

# 4.1.2 Rate of photosynthesis

## AQA GCSE Biology (Higher) Question and answer notes

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### How to use these notes

These notes cover everything you need to know for this part of the specification. They have been written in question-answer format to make them easier for you to study from.

In order to study successfully, I recommend you do the following for each question and answer:

- Read it carefully and make sure you **understand** it.
- **Memorise** the answer.
- **Practice** applying your understanding to past exam questions.

A good way to memorise information is to use **retrieval practice**. This is when you practise retrieving information from your memory. You could do this by making a flashcard for each question with the question on one side and the answer on the other. Or you could use a flashcard app. Alternatively, use a sheet of paper to cover up the answer so you can only see the question. Try to answer the question and then check how you did.

You should practise retrieving each answer from your memory until you can do it perfectly. Even once you can retrieve the answer perfectly, your ability to retrieve it will probably fade as time passes without practising. Therefore you will need to keep going back to the questions that you have previously mastered and practising them again. However, each time you re-learn the answer, the memory will be stronger and will last longer than the time before.

### Which factors affect the rate of photosynthesis?

The following factors affect the rate of photosynthesis:

- Temperature
- Light intensity
- Carbon dioxide concentration
- The amount of chlorophyll in the photosynthetic organism

**What is meant by the term ‘limiting factor’ when talking about photosynthesis?**

The rate of photosynthesis is affected by three aspects of the environment: temperature, light intensity and carbon dioxide concentration. At any point in time for a particular photosynthetic organism, one of these factors will be the one that is limiting the rate of photosynthesis. This is called the limiting factor.

**What happens to the rate of photosynthesis when a factor that is not the limiting factor is increased?**

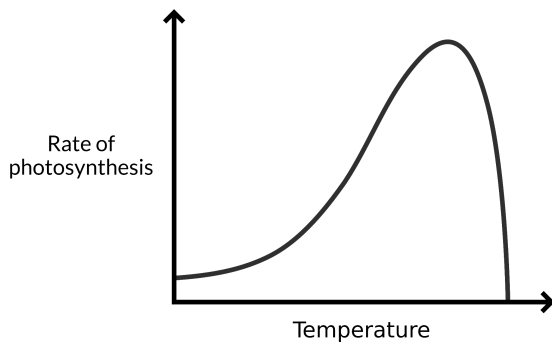
When a factor that is not the limiting factor is increased, the rate of photosynthesis does not change. For example, if light intensity is the limiting factor then increasing the temperature or the carbon dioxide concentration will have no effect on the rate of photosynthesis.

**What happens to the rate of photosynthesis when the limiting factor is increased?**

When the limiting factor is increased, the rate of photosynthesis will increase. If the limiting factor continues to increase, it will eventually stop being the limiting factor, at which point the rate of photosynthesis will stop increasing. For example, if light intensity is the limiting factor, then increasing the light intensity will increase the rate of photosynthesis. But eventually temperature or carbon dioxide concentration will become the limiting factor, at which point increasing the light intensity will have no further effect on the rate of photosynthesis.

**Describe the effect of temperature on the rate of photosynthesis.**

Initially, as the temperature increases, the rate of photosynthesis increases. However, above a certain temperature the rate of photosynthesis falls steeply to zero with increasing temperature.

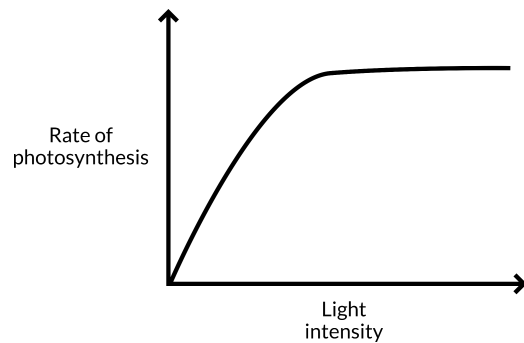


**Explain the effect of temperature on the rate of photosynthesis.**

As the temperature increases, the kinetic energy of the reactants (carbon dioxide and water) and the photosynthetic enzymes (the enzymes that control photosynthesis) increases. Therefore, they collide more frequently, leading to a faster rate of photosynthesis. However, above a certain temperature the photosynthetic enzymes become denatured meaning that they can no longer catalyse the photosynthetic reaction, so the rate of photosynthesis falls to zero.

**Describe the effect of light intensity on the rate of photosynthesis.**

Initially, as the light intensity increases the rate of photosynthesis increases. However, above a certain light intensity, there is no further increase in the rate of photosynthesis.

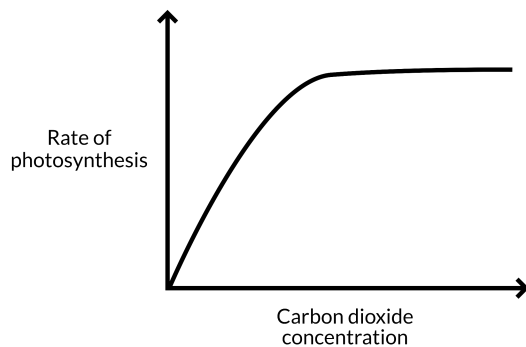


**Explain the effect of light intensity on the rate of photosynthesis.**

Energy from light is used to drive the photosynthetic reaction. Therefore the higher the light intensity, the more energy is available for photosynthesis. At low light intensities, light intensity is the limiting factor so increasing the light intensity increases the rate of photosynthesis. However, above a certain light intensity something else (temperature or carbon dioxide concentration) becomes the limiting factor, so increasing the light intensity has no effect on the rate of photosynthesis.

**Describe the effect of carbon dioxide concentration on the rate of photosynthesis.**

Initially, as the carbon dioxide concentration increases the rate of photosynthesis increases. However, above a certain carbon dioxide concentration, there is no further increase in the rate of photosynthesis.



**Explain the effect of carbon dioxide concentration on the rate of photosynthesis.**

Carbon dioxide is needed for photosynthesis because it is one of the reactions for the photosynthetic reaction. At low carbon dioxide concentrations, carbon dioxide concentration is the limiting factor so increasing the carbon dioxide concentration increases the rate of photosynthesis. However, above a certain carbon dioxide concentration something else (temperature or light intensity) becomes the limiting factor, so increasing the carbon dioxide concentration has no effect on the rate of photosynthesis.

**Describe the effect of the amount of chlorophyll on the rate of photosynthesis.**

The greater the amount of chlorophyll, the faster the rate of photosynthesis.

**Explain the effect of the amount of chlorophyll on the rate of photosynthesis.**

Chlorophyll is a pigment used to capture light energy for photosynthesis. The more chlorophyll a photosynthetic organism has, the more light energy it can capture and therefore the faster the rate of photosynthesis.

**What is the mathematical relationship between light intensity and the distance from the light source?**

Light intensity is inversely proportional to the square of the distance from the light source:

$$\text{Light intensity} \propto \frac{1}{(\text{distance})^2}$$

or

$$\text{Light intensity} = \frac{k}{(\text{distance})^2}$$

where k is a constant.

(Note: inverse proportion is covered in GCSE maths, so if you're not sure what this means look up this topic in your maths textbook or online, or ask your maths teacher).

**How can an understanding of limiting factors help a person who is trying to grow plants in a greenhouse?**

If a person who is trying to grow plants in a greenhouse understands limiting factors, they can use this understanding to identify which factor is the limiting factor in their greenhouse and then focus on increasing that factor. For example, if they find out that the limiting factor in their greenhouse is the temperature then it will know that it would be a waste of money to try to increase the carbon dioxide concentration since this will not lead to the plants growing more. Instead, they will know to focus on finding ways to increase the temperature.