Chemistry Investigation Essay, Research Paper

Investigate A Factor Which Affects the Rate Of Fermentation Of Yeast

This experiment is investigating one of the factors which affects the rate of fermentation of yeast.

Several factors affect the rate of reaction:

¬ Increasing the concentration. (See the lock and key theory.) If the substrate (glucose) is increased, then there would be more keys for the locks, therefore an increase in reactant concentration leads to an increase in reaction rate.

¬ The surface area, the bigger the surface area, the faster the reaction time is, as the reactant can reach more parts.

¬ The temperature, an increase in temperature leads to an increase in reactant rate. Generally, as the temperature is increased, the particles get more energy, so they bump into one another more, therefore speeding up the reaction time. This is called the collision theory, which I will discuss in greater depth later.

¬ Whether or not there is a catalyst. A catalyst speeds up the rate of reaction and remains chemically unchanged by the end of the experiment. A catalyst lowers the activation energy. This is the energy needed to start a reaction.

The variable that I have decided to change is the temperature. I have decided to alter the temperature of the yeast and time the amount of carbon dioxide that will be given off at different temperatures. I have decided to time how much carbon dioxide is given off in five minutes.

Throughout the investigation, I will keep the temperature the same as I have specified for each reading. For example, if I am taking a reading in which the temperature must be 5 degrees, I will make sure that the yeast is kept at this temperature. When I am altering the temperature of the yeast, I will place it in a water bath of the specified temperature, which makes the temperature much more accurate. For example, if I heat up the yeast using a Bunsen burner, I could heat it up too much, thereby denaturing the enzymes and ruining the experiment. After the enzymes have been denatured, they can no longer react.

It will also be important not to agitate the solution at all, because this would cause collisions between particles, speeding up the reaction time and making the test unfair.

While doing an experiment such as this, it is vital to be safe at all times. You should stand up at all times, making sure that stools are firmly under desks. When the Bunsen burner is not being used, make sure that the orange safety flame is on. Use a heatproof mat and safety gauze.

When I change the chosen variable (temperature), I predict that the reaction rate will increase. However, after the temperature has reached about degrees, the enzymes will be denatured, therefore the reaction rate will decrease, eventually reaching zero. Enzymes function most efficiently within a physiological temperature range. Since enzymes are protein molecules, high temperatures can destroy them. An example of such destruction, called protein denaturation, is the curdling of milk when it is boiled. Increasing temperature has two effects on an enzyme. First, the velocity of the reaction increases somewhat, because the rate of chemical reactions tends to increase with temperature; second, the enzyme is increasingly denatured. Increasing temperature thus increases the metabolic rate only within a limited range. If the temperature becomes too high, enzyme denaturation destroys life. Low temperatures also change the shapes of enzymes. With enzymes that are cold sensitive, the change causes loss of activity. Both excessive cold and heat are therefore damaging to enzymes.

The degree of acidity or basicity of a solution, which is expressed as pH, also affects enzymes. As the acidity of a solution changes, e.g. the pH is altered–a point of optimum acidity occurs, at which the enzyme acts most efficiently. Although this pH optimum varies with temperature and is influenced by other constituents of the solution containing the enzyme, it is a characteristic property of enzymes. Because enzymes are sensitive to changes in acidity, most living systems are highly buffered; e.g. they have mechanisms that enable them to maintain a constant acidity. This acidity level, or pH, is about 7 in most organisms. Some bacteria function under moderately acidic or basic conditions; and the digestive enzyme pepsin acts in the acid milieu of the stomach. There is no known organism that can survive in either a very acidic or a very basic environment.

Most chemical reaction happen faster when the temperature is high. At higher temperatures molecules move around faster, this makes it easier for them to react together. Usually, a rise of 10 degrees Celsius will double the rate of a chemical reactor. Most of the chemical reactions happening inside a living organism are controlled or catalysed by enzymes.

My prediction is also backed up by the lock and key theory . Enzymes are proteins that are BIOLOGICAL CATALYSTS. A catalyst is something that changes the rate of a chemical reaction without itself undergoing any change.

Enzymes have an active site. This is a special shape, in which a specific molecule can fit, e.g. starch fits into the active site of amylase. This is called the lock and key theory. A lock is a special shape and only a key of the required shape can fit and open the lock. The enzyme is the lock and the substrate is the key. In my investigation, the substrate is the glucose, the key. The lock is the enzyme.

I have also based my investigation on another scientific theory, which I have previously studied. It is called the COLLISION THEORY.

The collision theory is used to predict the rates of chemical reactions, particularly for gases. The collision theory is based on the assumption that for a reaction to occur it is necessary for the reacting species (atoms or molecules) to come together or collide with one another. Not all collisions, however, bring about chemical change. A collision will be effective in producing chemical change only if the species brought together possess a certain minimum value of internal energy, equal to the activation energy of the reaction. Furthermore, the colliding species must be oriented in a manner favourable to the necessary rearrangement of atoms and electrons. Thus, according to the collision theory, the rate at which a chemical reaction proceeds is equal to the frequency of effective collisions. Because atomic or molecular frequencies of collisions can be calculated with some degree of accuracy only for gases (by application of the kinetic theory), the application of the collision theory is limited to gas-phase reactions.

The equation for this experiment is:

Glucose ≡ Alcohol + Carbon Dioxide

I will take 35 readings, over a range of 7 values, from nought to sixty, going up each time by 10 degrees Celsius. I will take three readings for each value, and then find the average, in order to be more accurate and reliable.

I will use the following apparatus to get the most accurate results, (remembering to check for zero errors):

1. A reliable stop-clock

2. A Bunsen burner

3. A water bath

4. A safety gauze

5. A heat proof mat

6. A beaker

7. A measuring cylinder

8. A thermometer

9. A graduator test-tube

10. Smaller flask

11. Delivery Tube

12. Bung

I will also carry out a pilot test, in order to check that the experiment is working properly and as a practise test .

I will record my results clearly and accurately, using a table and remembering to put the quantity, units, and repeats in the table.

For my investigation, I will look at secondary sources, from a textbook, encyclop dia, and preliminary work that I have done in class.

Analysis of Results

I have shown my results on a bar chart and a line graph. On the line graph, I have drawn a curve of best-fit. There were no anomalous results. From my results, and my graph, I have found out that as the temperature of the enzymes (yeast in this case) is increased, the rate of reaction speeds up. However, when the temperature reached a certain point, (about 40 degrees Celsius), the enzymes became denatured, and the rate of reaction slowed down, eventually reaching zero, as I mentioned in my prediction.

I have drawn three construction lines on my graph, the first shows the temperature increasing steadily, and the reaction rate increasing steadily. The temperature is about 22θC, and the amount of carbon dioxide released is about 6.4 cm3. The second construction line is the fastest reaction rate in the investigation. The temperature is about 40θC, and about 14.6 cm3 of carbon dioxide has been released. The third construction line shows the temperature decreasing steadily, and the reaction rate decreasing rapidly, as the line is very steep. The temperature is 50θC, and about 7.4cm3 of carbon dioxide has been given off.

I can explain my results, using earlier scientific knowledge.

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So, by heating up the molecules more, it makes particles collide more often in a certain time, and makes it more likely that collisions result in a reaction. Because there are more effective collisions, temperature has a large effect on rates of reaction. If you raise the temperature by 10 θC, you roughly double the rate of many reactions.

Evaluation

I think that there are some improvements that I could make to the way that I did my method. I would try to manage my time better. I would also make sure that the yeast solution was measured out with better accuracy.

I do not think that I should have repeated any more readings, I think that three is enough to give a good level of accuracy.

If I were to repeat my results again, I think that I would get around the same results, I believe that they were reliable. I would not change the equipment in any way if I were to repeat the investigation.

My results were over a good range, which ensured that the results were more accurate, and a clearer picture could be obtained than if the range was very small. If the range was very small, for example, the enzymes would not have become denatured, and the full extent of the investigation would not have been realised. As the last reading shows no carbon dioxide given off, I believe that my range was good, just right for the experiment.

There are no results that do not fit in with the general pattern of readings, they all follow.

My results are good enough to draw a firm conclusion, because they show the temperature increasing, therefore the reaction rate increasing, then they show the enzymes reaching their OPTIMUM TEMPERATURE, (the highest temperature that they can reach before becoming denatured). They then show what happens after the enzyme has become denatured, the temperature still increases, but the reaction rate decreases, eventually to nothing.

To extend my investigation, I could investigate the other factors affecting the rate of fermentation of yeast. I could also use another substrate and see what occurs.

There is a pattern in my results, as I have earlier explained, but it only occurs over the range of values that I have used, because the enzymes become denatured.