# Set 4 Inside Plants

### Icons

Here is an explanation of the icons used in Parts 1, 2, 3 and 4



Write a response or responses as part of an activity. An answer is provided so that you can check your progress.



Compare your answers with those in the suggested answers section.



Complete an exercise in the exercises section that will be returned to your teacher.



Think about information or ideas. You need to pause and reflect. You may need to make notes.



Perform a practical task or investigation.



Stop and consider the risks to safety for yourself and others.



Access the Internet to complete a task or to look at suggested web sites. If you do not have access to the Internet, contact your teacher for advice.

#### Lesson 1 The importance of plants



Plants provide us with **food**, **fiber**, **shelter**, **medicine**, **beauty prodcuts and fuel**. The basic food for all organisms is produced by green plants. In the process of food production, oxygen is released. This oxygen, which we obtain from the air we breathe, is essential to life. The only source of food and oxygen are plants; no animal alone can supply these. Shelter, in the form of wood for houses; and clothing, in the form of cotton fibers, are obvious uses of plant materials. But we must not forget fuel, furniture, paper products, certain medicines like aspirin, and many other products like perfume and chewing gum. To these tangible aspects of the plant world we must also add the importance of beauty and relaxation derived from plants. Since animals are surrounded by and dependent upon plants, the factors that influence plant growth, structure, and distribution, affect the animal world as well. Many Australians are employed in jobs related to plants. I'm sure many people you know rely on plants for their livelihood.

In Australia, scientists are carrying out research in universities, hospitals, companies and government organisations to ensure plants continue to benefit our society. Scientists are aiming to make the growth of Australian commercial and native plants sustainable (able to continue over time).



Go to the send in pages and complete activity 1.1 and 1.2

#### Lesson 2 Plants and Ecosystems

#### **Plant - Animal Relationships**

Forests, lawns, streams, and marshes are all habitats that are easily recognized as unique biotic communities. A **community** is a naturally occurring, interactive assemblage of plants and animals living in the same environment. The interaction between plants and animals often exists out of the need for food, protection, transportation, and reproduction. The different kinds of interaction possible between organisms are extremely important in determining the abundance of species. If the interaction between species is beneficial, it is described as **mutualism**. Some of the most complex mutualistic relationships evolved between plants and pollinators. If the interaction proves disadvantageous, it is referred to as **competition**. **Commensal** relationships, in which one species benefits and the other is unaffected, are common between plants and animals. For example, when a bird builds a nest in a tree, the bird benefits and the tree is (usually) unharmed. Other relationships may positively affect one population and be detrimental to the other. Such relationships involve predation and parasitism. In predation, one organism directly kills and consumes its prey. Parasitism differs in that parasites live on or in the prey, but may not kill it outright. A good example of parasitism is mistletoe growing on a tree.

#### Ecosystems

#### Food chains

A food chain shows the different organisms that live in a habitat, and what eats what.

#### Producers and consumers

A food chain always starts with a producer, which is an organism that makes food. This is usually a green plant, because plants can make their own food by photosynthesis.

A food chain ends with a consumer, which is an animal that eats a plant or another animal. Here is an example of a simple food chain:

#### grass $\rightarrow$ cow $\rightarrow$ human

Take care - the arrow points to the organism that is doing the eating. If you get the arrows the wrong way round, instead of showing that humans eat cows, you are showing that cows eat humans, and that grass eats cows.

#### Other words in a food chain

There are several words used to describe the organisms in a food chain. Study this food chain:

Grass	$\rightarrow$	Grasshopper	$\rightarrow$	Frog	$\rightarrow$	Hawk
Producer		Consumer		Consumer		Consumer
		Primary consumer		Secondary consumer		Tertiary consumer
		Herbivore		Carnivore		Carnivore

The plant is the producer and the animals are consumers.

Notice that the first consumer in the chain is also called the primary consumer, the next one is the secondary consumer and the one after that is the tertiary consumer.

A consumer that eats plants is called a **herbivore**, and a consumer that eats other animals is called a **carnivore**. An **omnivore** is an animal that eats both plants and animals.

#### Predators and prey

A predator is an animal that eats other animals, and the prey is the animal that gets eaten by the predator. In the food chain above:

- the frog is a predator and the grasshopper is its prey.
- the hawk is a predator and the frog is its prey.





There are a number of words that you may not have heard of before in the text above. Write a definition for each of them in the table provided.

Community	
Mutualism	
Competition	
Commensal	
Ecosystem	
Producers	
Consumers	
Photosynthetic	
Producers	
Consumers	



Go to the send in exercises and complete exercise 2.1 and 2.2  $\,$ 

#### Lesson 3 Plants, beauty and wellness

Plants help reduce health problems caused by air pollution

Air pollution is harmful substances in the air. Air pollution is a risk to health. The lower the levels of air pollution, the better will be the lung and heart health of a population.



The harmful substances that make up air pollution are **particles** and **gases**:

- released by burning fuels
- given off by synthetic materials.

**Scientific research** has found that plants can help reduce outdoor and indoor air pollution. Plants reduce air pollution by taking in harmful gases via stomates in their leaves. Once inside the leaf, the gases react with plant compounds.



In 2014, a research project in USA showed that in one urban park, the trees removed the major pollutants produced by burning fossil fuels for transport and electricity production. The trees absorbed 24 kg of particles, 5 kg of nitrogen dioxide and 3 kg of sulfur dioxide gases, as well as 50 kg of carbon dioxide daily.

In another study in 2014, U.S. Forest Service scientists calculated that trees are preventing 670,000 incidents of acute respiratory problems. The researchers valued the human health benefits of reduced outdoor air pollution in USA at nearly \$7 billion every year.

The following article gives you some information about scientific research into indoor air pollution.

#### Mother nature network

10 December 2015

Houseplants for improving indoor air quality

Scientists from NASA carried out research to see if houseplants could purify the air in spacecraft. They found fifteen plants that filter out common harmful gases. Lucky for us, the plants can also help clean indoor air on Earth. Other research studies have been published in the Journal of American Society of Horticultural Science, also proving this science. The Peace Iily (Spathiphyllum) indoor plant, topped NASA's list for removing all three of most common indoor polluting compounds: formaldehyde (common in cleaning products, toilet paper, tissues and personal care products), benzene (chemical-based cleaners, paints and more). It can also remove xylene (a solvent used in producing leather, rubber and printing products).



2. Describe how plants reduce air pollution.

3. How many plants did NASA's scientists find were successful at purifying the air in space craft.

4. Name the indoor plant that NASA scientists found was the best indoor plant at removing harmful gases from air inside a home?

#### Johns Hopkins

Bloomberg School of Public Health US June 16, 2014



# Broccoli Sprout Drink Removes Air Pollutant from Body

Air pollution is an increasing global problem causing many illnesses worldwide, according to the World Health Organisation.

Researchers from the Johns Hopkins Bloomberg School of Public Health in the USA worked with scientists at several Chinese institutions to develop plant food strategies to protect people in polluted cities.

The 12-week research trial involved 290 participants who live in one of China's heavily industrialized regions. They were divided into two groups.

Participants in the **control group** drank a beverage made of sterilised water, pineapple and lime juice.

Participants in the **test group** drank the same beverage with an added powder made from broccoli sprouts.

Regular urine samples were taken from both groups to measure the fate of cancer-causing benzene inhaled from the polluted air.

The research team found that the participants in the test group, receiving the broccoli sprout beverage, excreted 61% more benzene than those in the control group. Excreting more benzene meant there was less inside the body to cause harm.

"This study points to a simple and safe means that can be taken by individuals to reduce the long-term health risks associated with inhaling benzene in air pollution," notes Thomas Kensler, PhD, professor at the Johns Hopkins Bloomberg School. Further clinical trials, to evaluate dosage and frequency of the broccoli sprout beverage, are planned in the same general region of China.



#### Activity

1. List the ingredients of the beverage drunk by the control group.

2. List the ingredients of the beverage drunk by the test group.

3. Explain why it was necessary for the scientists to use the two groups.

#### Plants make us feel good

Numerous recent research studies have focused on the effects of trees and plants on mental health.

In 2015, scientists published their research findings in the scientific journal *Nature*. The researchers used satellite images of trees

and the health surveys of 31,109 residents of the Toronto area in Canada. The study found that people who live in areas with more trees in their street, report a general feeling of well-being and better health, compared

with their peers living in areas with fewer trees.

The following two research reports show some of the effects of flowers and plants, on our mental health.

#### Evolutionary Psychology, April 2005

http://www.aboutflowers.com/health-benefits-a-research/emotional-impact-of-flowers-study.html Research on positive effect of flowers

A behavioral research project conducted at Rutgers, University of New Jersey USA, investigated the effect of flowers on people.

A team of researchers explored the link between flowers and life satisfaction in a 10month study of participants' behavioral and emotional responses to receiving flowers. The results show that flowers moderate moods, and give enjoyment and life satisfaction

Study participants reported feeling less depressed, anxious and agitated after receiving flowers, and demonstrated a higher sense of enjoyment and life satisfaction.

"Observations tell us that flowers make us happy," "Now, scientific research shows that flowers have positive effects on our emotional well- being." said Dr. Haviland-Jones, professor of phycology at Nutgers and lead researchers I the study.

Figure 34







a) Describe the results of the 10-month research project.

b) What caused the effect you described in the results?

#### About Flowers – Health benefits and research December 2015 Work place productivity study

In an eight-month study, the Texas A&M University research team explored the link between flowers and plants, and workplace productivity. To start with, participants were given creative problem solving tasks to do in an office with no flowers or plants.

Then participants performed regular creative problem solving tasks in a variety of environments: with flowers and plants, with sculpture and with no decorations over an 8-month period.

During the study, both women and men demonstrated more innovative creative thinking, and original solutions to problems in the office environment that included flowers and plants.





#### Activity

Summarise the results of this research study in bullet points below.



Go to the send in pages and complete exercise 3

### Lesson 4 Genetically Modified Plants (GMO'S-

#### short for genetically modified plants)

Watch this video as an introduction into genetically mod https://www.youtube.com/watch?v=CIRyCjL\_weo

In the past week you've probably eaten crops that would nature, or that have evolved extra genes to reach freakisn sizes. You've probably eaten "cloned" food and you may have even eaten plants whose ancestors were once deliberately blasted with radiation. And you could have bought all this without leaving the "organic" section of your local supermarket.

Anti-GM dogma is obscuring the real debate over what level of genetic manipulation society deems acceptable. Genetically-modified food is often regarded as something you're either for or against, with no real middle ground.

Yet it is misleading to consider GM technology a binary decision, and blanket bans like those in many European countries are only likely to further stifle debate. After all, very little of our food is truly "natural" and even the most basic crops are the result of some form of human manipulation.



Between organic foods and tobacco engineered to glow in the dark lie a broad spectrum of "modifications" worthy of consideration. All of these different technologies are sometimes lumped together under "GM". But where would you draw the line?





(Un) natural selection

Think of carrots, corn or watermelons – all foods you might eat without much consideration. Yet when compared to their wild ancestors, even the "organic" varieties are almost unrecognizable.

Domestication generally involves selecting for beneficial traits, such as high yield. Over time, many generations of selection can substantially alter a plant's genetic makeup. Man-made selection is capable of generating forms that are extremely unlikely to occur in nature

Scientific knowledge has influenced the development of cloning practices in agriculture to improve yields and sustainability.



Painted picture of a watermelon from the 17<sup>th</sup> Century

This 17th-century painting by Giovanni Stanchi depicts a watermelon that looks strikingly different from modern melons. A cross-section of the one in the painting, which was made between 1645 and 1672, appears to have swirly shapes embedded in six triangular pie-shaped pieces.

#### Modern watermelon

Over time, humans have bred watermelons to have a red, fleshy interior – which is actually the placenta – like the ones seen here. Some people think the watermelon in Stanchi's painting may just be unripe or unwatered, but the black seeds in the painting suggest that it was, in fact, ripe



# How do scientists actually genetically modify plants?

**1.Cloning** is the production of an identical organism (a clone) from **one parent**.

Many plants clone themselves naturally to reproduce. They do not reproduce using pollination these cloning plants send a small shoot-like structure called a runner, along the soil. The runner grows into a new separate plant, which is



genetically identical to the original plant. It is a clone.

People can clone some plants by simply taking a cutting of the plant such as a twig or stem and planting it followed by regular watering. This is called **vegetative propagation**.

Plants have been "cloned" from stem cuttings for many centuries, perhaps dating back as far as the beginnings of agriculture.



Clone of a geranium plant produced from a cutting

#### 2. Tissue culture

Scientists, horticulturists and farmers use cloning to grow plants with specific qualities. They use a more complex method than vegetative propagation called **tissue culture**.

Tissue culture starts by using a small piece of the



desired plant such as a leaf segment. It is grown on a culture medium that provides nutrients.

It is then chemically treated to produce shoots. Buds from each of these shoots can then be separated to grow more shoots. The shoots are then treated to grow roots so that they develop into whole plants.

All the plants produced in this way are genetically identical (have exactly the same characteristics) because they have all come from the same parent plant.

Today, many plants are commonly propagated (reproduced) via tissue culture techniques. Examples are potatoes, strawberries, grapes, orchids, roses and pine trees.

Activity 3

1. What is a clone?

2. Describe how you could grow a new geranium clone by vegetative propagation.

3. Describe how plant clones are produced by tissue culture.

#### Crop yields also improved by genetic research

Scientists are also aiming to improve crops by identifying the genes that direct how plants use water and how they store water. Scientists aim to use **genetic engineering** to produce genetically modified (GM) plant varieties that:

- use water efficiently and are drought tolerant
- produce greater yields
- are pest resistant
- are resistant to herbicides (weed killers).

Scientists select genes that determine the required characteristic. They place the selected gene into the gene sequence of a crop plant. The crop plant will then produce seeds that will produce plants with the required characteristic, such as drought tolerance.



The process of producing a genetically modified (GM) plant variety

#### Scientists help diversity by collecting seeds

The Australian Tree Seed Centre (ATSC) was formed in 1962 by the CSIRO. It was set up to collect, store and distribute seeds of all Australian trees. Australian trees are fast growing and their seeds have been used in many countries to produce wood for fuel and materials for building.

Since the 1990s, the ATSC has become active in promoting the growing of Australian tree varieties to reduce:

- soil erosion
- wind and wave damage to coastal areas during storms

- carbon dioxide in the atmosphere (carbon sequestration)
- salt/salinity in surface soils (by taking up water and lowering the water table/level)

# Scientists researching new medicines from plants

Today over five billion people worldwide use natural plant-based

remedies for health problems. Plants are also the original source materials for as many as 40% of the medicines produced by pharmaceutical companies. Much of the current medicine/drug research is plant-based.

# So what's the problem with genetically modified plants?



- Some people feel that the effects of GM crops on human health are not yet adequately understood. There are concerns modification process, and some question whether there would be new health risks if genes introduced in a GM crop were to be taken up by the human body.
- There are concerns that the introduction of GM crops might lead to a reduction in biodiversity (the variety of plants and animals in the wild), particularly in areas where a crop originated and a wide range of natural genetic variation is found.
- Many people are concerned that genetic modification is 'unnatural'.
  Arguments about naturalness are complex, and raise many difficult



issues. We discuss these in detail, particularly in relation to similarities and differences between conventional and GM plant breeding techniques. The transfer of genes between species is often thought to be particularly unacceptable because it violates boundaries between natural species.

#### Send-in exercises

#### Exercise 1.1

Write down as many reasons why you think plants are important using the mind map below.



The Amazing Tree

Exercise 1.2

Instructions

Draw a picture of your favorite tree and list the uses and/or products made from that tree.



Uses	Products

# Exercise 2.1 Food Webs and Food Chains Worksheet

**1** Look at this food chain.



2. Look at these food chains.



 a Use the food chains to help you fill in the arrows on this food web. One has been added for you.



Use the food web to help you answer these questions.

- **b** Name the producer in this food web.
- c Name a consumer in this food web.
- d What eats rabbits?
- e What does a fox eat?
- 3. Look at this food web. Then answer the questions.



- **a** Name two producers in the food web.
- **b** Name three consumers in the food web.
- **c** Write a food chain from this food web with six trophic levels..
- **d** Name the animals that the small fish eats.

- e Name the animals that eat the small fish.
- **f** Explain what could happen to the community if all the plants suddenly died

**4.** How are food webs different to food chains? Explain why food webs are more useful.

#### Exercise 3.1



The name and images of plants below show native Australian plants and how aborigines strategically used them for different uses. You must use the internet to explain exactly how each plant was used.

https://www.anbg.gov.au/gardens/education/programs/pdfs/aboriginal\_plan t\_use\_and\_technology.pdf

Name	Image	Uses
She-oaks	Returning boomerang	
Eucalypt		
Mint bush		
Banksia		
Australian Bugle		

Mulberr y	

#### **Exercise 4.1** Genetically Modified Foods: Benefits and Risks

Watch this video on genetically modified foods and answer the questions below as you watch it

https://www.youtube.com/watch?v=8z\_CqyB1dQo&list=PLiI1VfhRvKRtLrTj1FG8JobNfhtL Wjc6m

1. In the United States, grocery shelves are filled with

\_\_\_\_\_\_ foods. An

example would be \_\_\_\_\_.

- 2. Can you take a gene from a fish and put it into a tomato?
- If genes provide instructions to build a living thing, what happens if you change one of the genes?
- 4. True or false: Most if the food you eat CANNOT be found in nature.
- 5. What was the difference between the two papayas?

6. What does transgenic mean?\_\_\_\_\_

7. "Agro-chemical companies created Golden Rice, a genetically modified species of rice, to help fight

\_\_\_\_\_ on developing countries."

8. BT corn crops take proteins from \_\_\_\_\_\_ to help fight certain insects.

9. When are you eating genetically modified foods? What are some examples of genetically modified foods used in many products which you commonly eat every day?

a		 	_
b	 	 	
c			

10. What are the three things Nye suggests for the human race:

- a.Lets farm \_\_\_\_\_
- b.Lets require \_\_\_\_\_

c.And lets carefully \_\_\_\_\_\_ these foods case by case.

11. Do you think genetically modified foods have more risks or benefits and are comfortable eating genetically modified foods (like fish genes in tomatoes or bacteria proteins in corn)?

### The ethics of genetic modification

Use the following prompts to discuss the ethics of genetic modification.

If we continue to make crops resistant to pests by using genetic modification, this might mean that the pests evolve more quickly or start eating other plants. Genetic modification is 'playing God'. Genetic modification has many uses in medicine. Insulin for \_diabetics is now produced in genetically modified bacteria. We are still not sure if these 'Frankenstein foods' made by modificationofcrops Genetic genetic modification hasthepotentialtoreduce really are safe. hungerandmalnutrition, especiallyforthoselivinginthe developingworld.ltcanmake cropsmoretoleranttocoldor 34

Exercise 4.2 Use one of the statements above to write and argument *for* or *against* genetically modification. Use may use examples and the internet to help you make your argument strong.

