

ORGANISM LEVEL BIOLOGY

PART #1: PLANT

UNIT 1: PLANT NUTRITION

Learning Outcome

Students should be able to:

- Describe the differences between the terms autotrophic and heterotrophic nutrition.
- Identify and describe the functions of cuticle, epidermis, palisade mesophyll, spongy mesophyll, vascular bundle, stoma, guard cell and air space.
- Explain how factors such as carbon dioxide, light intensity, water, temperature and concentration of carbon dioxide may affect the rate of photosynthesis.

- All plants are **autotrophs** because they can make their own food by the process of photosynthesis.
- Plants trap sunlight in the chloroplasts to make glucose (food).
- Humans are heterotrophs (unable to make their own food).

STRUCTURE OF A LEAF

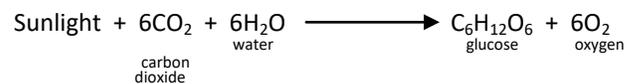
- Leaves in plants are the specialized organ where photosynthesis occurs.
- Leaves have large surface area to capture as much sunlight as possible ensuring maximum rate of photosynthesis.

Refer to page 2

PARTS OF THE LEAF & ITS FUNCTIONS

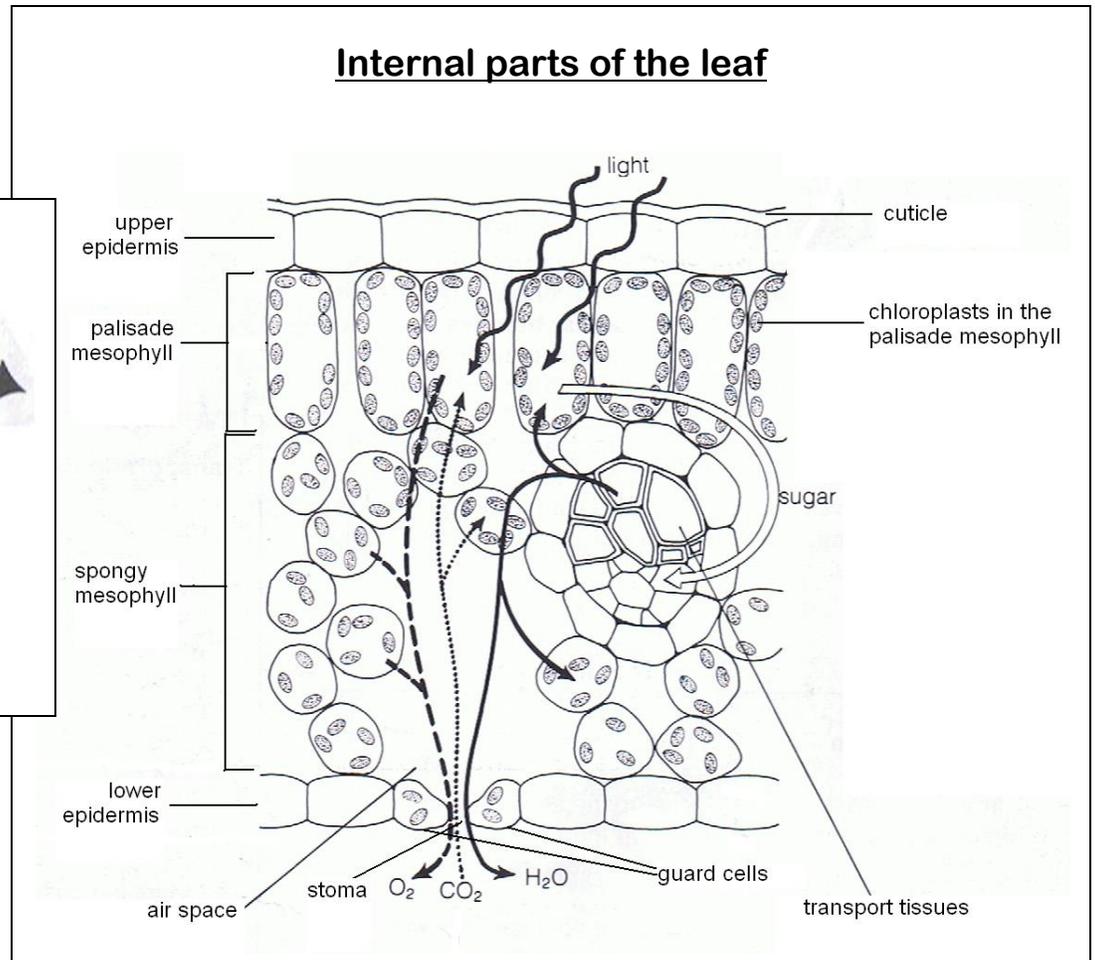
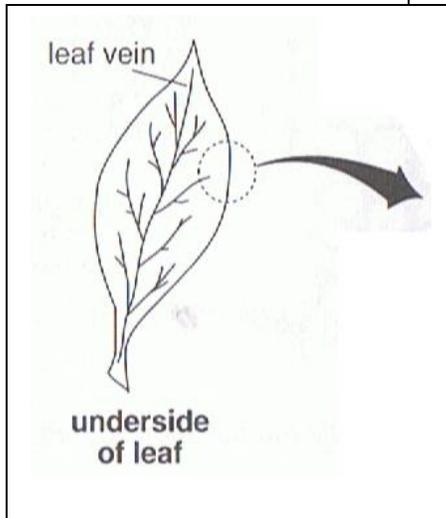
Leaf Structure	Features	Functions
1. Cuticle	<ul style="list-style-type: none">• Has a waxy layer	<ul style="list-style-type: none">• Prevent water loss (water proof)
2. Epidermis	<ul style="list-style-type: none">• Thin layer (approx 1-3 layer of cells)	<ul style="list-style-type: none">• Protect leaf from injury
3. Palisade mesophyll	<ul style="list-style-type: none">• Regular shape• Tightly packed with cells filled with chloroplasts	<ul style="list-style-type: none">• Site of photosynthesis
4. Spongy mesophyll	<ul style="list-style-type: none">• Irregular shape• Many cells are surrounded by airspace.	<ul style="list-style-type: none">• Main site of gas exchange.• Air space facilitate the diffusion of gases (CO₂, O₂)
5. Stomata	<ul style="list-style-type: none">• Surrounded by guard cells	<ul style="list-style-type: none">• Controls gas exchange

Photosynthesis Equation:



In plants, photosynthesis is very important to keep plant supplied with food.

Internal parts of the leaf



Factors that affect the rate of photosynthesis

1. **Water Availability**

As more water becomes available to the plants the more photosynthesis that will occur in its leaves. This is shown by rapid growth of plants in area that has abundance of water supply.

2. **Availability of Carbon Dioxide**

The more CO₂ gas available for the plants, photosynthesis occurs at a faster rate.

3. **Temperature**

Photosynthesis occurs best in warm temperatures. Plants grow quicker in warm glass houses than in frosty areas. Plants growing in cold areas appear to be stunted in growth.

4. **Light Intensity**

The more light captured by the plants (through its leaves), the more photosynthesis that occurs. Plants growing in shady area receive less sunlight and appear to be growing at a slower rate compared to plants exposed to direct sunlight.

5. **Wavelength of Light**

Photosynthesis is greatest at blue and red light because chlorophyll absorbs these colours. *(Since chlorophyll reflects green light, plants that are exposed to green light have very low rates of photosynthesis).*

6. **Chlorophyll concentration in chloroplasts**

The more chlorophyll present in the chloroplasts, the faster the rate of photosynthesis.

Chlorophyll - is the green pigment in plants that gives leaves its green colour. Chlorophyll contains magnesium. In plants lacking magnesium, the leaves turn yellow because not enough chlorophyll is present. The growth rate of such plant is slow.

UNIT 2: GAS EXCHANGE IN PLANTS

Learning Outcome

Students should be able to:

- Identify the gases exchanged during photosynthesis and respiration.
- Explain how the guard cells regulate the movement of gases.
- Explain how stomata help to cool the plant by evaporation.

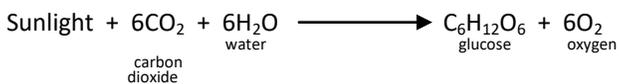
Gas exchange in leaves occurs through the stomata which are located mainly in the lower epidermis of a leaf.

[refer to the diagram on page 2]

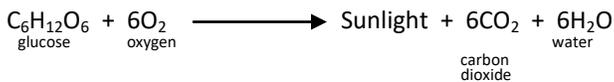


RECALL

Photosynthesis Equation:



Respiration Equation:



Gas Exchange at DAY time

- Carbon dioxide (CO₂) produced during the day through respiration are mostly recycled and used up by the plant again in the photosynthesis process.
- However, respiratory CO₂ alone cannot meet the demands of photosynthesis, so more CO₂ diffuse through to the leaves through the stomata.
- The oxygen gas (O₂) produced in the process of photosynthesis during the day is in surplus amount compared to the amount required for respiration.
- Thus, some oxygen is recycled for plant respiration but the excess amount of oxygen diffuses out through the stomata.

Gas Exchange at NIGHT time

- The absence of sunlight at night means that the process of photosynthesis cannot occur.
- Therefore at night, the only process taking place in plants is respiration.

OVERALL GAS BEING EXCHANGED

DAY TIME

Gas diffusing into the leaf = CO₂

Gas diffusing out of the leaf = O₂

NIGHT TIME

Gas diffusing into the leaf = O₂

Gas diffusing out of the leaf = CO₂

STOMATA

- The leaf epidermis (upper & lower) is covered with tiny pores called stomata. There are more stomata present in the lower epidermis compared to the upper epidermis.
- Each stoma has a special guard cell on each side. The guard cells are usually the only cells in the epidermis to have chloroplasts.
- The opening and closing of the stomata controls the entry and exit of both gas and water from the plants.
- Stomata are also the major route in which water escape or lost from the plants through transpiration.
- About 90% of the water lost from the plant occurs in the stomata.



Figure 1.1: Electron micrograph of the lower epidermis of a leaf showing the stomata.

HOW STOMATA CONTROL GAS EXCHANGE & WATER LOSS

- ✓ When guard cells absorb water, they swell up (turgid). The inner wall of the guard cells thickens causing the cells to bend slightly causing the pore (stoma) to open. When the stoma opens, gas and water can move in and out of the leaf.
- ✓ In the absence of water, the guard cells lose water causing the cells to shrink and become flaccid. As the cell becomes flaccid, the two guard cells close the pore and the stoma closes. When the stoma closes, gas and water are not allowed to move in and out of the leaf.

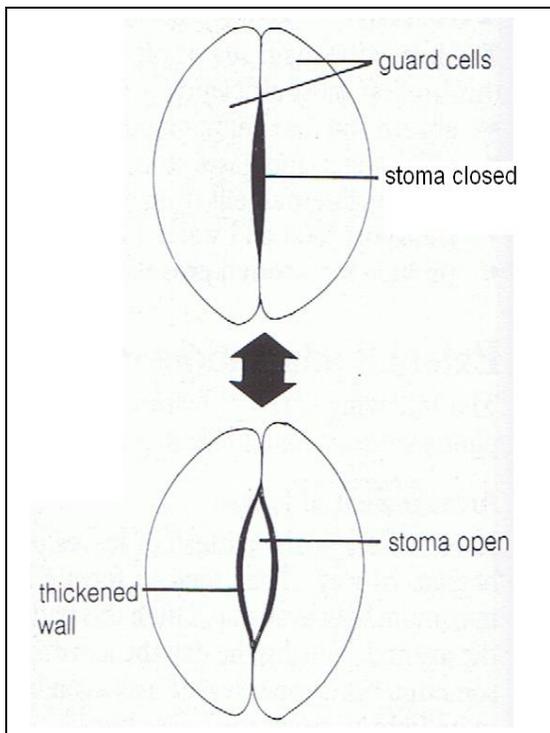


Figure 1.2: Action of Guard Cells to Open and Close Stomata

- ✓ Generally, stomata open during daylight hours when photosynthesis is greatest and the requirement for carbon dioxide is highest.

TRANSPIRATION

Transpiration is the process in which water is lost from the plants through the stomata.

- ✓ Plants lose water all the time, despite the adaptations they have to help prevent it (eg. Waxy cuticle).
- ✓ Approximately 99% of the water a plant absorbs from the soil is lost by evaporation from the leaves and stems.
- ✓ This loss occurs mainly through the stomata.
- ✓ The flow of water through the plant is called the **transpiration stream**.
- ✓ Plants rely on a gradient in water concentration from the roots to the air to move through their cells.
- ✓ Water flows passively from soil to air along a gradient of decreasing water concentration.
- ✓ This gradient is the driving force in the rise of water up a plant.
- ✓ Transpiration seems like a wasteful process, but it has benefits:
 - Constant water loss ensures water flowing constantly inside the plants. This help cools the plant.
 - The transpiration stream helps the plant to maintain an adequate mineral uptake as many essential minerals occur in low concentrations in the soil.

Three processes that contribute to the movement of water up the plants are:

1. **Transpiration Pull**

- Water lost from the air spaces of leaves by evaporation through stomata is replaced by water from the mesophyll cells.
- The constant loss of water to the air creates a lower water potential in the leaf cells that in the cells further from the evaporation site.
- Water is pulled through the plant along a **decreasing gradient in water potential**.

2. **Cohesion**

- The transpiration pulls is assisted by the special cohesive properties of water. Water molecules cling together as they are pulled through the plant and they adhere to the walls of the xylem.
- This creates an unbroken column of water through the plant.

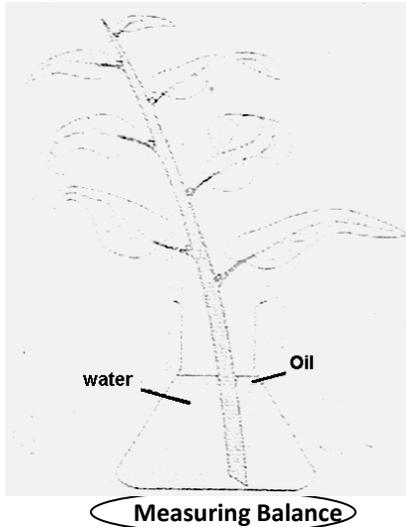
3. **Root Pressure**

- Water entering the root from the soil creates a root pressure: a weak 'push' effect from the waters upward movement through the plant.

Transpiration is measured using equipment called **potometer**.

Two types of Potometer

(i) **Weight Potometer**

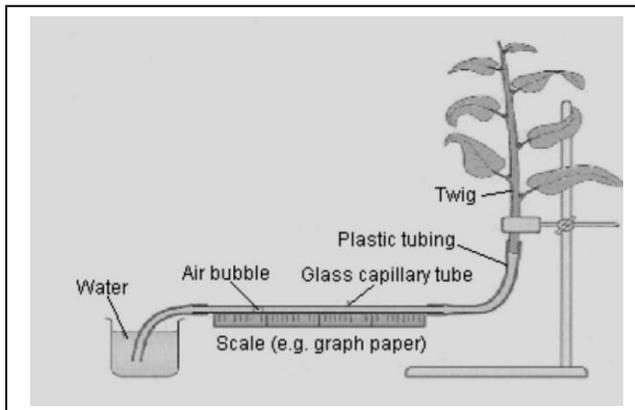


Mass: (Beaker + H₂O + Oil + Leaf Stem)

Note: loss of weight is due to transpiration.

- The purpose of putting oil into the beaker is to prevent any water lost from the beaker of water so that the scale accurately measures just the amount of water lost from the plants only.

(ii) **Bubble Potometer**



- The bubbles will move along the glass capillary tube as water escapes from the leaves.
- The faster the bubble moves implies water being lost (transpiration) at a very fast rate.

Ways in which the plants reduce water loss through transpiration.

1. Stomata set into pits in the leaf – increases distance for water vapour to diffuse, thus reducing the water concentration gradient.
2. Hairs on the leaf structure ‘traps’ air around water – therefore reduces the water concentration gradient and thus transpiration.
3. Leaves reduced to spines (e.g cactus) – transpiration only occurs through their stems.

- * All plants can control the rate of transpiration by the opening and closing of the stomata.

Factors affecting the rate of transpiration.

Since the rate of transpiration depends upon the concentration gradient of water inside the leaf and outside the leaf, any factor affecting the concentration gradient also affects the rate at which is being lost from the plant.

Such factors include:

1. High temperature

- On hot sunny days, plants tend to lose water quicker as heat speeds up the rate of water evaporation from leaves.
- In doing so, it reduces the water concentration outside the leaf, further gapping it from the water concentration inside the leaf.
- As a result, water will move out of the leaf at a faster pace in order to equalize the difference in concentration.

2. Light intensity

- Increasing light intensity results in more rapid transpiration.
- On sunny days, light intensity increase which causes the plant to lost lots of water through its stomata.

3. Low humidity

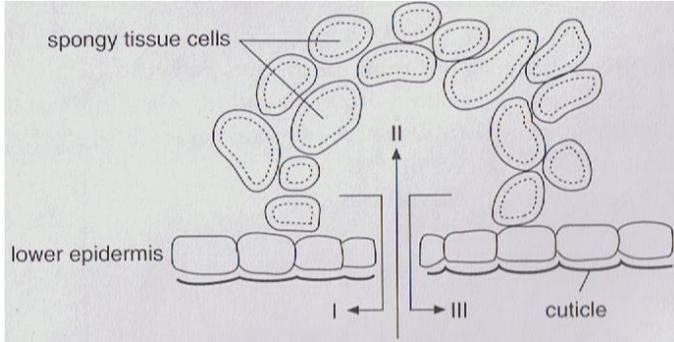
- When air is less humid (i.e low water concentration) leaves tend to lose water faster to surrounding air due to the existing water concentration gradient.
- On humid days, the atmosphere outside stomata is high in water vapour, so transpiration is slow.

4. High Wind

- Windy condition blow off water quickly from surface of leaves, thus evaporation tends to occur at a faster rate.
- On windy days, water vapour is blown away, resulting in a lower water concentration just outside the stomata. The high gradient of water concentration existing between the leaf and the atmosphere results in rapid transpiration.

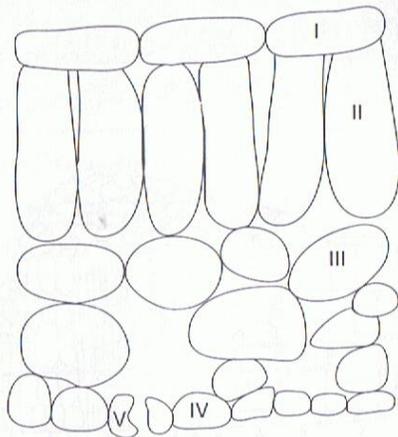
Self-check #1.1: Plant leaves – its structure & functions

1. Question 1 and 2 are based on the following diagram of a section through the lower part of a leaf. The arrows represent diffusion of some substances from the air.



- a) During photosynthesis, what do the arrows labelled I, II and III represent.
 - i. Arrow I
 - ii. Arrow II
 - iii. Arrow III
- b) If the stoma was open in the dark, what "gas" would arrow II represent?

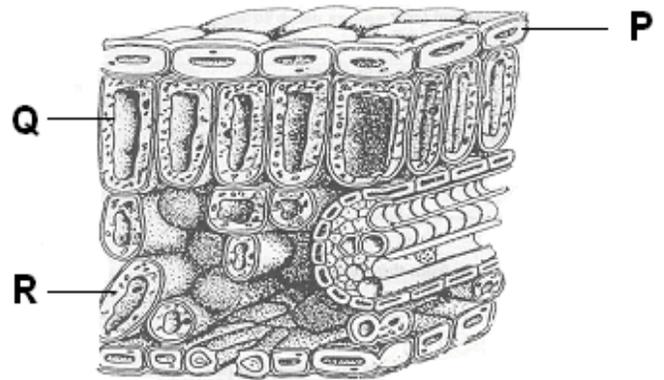
2. The diagram below shows part of a vertical section through a green leaf.



- a) What number represents the following cells?
 - i. A guard cell
 - ii. A mesophyll cell
 - iii. A cell that contains no chloroplast
- b) As a result of photosynthesis, plants make sugar. State ONE use of this sugar to:
 - i. The plant itself
 - ii. Human

- c) Define the following terms:
 - (i) Autotrophs
 - (ii) Heterotrophs
 - (iii) Transpiration
- d) Explain in your own words how the following contributes to the movement of water in plants.
 - (i) Cohesion
 - (ii) Transpiration Pull
 - (iii) Root pressure

3. Study the diagram below and answer the question that follows.



- i. Name the structures P, Q and R.
 - ii. State the function of structure P.
4. a) Plants constantly lose water by transpiration. Explain how plants compensate for this.
 - b) Describe ONE benefit of the transpiration stream for a plant.
5. a) Write the balanced equation for the process below:
 - i. Photosynthesis
 - ii. Respiration
 - b) Explain what you understand about each of the two processes.
6. Name 3 environmental conditions that may increase the rate of transpiration in plants. Explain how.
7. Draw and label the guard cells to show when the stomata will:
 - i. Open
 - ii. Close

UNIT 3: SUPPORT & TRANSPORT IN PLANTS

Learning Outcome

Students should be able to:

- Explain why some plants need a system for support and transport of materials.
- Describe the importance of the factors affecting cell turgidity in plant support.
- Describe the structure and function of the stem tissues: epidermis, cortex, vascular bundles (phloem, cambium, xylem) and lignified fibres.
- Describe the structure and function of the root hair.
- Describe translocation, and its role in the transport and storage of materials.

Why Plants need a Transport System?

- To transport water and minerals from the roots to other parts of the plant that needs it.
- Transport glucose from leaves to other parts of the plant.

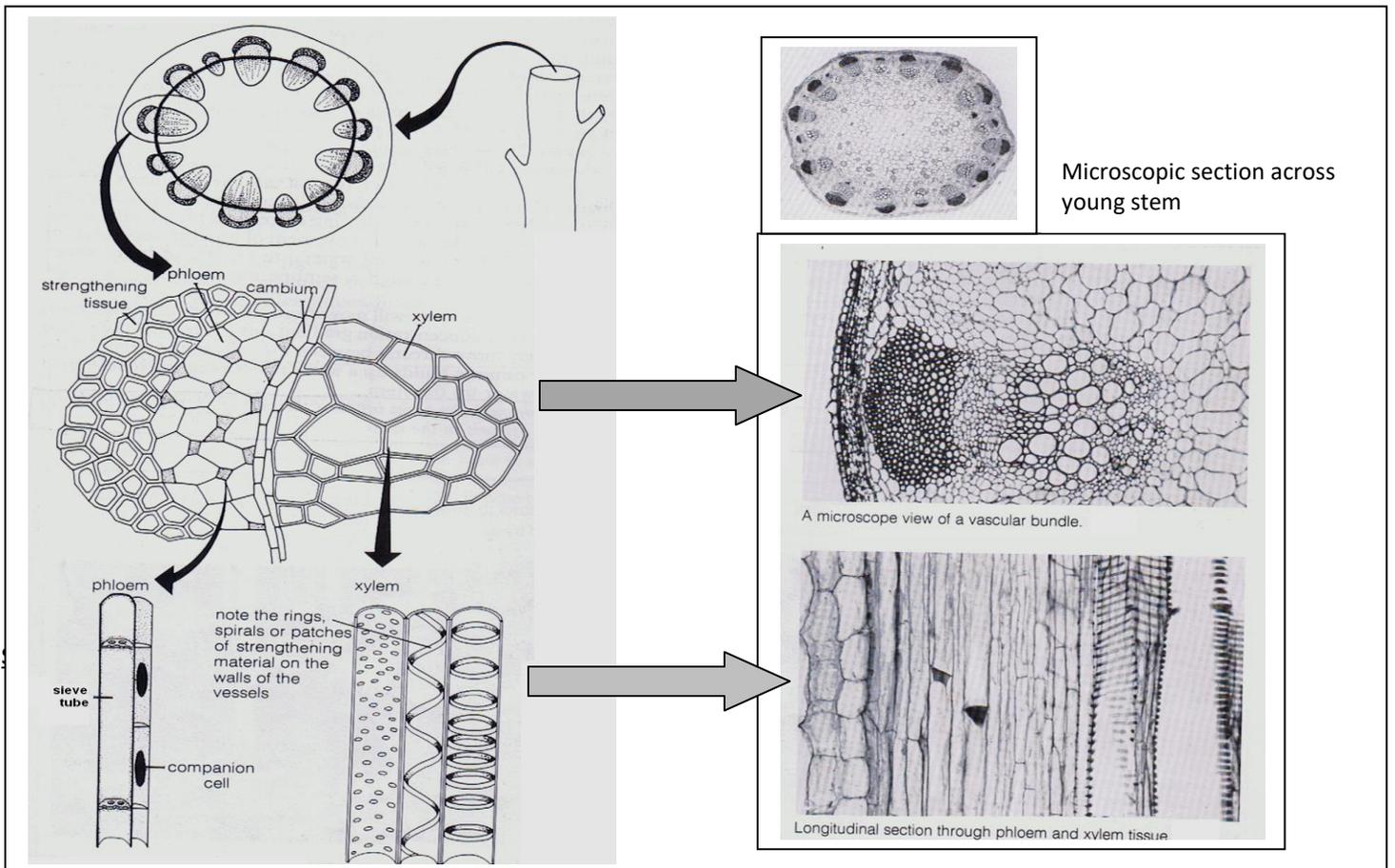
Transport system of plants is found in the **vascular bundle**.

The diagram below shows the cells and tissues that are specialized for transporting materials in the plant. The pattern shown here is typical of the young part of a stem of a dicotyledon.

- Vascular bundles are arranged in a ring form in dicotyledons.
- Vascular bundle consists of:
 - i) Xylem (found on the inside)
 - ii) Phloem (found on the outside)
 - iii) Cambium (in between xylem and phloem)
- The area inside the ring of a vascular bundle is called the **pith**.
- The area between the ring and the epidermis is called the **cortex** (also found between vascular bundles).

Function of various parts of the vascular bundle

Structure	Function
1. Xylem	• Conduct or transport water and undissolved minerals around the plant (particularly from the root to the leaves)
2. Cambium	• Cells that is responsible for growth. The cambium consists of cells that divide to produce new xylem and phloem cells.
3. Phloem	• Transport glucose around the plants (from the leaves of plants down to roots)
4. Epidermis	• Single layer of cells that secrete a waxy covering that helps to prevent too much water loss from plants
5. Cortex	• Surrounds and protects the vascular bundle

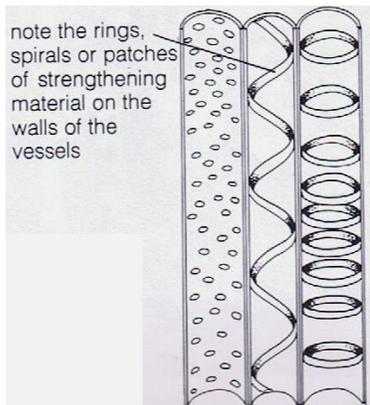


- Unspecialised packaging cells, called **parenchyma** cells, form the inner **pith** and the outer **cortex** and **epidermis**.
- Cambium cells are **meristematic cells**, cells which divide to form other cells.
- Cambium continually divides to form phloem and xylem.

Vascular Tissue

- The xylem and the phloem form long, continuous tubes throughout the plant.
- They also form the main transport system in plants called the **vascular system**.

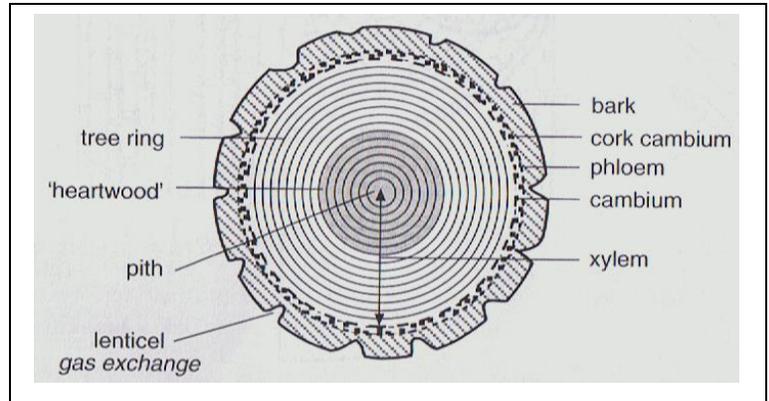
i) XYLEM



- Water conducting tissue.
- Have walls impregnated with **lignin**. Lignin forms the spiral and ring pattern. It also forms a thick wall around the edge of the vascular bundles which gives the plant support.
- In larger plants, xylem stem tissue develops into *wood*.

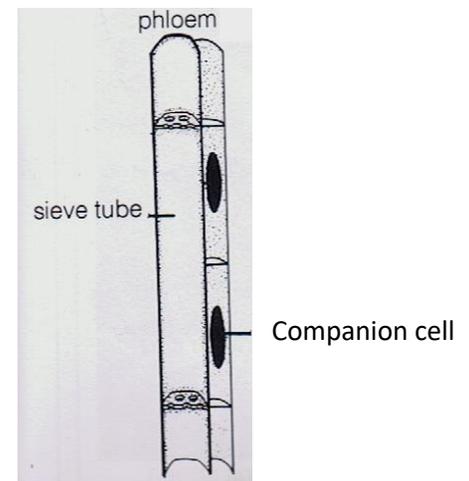
Annual Rings

- In woody plants, vascular bundles fuse together to form a continuous ring.
- Only one ring of phloem cells survives each year, because the phloem from the past year is destroyed by the current year's growth of phloem.
- Hence most of a tree is xylem while phloem forms a very thin layer around the outside.
- Xylem found each year remains, so that after a while the tree becomes largely made up of xylem, which provides the *strength* and *support* for the tree.
- Woody plants from temperate regions of the world (ie those regions with seasonal changes in their climate), different growth rates of xylem in spring and summer appear as conspicuous rings of xylem called **annual growth rings** or **tree rings**.



- In old trees, xylem often becomes full of resins, gums organic compounds and other materials to form **heartwood**, which gives very strong mechanical support.
- Cork cambium, which forms as a ring outside phloem, produces **cork** cells which combine with dead phloem to form **bark**.

ii) PHLOEM

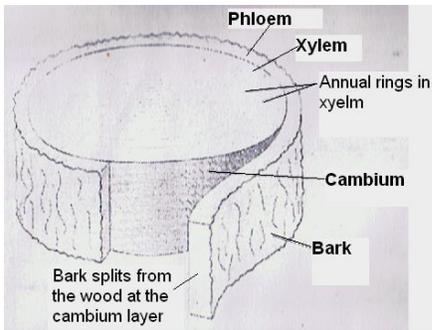


- Phloem is the transporting tissue that carries food particularly glucose produced in the leaves (by photosynthesis) to other parts of the plants that needed it.
- Unlike xylem, phloems are live cells when mature.
- Phloem consists of 2 types of cell:
 1. Sieve tubes
 - These cells consist of sets of tubes end to end, with the end walls punctured by many holes so they look like sieves, called '*sieve tubes*'.
 2. Companion cells
 - Each sieve tubes is attached to a companion cell. The companion cell controls the functioning of the sieve tubes as it has a nucleus and ribosome.

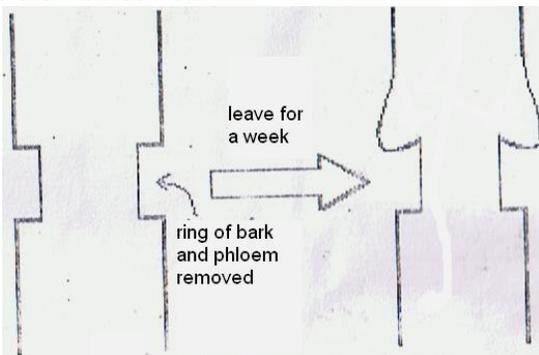
TRANSLOCATION

- the process whereby glucose (food) produced in the leaves can be transported to other parts of the plants in the phloem.
- The phloem can transport food upwards and vice versa.
- Normally food is made in the leaves during the day by photosynthesis and is moved down to be stored in the roots or stems at night.
- However, there are times when the stored food is needed by the plant and the food then moves up the plant.
- Most plant store their excess food in their roots e.g carrots, kumara.....etc.

Ringbarking – the removal of a wide band of bark by cutting it in a complete circle around the trunk of a tree.



- This ultimately kills the tree as the phloem is removed as the bark of the tree is peeled off. This affects the transport of food around the plant.
- Transporting of food around the plant gets disconnected. For this reason, a plant may die after few days of the bark being removed.
- The early pioneer noticed that if they ring-barked a tree, this is what they normally observed after few weeks before the tree dies.



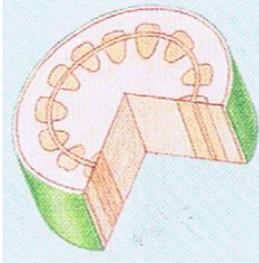
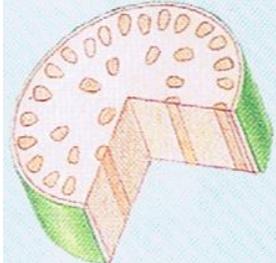
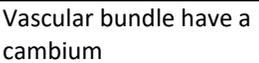
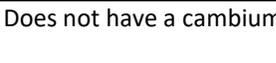
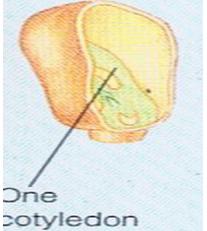
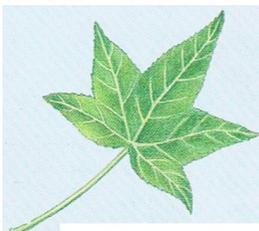
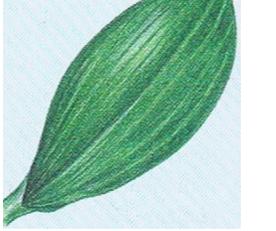
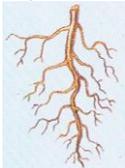
- The swollen trunk is due to the accumulation of the glucose being transported down from the leaves to lower parts of the plants since the phloem has been removed when the bark was cut off.

NOTE:

- Only the phloem is removed when the bark of a stem is cut off. The xylem still remains. Therefore, only the transportation of glucose is affected, but the transportation of water can still be carried out well.

TRANSPORTING TISSUES OF DICOTYLEDON vs MONOCOTYLEDON

- In older dicotyledon stem and in monocotyledons, the pattern of tissues is quite different.
- The table below outline some of the major differences between Dicotyledon and Monocotyledon.

DICOTYLEDON	MONOCOTYLEDON
1. Vascular bundle are arranged in a ring 	Vascular bundle are scattered randomly 
2. Vascular bundle have a cambium 	Does not have a cambium 
3. Has two cotyledons 	Have only one cotyledon 
4. Leaves with a network of veins 	Leaves with parallel veins 
5. Flower parts in 4's or 5's or multiple of 4 or 5 	Flower parts in 3's or multiple of 3 Fibrous root system 

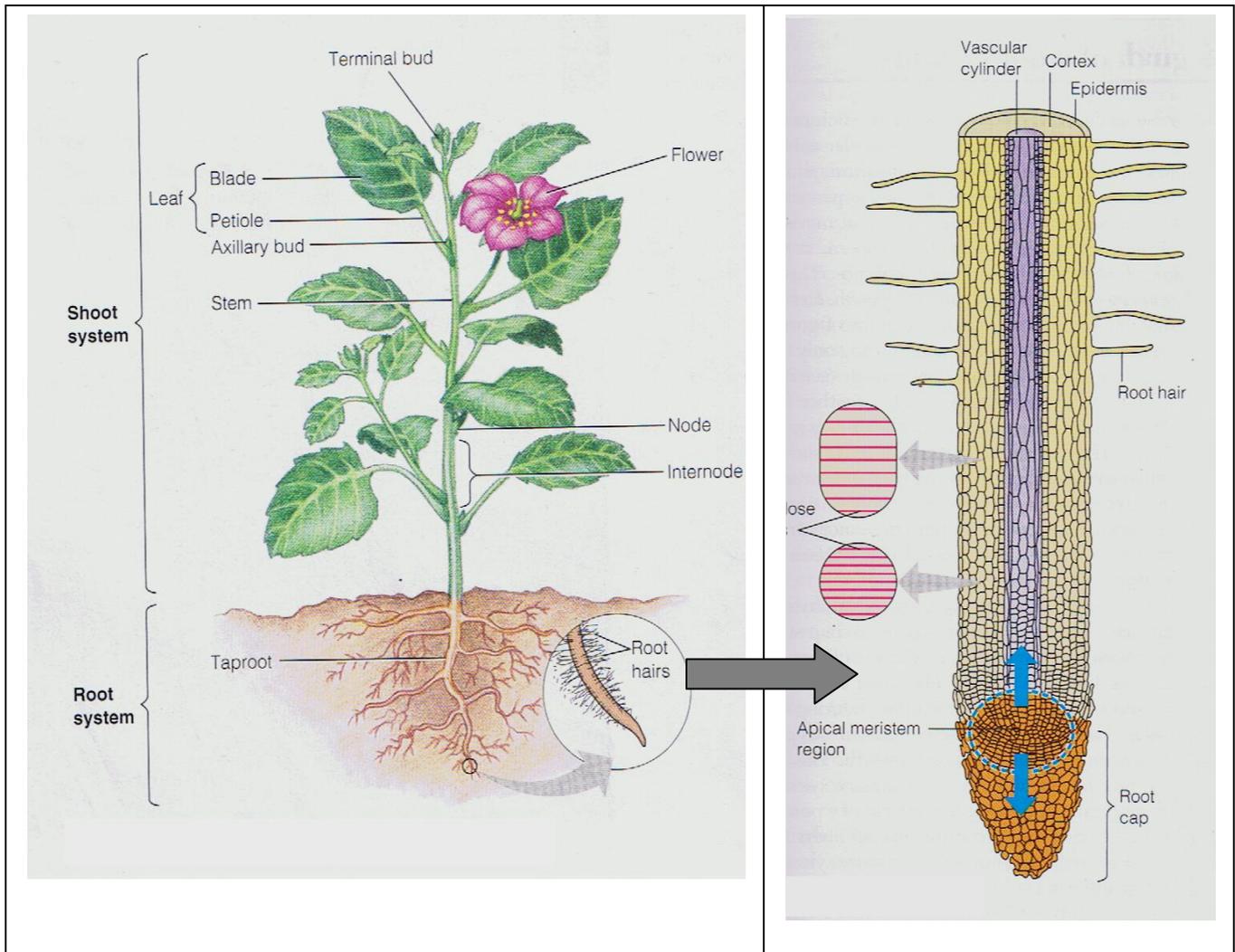
ROOTS

- Water enters the plant through its roots. Thus, the roots of plants have been well structured in order to carry out its function efficiently.
- The growth of roots pushes them through the soil.
- The tip of the root, which is delicate tissues is covered with a root cap. The root cap has cells that secrete a slime which forms some kind of lubrication.
- The type of cells found mostly in the root is meristematic cells. Meristematic cells are responsible for cell division when tips of plants grow. They are also found in the shoots and cambium.
- Delicate root hairs extend from the epidermis. This gives roots a hairy appearance. Root hair increases the surface area in which water absorption by the plant is maximised.

PARTS OF THE ROOT AND ITS FUNCTIONS

Structure	Function
1. Root hair	Increases the surface area for maximum water absorption
2. Root cap	Protect the tip of the root from being damaged.
3. Cortex	Store water and mineral

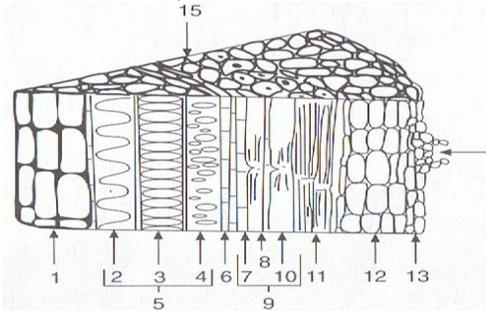
The following diagram shows the plant root and its structure.



Self-check 1.2: Plants Gas Exchange & Support

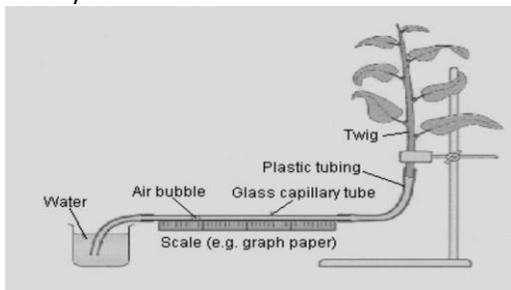
1. Below is a diagram of the structure of part of a plant stem. Match up the numbers with the letters (a) – (g) of the statements below.

(Note: Some numbers may need to be referred to in more than one answer).



- a) Cells which is lengthwise section are the longest.
- b) Cells which would show the strongest response to the test for the presence of glucose.
- c) Cells which provide new cells for growth.
- d) An item that provides a site for gaseous exchange.
- e) Cells that provide a site for food storage.
- f) Cells that provide for transport of water.
- g) Cells that provide for transport of food.
- h) Cells that show the age of this stem.

2. A group of biology students set up the apparatus shown to compare the rate of transpiration in still air and moving air. A fan was used to create moving air. The rate was calculated by measuring the distance the water bubble moved every ten minutes.

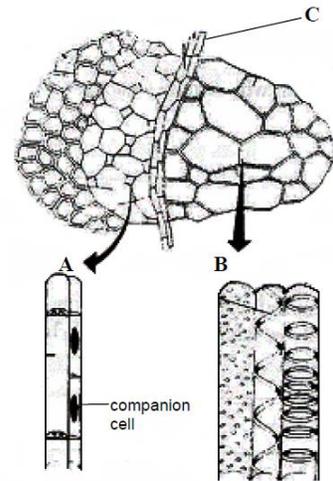


The results of their experiment are shown in the table.

Time (min)	Distance moved (mL)	
	Still Air	Moving Air
0		
10		
20		
30		
40		
50		
60		
70		
80		

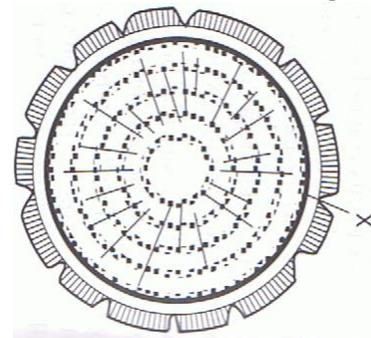
- (i) In setting up the apparatus, the leafy shoot must be cut and inserted in the apparatus under water. Suggest a reason for this.
- (ii) Which condition increased the rate of transpiration? Explain why this was so.
- (iii) Which of the conditions is the control for the experiment?
- (iv) Name ONE factor that must be kept constant throughout the experiment.

3. The diagram below shows part of a vascular bundle in a plant.



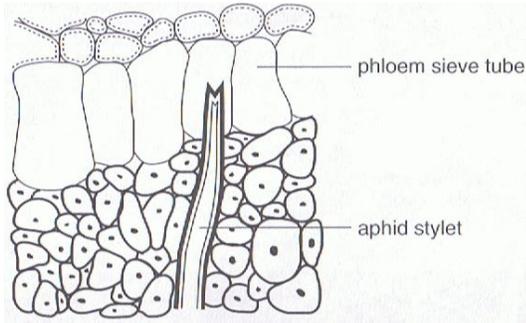
- a) Name the tissue labelled A, B and C.
- b) What is the function of the rings, spirals or patches of material on the walls of tissue B?
- c) Tissue labelled C tells us that this vascular bundle is from a dicotyledon. What the name of this tissue?

4. The diagram below shows a view of the stump left after a young pine tree had been cut down during 'thinning'.



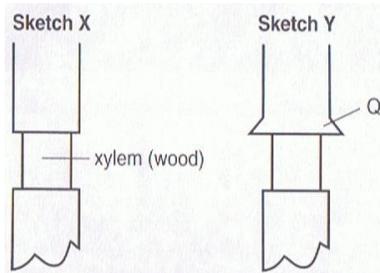
- a) How old was this pine tree when it was cut down?
- b) What the name of the tissue that forms the woody part of the stem?
- c) What is the name given to the layer of cells marked X on the diagram?

5. Below is a diagram showing an aphid stylet (sucking mouthpart) penetrating the stem of a plant.



Starch can be shown to be present in the leaf of the plant and yet carbohydrates in the phloem sap are in the form of sugars.

- What is the function of a phloem sieve tube?
 - Briefly describe how you could show that starch was present in the leaf of the plant.
 - Why is the starch converted to sugars for transport in the phloem?
 - Briefly describe ONE theory of how sugars are made to move through the phloem cells from one part of the plant to another.
6. State the name of the process by which plants gain most of their:
- Mineral ions
 - Water
 - Carbon dioxide
7. When a ring of all the tissues outside the xylem was removed from a woody twig (as in sketch X), it was found that the region Q above the ring became enlarged with food materials (as shown in sketch Y).



Which of the following is the best conclusion to be drawn from this experiment?

- A tissue outside the xylem carries food downwards.
- Food travels upwards in the xylem
- Xylem carries food downwards.
- Xylem carries water and ions upwards.

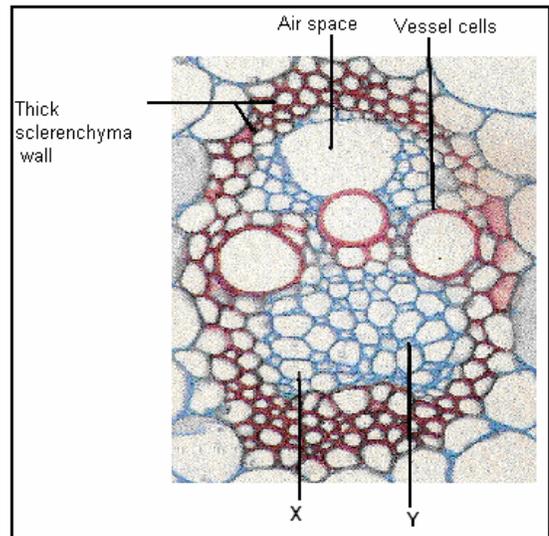
8. Water is conducted in plants most efficiently in:

- Root hairs
- Sieve tubes and companion cells
- Xylem vessels
- Hydrathodes

9. Transpiration rate in guava trees is controlled by:

- Tracheids
- Root hairs
- Stomata
- Lenticles

10. The diagram below shows the vascular bundle of a monocot.



- Which conducting tissue in the plant tissue contains vessel cells?
- The thick sclerenchyma cells are highly lignified. Describe the effect of these lignified fibres on the stem.
- Describe how the structure X cells enable them to carry out their function successfully.
- Give the name of the tissue that contains cells X and Y.
- Compare the vascular bundle in a monocot and a dicot stem and state their:
 - Similarities
 - Differences

UNIT 4: PLANTS REPRODUCTION & LIFE CYCLE

Learning Outcome

Students should be able to:

- Describe the structure and function of sepals (calyx), stamen (filament, anther & pollen), petals (corolla), carpel (stigma, style, ovary and ovule)
- Explain how the pollen tube is involved in fertilization.
- Describe the development of the fertilized ovule into seed and ovary into fruit.
- Compare the sporophyte and gametophyte generations of ferns and angiosperms.

PLANT REPRODUCTION

Terms:

- i. Gamete – a sex cell
- ii. Pollen – a male gamete in plants
- iii. Egg (or ova) – a female gamete in plants
- iv. Pollination – the process of transferring a pollen from the anther to the stigma.
- v. Angiosperms – a flowering plant.

In a flowering plant, the structure specific to reproduction is the flower.

Structure of a flower

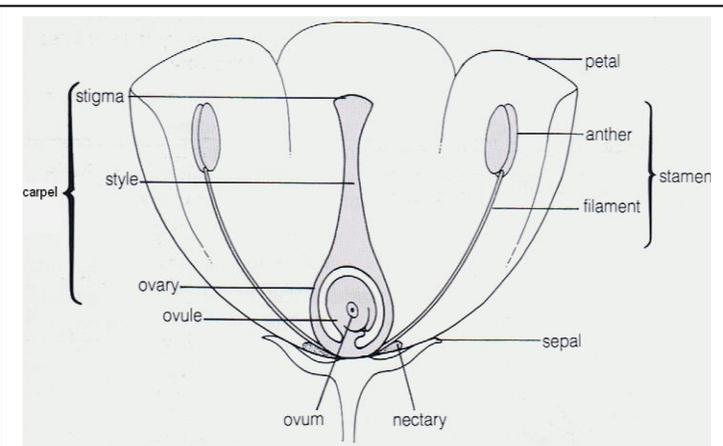


Figure 2: The structure of a flower.

- The flower's reproductive organs are the **stamens** and **carpel**.
- The **stamens** are the male organs. At the tip of each stamen is an **anther**, a sac in which meiosis occurs and in which pollen grains develop. The **filament** holds the anther.

- The **carpel** is the female organ of the flower. The tip of the carpel, the **stigma**, is the receiving surface for pollen grains. It is sticky in nature to help trap the pollen brought from other flowers, or from the same flower.
- The base of the carpel is the **ovary**, which houses reproductive structures called the **ovules**. The ovule contains the developing egg cells.
- The **sepals** are usually green and look more like leaves than the other flower parts. Before the flower opens, the sepals enclose and protect the flower bud.
- The **petals** are often bright and colourful. This helps advertise the plants to insects and other pollinators.

FERTILISATION

- Most plants have both male and female reproductive organ (i.e **hermaphrodites**)
- Once a pollen land on a stigma, a **pollen tube** is formed. This tube grows from the pollen grain down the style to the ovary.
- As soon as the pollen tube is formed, the pollen travels down the tube to the ovary. The pollen enters the ovule and fertilizes an egg.

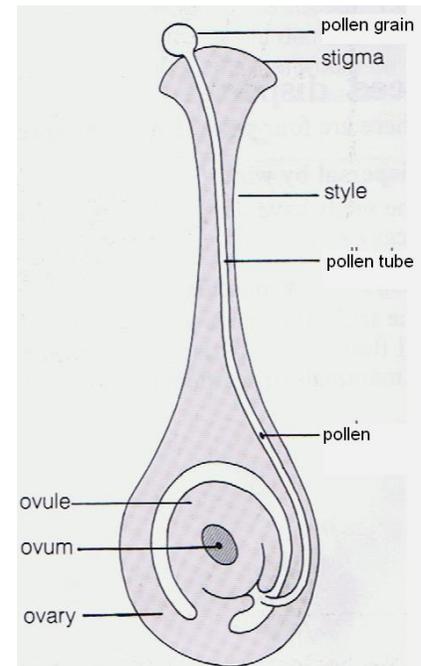


Figure 3: The growth of the pollen tube enables the pollen to fertilizes the egg.

- Usually there are many ovules inside the ovary, and each contains an ovum that has to be fertilized by different pollen.
- To achieve this, many pollen grains may land on the stigma and many pollen tubes grow down the style.

SEEDS AND FRUITS

Once fertilization has occurred several changes take place:

- 1. The zygote starts dividing and develops into an embryo.**
This consists of a **plumule** (young shoot), a **radicle** (young root) and one or two **cotyledons** (seed leaves).

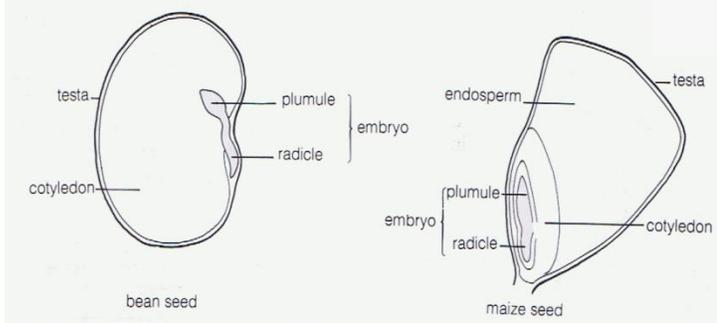


Figure 4: Seed consist of stored food (in cotyledons and endosperm) and a tiny embryo plant.

- The embryo inside the seed needs a supply of food to nourish it until it is germinated and the new leaves start making their own food by photosynthesis.
 - While awaiting germination, in many seeds the food is stored in the **cotyledons** (such as beans); while in others, it is stored in special tissues called **endosperm** that surrounds the embryo, for example: maize seed.
- 2. The ovule develops into the seed.** The outer layers of the ovule form the tough seed or testa.
 - 3. The ovary develops into the fruit.**

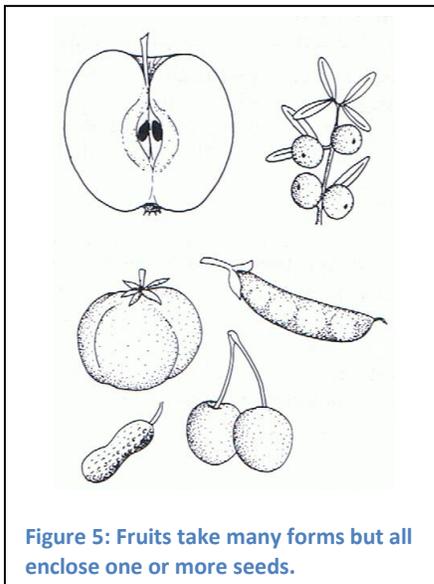


Figure 5: Fruits take many forms but all enclose one or more seeds.

POLLINATION: transferring of a pollen from the anther to the stigma.

- Before fertilization can occur, pollens must be transferred from the male reproductive organ (anther) in plants to the female reproductive organ (stigma).
- Flowering plants rely on either insects or the wind to transfer the pollen grains to the stigma of another flower or stigma of the same plant.
- It is easy to tell if a plant is relying on insects or wind as the mode of transferring pollen. Each has flowers with special adaptations to suit their particular method of pollination.

	Insect Pollinated Flowers	Wind Pollinated Flowers
1.	Have large, colourful petals to attract insects	Flowers have small and not highly coloured petals
2.	Flowers produce scent and nectar to attract insects	No scent or nectar produced.
3.	Pollen grains are spiked or sticky	Large amounts of smooth, light pollen are produced that enables it to be blown easily by the wind
4.	Stamen and stigma are found inside the plants	Have very long stamen and stigma that hangs out of the flower making it easy to be blown by the wind.
5.	Stigma is sticky to enable pollens carried by the insects to be trapped easily	Stigma is feathery so that it can trap the pollen blown by the wind easily.

- Although both male and female gametes are usually produced in the flower, self-pollination does not normally occur.
- There are various ways that a plant ensures cross-pollination occur e.g the flower may produce male and female gametes at different times.

Self-pollination – when pollen of the same plant fertilizes eggs in its own ovary.

Cross-pollination – when pollen of a different plant fertilizes eggs in the ovary of another plant.

LIFE CYCLE – PLANTS

- The diagram below shows the life cycle of a generalized angiosperm.
- Fertilization occurs in the ovule, which then matures into a seed containing the embryo.
- Meanwhile, the ovary develops into a fruit, which protects the seed and aids in dispersing it.
- Completing the life cycle, the seed germinates (begin to grow) in a suitable habitat, the embryo develops into a seedling, and the seedling grows into a mature plant.

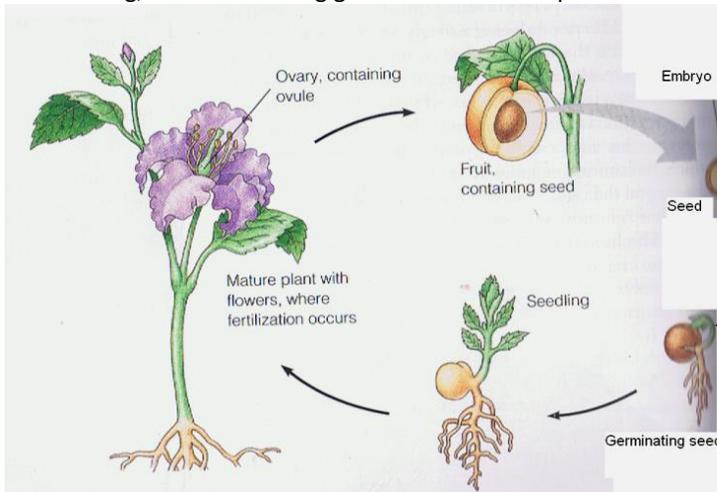


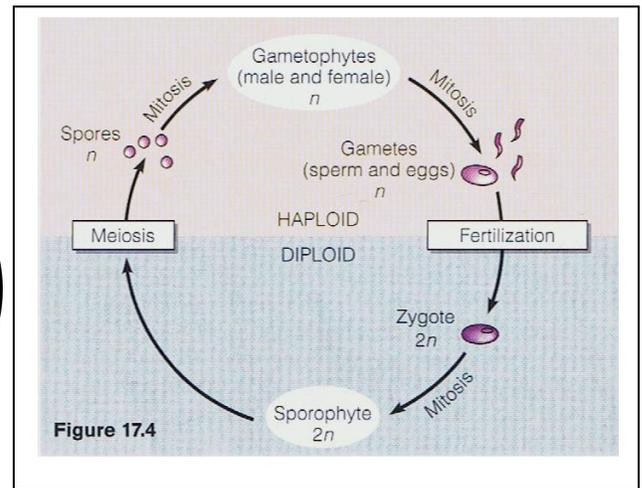
Figure 6: Life cycle of a generalized angiosperm

- Plants have life cycles very different from humans. Each of us is a diploid individual; the only haploid stages in the human life cycle are sperm and eggs.

- By contrast, plants have an **alternation of generations**:
 - diploid ($2n$) individuals called **sporophytes** and
 - haploid (n) individuals called **gametophytes**.

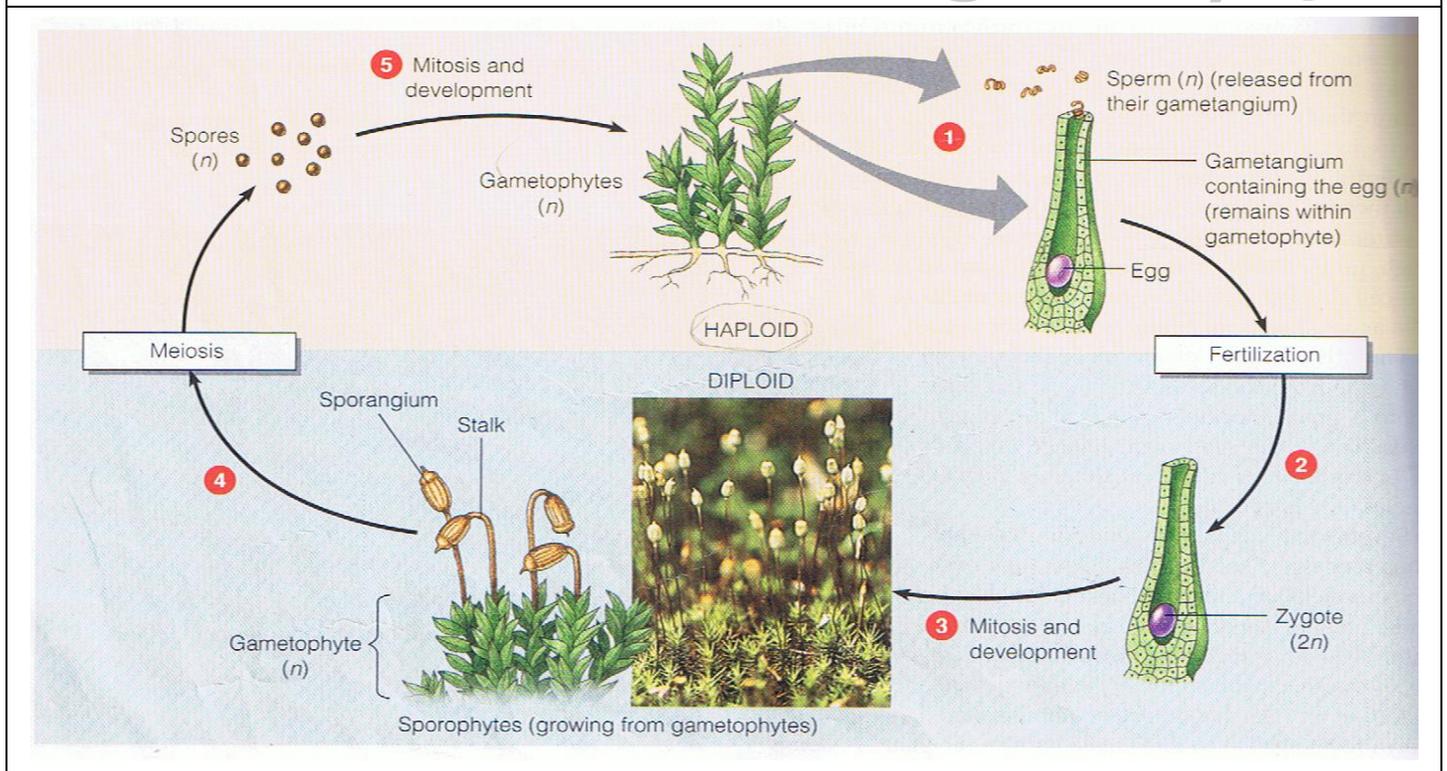
- These two generations generate each other in the life cycle.

The diagram below shows how the **haploid gametophytes** produce **gametes** by **mitosis**.



- Fertilization** results in a **diploid zygote**.
- The zygote divides by mitosis and develops into the diploid sporophyte.
- The **sporophyte** produces **spores** by **meiosis**.
- A spore develops by mitosis into a multicellular haploid gametophyte.

Mosses have a dominant gametophyte



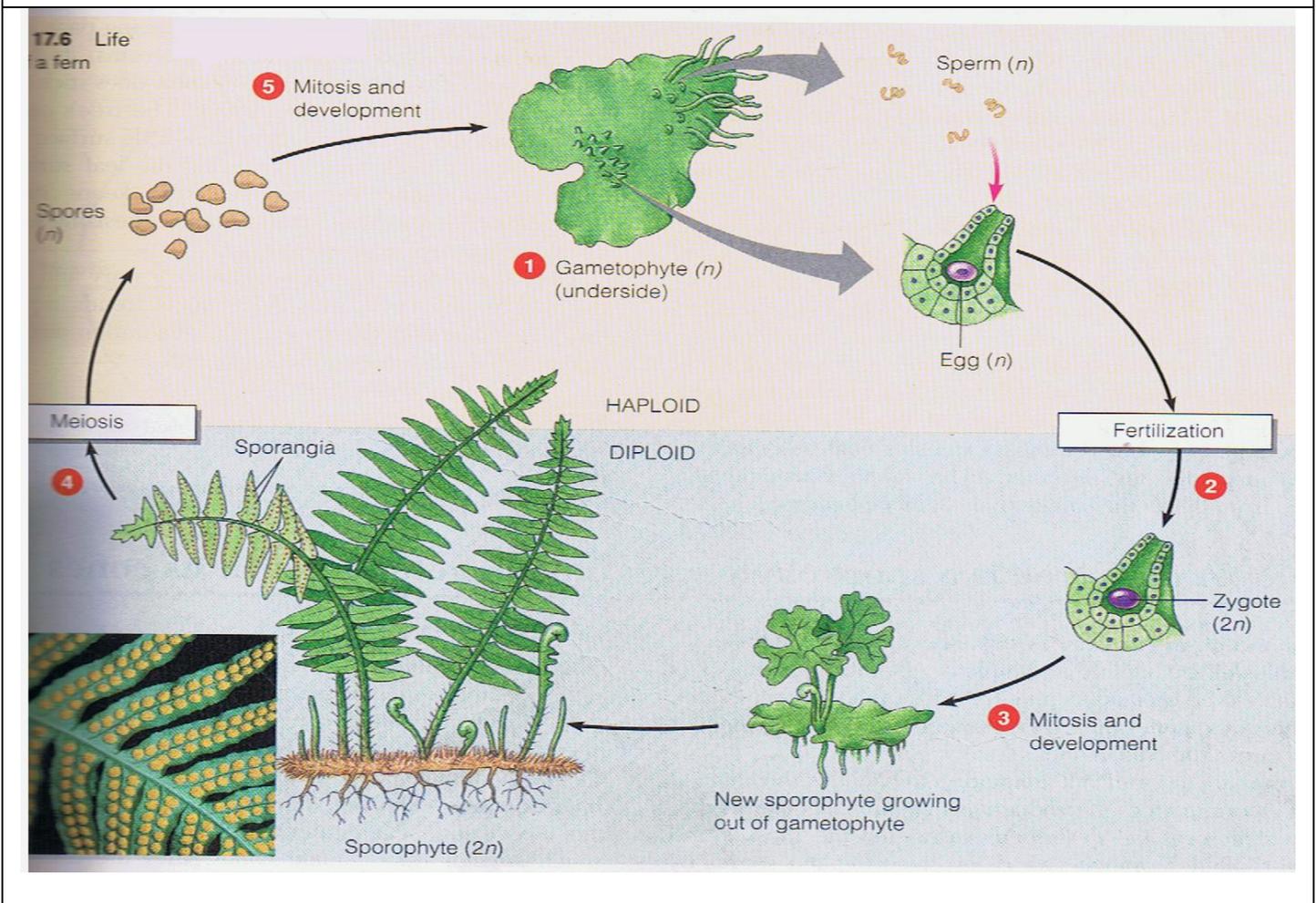
LIFE CYCLE OF A MOSS

- In moss, most of the green, cushiony growth we see consists of gametophytes.
- Moss plants are very small. This is due to their supporting tissue not being well-developed. Thus plants are restricted to damp habitats only.
- Although they live on land, mosses are mainly found in ponds and damp areas.
- Gametes develop in gametangia on the gametophytes. The flagellated sperm require a film of water in which to swim to the egg, which remains in the female gametangium. (1)
- After fertilization, the zygote remains in the gametangium. (2)
- There it divides by mitosis and develops into a sporophyte. Each sporophyte remains attached to a gametophyte. (3)
- Meiosis occurs in the sporangia at the tips of the sporophyte stalks. Haploid spores resulting from meiosis are released. (4)
- They undergo mitosis and develop into gametophytes, completing one life cycle. (5)

LIFE CYCLE OF A FERN

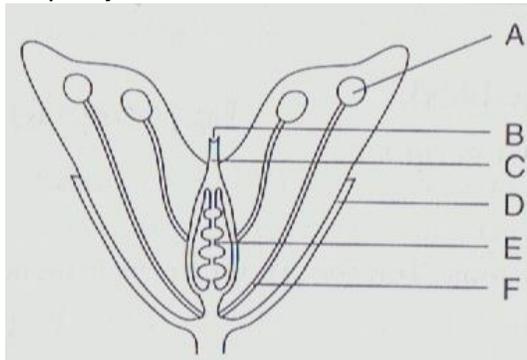
- The life cycle of a fern shows a dominant sporophyte generation. In fact, all we usually see of a fern is the sporophyte.
 - Fern gametophytes often have a distinctive heartlike shape, but they are quite small and inconspicuous. (1). Like mosses, ferns have flagellated sperm that require moisture to reach the egg.
 - The zygote remains on the gametophyte (2) where it develops into the sporophyte (3).
 - Cells in sporangia undergo meiosis, producing haploid spores. (4)
 - The spores are released and develop into gametophytes by mitosis (5).
-
- Today about 95% of all plants, including all seed plants, have a dominant sporophyte in their life cycle.
 - As seed plants evolved, their sporophyte became adapted to house the gametophyte and all reproductive stages (including eggs, sperm, spores, zygotes and embryos).

Ferns have a dominant sporophyte



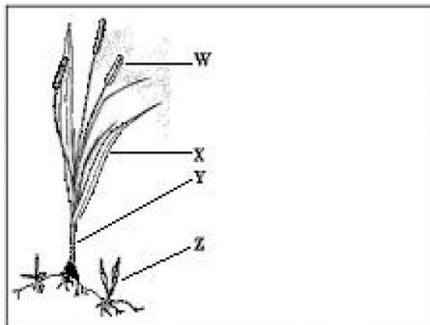
Self-check #1.3: Plant Reproduction

1. Study the flower below.



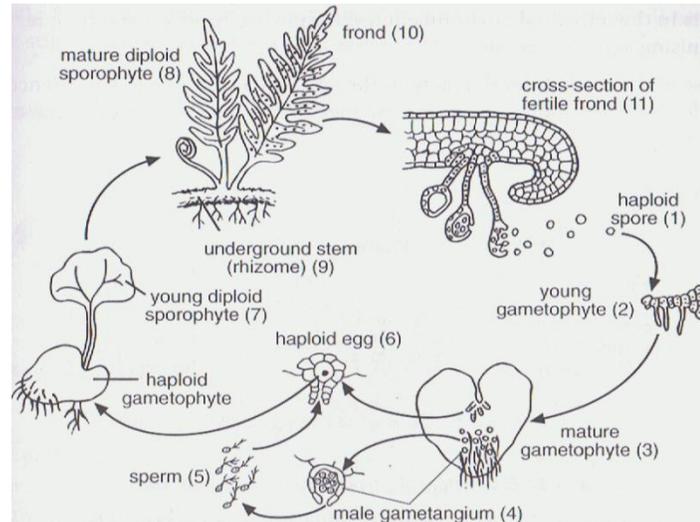
- Name the parts A – F on the diagram and give their functions.
- Write the letter of the structure that is responsible for producing the:
 - Male gametes in plants
 - Female gametes in plants
- Is the flower above from a wind pollinated plant or an insect pollinated plant?
- Give a reason to justify your answer to c) above.

2. The diagram below shows a grass plant that is a common weed in farms.



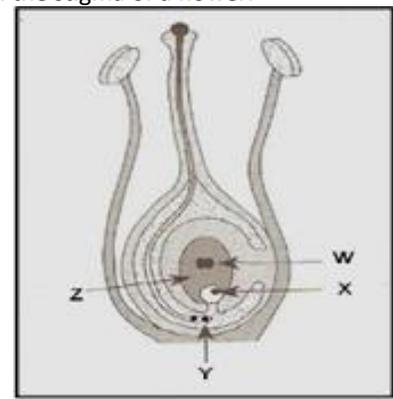
- Name structure **W** and give its function.
- One of the labelled structures above can be removed without having any significant effect on the reproduction the grass plant. What letter represents this structure?
- Is the above plant insect pollinated or wind pollinated?
- Give 2 reasons to support your answer for c) above.
- By studying the diagram carefully, how does the above plant reproduce? (Asexually or sexually).
- What evidence is there that supports your answer in e)?
- Give ONE disadvantage and ONE advantage of the type of reproduction named above.

3. The diagram shows the main stages in the life history of a fern.



- State the function of the following parts: gametophyte, male gametangium, sperm.
- Which number in the diagram represents the time when meiosis occurs?
- Which item restricts fern to damp habitat?
- Give the number of an item that is an adaptation to asexual reproduction.
- Which stage is primarily adapted for photosynthesis?
- Which generation is dominant in plants higher than ferns?

4. The diagram below shows a germinating pollen grain landing on the stigma of a flower.



Say if the statements below are TRUE or FALSE. If False, give the correct statement.

- Letter **Z** shows the male gametophyte.
- One sperm nucleus will fertilize **X** to form the endosperm.
- The two sperm nuclei is shown by letter **W**.
- The pollen tube carries **Y** to the ovary through the microphyle.
- After fertilization, **W** forms the fruit.