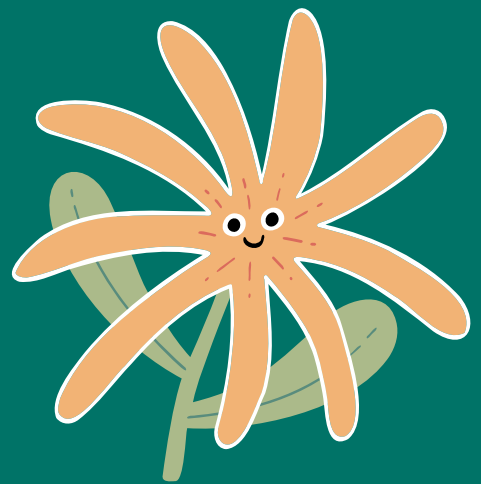




# Growing and Grafting

TEACHER GUIDE

LESSON 2



YEAR 9–10

This resource has been developed by:



Primary Industries Education  
Foundation Australia



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## LESSON 2

# Growing and Grafting

### ➤ 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](#))

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➤ **LESSON OBJECTIVE**

During this lesson students will apply their understanding about plant propagation techniques used in the nursery industry by performing a grafting practical task. Students will consider the ways plant propagation techniques are utilised to improve the productivity, profitability, and sustainability of the nursery industry.

➤ **LESSON OVERVIEW**

**Activity 2.1 – Advantages and Disadvantages of Plant Reproduction Processes** (30 minutes)

**Activity 2.2 – The Anatomy of a Tree** (30 minutes)

**Activity 2.3 – The Advantages of Grafting and Budding** (30 minutes)

**Activity 2.4 – Grafting Practical or Modelling Task** (60 minutes)

**Activity 2.5 – Careers in the Nursery Industry** (40 minutes)



This resource has been developed by:

# Resources and Equipment

## ➤ **ACTIVITY 2.1 – Advantages and Disadvantages of Plant Reproduction Processes**

1. **Worksheet 2.1a - Advantages and Disadvantages of Plant Reproduction Processes** (Concept cartoon)

## ➤ **ACTIVITY 2.2 – The Anatomy of a Tree**

1. **Stimulus 2.2a – Fruit Salad Tree** (Observation task)
2. Access to computer/digital device
3. **Worksheet 2.2b – The Anatomy of a Tree** (Labelling task)
4. [Anatomy of a Tree](#)
5. [Vegetative Plant Propagation](#)

## ➤ **ACTIVITY 2.3 – The Advantages of Grafting and Budding**

1. Access to computer/digital device
2. **Worksheet 2.3a – What’s So Good About Grafting and Budding** (Read and response task)
3. [Master Grafter](#) (5:15)
4. [Grafted Plants Explained](#)

## ➤ **ACTIVITY 2.4 – Grafting Practical or Modelling Task**

1. Access to computer/digital device
2. [Get Grafting](#) (6:11)

### **Practical task materials:**

3. **Worksheet 2.4a – Asexual Reproduction Through Grafting – Practical task** (Grafting practical task)
4. Rootstock and scion of the same genus
5. Secateurs
6. Grafting knife/scalpel
7. Grafting tape
8. Gloves

### Modelling task materials:

9. Worksheet 2.4b – Asexual Reproduction Through Grafting – Modelling Task  
(Grafting modelling task)
10. Coloured straws
11. Scissors
12. Sticky tape
13. Blu tack or modelling clay
14. Adhesive labels or sticky notes

### ➤ **ACTIVITY 2.5 – Careers in the Nursery Industry**

1. Worksheet 2.5a – Nursery Careers (Read and response task)
2. Access to computer/digital device
3. [Career Pathways](#)
4. [Daniel Ewings Case Study Industry Loves](#)
5. [Carol Fudge Case Study Industry Loves](#)

# Lesson Guide

## ➤ ACTIVITY 2.1 – Advantages and Disadvantages of Plant Reproduction

Students will revise what they know about asexual and sexual reproduction as they record the advantages and disadvantages of each method for plants and plant producers.

1. Distribute **Worksheet 2.1a – Advantages and Disadvantages of Plant Reproduction Processes** (Concept cartoon) and read through the information as a class. Brainstorm possible advantages and disadvantages of artificially asexually reproducing plants using column one, recording these in the spaces provided on the activity sheet.  
*Possible advantages could be that asexual reproduction allows for greater consistency in plant products sold by nurseries, asexual reproduction is often a faster method of reproducing plants than sexual reproduction methods, etc. Disadvantages could be that asexual plant reproduction does not allow for variation in the species, meaning genetically identical cloned plants may be more vulnerable to adverse conditions such as extreme weather, pests, and diseases, etc.*
2. Allow students to complete the worksheet before selecting some students to share their answers with the class.
3. Remind students of the important role Australia's nursery industry plays in producing and distributing ornamental and non-ornamental plants. Revise what students remember from lesson one by revisiting the idea that the nursery industry implements both sexual and asexual reproduction methods to produce plants that meet the needs of consumers and the wider horticultural industry. The nursery industry implements artificial plant reproduction methods for a range of different reasons including:
  - Consumer demand for specialised plant varieties with characteristics that are not commonly naturally occurring (e.g. seedless fruits and vegetables or dwarfed trees).
  - To increase the rate of plant growth ensuring that supply and demand are met.
  - To ensure plants distributed by nurseries are consistent in their characteristics.
  - To develop plants that are resistant to pests or diseases.
  - To optimise opportunities for pollination and cross-pollination between plants (e.g. grafting multiple varieties of plant onto the same rootstock to allow for cross-pollination).
  - To develop high yielding plants for use in the horticulture industry for food production.

4. Explain that each of the methods of plant reproduction utilised within the nursery industry is selected based on the requirements of the plant being produced. Facilitate a discussion about the asexual propagation techniques explored in lesson one.

Record the following terms on the whiteboard: **Tissue Culture Propagation, Grafting and Budding, Layering, Cuttings.**

5. Distribute one sticky note to each student and ask them to select one of the propagation methods to explain in one sentence.
6. When finished recording their explanation, students should stick their sticky note under the corresponding propagation method.
7. Select one sticky note explanation of each propagation method to share with the group. Ensure that students have a sound understanding of each of the methods by reiterating the following statements:

**Tissue Culture Propagation:** This form of propagation uses small fragments of plants which are treated with nutrients and hormones to stimulate their growth. Tissue culture propagation can produce many clones from the one mother plant which grow more rapidly than plants grown from seed.

**Grafting and Budding:** Grafting and budding are two means of joining two plants of the same genus, allowing them to form a hybrid plant either using 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:** 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.

## ➤ ACTIVITY 2.2 – The Anatomy of a Tree

Students will identify the role of each of the parts of a tree as they explore the importance of the cambium layer of plants in the grafting process.

1. Display **Stimulus 2.2a – Fruit Salad Tree** (Observation task).
2. Facilitate a class discussion by asking students:
  - What are the features of this plant?
  - How might this plant have been produced?
  - What would the benefits of growing this type of plant be for plant producers, consumers, and plants?
3. Explain that this is an example of a tree that has been grafted to grow a variety of different types of citrus fruits. Grafting occurs when the stem of one plant is joined with another plant that has roots or has the capacity to develop roots.
4. Distribute **Worksheet 2.2b – The Anatomy of a Tree** (Labelling task) and provide students with access to computers or digital devices to complete the anatomy of a tree labelling task.
5. Upon completion of the worksheet, explain that grafting occurs when the stem of one plant (scion) is joined with another plant that has roots or has the capacity to develop roots (rootstock).

For a graft to be successful, the cambium layers of both plants must fuse together as the plants heal from the cuts made during the grafting process. When the cambium layers of both plants have fused together, the hormones that promote growth are able to travel from the phloem (near the root of the plant) to the other parts of the plant (including the now fused scion) to allow the tree to continue to grow and produce fruit.

Explain that, for grafting to be successful the rootstock and the scion generally need to be from the same genus of plants. For example, citrus plants like lemons and limes can be grafted together, and stone fruit plants (from the prunus genus) like plums and nectarines can be grafted together. However, it is unlikely that a graft between a lemon and a nectarine plant would be successful as they are not from the same genus.



## ➤ ACTIVITY 2.3 – The Advantages of Grafting and Budding

Students will explore the advantages of grafting and budding and consider the role this form of propagation plays in improving productivity, profitability, and sustainability outcomes in the nursery industry.

1. Facilitate a discussion about the possible advantages of grafting and budding as a form of propagation used by the nursery industry. Explain that there are many advantages to the use of grafting and budding techniques as they allow the positive characteristics of two plant varieties to work together to create a specialised plant. Examples of these include dwarf fruit trees (using a dwarf rootstock and a fruit-bearing scion to create a fruit tree that can be contained in smaller areas), and greater pollination or cross-pollination of fruit trees that may not be able to self-pollinate naturally, etc.
2. Distribute **Worksheet 2.3a – What’s So Good About Grafting** (Read and response task) and provide students with access to computers or digital devices.
3. Allow students to complete the activities on the worksheet before sharing their ideas about the ways grafting and budding techniques can be used to improve the productivity, profitability, and sustainability of the nursery industry.

**Answers** 

## ➤ ACTIVITY 2.4 – Grafting Practical or Modelling Task

Students will apply their understanding of the process of grafting by completing Option A (Practical task) or Option B (Modelling task).

1. Play '[Get Grafting](#)' video. (6:11)

Source: ABC. (2016, August 26). *Get Grafting*. Gardening Australia.  
<https://www.abc.net.au/gardening/how-to/get-grafting/9438216>

2. Pause the video at 1:46 and ask students to recall any factors that could be considered when selecting a rootstock and scion used for grafting. Examples for rootstock may include adaptability to soil type, disease resistance, and rate of growth. Examples for scion may include the quality of fruit.
3. Continue playing the video until it's finished. Explain that as well as the methods shown in the video, there are many other grafting techniques that can be used. Highlight that some nurseries and horticulture industries use root promoting substances to support the development of a healthy root system in the plant. Examples of these substances are hormone-based powders or solutions which are applied to the base of the cuttings when they are planted.

### Option A – Practical task:

Students will use real plant materials to perform a cleft or 'V' graft. Rootstock and scions from the same genus of plant are required for this task. Examples include lime and lemon, plum and apricot, apple varieties, etc.

1. Divide students into groups of approximately three. Explain that during this activity groups will have the opportunity to create their own grafted plant.
2. Distribute **Worksheet 2.4a – Asexual Reproduction Through Grafting – Practical task** ([Grafting practical task](#)) to each student and provide groups with the required materials for the task. Revise any required safety procedures for use of gardening equipment before commencing the task. *Schools are required to complete their own risk assessment for this task.*
3. Demonstrate to the students the steps of the procedure on the grafting practical experiment worksheet. Highlight the importance of the cambium layers of both the scion and the rootstock having as much contact as possible to ensure a successful graft.
4. Allow student groups to follow the steps on the practical worksheet to complete the grafting task. Upon completion of the practical, students should respond to the questions on the worksheet.

### Option B – Modelling task:

Students will use hands-on materials to model the grafting process.

1. Divide students into groups of approximately three. Explain that during this activity students will have the opportunity to create a model grafted plant.
2. Distribute **Worksheet 2.4b – Asexual Reproduction Through Grafting – Modelling Task** (Grafting modelling task) to each student and provide each group with the required materials listed on the worksheet.
3. Demonstrate to students the steps of the procedure on the grafting practical experiment worksheet. Highlight the importance of the cambium layers of both the scion and the rootstock having as much contact as possible to ensure a successful graft.
4. Allow student groups to follow the steps on the practical worksheet to complete the grafting modelling task. Upon completion of the practical, students should respond to the questions on the worksheet.

### Optional Extension Task:

#### ➤ **ACTIVITY 2.5 – Careers in the Nursery Industry**

1. Distribute **Worksheet Worksheet 2.5a – Nursery Careers** (Read and response task) and read through the information as a class. Explain that students will be completing two case studies about careers in the nursery industry.
2. Provide students with access to computers or digital devices and allow them to complete the activities on the worksheet before discussing the answers as a class.

**Answers** 

# Student Resources

1. **Worksheet 2.1a – Advantages and Disadvantages of Plant Reproduction Processes** (Concept cartoon)
2. **Stimulus 2.2a – Fruit Salad Tree** (Observation task)
3. **Worksheet 2.2b – The Anatomy of a Tree** (Labelling task)
4. **Worksheet 2.3a – What’s So Good About Grafting and Budding** (Read and response task)
5. **Worksheet 2.4a – Asexual Reproduction Through Grafting – Practical task** (Grafting practical task)
6. **Worksheet 2.4b – Asexual Reproduction Through Grafting – Modelling Task** (Grafting modelling task)
7. **Worksheet 2.5a – Nursery Careers** (Read and response task)

# Answers

## ➤ **WORKSHEET 2.1a – Advantages and Disadvantages of Plant Reproduction Processes** (Concept cartoon)

Answers will vary depending on individual student responses.

## ➤ **STIMULUS IMAGE 2.2a** (Observation task)

Answers will vary depending on individual student responses.

## ➤ **WORKSHEET 2.2b – The Anatomy of a Tree** (Labelling task)

Answers can be found on the Arbor Day Foundation – Anatomy of a Tree webpage.

<https://www.arborday.org/trees/ringstreenatomy.cfm>

## Answers (continued)

### ➤ **WORKSHEET 2.3a – What’s So Good About Grafting** (Read and response task)

#### **Productivity:**

Grafting and budding onto established rootstock allows new plants to grow at a faster rate than growing from seed, allowing a greater number of plants to be produced, improving productivity.

#### **Profitability:**

- Grafting and budding to create specialised varieties of plants such as dwarf fruit trees or multi-species ‘fruit salad’ trees increases profitability by meeting consumer demand.
- Nurseries are able to charge a greater amount for products that consumers cannot readily produce themselves.

#### **Sustainability:**

- Grafting and budding multiple varieties onto one rootstock can support biodiversity and encourage cross-pollination.
- Grafting and budding onto pest and disease resistant rootstock can reduce the need for pesticides and fungicides.

### ➤ **WORKSHEET 2.4a – Asexual Reproduction Through Grafting – Practical task** (Practical task)

Answers will vary depending on individual student responses.

### ➤ **WORKSHEET 2.4b – Asexual Reproduction Through Grafting – Modelling task** (Modelling task)

Answers will vary depending on individual student responses.

### ➤ **WORKSHEET 2.5a – Nursery Careers** (Read and response task)

#### **1. Case Study One – Carole Fudge**

**Career:** Sales and Marketing Manager, **Qualifications::** Bachelor degree/ Advanced Diploma, **Skills required:** Good communication skills, love of plants and willingness to learn and embrace change, adaptability.

#### **Case Study Two – Daniel Ewings**

**Career:** General Manager (Alpine Nurseries), **Qualifications::** An apprenticeship, certificates in Arboriculture, Parks and Gardens, Frontline Management and Work, Health and Safety, Diploma in Horticulture, Certificate III in LEAN manufacturing, and completion of a Masterclass in Horticultural Business, **Skills required:** Experience in all of the different aspects of greenlife production businesses and the supporting qualifications.

**2.** Answers will vary depending on individual student responses.

# References

## ➤ ACTIVITY 2.2

Arbor Day Foundation. (2022). *Anatomy of a tree at arborday.org*. [www.arborday.org](http://www.arborday.org).  
<https://www.arborday.org/trees/ringstreenatomy.cfm>

Image Source: Fruit Salad Trees. (n.d.). *Citrus Fruit Salad Trees*. Retrieved November 30, 2022, from: <https://www.fruitsaladtrees.com/collections/citrus/3-graft-citrus>

## ➤ ACTIVITY 2.3

ABC. (2014, November 14). *Master Grafter*. Gardening Australia. <https://www.abc.net.au/gardening/how-to/master-grafter/9436096>

Sustainable Gardening Australia. (2022). *Grafted plants explained | Sustainable Gardening Australia*. Grafted Plants Explained. <https://www.sgaonline.org.au/getting-graft-grafted-plants-explained/>

## ➤ ACTIVITY 2.4

ABC. (2016, August 26). *Get Grafting*. Gardening Australia. <https://www.abc.net.au/gardening/how-to/get-grafting/9438216>

## ➤ ACTIVITY 2.5

Greenlife Australia. (2022). *Career Pathways*. [www.greenlifeindustry.com.au](http://www.greenlifeindustry.com.au).  
<https://www.greenlifeindustry.com.au/greenlife-careers-hub/career-pathways>

Greenlife Australia. (n.d.-a). *Daniel Ewings Case Study Industry loves*. Retrieved November 30, 2022, from: <https://www.greenlifeindustry.com.au/static/uploads/files/danielewings-careercasestudy-wfrmkjkbtozh.pdf>

Greenlife Australia. (n.d.). *Carole Fudge Case Study Industry Loves*.  
<https://www.greenlifeindustry.com.au/static/uploads/files/carole-fudge-careercasestudy-wfevnoqxwvtl.pdf>



## OBSERVATION TASK

# Fruit Salad Tree



Image source: Fruit Salad Trees.(n.d.). Citrus Fruit Salad Trees. Retrieved November 30, 2022, from: <https://www.fruitsaladtrees.com/collections/citrus/3-graft-citrus>

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LABELLING TASK

# The Anatomy of a Tree



Each part of a tree plays an important role in its survival and ability to reproduce. Scan the QR code or click on the [link](#) to learn about the anatomy of a tree.

▶ Anatomy of a Tree: <https://www.arborday.org/trees/ringstreenatomy.cfm>



1. Record a sentence describing the role of each part of a tree's anatomy.

**Outer bark:**

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**Inner bark:**

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**Cambium layer:**

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**Sapwood:**

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**Heartwood:**

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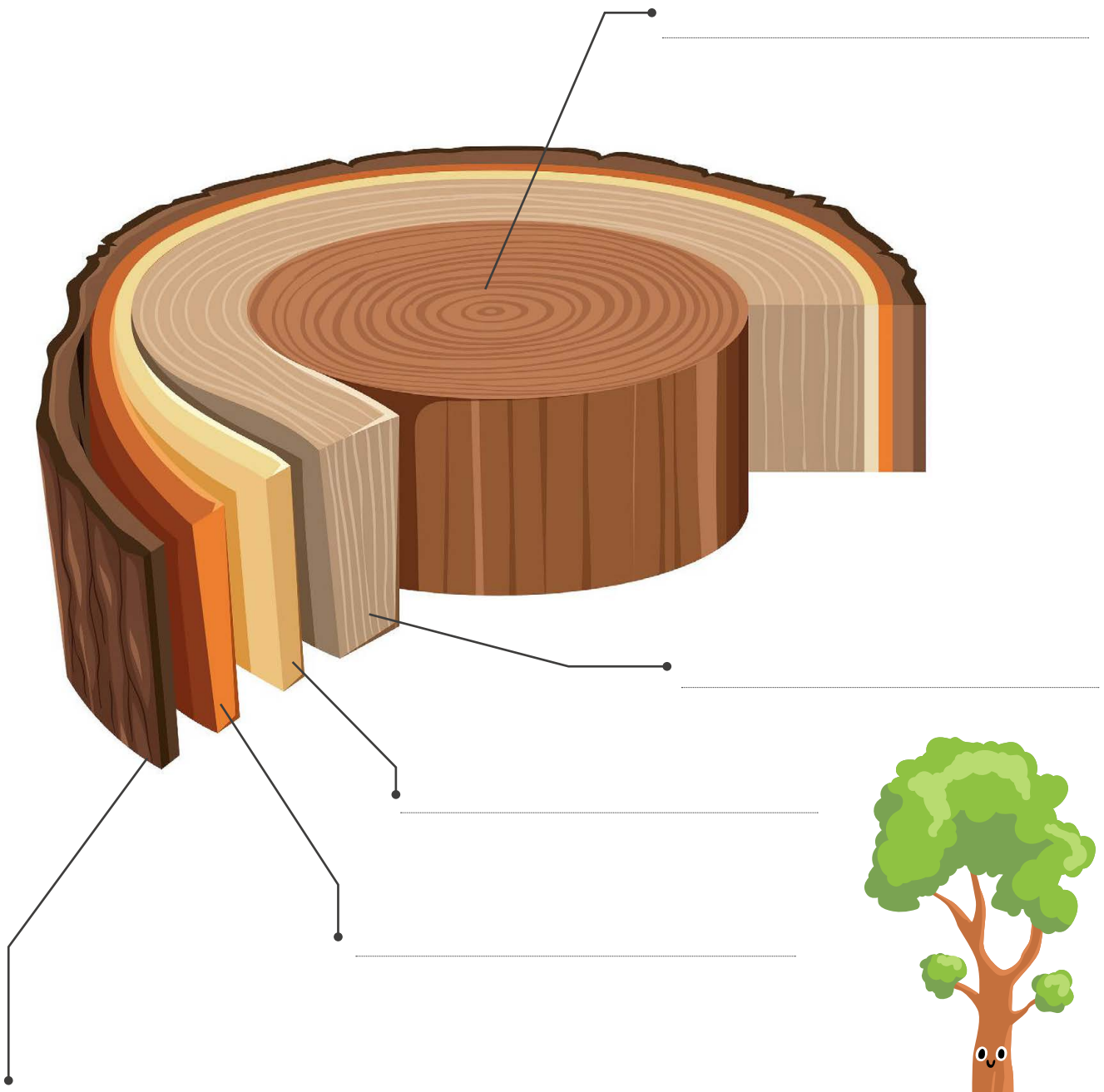
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LABELLING TASK

# The Anatomy of a Tree (cont.)

2. Label the diagram to show each of the tree layers described in Question 1.



This resource has been developed by:

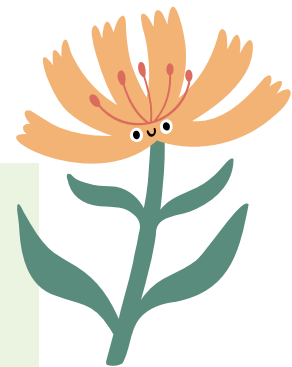


GRAFTING PRACTICAL TASK

# Asexual Reproduction Through Grafting – Practical Task

Grafting is a form of asexual plant reproduction commonly used in the horticulture industry. Grafting is the joining together of two varieties of plant of the same genus allowing them to form a hybrid 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.

Follow the steps to complete the grafting practical. Illustrate each of the steps in the boxes provided.



Materials

- Rootstock
- Scion
- Secateurs
- Grafting knife/scalpel
- Grafting tape
- Gloves

## Step One

- Slice the top of rootstock into a V-shape by making two 2.5-3cm sloping cuts.

## Step Two

- Slice the the scion to make two corresponding cuts of the same length, creating a pointed end.


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GRAFTING PRACTICAL TASK

# Asexual Reproduction Through Grafting – Practical Task (cont.)

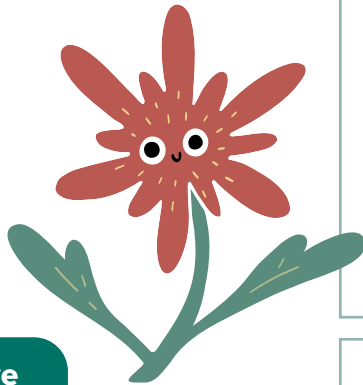
## Step Three

- Fit the sliced end of the scion into the V-shaped wedge of the rootstock. Use grafting tape to secure the two pieces together.



## Step Four

- Prune back the scion leaving only 2-3 buds on the plant.



## Step Five

- When your scion begins to shoot, remove the grafting tape.

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GRAFTING MODELLING TASK

# Asexual Reproduction Through Grafting – Modelling Task

Grafting is a form of asexual plant reproduction commonly used in the horticulture industry. Grafting is the joining together of two varieties of plant of the same genus allowing them to form a hybrid 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.

Follow the steps to complete to model the grafting process.  
Illustrate each of the steps in the boxes provided.

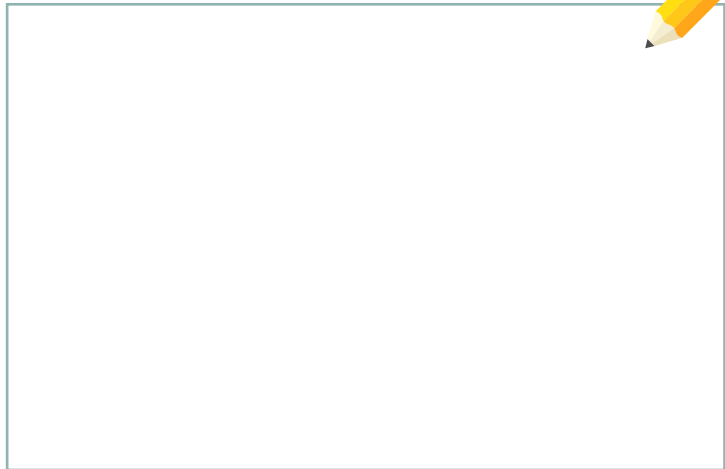


**Materials**

- 4 coloured straws (two of one colour and two of another colour)
- Scissors
- Sticky tape
- Blu tack or modelling clay
- Adhesive labels or sticky notes

## Step One

- Use sticky tape to join the first pair of coloured straws together creating a long thin structure to represent the rootstock. Slice the top of the rootstock model structure into a V-shape by making two sloping cuts with a pair of scissors. Secure your rootstock structure to the table or a hard surface using modelling clay, so that it is able to stand upright as if it were a plant growing in a pot or from the ground.



## Step Two

- Use sticky tape to join the second pair of coloured straws together creating a long thin structure to represent the scion. Slice the end of the scion model structure to make two corresponding cuts of the same length, creating a pointed end.



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GRAFTING PRACTICAL TASK

# Asexual Reproduction Through Grafting – Modelling Task (cont.)



## Step Three

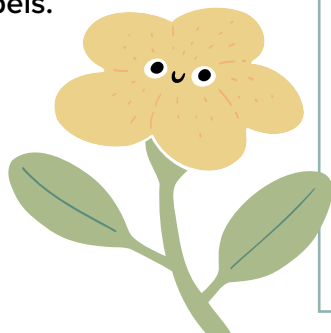
- Fit the sliced end of the scion model into the V-shaped wedge of the rootstock model. Use sticky tape to secure the two pieces together.

## Step Four

- Use a small amount of blu tack or modelling clay to create 2-3 small buds on the scion section of the model. During the grafting process, these buds will begin to shoot when the parts of the plant have fused together. When the first shoots appear on the scion the grafting tape should be removed from the plant.

## Step Five

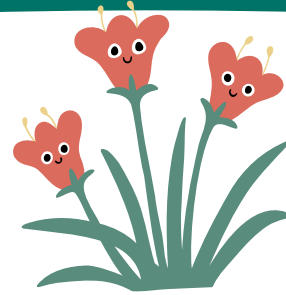
- Label the parts of your grafting model using sticky notes or adhesive labels.



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READ AND RESPONSE TASK

# Nursery Careers



Australia's Nursery Industry employs 25,000 people throughout Australia, encompassing plant growers, growing media manufacturers, allied suppliers of plant nutrition and protection products, and retailers (Greenlife Industry Australia, 2021).

Scan the QR code above or click on the [link](#) below to explore the diversity of careers and career pathways in the nursery industry. Study the Greenlife Industry Career Pathways flow diagram to investigate the required qualifications for the various careers in the industry.

▶ Greenlife Industry Career Pathways: <https://www.greenlifeindustry.com.au/greenlife-careers-hub/career-pathways>

1. Using what you've learnt, scan the QR codes or click on the links for the the two Career Pathways Case Studies below. Record the name of the career, the relevant qualifications, and skills required for each.

## CASE STUDY ONE – Carole Fudge



▶ <https://www.greenlifeindustry.com.au/static/uploads/files/carole-fudge-careercasestudy-wfevnoqxwvtl.pdf>

Career:

Qualifications:

Skills required:

## CASE STUDY TWO – Daniel Ewings



▶ <https://www.greenlifeindustry.com.au/static/uploads/files/danielewings-careercasestudy-wfrmkjkbtozh.pdf>

Career:

Qualifications:

Skills required:

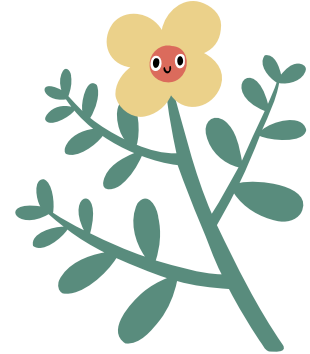
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READ AND RESPONSE TASK



# Nursery Careers (cont.)



- 2. Select two of the other careers listed on the [Greenlife Industry Career Pathways](#) flowchart to research. Record the qualifications and skills required for each role.

▶ Greenlife Industry Career Pathways: <https://www.greenlifeindustry.com.au/greenlife-careers-hub/career-pathways>

Career One	Qualifications	Skills required

Career One	Qualifications	Skills required

This resource has been developed by:

