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Rate of photosynthesis

The rate of photosynthesis changes depending on a number of different, interacting factors.

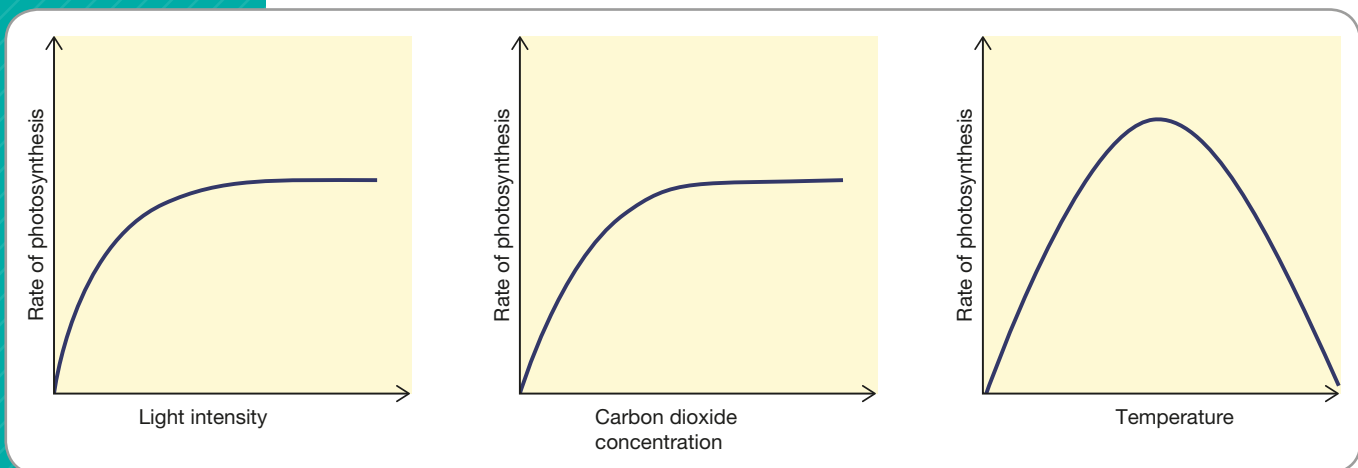
Factors that affect the rate of photosynthesis

The rate of photosynthesis increases if:

- the temperature increases (up to an optimum temperature)
- light intensity increases
- carbon dioxide concentration increases
- the amount of chlorophyll increases.

Limiting factors

The rate of photosynthesis can be measured by measuring the volume of oxygen produced by a plant in a certain time, under certain conditions. The shape of the graph for each condition is shown below:



SNAP IT!

Copy out these graphs and take a photo to help you learn their shapes.

Effect of light and carbon dioxide

As the light intensity, or the carbon dioxide concentration increases, the rate of photosynthesis increases, until a certain point. After this point, the rate of photosynthesis remains constant. That is because one of the other factors is limiting the rate of photosynthesis. This is called the **limiting factor**. For example, in the first graph, as the light intensity increases and rate of photosynthesis increases, light intensity is the limiting factor. When the rate of photosynthesis no longer increases some other factor (such as the concentration of carbon dioxide) has become the limiting factor.

Effect of temperature

As the temperature increases, the rate of photosynthesis increases, until the **optimum** temperature for the enzymes and proteins that carry out photosynthesis is reached. Above this temperature, the enzymes and proteins begin to **denature** and can no longer carry out their function. Therefore the rate of photosynthesis decreases.

Measuring the rate of photosynthesis

In an experiment, the volume of oxygen given off by a plant is measured over time. The rate of photosynthesis can be calculated by dividing the volume of oxygen collected over time:

$$\text{Rate of photosynthesis} = \frac{\text{volume of oxygen}}{\text{time}}$$

WORKIT!

12 cm³ of oxygen is collected in 3 minutes. Calculate the rate of photosynthesis. (3 marks)

$$\text{Rate of photosynthesis} = \frac{12 \text{ m}^3}{3 \text{ min}} = 4 \text{ cm}^3/\text{min} \text{ (3)}$$

H The inverse square law and light intensity in photosynthesis

In an investigation into the effect of light on the rate of photosynthesis, a lamp is moved away from the plant. As the distance from the plant increases, the light intensity decreases. The light intensity is **inversely proportional** to the square of the distance.

Increasing the rate of photosynthesis

Farmers need to increase the rate of photosynthesis in plants in order to increase the yield (the volume of plants, fruit or vegetables produced). They do this by:

- growing plants in a greenhouse to increase the temperature
- increasing the hours of light by switching lights on at night
- increasing the amount of carbon dioxide inside the greenhouse.



NAILIT!

Remember to include units when you answer a question.



STRETCHIT!

Read up on the greenhouses at Thanet Earth to get an idea of how photosynthesis is controlled to increase the yield of tomatoes.



CHECKIT!

- 1 Explain the term 'limiting factor'.
- 2 Describe and explain what would happen to the rate of photosynthesis if the carbon dioxide concentration were decreased.
- 3 Calculate the rate of photosynthesis if 28 cm³ of oxygen is collected in 4 minutes.