide using enzymes.

Collect the following equipment:

* 3% Hydrogen Peroxide Solution
* 0.5 M Iron (III) nitrate solution
* Fresh ground liver as a source of catalase
* Boiled liver
* 4 test-tubes

Label the four test-tubes A, B, C and D, then follow the steps described below.

|  |  |
| --- | --- |
| **A – Iron (III) Nitrate catalyst**   1. Make a mark 2cm from the bottom of the test-tube 2. Add H2O2 up to the mark 3. Add 1ml of iron(III) nitrate solution 4. When the reaction stops, add about 1ml more of H2O2 5. Record your observations in Table 1 | **B – Liver Enzyme (catalase)**   1. Make a mark 2cm from the bottom of the test-tube 2. Add H2O2 up to the mark 3. Add about 1 teaspoon of fresh ground liver. 4. When reaction stops, add about 1ml more of H2O2 5. Record your observations in Table 1. |
| **C- Boiled Liver**   1. Make a mark 2cm from the bottom of the test-tube 2. Add H2O2 up to the mark 3. Add about 1 teaspoon of boiled liver. 4. When reaction stops, add about 1ml more of H2O2 5. Record your observations in Table 1. | **D – Control**   1. Make a mark 2cm from the bottom of the test-tube 2. Add H2O2 up to the mark 3. When reaction stops, add about 1ml more H2O2 4. Record your observations in a Table 1 |

**Table 1 : Observations from catalyst experiment**

|  |  |  |
| --- | --- | --- |
| **Experiment** | | **Observations** |
| **A** | **Iron(III) Nitrate** |  |
| **B** | **Liver (catalase)** |  |
| **C** | **Boiled Liver** |  |
| **D** | **Control** |  |

**Using your knowledge from the experiments, answer the following questions:**

**1.** What is the reason for setting up the control in this experiment?

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2. What effect did adding Iron (III) Nitrate to the solution of hydrogen peroxide have on the decomposition of hydrogen peroxide?

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3. What effect did adding fresh liver to the solution of hydrogen peroxide have on the decomposition of the solution?

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4. Explain why there was a difference in the rate of reaction between experiment B and C.

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**Part B : Homework (4 marks)**

Design an experiment that you are going to carry out in class to investigate the effect of changing one environmental factor on the functioning of the liver enzyme catalase. You have available fresh liver, hydrogen peroxide and any normal laboratory equipment.

Your design must include a hypothesis, independent variable and dependent variable, controlled variables and a step by step method. You also need to include a detailed equipment list and a suitable table to record your data.

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**Part C : Individual – one period for carrying out your experiment, recording results and answer questions.**

Carry out your experiment and record your results in your table.

There is no need to carry out trials, only repeat if you suspect an error.

**Answer the following questions:**

5. What is catalase, and how does it increase the rate of decomposition of hydrogen peroxide? (2 marks)

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6. Describe the effect that changing the environmental factor had in your experiment. (2 marks)

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7. Using the lock and key model, explain how the enzyme catalase works in your experiment. Use diagrams and or illustrations to show your answer. (3 marks)

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8. Describe two more factors that could have been investigated to see if they had an effect on the functioning of the enzyme catalase and discus how they would have affected the functioning of the enzyme when it reacts with hydrogen peroxide. (4 marks)

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9. Iron (III) Nitrate catalyses the reaction by forming an intermediate complex with hydrogen peroxide. What evidence is there for the formation of this intermediate complex, and what evidence supports the hypothesis that the catalyst is reformed at the end of the reaction? (2 marks)

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10. A type of amylase found in saliva acts on starch. In an experiment a biologist investigated the effect that acidity (pH) had on the rate of activity of amylase. A number of small, sterilised tubes, each containing the same amount of starch and amylase were set up. Each tube had a different pH. The tubes were incubated at 37 degrees Celsius and after 30 minutes the relative activity of the enzymes in each tube were measured. The results are shown below.

|  |  |  |
| --- | --- | --- |
| **Tube number** | **pH contents of tube** | **Relative activity** |
| 1 | 4.5 | 58 |
| 2 | 5.0 | 67 |
| 3 | 5.5 | 75 |
| 4 | 6.0 | 84 |
| 5 | 6.5 | 73 |
| 6 | 7.0 | 40 |
| 7 | 7.5 | 7 |

Plot the data on the grid below. (5 marks)

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11. Write a hypothesis for the experiment the biologist carried out. (1 mark)

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12. Describe what happens to the relative activity of the enzyme as the pH increases. (3 marks)

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13. The pH of the stomach can vary from 1 to 3 due to the secretion of hydrochloric acid by the cells in the stomach wall. Predict what the relative activity would be for the amylase if the stomach was pH2, state why.

(2 marks)

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14. A different type of amylase is found in the intestine of cold water frogs, where it has a similar action to the amylase found in human saliva. When placed in a solution at 37 degrees Celsius, it was found to be inactive. What is the probable reason for this? (2 marks)

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15. Briefly explain why enzymes are so vital to all living things. (1 mark)

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