An investigation of the factors that affect the rate of respiration in Yeast.

Introduction

Yeast is one of the living cells, which can respire aerobically, and anaerobically in this investigation I am just taking into consideration respiration as whole. The equation of respiration in yeast is:

Equation:

There are different variables in this experiment. These consist of the range in temperature, concentration of glucose, amount of hydrogen carbonate solution used and amount of water used for the water bath. These variables are important and affect the way in which yeast respires. I shall be choosing the range in temperature as the variable to study to see if it affects the rate of respiration.

Prediction

In this experiment the temperature shall affect the way in which yeast respires. I predict that the temperature at which the rate of reaction shall be fastest is at higher temperatures but below 50ºC. This is because enzymes work best at the higher temperatures. If the temperature is above around 50ºC enzymes break down and stop working causing for respiration not to take place. However if the temperature is less than around 30ºC it shall mean that the enzymes work slower and therefore the reactions will be slower and the energy produced by respiration shall decrease.

Preliminary investigation

In the first incidence I decided that I would fill a beaker full of 200 cm^3 of water from the kettle. The temperature of the water was 70ºC. I noticed at this temperature nothing happened and I then came to the conclusion that the enzymes in the yeast cell had denatured. I then poured purely tap water at a temperature of 18ºC into the 200cm^3 beaker. In this case there was no change in the yeast even though I left it for 10 minutes. After this I then came to the conclusion that I should only stay a few degrees below 37ºC and a few degrees above it. I did this but there was not much difference in rate of reaction between each of these degrees and therefore the results would mostly be the same. I also realised that in the

end after I had set the temperature it would gradually decrease and this mean that I would have to find a way in which I could keep the temperature constant. To overcome this I found it easier for me to use a syringe in which I would extract some water and replace it with hot water from the kettle until the water bath had reached the temperature at which it had started. So in the end the temperatures I chose to study were 19ºC, 29ºC, 37ºC, 45ºC and 55ºC. Another factor that I noticed which may had been a problem was the fact that if I used 20cm³ of glucose and yeast the solution would travel up the delivery tube as respiration took place so I then decided that I should use 20cm³ of yeast and 10cm³ of glucose solution.

Outline plan

- **List of Apparatus**

In this experiment I shall be using: a test tube rack, a Delivery tube, a boiling tube, a test tube, hydrogen carbonate indicator, yeast, glucose solution, syringe, 200cm³ beaker measuring cylinder, a straw and a kettle. And they were arranged in this order.

- **Fair Testing**

In order for this to be a fair experiment quantities of each substance must be measured and the kept the same throughout the experiment except for

the variable in which I am testing temperature. This means that the amount of glucose and yeast must remain the same throughout the experiment. Another thing that may make the experiment unfair is the amount of the hydrogen carbonate solution this is because it will take a longer time for the indicator to gain the orange colouration it does when carbon dioxide is present. In order for the temperature of the water bath to be kept the same during the experiment a syringe shall be used to extract cold water, which shall be replaced with hot water.

- **Range of measurements**

In order for this experiment to be successful there needs to be exact measurements for each substance used. From the preliminary investigation I have chosen to use 20cm³ of yeast and 10cm³ of glucose. I shall only ever fill the water bath with 200cm³ of water. I shall only use 5cm of hydrogen carbonate solution. The temperatures, which I shall be using, are 19ºC, 29ºC, 37ºC, 45ºC and 55ºC.

- **Accuracy**

Accuracy in this experiment will be gained by measuring each of the substances with a measuring cylinder and this means that the right amount of each substance shall be used. Also it means that that I shall be testing each temperature three times and get an average for each temperature.

- **Safety**

Safety should be taken into consideration whilst pouring boiling hot water into the beaker because scolding could occur should the water come into contact with the skin. Another safety precaution that should be taken into consideration is the fact that as the kettle is being boiled electricity is used to power it from the socket and therefore it maybe a possibility for the electricity coming in contact with the water and there fore this may cause electric shock. Another aspect of safety that should not be noticed is the fact that whilst handling the boiling tube it is placed in boiling water and therefore should be handled with caution cause scolding could still occur.

- **Detailed Method**

1. 5cm of hydrogen carbonate solution will be poured into a test tube.

2. A straw will then be put into the solution and blown down until the indicator would not change colour any more and this will then be called the standard. Which is used to compare the indicator solution used in the experiment.
3. 20cm³ of yeast will then be poured into a boiling tube and then 10cm³ of glucose solution will then be poured into this same boiling tube.
4. The stop clock will then be started to allow the glucose and yeast to calibrate for 10 minutes.
5. A 200cm³ beaker will be filled with water. 100cm³ of water from the tap and then another 100cm³ of boiling water from the kettle.
6. The temperature of the water will then be taken using a thermometer.
7. After that various amounts of water will be taken out of the beaker using a syringe to then be replaced by cold water to allow the water to reach the exact temperature needed for the experiment being conducted.
8. The glucose and yeast solution will then be placed into the water bath, which will have been set at a specific temperature.
9. A delivery tube will then be placed on the boiling tube containing the glucose and yeast solution. The tip of the tube will then be placed 1cm below the Damascus of the water to allow the carbon dioxide to produce effervescence in the test tube containing hydrogen carbonate solution.
10. The stop clock will then be started to gain the amount of time it will take for the hydrogen carbonate indicator to change colour and look like the standard.
11. A thermometer will then be placed into the water bath to allow awareness of the temperature in the water bath was at all times. If the temperature dropped then a syringe was used to first of all extract water from the beaker, which was then replaced by sufficient amounts of boiling water for that temperature to be gained.
12. As the glucose and yeast solution begin to produce a constant flow of effervescence in the test tube containing hydrogen carbonate solution, the test tube will then be moved up and down so that the change in colour of the solution will be evenly distributed.
13. Once the hydrogen carbonate solution reaches the colouration to that of the standards the stop clock will then

be stopped and the delivery tube removed from the boiling tube and test tube.

- **Evaluation**

In this experiment different variables needed to be taken into consideration. I noticed at first that I needed to decide the amount of glucose and yeast, which would be needed for the experiment. At first I thought that I would use 20cm³ of both glucose and yeast. Prior to this experiment an experiment of the same sort had been carried out and in this experiment the glucose and yeast solution measured 20cm³. So I decided that I would use 20cm³ for glucose and 20cm³ for yeast. However, as I poured the 20cm³ of glucose I realised that this already filled the boiling tube to the brim and therefore I needed to use different amounts. I then decided that I would use 10cm³ of glucose and 20cm³ of yeast. I chose to use this because I thought that the yeast would react better being as there was not that much glucose, which would mean that the yeast would use the glucose and begin to respire with better results. The temperature I chose at first was 37ºC because I had read in the textbook that enzymes work best in the human body at this temperature. I then made a water bath with the temperature of 67ºC but the yeast starte d respiring quickly and then after roughly 5 minutes it appeared to me that the enzymes in the yeast cell had become denatured.

- **Conclusion**

In conclusion to this experiment I have found that my results have not contradicted my prediction. As it can be seen due to the results table and graph the rate of respiration in yeast has reached its optimum and then gradually declined after the temperature reached above around 45ºC. Respiration is affected very much by the temperature at which the yeast is surrounded by and this was shown in the investigation. As the investigation was carried out, it was noticed that as the temperature increased so to did the rate of reaction. This is due to the reason that enzymes affect the rate of reaction. Enzymes are catalysts, which are in cells to help the rate of reactions. These enzymes are very particular meaning that there are specific enzymes for specific reactions. In the case of the yeast cell catalase is used. Inside the mitochondrion of the yeast cell a chemical reaction is taking place and this is affected by temperature. As the particles in the enzymes reach a certain temperature, or there around it, reactions begin to quicken due to the fact that there are more collisions taking place therefore causing more energy to be made. This is because catalysts work as faster due to the collision theory meaning when the catalyst reaches a certain temperature more energy is given to particles by the heat. As the particles in the catalyst now have more energy the likelihood of collision between particles is much greater. This can be seen in the results of my experiment because as the yeast got to around 40ºC it was noticed that the rate of reaction had changed vigorously and there was a notable difference in the amount of effervescence that was being made. If the temperature is too cold for the enzymes it means that they do not work as efficiently and reactions become slower. Although on the other hand it was noticed that after the temperature of the water bath came above 50ºC the reactions were even slower than the results conducted in lower temperatures. This was due to the fact that as the temperature became too hot the enzymes in the yeast cell become denatured and cause the reactions to be nonexistent. I found that the results of my experiment agreed with all the information that I had gathered this being that the enzymes would work at higher temperatures. In my experiment I noticed that at 19ºC the cell did not seem to be respiring at all. I left the yeast cell in the 19ºC for almost 30 minutes for the hydrogen carbonate solution to change its colouration. Then, as I increased the temperature of the water bath, so to did the rate of reaction and this agrees with the graph of rate of reaction below. This deduction can be made due to the fact that as the enzymes reach the optimum temperature the rate of reaction is grates although once this range of temperatures had been exceeded (from around 35ºC to 45ºC) the

rate of reaction has a rapid decline until around the enzymes then be come denature which is around 60ºC.

Results Table

Temperature of water Bath in ºC	Minutes taken in 1st Experiment	Minutes taken in Experiment	Minutes taken in Experiment	Average time taken Experiments
55	25	22	27	25
45	9	12	13	11
37	4	6	7	6
29	17	15	20	17
19	29	30	29	29