

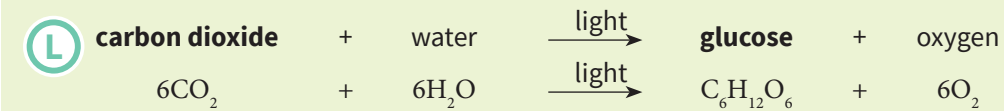
Chapter 8: Photosynthesis

Knowledge organiser

Photosynthetic reaction

Photosynthesis is a chemical reaction in which energy is transferred from the environment as light from the Sun to the leaves of a plant. This is an **endothermic** reaction.

Chlorophyll, the green pigment in **chloroplasts** in the leaves, absorbs the light energy. Leaves are well-adapted to increase the rate of photosynthesis when needed.



Rate of photosynthesis

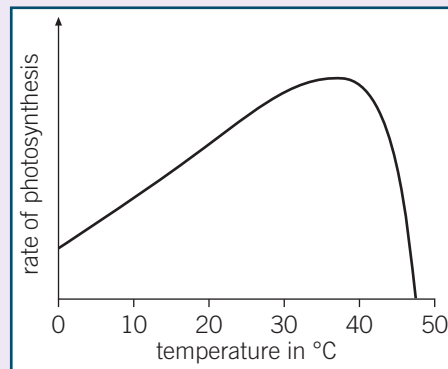
A **limiting factor** is anything that limits the rate of a reaction when it is in short supply.

The limiting factors for photosynthesis are

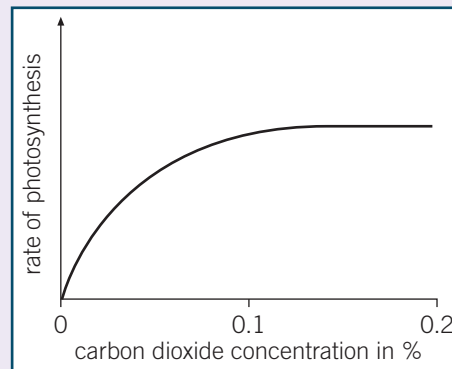
- temperature
- carbon dioxide concentration
- light intensity
- amount of chlorophyll.

Less chlorophyll in the leaves reduces the rate of photosynthesis. More chlorophyll may be produced by plants in well-lit areas to increase the photosynthesis rate.

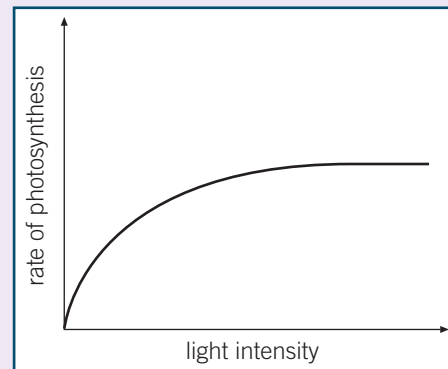
Limiting factors and photosynthesis rate (HT only)



- At low temperatures the rate of photosynthesis is low because the reactant molecules have less kinetic energy.
- Photosynthesis is an enzyme-controlled reaction, so at high temperatures the enzymes are denatured and the rate quickly decreases.



- Carbon dioxide is used up in photosynthesis, so increasing carbon dioxide concentration increases the rate of photosynthesis.
- At a certain point, another factor becomes limiting.
- Carbon dioxide is often the limiting factor for photosynthesis.

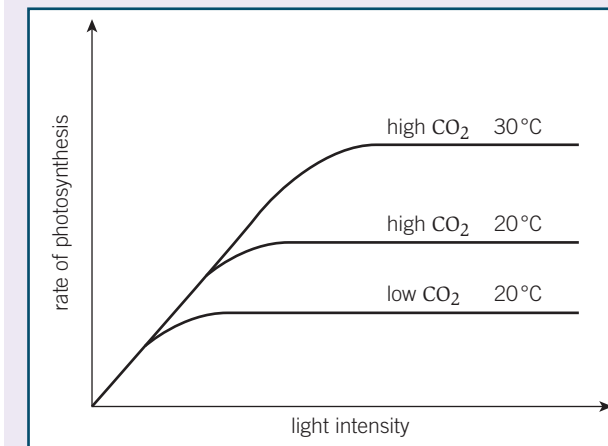


- Light energy is needed for photosynthesis, so increasing light intensity increases the rate of photosynthesis.
- At a certain point, another factor becomes limiting.
- Photosynthesis will stop if there is little or no light.

Interaction of limiting factors (HT only)

Limiting factors often interact, and any one may be limiting photosynthesis.

For example, on the graph the lowest curve has both carbon dioxide and temperature limiting photosynthesis. Temperature is limiting for the middle curve, and the highest curve shows photosynthesis rate increases when both temperature and carbon dioxide are increased until another factor becomes limiting.



Inverse square law (HT only)

As the distance of a light source from a plant increases, the light intensity decreases – this is called an inverse relationship. This relationship is not linear, as light intensity varies in inverse proportion to the square of the distance:

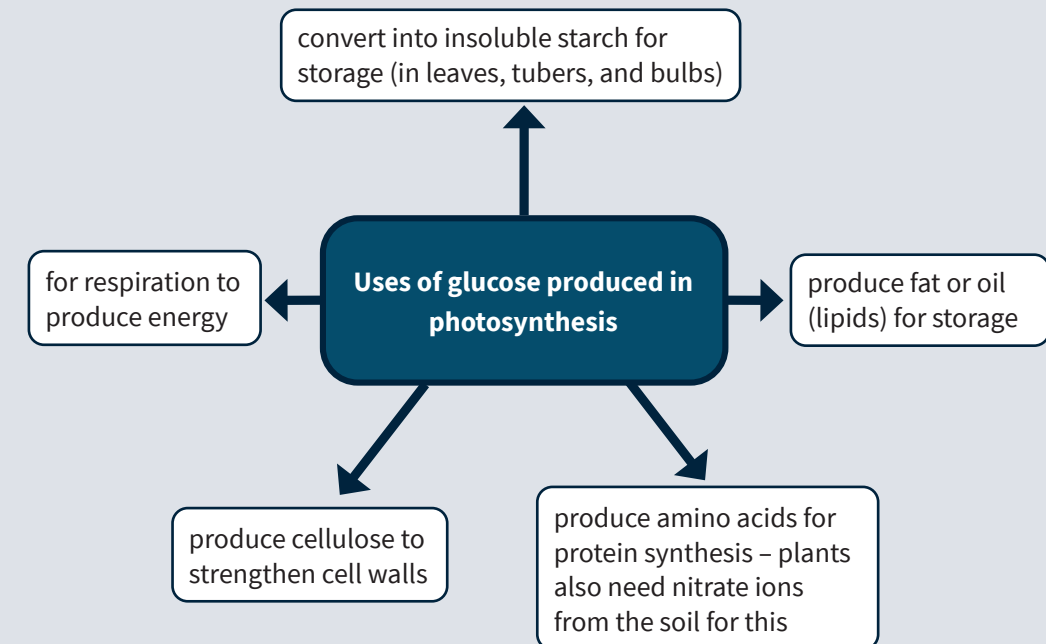
L $\text{light intensity} \propto \frac{1}{\text{distance}^2}$

For example, if you double the distance between a light source and a plant, light intensity falls by three-quarters.

Greenhouse economics

Commercial greenhouses control limiting factors to get the highest possible rates of photosynthesis so they can grow plants as quickly as possible or produce the highest yields, whilst still making a profit.

Uses of glucose



Key terms

Make sure you can write a definition for these key terms.

carbon dioxide chlorophyll chloroplast concentration endothermic glucose greenhouse gases light intensity inverse square law limiting factor photosynthesis protein synthesis

Chapter 8: Photosynthesis

Retrieval questions

Learn the answers to the questions below, then cover the answers column with a piece of paper and write as many as you can. Check and repeat.

B8 questions		Answers
1	Where does photosynthesis occur?	chloroplasts in the leaves of a plant
2	What is the name of the green pigment in the leaves?	chlorophyll
3	What type of reaction is photosynthesis?	endothermic
4	What type of energy is used in photosynthesis?	light energy
5	Give the word equation for photosynthesis.	carbon dioxide + water → glucose + oxygen
6	Give the balanced symbol equation for photosynthesis.	$6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$
7	Define the term limiting factor.	anything that limits the rate of a reaction when it is in short supply
8	Give the limiting factors of photosynthesis.	- temperature - carbon dioxide concentration - light intensity - amount of chlorophyll
9	Describe how light intensity affects the rate of photosynthesis.	increasing light intensity increases the rate of photosynthesis until another factor becomes limiting
10	Describe how carbon dioxide concentration affects the rate of photosynthesis.	increasing carbon dioxide concentration increases the rate of photosynthesis until another factor becomes limiting
11	Describe how temperature affects the rate of photosynthesis.	increasing temperature increases the rate of photosynthesis as the reaction rate increases – at high temperatures enzymes are denatured so the rate of photosynthesis quickly decreases
12	Give the equation for the inverse square law for light intensity.	$\text{light intensity} \propto \frac{1}{\text{distance}^2}$
13	Why are limiting factors important in the economics of growing plants in greenhouses?	greenhouses need to produce the maximum rate of photosynthesis whilst making profit
14	How do plants use the glucose produced in photosynthesis?	- respiration - convert it into insoluble starch for storage - produce fat or oil for storage - produce cellulose to strengthen cell walls - produce amino acids for protein synthesis