To examine the effect of temperature on the enzyme catalase

At the most basic level, enzymes are biological catalysts. They are proteins, meaning that they are polymers of amino acids. Their tertiary structure gives them a globular form due to the bonding present in the molecule.

Many types of bonds hold the structure together and in the right shape. They strongest of these are the di-sulphide bridges between two cysteine amino acids. Also present are hydrogen bonds, although singly week when many are present the bond is strong. In addition are hydrophobic non-polar R-groups which by pointing to the middle of the molecule act as a bonding force. Every enzyme is present to speed up a reaction or make the reaction workable in ‘ normal’ circumstances.

However enzymes are not universal. So how does the simple molecule decide what reaction it will aid? Each enzyme has an active site. This site is designed specifically to allow the substrate to cling to the enzyme forming an enzyme-substrate complex. However it does occur that other molecules fit into the active site. This is known as either competitive or non competitive inhibition* What is Catalase specificallyCatalase is an enzyme found in most creatures. It converts naturally produced hydrogen peroxide into water and oxygen.

The equation for the reaction is: H2O2 H2 + O2.” Catalase is an example of a particularly efficient enzyme. Catalase has one of the highest turnover numbers for all known enzymes (40, 000, 000 molecules/second). This high rate shows an importance for the enzymes capability for detoxifying hydrogen peroxide and preventing the formation of carbon dioxide bubbles in the blood.” i (Unknown author)* Denaturing and Ideal ConditionsLike all

proteins and enzymes, Catalase is not impervious to heat. At a certain temperature the bonds that hold the shape together will break and so the active site will change shape causing the enzyme to lose function.

Enzymes and proteins consist of polypeptide chains held together by a series of cross-links. When the temperature gets too high, the links holding the shape of the enzyme are broken and the polypeptide chains open up. Given that it is the specific shape of the active site of the enzyme that is crucial to its performance this reshaping of the molecule renders the enzyme useless. The other causes of denaturing are extremes of pH and certain chemicals, e.

g. urea alcohol and others. However, that does not mean that the lower the temperature the better it will perform. Like all reactions the rate of decomposition of H2O2 will increase with heat.

This is further increased when in the presence of the enzyme. So we can see that whilst a higher temperature is favourable, if the temperature goes too high, the catalase will denature and the breakdown of the substrate will slow down dramatically. Therefore, we can see that at some point there is an optimum temperature for the enzyme. Read aboutLike all enzymes catalase works best at a particular pH.

In this experiment the pH will be 7 or neutral.* Molecular diagramBelow I have included both a 3D computer-generated model of the enzyme and a structural representation.* What is H2O2Hydrogen peroxide is a chemical. It is produced as a by-product of many intra cellular reactions. In a bottle it stays in a state of dynamic equilibrium.

This means that the decomposition into O2 gas and water and the reverse reaction doesn’t stop. In the right conditions the reaction will keep on going ad infinitum. However in reality this cannot happen because the oxygen gas will escape and so eventually only water will remain. For this reason one cannot tell the concentrations of hydrogen peroxide in terms of moles per dm3. Instead we use percentage by volume.* How is it produced in the body? Hydrogen peroxide is a by product of many intra cellular reaction all of which happen continuously in our bodies and the bodies of most organisms.

However, if hydrogen peroxide were to just remain in our bodies we could soon die. Therefore, to safely and quickly break down H2O2, Catalase is produced catalyse its breakdown.* Why use potato? The ways in which H2O2 is produced in potatoes and humans is the same; as are the ways Catalase is produced and applied. Therefore this experiment could be applied to human biochemistry. However, using natural materials does pose some problem to the accuracy of results. When materials that are produced naturally are used the results rarely match up exactly.

In a potato, for instance, as the plant grows, so does the tuber. In a natural environment the conditions that the plant encounters change day by day, causing the processes inside the cells to change to suit the factors. When the tuber was taken the cells would not have been at exactly the same stage in all processes. This means that in each sample of potato their will be different amounts of Catalase. There may also be other chemicals which affect the reaction.

* How do the substrate and enzyme meet? In normal reactions, the rate is determined by how fast and often the particles involved collide. However, when enzymes are involved the substrate has to collide with the correct speed and orientation. This last part is crucial. As we have discussed, the enzyme is made with an active site that exactly complements the shape of the substrate.

Therefore if the substrate collides at any other angle than the one that the enzyme is expecting it will be rejected like any other chemical. Below is a diagram of the lock and key model of the substrate enzyme complex. It is a formation reaction that is catalysed by an enzyme, whereas the reaction in this practical is a division reaction however the process is the same.