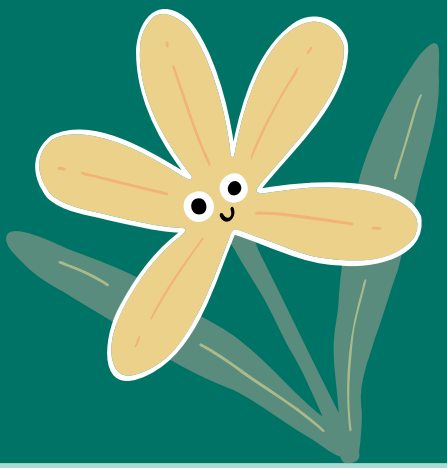
Sexual and Asexual Reproduction in Plants

TEACHER GUIDE



LESSON 1

YEAR 9–10

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LESSON 1

Sexual and Asexual Reproduction in Plants

LEARNING AREAS / YEAR LEVEL

Science (Year 9–10)

Design and Technologies (Year 9–10)

AUSTRALIAN CURRICULUM CONTENT

Describe the form and function of reproductive cells and organs in animals and plants, and analyse how the processes of sexual and asexual reproduction enable survival of the species (**AC9S9U02**)

Explain the role of meiosis and mitosis and the function of chromosomes, DNA and genes in heredity and predict patterns of Mendelian inheritance (**AC9S10U01**)

Analyse and make judgements on the ethical, secure and sustainable production and marketing of food and fibre enterprises (**AC9TDE10K04**)

Contents

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LESSON OBJECTIVE

During this lesson, students will develop an understanding of the processes of sexual and asexual reproduction carried out by plants to enable the survival of their species. Students will explore the ways in which asexual plant reproduction is utilised by the nursery industry to meet the needs of consumers and produce ornamental, and non-ornamental fruit and vegetable plants in ways that address environmental challenges as well as pests and diseases that threaten production.

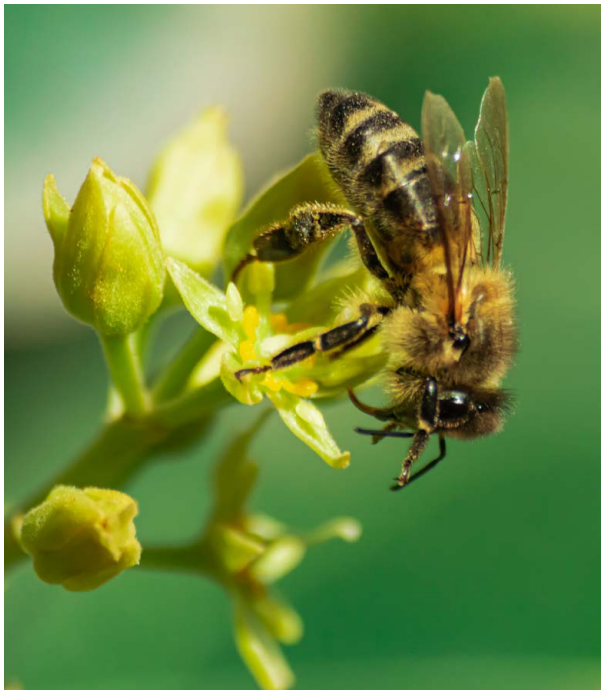
LESSON OVERVIEW

Activity 1.1 – Odd One Out (10 minutes)

Activity 1.2 – Sexual and Asexual Reproduction of Plants (60 minutes)

Activity 1.3 – The Australian Nursery Industry and Artificial Plant Reproduction (60 minutes)

Activity 1.4 – Plant Reproduction in the Nursery Industry (30 minutes)



Resources and Equipment

ACTIVITY 1.1 – Odd One Out

1. Access to computer/digital device
2. **Stimulus 1.1a – Odd One Out** (Problem solving activity)

ACTIVITY 1.2 – Sexual and Asexual Reproduction of Plants

1. Access to computer/digital device
2. **Worksheet 1.2a – Sexual Reproduction in Plants** (Research and response task)
3. Sexual Reproduction in Plants | Plants | Biology | FuseSchool (4:06)
4. **Worksheet 1.2b – Asexual (Vegetative) Reproduction in Plants** (Research and response task)
5. Vegetative plant propagation
6. Butchers paper and markers, or whiteboard and markers

ACTIVITY 1.3 – The Australian Nursery Industry and Artificial Plant Reproduction

1. Where did I come from (7:0)
2. Timer
3. Access to computer/digital device
4. **Worksheet 1.3a – Nursery Industry Fast Facts Scavenger Hunt** (Information scavenger hunt task)
5. **Worksheet 1.3b – Plant Propagation Techniques** (Research and describe task)
6. Facts at a Glance Australian Nursery Industry
7. How to graft (5:07)
8. Propagating by Layering (6:06)
9. Tissue Culture

ACTIVITY 1.4 – Plant Reproduction in the Nursery Industry

1. Access to computer/digital device
2. Butchers paper and markers
3. World-first technique to double Queensland's avocado production and ease global shortage (1:59)
4. **Worksheet 1.4a – Case Study – Avocado Tissue Propagation** (Group case study)

Lesson Guide

ACTIVITY 1.1 – Odd One Out

During this stimulus activity students will observe three images and consider the similarities and differences between them before using their reasoning skills to justify which of them they believe is the odd one out.

1. Display **Stimulus 1.1a – Odd One Out** (Problem solving activity). Ask students to consider the similarities and differences between the three images. Encourage students to consider the appearance, function, and requirements (what they need to grow/where they might be grown) of the three images. Ask students to work in pairs to record their ideas in a workbook.
2. Explain that students must now decide which of these images they believe is the 'odd one out' and justify their answer.
3. Discuss each of the images and select one student to justify their explanation as to why they considered that image to be the odd one out.

   Note: there is no right or wrong answer for this activity; the focus is on eliciting student ideas about the features of different varieties of plants.
4. Explain that each of these plants reproduces in a different way. Avocado trees cross-pollinate through sexual reproduction. The trees contain both female and male flowers, however these flowers are never open at the same time to prevent self-pollination. At some stages of the day the flowers open with female reproductive parts and then close again before opening with male reproductive parts. This adaptation ensures greater variation in the avocado plant species. In many species of banksia plants (which are native to fire-prone regions of Australia), the seeds cannot be released for reproduction unless the woody fruits of the plants are completely dried out or burned. The seeds are released from their pods during or soon after a fire and are able to reproduce in landscapes that have been recently burned. Strawberry plants reproduce asexually through the growth of 'runners' or stolons, a type of horizontal stem that forms roots at its nodes allowing an identical genetic clone of the parent plant to begin to grow independently.

ACTIVITY 1.2 – Sexual and Asexual Reproduction in Plants

During this activity, students will explore and compare sexual and asexual reproductive strategies in plants.

1. Explain that reproduction can occur in two forms: sexual or asexual. Asexual reproduction only requires one parent and allows for an organism to reproduce identical clones of itself. Organisms that reproduce asexually use the process of mitosis to create genetically identical clones of their cells which form a new plant or animal. These organisms have the same DNA, meaning they will have the same characteristics. Sexual reproduction requires two parents, each with their own genetic information. Sexual reproduction uses the process of meiosis which forms gametes (sex cells). Each gamete is genetically unique (has differing DNA), meaning when the process of fertilisation occurs during sexual reproduction, the genetically unique gametes of the two parent organisms fuse together to create a new organism with its own genetic information. As sexual reproduction results in offspring with unique DNA, the characteristics of the offspring are different to their parent organisms.
2. Explain that some plants reproduce sexually, whilst others reproduce asexually. Some plants can reproduce both asexually and sexually through the processes of self-pollination or cross-pollination.

   Plant propagation is the process of increasing the number of plants of a particular species or cultivar. Propagation can be via sexual or asexual means. Over the years, horticulturalists have developed asexual propagation methods that use vegetative plant parts. This allows plants to be created in ways that nature cannot duplicate (Science Learning Hub, 2013).
3. Distribute **Worksheet 1.2a – Sexual Reproduction in Plants** (Research and response task) and provide students with access to computers or digital devices.

   Answers
4. Allow students to watch the video about the sexual reproduction of plants before completing the questions on the worksheet. Upon completion, ask students to share their answers to the questions.
5. Distribute **Worksheet 1.2b – Asexual (Vegetative) Reproduction in Plants** (Research and response task) and as a class read through the questions on the worksheet. Ensure students understand the difference between artificial (made by humans rather than occurring naturally) and natural propagation before commencing the task.
6. Encourage students to share their definitions of each of the forms of naturally occurring asexual reproduction in plants and elicit examples from students of plants that perform each method.

   Answers

7. Facilitate a class discussion about the advantages and disadvantages of both sexual and asexual reproduction in plants. Encourage students to consider the challenges that a plant species might face if it relied on vegetative propagation for reproduction, and the parent plant was susceptible to a particular pest or disease. What would happen to the genetically identical clones propagated from that plant if the disease or pest were to reach them? Explain that sexual reproduction and the process of meiosis (which forms gametes) gives a species a greater chance of survival when faced with threats that may wipe out entire populations of asexually reproduced plants. This is because each of the sexually produced plants contains its own unique genetic information and genes, meaning they are potentially resistant to a particular pest or disease. This variation between sexually reproduced organisms plays an important role in their survival and ability to adapt to changing conditions.
8. On the whiteboard or a piece of butchers paper create a table with two columns: one labelled asexual reproduction and the other labelled sexual reproduction.
9. Explain that students will be brainstorming the benefits of natural sexual reproduction and asexual reproduction for species of plants.
10. As a class, brainstorm some of the advantages of natural asexual and sexual reproduction for plants. Record student suggestions in the table.

    (*Possible answers have been recorded in the table below*).

The advantages of **natural** reproduction methods for plants

Sexual reproduction	Asexual reproduction
– Promotes greater variation in species of plants ensuring a greater chance of survival against adverse conditions such as extreme weather, pests, and diseases.	– The population of the plant species can rapidly increase. – Asexual reproduction occurs faster than sexual reproduction and only requires one parent for the process to take place.

11. When all suggestions have been recorded in the table, ask students to consider some of the disadvantages of asexual and sexual production for plants. Remind students that pests and diseases have the potential to decimate entire species of plants rapidly if there is no variation.

ACTIVITY 1.3 – The Australian Nursery Industry and Artificial Plant Reproduction

Students will consider the role of the nursery industry in Australia's economy and the methods of asexual plant propagation used within the industry to meet consumer demand for plant production.

1. Explain that Australia's nursery industry plays a vital role in the development and distribution of plants used for ornamental purposes, as well as those required for food and fibre production. Industries such as Australia's horticulture sector rely on nurseries for the seeds, seedlings, and plants that supply much of the country's fresh fruit and vegetables.
2. Distribute **Worksheet 1.3a – Nursery Industry Fast Facts Scavenger Hunt** (Information scavenger hunt task) and provide students with access to computers or digital devices. Allow students to complete the scavenger hunt activity before sharing answers as a class.

   Answers
3. Explain that to ensure nurseries can meet the demand of consumers and other sectors, artificial plant propagation plays an important role in allowing primary producers, gardeners, and horticulturalists to create plants in ways and at rates that nature cannot. Asexual vegetative plant production methods including grafting, cutting, layering, and tissue culture cloning are used in nurseries and large-scale horticulture production systems to meet global consumer demand for consistency in high-quality plant products, plant breeds that are pest and disease-resistant, and plants and plant products that produce at faster rates to meet this demand.
4. Ask students to turn and talk at their table to share any forms of artificial plant propagation they may be familiar with. After allowing students to share their ideas with the people at their tables, select a number of students to share their suggestions with the class.
5. Explain that students will now be observing a video about a range of artificial plant reproduction techniques used in an Australian nursery. Encourage students to listen for any forms of plant propagation mentioned throughout the video.
6. Play '**Where did I come from?**' video. (7:00)

   Source: ABC. (2022, October 14). *Where Did I Come From*? Gardening Australia. https://www.abc.net.au/gardening/how-to/where-did-i-come-from-/101534022
7. After watching, ask students to share any propagation techniques they heard mentioned throughout the video.
8. Allocate students into pairs and distribute **Worksheet 1.3b – Plant Propagation Techniques** (Research and describe task).

9. Provide each pair of students with access to computers or digital devices and allow them to work collaboratively to research the different methods of propagation utilised in the nursery industry.
10. Upon completion of the worksheet, select some of the student pairs to share their definitions of each of the propagation techniques.

    Answers
11. Facilitate a class discussion about the use of propagation techniques to improve profitability, productivity, and sustainability in the nursery industry. Prompt students with the following questions:

    - How might propagation using cuttings improve productivity in the nursery industry?
    - Could more plants be grown from cuttings than from seeds? Why/why not?
    - Which of these propagation methods might produce the most plants?
    - Which propagation methods might produce plants the fastest?
    - Which of these methods would be the most expensive to implement?
    - Which of these methods would be the most sustainable?

ACTIVITY 1.4 – Plant Reproduction in the Nursery Industry

Students will work collaboratively to complete a case study exploring the innovations in tissue culture propagation and its impact on Australia's avocado industry.

1. Allocate students into groups of four or five and provide each group with a copy of **Worksheet 1.4a – Case Study – Avocado Tissue Propagation** (Group case study task) and a piece of butchers paper.
2. Ask students to use a pencil or marker to divide their butcher's paper into four quarters and record one of the questions from **Worksheet 1.4a – Case Study – Avocado Tissue Propagation** (Group case study task) in each of the quarters.
3. Explain that during this task, groups will be completing a case study about an innovation in plant propagation designed to enhance the profitability and productivity of the avocado industry.
4. Provide groups with access to computers or digital devices and allow them to read and watch the information in the case study, recording their answers to the questions provided on their butchers paper.
5. Upon completion of their research, allow each group to share their answers to the questions on their butchers paper.

6. On the whiteboard or a piece of butchers paper, create another table with two columns: one labelled asexual reproduction and the other labelled sexual reproduction. Ask students to share their thoughts on the advantages of artificial asexual and sexual reproduction methods used in the nursery industry. Record student ideas in the table.

   (*Possible answers have been recorded in the table below*).

The advantages of artificial reproduction methods in the nursery industry

Sexual reproduction	Asexual reproduction
– Promotes greater variation in species of plants ensuring greater chance of survival against adverse conditions such as extreme weather, pests, and diseases. – Can be used to breed plants, fruits, and vegetables of higher quality to meet consumer needs. – Allows growers to breed plants with resistance to specific pests and diseases.	– Allows for plants to be produced faster than natural rates of growth from seed. – Allows for greater consistency in plants produced for distribution. – Allows growers to produce larger numbers of plants in shorter amounts of time. – Allows growers to produce plants with resistance to specific pests and diseases. – Allows growers the ability to produce plants with specialised features (such as dwarfed fruit trees).

7. Ask students to share any factors that nursery workers, primary producers, or horticulturalists may have to consider when artificially reproducing plants. Encourage them to share some of the disadvantages of sexual and asexual reproduction in large-scale plant production systems.

   (*Possible suggestions could be lack of biodiversity in particular plant species when asexually reproduced leading to greater risk of widespread loss when faced with new pests or diseases/unfavourable conditions.)*

Student Resources

1. **Stimulus 1.1a – Odd One Out** (Problem solving activity)
2. **Worksheet 1.2a – Sexual Reproduction in Plants** (Research and response task)
3. **Worksheet 1.2b – Asexual (Vegetative) Reproduction in Plants** (Research and response task)
4. **Worksheet 1.3a – Nursery Industry Fast Facts Scavenger Hunt** (Information scavenger hunt task)
5. **Worksheet 1.3b – Plant Propagation Techniques** (Research and describe task)
6. **Worksheet 1.4a – Case Study – Avocado Tissue Propagation** (Group case study)

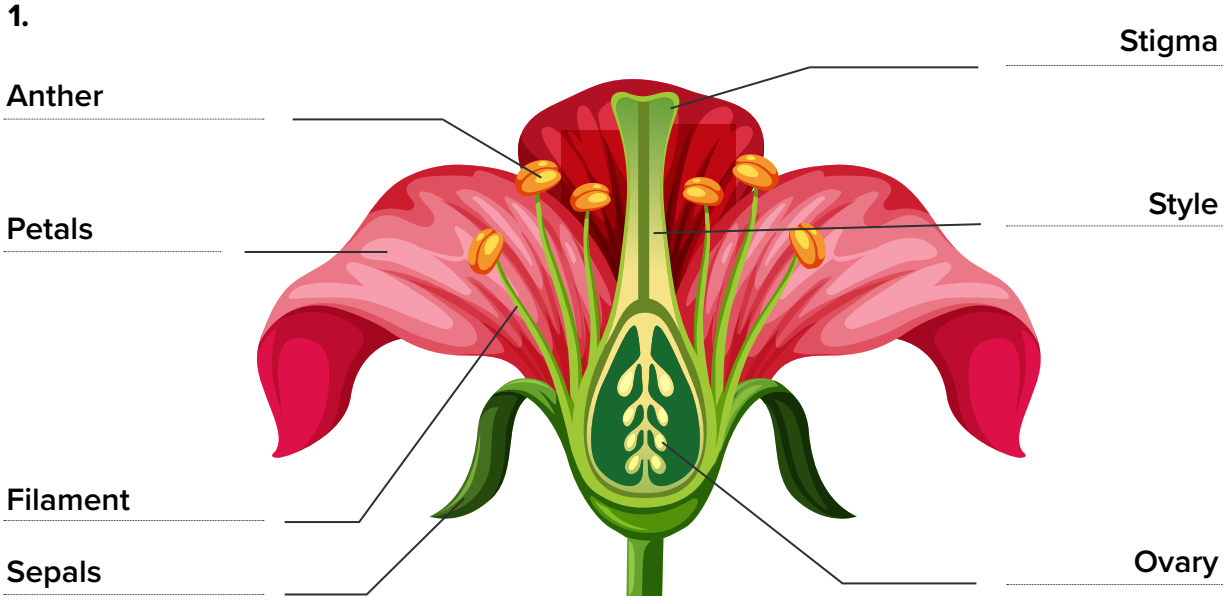
Answers

STIMULUS 1.1a – Odd One Out (Problem solving activity)

Answers will vary depending on individual student responses.

WORKSHEET 1.2a – Sexual Reproduction in Plants (Research and response task)

1.



Answers (continued)

2. a) stamen, b) carpel, c) gametes, d) wind, e) water, f) pollinators

3. **Petals** – Helps protect the flower bud. Can be brightly coloured or scented to attract pollinators such as bees

Sepals – Helps protect the flower bud

Anther – Where the pollen (the male gamete) is produced

Filament – Holds the anther in position

Stigma – The sticky bulb where pollen lands to begin the fertilisation process

Style – Where the pollen grain descends towards the ovary

Ovary – Where the ovule (female gametes) are located

WORKSHEET 1.2b – Asexual (Vegetative) Reproduction in Plants (Research and response task)

1. Vegetative plant propagation is the process of a plant asexually reproducing to form genetically identical clones of itself.

2.
- Only one parent is required for this form of reproduction
- If the conditions are right, the plant species can reproduce rapidly
- In the horticulture industry it allows growers to produce consistent plant products to meet consumer demand.
- Vegetative propagation allows plants to grow faster than growing them from seed

3. Possible lack of biodiversity and variation in a plant species which could lead to entire populations of plants being impacted by specific pests or diseases that the parent plant of all asexual clones may be susceptible to.

4. **Tubers** – Enlarged underground portions of stem that form buds on the surface of the tuber which sprout into new plants

Stolons (Runners) – Stolons or runners are a type of horizontal stem that forms roots at its nodes, allowing an identical genetic clone of the parent plant to begin to grow independently of its parent plant.

Bulbs – Bulbs are spherical structures that form buds from its sides. These buds are able to form new plants.

Answers (continued)

WORKSHEET 1.3a – Nursery Industry Fast Facts Scavenger Hunt (Information scavenger hunt task)

a) $2.8 billion, b) 25,000, c) 2.3 billion, d) $58,500, e) 25%, f) 30%

WORKSHEET 1.3b – Plant Propagation Techniques (Research and describe task)

Grafting and budding – Grafting and budding are two means of joining two plants of the same genus together allowing them to form a hybrid plant either through the use of the stem of a plant (scion) or the bud of a plant. This form of reproduction can be a useful way of propagating plants that are resistant to specific pests and diseases, as well as producing fruit or vegetables with consistent specifications to meet consumer demands.

Layering – Layering involves bending the stem of a plant that is growing and partially covering it with soil. Over time the soil covered area of the plant begins to develop roots, forming a new plant.

Cuttings – A cutting is a piece of a plant that has been cut from a parent plant and forms into an identical clone of the parent plant. Cuttings are often treated with hormones to support root growth.

WORKSHEET 1.4a – Case Study – Avocado Tissue Propagation (Group case study)

Answers will vary depending on individual student responses.

References

ACTIVITY 1.2

FuseSchool – Global Education. (2017). Sexual Reproduction in Plants | Plants | Biology | FuseSchool. In YouTube. https://www.youtube.com/watch?v=R8_ScKzLAfE

The University of Waikato Te Whare Wānanga o Waikato. (2013). Vegetative plant propagation. Science Learning Hub; Science Learning Hub. https://www.sciencelearn.org.nz/resources/1662-vegetative-plant-propagation

ACTIVITY 1.3

ABC. (2016, July 8). *Cuttings 101*. Gardening Australia. https://www.abc.net.au/gardening/how-to/cuttings-101/9437930

ABC. (2009, July 24). *How to Graft*. Gardening Australia. https://www.abc.net.au/gardening/how-to/how-to-graft/9430148

ABC. (2007, October 26). *Propagating By Layering*. Gardening Australia. https://www.abc.net.au/gardening/how-to/propagating-by-layering/9428330

ABC. (2022, October 14). *Where Did I Come From?* Gardening Australia. https://www.abc.net.au/gardening/how-to/where-did-i-come-from-/101534022

Hort Innovation Nursery Fund. (2021). FACTS AT A GLANCE PLANTS SOLD* SALES** TURNOVER/ HECTARE DID YOU KNOW? https://www.greenlifeindustry.com.au/static/uploads/files/nursery-facts-at-a-glance-2020-21-wfkptzcbbiqw.pdf

The Royal Botanic Garden Sydney. (2017). *Tissue culture at the Australian PlantBank*. The Royal Botanic Garden Sydney. https://www.rbgsyd.nsw.gov.au/science/australian-plantbank-1/conservation-and-research-at-plantbank/tissue-culture-and-cryopreservation/tissue-culture

ACTIVITY 1.4

Queensland Alliance for Agriculture & Food Innovation (QAAFI). (2017). *World-first technique to double Queensland's avocado production and ease global shortage*. www.youtube.com. https://youtu.be/itAcSPKEYhE

PROBLEM SOLVING ACTIVITY

Odd One Out

Observe the three plants in the pictures below. Consider their appearance, function, and requirements (what they need to grow/where they might be grown). Record your ideas in your workbook.

Which of these plants is the odd one out? Justify your answer and share your ideas with a partner.

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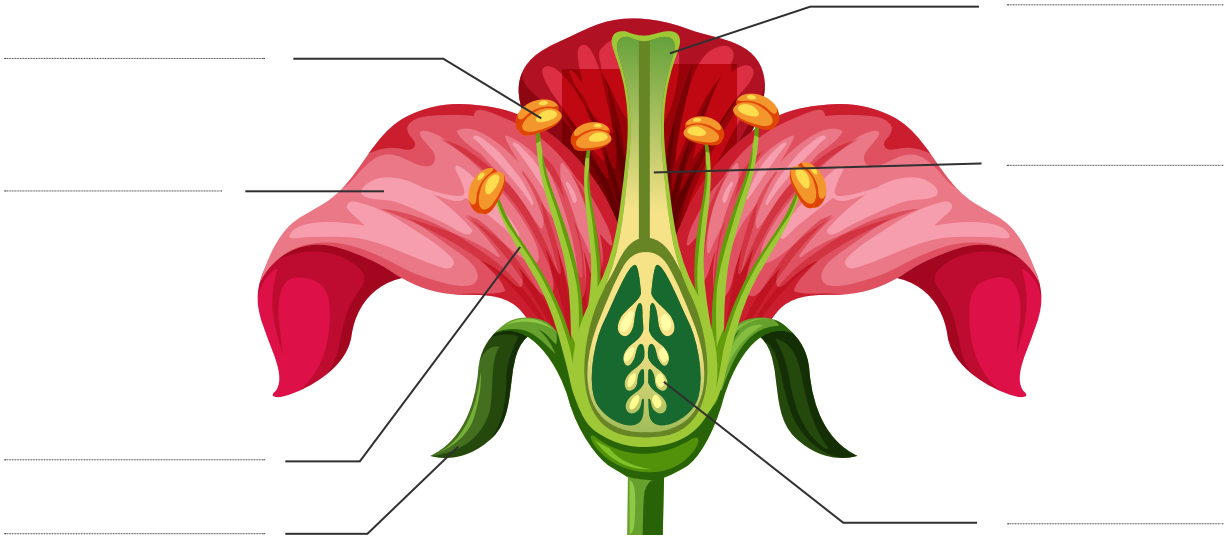
RESEARCH AND RESPONSE TASK

Sexual Reproduction in Plants

Scan the QR code or click on the link to watch the video about sexual reproduction in plants. Answer the questions below using the information provided in the video.

Sexual Reproduction in Plants: (4:06) https://www.youtube.com/watch?v=R8_ScKzLAfE

1. Label the reproductive parts of the flower.



2. Use the word bank in the box below to complete the sentences.

stamen	wind	gametes	water	carpel	pollinators

a) The anther and the filament are the male parts of the flower, known as the _____.

b) The stigma, style and ovary are the female parts of the flower, known as the _____.

c) _____ are the sex cells contained in the anthers and ovaries of flowering plants that must fuse together during sexual reproduction.

d) _____ , _____ and _____ help flowering plants to reproduce by transferring pollen from one plant to another.

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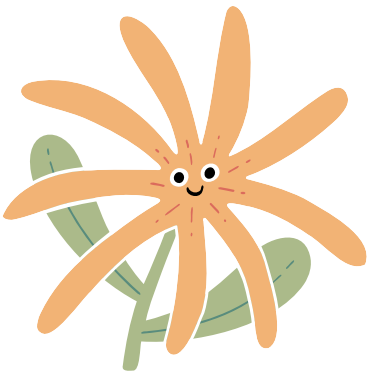
RESEARCH AND RESPONSE TASK

Sexual Reproduction in Plants (cont.)



3. Complete the table below by recording the role of each of the parts of the flower.

Parts of flower	Role in reproduction
Petals	
Sepals	
Anther	
Filament	
Stigma	
Style	
Ovary	

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RESEARCH AND RESPONSE TASK

Asexual (Vegetative) Reproduction in Plants

Asexual reproduction only requires one parent and allows for that organism to reproduce genetically identical clones of itself. No gametes are required for asexual reproduction to take place. There are a number of different ways plants may reproduce asexually.

Scan the QR code or click on the link to read the information about natural and artificial forms of asexual reproduction in plants. Use the spaces provided to take notes and answer the questions about the information you have read.

- **Vegetative plant propagation: https://www.sciencelearn.org.nz/resources/1662-vegetative-plant-propagation**

1. Explain the term vegetative plant propagation.

2. Explain the **advantages** of vegetative propagation.

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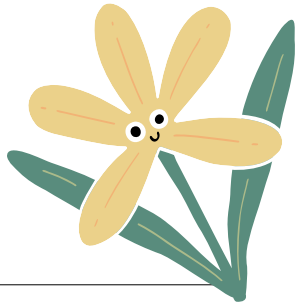
RESEARCH AND RESPONSE TASK

Asexual (Vegetative) Reproduction in Plants (cont.)



3 Explain the **disadvantages** of vegetative propagation.

4. Describe and draw a diagram showing each of the types of natural vegetative propagation in plants.

Tubers:

Stolons (Runners):

Bulbs:

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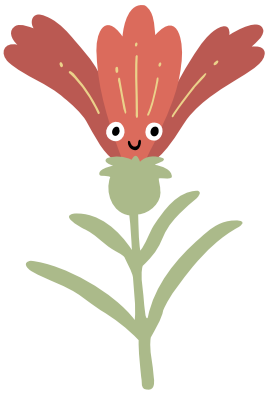
INFORMATION SCAVENGER HUNT TASK

Nursery Industry Fast Facts Scavenger Hunt



Australia's Nursery Industry is responsible for the large scale production and distribution of plants used for ornamental purposes, fruit and vegetable production, forestry and landscaping. This diverse industry employs people throughout Australia along each of the stages of the value supply chain.

1. Read the questions, and record an estimate of each answer in the table below before the timed activity begins.
2. Use the QR code or click the industry facts link to find the correct statistic. Record your answer in the table.

   Facts at a Glance: https://www.greenlifeindustry.com.au/static/uploads/files/nursery-facts-at-a-glance-2020-21-wfkptzcbbiqw.pdf

Question	Estimate	Answer
a) What is the approximate value of the Nursery Industry to Australia's economy?		
b) Approximately how many people are employed by Australia's Nursery Industry?		
c) How many plants were produced and distributed by the Nursery Industry between 2020–2021?		
d) What is the estimated average wage for someone working in the Nursery Industry?		
e) What percentage of the plants produced by the Nursery Industry are fruit trees, nut trees or vines?		
f) What percentage of growers made a profit greater than $2 million between 2020–2021?		

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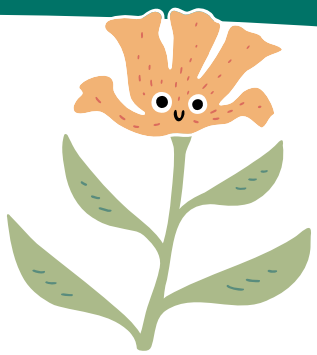

INFORMATION SCAVENGER HUNT TASK

Nursery Industry Fast Facts Scavenger Hunt (cont.)

3. Record any other interesting facts you have learned about Australia's Nursery Industry.

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RESEARCH AND DESCRIBE TASK

Plant Propagation Techniques

Scan the QR codes to learn about the following plant propagation techniques used by the nursery industry to address environmental challenges and meet the needs of consumers. Record a description for each of the types of propagation.

Propagation technique	Description
Tissue culture: https://www.rbgsyd.nsw.gov.au/science/australian-plantbank-1/conservation-and-research-at-plantbank/tissue-culture-and-cryopreservation/tissue-culture	This form of propagation uses small fragments of plants which are treated with nutrients and hormones to stimulate their growth. Tissue culture propagation is able to produce many clones from the one mother plant which grow more rapidly than plants grown from seed.
Grafting and budding: How to Graft (5:07) https://www.abc.net.au/gardening/how-to/how-to-graft/9430148	

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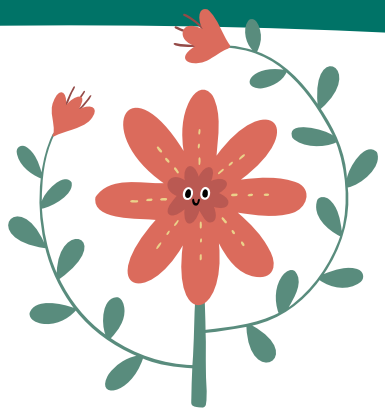

RESEARCH AND DESCRIBE TASK

Plant Propagation Techniques (cont.)

Propagation technique	Description
Layering: Propagating by layering (6:06) https://www.abc.net.au/gardening/how-to/propagating-by-layering/9428330	
Cuttings: Cuttings 101 (1:28) https://www.abc.net.au/gardening/how-to/cuttings-101/9437930	

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GROUP CASE STUDY

Case Study – Avocado Tissue Culture Propagation

Tissue culture propagation is used in the nursery and horticulture industries as an asexual form of plant reproduction. This form of propagation uses small fragments of plants which are treated with nutrients and hormones to stimulate their growth.

Tissue culture propagation is being implemented in a variety of plant production systems to address issues such as pest and disease impacts on crops, the rate of growth time required to form new plants for production, as well as vastly increasing the number of plants propagated from a single parent plant.

Scan the QR code or click on the link to watch the video about avocado tissue culture propagation. In your groups, record your answers to the following questions on a piece of A3 or butchers paper.

Avocado tissue propagation: (1:59) https://youtu.be/itAcSPKEYhE

1. Explain the possible advantages and disadvantages of the use of avocado tissue culture propagation for the avocado industry.

2. Explain the problem researchers were trying to address when they began their work on avocado tissue culture propagation.

3. Explain how this form of propagation could improve the productivity, profitability and sustainability of the avocado industry.

4. Describe the current method of avocado propagation described in the video and record some of the issues surrounding this form of propagation.

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