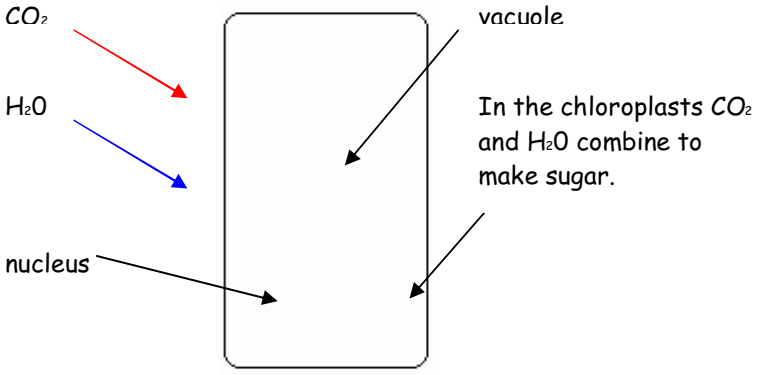
Biology Coursework

Investigating the affect light intensity has on photosynthesis

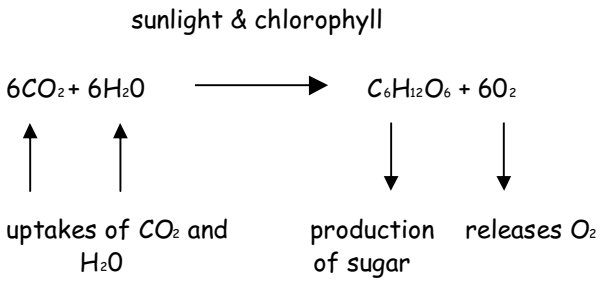
Plan

All living organisms need food. They need it as a source of raw materials to build new cells and tissues as they grow. They also need food as a source of energy. Food is a 'fuel', which drives essential living processes and brings about chemical changes. Animals take in food, digest it, and use the products to build their tissues or to produce energy, but plants, apart from a few insect-eating species, do not appear to take in food. This is because plants find food sources in water and the air. This is known as photosynthesis.

Chlorophyll is a green substance found in the chloroplasts of plant cells. It absorbs sunlight and makes the energy from sunlight available for chemical reactions. Thus, chlorophyll converts light energy to chemical energy. Therefore photosynthesis is the building-up of food compounds from carbon dioxide and water by green plants using energy from sunlight, which is absorbed by chlorophyll. The products of photosynthesis are glucose and oxygen. There are many factors, which affect the rate of photosynthesis, including light intensity, temperature and carbon dioxide concentration. The maximum rate of photosynthesis will be constrained by a limiting factor.



The chemical equation for photosynthesis is:

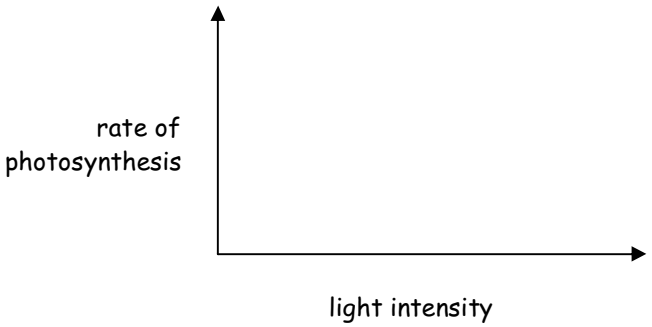


I am going to investigate what affect, if any, light intensity has on the amount of oxygen gas produced during photosynthesis. I am going to use anelectric lamp as my source of light and Canadian pondweed as, when placed in water, it gives off bubbles of gas from the cut end.

In my experiments it is important that only one condition is altered. For example, the method of keeping light from a leaf also cuts off its carbon dioxide supply. It would be impossible to decide whether it was the lack of light or the lack of carbon dioxide, which stopped the production of sugar. To make sure that no more than one condition is altered in my experiments I will set up a control in an identical situation but in darkness. I predict that the pondweed will not photosynthesis at all in darkness. To ensure a fair test I will use the same species and general size of the pondweed each time. I will also use the same set up of apparatus in each experiment and keep the water at the same temperature as a rise in temperature increases the rate at which carbon dioxide combines with hydrogen to produce carbohydrates. It is important to use the same lamp in each experiment as light wavelength (colour) can affect the rate of photosynthesis. Chlorophyll easily absorbs red and blue light but does not easily absorb green or yellow light; rather it reflects them, decreasing the amount of light absorbed, and therefore the rate of photosynthesis.

I am going to repeat my experiment three times so that I will be able to draw to a reliable conclusion. In each experiment I am going to investigate 5 different distances between the lamp and the rest of the apparatus. My chosen distances are 5cm, 10cm, 20cm, 30cm and 40cm. I will count the number of bubbles given off at each distance for 1minute. Between the changes in distance I will allow a settling period of 3minutes for the pondweed to adjust itself to the change in light intensity.

I predict that the greater the intensity of light the faster the rate of photosynthesis, as there will be more available light for the chlorophyll to convert the carbon dioxide and water into glucose and oxygen. I predict that to begin with as light intensity increases, the rate of photosynthesis will increase at a proportional rate until a certain level is reached, and the rate of photosynthesis will then go down. Eventually, a level will be reached where an increase in light intensity will have no further effect on the rate of photosynthesis, as there will be another limiting factor e.g. temperature. If I was draw a curve of light intensity against the rate of photosynthesis, this is how I predict it would look:



I predict that I won't be able to draw this curve with my results as I probably will not reach a high enough light intensity to level out my graph.

Preliminary

I completed a preliminary investigation to test my basic idea and equipment. I placed the pondweed 5cm away from the lamp. At first no bubbles were given off and so I decided to increase the temperature of the water from around 17°C to 25°C. The pondweed started to give off bubbles and I collected 17 in a minute. I then moved the lamp 10cm away from the equipment and collected 9 bubbles in a minute. After completing my preliminary investigations I decided that the water I use in my experiments should be at 25°C to encourage photosynthesis. Therefore all the water I use must be at 25°C to ensure a fair test. I didn't experience any other problems with the equipment used in my preliminary investigation and so I decided I was ready to begin my experiments.

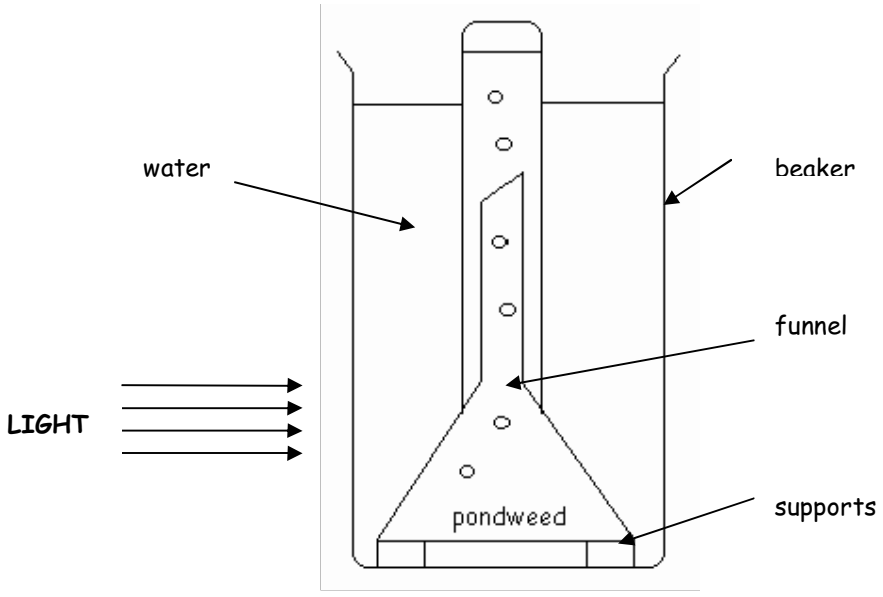
Practical – Obtaining my evidence

Aim: To discover what effect light intensity has on the rate of photosynthesis.

Apparatus: Canadian pondweed, funnel, supports, a test tube, a beaker, water at 25°C, a lamp, a ruler and a bung.

Method:

1) Fill a beaker with 700cm^3 of water at a temperature of 25°C.
2) Cut the Canadian pondweed into a 3cm segment.
3) Fill a test tube with water (also at 25°C) and put a bung into the end of it.
4) Place a funnel on supports and lower it into the beaker with the pondweed inside it so that the water within the beaker also fills the funnel. Ensure that the stem of the weed faces up the funnel, as the majority of the bubbles will be released from here.
5) Place the test tube of water over the funnel (shown below) ensuring that it is completely full of water to begin with.
6) Move the equipment the designated distance from the lamp and switch the light on.
7) Leave the equipment for a settling period of 3minutes for the weed to adjust to the light intensity.
8) Record the number of bubbles given off in 1minute.
9) Repeat this process for the 4 other distances between the equipment andthe lamp.
10) Repeat this experiment 3 times, recording all the results.



Results:

Distance from lamp	Result 1	Result 2	Result 3	Average Result
5cm	15	16	14	15
10cm	12	10	12	11.3
20cm	4	5	4	4.3
30cm	3	3	4	3.3
40cm	2	3	3	2.7

Conclusion: From my results I can conclude that the less light a plant receives the less oxygen that it produces, thus the slower its rate of photosynthesis. Therefore, light intensity does have an affect on the rate of photosynthesis within plants.

Analysis

In my plan I predicted that the higher the intensity of the light the faster the rate of photosynthesis as chlorophyll absorbs sunlight and uses the energy in chemical reactions e.g. photosynthesis in which it produces glucose and oxygen. Thus the more energy (light) that it receives the faster the rate of photosynthesis. My results prove this theory and support my conclusion. I also predicted that at a certain distance, even if the light became brighter, the pondweed would not photosynthesis any faster. In my experiments I did not reach a high enough intensity of light to prove this theory 100% but my results suggest that this may well be so.

My graphs are in the form of best-fit curves rather than straight lines as there was a clear pattern within my results. This meant that the rate of photosynthesis increased as the light intensity increased. This is because photosynthesis is a reaction, which needs energy from light to work, so as the amount of energy available increased with the rise in light intensity, so did the amount of oxygen produced. My graph shows that the relationship between the light intensity and the rate of photosynthesis was non-linear, as all my graphs produced best-fit curves. The gradual decrease in the increase of the rate of photosynthesis is because of other factors limiting the reaction. These factors do not immediately limit the rate of photosynthesis but gradually until the rate of photosynthesis becomes constant.

Evaluation

As my graphs show I experienced anomalies in my results. I believe this is because there were many points where my accuracy left a little to be desired. Firstly, the distance between the lamp and the Canadian pondweed was not measured to a high degree of accuracy. Ideally the distance should have been measured from the filament of the light bulb to the centre of the plant but this was not possible. Another inaccuracy was in the time keeping as there was often a small difference in when I began timing the minute, e.g. after the first bubble had been released or just before.

Overall even though my experiment was open to some inaccuracies I believe it was accurate enough to support my predictions. To improve my resultsI could simply increase the length of time I measure the number of bubbles released to 5minutes although I would have to ensure that the water remained at the same temperature throughout. One way of doing this would be to place a Perspex block between thelamp and the plant, which would absorb most of the heat, while allowing the light energy to pass through. Another way of increasing the reliability of my results would be to take more readings.

I would like to extend my investigations into light intensity and photosynthesis by investigating which colour of the spectrum produces the highest rate of photosynthesis and what effect halogen and fluorescent lights have on the rate of photosynthesis.

Sources:

G.C.S.E. Biology – D.G. Mackean
Biology – Mary Jones & Geoff Jones