

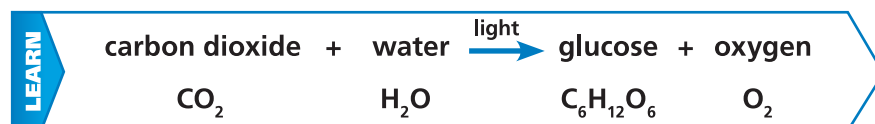
# Photosynthesis

You must be able to:

- Recall the word equation for photosynthesis
- Understand that photosynthesis is an endothermic reaction
- Explain how various factors can change the rate of photosynthesis
- Describe how the products of photosynthesis are used by plants.

## Photosynthesis

- The equation for photosynthesis is:



- To produce glucose molecules by photosynthesis, energy is required.
- This is because the reactions are **endothermic** (take heat in).
- The energy needed is supplied by sunlight.
- It is trapped by the green chemical **chlorophyll**, which is found in chloroplasts.

## Factors Affecting Photosynthesis

- There are several factors that may affect the rate of photosynthesis.

**HT** At any moment, the factor that stops the reaction going any faster is called the **limiting factor**.

### Temperature

- As the temperature increases, so does the rate of photosynthesis.
- This is because more energy is provided for the reaction.
- As the temperature approaches 45°C, the rate of photosynthesis drops to zero because the enzymes controlling photosynthesis have been destroyed.

### Carbon dioxide concentration

- As the concentration of CO<sub>2</sub> increases, so does the rate of photosynthesis.
- This is because CO<sub>2</sub> is needed in the reaction.

**HT** After reaching a certain point, an increase in CO<sub>2</sub> has no further effect. CO<sub>2</sub> is no longer the limiting factor.

### Light intensity

- As light intensity increases, so does the rate of photosynthesis.
- This is because more energy is provided for the reaction.

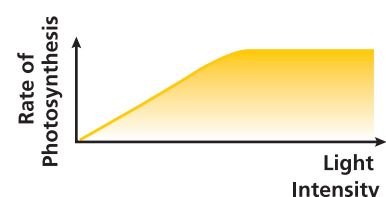
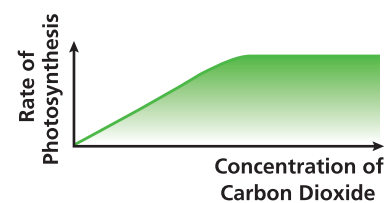
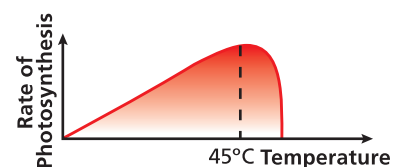
**HT** After reaching a certain point, any increase in light has no further effect. It is no longer the limiting factor.

### Chlorophyll concentration

- This does not vary in the short term but may change if plants are grown in soil without enough minerals to make chlorophyll.

### Key Point

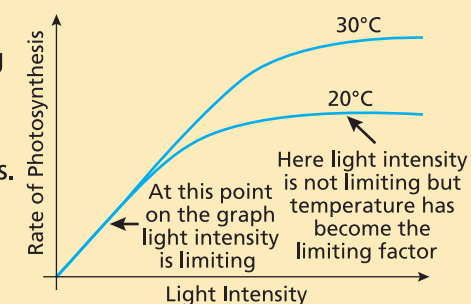
During photosynthesis, the energy from sunlight is converted to chemical energy in the form of glucose molecules.



## Revise

### Key Point

Farmers have to carefully work out if the extra cost of lighting and heating will be paid for by the extra growth that their crops achieve.



**HT** By looking at a graph, it is possible to say what the limiting factor is at any point.

**HT** Greenhouses can be used to increase the rate of photosynthesis. By controlling lighting, temperature and carbon dioxide, farmers can increase the growth rate of their crops.

### REQUIRED PRACTICAL

Investigate the effect of light intensity on the rate of photosynthesis using an aquatic organism such as pondweed.

#### Sample Method

- Place a piece of pondweed in a beaker and shine a light at it using a lamp a specific distance away.
- Record the number of bubbles of gas coming out of the pondweed in one minute.
- Repeat this with the lamp at different distances from the pond weed.

#### Considerations, Mistakes and Errors

- It is best to take at least two readings at each distance and calculate the mean of the number of bubbles.
- Carbon dioxide is provided by adding a small amount of sodium hydrogen carbonate to the water.

#### Variables

- The independent variable is the light intensity (distance from the light).
- The dependent variable is the number of bubbles in one minute.
- The control variables are the piece of pondweed, the temperature, and the concentration of carbon dioxide.

#### Hazards and risks

- Care must be taken to avoid any water being dropped onto the hot light bulb.

**HT** When light intensity is studied, doubling the distance between the lamp and the pondweed will reduce the light intensity by a quarter. This is called the **inverse square law**.

## Converting Glucose

- The glucose produced in photosynthesis may be used by the plant during respiration to provide energy.
- Glucose may also be changed into other products such as:
  - insoluble starch, which is stored in the stem, leaves or roots
  - fat or oil, which is also stored, e.g. in seeds
  - cellulose, to strengthen cell walls
  - proteins, which are used for growth and for enzymes.
- To produce proteins from glucose, plants also use nitrate ions, which are absorbed from the soil.

### Quick Test

- Name the green pigment essential for photosynthesis.
- Where do plants obtain the carbon dioxide used in photosynthesis?
- List **three** factors that may limit the rate of photosynthesis.
- What do plants need, in addition to glucose, to make proteins?

### Key Point

Nitrate ions are needed to make proteins because amino acids contain nitrogen, but glucose does not.

### Key Words

endothermic reaction  
chlorophyll

**HT** limiting factor

**HT** inverse square law