

# BIOLOGY



# PHOTOSYNTHESIS

## EFFECT OF LIGHT ON THE RATE OF PHOTOSYNTHESIS

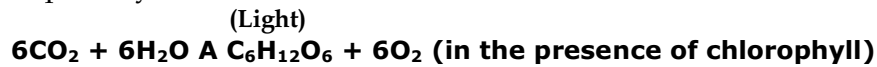
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## Aim

For my biology coursework I will be investigating the affect of light intensity on the rate of photosynthesis, at a determined distance. The investigation will be carried out with experiment using scientific techniques. I will then make possible predictions, which I will be, explaining using appropriate scientific knowledge.

## Background knowledge

Photosynthesis is light dependant reaction. In photosynthesis water splits to make hydrogen and oxygen. This stage needs light, so is called light reaction. The second stage of photosynthesis is called dark reaction three hydrogen combine with carbon dioxide to make glucose. In this stage enzymes are involved, so by looking at the equation below the factors which affect the rate of photosynthesis can be found which are:



- Light intensity
- Carbon dioxide
- Temperature

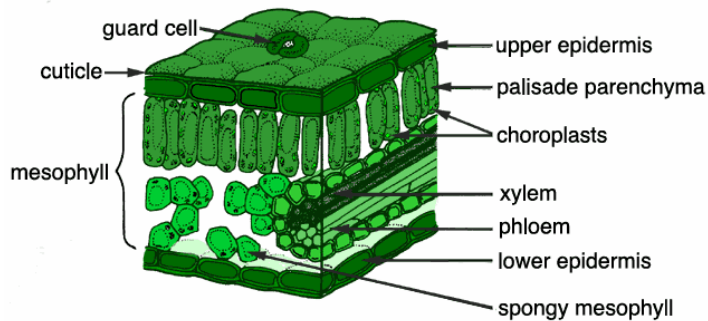
Each of the above factors is dependant on each other, therefore

Four things are needed for photosynthesis to happen.

- Light form the sun
- Chlorophyll, the green substance which is found in chloroplasts
- Carbon dioxide, enters the leaf form the air around
- Water comes from the soil, up the stem and into the leaf

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Photosynthesis takes place in the leaves of all green plants. The leaves are best for photosynthesis, because:

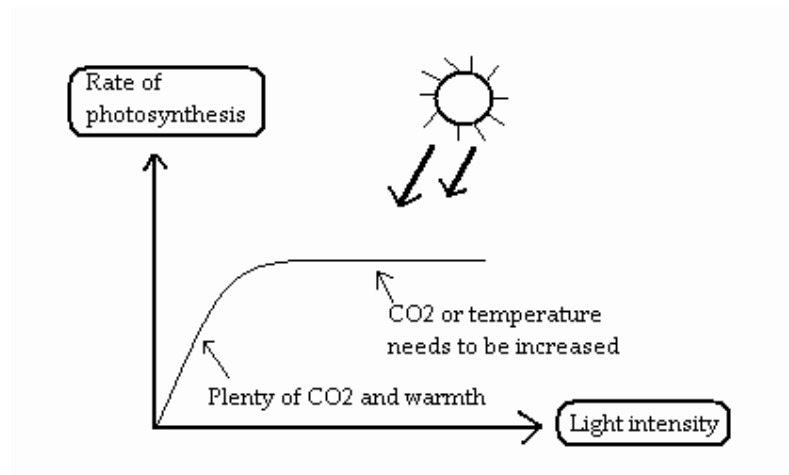


- Leaves are thin and flat to provide a large surface area to catch lots of sunlight.
- The palisade cells are near the top of leaf and are packed with chloroplasts.
- The guard cells control the movement of gases into and out of the leaf.

### Light intensity

Temperature, carbon dioxide and light intensity are factors that affect the rate of photosynthesis. At any given time one or other of the three factors will be the limiting factors, which are keeping the photosynthesis down at the rate, it is.

The chlorophyll uses light energy to perform photosynthesis. It can only do it as fast as the light energy is arriving.



Rates of photosynthesis investigation

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1) As the light level is raised, the rate of photosynthesis increases steadily but only up to a certain level.

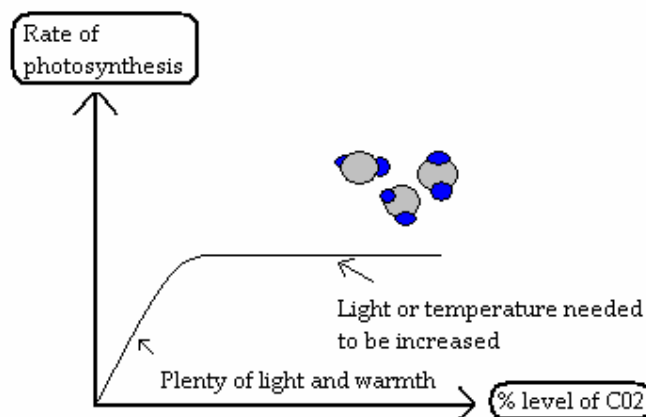
2) Beyond that, it won't make any difference because then it will either be the temperature or the carbon dioxide level, which is the limiting factor.

Ordinary white light (sunlight) is made up of different colour lights of different wavelengths. Chlorophyll absorbs blue and red light, but reflects green light (which is why chlorophyll looks green). When growing plants in artificial light (e.g. indoor), it is important that they get enough blue and red light. (Special lights.)

Very bright sunlight can actually damage plants, because of the ultraviolet rays.

### Carbon dioxide

Carbon dioxide, this is one of the key ingredients for photosynthesis. Carbon dioxide and water are the raw materials. Water is never really in short supply in a plant but only 0.035 of the air around is carbon dioxide so it is scarce to a plant.



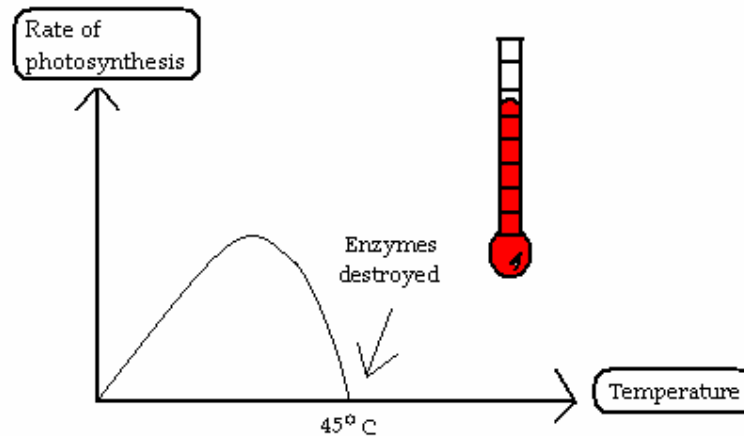
1) As with light intensity the amount of carbon dioxide will only increase the rate of photosynthesis up to point. After this the graph flattens out showing that carbon dioxide is no longer the limiting factor.

2) As long as light and carbon dioxide are plentiful supply then the factor limiting photosynthesis must be temperature.

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## Temperature

Enzymes usually work faster at higher temperature. Chlorophyll is like an enzyme, it works best when it is warm but not too hot. The rate of photosynthesis depends on how well the chlorophyll is: warm but not too hot.



- 1) Note that you can't really have too much light or carbon dioxide. The temperature however must not get too high or it destroys the chlorophyll enzyme.
- 2) This happens at about 45°C
- 3) Usually, if the temperature is limiting factor it's because it's too low.

Plants will photosynthesis faster on a hot day than a cold day, but if the temperatures get too hot the stomata close to prevent water loss. This means photosynthesis slows down or stops because carbon dioxide cannot diffuse in.

The optimum rate of photosynthesis occurs when temperature, light and carbon dioxide availability are all optimal. If any one of these three factors is reduced, the rate of photosynthesis is reduced. The external factors that restrict the effects of the others are called the limiting factor

## Prediction

For this investigation I predict:

*Increasing the light intensity, will increase the rate of photosynthesis.*

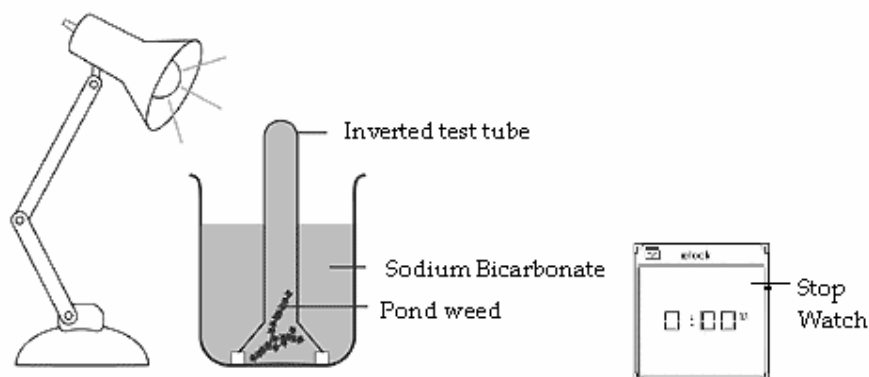
This is because Chlorophyll uses light energy to perform photosynthesis. It can only do this as fast as the light energy is arriving. The rate of photosynthesis will increase up to a certain limit because after this either the temperature or the carbon dioxide level, will be the limiting factor.

If the light provided is decreased then less light will be arriving, hence *Decreasing the light intensity will decrease the rate of photosynthesis,* because now the chlorophyll is using less light energy to perform photosynthesis.

## Experiment: Light intensity

### Apparatus

- ⊕ Inverted test tube
- ⊕ Pond weed
- ⊕ Sodium bicarbonate
- ⊕ Metre ruler, to measure the distance
- ⊕ Bench lamp
- ⊕ Stop watch
- ⊕ Lab coat
- ⊕ goggles



### Method

- ⊕ Place a pond weed in sodium bicarbonate.
- ⊕ Invert a test tube in the solution of sodium bicarbonate, so the pond weed is trapped

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- ⊕ Pace the lamp (the only light source) at predetermine distance from the plant.
- ⊕ Allow the plant to adjust to the new condition.
- ⊕ Start the stop watch, count the number of oxygen bubbles given off by the pond weed in a five-minute period.
  - Repeat the count twice more and calculate the average of the readings
  - This is the rate of photosynthesis at a particular light intensity from the pond weed.
  
- ⊕ Repeat the experiment with different powered bulbs (using different powered bulbs) with a fixed distance.
- ⊕ Record the readings.

### **Safety measures**

Safety measures were an important part of our experiment. Therefore before carrying out the experiment I took number of things in consideration:

1. I wore a lab coat to prevent any damage to my skin and cloths.
2. I wore gloves to prevent harmful corrosive, irritant, toxic substance to come in contact with my skin.
3. I wore goggles to prevent any chemical gasses from entering my eyes.
4. I wore a cap to keep my hair away form our mouth and face, especially eyes, because it can cause disturbance.
5. I made sure that their weren't any objects on the floor, because that can cause a student to trip over and result in an injury.
6. I handled glass equipment with care.
7. I made sure that I was tidy, and didn't have any books or personal belongings in the area where I was carrying out the experiment.
8. I also made sure that I didn't leave unclamped piece of apparatus, where it can easily be knocked off.

### **Fair test**

In order to get accurate and reliable results, I made sure that the experiment I was carrying out was fair. We took number of things in to consideration.

1. I carried out each experiment twice to get an average and also make my result more reliable.
2. Since I was only investigation the affect of light intensity on the rate of photosynthesis, I performed the experiment in the same room, so the experiment is given the same temperature, in which the experiment can be carried out, This was because, the temperature can cause the

rate of photosynthesis to change, as it is one of the factor that affect the rate of photosynthesis.

3. I allowed the pond weed to adjust to the new conditions.
4. I kept the quantity of sodium bicarbonate same throughout the experiment, as this can cause the rate of photosynthesis to change.
5. I also kept the same pond weed throughout the experiment, using different pond weed will have different surface exposed to light, which would cause the rate of photosynthesis to change, because there will be more/less surface area.
6. I made sure that the same distance was used through out the experiment, as using different distance can increase/decrease the amount of light being absorbed by the pond weed, hence can cause the rate of photosynthesis to change.

### **Table of results**

Below is a table showing the results obtained form the experiment.

**Table 1: Rates of photosynthesis at a distance of 5 cm, when varying the light intensity.**

Experiment number	Bulb power (volts)	Number of bubbles given off: <u>First time</u>	Number of bubbles given off: <u>Second time</u>	Number of bubbles given off: <u>Third time</u>	Average bubbles (in 5-minutes)
1	20v	1	1	1	1
2	40v	1	3	2	2
3	60v	1	1	1	1
4	80v	4	2	3	3
5	100v	6	3	3	4
6	140v	7	5	3	5
7	160v	6	6	3	6

Note: in analysis and evaluation section the statistics worked out refer to the average results, as they are the most reliable and accurate.



## Analysis

I have decided to show my results in a table, because a give me an opportunity to organise my data in to groups. The table also helps me to simplify and analyse my information.

I have then decided to draw a line graph using my results, because a line graph is simple way of showing a change. It is also the best way of showing trends and relationships, between two dimensions. The data is also continuous that's why line graph is most appropriate.

The graph one shows the numbers of bubbles given out (rate of photosynthesis) at a distance of 5 cm, when varying the bulb power (Light intensity).

The line of best fit on graph shows a positive correlation. This shows when a higher powered bulb is used the number of bubbles given out are increased. The line of best fit shows the trend. The graph shows when a 160volts bulb is used, at a 5 cm distance, the average bubbles given out are 6.

This suggests that, *increasing the light intensity will increase the rate of photosynthesis*, hence proves my prediction.

This is because; chlorophyll uses light energy to perform photosynthesis. It can only do this as fast as the light energy is arriving. Providing more light intensity, will allow the chlorophyll to absorb light faster, resulting in a faster rate of photosynthesis.

The rate of photosynthesis increases up to certain limit because after this either the temperature or the carbon dioxide level, will be the limiting factor.

Similarly, the graph show if a low powered bulb is used the number of bubbles given out are decreased. The line of best fit shows the trend.

The graph shows when a 20 volt bulb is used, at a 5cm of distance, the average bubble given of is only 1.

This suggests that, *decreasing the light intensity will decrease the rate of photosynthesis*, hence proves my prediction.

This is because: providing less light intensity, allow the chlorophyll to absorb light slowly, and resulting in a slower rate of photosynthesis.

The graph shows that as the number of bubbles is increased, the rate of photosynthesis increases steadily, but only up to a certain limit, because after this either the temperature or the carbon dioxide level, will is the limiting factor.

## Evaluation

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The method I used to was good, but could have been better, as there was one anomalous result, my graph and my table supports this. There was one anomalous, as shown on the graph, which may have resulted from a human error, made during the experiment. This may be because; the pond weed may have been tiered, when the test tube was inverted in the solution, to trap the pond weed, which may have caused a decrease in the surface area of pond weed, being exposed to light, resulting a change of rate of photosynthesis. The anomalous result might also have occurred, because during the experiment, I may have not given the pond weed enough time to adjust to the new conditions. The same distance might not have been used.

I could have improved my method, by not rushing and giving myself and partner a fixed duty, so that the time of experiment could have been shortened. To get an unbiased results make sure that conditions for the experiment are kept the same thought out the experiment, including the pond weed and the distance, as this can cause the rate of photosynthesis to change.

My results were realisable, excluding the anomaly. They proved my prediction. To make my results more reliable I could have also investigated, how does varying the distance affect the rate of photosynthesis at a fixed power bulb.

I could carry out further work to get more results that would be relevant to rate of photosynthesis investigation. I could investigate the other two factors that affect the rate of photosynthesis. These are temperature and carbon dioxide. I could use the pond weed in sodium bicarbonate and apply different temperature, and record the number of bubbles given out at different temperature. The evidence I should get is, increasing the temperature to an appropriate degree, increases the rate of photosynthesis. I can also apply different amount of carbon dioxide to the pond weed in sodium bicarbonate, and record the bubbles given out, when different amount of carbon dioxide is applied. The evidence I should get is, as more carbon dioxide is applied to the bond weed the rate of photosynthesis increases.

### Bibliography

- ⊕ [www.rateofphotosynthesis.com](http://www.rateofphotosynthesis.com)
- ⊕ [GCSE biology CGP book](#)
- ⊕ [Diagrams: www.google.com](#)