TREVOR LEE 10R Wednesday 1st November, 2000

Experimental and Investigative Science GCSE

I am going to do an experiment about photosynthesis but before we do this I am going to give you a brief introduction of what photosynthesis is…

The history of photosynthesis.

Two different scientists found the Discovery of Photosynthesis: Jean Senebier and Theodore de Saussure. Jean Senebier, a French pastor, showed that CO_2 was the "fixed" or "injured" air and that plants in photosynthesis took it up. Very soon afterwards, Theodore de Saussure showed that the increase in mass of the plant as it grows could not be due only to uptake of CO_2, but also to the incorporation of water.

So the basic reaction of photosynthesis was outlined:

$$CO_2 + H_2O + \text{light energy} \longrightarrow (CH_2O)n + O_2$$

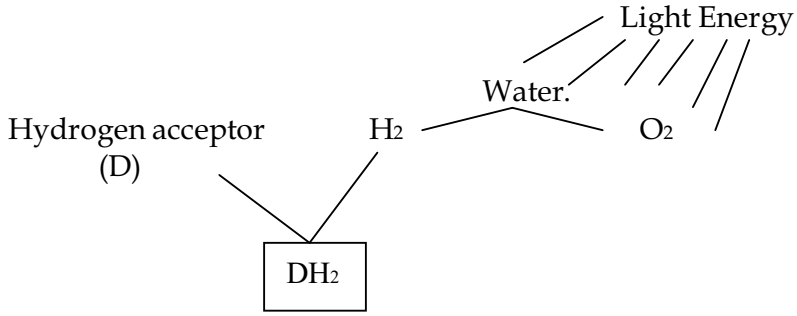
What is photosynthesis?

Photosynthesis is a process by which organic compounds are synthesised by the reduction of carbon dioxide. The energy for this process is when a right wavelength of light hits the chlorophyll in a leaf, which then makes its own food (Glucose but it is converted into starch immediately for easy storage). There are also other coloured pigments that helps in photosynthesis by picking up other wavelengths of light that chlorophyll cannot pick up; but these colours are covered or hidden by the green chlorophyll. The light energy that the other colours collect is transferred to the chlorophyll in the leaf to produce glucose. So only the chlorophyll is directly involved in photosynthesis. The process photosynthesis consists of two separate parts i) light and dark reactions ii) temperature dependant

Light and Dark reactions:

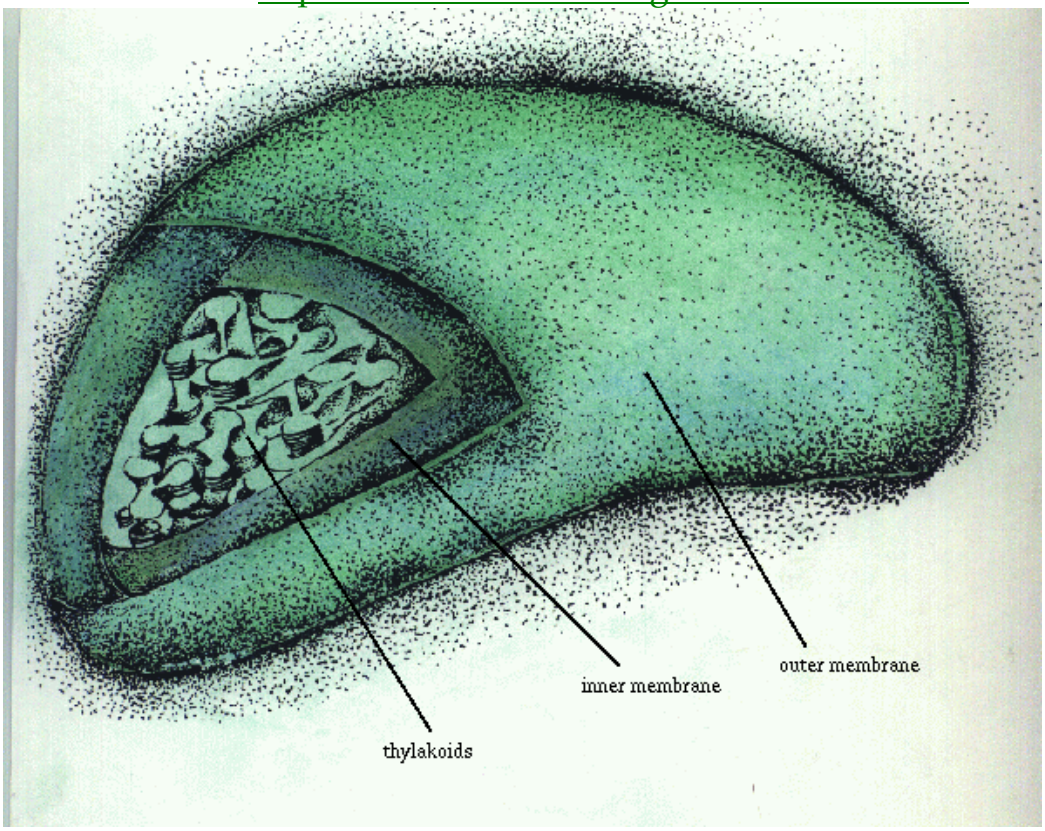
Light reaction:

When light strikes the chloroplast light energy is trapped by the chlorophyll (and accessory pigments) in the chloroplast, then it is converted into chemical energy. The solar energy is used to split the molecules of water into hydrogen and oxygen (photolysis of water) oxygen is released as a by-product of this process. The hydrogen combines with a hydrogen acceptor to form reduced hydrogen acceptor.



Light energy entering the plant splits the water into hydrogen and oxygen:

$$H_2O + \text{light energy} \longrightarrow \tfrac{1}{2} O_2 + 2H^+ + 2 \text{ electrons}$$



This is what a chloroplast looks like on the inside. This chloroplast is used for the process of photosynthesis.

Method.

Firstly we will set up the apparatus (as shown in the diagram on page 7) then we will put the lamp 5cms by the beaker containing the conical flask with the elodea inside then we will wait for two minutes for the elodea to adapt to the intensity of the light. After that we will wait five minutes and measure how far the dye has moved along the capillary tube. We will do this ten times, each time moving 5cms further away from the beaker and three times with the same distances to calculate an average.

Safety.

HAZARD	a) Danger (0-3)	b) Likelihood (0-3)	Score (a*b) (0-9)	Preventive Action
Electrical wires.	3	3	9	Put the wires safely out of the way.
Spillage of water or/and chemicals.	3	2	6	Make sure every thing is not easy to knock over and be careful where we step.
Burn yourself on a hot lamp.	2	3	6	Make sure your hand is not close to the lamp when it is hot.

Broken glass.	3	3	9	Make sure that you do not knock over anything and that when there is broken glass DON'T touch it.
Break a thermometer with mercury in it.	3	1	3	Call the teacher if you find a broken thermometer.
You could knocking over someone's experiment.	2	2	4	Make sure that you or anyone else is not running in the laboratory.

To make it a fair test.

In this test we are going to keep the heat of the water constant so that heat will not affect the rate of photosynthesis buy putting the conical flask con taining the elodea in a water bath (at room temperature). We are going to keep the same amount of ink/dye in the capillary tube so it does not take the oxygen bubbles longer to move the dye. We will also keep the same amount of water in the conical flask. We will keep the same amount of water in the flask. We will keep the same amount of CO_2. We will only vary the light intensity given to the plant.

Prediction.

I think the more intense the light is the faster the rate of photosynthesis is because photosynthesis needs light in the reaction.

This is what I think the graph will look like:

Equipment:

1x capillary tube.
1x rubber bung.
2x rubber tubing.
1x conical flask.
Some pondweed.
Water.
1cm^3 dye.
1x Lamp.
1x Stop clock.
1x Ruler.
1x Beaker.
1x Thermometer.

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Diagram:

How does photosynthesis work?

Photosynthesis begins when light hits the chlorophyll molecule in the leaf of a plant, which reflects the green part of the chlorophyll and captures the light (also the other coloured parts of the chloroplast capture the different waves of light). The energy trapped in the chlorophyll is then converted into chemical energy, this reaction is written as:

$$ADP+P \longrightarrow ATP$$

This process involves several things. Firstly the light energy absorbed by the chlorophyll is used to separate hydrogen and the oxygen molecules from the water. The oxygen is then released through the stomata. The hydrogen combines with a hydrogen acceptor to form reduced hydrogen acceptor. Chlorophyll makes energy available for the regeneration of ATP from ADP. This process is called Photolysis, and takes place in the grana of the chloroplast. The energy is stored and then used in the process of photosynthesis so this is a continuous cycle where the plant creates energy from photosynthesis for food and also reusing this energy in a further process of photosynthesis.

Why we are doing the experiment with light intensity.

We are using light intensity because in the reaction of photosynthesis light and chlorophyll is used to convert carbon dioxide and water into glucose and oxygen I choose light because it was easy to work with because if it was chlorophyll it would be to complicated to work with and if I was varying the amount of carbon dioxide in the water I would have to bubble it through and make the experiment more complicated and harder to understand. So I choose to vary the light intensity as it is much easier to vary and keeps the experiment simple.

If the experiment is successful then the graph will look something like this:

because the light is further away the light is spreading out on to a wider surface area so it is not concentrated on the elodea as much as it was when the lamp was closer to the plant.

Key factors:

The key factors to vary would be the light intensity given to the plant (how far the lamp would be from the flask containing the plant). We will control the temperature of the water so it stays constant and the surrounding heat (room temperature).

The heat may affect the rate of photosynthesis; if you put it in a water bath the temperature will stay constant because it absorbs heat and the amount of pondweed we put in would affect the amount of bubbles produced.

My results table:

Distance away from plant. (Cm)	Temperature of water in beaker. (°C)	1st reading of the amount of O_2 given off. (Cm^3)	2nd reading of the amount of O_2 given off. (Cm^3)	3rd reading of the amount of O_2 given off. (Cm^3)	Average amount of O_2 given off. (Cm^3)

I think the distance of the lamp from the flask should go by 5cms because if I was less than that I think that there would not be much difference in the results and if was more than 5cms there would be a huge difference in the results so I think that 5cms is the best distance to use.

I think that we need to change the distance of the lamp (intensity of light) because the reaction of photosynthesis is spit into two parts a light reaction and a dark reaction.
The light reaction is when the sunlight is absorbed by the chlorophyll and water is absorbed in the roots the sunlight excites the electron leaves the atom and it is replaced by hydrogen and hydroxide atoms. The oxygen is released into the air and the hydrogen is used in the dark reaction with carbon dioxide from the air to produce glucose and oxygen.
The formula for the reaction is:

$$6CO_2 + 6H_2O \xrightarrow[\text{Chlorophyll}]{\text{Light}} C_6H_{12}O_6 + 6O_2$$

Light is needed in the reaction so I think that the intensity of light in p hotosynthesis is relevant. So I think that the more intense the lamp is the more oxygen would be given out because the rate of photosynthesis has increased.
The light energy from the chlorophyll goes to the water from the roots of the plants, which is split, into separate hydrogen and oxygen molecules. The oxygen molecules go into the air as a by-product and the hydrogen is used to make a different type of energy called DH_2 where the D is the reduced hydrogen acceptor. This part is the light reaction and is light dependant. The energy produced then goes into making glucose this is the dark reaction of the process.

I am doing the same distance three times because I need an average to see if my results are reliable or not. I will displace the results that are odd so that I will know which part I need to do again to get a proper set of results. I think that in the graph the amount of oxygen produced will rise rapidly because the plant needs light to produce the energy needed for photosynthesis and then the curve will tail off because the lamp is so far away the light is not concentrated on the lamp there is a loss of light like in this diagram:

So I think that the graph will look like this:

The limiting factors will be the CO_2 levels because the elodea uses the CO_2 during photosynthesis so the CO_2 levels will slowly drop. In order to stop this from happening I will change the water every time I change the distance of the lamp from the beaker so therefore the CO_2 levels will stay constant.

BIBLIOGRAPHY.

SOURCE OF INFORMATION	AUTHOR
CHEMISTRY OF PHOTOSYNTHESIS	UNKNOWN
VIDEO	BBC
TEXT BOOK	NUFFIELD CO -ORDINATED SCIENCES