

AGRICULTURAL SCIENCE STUDY GUIDE

Week 3



Plant physiology

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Plants the lungs of the earth

Plants absorb carbon dioxide and replace it with oxygen which humans and many heterotrophs need to survive

Plants can be classified as angiosperms – seed contained within an ovary (eg daises, grasses and barley) or gymnosperms – produces seeds in cones and the leaves are reduced to spines (eg Sitka spruce and Scots pine).

Photosynthesis

Plants are autotrophic. This means they can produce their own food by a process called photosynthesis. This process occurs in special organelles in the leaves called chloroplasts. For photosynthesis to occur, carbon dioxide diffuses from the atmosphere into the leaves through the stomata. Water is absorbed from the soil through the root hairs by osmosis and travels to the site of photosynthesis by special tubes called xylem. Light energy from the sun is absorbed and trapped by the green pigment called chlorophyll, producing oxygen (which is either used in aerobic respiration or passed out of the leaf into the atmosphere) and glucose (stored in the plant as starch or used in aerobic respiration to produce energy). This process is summarised by the following balanced chemical equation:



The plant and especially the leaf is well adapted to carry out the process of photosynthesis efficiently.

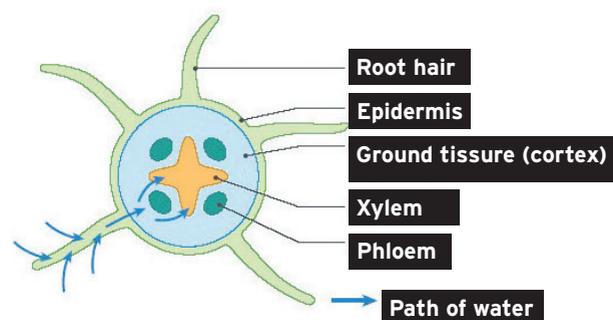
These are some of the adaptations the leaf has:

- ➔ **Flat shape:** allowing greater exposure to light.
- ➔ **Cuticle:** a layer of waterproof wax on the outer surface of the dermal tissue to prevent water loss.
- ➔ **Many chloroplasts:** to make more food.
- ➔ **Air Spaces:** for rapid diffusion of carbon dioxide to the cells for photosynthesis.
- ➔ **Thinness:** for fast diffusion of gases.
- ➔ **Guard cells:** to control the closing and opening of the stomatal pore.
- ➔ **Stomata:** to allow rapid entry of carbon dioxide into the leaf from the air.

In leaves, the ground tissue is the layer where photosynthesis takes place. The ground tissue comprises the spongy mesophyll and the palisade mesophyll.

Osmosis

The absorption of water by the root hairs from the soil occurs by osmosis. Osmosis is defined as the movement of water from a region of high water concentration to a region of low water concentration across a semi-permeable membrane.



Water enters the root hair via osmosis due to the water concentration in the soil being higher than the water concentration in the epidermal cell. Water diffuses across the ground tissue and enters the vascular tissue at the xylem and can travel up the stem to the leaf.

Respiration

Once glucose is manufactured in the plant it can be stored as starch or it can be converted to energy. This process is called respiration. Respiration occurs in the mitochondrion of the cell. In the mitochondrion, the glucose produced in photosynthesis is broken down to release energy which can be used in all the cells of the plants for growth, producing leaves and flowers and absorbing mineral ions from the soil.

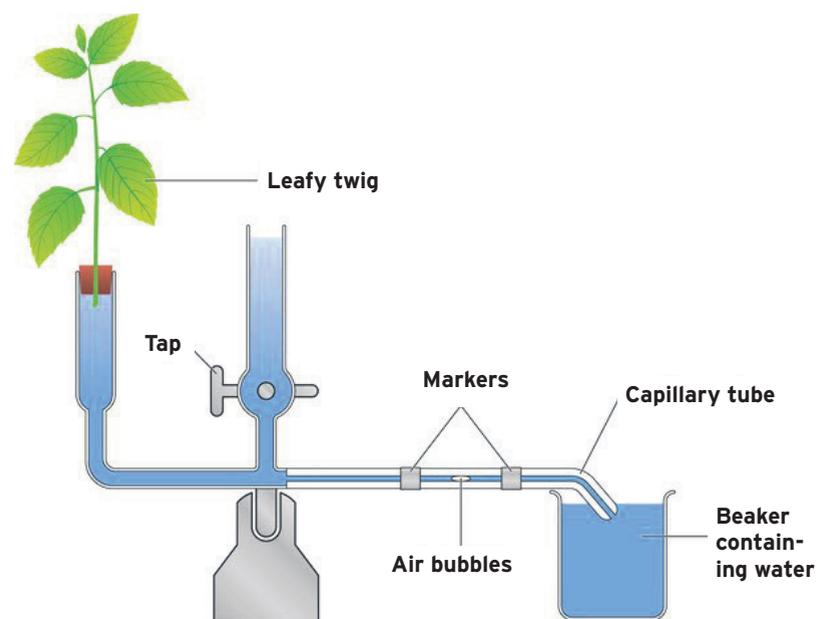
Transpiration

Transpiration is the loss of water from the surface of the leaf through the stomata. Transpiration is important in that it allows the plant to remain at its optimum temperature of approximately 25°C and it also allows for the excretion of harmful substances. Flowering plants can be further sub-divided into monocotyledons and dicotyledons. Examples of monocots found on the farm include grasses, barley, wheat, oats and maize. Examples of dicots include dockleaves, ragwort, daisies and nettles.



Translocation is the movement of glucose in the phloem down the plant

*Past exam questions



2010: higher level

Describe a laboratory or field method to determine the rate of transpiration of a plant.

Suggested solution: when writing up a laboratory experiment always be sure to use the following headings:

➔ **Apparatus:** potometer, leafy shoot, water, beaker, ruler, blade.

➔ **Labelled diagram:**

➔ **Method – (include a control):**

1. Using a backed blade cut a leafy shoot at an angle.
2. Place the leafy shoot into the potometer held in place with a rubber bung or cork.
3. Seal fully with Vaseline.
4. Immediately immerse the whole apparatus in a sink of water.
5. Place the plant in good light levels.
6. Mark where the air bubble is.
7. Measure the position of the air bubble after a period of time using the ruler.
8. Repeat this procedure two more times and calculate the average.
9. A control would be the same apparatus above but without leaves on the shoot.

➔ **Results:**

Experiment: the bubble moved.
Control: the bubble did not move.

➔ **Conclusions:** the rate of transpiration increases with increased levels of light intensity.

➔ **Discussion:**

2015 – Higher level

Describe how any three environmental factors affect the rate of transpiration in a plant.

➔ **Sample answer:** the following key points must be included in order to get top marks.

Ensure to write full sentences in or-

der to explain fully the environmental factor and how it affects the rate of transpiration.

➔ **Light intensity:** with increased light levels, then the rate of transpiration will be increased.

➔ **Relative humidity:** if the air is dry then the rate of transpiration will be increased.

➔ **Air movement:** when the wind levels increase then the rate of transpiration will be increased.

➔ **Soil water level:** if the soil is dry then the rate of transpiration will decrease.

➔ **Carbon dioxide concentration:** if the level of carbon dioxide decreases then the stomata close and the rate of transpiration is reduced.

Here are some questions to try yourself:

➔ **2019 higher level:** photosynthesis takes place mainly in the leaves of green plants.

(1) Give a balanced chemical equation for photosynthesis.

(2) Outline four ways in which the structure of the leaf is suited to photosynthesis.

(3) Draw a labelled diagram of a transverse section (TS) of a dicotyledonous (dicot) stem.

(4) Outline two differences to be seen in the transverse sections of monocot and dicot stems.

➔ **2018 higher level:** plants are made of different cell types. Give the function of each of the following plant cell type: (1) xylem (2) phloem (3) epidermis.

➔ **2017 higher level:** give two structural differences between monocotyledonous plants and dicotyledonous plants.

Give one example of a monocot plant and one example of a dicot plant.

Outline three ways in which the structure of the leaf is suited to photosynthesis.