Biology Coursework – Photosynthesis

Prediction: As I increase the amount of heat being applied to the elodea the rate of photosynthesis will rise at a directly proportional rate. As the temperature reaches 40* the rate of photosynthesis will start to decrease. As the temperature increases, the rate of photosynthesis will continue to fall, starting to fall quite slowly, but the decrease will speed up until reaching 0 at roughly 60*.

Elodea are autotrophs, these are organisms, which use chlorophyll to make energy needed for food by photosynthesis. Like all autotrophs, certain ingredients are needed for the photosynthesis to occur, for the maximum photosynthesis rate, a never ending supply of all the key ingredients is needed, if there are few of one or all of the ingredients then photosynthesis will be limited. As such, the lack of 1 ingredient can limit the entire rate of photosynthesis.

The main factors in a plants rate of photosynthesis are:

1. Day Length (Photo period)
2. Light Intensity (strength)
3. Light Wavelength
4. Temperature
5. Carbon Dioxide Availability
6. Water Availability

Each of these ingredient's are needed in photosynthesis for different reasons, but without a combination of them all, photosynthesis cannot take place.

Inside the chloroplasts, the carbon dioxide and the light are used by the chlorophyll and glucose and oxygen are given out, the glucose is used for energy by the plant and the oxygen is given off into the atmosphere as a by product of the reaction. The enzymes inside the chlorophyll work best at their 'optimum' temperature, so hence heat is a factor, as if the plant is too cold the plant will not photosynthesis as quick as it could do, and once the enzymes go over their optimum temperature they become denatured, this where they 'die', they do not die like living creatures but they do stop working and the amount of photosynthesis drops rapidly to zero as there is no chlorophyll left to make photosynthesis happen.

The Day Length is a factor because of its control on the amount of light a plant can absorb before night. In a long day there are many hours of sunlight available and the plant can partake in a large amount of photosynthesis, but in a shorter day the amount of sunlight the plant can absorb is limited and so the amount of photosynthesis possible is shortened. The Light provides the energy for the reaction so photosynthesis cannot happen without the light, at night time very little photosynthesis happens compared to in the day due mostly to the lack of light.

Light Intensity is a factor because of the same reasons as the day length. The more intense the light the more energy the chlorophyll will take from it, the more photosynthesis can happen. Whereas in weak light little energy can be taken from the light, hence the amount of photosynthesis will be limited.

The Wavelength of the light makes a difference too, the higher the wavelength, the quicker the energy gets transferred to the chlorophyll, the quicker photosynthesis can happen, so a high wavelength light will mean more photosynthesis can happen quicker, also the higher the wavelength, the higher the amount of energy the light carry's, so again more photosynthesis can happen.

The temperature has a large control over the rate of photosynthesis. The enzymes in the chlorophyll that make the reaction happen work best at an 'optimum temperature', this is about 41', any below this level and the rate of photosynthesis will slow, for instance, at 10' the rate of photosynthesis will be very slow, at 20' it will be a bit faster, at 30' it will be faster still, and at 40' it will be the fastest. Once the temperature goes above 40' the rate of photosynthesis drops rapidly. This happens because the chlorophyll, and the enzyme's, which cause photosynthesis to happen, become 'denatured', they literally become boiled, stop working and they die. It is worth saying that they don't literally die like you or me, they stop working and as such no photosynthesis can happen, when this happens there is no way the plant can recover and it will die.

During Photosynthesis, carbon dioxide is changed by the enzymes in the chlorophyll into glucose, which the plant uses for energy, and into oxygen. So without carbon dioxide photosynthesis cannot happen. The more carbon dioxide the plant has available for photosynthesis the bigger the scope for the rate of photosynthesis becomes. Without carbon dioxide photosynthesis simply isn't possible, there is no raw material for creating the glucose. As a result of this, the more carbon dioxide available the higher the rate of photosynthesis and the less carbon dioxide available, the lower the rate of photosynthesis is.

Water is also needed for photosynthesis. All creatures need water to survive, and in plants photosynthesis happens in water, inside the chlorophyll, the water keeps the provides a substance in which the reaction can happen easily, without water the reaction wouldn't be able to happen as there would be nothing it could be done in, also the plant would soon dehydrate and die, so as the amount of water in the plant increases, so the rate of photosynthesis will too, but too much water is bad for the plant

All the above factors affect photosynthesis, but removing any one of them means photosynthesis cannot happen. Hence if we reduce the heat of the elodea, I believe the rate of photosynthesis will decrease, but as we heat the elodea up it will increase, but as we know that enzymes get denatured I believe that after 40' the rate of photosynthesis will begin to drop and will continue to drop rapidly.

Method: We took some Elodea. This is a waterweed that will photosynthesis in water and as such is useful for our experiment. We put this in a large beaker of water and put a funnel over the top of the elodea. This meant that the elodea would be able to photosynthesis and the oxygen produced would go through the top of the funnel so we could measure the amount produced. We then put a test tube, upside down on top of the funnel, filled with water. It was filled with water so we could tell how much gas (oxygen) had been trapped in it. This meant we had apparatus set up to catch the oxygen produced by the elodea in photosynthesis. We then added the variables that we were keeping constant for the experiment (those that weren't the subject of our experiment. So we had a large, powerful lamp, which we placed, next to the large beaker, we also added 3 ml of Sodium Hydroxide Carbonate. This produces carbon dioxide in the water so the elodea will have a supply of C02 that it needs for photosynthesis. We then put a Bunsen burner, on a blue flame under the large beaker, this meant we could change the heat; this was the variable we were changing.

Then we started the Bunsen burner, we decided to heat the elodea at stages of 5 degrees centigrade, starting at 20 and going up to 65. When the water reached the correct temperature we turned off the Bunsen burner and measured how much water was displaced from the test tube, this would tell us how much oxygen had been produced, we gave the plant 1 minute at each interval, which we measured and then turned the Bunsen back to the same heat and did the same at the next interval.
Safety: Because we are heating water we must wear eye goggles, we must not touch hot glass and we must tuck in out ties, long hair and any loose clothing etc.

Results: After repeating the experiment 3 times I drew these results:

The Table and Graphs of my results agree with my prediction. As the heat is increased the rate of photosynthesis increases at a directly proportional rate until roughly 30', here the rate of photosynthesis slows down, at 40' it stops increases and starts decreasing, it decreases rapidly until roughly 60', after which there is no photosynthesis

This can all be explained, as the heat is increased, the rate of photosynthesis rises. This is because the enzymes in the chlorophyll are being heated up and are working quicker and quicker, the more heat they have, the quicker they will work, hence the higher rate of photosynthesis, until 35' –40' where they reach their optimum, this is shown in the graphs by the straightening off of the graph between 30' and 40'. The severe drop in the rate of photosynthesis, back to 0 after 40' can be explained too. The plant has reached it's 'optimum' temperature for photosynthesis, after this point the cells become denatured, they stop working and photosynthesis stops, this is why the rate of photosynthesis drops rapidly after 40' because all the chlorophyll have been denatured.

These results support my prediction. The graph is very similar to my graph prediction. Both graphs rise at a directly proportional rate until 35', where they both level off. The difference comes after this point, where as I was expecting the graph to fall almost straight down, it did not, it levelled of a lot slow er tan I expected. This can be explained by the fact that some bubbles that came after the plant reached 40' may have not just been produced and may have escaped as they were heated up and pressure pushed them out of the plant. At 10' on my prediction grap h I predicted that there would be 40 bubbles a minute escaping, this is close to the actual average of 38', this is because the graphs are both directly proportional and rise at very similar angles. In my prediction graph I had the amount of bubbles levelling off at 100 a minute, on the actual graph the average is 95, again this is very similar as I knew it would rise at a proportional rate and I knew the point at which the 'optimum' would be reached. After this on my prediction graph I had the rate falling from 100 bubbles a minute to 0 in-between 40' and 45'. In actual fact this happened over a much larger period it took up to 60' for the amount of bubbles per minute to fall to 0.

Most of these points support my prediction and the graphs are very similar. I believe that the fact that the shape of the graph after 40' differs from the actual graph does not undermine my prediction, I think that the general shape and the closeness of many of the points on the graphs means that they are very similar, the last bit of the graph differs because I failed to take into account the affect of the bubbles still left inside the plant, I do not believe that the plant was still photosynthesising after 40'.

Evaluation: I had a few problems while doing the experiment. Keeping the light intensity the same should have been easy as we used one big lamp all the time, but the classroom light, lights from other people experiments and light from outside all would have affected the intensity and frequency of the light meaning that some of the results may be slightly too high or slightly too low, but I Do not think that this undermined the experiment. The availability of carbon dioxide would have been the same all the way through the experiment because of the Sodium Hydrogen Carbonate, although it may have altered slightly, because of the amount of carbon Dioxide dissolving in the water from the air may have altered but not enough to affect any of the results. The amount of water in the experiment was kept the same throughout so this was one of the control variables we were able to keep the same all the way through.

We found that the initial method was not as accurate as we hoped it would be so I changed a few things to it, the revised method is basically the same but with these alterations: Firstly the fact that we only gave the plant 1 minute to count the photosynthesis meant that we didn't have long enough to see much difference so we changed the time to 3 minutes. Secondly we found that the method of counting the photosynthesis by gas displacement mean that there was little change to note so we decided to instead count the amount of bubbles the elodea gave off during photosynthesis. These changes meant that we could measure the rate of photosynthesis far more accurately than before and meant that our experiment was much more accurate.

After the experiment I believe that if I were to repeat the experiment I would increase the amount of time we counted the bubbles for at each point from 3 minutes to 5 minutes, although it would be difficult to maintain the same heat for this period of time. I would also do the experiment in a room devoid of all light except the lamp we were using; this would mean that this control variable could be kept exactly the same.

I believe that my data is fairly reliable. The control Variable's were all kept the same, as much as was possible and I believe that any alterations were not large enough to make a discernable change in the results. Too improve the reliability of the data we would have to control the control variables even more tightly, we could measure the amount of carbon dioxide in the water and keep it at an exactly level point. We could measure the light intensity getting to the experiment and adjust our settings so that this stayed at an equal level and we could use an even more accurate thermometer so that the temperature could be recorded exactly, all of these would improve the reliability of our results.

I believe that the entire series of results from my second attempt at the experiment were anomalous, they are different from both the other experiments by large margins and they also differ widely from the set results we were given. For example, The average of the two correct series I did at 30' was 100', for the anolomous result, this point was 45', this is too far out to be a slight mistake, this lower rate of photosynthesis is apparent throughout this entire series. I believe this happened because less Sodium Hydroxide Carbonate solution was added to this experiment, this would change the amount of carbon dioxide available, changing one of the control variables. The fact that there was a limited supply of carbon dioxide would explain a, lower rate of photosynthesis throughout the whole series. In my final results I excluded this series from my average and repeated it.

I believe I can be very confident in my results. The revised method got rid of most of the problems with the original method and the fact that every time I repeated the experiment without forgetting something the results were very similar. There are clear patterns throughout all 3 useful results that are echoed in the average. I believe that the difference between the ending (after 40') of my prediction graph and the actual graph can be explained. As the plant got heated the oxygen trapped inside the plant would have expanded, at 40' plus, it expanded to the point where it was being pushed out of the plant, and appeared like the plant was still photosynthesising, this explains why it takes longer for the rate of bubbles per minute to drop in the actual experiment. If I was to repeat the experiment this could begot rid of by only measuring the amount of oxygen being produced and not measuring all the gasses coming out of the plant.

There is more we could do to these results. To improve them we could repeat the amount of times we repeated the experiment to get a more accurate average. We could collect data on the effect of the other factors of photosynthesis, maybe repeating the experiment but rather than having heat as the independent variables we could have, day length, light intensity, light wavelength, carbon dioxide availability and water availability in turn as the independent variable. This would give us more ideas into the levels the control variables could be kept to help our experiment. By doing this we could gave all the control variables at their ‘optimum’ point and thus the experiment would work as well as it possibly could.