Department of Primary Industries

# Industry insights- Plant structure and function

## Supporting document

**NSW DPI Schools Program**

Answer guide

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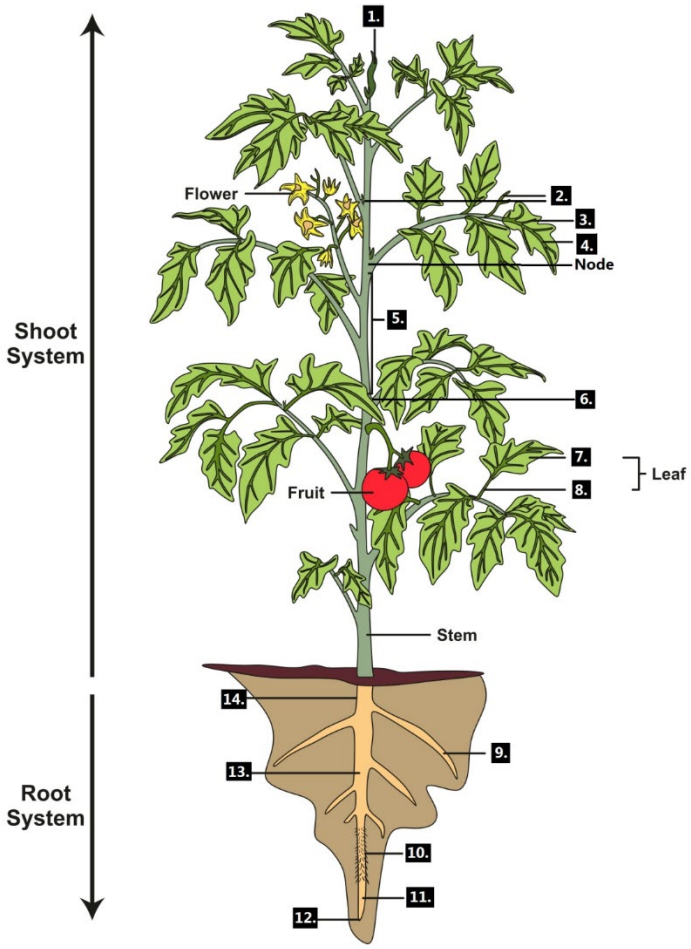
# Industry insights - Plant structure and function

Go to NSW DPI Industry Insights- Plant structure and function site to find all resources.

Sample answers have been provided for learning activities where applicable for this document. The following suggested answers should be used as a guide. It should be noted that these sample answers are suggested answers and not necessarily the very best answer, nor are they the only possible answers.

## Basic structure of a flowering plant

1. **What is an angiosperm? List three characteristics.**
   Angiosperms or 'true flowering plants' are seed-bearing, vascular plants that produce flowers, seeds and fruit via sexual reproduction.
2. **Label parts 1-14.**

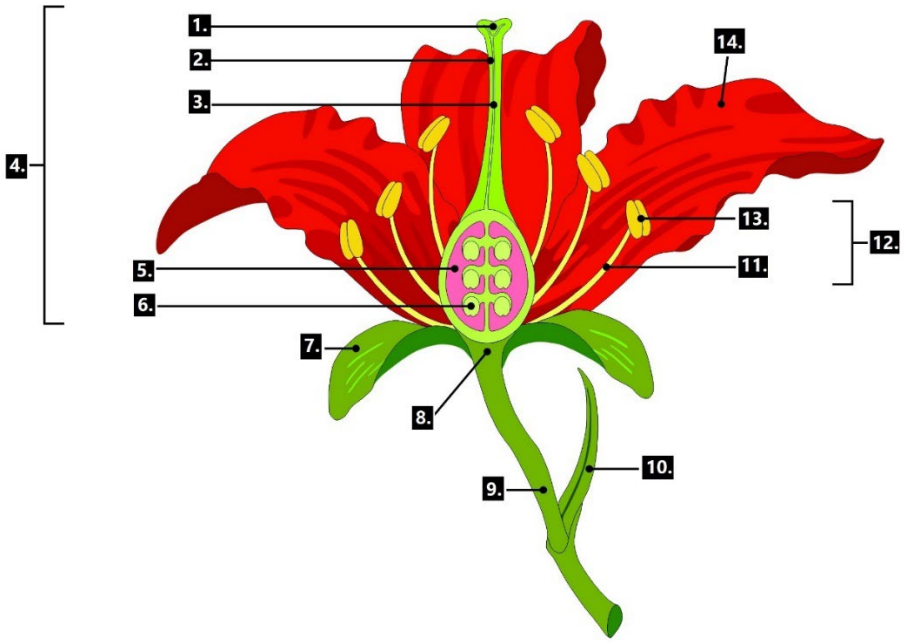



| Plant structure | |
|---|---|
| 1. Terminal bud | 8. Petiole |
| 2. Axillary bud | 9. Lateral root |
| 3. Vein | 10. Root hairs |
| 4. Midvein/midrib | 11. Root tip |
| 5. Internode | 12. Root cap |
| 6. Node | 13. Primary root |

| | |
|---|---|
| 7. Blade | 14. Vascular tissue |

## Structure of a basic flower

3. **Label parts 1-14 in the space below.**




| Flower structure | |
|---|---|
| 1. Stigma | 8. Receptacle |
| 2. Style | 9. Stem |
| 3. Pollen tube | 10. Leaf |
| 4. Pistil | 11. Filament |
| 5. Ovary | 12. Stamen |
| 6. Ovule | 13. Anther |
| 7. Sepal | 14. Petal |

## Reproduction in flowering plants

4. **Define the following terms and give examples where possible:**

**A) Gamete**

Sex cell containing genetic material (DNA) from the parent. In plants, pollen cells are male gametes and ovules are female gametes.

**B) Seed**

Mature embryo. With correct environmental conditions (water and sunlight), the seed germinates, becoming a seedling.

**C) Sexual reproduction**

Sexual reproduction occurs when gametes fuse combining genetic material from both parents. This produces a genetically distinct offspring. For example, a pollen cell and ovule cell combine to form a zygote, then embryo which then matures into a seed.

**D) Asexual reproduction**

Asexual reproduction occurs when offspring arise from a single organism and inherit the genes of that parent only. It does not involve the fusion of gametes, and almost never changes the number of chromosomes.

**E) Vegetative propagation**

Vegetative propagation is a form of asexual reproduction of a plant. Only one plant is involved. The new plant is genetically identical to the parent. Examples include grafting, cutting, layering, tuber, bulb or stolon formation, suckering and tissue culture.

**F) Stolon**

A horizontal plant stem or runner that takes root at points along its length to form new plants. For example, strawberry or kikuyu.

**G) Rhizome**

A horizontal underground stem, that can produce the shoot and root system from its nodes which can become a genetically identical new plant. Examples include Iris, sugarcane and ginger.

**H) Tubers**

A tuber is an enlarged part of an underground stem (stolon) or root (rhizome). The thickened tuber is a storage organ containing nutrients such as carbohydrates (starch) for plant growth. For example, potatoes, sweet potatoes and dahlia.

**5. Describe pollination using the following terms:**

- **Pollination**
- **Gamete**
- **Stigma**
- **Style**
- **Pollen tube**
- **Ovary**
- **Ovule**
- **Sexual reproduction**

Pollination is the process whereby pollen (male gamete) lands on the stigma (female part) of the plant. The pollen then travels down a pollen tube within the style, reaching the ovary. Here the pollen cell fertilises an ovule through the process sexual reproduction.

**Tissue culture micro-propagation is a specialist field of vegetative plant propagation. It is used widely in agriculture for species such as developing and speeding up the development of new plant varieties. See examples for avocado plants, (Could tissue culture meet avocado plant demand on the University of Queensland website), and disease resistant bananas (Establishing tissue culture bananas in NSW under Horticulture on the NSW DPI website).**

**6. Use the internet to research the process of plant tissue culture. Describe the process at each stage of the following diagram,**

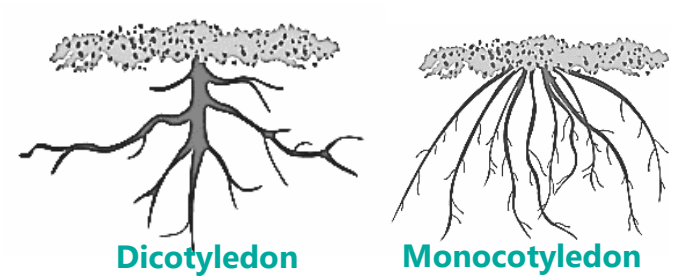
| Step | Description |
|---|---|
| 1 | Shoots and nodes are collected from a plant's fresh new growth. Embryos or even groups of cells can also be used. |
| 2 | The plant material or 'explant' needs to be as clean as possible at the beginning of the process to limit bacterial and fungal contamination. The explant is cleaned and sterilised, then cut into sections in a sterile environment. The material is then placed on an agar-based medium containing sucrose and other macronutrients, micronutrients and vitamins to promote plant growth. |
| 3 | Explants are left for a couple of weeks to undertake cell multiplication (mitosis). Any material that shows signs of contamination or has died off is eliminated, while clean, living material goes to the next stage. |
| 4 | Clean explants are placed on a medium, containing growth regulators to encourage shoot growth. A growth regulator is a chemical that mimics a plants natural hormone's and determines how the explants grow. The relative proportion of cytokinins (growth regulators that encourage shoot multiplication) and auxins (growth regulators that encourage root formation) determines whether shoots or roots are produced. A higher proportion of cytokinins are required at this stage to generate shoots. |
| 5 | Once a suitable medium and supply of growth regulators is found, the plant cells will begin to generate into specialised plant cells such as roots or shoots. Shoots are regularly divided and placed into fresh medium. This step is called subculturing and allows plant numbers to increase rapidly. |
| 6 | Once the plant has sufficiently grown in tissue culture it is ready to be transferred. |
| 7 | The transferral process is known as 'exflasking'. This involves delicately moving the explant from the sterile culture to potting mix. |
| 8 | Explants removed from tissue culture are very delicate and require careful handling, controlled temperatures and high humidity until the tissues have had an opportunity to 'harden-off'. This is usually in a controlled environment such as a glasshouse. Eventually the explants re-establish or acclimatise to the conditions outside of the tissue culture jar and become 'fully functioning' plants again. |

7. **Make a list of benefits of tissue culture compared to sexual plant reproduction.**
    - One mother plant can create large quantities of new plants in a short period of time.
    - Cultivars hold their true form, retaining unique characteristics and are genetically strong.
    - Plants difficult to propagate by conventional methods can be more successful in tissue culture.
    - Large quantities of high-quality uniform plants can be produced over a short time. This reduces time that is involved in sexual reproduction such as generation length.
    - Predictable growth allows for carefully scheduled production.
    - Large-scale micropropagation of plants.
    - To conserve highly threatened species, particularly when there is a shortage of material available for conservation.
    - To reproduce plants which don't produce seed or don't germinate well.
    - To conserve plants not suited to seed banking e.g. rainforest seeds.
    - To enable the transport of plants to other states or countries without transporting pathogens or pests.

## Monocotyledons vs. dicotyledons

**8. Read the passage and complete the activities.**

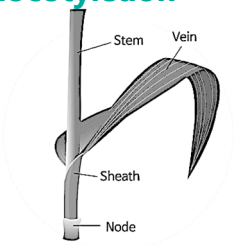
Root system: On the diagrams below colour the taproot dark brown and the fibrous root light brown. Identify and label each as either a monocot or dicot.



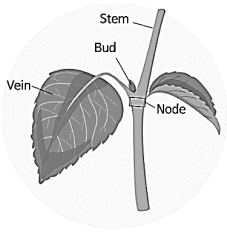
Dicotyledon Monocotyledon

Leaf structure: On the diagrams below colour the leaves in green, outline the veins in black and colour the stems in blue. Identify and label each diagram as either a monocot or dicot.

Monocotyledon



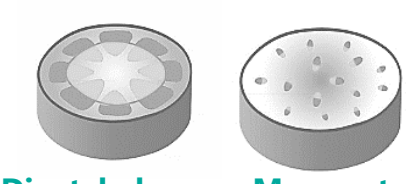

Dicotyledon




Flowers: Colour the monocot flower in purple and the dicot flower in pink on the diagrams below, making sure all petals are coloured. Label the diagrams as either a monocot or dicot flower.

Dicotyledon Monocotyledon

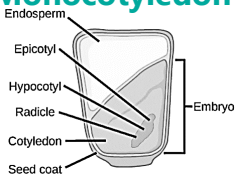
Vascular systems: On the diagrams below colour the xylem in purple and the phloem in orange. Label as either a monocot stem or dicot stem.



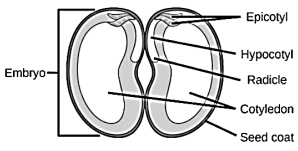
Dicotyledon Monocotyledon

Seeds: On the diagrams below colour the seed coats in blue, the cotyledons in yellow, the epicotyl in green, the hypocotyl in orange and the radicle in brown. Label each diagram as either a monocot or dicot seed.

Monocotyledon




Dicotyledon

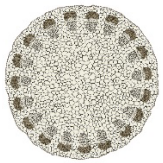


9. **Identify whether the traits listed in the table below are found in monocots, dicots or both by placing a tick in the correct column.**

| Trait | Monocotyledons | Dicotyledons | Both |
|---|---|---|---|
| Single cotyledon | ✓ | | |
| Flowering plants | | | ✓ |
| Stem vascular system in a ring | | ✓ | |
| Sheath like leaf | ✓ | | |
| Branched veins | | ✓ | |
| Fibrous root system | ✓ | | |
| Produce seeds and fruit | | | ✓ |
| Parallel veins | ✓ | | |
| Two cotyledons | | ✓ | |
| Seeds covered with protective seed coat | | | ✓ |
| Root vascular bundles in the centre of the root with xylem surrounded by phloem | | ✓ | |
| Petals arranged in groups of four or five | | ✓ | |
| System of transport tubes (vascular system) | | | ✓ |
| Petals arranged in groups of three | ✓ | | |
| Broadleaf | | ✓ | |
| Seed contains a hypocotyl and radicle | | | ✓ |
| Stem vascular bundles scattered | ✓ | | |
| Taproot | | ✓ | |

**10. Classify the following plants or plant parts as either a monocotyledon or dicotyledon in the space below the image. Remember to use multiple characteristics to identify the plants. Include the name of the plant if you recognise it.**

| | | | |
|---|---|---|---|
|  |  |  |  |
| Monocotyledon - tulip | Dicotyledon – potato plant | Monocotyledon - fibrous roots | Dicotyledon - taproot |
|  |  |  |  |
| Dicotyledon - germinating beans | Monocotyledon – germinating wheat | Dicotyledon - cherry blossom | Monocotyledon - lily |
|  |  |  |  |
| Dicotyledon – Scottish thistle | Dicotyledon - Canola | Monocotyledon – tulip leaf | Dicotyledon - clover |

| | | | |
|---|---|---|---|
|  |  |  |  |
| Dicotyledon - carrot | Monocotyledon - grass | Monocotyledon - Cocksfoot | Dicotyledon - Lucerne |
|  |  |  |  |
| Dicotyledon - cotton | Dicotyledon – cherry tomato | Monocotyledon - oats | Monocotyledon - pineapple |
|  | **Stem cross section**  | **Stem cross section**  |  |
| Monocotyledon - Maize | Dicotyledon – stem cross section | Monocotyledon – stem cross section | Dicotyledon - lemon |

## Growth and development

**Use the poster to answer questions 11-13**

**11. Contrast growth and development in plants.**

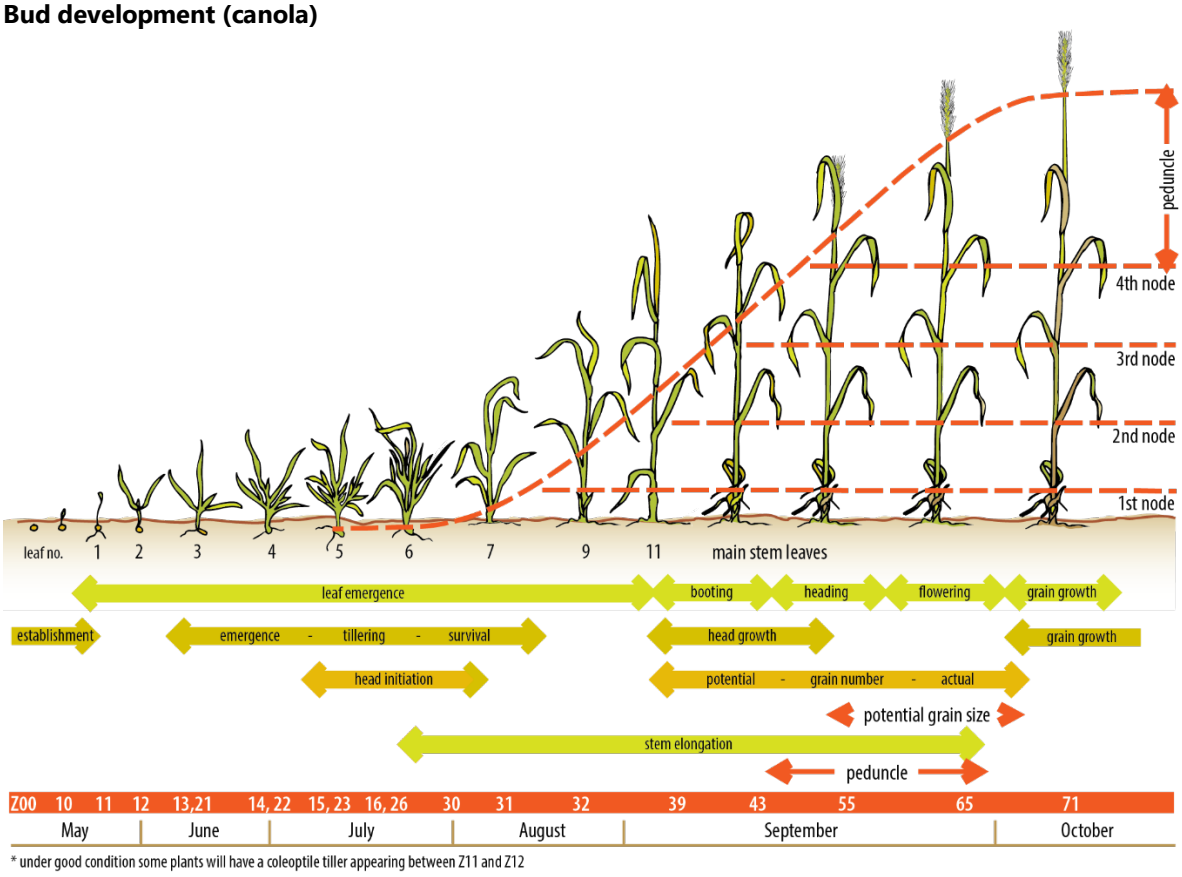
Growth (the increase in size and number of leaves and stems) and development (the process of the plant moving from one growth stage to another) in any plant is a complex process. During the life cycle of any plant, many of the growth stages overlap. Growth and development are continuous processes.

**12. List the factors that affect the length and timing of each growth stage.**

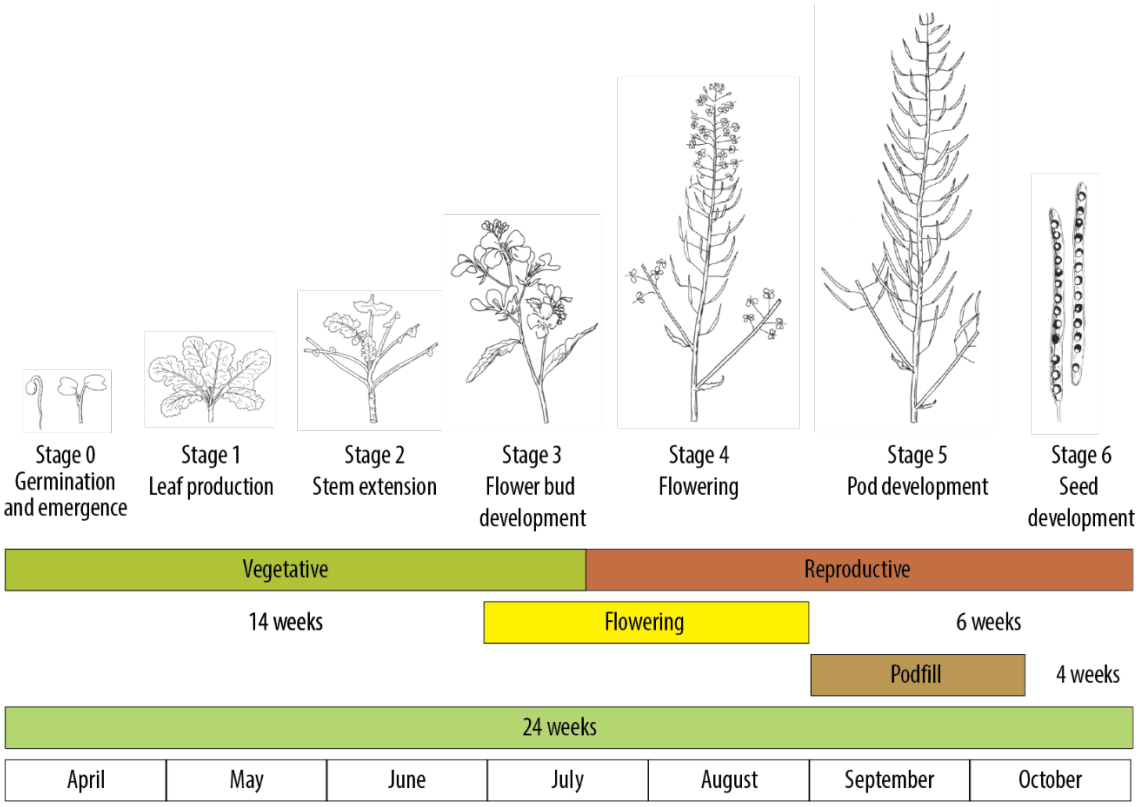
The length and timing of each growth stage is influenced by genetics, species, temperature, moisture, light (day length), nutrition and variety. Light, temperature and moisture are the most important environmental factors regulating growth and development.

**13. Label the following growth and development stage on both images.**

- **Germination and emergence**
- **Leaf production and emergence**
- **Tillering (wheat)**
- **Stem extension and elongation**
- **Booting (wheat)**
- **Heading (wheat)**
- **Bud development (canola)**
- **Flowering (anthesis)**
- **Grain growth (wheat)**
- **Podfill (canola)**
- **Senescence**
- **Vegetative stages**
- **Reproductive stages**

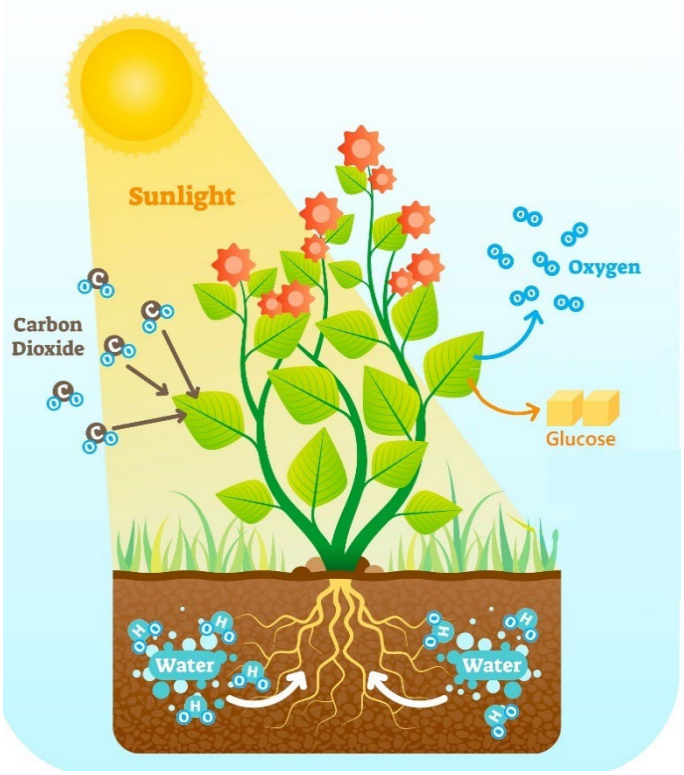



* under good condition some plants will have a coleoptile tiller appearing between Z11 and Z12


Stage 0
Germination
and emergence
Stage 1
Leaf production
Stage 2
Stem extension
Stage 3
Flower bud
development
Stage 4
Flowering
Stage 5
Pod development
Stage 6
Seed
development
Vegetative
Reproductive
14 weeks
Flowering
6 weeks
Podfill
4 weeks
24 weeks
April
May
June
July
August
September
October

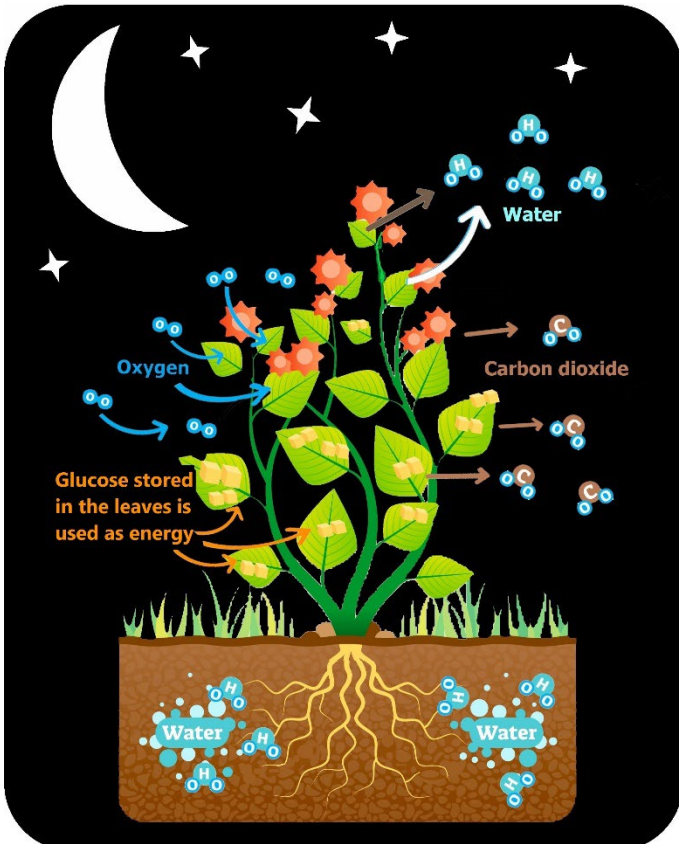
## Photosynthesis and respiration

14. **List the living things photosynthesis occurs in?**
    Plants, algae and some bacteria. Only organisms with chloroplasts.
15. **Name the specialised organelles that carry out photosynthesis?**
    Chloroplasts
16. **Name the chemical in specialised plant organelles that allows photosynthesis to occur?**
    Chlorophyll
17. **Name the chemical that makes plants appear green?**
    Chlorophyll
18. **Write the word equation for photosynthesis.**
    Carbon dioxide + water + sunlight energy and chlorophyll → glucose + oxygen
19. **Write the chemical equation for photosynthesis.**
    $6CO_2 + 6H_2O$ + sunlight energy and chlorophyll → $C_6H_{12}O_6 + 6O_2$
20. **What energy source is essential for photosynthesis to occur?**
    Light energy
21. **How could you manipulate a plants' environment to make photosynthesis occur for longer periods?**
    Provide artificial light for example in a greenhouse or growing shed. This would allow photosynthesis to be carried out for longer periods.
22. **Label the parts of the diagram.**




23. **Name the structures that allows the transfer of gases into and out of a plant?**
    Stomates
24. **Describe the role of the xylem.**
    Xylem is a part of the vascular system of plants. It carries water and nutrients up through the plant from the roots to the stems etc. It is a one-way transport system.
25. **Describe the role of phloem**
    Phloem is a part of the vascular system of plants. It carries carbohydrates (starch and glucose) and water around the plant. It is a 'two-way' transport system.
26. **Name the specialised organelles that carry out respiration?**
    Mitochondria

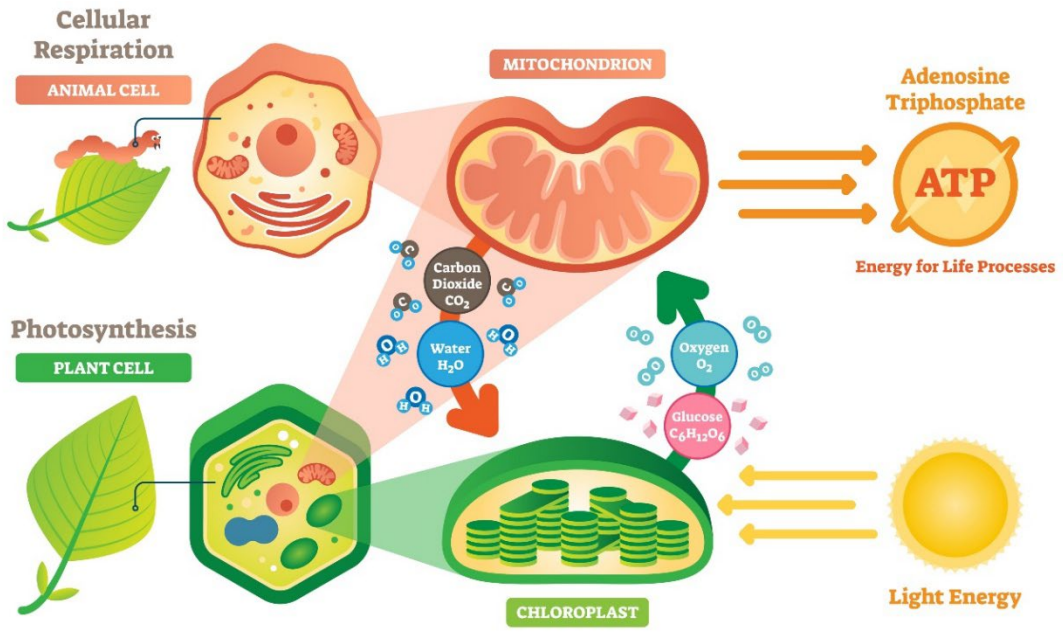
27. **Write the word equation for respiration.**
    Glucose + oxygen → carbon dioxide + water + energy
28. **Write the chemical equation for respiration.**
    $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + energy (38 ATP)
29. **Does respiration only occur during a specific time of day?**
    No, respiration occurs all the time, however, in plants the rate of respiration is greatest in the dark.
30. **Label the diagram.**



**31. Use the information from the 'Comparing photosynthesis and respiration' section to complete the table. Match each dot point into the following table using the headings 'Photosynthesis', 'Respiration' or 'Similarities'. The first two dot points have been included.**

| Photosynthesis | Respiration | Similarities |
|---|---|---|
| Plants obtain glucose for respiration by producing it through a process known as photosynthesis. | Animals obtain glucose for respiration by digesting food that they eat. | Both need common molecules glucose, oxygen, carbon dioxide and water. |
| Photosynthesis uses the energy of sunlight to convert carbon dioxide and water into glucose and oxygen. | Respiration allows living organisms to breakdown glucose in their cells to obtain energy. | Both involve energy conversions. |
| Photosynthesis can be summarised as:<br>carbon dioxide + water + sunlight energy and chlorophyll → glucose + oxygen | Respiration can be summarised as:<br>Glucose + oxygen → carbon dioxide + water + energy | |
| Respiration takes place in cell organelles called mitochondria. | Photosynthesis takes place in cell organelles called chloroplasts. Chloroplasts occur in the cells of plants, green algae and some bacteria; therefore, photosynthesis only takes place in these organisms. | |
| Respiration is an exothermic process that releases energy (from glucose) | Photosynthesis is an endothermic process that absorbs energy (from sunlight). | |
| Photosynthesis requires light, so naturally only occurs through daylight hours. | Respiration occurs all the time and does not require light. | |

**32. Label the parts of the diagram.**



## Agricultural Technology Years 7-10 Syllabus, 2019

| Outcomes | Content |
|---|---|
| **AG5-1 explains why identified plant species and animal breeds have been used in agricultural enterprises and developed for the Australian environment and/or markets**<br><br>**AG5-9 evaluates management practices in terms of profitability, technology, sustainability, social issues and ethics** | Plant Production 1<br>• identify plants relevant to agricultural production, for example: – important plant crops in Australia, eg wheat, barley, oats – importance of legumes in pastures – commercially grown bush plants eg wattle, sandalwood<br>• explain the function and structure of plants related to the enterprise, for example: – the role of leaves, stems, roots – the role of fruits and flowers<br>Plant Production 2<br>• investigate timing and impact of relevant operations in a plant production cycle, for example: – application of fertiliser – pruning – sowing – irrigation |

## Science Years 7-10 Syllabus, 2018

| Outcomes | Content |
|---|---|
| **SC4-14LW relates the structure and function of living things to their classification, survival and reproduction** | LW1 There are differences within and between groups of organisms; classification helps organise this diversity (ACSSU111)<br>• classify a variety of living things based on similarities and differences in structural features<br><br>LW3 Multicellular organisms contain systems of organs that carry out specialised functions that enable them to survive and reproduce (ACSSU150)<br>• describe the role of the flower, root, stem and leaf in maintaining flowering plants as functioning organisms<br>• identify the materials required by multicellular organisms for the processes of respiration and photosynthesis |