Limiting Factors of Photosynthesis

- Light intensity, carbon dioxide (CO2) concentration, temperature and amount of chlorophyll have a combined affect on the rate of photosynthesis.

- If there is a problem with these factors, they can limit the rate of photosynthesis – they become the limiting factor:

  - **At night:** it is dark, so light becomes the limiting factor. If there was more light, photosynthesis would happen quicker.
  - **In winter:** it is cold, so temperature becomes the limiting factor. If the temperature was warmer, photosynthesis would happen quicker.
  - **In sunny and warm days:** light intensity and temperature levels are both high so CO2 concentration becomes the limiting factor. Increasing CO2concentration would increase the rate of photosynthesis.
  - **Diseased plants:** may have less chlorophyll so will not be able to absorb as much light for photosynthesis. This means the amount of chlorophyll is the limiting factor.

Factors that Affect Photosynthesis

- For photosynthesis a plant needs light, water and carbon dioxide

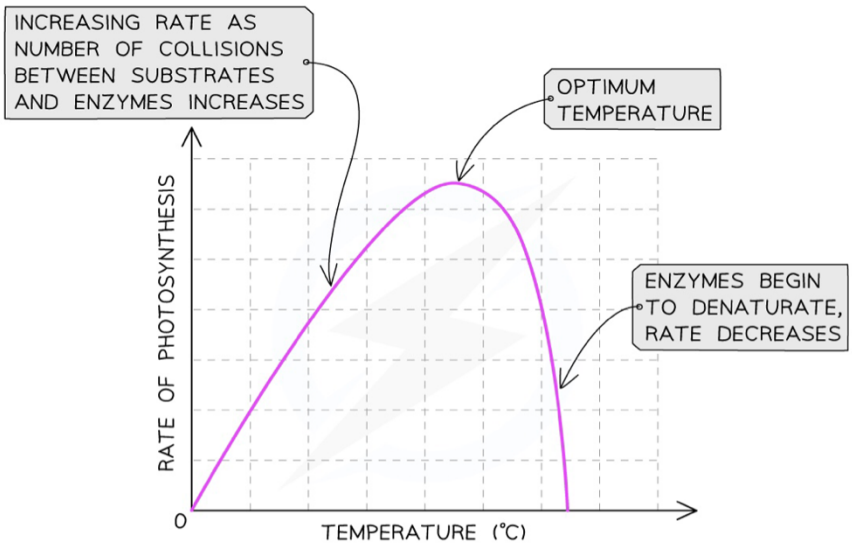
- The availability of light and carbon dioxide can affect how much and how quickly (the rate) photosynthesis occurs
- Although water is necessary for photosynthesis, it is **not considered a limiting factor** as the amount needed is relatively small compared to the amount of water transpired from a plant.
- Other environmental factors such as temperature and the amount of chlorophyll in the chloroplasts can also affect the **rate** of photosynthesis

1- Heat/ Temperature:

- The temperature of the environment affects how much **kinetic energy** all particles have – so temperature affects the speed at which carbon dioxide and water move through a plant

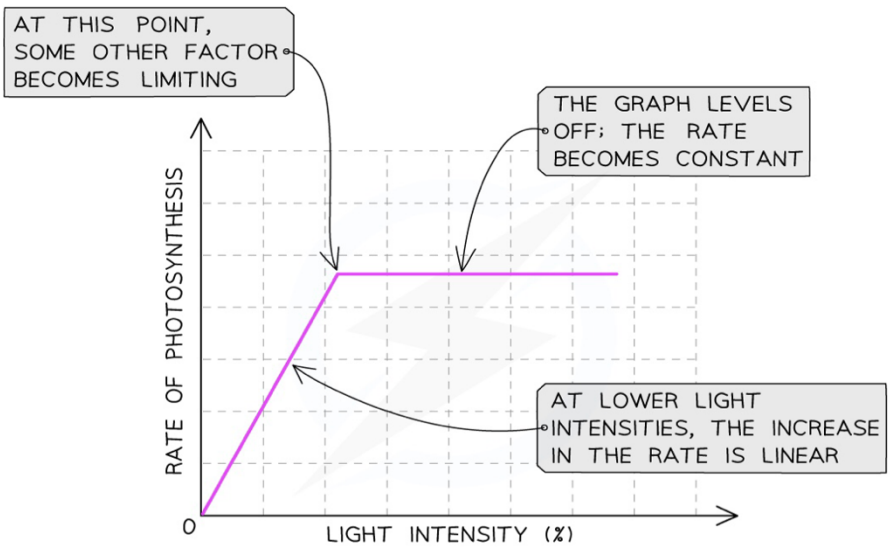
- The lower the temperature, the less kinetic energy particles have and resulting in fewer **collisions** occurring?
- Increasing temperature increases the kinetic energy of particles, increasing the likelihood of collisions between reactants and enzymes which results in the formation of products

- At higher temperatures, however, enzymes that control the processes of photosynthesis can be **denatured**



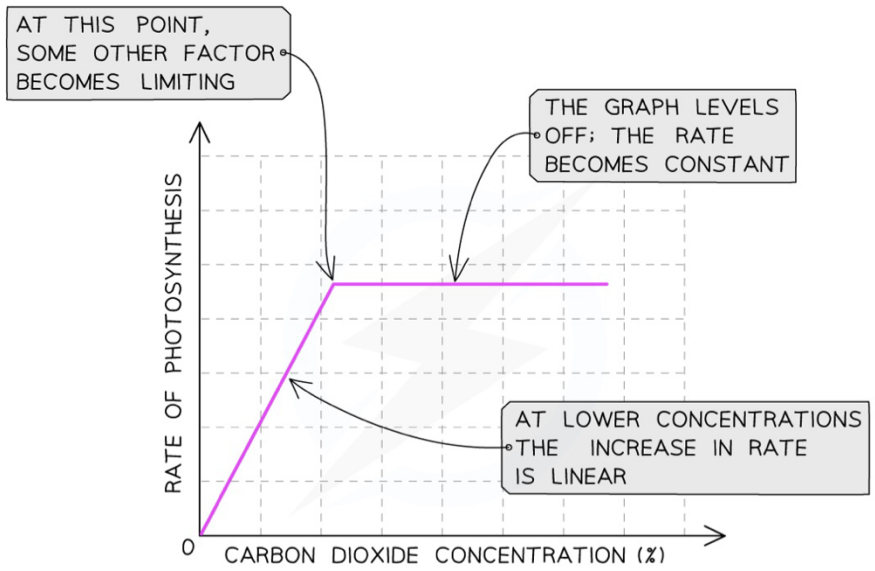
2- Light:

- The **intensity** of the light available to the plant will depend on the amount of energy that it has to carry out photosynthesis
- The **more light** a plant get, the **faster** the rate of photosynthesis



3- Carbon dioxide concentration:

- Carbon dioxide is one of the raw materials required for photosynthesis
- the **more carbon dioxide** that is present, the **faster the reaction** can occur



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Techniques used by Farmer for faster growing

- Farmers use these techniques to make their crops grow faster and stronger, increasing their crop yields and making more money. However, controlling all of the factors on a large scale can be very expensive.
- It is important that the increase in crop yield is enough cover the costs of the greenhouse while also making a profit.
- Farmers will provide their crops with the optimum amounts of heat, light etc. but no more than that, as this would be wasting money.

Multiple Factors Affecting Rate of Photosynthesis

1- Light Intensity and Temperature

- In the graph, CO2 concentration is constant, so the effect of light intensity and temperature on photosynthesis is shown.
- As you increase light intensity, rate increases until we reach a plateau, after which light is no longer the limiting factor.

- As you increase temperature (shift from 20ºC to 30ºC), the rate increases. Also, the light intensity effect plateau's at a higher level, so light intensity is a limiting factor for longer.

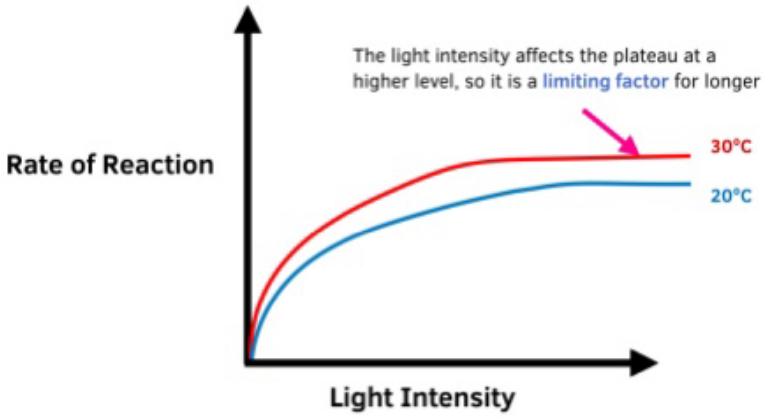

Fig 4. Affect of Light Intensity and Temperature on the Rate of Photosynthesis.

2- Light Intensity and CO2 concentration

- In the graph, temperature is constant, so the effect of light intensity and carbon dioxide concentration on photosynthesis is shown.
- As you increase light intensity, rate increases until we reach a plateau, after which light is no longer the limiting factor.
- As you ice increase CO2 (shift from 0.05% to 0.5%), the rate increases. Also, the light intensity effect plateau's at a higher level, so light intensity is a limiting factor for longer.

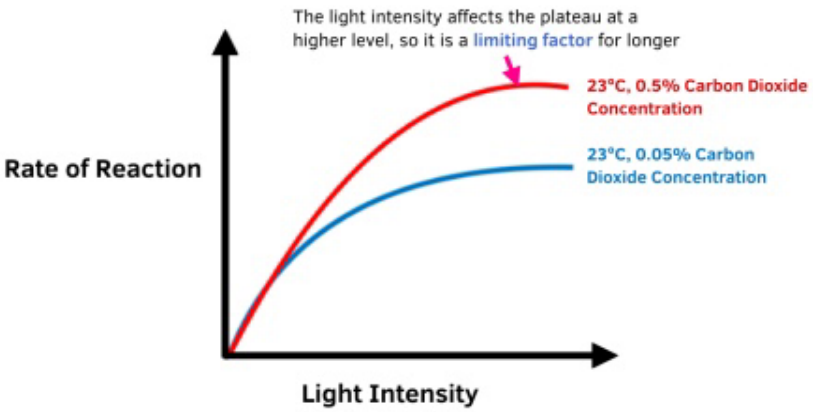

Fig 5. Affect of Light Intensity and CO_2 Concentration on the Rate of Photosynthesis.