Background Knowledge

Photosynthesis is a chemical reaction used by photosynthetic plants in order to make glucose. Displayed below, are the word and balanced symbol equations for the photosynthesis reaction.

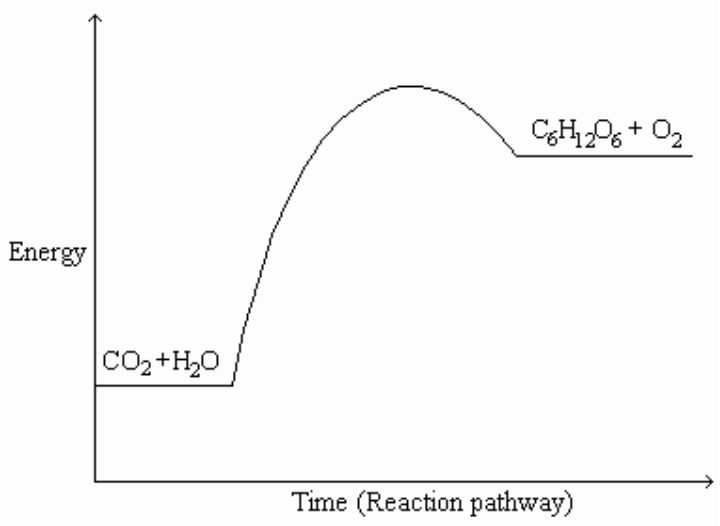
			catalysed by chlorophyll			
Carbon dioxide	+	Water	→	Glucose	+	Oxygen
$6CO_2(g)$	+	$6H_2O(l)$	→ sunlight	$C_6H_{12}O_6(aq)$	+	$6O_2$

The photosynthesis reaction converts carbon dioxide and water into glucose and oxygen.

The green pigment in the chloroplasts, called chlorophyll, acts as the catalyst in the photosynthesis reaction.

It can be seen from the reactions, that the energy of the chemical bonds on the left-hand side of the equation is less than the energy of the chemical bonds on the right hand side; therefore the reactants must take in energy before the reaction can take place. This energy is provided by sunlight.

The diagram below would correctly describe the photosynthesis reaction as plants take in the Sun's energy:

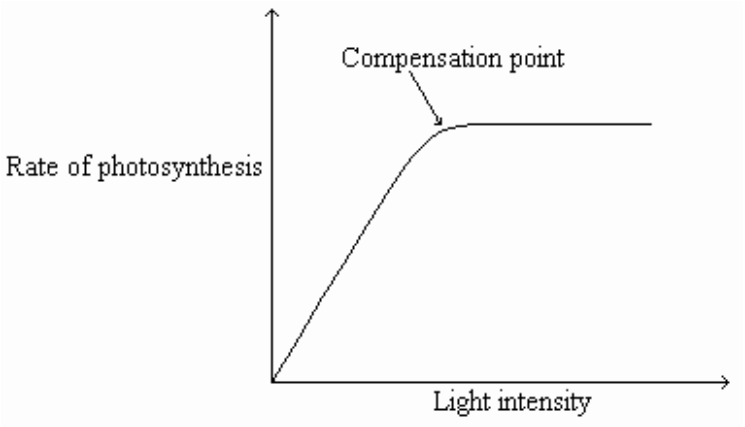


As with all chemical reactions, the photosynthesis reaction has certain factors that affect the rate of the reaction. These factors can be adjusted to deliver conditions under which the reaction will take place most efficiently. These conditions are referred to as the optimum conditions.

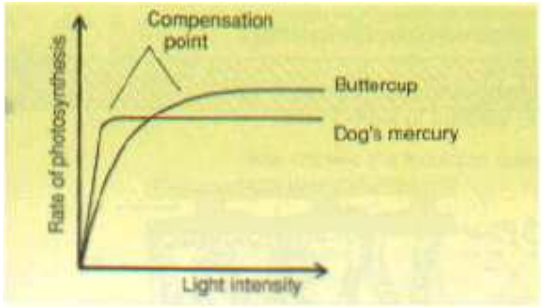
There are several factors that affect the rate of the photosynthesis reaction. These factors include the intensity of light, the concentration of carbon dioxide (CO_2) in the surrounding air, amount of water that the plant is provided with, temperature of the surrounding environment, wavelength of light that the plant receives.

Factors affecting the rate of the photosynthesis reaction

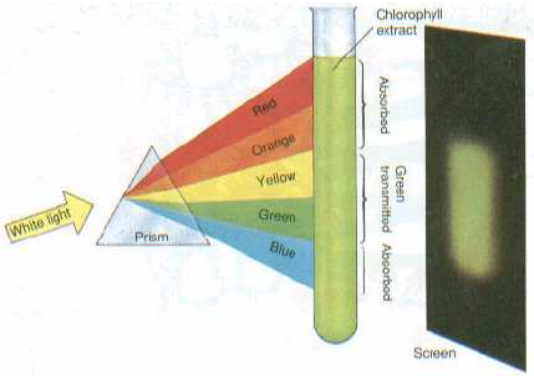
- The intensity of light that is provided to the plant is a factor that affects the rate of the reaction of photosynthesis. As mentioned before, the chemical bonds of the reactants have less energy than those of the products. Therefore, more energy is needed before the reaction can take place, this energy is generally provided by the sun in the form of light, however the light energy can also be provided by artificial means i.e. lamplight etc.
  The general relationship between the intensity of light and the rate of the photosynthetic reaction is that the rate of reaction increases as the intensity of light is increased. However, once a particular light intensity is reached, the rate of reaction remains constant, even if the intensity of light is increased further. The point at which the light intensity no longer has an affect on the rate of the photosynthetic chemical reaction is called the compensation point. The compensation point varies in different species of plant; this is because certain plants have adapted to their environment.
  The diagram below displays the general relationship between light intensity and the rate of photosynthetic reactions:
  It can be seen from the diagram below, that until the compensation point, the rate of reaction is proportional to the light intensity.



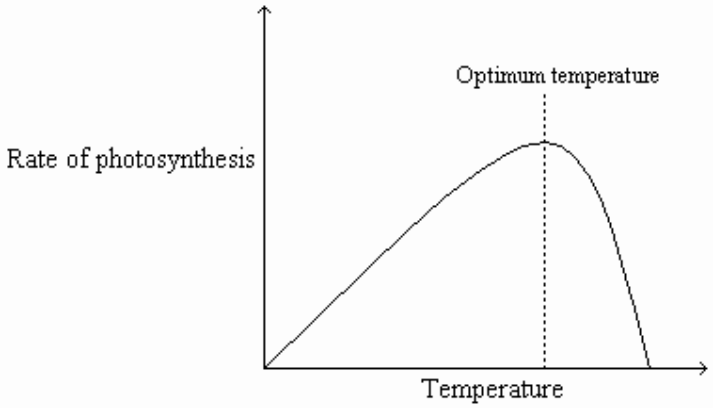
An example of how light intensity affects the plants: Buttercups and Dog's mercury is given below in the form of a graph:



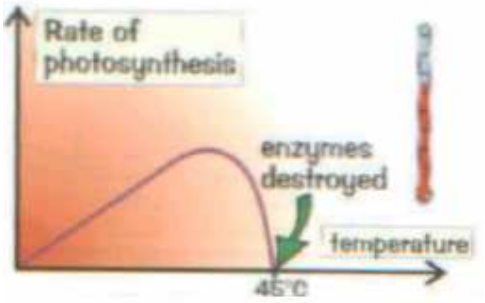
- The wavelength of light that the plant receives is also an affective factor of the rate of photosynthesis. The catalyst (chlorophyll) requires light energy in order to function, but in order to function efficiently; chlorophyll prefers light of red and blue wavelengths. This is why we find that photosynthetic plants are green; the chlorophyll in the chloroplasts absorbs the red and purple/blue colours and reflects the unneeded green colour. This can be shown by using a spectrum of white light and chlorophyll:



- As it does with most chemical reactions, temperature also affects the rate of reaction for photosynthesis. This is because all catalysts have a certain temperature range at which they function most efficiently. The catalyst in the photosynthesis reaction is chlorophyll, a green pigment in the chloroplasts. Chlorophyll is an enzyme so it works best when its war but not too hot. In order for this catalyst to work efficiently the optimum temperature is required. Obviously the more efficiently the catalyst functions, the higher the rate of reaction would be. The optimum temperature may differ slightly from plant to plant depending on the climate that the plant is adapted to. The illustration below shoes the general relationship between the temperature and the rate of photosynthesis:



The graph below shows a general graph for how photosynthesis is affected by temperature:



As we can see the graph shows us that as the temperature increases, so does the rate of photosynthesis, until a certain point. This is the optimum temperature. After this point as the temperature is increased, the rate of photosynthesis decreases and then at a certain point the enzymes are destroyed and the chlorophyll can no longer carry out its task. For this particular organisms/plant the enzyme becomes **denatured** at 45°C.

- Another factor that affects the rate of photosynthesis is the concentration of carbon dioxide present in the air surrounding the organism/plant. Carbon dioxide (CO_2) is one of the reactants in the photosynthesis chemical reaction. It is therefore necessary that there is sufficient amount of carbon dioxide in the air in order to make enough glucose.
  As with light intensity and temperature, there is a limit to the amount of carbon dioxide that the plant can use during the reaction. Thus, at a certain point, an increase in the level of carbon dioxide concentration would no longer affect the rate of photosynthesis.

- The amount of water that the plant is provided with is another factor that would affect the rate of a photosynthesis reaction. This is because water (H_2O), like carbon dioxide, is also a reactant in the reaction of photosynthesis. Hence, a lack of water would result in a lack of produce and the rate of reaction would not be sufficient in order for the organism to survive.

Photosynthesis is a very important process in nature. It is the production of energy in the form of glucose involving water from the soil, carbon dioxide from the air and light energy from the sun. It takes place in all green plants, which use the green chlorophyll, held in chloroplasts in the leaves, to trap light. The main site of photosynthesis is the palisade cells in the leaf of a plant. It is these cells that contain the green chloroplasts and are very well adapted to their task. They are near the upper side of the leaf where they can obtain the maximum amount of light and are packed very closely together.

Plants photosynthesise to produce food chemicals that are needed to allow them to grow. The main reaction is to produce oxygen and glucose to be changed into energy during respiration. Glucose is stored in the form of starch, which is insoluble and does not affect the osmosis taking pace in the plant. As plants respire both day and night this starch is often used up during the night when photosynthesis cannot take place. The uses of glucose within the plant are for active transpiration, cell division, the production of protein and the production of cellulose.

In photosynthesis the raw materials are carbon dioxide and water. They react to form the products of the reaction - oxygen and glucose. The reactions need energy and this comes from sunlight. The green chloroplasts allow light to be used as energy and therefore both of these things are like helpers in the reaction. Glucose is formed firstly then turned into starch to be stored up for when it is needed. Although photosynthesis is a complicated process it can be summed up in this equation:

Carbon dioxide	+	Water	→ (catalysed by chlorophyll, sunlight)	Glucose	+	Oxygen
$6CO_2(g)$	+	$6H_2O(l)$	→	$C_6H_{12}O_6(aq)$	+	$6O_2$

It is important to the reaction that certain factors are present when it is occurring. We know that these are carbon dioxide, water, light and chlorophyll. Without these the reaction will not take place at all, but some of them also determine how quickly the reaction takes place. Water, carbon dioxide and light, along with temperature, all have a particular effect on the rate of photosynthesis. In terms of carbon dioxide the levels in the atmosphere do not really alter very much, but if gardeners wish to increase the rate of photosynthesis then sometimes carbon dioxide is pumped into greenhouses.

Up to a certain point as temperature goes up so does the rate of reaction. After it reaches a certain point though the enzymes involved in the reaction become denatured and stop working properly.

A decrease in the amount of water present may cause photosynthesis to occur at only half the normal rate. The reason for this is the stomata are being closed.

The final factor that contributes is light. The chlorophyll uses light energy to perform photosynthesis. It can only photosynthesis while the chloroplasts are absorbing the light they are receiving. Chlorophyll only absorbs the red and blue ends of the visible light spectrum, the green light in the middle is reflected back.