TISSUES AND ORGANS

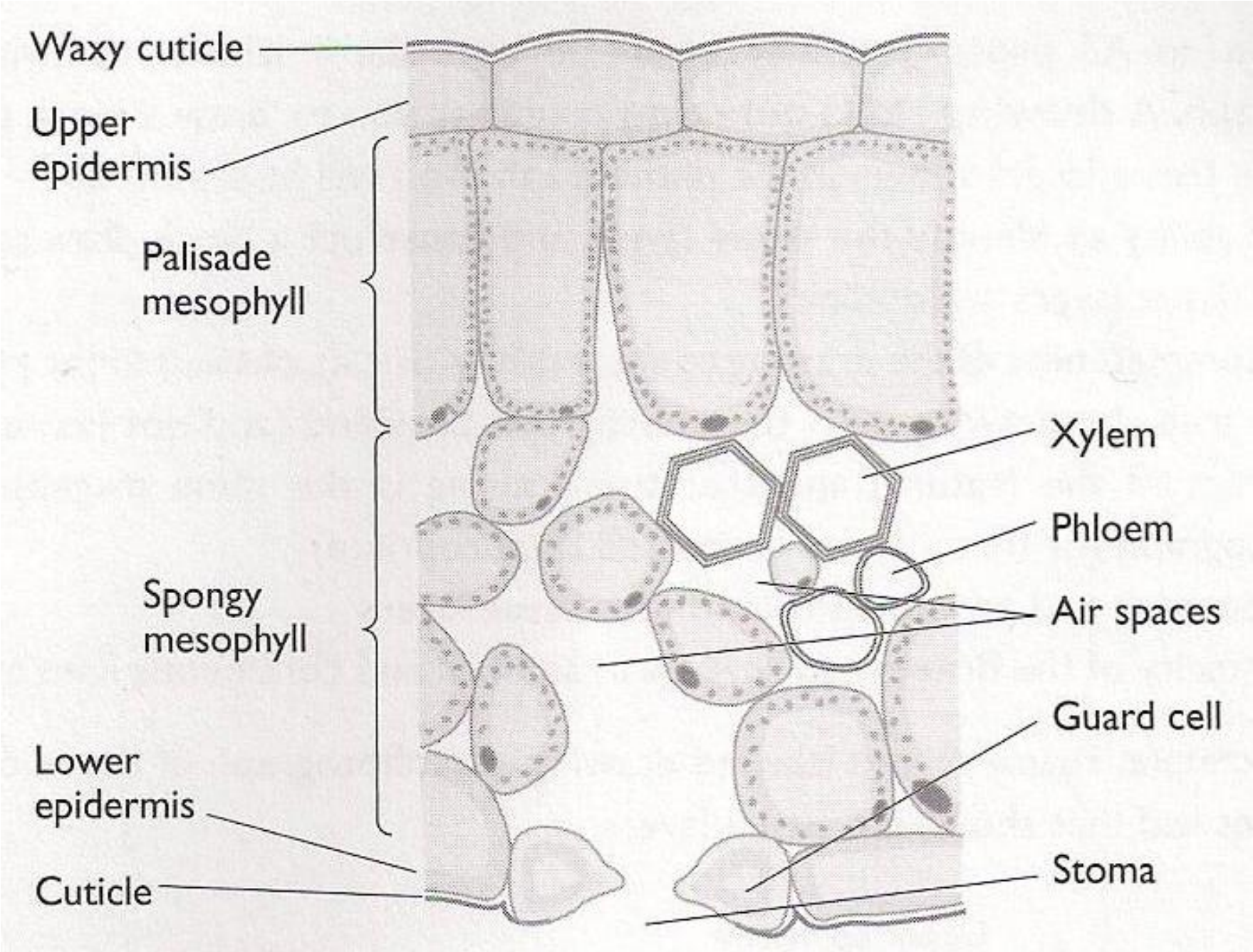
PART 2

The structure and function of the mesophytic leaf (a plant organ)

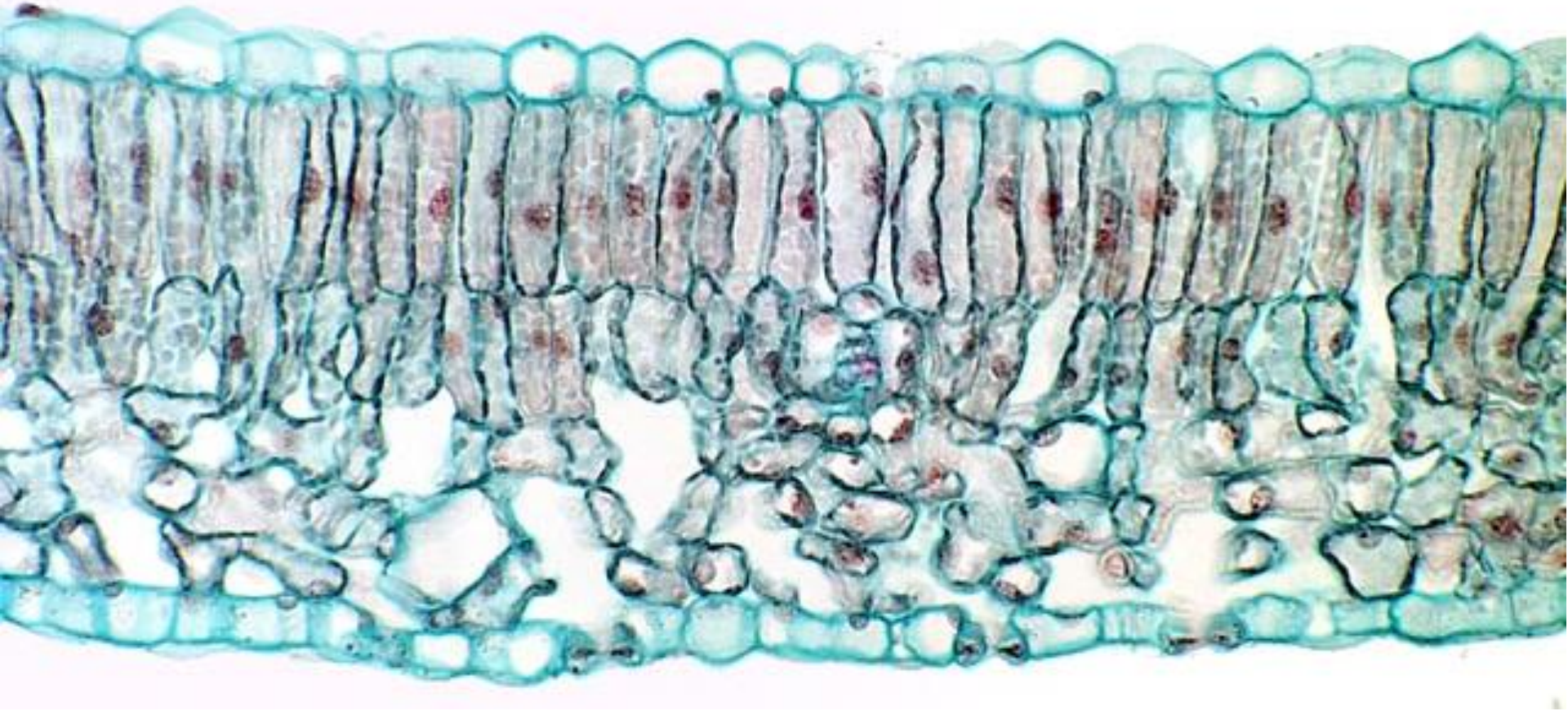
The mesopyhtic leaf (lives in a moderately moist environment) contains 7 layers of **tissue:**

1. Upper epidermis
2. Palisade mesophyll
3. Spongy mesophyll
4. Xylem vessels (in vascular bundles)
5. Phloem sieve tubes (in vascular bundles)
6. Lower epidermis
7. Stomata

The structure of the leaf:



Light microscope cross section of the leaf; can you see the layers of tissue?

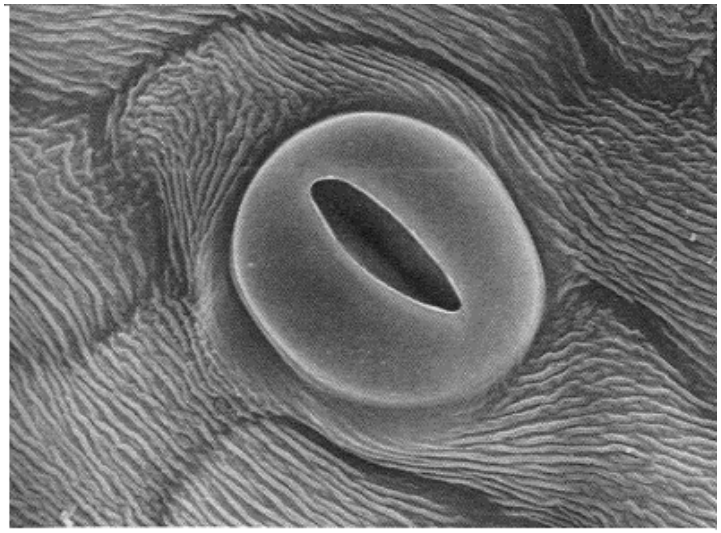


The leaf is an organ with adaptations for maximising photosynthesis while reducing transpirational water loss

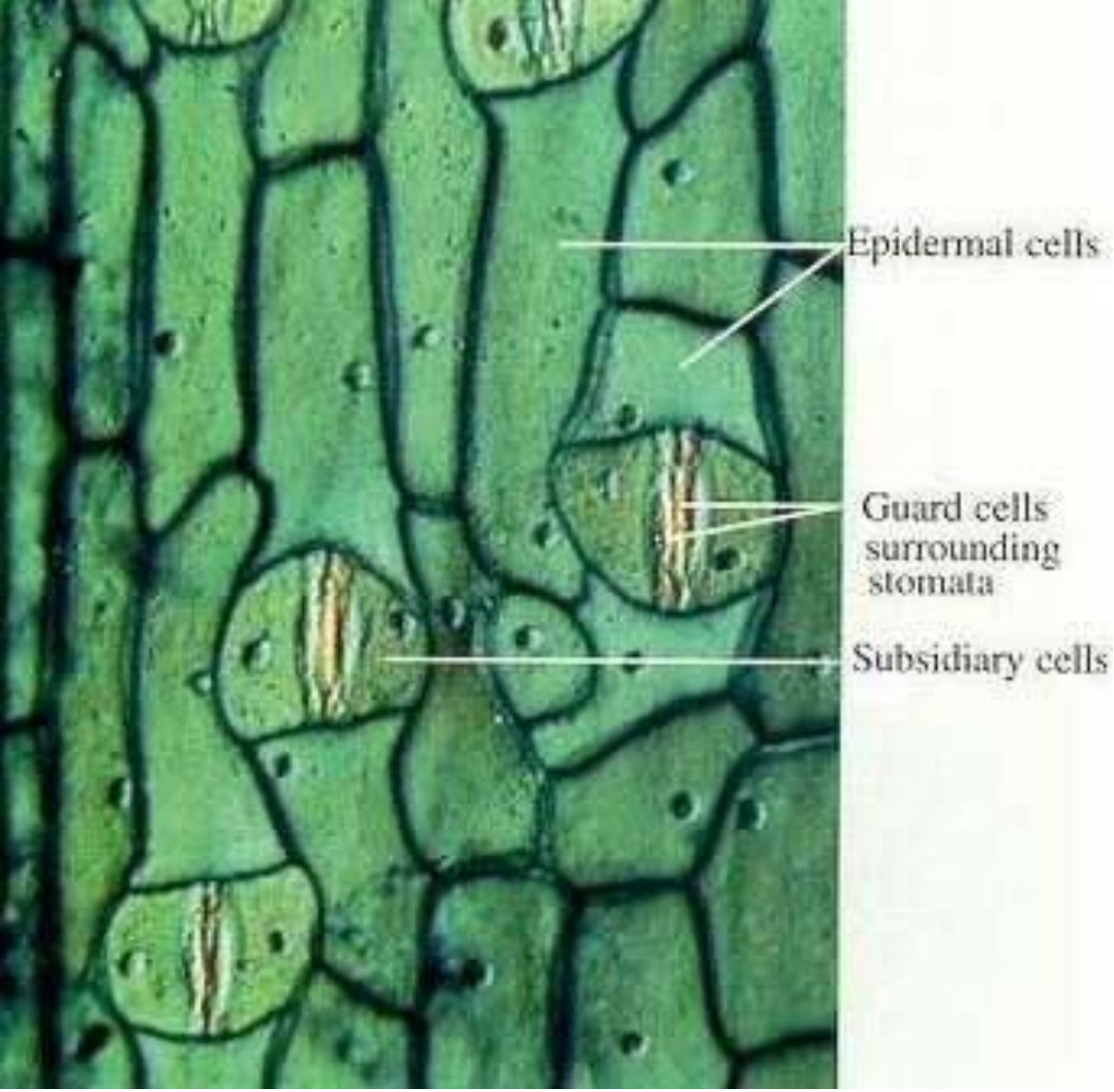
Upper and lower epidermis:

- The leaf has a layer of closely fitting cells on both the top and the bottom of the leaf
- This is the upper and lower epidermis
- These cells do not contain chloroplasts, their function is to protect the inner layers of cells in the leaf
- The cells of the upper epidermis secrete a waxy cuticle that is waterproof to stop water evaporating
- The cuticle secreted onto the lower epidermis surface is thinner than the upper epidermis as it is not exposed directly to the sun

- In the lower epidermis there are small holes called stomata (singular=stoma) which allow gaseous exchange
- Each stoma is surrounded by a pair of guard cells which control the pore opening and closing
- Unlike other cells of the epidermis, guard cells do contain chloroplasts (they can photosynthesise)
- The stomata allow water vapour to diffuse easily out of the leaf
- Stomata close at night to reduce water lost by transpiration (water lost from the plant, mostly through the stomata)



Photomicrograph of leaf surface showing one of the stomata. Dr. Jeremy Burgess/Science Photo library (after: Dingman, 1994)



SEM of Lower epidermis showing guard cells and stomata

The middle layers of the leaf are called the mesophyll; these cells all contain chloroplasts

Palisade mesophyll:

- The cells in the upper half of the leaf are arranged like a fence or palisade, and form the palisade mesophyll
- The cells are packed tight together and contain many chloroplasts for maximal light absorption
- This is the main photosynthetic region of the leaf

Spongy mesophyll:

- The cells in the lower half of the leaf are rounder and arranged quite loosely with large air spaces between them – they form the spongy mesophyll
- Gas exchange occurs between the atmosphere and these air spaces through the stomatal pores
- This allows gas exchange to occur between the air spaces and the surrounding cells
- Spongy mesophyll cells contain chlorophyll and are thus photosynthetic

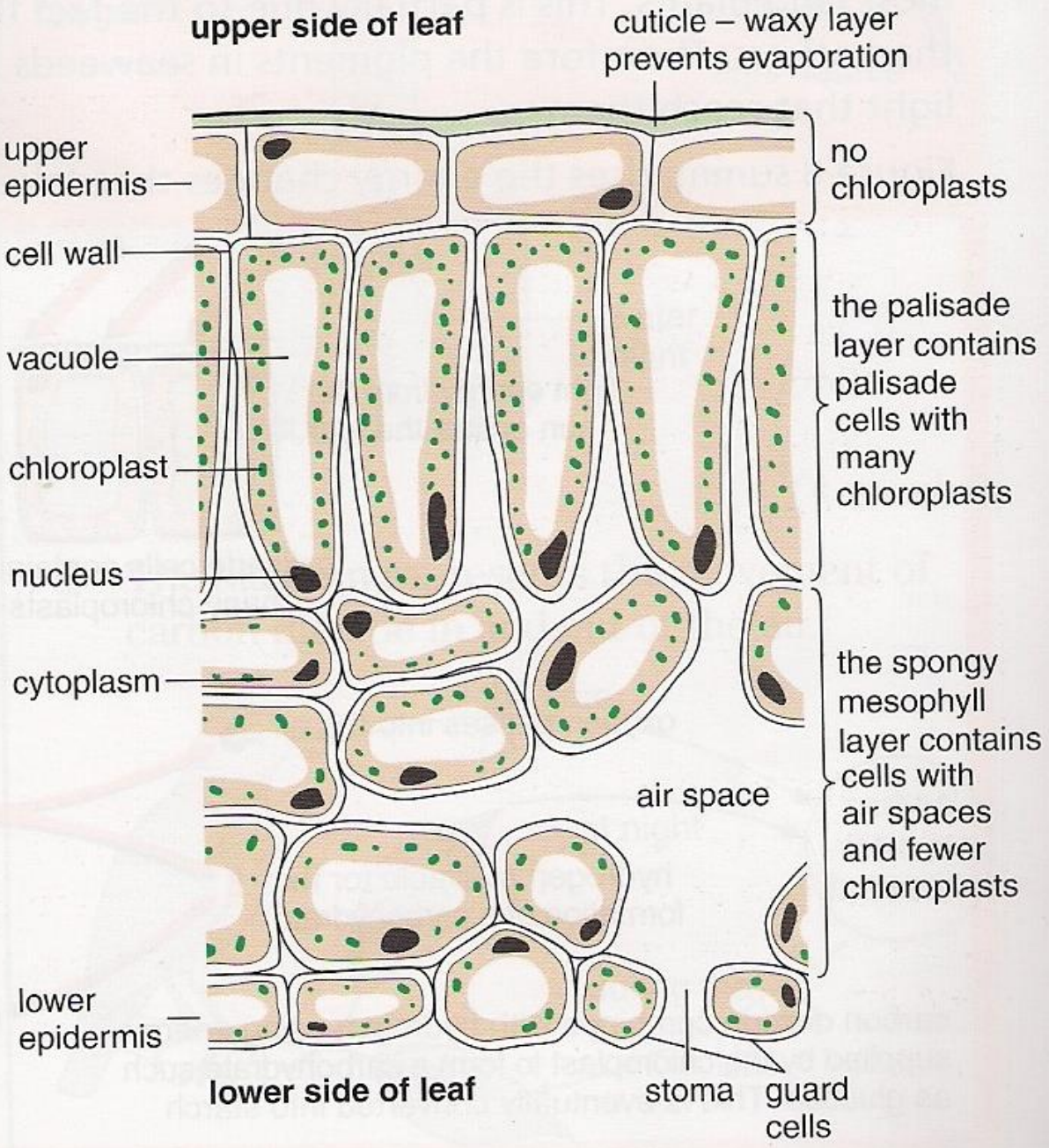
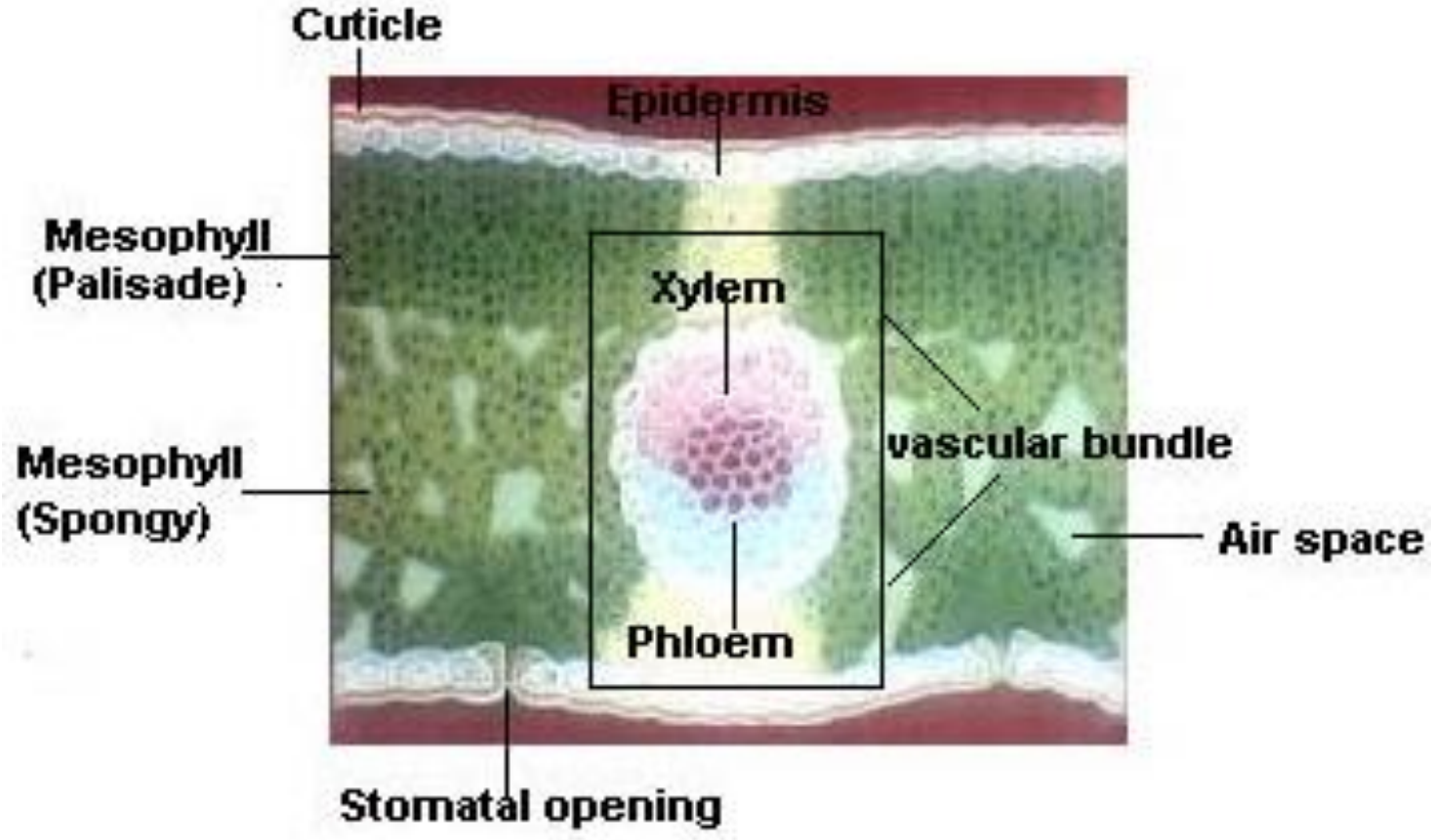


Figure 7 Cross section of a leaf

- Running through the mesophyll are veins
- These contain the xylem and the phloem vessels
- These are arranged into structures called **vascular bundles**, with phloem to the lower surface of the leaf, and xylem to the upper surface



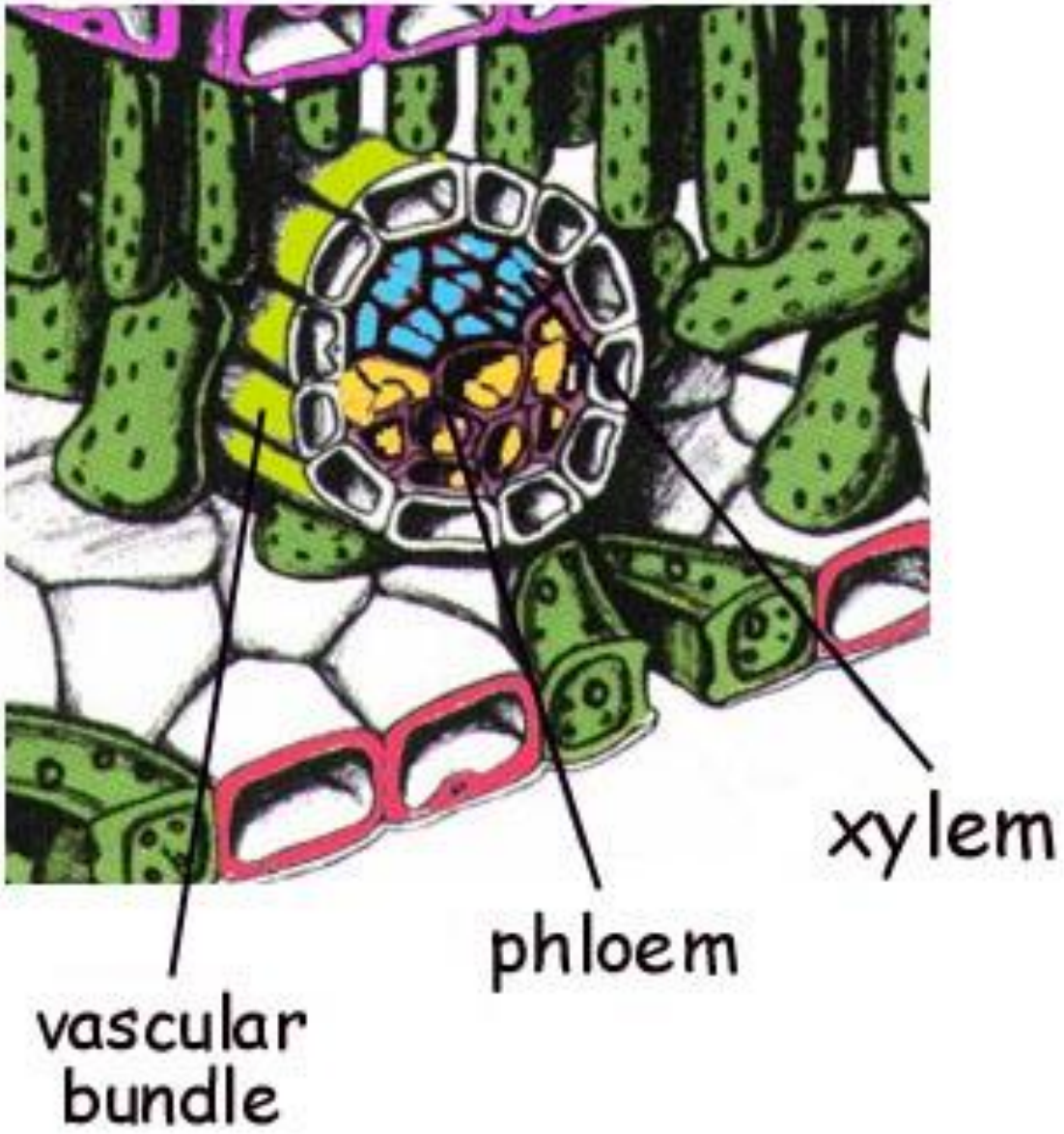
Transport vessels

Xylem vessels:

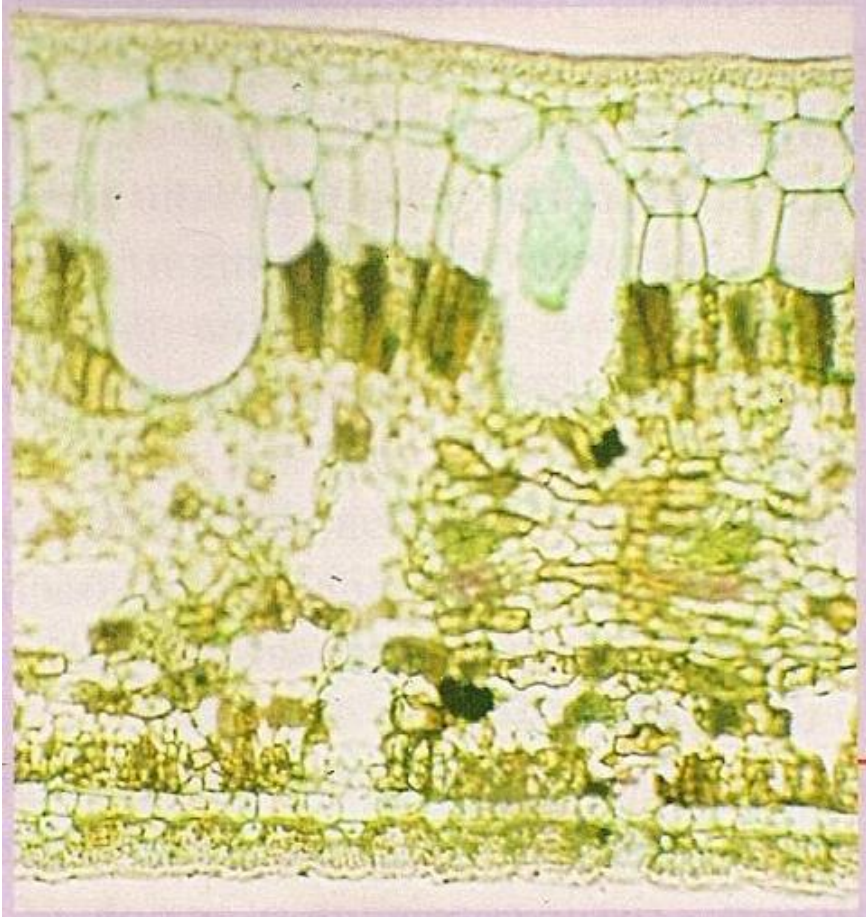
Inside vascular bundles, they transports **water and dissolved inorganic (mineral) ions** form the roots to the leaf. The cells are dead, containing no cytoplasm. They are stacked on top of one another and because the end walls break down they form a long continuous hollow tube. The walls are often impregnated with lignin which provides the plant with support

Phloem sieve tubes:

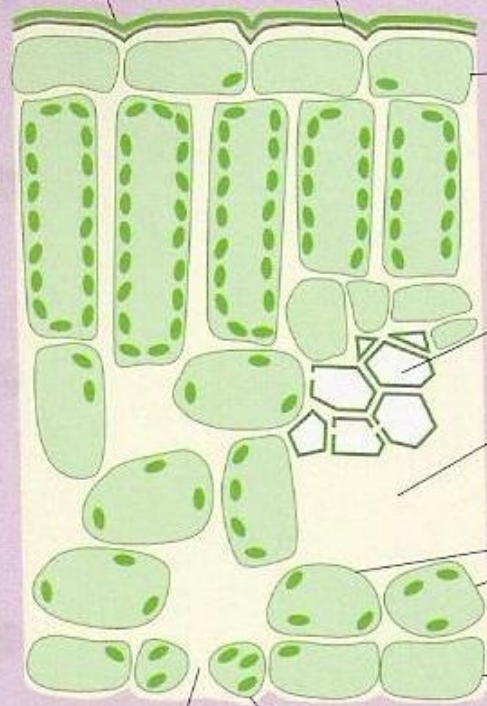
Living cells that transport soluble organic substances such as **sucrose** away from the leaf and around the plant (translocation) e.g. to the roots to be stored. Consists mostly of **sieve tubes** (cells with no nuclei joined end to end with perforations in their cell walls to form sieve plates)


xylem
phloem
vascular bundle

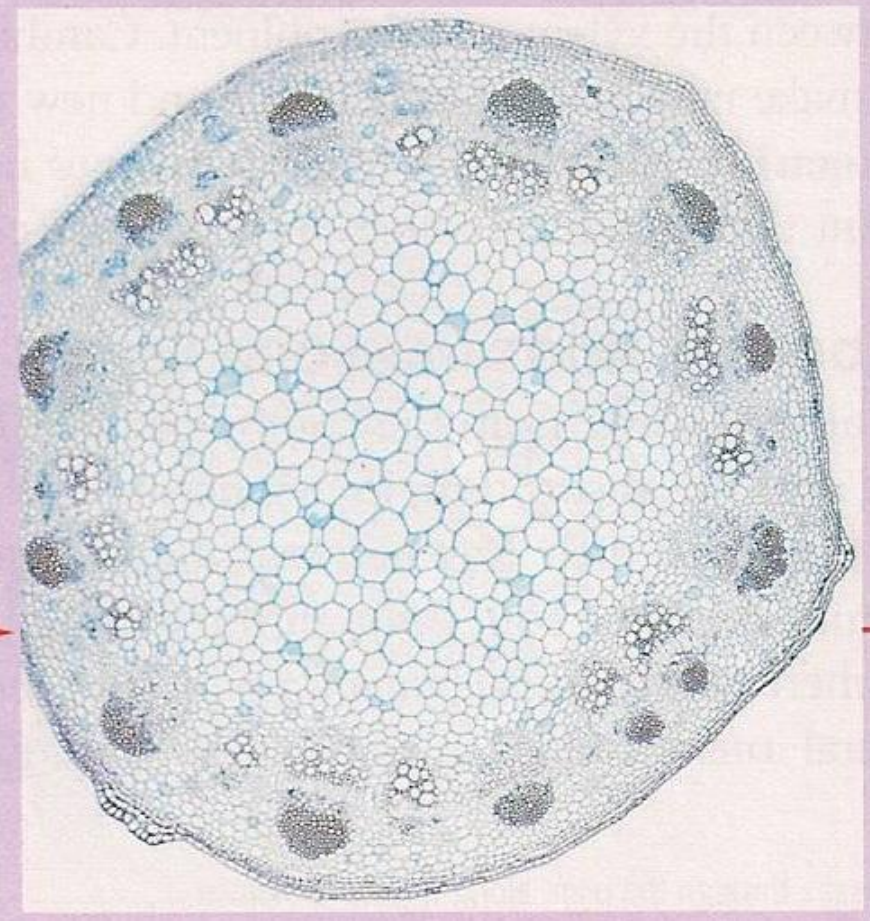
(a) Section through a leaf

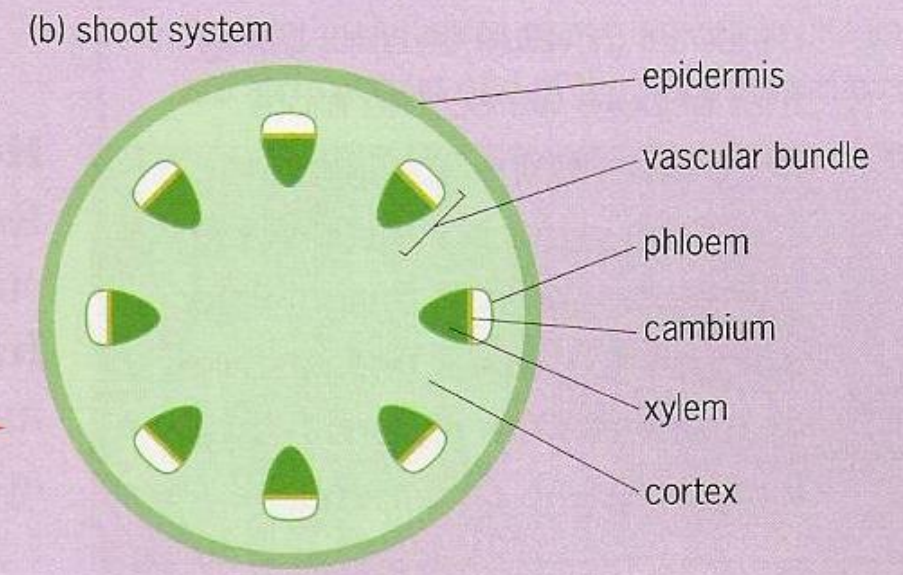


(c) leaf section

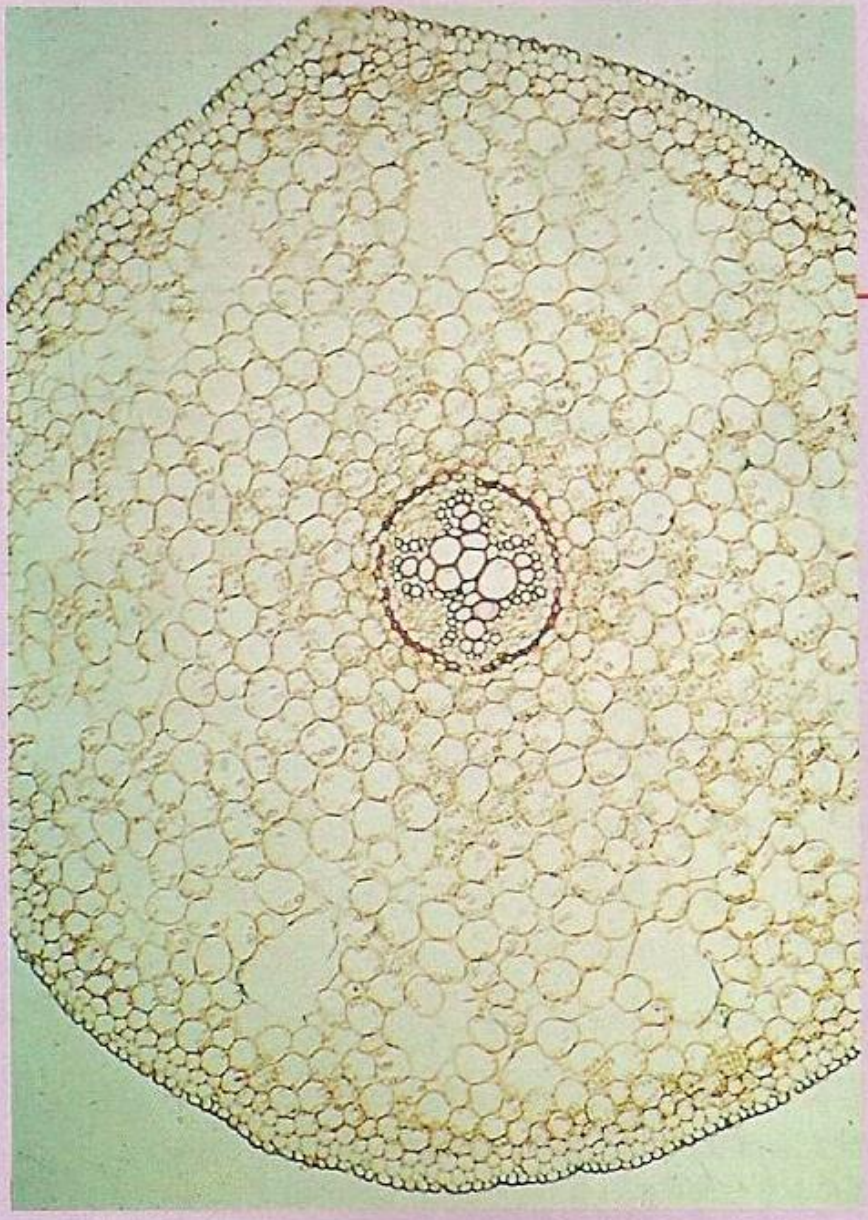


(b) Section through a stem. Note the separate vascular bundles

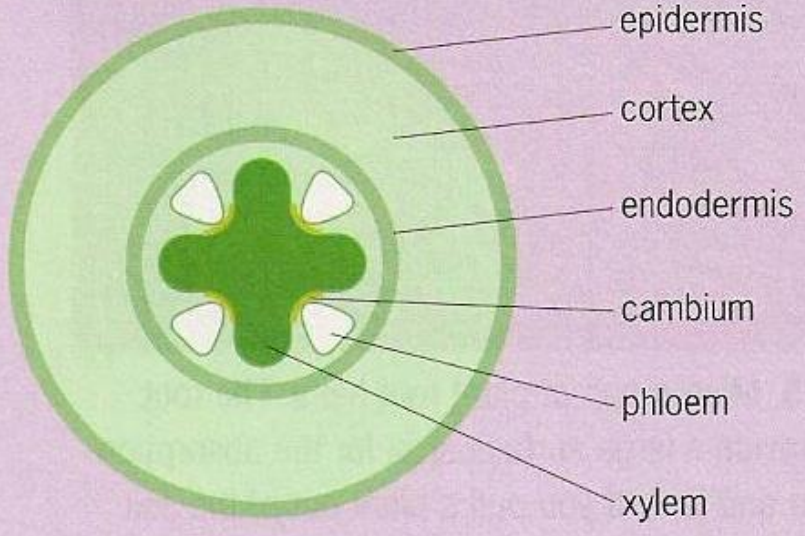




(c) Section through a root. Note the central vascular bundle and the X-shaped xylem



(a) root system



Photosynthesis

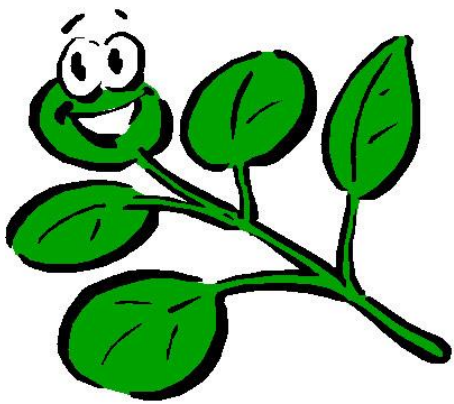
- Photosynthesis is the process by which living organisms, particularly plants, capture solar energy and use it to convert carbon dioxide and water into simple sugars

- Qu.: *What is the equation for photosynthesis?*

CO_2 + Water ⟶ Glucose + O_2

$6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$

This process is dependent on pigments, particularly chlorophyll present in the chloroplasts



Adaptations of the leaf for photosynthesis

- *Look at the points on the next slide and rewrite the adaptations of the leaf under these headings:-*

1. **Increasing exposure to sunlight**
2. **Efficient gas exchange**
3. **Transport of materials**
4. **Reducing water lost through transpiration**

Adaptations of the leaf shown in Fig 9.3:

- It is thin, so that gases can diffuse in and out quickly.
- It has a large surface area to maximise light absorption.
- It has a thin layer of wax – the **cuticle** – to reduce evaporation from the upper surface.
- It has a rich network of **xylem** fibres to deliver water and minerals, and **phloem** fibres to remove the product of photosynthesis (mainly as sucrose). This vascular tissue also gives the leaf more rigidity.
- The cells of the upper epidermis have no chloroplasts, so that more light gets through to the palisade cells.
- The palisade cells are deep and tightly packed. The chloroplasts within them can move so that all have a chance of obtaining all the light they need.
- Guard cells surround pores called **stomata** (singular = stoma; 'hole') opening in the day to allow carbon dioxide in, then closing at night to reduce water loss.
- Loosely packed **spongy mesophyll** cells create air spaces, making gas exchange more efficient between the atmosphere and the palisade cells. The air spaces also trap a little carbon dioxide, allowing some photosynthesis even when the stomata are closed.

PRACTICAL WORK

- Examine sections of a mesophytic leaf (from light microscope or photographs):

  - recognise the epidermal layers, waxy cuticles, palisade mesophly, chloroplasts, spongy mesophyll, vascular vessels with xylem and phloem, and guard cells and stomata

- Make accurate drawings of sections of the ileum and leaf to show the tissue layers:

  - draw block diagrams of tissues within the ileum and the leaf

Block diagram guidance

A drawing showing blocks of tissues remains a difficult skill for many candidates. This was a relatively simple leaf structure easily illustrated by slightly curved horizontal lines. Each of the five marks required particular components of the drawing.

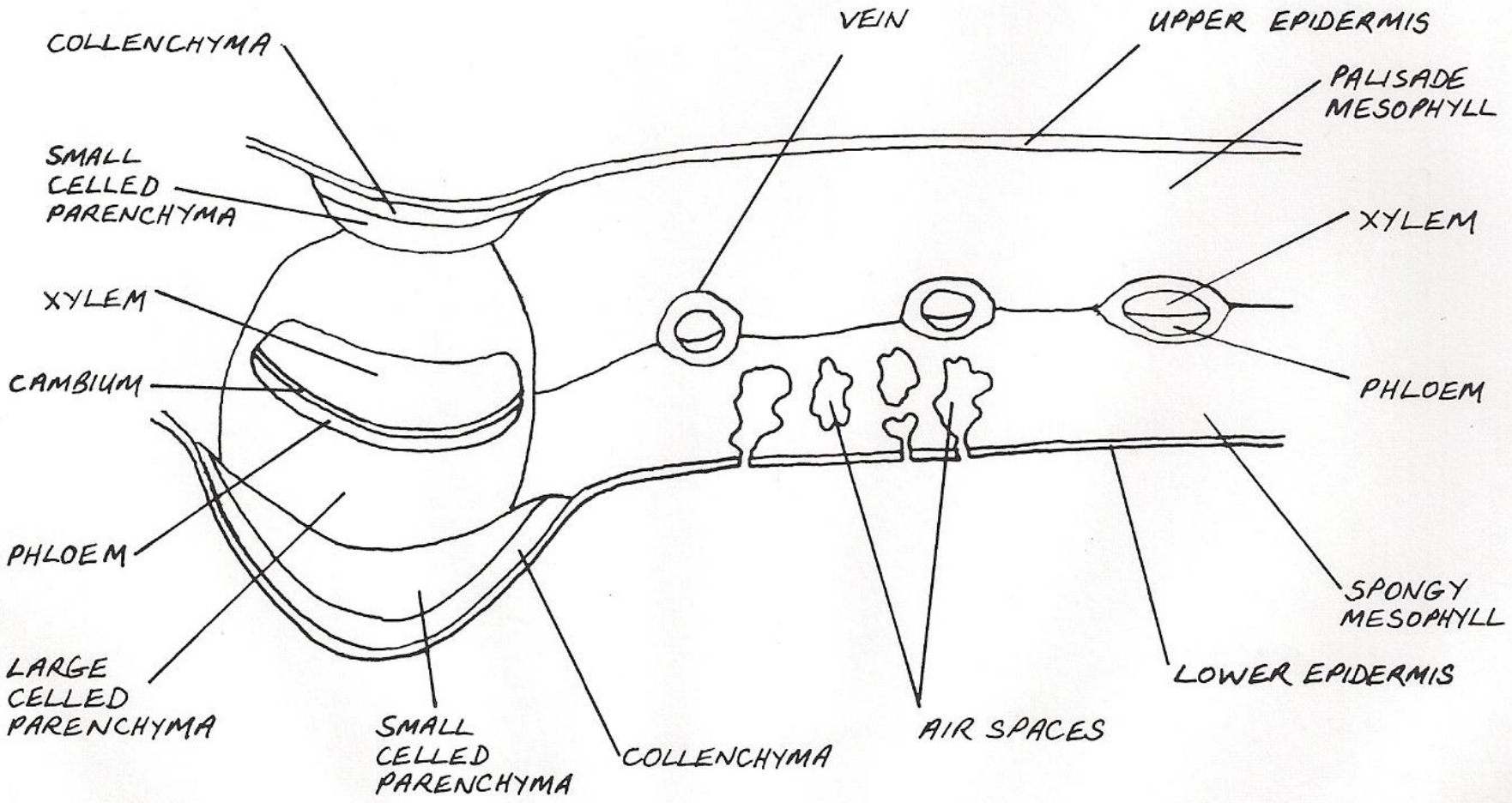
1. A series of lines drawn to illustrate blocks of tissue. There was no need to include cells.
2. The blocks indicating upper epidermis, (shown as one or two layers of tissues), the palisade and spongy mesophyll layers, and the lower epidermis were required to show completeness of the drawing. The inclusion of vascular tissue was not assessed.
3. The slight curvature of the leaf was an indicative feature required to illustrate the photograph.
4. Upper epidermis wider than lower epidermis indicating the proportionality of the drawing.
5. The lines drawn must be unambiguous, (not sketchy or incomplete).

Mesophytic leaf block diagram

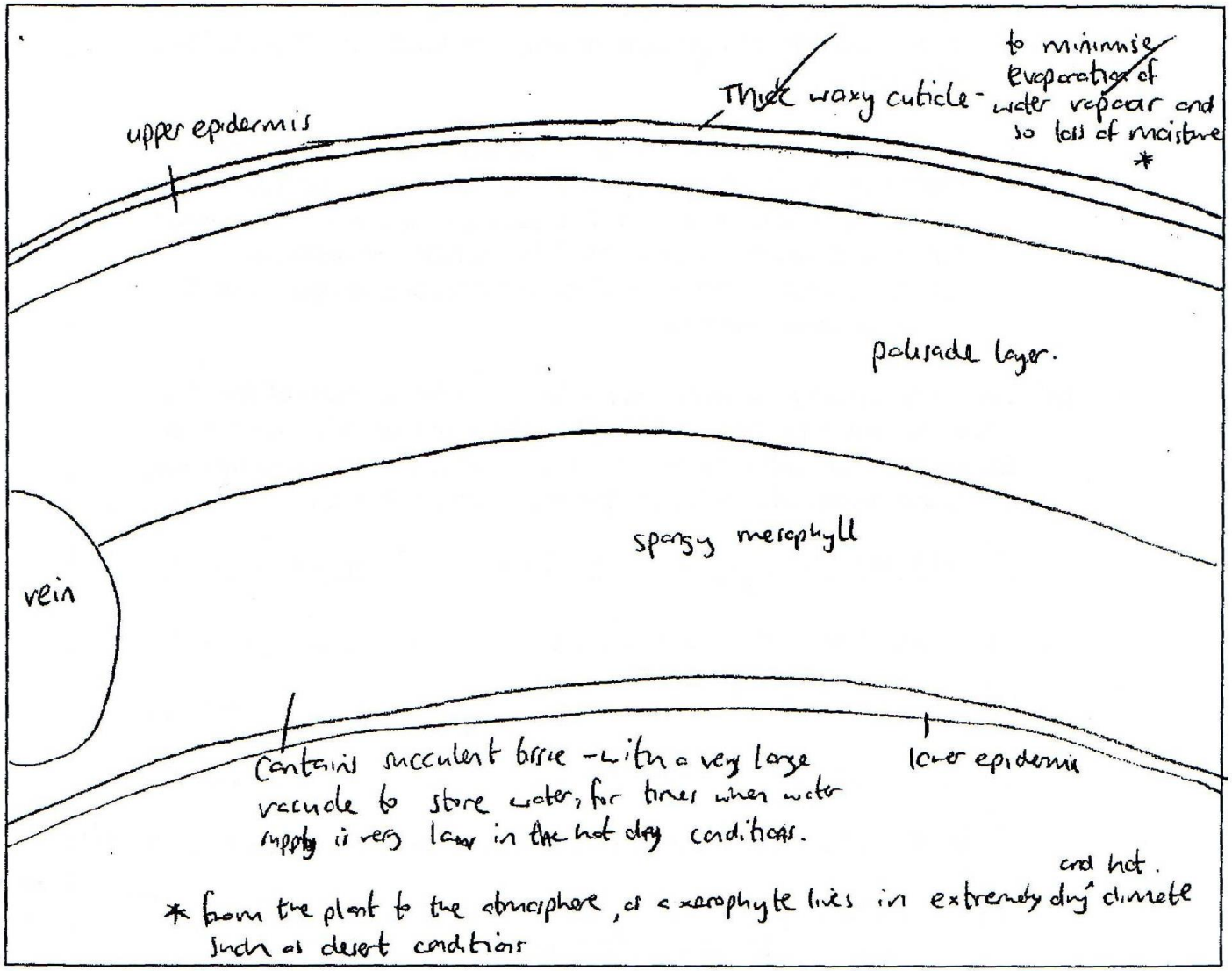
DICOT

LIGUSTRUM LEAF:
T.S. X60

Fig. 3.11



Example of a block diagram from a cross section of a tobacco leaf (shows xerophytric adaptations allowing it to survive in dry climates)



AS sample question and answers:

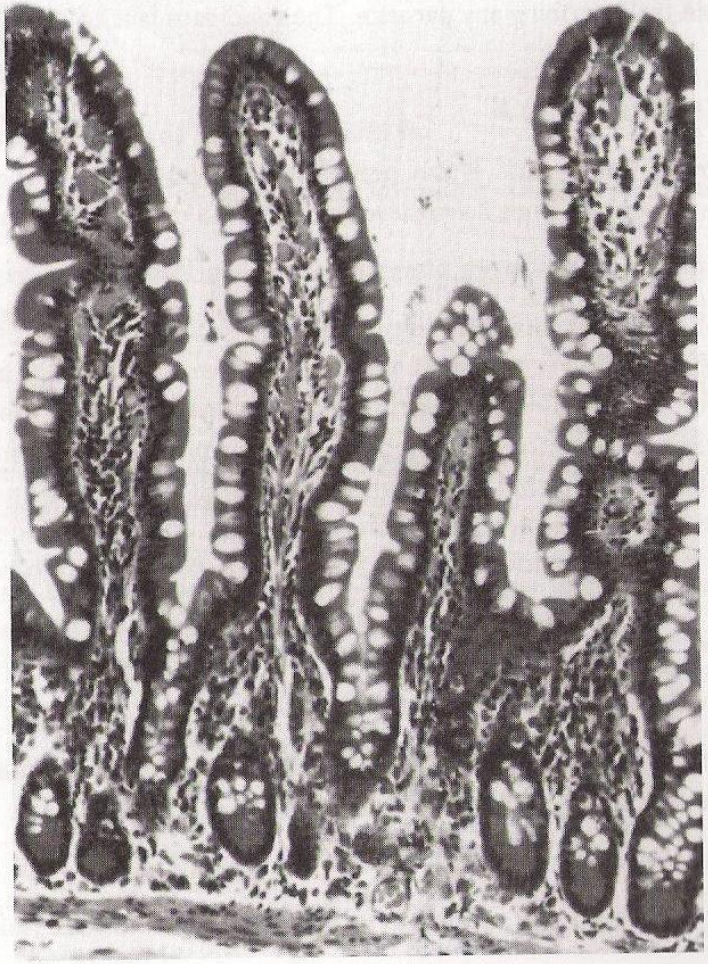
Question 5

The photograph below is a photomicrograph of a transverse section through part of the wall of the small intestine (ileum).

Draw a block diagram to show the tissue layers in the ileum, as shown in the photograph. Label the drawing to identify at least five structures.

(9 marks)

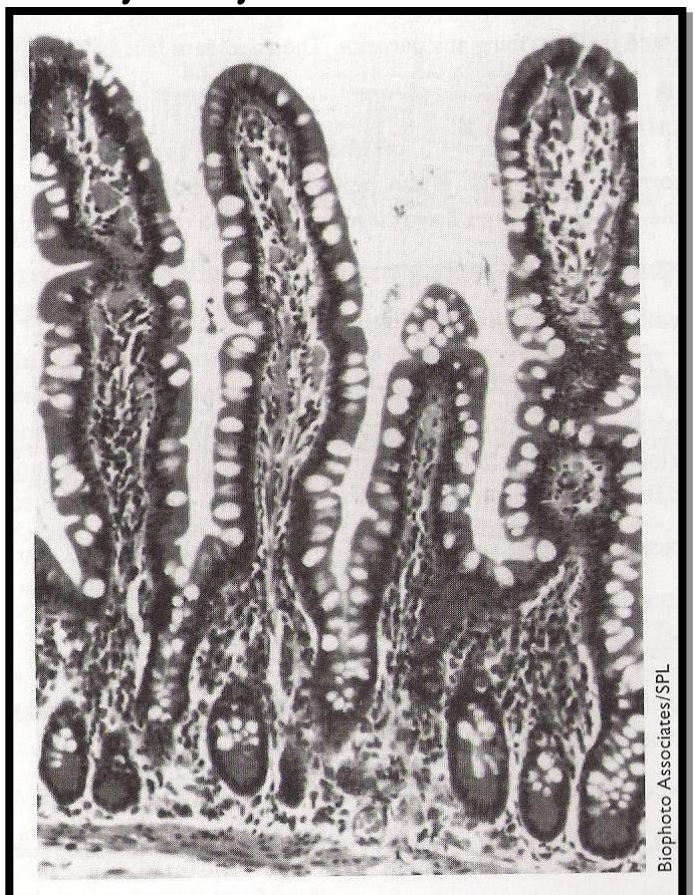
Total: 9 marks

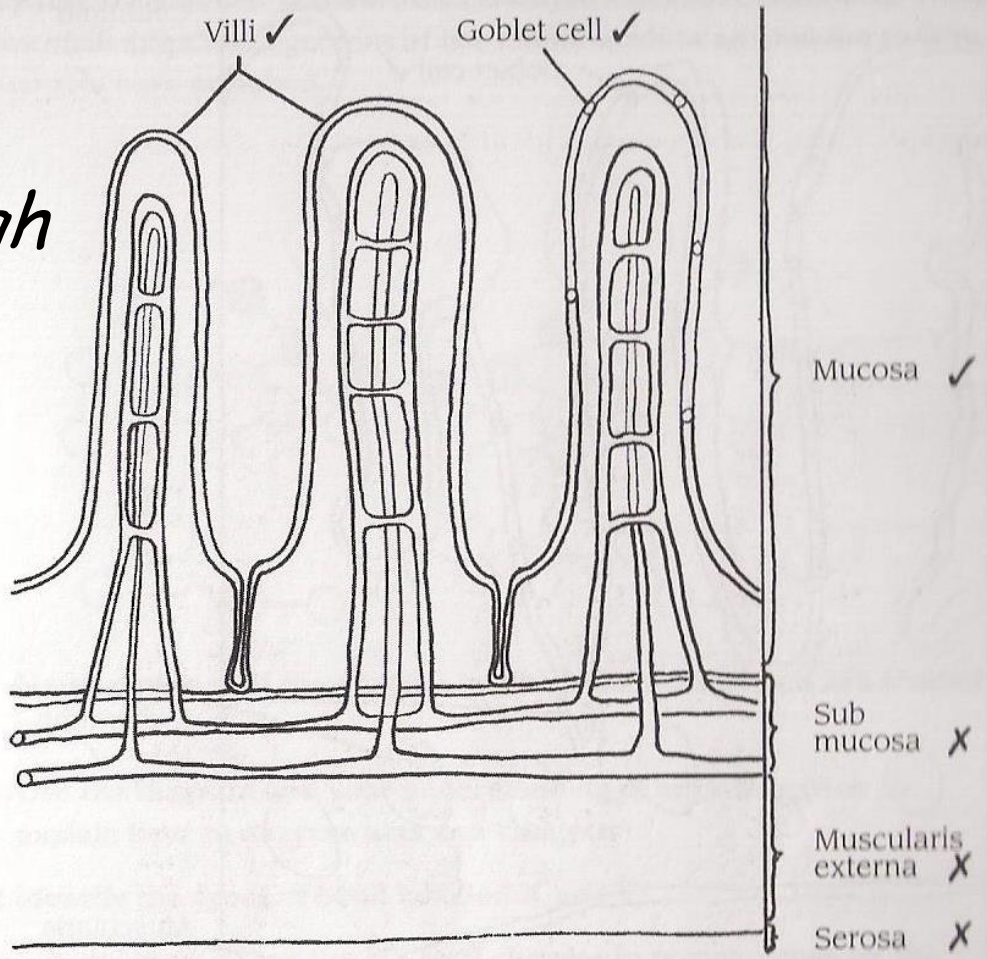


Biophoto Associates/SPL

Candidate A's answer:

Too much like a text book diagram, not enough like the actual photomicrograph, and not proportional sizes



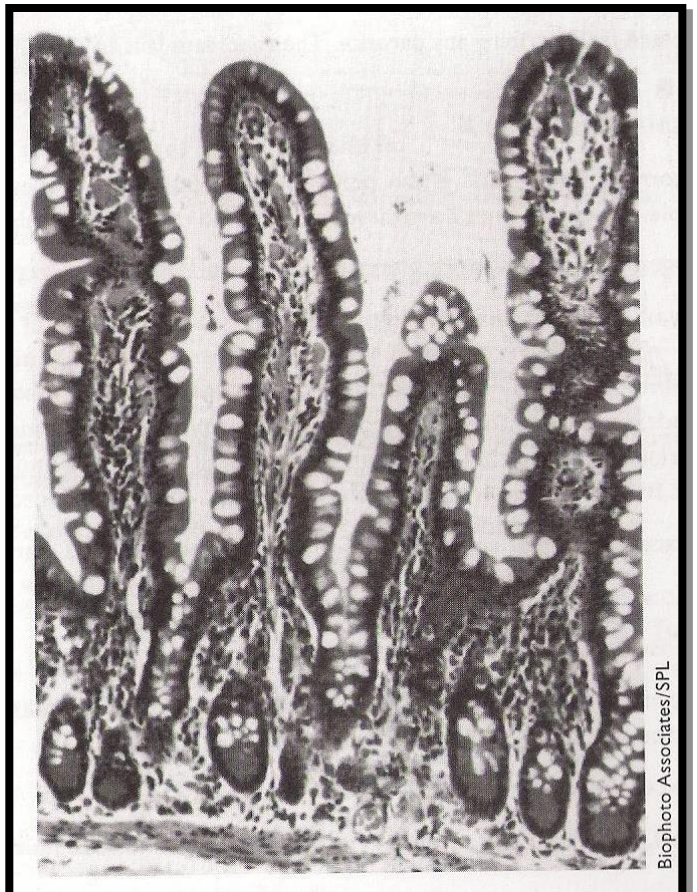


This is a well-learned textbook diagram. It is a block diagram showing tissue layers ✓ and has a degree of completeness in showing the tissues obvious in the photograph ✓. However, it is not an accurate representation of the photograph ✗ and it lacks the proportionality of the features shown ✗. The lines drawn are smooth and continuous, not sketchy ✓. The candidate earns 3 marks out of 5 for drawing skills.

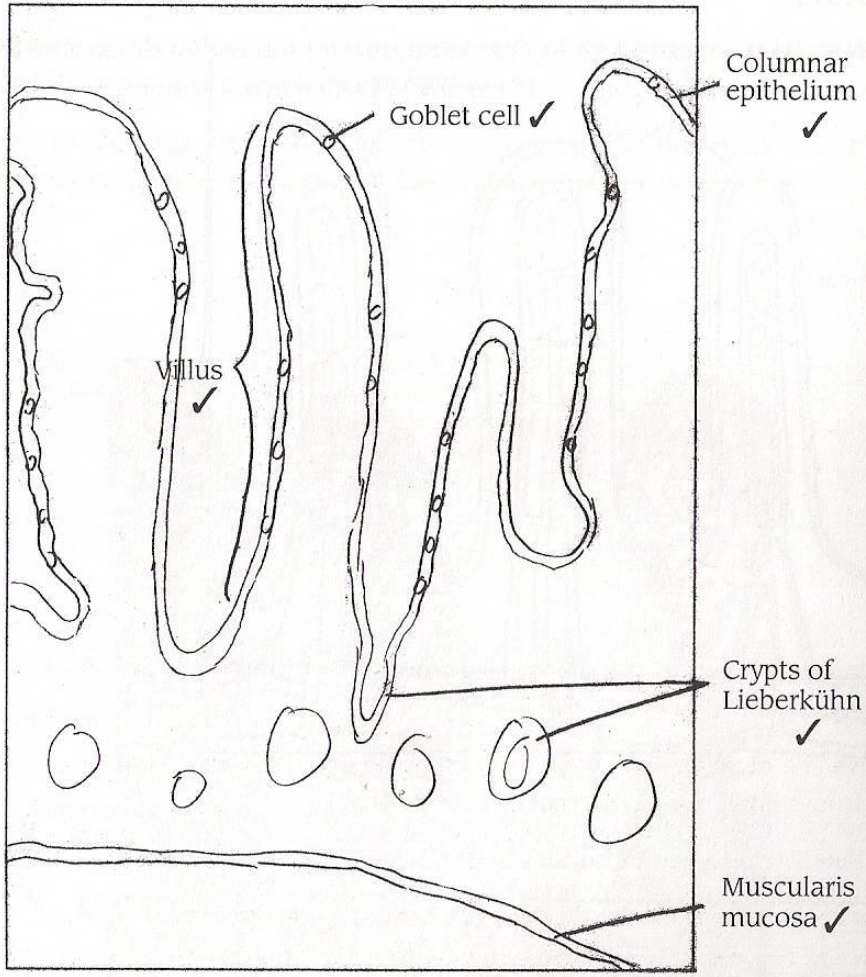
Five labels are required for 4 marks etc. The candidate has three features correct, so gains 2 marks. The layers submucosa, muscularis externa and serosa are not included in the photograph and so cannot be awarded marks.

Candidate B's answer:

Better representation of the picture and correct tissue layers labelled, although some lines are sketchy



Candidate B



This is a block drawing showing tissue layers ✓ that illustrates all the obvious features ✓. It is a fair attempt to draw the photograph ✓ and the proportionality of features is sufficiently accurate ✓. However, the lines tend to be sketchy in places, and circular structures, such as those for the goblet cells, are incomplete ✗. The candidate earns 4 marks out of 5 for drawing skills.

Five labels are correctly identified, for 4 marks.

Overall, Candidate A scores 5 marks and Candidate B scores 8.

REVISE, REVISE, REVISE FOR YOUR MOCK, MOCK, MOCK!