

PLANTS



Roots – anchor plant, absorb water and nutrients. Know the diagram: root cap, zone of cell division (directly behind root cap), zone of root elongation (behind dividing cells), and root hairs. Root hairs vastly increase root surface area.

Stem and branches – hold leaves in best position for photosynthesis - spread out leaves to get as much light as possible.

Leaves – main structure for photosynthesis. Thin (gases don't have to diffuse far), flat (large SA), arranged fanned out (to get most light).

Flowers – for **sexual** reproduction

Transpiration: passage of water and minerals from root → leaves. Water enters root by diffusion, moves through and between cells by osmosis, rises up stem due to “root pressure” and capillary action, and by “stream” of water pulled up due to loss of water from leaves (by evaporation). Water travels in xylem.

Water is lost through stomata (mostly on lower surface of leaf). In hot and windy conditions stomata close to reduce water loss but photosynthesis then reduced. Each guard cell has a thick and quite inelastic wall bordering the pore, and a thin elastic outer wall. In the light, guard cells take up water → become turgid → thin outer walls to bulge outwards, and the thicker inner walls bend with them. This gives the guard cells a curved banana-like shape, and opens the pore. In the dark the guard cells lose water, become flaccid, and the pore closes.

Plants have waxy **cuticle** (waterproofing). Sunken stomata and rolled leaves reduce water loss etc (think cacti and plants found at beach).

Photosynthesis: **water + carbon dioxide → glucose + oxygen.** Needs LIGHT energy. Occurs in **chloroplasts** using the green pigment **chlorophyll**. Plants need Mg^{2+} ions to make chlorophyll – “deficient” plants are yellow. Glucose is used or turned to starch for storage in leaves or roots. Glucose/starch are carbohydrates.

Respiration: is how the plant **releases energy** from the glucose it made. Occurs night and day. $glucose + oxygen \rightarrow water + carbon\ dioxide$ (ie reverse of photosynthesis, occurring in special structures called mitochondria). Cross section of leaf: **Cuticle, upper epidermis, palisade cells, mesophyll layer, veins (xylem and phloem), lower epidermis with guard cells and stomata.** Most photosynthesis occurs in palisade cells. Spongy mesophyll – many air spaces for gases O_2 and CO_2 to circulate. **Veins** (vascular bundle) run through spongy mesophyll - bring water in **xylem**, take food away in **phloem** vessels (tubes). Transport of sugar in phloem is called translocation.

Limiting factors: Increasing light or CO_2 concentration or temperature will increase rate of photosynthesis – up to a point. At some stage the plant will be photosynthesising as fast as it can and extra light or CO_2 or warmer temperature has no effect. Graph of, say O_2 produced, rises, starts to flatten... flattens out. Knowing about this can be useful to horticulturalists / glass house growers.

PHOTOSYNTHESIS EXPERIMENTS:

To show O_2 is product: pondweed in water under funnel, test tube of water over funnel. O_2 collects, displaces the water. Confirm O_2 by relighting a glowing splint.

Testing for **starch:** To test leaf, dip leaf in boiling water to soften, put leaf in tube, cover with alcohol, stand tube in hot water (no flames!!), wait until chlorophyll removed from leaf, remove leaf, soften in water, spread out, cover with iodine solution. Iodine turns from brown to blue-black if starch present.

Destarched plants used in photosynthesis experiments – put in dark 2-3 days so it uses up stored starch in leaves.

To show need for light (Paper shield over part of leaf). Test leaf for starch. **To show need for CO_2** (Leaf sealed in bag with NaOH or soda lime to removed CO_2). Test leaf for starch. **To show green parts make starch** test variegated leaf (green and yellow leaf) for starch – starch only found in green part. You can use the escape of O_2 bubbles from pondweed to investigate effect of light intensity. Use a glass plate or beaker of water to prevent lamp from warming the weed. Adding a pinch of $NaHCO_3$ to the water increases the CO_2 available.

GROWTH

Why grow? Increased height – get above surrounding plants to get more light, increased width – better support, makes more leaves – more photosynthesis, replaces tissues – leaves eaten by animals etc.

PRIMARY GROWTH: When young plant begins to grow, its shoots & roots mainly grow longer - called primary growth. Cell division occurs at certain regions called meristems. Eg shoot tip and behind the root cap.

SECONDARY GROWTH: Trees have stems and roots which grow much wider - secondary growth. **Cambium**, narrow band of cells between the primary xylem and primary phloem, is meristematic (cells can divide and make other types of cells). It forms a narrow ring. Each growing season it produces a new layer of secondary xylem toward the centre and secondary phloem toward the surface. The inner xylem becomes “wood”. The cambium and all outer tissues are pushed further out. Old phloem cells are crushed - only a thin strip of newly-formed phloem remains alive. The stem expands & ruptures the epidermis; cork cambium develops. Multiple layers of dead cork cells replace the epidermis and protect the stem as BARK.

Secondary growth takes place mainly in summer and slows or stops in winter. If you look at a cut tree each “ring” corresponds to a years secondary growth. The narrower, darker rings show the tree’s growth during the autumn, when growth slows. The wider, lighter rings show the tree’s rapid growth in the spring and early summer.

REPRODUCTION

Sexual: Flower parts (learn the diagrams of insect and wind pollinated plants). Male: stamen - anther (holds pollen) & filament. Female: carpel - stigma (“catches pollen”), style and ovary (contains eggs/ovules) Sepals (protect bud) and petals.

Pollination: Transfer of pollen from plant to plant. Pollen is ridged and sticky. Same plant – self pollination, another plant (must be of same species) – cross pollination. Cross pollination better than self- leads to variation. Insect pollinated flowers: bright colours, nectar, scented to attract insects / pollen wills tick to insects and be carried from flower to flower. More efficient process than wind pollination. Wind pollinated flowers: Green, small petals (scales), dangly anthers and long feathery stigmas (know diagram). Pollen of wind pollinated plants – light, small and smooth – to be carried by breeze.

Pollen lands on stigma, pollen tube grows down style into ovary, pollen nucleus fuses (joins) with ovule – fertilization: Develops into seeds and ovary develops into the fruit.

Mechanisms of seed dispersal: wind, explosive, sticky, hooked, succulent (fruit that’s eaten), floating seeds. Aims to distribute seeds to minimise competition between plants for light, water, nutrients; to colonise new areas.

Asexual reproduction: also called vegetative reproduction - make new plants without making seeds. Plant made has same genetic information as parent plant. Eg: runners/shoots above surface (strawberry), tuber/swollen underground stems with “eyes”/buds (kumara, potatoes), bulb/swollen underground leaf scales (daffodil, onion), corm/swollen underground stem (gladioli), rhizome/thick underground stem (bracken fern).

Germination: growth of embryo plant in seed. Seeds can be dormant for years until condition right – usually needs warmth, moisture and O_2 . Germination - seed takes in water, seed swells, enzymes carry out chemical reactions in the seed, and embryo plant starts to grow. Radicle (root) develops first, then plumule (shoot). Cotyledons are food reserve (starch) until plant can photosynthesise and make own food.