Photosynthesis (bubble counting method) with CobraSMARTsense

Biology > Plant Physiology / Botany > Photosynthesis

Difficulty level	Group size	Preparation time	Execution time
medium	2	20 minutes	30 minutes

This content can also be found online at:

https://www.curriculab.de/c/699f0139b799470002a10bd7

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Teacher information

Application

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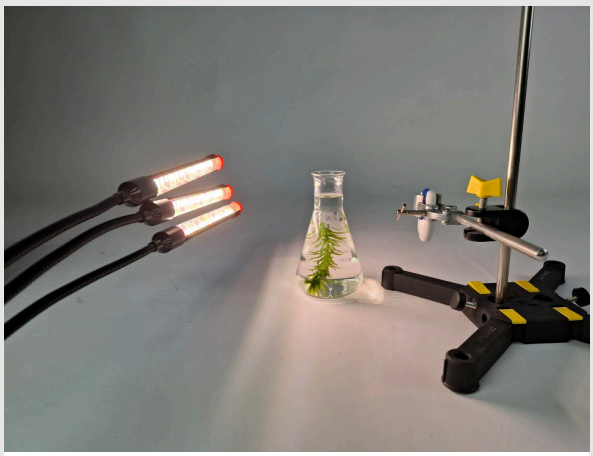

Experimental setup

In this experiment, the dependence of photosynthetic performance on light intensity is measured by counting the oxygen bubbles secreted from an aquatic plant.

The influence of the carbon dioxide content of water on the photosynthesis rate is also being investigated.

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Other teacher information (1/5)

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Prior knowledge

Students should be familiar with the basic biological and chemical principles of photosynthesis.

Principle

In this experiment, the dependence of photosynthetic performance on brightness is measured by counting the oxygen bubbles secreted from an aquatic plant.

Other teacher information (2/5)

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Learning objective

The students should recognise that the photosynthesis rate of the waterweed increases with an increased light supply. Therefor they count the oxygen bubbles.

Tasks

The students should use the bubble counting method to demonstrate the photosynthetic activity of an aquatic plant. They should also investigate the influence of the carbon dioxide content of water on the rate of photosynthesis.

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Other teacher information (3/5)

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Information on procuring materials and the best conditions for the experiment

Aquatic plants are used, the simplest being fresh waterweed (*Elodea canadensis*). This can be obtained wherever aquarium supplies are available (pet shops).

If the results are to be comparable and reproducible, it is particularly important that the shoot sections used are as similar in size as possible.

Other teacher information (4/5)

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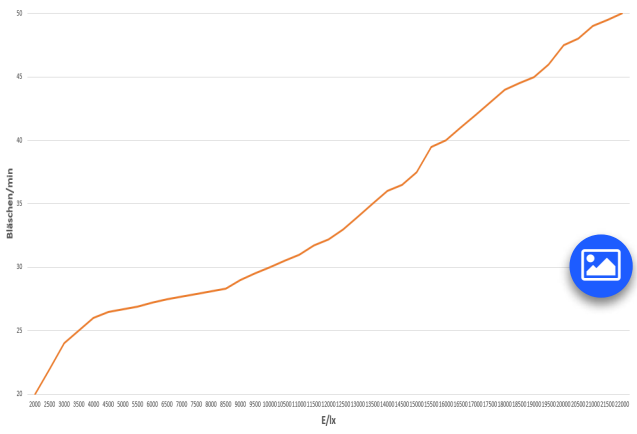
Further information on the results

Once the measurements have been completed, the values determined can be transferred to a spreadsheet using any programme, e.g. measureLAB or Microsoft Excel, and displayed graphically and analysed in detail.

- The photosynthesis rate measured by the released oxygen increases almost linearly with the brightness, because at lower brightness the light is the limiting factor in photosynthesis (Fig. right).



Graphical representation of the values after transfer to Microsoft Excel

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Other teacher information (5/5)

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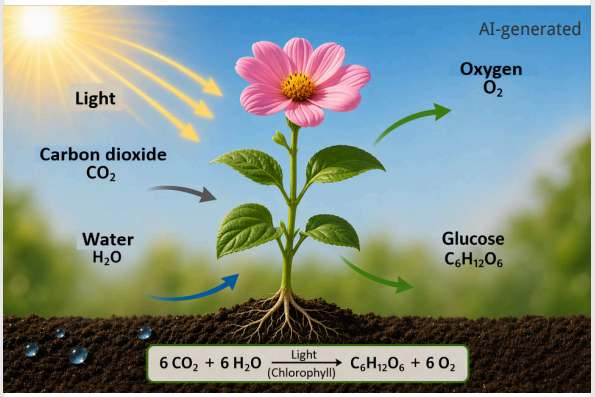
Notes

- At higher brightness levels (e.g. film light), other factors, such as the available carbon dioxide, play a limiting role. The photosynthesis rate then no longer increases linearly with the brightness, but tends towards a saturation value.
- Reducing the carbon dioxide content in the water (distilled water or tap water instead of CO_2-containing mineral water), the influence on the photosynthesis rate can be demonstrated.



Safety instructions

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- The general instructions for safe experimentation in science lessons apply to this experiment.

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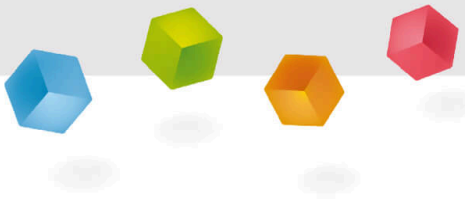

Student information

Theory

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Without plants that photosynthesise, life as we know it would not be possible. The air, which currently consists of approx. 78 % nitrogen, 21 % oxygen, 1 % noble gases and 0.04 % carbon dioxide, would have a completely different composition.

During photosynthesis, water, carbon dioxide and solar energy are converted into oxygen and sugar by the plant. The plant builds up biomass and releases oxygen into its environment.

As both plants on land and plants under water carry out photosynthesis, aquatic plants are ideal objects for investigation, as oxygen production is visible here through air bubbles, which can be easily counted.

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Equipment

Position	Material	Item No.	Quantity
1	Cobra SMARTsense Light - Sensor for measuring the illuminance 0 ... 128 kLx (Bluetooth + USB)	12906-01	1
2	Support base, separable for 2 rods	02001-00	1
3	Support rod, l = 600 mm, d = 10 mm, split in 2 rods with screw threads	02035-00	1
4	Boss head	02043-00	1
5	Erlenmeyer flask, borosilicate, narrow neck, 250 ml	46142-00	1
6	measureAPP - the free measurement software for all devices and operating systems	14581-61	1
7	Universal clamp	37715-00	1
8	Photosynthesis lamp, LED, full spectrum, 27 W	65752-99	1

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Additional equipment

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Position	Art. No.	Designation
1		Mobile device (smartphone / tablet)
2	14581-61	measureAPP
3		Mineral water (strongly sparkling)
4		Tap water
5		Waterweed (Elodea canadensis)

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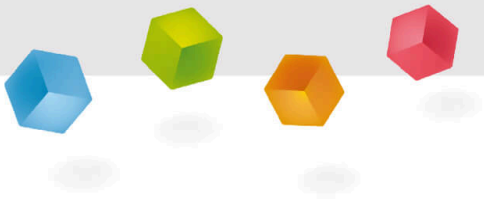

Setup and procedure

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Setup (1/3)

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For measurement with the **Cobra SMARTsense sensors** the **PHYWE measureAPP** required. The app can be downloaded free of charge from the relevant app store (see below for QR codes). Before starting the app, please check that **Bluetooth is enabled** on your device (smartphone, tablet, desktop PC).

iOS

Android

Windows

Setup (2/3)

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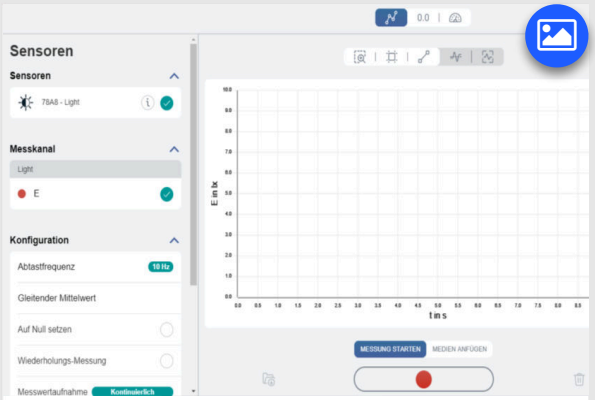

User interface measureApp in the Windows 10 version

- Switch on the SMARTsense Light Sensor by pressing and holding the switch-on button.
- Connect the sensor to the device in the measureAPP under "Measure", as shown in the illustration on the left.
- The SMARTSense Light Sensor is now displayed in the app.

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Setup (3/3)

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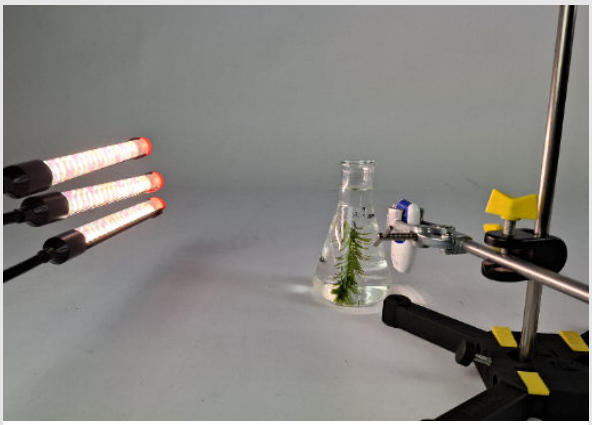

Assemble the devices as shown in the illustration.

- The experiment is carried out twice. Once with tap water and a second time with mineral water (strongly sparkling).
- Attach the photosynthesis lamp to the table.
- Set up a tripod base opposite the lamp and clamp in a tripod rod with a double sleeve. Attach the tripod clamp to it and mount the Cobra SMARTsense Light horizontally in the direction of the photosynthesis lamp. The distance between the photosynthesis lamp and the measuring unit should initially be approx. 1.5 meters.
- Fill the 250 ml Erlenmeyer flask with the relevant water and place it at the height of the SMARTsense Light.

Procedure (1/2)

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- Cut off a stem of the waterweed and place it in the 250 ml Erlenmeyer flask with the cut side facing upwards. To prevent the plant from floating upwards, it should be weighted down. A little creativity is required here: In the example experiment, a paper clip was used as a weight with a small screw nut attached to it.
- Initially, carbon dioxide bubbles bubble out of the stem. In addition, in the experiment with mineral water, the water bubbles very strongly at the beginning (make sure that the beaker is not dirty!). The actual measurement should therefore only be started after a few minutes.
- Then count the oxygen bubbles that swell out of the end of the stem in one minute and note the values on a piece of paper. At the same time, note the brightness in lux.

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Procedure (2/2)

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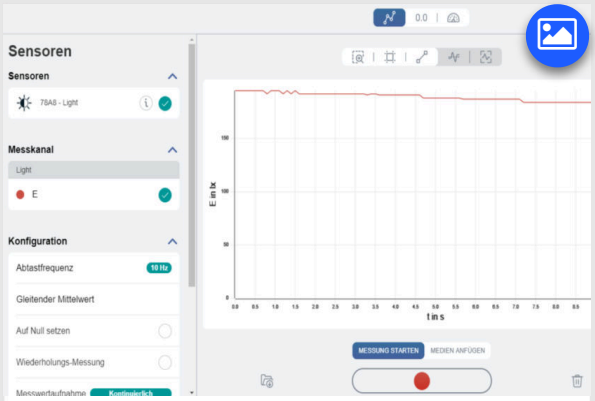
- Move the photosynthesis lamp approx. 10-15 cm closer to the test object and wait approx. 1 minute until the plant has adapted to the new conditions. Repeat the measurement as described above until the photosynthesis lamp is directly in front of the 250 ml Erlenmeyer flask. **Please note:** If you are using mineral water, the measurements should be carried out as quickly as possible, as the sparkling water is constantly losing CO_2. If the number of bubbles decreases despite the higher brightness, the sparkling water should be replaced.
- Once the measurements have been completed, the values determined can also be graphically displayed and analysed in a spreadsheet using any programme.



Measure the light intensity when you move the lamp closer

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Report

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Task 1

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Drag the words into the correct places.

Plants need _____ to be able to photosynthesise. The photosynthesis rate can be influenced by _____ the light intensity. As the light intensity _____, so does the demand for _____, which the plant needs. The rising water bubbles represent _____.

- oxygen
- changing
- light and carbon dioxide
- increases
- carbon dioxide

Check

Task 2

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Which statement about photosynthesis is correct?

- During photosynthesis, the plant stores an image it has seen of an optimal environment in its genes. This information later gives rise to new subspecies.
- None.
- During photosynthesis, the plant converts sunlight (i.e. energy), oxygen and water into carbon dioxide and sugar. The carbon dioxide is released by the plant in the process.
- During photosynthesis, the plant converts sunlight (i.e. energy), carbon dioxide and water into oxygen and sugar. The oxygen is released by the plant in the process.

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Task 3

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Complete the equation for photosynthesis.

6 [ ] + 6 CO2 = 6 [ ] + C6H12O6

Check

Photosynthesis is carried out by plants on land and in water. The green pigment, i.e. chlorophyll, is important for photosynthesis.

○ True ○ False

Check

Slide	Score / Total
Slide 20: Photosynthesis	0/5
Slide 21: Photosynthesis process	0/1
Slide 22: Multiple tasks	0/3

Total amount 0 / 9

Solutions Repeat

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