Plant tissues

4.2.3.1 · Organisation · revision notes

The tissues that make up a leaf (a plant organ) and how the structure of each tissue relates to its function: epidermis, palisade and spongy mesophyll, xylem, phloem, guard cells and stomata, plus meristem tissue. Questions ask you to label a leaf cross-section and explain adaptations for photosynthesis and gas exchange.

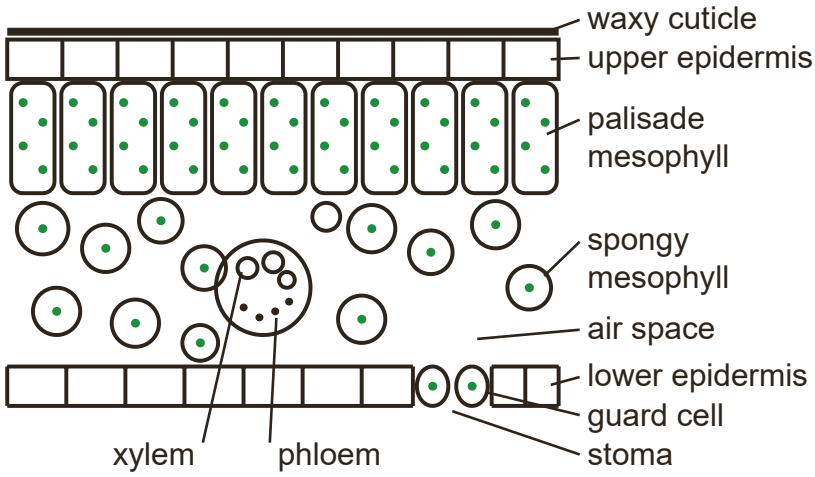
Key facts

- Leaf = an organ; epidermis, palisade, spongy mesophyll, xylem and phloem = tissues
- Palisade mesophyll: many chloroplasts; most photosynthesis
- Stomata (mostly in the lower epidermis): CO_2 in; O_2 and water vapour out
- Xylem: water and mineral ions, from the roots upwards
- Meristem: at the tips of shoots and roots; cells divide and differentiate
- Waxy cuticle: reduces water loss
- Spongy mesophyll: air spaces for gas diffusion
- Guard cells: open and close the stomata
- Phloem: dissolved sugars, from the leaves to the rest of the plant

Notes

The leaf is an organ

- A leaf is a plant organ made of several tissues that work together, mainly for photosynthesis and gas exchange.
- **Upper epidermis**: a single layer of transparent cells, so light passes through. It is covered by a **waxy cuticle** that reduces water loss.
- **Palisade mesophyll**: tall, tightly packed cells near the top of the leaf, with many **chloroplasts**. Most photosynthesis happens here because these cells receive the most light.
- **Spongy mesophyll**: rounded, loosely packed cells with many **air spaces**, so carbon dioxide and oxygen diffuse quickly through the leaf.
- **Lower epidermis**: contains most of the **stomata** (tiny pores). Each stoma is surrounded by two **guard cells** that open and close it. Carbon dioxide diffuses in, and oxygen and water vapour diffuse out, through the stomata.



Leaf cross-section. Green dots are chloroplasts: most are in the palisade mesophyll.

Transport and growth tissues

- **Xylem**: hollow tubes of dead cells, strengthened by lignin, which carry water and mineral ions from the roots to the leaves.
- **Phloem**: tubes of elongated living cells, which carry dissolved sugars from the leaves to the rest of the plant.
- Xylem and phloem run together in the veins of the leaf.
- **Meristem** tissue is found at the growing tips of shoots and roots. Its cells divide by mitosis, and the new cells can differentiate into many types of plant cell.

Whole-leaf adaptations Grade 7+ only

- Broad and flat: a large surface area to absorb light.
- Thin: a short diffusion distance for carbon dioxide to reach the mesophyll cells.
- Network of veins: xylem brings water for photosynthesis and phloem carries the sugars away.

How to answer each type of question

Name or label a leaf tissue

1 mark each | Grade 4

1. Work from top to bottom: cuticle, upper epidermis, palisade, spongy mesophyll, lower epidermis.
2. Stomata and guard cells are mostly on the lower surface.
3. The veins (xylem and phloem) are in the middle of the leaf.

Example. Name the tissue in a leaf that:
(a) contains the most chloroplasts
(b) transports water into the leaf
(c) contains air spaces for gas exchange.

Model answer.

(a) palisade mesophyll (1)
(b) xylem (1)
(c) spongy mesophyll (1)

Explain how a tissue is adapted to its function

2 to 3 marks | Grade 5

1. Give a feature of the tissue.
2. Link it to the job with 'so': more light absorbed, faster diffusion, less water lost.

Example. Explain how the palisade mesophyll is adapted for photosynthesis.

Model answer. Its cells contain many chloroplasts (1), which contain chlorophyll to absorb light (1). The cells are near the top of the leaf, so they receive the most light (1).

Explain how the leaf is adapted for gas exchange

3 marks | Grade 7

1. Stomata let gases in and out (opened by guard cells).
2. Air spaces in the spongy mesophyll let gases diffuse quickly.
3. A thin leaf gives a short diffusion distance.

Example. Explain how the structure of a leaf allows carbon dioxide to reach the palisade cells.

Model answer. Carbon dioxide diffuses into the leaf through the stomata (1). The spongy mesophyll has air spaces, so carbon dioxide diffuses quickly through the leaf (1). The leaf is thin, so the diffusion distance is short (1).

Describe meristem tissue 2 marks **Grade 4**

1. Say where it is: the growing tips of shoots and roots.
2. Say what it does: its cells divide to make new cells, which differentiate.

Example. Where in a plant is meristem tissue found, and what is its function?

Model answer. At the growing tips of shoots and roots (1). Its cells divide (by mitosis) to produce new cells for growth, which can differentiate into different types of cell (1).

Don't lose marks

- Calling the leaf a tissue. The leaf is an organ; palisade mesophyll, xylem and so on are tissues.
- Saying most photosynthesis happens in the epidermis or spongy mesophyll. Most happens in the palisade mesophyll.
- Calling the guard cells the pores. The stoma is the pore; the guard cells surround it and open and close it.
- Mixing up xylem (water and mineral ions) and phloem (dissolved sugars).
- Saying the waxy cuticle stops all water loss. It reduces water loss.

More tips

Memory tricks

- Leaf layers, top to bottom: 'Can Unicorns Paint Silly Little Goats?' = Cuticle, Upper epidermis, Palisade, Spongy mesophyll, Lower epidermis, Guard cells.
- Palisade = Packed with chloroplasts. Spongy = Spaces for gases.
- Phloem: 'ph' sounds like 'f' for food (sugars). Xylem carries water.

Exam technique

- For 'explain how it is adapted' questions, give feature + function pairs.
- Name the gas and the direction: carbon dioxide diffuses in; oxygen and water vapour diffuse out.
- When labelling a diagram, make sure each label line ends exactly on the correct layer.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3 — **Name the tissues in a leaf**
Upper and lower epidermis, palisade mesophyll, spongy mesophyll, xylem and phloem, with guard cells around the stomata.

Grade 4 — **Label a leaf cross-section**
From top to bottom: waxy cuticle, upper epidermis, palisade mesophyll, spongy mesophyll with air spaces and veins, lower epidermis with stomata.

Grade 4 — **State where meristem tissue is found**
At the growing tips of shoots and roots, where cells divide to make new cells.

Describe what guard cells and stomata do

Grade 4

Guard cells open and close the stomata to control gas exchange and water loss.

Grade 5

State the function of each leaf tissue

Epidermis covers the leaf, palisade does most photosynthesis, spongy mesophyll lets gases diffuse, xylem carries water and phloem carries sugars.

Grade 5

Explain how the mesophyll layers are adapted

Palisade cells are packed with chloroplasts near the top of the leaf; spongy mesophyll has air spaces for gases to diffuse through.

Grade 5

Explain how leaf structure suits photosynthesis

Link the thin, broad shape, transparent epidermis, chloroplast position, air spaces, stomata and veins to supplying light, carbon dioxide and water.

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