

Exercise walk-through

6.1.1

Testing a leaf for starch, and the experiments behind the equation

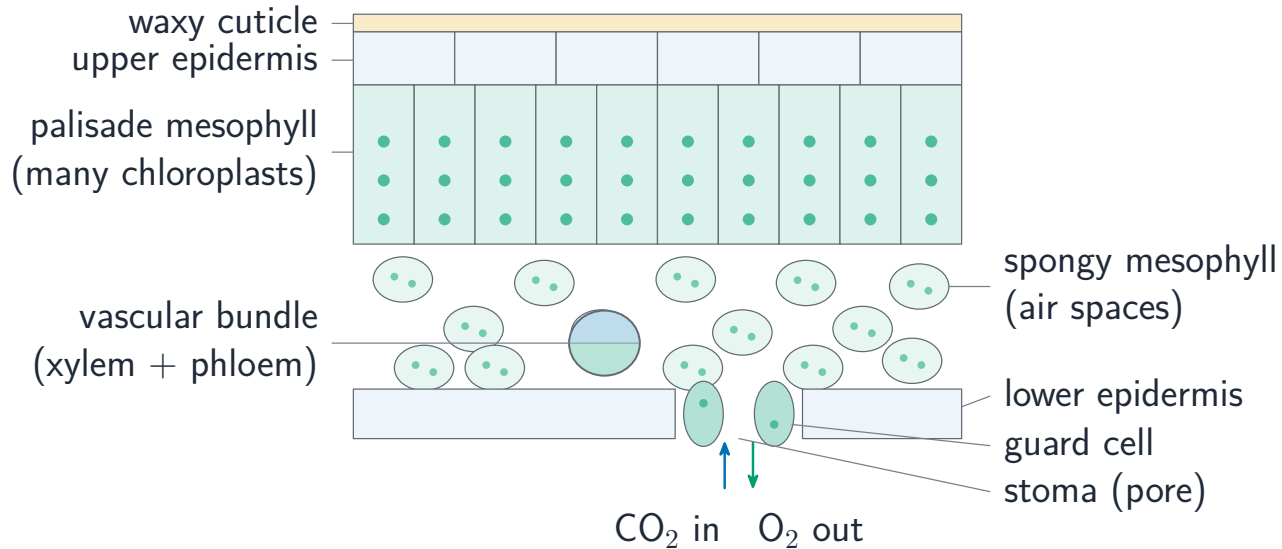
IGCSE Biology

Leaf structure

A leaf is **adapted** – broad & thin to catch light.

- **palisade** cells: packed with chloroplasts
- **spongy** layer: air spaces for gas
- **xylem** brings water; phloem takes sugar

Leaf structure, in detail



A leaf is **adapted** – broad & thin to catch light.

The leaf, layer by layer

the cuticle

a waxy waterproof layer on top – reduces water loss, and lets light through

the epidermis

a single transparent layer, with no chloroplasts, protecting the tissue beneath

palisade mesophyll

tall cells packed with chloroplasts, near the top where the light is strongest

spongy mesophyll

loosely packed with air spaces – a large **surface area** for gas exchange

vascular bundles

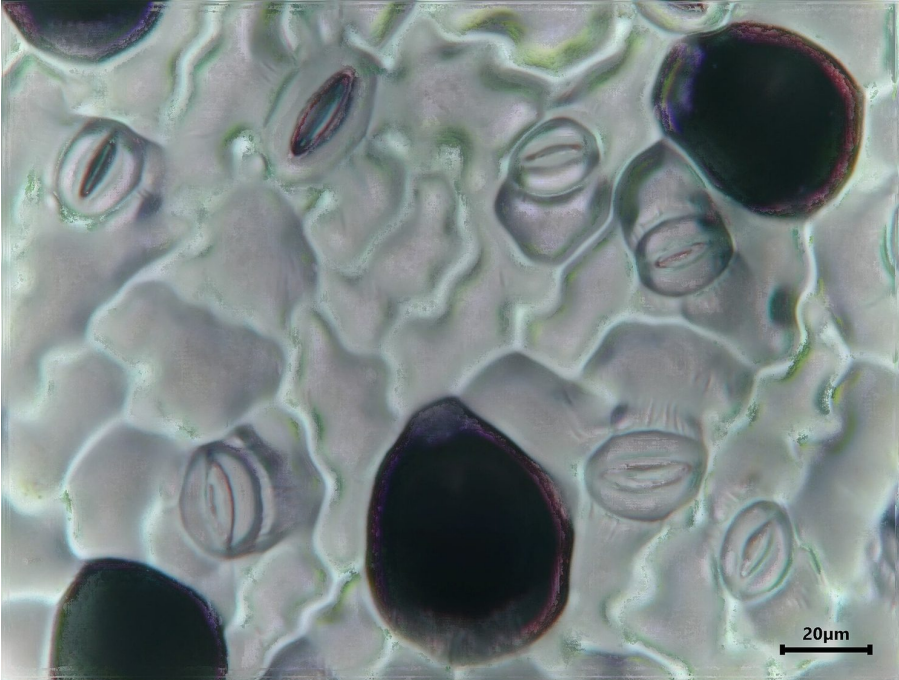
the leaf's veins: **xylem** brings water in, phloem takes sugar away

stomata

pores in the lower epidermis, opened and closed by guard cells

To test what photosynthesis needs, remove **one** of light, chlorophyll or carbon dioxide, keep every other condition the same as the **control**, and test the leaf for starch with iodine – blue-black means starch. Hydrogencarbonate **indicator** is the separate test, for carbon dioxide.

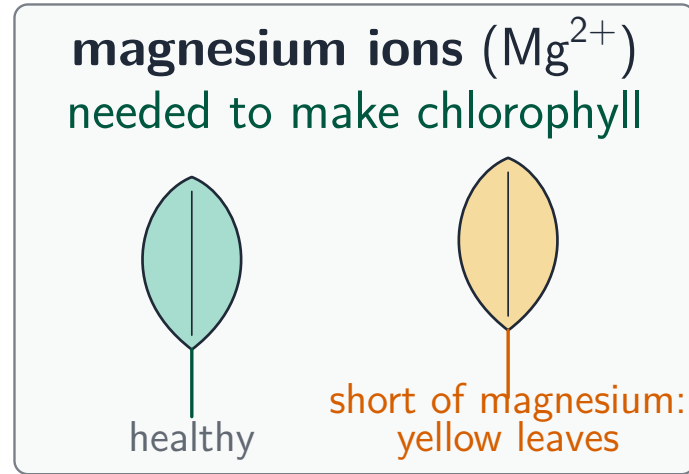
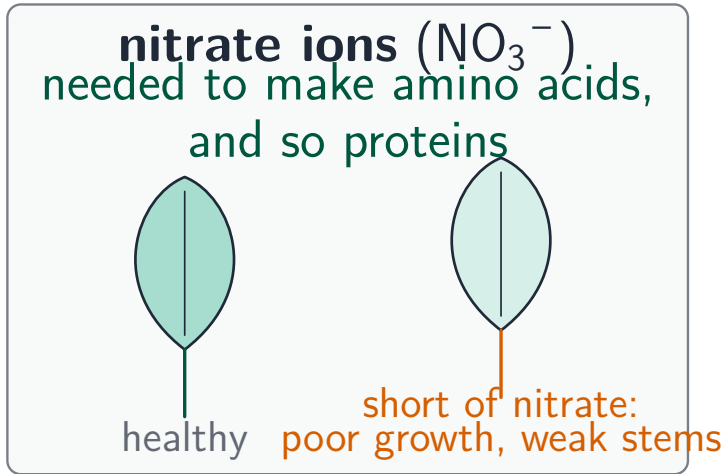
Stomata and guard cells



Stomata are tiny pores (mostly on the lower surface) that let CO_2 in & O_2 out.

A pair of **guard cells** opens & closes each stoma.

Minerals from the soil, continued



A plant short of nitrate grows poorly; a plant short of magnesium has yellow leaves

Exercises 2.1-2.3

2.1 Name the substance that turns iodine solution blue-black, and state what finding it in a leaf tells you. [2]

2.2 Explain why a leaf is boiled in ethanol during the starch test. [2]

2.3 Explain why the ethanol is heated in a water bath and not over a flame. [1]

Exercises 2.1-2.3

2.1 Name the substance that turns iodine solution blue-black, and state what finding it in a leaf tells you. [2]

2.1

- **starch**
 - starch is the store made from the glucose produced, so finding it shows that **photosynthesis has taken place** in that part of the leaf
-

2.2 Explain why a leaf is boiled in ethanol during the starch test. [2]

2.2

- to remove the green **chlorophyll** from the leaf
 - so that the colour of the iodine solution can be seen against a pale leaf
-

2.3 Explain why the ethanol is heated in a water bath and not over a flame. [1]

2.3

- ethanol is **flammable** and would catch fire over a flame

Exercises 2.4·2.5

2.4 A plant is left in a dark cupboard for two days before an experiment on photosynthesis. Explain why. [2]

2.5 A variegated leaf from a plant kept in bright light is tested for starch. Describe the result, and explain what it shows. [3]

Exercises 2.4·2.5

2.4 A plant is left in a dark cupboard for two days before an experiment on photosynthesis. Explain why. [2]

2.4

- to **destarch** it: any starch already in the leaves is used up or moved away
- so that any starch found at the end of the experiment must have been made **during** the experiment

2.5 A variegated leaf from a plant kept in bright light is tested for starch. Describe the result, and explain what it shows. [3]

2.5

- the **green** parts go **blue-black**; the **white** parts stay **orange-brown**
- starch was made only where there was chlorophyll
- so **chlorophyll is needed** for photosynthesis; the white part of the same leaf acts as the control, because everything else about it is the same

Exercise 2.6

2.6 Pondweed is left in red hydrogencarbonate indicator in bright light for two hours. State the colour of the indicator at the end, and explain the change. [3]

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2.6

- it turns **purple**
- the pondweed has taken in more carbon dioxide for photosynthesis than it gave out in respiration
- so the carbon dioxide concentration of the water has **fallen** below normal

Exercise 3.1

3.1 A destarched plant is left in the light for a day with one leaf partly covered by foil. That leaf is then tested for starch. Which result is correct? [1]

☐

A the covered part is blue-black, the uncovered part is orange-brown

B the covered part is orange-brown, the uncovered part is blue-black

C both parts are blue-black

D both parts are orange-brown

Exercise 3.1

3.1 A destarched plant is left in the light for a day with one leaf partly covered by foil. That leaf is then tested for starch. Which result is correct? [1]

☐

A the covered part is blue-black, the uncovered part is orange-brown

B the covered part is orange-brown, the uncovered part is blue-black

C both parts are blue-black

D both parts are orange-brown

3.1 B

- the covered strip received no light, so no photosynthesis happened there and no starch was made: **orange-brown**
- the uncovered part had light, chlorophyll and carbon dioxide, so it made starch: **blue-black**
- **A** has it the wrong way round; **C** and **D** would show that light made no difference, which is not what happens

Exercise 3.2 (a)

3.2 A student set up three boiling tubes, each containing red hydrogencarbonate indicator solution. Tube **A** held pondweed and was left in bright light. Tube **B** held pondweed and was wrapped in foil. Tube **C** held no pondweed. All three were left for two hours at the same temperature.

(a) State the colour of the indicator in tube **A** at the end, and explain the change. [3]

Exercise 3.2 (a)

3.2 A student set up three boiling tubes, each containing red hydrogencarbonate indicator solution. Tube **A** held pondweed and was left in bright light. Tube **B** held pondweed and was wrapped in foil. Tube **C** held no pondweed. All three were left for two hours at the same temperature.

(a) State the colour of the indicator in tube **A** at the end, and explain the change. [3]

(a)

- **purple**
- the pondweed photosynthesised faster than it respired, so it took in more carbon dioxide than it gave out
- the carbon dioxide concentration of the water fell below normal, and the indicator shows this as purple

Exercise 3.2 (b)

3.2 A student set up three boiling tubes, each containing red hydrogencarbonate indicator solution. Tube **A** held pondweed and was left in bright light. Tube **B** held pondweed and was wrapped in foil. Tube **C** held no pondweed. All three were left for two hours at the same temperature.

(b) State the colour in tube **B** at the end, and explain the change.

[2]

Exercise 3.2 (b)

3.2 A student set up three boiling tubes, each containing red hydrogencarbonate indicator solution. Tube **A** held pondweed and was left in bright light. Tube **B** held pondweed and was wrapped in foil. Tube **C** held no pondweed. All three were left for two hours at the same temperature.

(b) State the colour in tube **B** at the end, and explain the change. [2]

(b)

- **yellow**
- in the dark there is no photosynthesis, but the pondweed still respire, so carbon dioxide was added to the water

Exercise 3.2 (c)

3.2 A student set up three boiling tubes, each containing red hydrogencarbonate indicator solution. Tube **A** held pondweed and was left in bright light. Tube **B** held pondweed and was wrapped in foil. Tube **C** held no pondweed. All three were left for two hours at the same temperature.

(c) Explain why tube **C** was included.

[1]

Exercise 3.2 (c)

3.2 A student set up three boiling tubes, each containing red hydrogencarbonate indicator solution. Tube **A** held pondweed and was left in bright light. Tube **B** held pondweed and was wrapped in foil. Tube **C** held no pondweed. All three were left for two hours at the same temperature.

(c) Explain why tube **C** was included.

[1]

(c)

- it is the **control**: it shows that any colour change in A and B was caused by the pondweed and not by the light, the tube or the indicator itself

Setup for exercise 3.3

3.3 A student investigated how carbon dioxide concentration affects the rate of photosynthesis. She placed the same mass of pondweed in tubes of sodium hydrogencarbonate solution of different concentrations, which supplies carbon dioxide. The lamp stayed at the same distance and the temperature was kept at 20 °C. She collected the gas given off and measured its volume after 10 minutes.

concentration of solution / %	volume of gas / cm ³
0.0	0.2
0.1	1.4
0.2	2.6
0.4	4.1
0.8	4.4
1.6	4.5

Exercise 3.3 (a)

(a) Name the gas collected, and describe a test that would confirm it.

[2]

Exercise 3.3 (a)

(a) Name the gas collected, and describe a test that would confirm it.

[2]

(a)

- **oxygen**
- **it relights a glowing splint**

Exercise 3.3 (b)

(b) Describe the results shown in the table.

[3]

Exercise 3.3 (b)

(b) Describe the results shown in the table.

[3]

(b)

- the volume of gas **rises steeply** between 0.0% and 0.4%, from 0.2 cm³ to 4.1 cm³
- above 0.4% the volume **levels off** at about 4.5 cm³
- so the rate rises with carbon dioxide concentration at first, and then stops rising

Exercise 3.3 (c)

(c) Explain the shape of the results above 0.4%.

[3]

Exercise 3.3 (c)

(c) Explain the shape of the results above 0.4%.

[3]

(c)

- above 0.4%, carbon dioxide is no longer the **limiting factor**
- something else is limiting the rate – here the **light intensity** or the **temperature**, because both were held constant
- so adding more carbon dioxide cannot make the reaction go any faster

Exercise 3.3 (d)

(d) Explain why the lamp was kept at the same distance throughout.

[1]

Exercise 3.3 (d)

(d) Explain why the lamp was kept at the same distance throughout. [1]

(d)

- light intensity is a **control variable**: if it changed, a change in the rate could not be blamed on the carbon dioxide

Exercise 3.3 (e)

(e) Describe what the student should do to make her results more reliable.

[2]

Exercise 3.3 (e)

(e) Describe what the student should do to make her results more reliable. [2]

(e)

- **repeat** each concentration at least three times
- calculate a **mean** volume for each, ignoring any anomalous result