Growing Plants One

Growing Plants One is the new edition of Growing Plants.

The same features that have made this book so practical and useful for Forms 3 and 4 horticulture remain:

- targeted language
- clear line drawings
- a clear word list in every chapter
- question panels to reinforce key points
- revision questions ending each chapter

At the request of teachers, Growing Plants One also contains an appendix of practical activities which relate to each chapter in the book. They are designed to require a minimum of equipment and little teacher input. There is also an index for easy reference.

Growing Plants Two will be the Form 5 sequel to Growing Plants One.

Heinemann



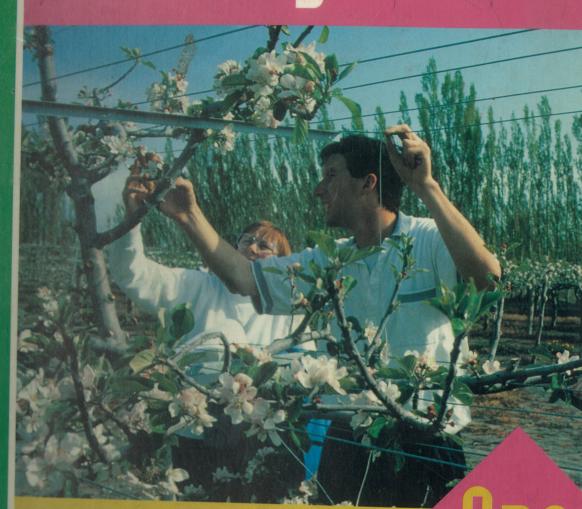


Growing Plants One

G.H. Moriarty



Growing Plants



G.K. MORIARTY





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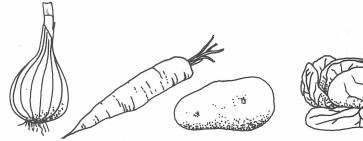
1: Horticulture

'Horticulture' means growing fruit, vegetables, flowers and nursery plants commercially (to make money) or for pleasure, or both. Growing plants is an enjoyable hobby, but it is also more than that. In New Zealand horticulture is important for food production and employment, it provides **export** earnings, and it makes our surroundings beautiful.

Food production

Fruit and vegetables form a large and important part of what we eat. They give us energy and contain the vitamins, minerals and fibre we need to stay healthy.

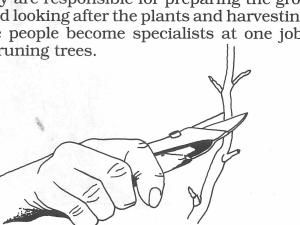
A wide range of fruit and vegetables is grown in New Zealand. Fruit is grown commercially in **orchards** and vegetables are grown commercially in **market gardens**.



Fruit and vegetables are part of a healthy diet.

Employment

Many people have jobs in, or connected with, horticulture. Some of them are directly involved with growing plants. They are responsible for preparing the ground, planting and looking after the plants and harvesting the crop. Some people become specialists at one job, for example, pruning trees.



Pruning orchard trees is a skilled job.



WORD LIST

AMENITY HORTICULTURE growing plants for their appearance

CITRUS oranges, grapefruit, mandarins, tangelos, lemons

CULTIVATED ploughed or dug, by hand or machine EXPORT send out of the

country for sale overseas FERTILE containing nutrients

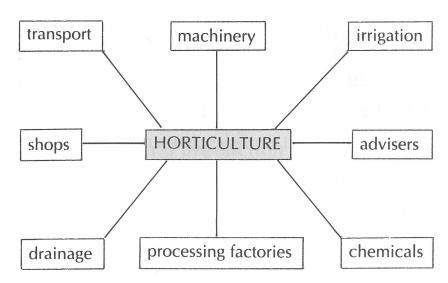
needed for growth
HUMIDITY amount of

moisture in the air
MARKET GARDENS areas
where vegetables are
grown commercially

NURSERIES places where young plants are raised

ORCHARDS areas where fruit is grown commercially

Other people do not grow or care for plants but still have jobs that are related to horticulture, for example, retailers who sell fruit and vegetables, winemakers, and the people who work in the factories that produce canned or frozen fruit and vegetable products.



People who also depend indirectly on horticulture for their work include those who make or sell horticultural chemicals, people who make and service horticultural machinery, truck drivers and contractors, and many others.



Truck drivers may depend indirectly on horticulture, if they carry horticultural products.

Export earnings

Most of the kiwi fruit, pears, apples, onions, cut flowers and strawberries produced in New Zealand are exported, as is a wide range of nursery crops. Vegetables and fruit are also grown for processing and then the dried, canned or frozen products are exported. This brings in to New Zealand money from overseas.



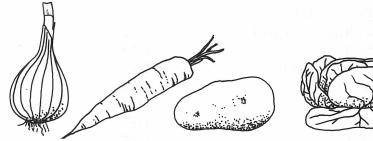
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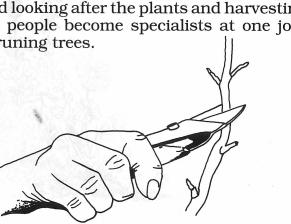
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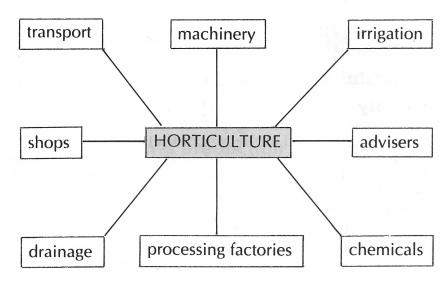
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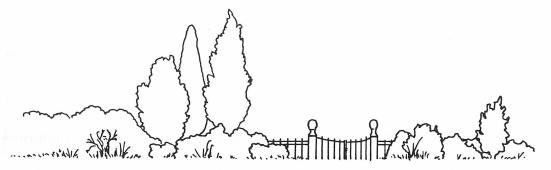


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Beautiful surroundings

Amenity horticulture is the branch of horticulture concerned with growing plants for their appearance. People have a need for beauty in their lives and this can be provided by gardens and parks. Towns and cities throughout the country have specially trained people who care for the plants in parks and public places. **Nurseries** and garden centres sell plants to people for their own homes and gardens.

Questions

- 1 What does 'horticulture' mean?
- 2 Why are vegetables and fruit important in our diet?
- 3 Give an example of a specialised horticultural job.
- 4 Give an example of a job that depends indirectly on horticulture.
- 5 Name four horticultural crops that are exported from New Zealand.
- **6** Which branch of horticulture is concerned with growing plants for their appearance?

Conditions needed for horticultural land

If an area of land is to grow plants well it needs to have

- a suitable climate, with temperatures warm enough for growth, adequate rainfall but not too much, and no strong cold winds
- deep, well drained soil
- flatness or gentle slope so that it can be easily **cultivated** and soil does not get washed away.

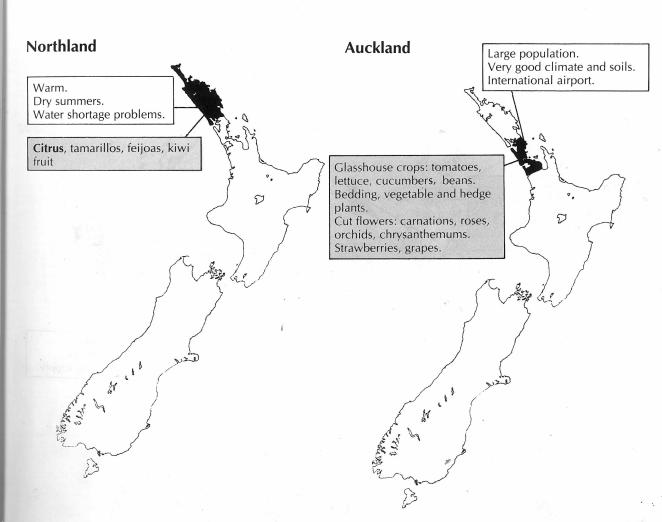
If the land is to grow plants for profit it should be near a town or city so that there will be people to work with the plants when they are needed and so that it will not cost too much to transport the produce to where it is sold.

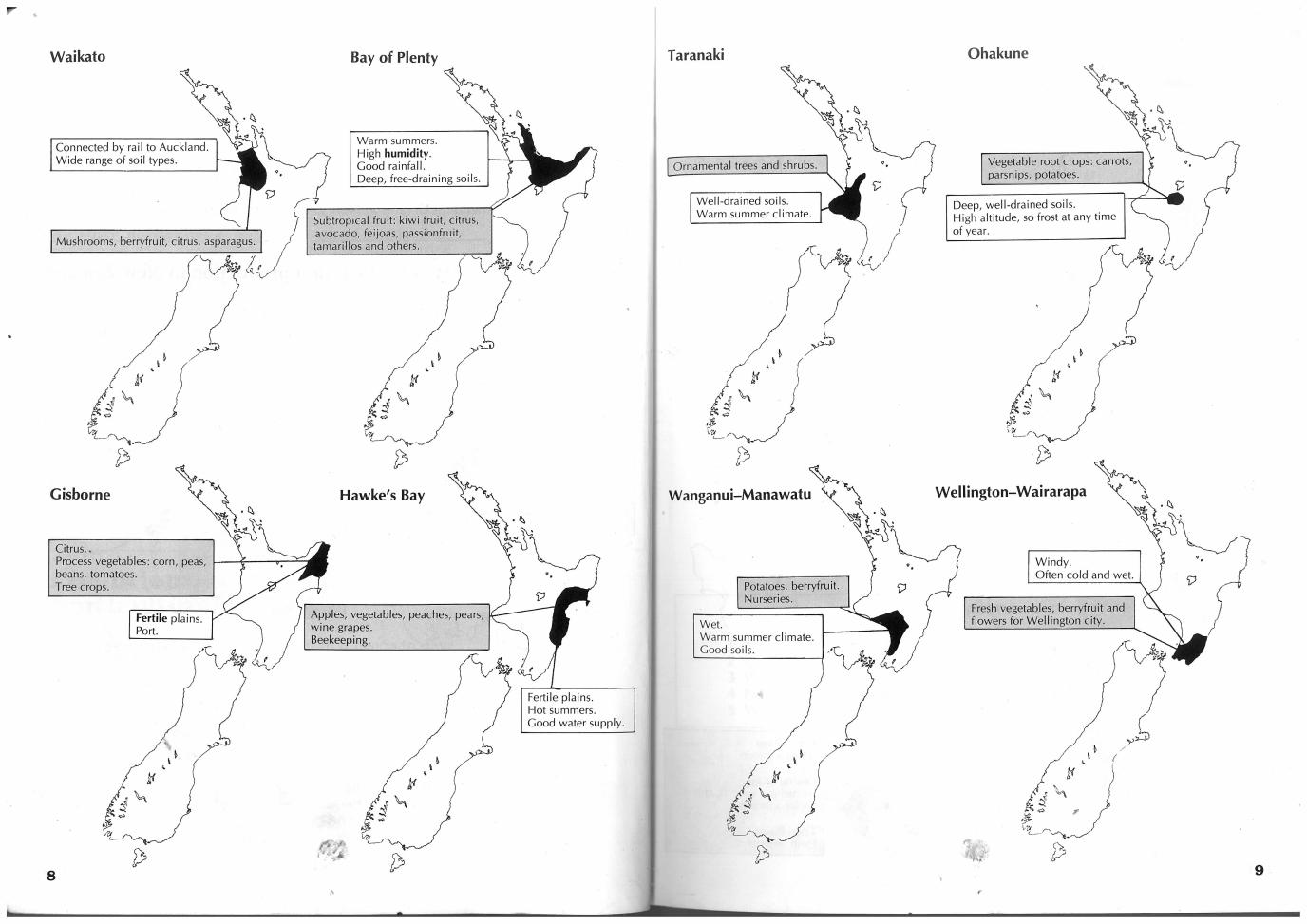
Questions

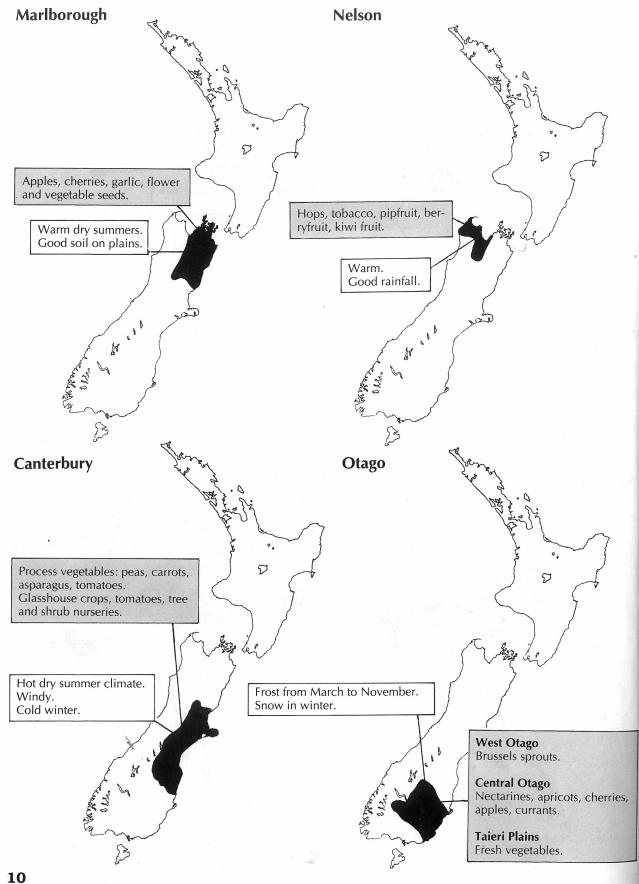
- 1 What three main features does an area of land need if it is to grow plants well?
- 2 Give two reasons why land that is to grow plants for profit should be near a town or city.
- 3 How many hectares of land in New Zealand are in horticultural crops?

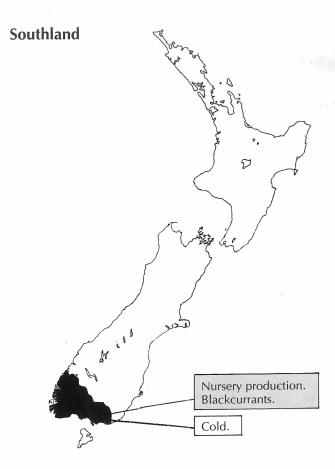
Areas of horticultural production in New Zealand











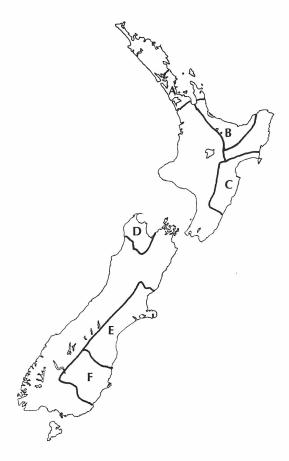
Areas where it is very wet, for example, Westland, or where soil is poor, for example, the Taupo area, are mainly unsuitable for large-scale commercial horticulture.

Questions

- 1 Name three major citrus growing regions.
- 2 In which region are hops and tobacco grown?
- 3 Which region has a large population, good climate and good soils?
- 4 Name three regions where kiwi fruit are grown.
- 5 What fruits are grown in Central Otago?

REVISION QUESTIONS

1 Copy or trace the map of New Zealand. Beside each labelled region write the names of two horticultural crops that are grown there.



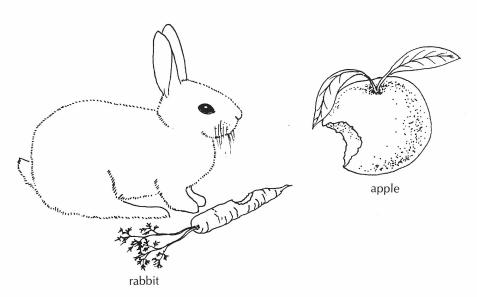
- 2 'Horticulture, in one form or another, is part of the life of everyone in New Zealand.' Write a paragraph to explain this statement.
- 3 Copy and complete each sentence.
 - a Beekeeping is important in Hawke's Bay because . . .
 - **b** Subtropical fruits are grown in the Bay of Plenty because . . .
 - c Cut flowers for export are grown near Auckland because . . .
 - **d** Exporting is important for New Zealand because . . .
 - e Hilly areas are not suitable for horticulture because . . .

2: Uses of plants

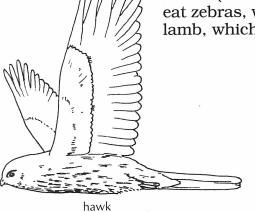
Think of a world without plants! It would be a very bare place. We are so used to living with plants around us that we may take them for granted. But plants are very important living things. Here are some of the reasons why they are important.

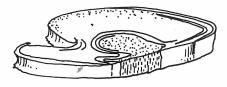
Food supply

Either directly or indirectly, green plants are food for all animals. Examples of animals that eat plants *directly* are snails, rabbits, sheep and you — when you eat an apple or a lettuce leaf.



Examples of animals that eat plants *indirectly* are hawks (which eat rabbits, which eat grass); lions (which eat zebras, which eat plants); and you — when you eat lamb, which eats . . .





lamb chop

So plants are at the start of all food chains. They are vital for life.

For man, the main plants used as food are grains, vegetables, cereals, seeds and fruit.



grains



vegetables





fruit



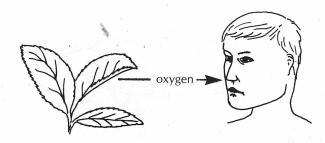
Spices and herbs make food taste better. Coffee, tea and cocoa also come from plants.

Questions

- 1 Complete these food chains.
 - a Grass → sheep →?
 - **b** ? → rabbit → hawk
- 2 Name one plant food that man eats directly.
- 3 How have lamb chops come, indirectly, from plants?
- 4 Give an example of plant seeds that are eaten by man.
- 5 Name two drinks obtained from plants.

Oxygen

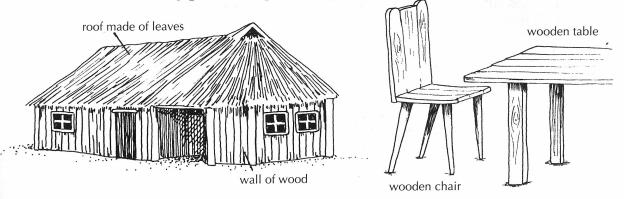
When green plants make food they use up carbon dioxide and give out oxygen as a waste product. Animals (including people) need to breathe in oxygen.



Shelter



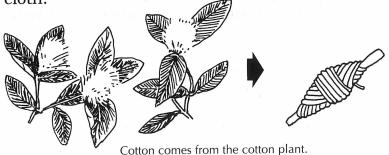
Larger animals (and people) often make their homes out of plants or parts of plants.

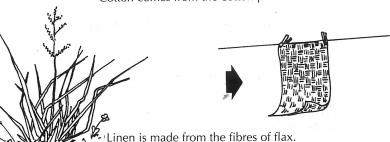


Furniture may also be made from parts of plants.

Clothing

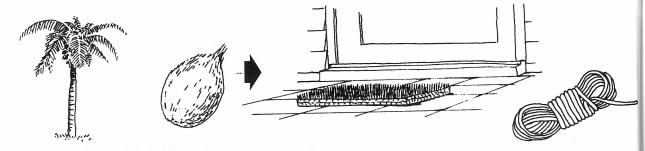
Many plants have strong fibres that can be woven into cloth.



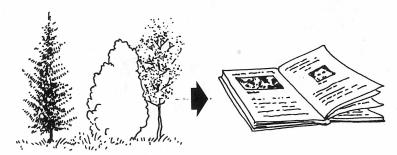


Rope and paper

Some fibres are so strong that they can be made into rope. An example is coconut fibre, which can be used for ropes and matting.

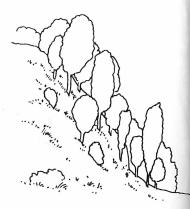


Wood chips and bark are made into a pulp from which paper is made.



Erosion control

Plants hold soil together. Sometimes trees are specially planted on sloping ground so that their roots will hold the soil and stop it from slipping away when it gets very wet.

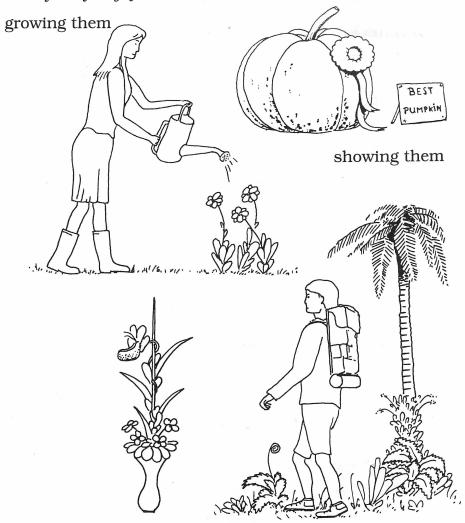


Questions

- 1 Which important gas do plants give out as a waste product?
- 2 Give an example of a plant with strong fibres from which we make clothes.
- 3 What is used to make paper?
- 4 Why are trees sometimes planted on sloping ground?

Recreation

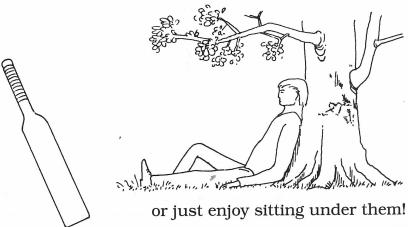
People get pleasure from plants in many different ways. They may enjoy



arranging them

or walking amongst them.

They may use sporting equipment made from them



Other plant products

Natural rubber comes from the rubber tree and is used in many ways.



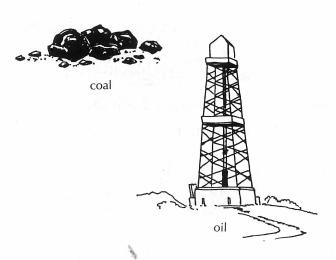


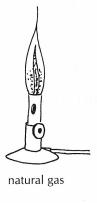
Perfumes are made from plant oils. They are used to scent soaps, shampoos and other toilet articles.



perfume

And plants of the past, preserved and changed deep in the earth, have given us coal, oil and natural gas, so we can travel, warm ourselves and cook our food.

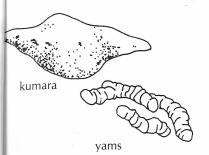




Questions

- 1 Give five ways in which people may get pleasure from plants.
- 2 What are perfumes made from?
- 3 Name three fuels that have come from plants of the past.

The early Maoris and their use of plants

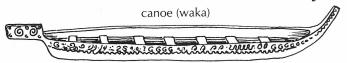


Our earliest New Zealand settlers introduced as food the kumara, yam and taro. Special methods of cultivation were used, especially for kumaras, which were protected with windbreaks. Soil improvement with sand and charcoal was carried out.

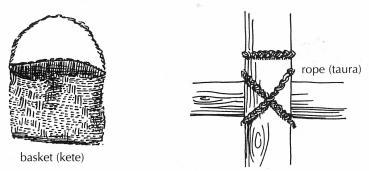
The early Maoris knew which berries to gather from the bush for food and made flour from the roots of ferns.



Buildings were made of wood and reeds and protected by high wooden palisades. Large tree trunks were used to make canoes and the wood was often skilfully carved.



New Zealand flax was used for many things, especially making clothing, fishing nets and baskets. Plant dyes were used to give colour to the flax.



Plants were used as medicines, and today there are scientists who are studying these old remedies. Many of them may, in some form, find a place in modern medicine.

Questions

- 1 Name three foods introduced by the Maoris.
- 2 What was added to soil to improve it for growing kumaras?
- 3 What were buildings made of?
- 4 Name three things for which New Zealand flax was used.

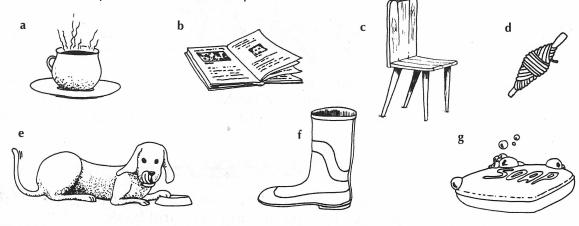
REVISION QUESTIONS

1 Copy and complete the paragraph using words from the list below.

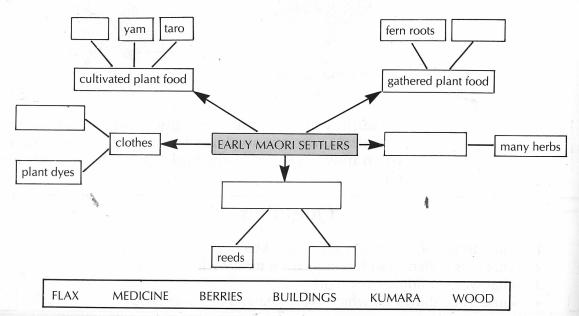
Plants are very important . . . things. Either directly or indirectly, they provide . . . for all animals. They also give out . . . gas, which animals need. Plants provide . . . in the form of houses and fences. Strong plant . . . can be made into cloth or rope. Plants that hold soil together prevent . . .

SHELTER EROSION LIVING FIBRES OXYGEN FOOD

2 Each of these things comes from, or depends on, plants. Name each item and say how it is related to plants.



- **3** Write a paragraph explaining how your family or friends use plants for recreation.
- 4 Copy the diagram, which summarises some of the ways in which the early Maori settlers used plants. Fill in the boxes using words from the list.



3: Plant growth

A plant grows well when it has all the things it needs in the right amounts. The best conditions are similar to those where the plant would grow in nature.

The main things that affect plant growth are water, air, light, mineral nutrients, temperature, wind, humidity, pests and diseases.

Water

Plants contain more water than any other substance, so their roots must have a continuous supply of water. Water is needed for three main reasons.

1 Photosynthesis. This is the process by which the plant makes its own food. Water is one of the things it uses to build up the sugar that is its food. Plants that do not have enough water do not grow well because they cannot make enough food.





Plant with too little water has stunted growth.

Plant with enough water grows

2 Transportation of nutrients. Nutrients are chemicals needed for healthy growth. Nutrients enter plant roots from the soil. They are carried around the plant in a stream of water and in this way get to all the parts of the plant where they are needed.

WORD LIST

CARBON DIOXIDE gas needed for photosynthesis FTIOLATED when a stem is

long and weak and plant parts are yellow from lack of light

FERTILISERS substances that have the nutrients that plants need for healthy growth

HUMIDITY amount of moisture in the air

NUTRIENTS substances needed by plants for growth

OPTIMUM best

OXYGEN gas needed for respiration

PRUNING removing plant parts by cutting them off

RESPIRATION process by which cells get energy from food

THINNING removal of some plants or some fruit to improve conditions for those left

TRAINING shaping a plant into the form you want VENTILATION free circula-

tion of air

WILT leaves and stems partly collapse and droop

3 Support. Plants that are not woody and have soft stems need plenty of water in their stems to hold them up. A soft-stemmed plant will wilt if it does not have enough water. The stem becomes floppy and the leaves sag down.



wilting plant does not have enough water to hold it up

healthy, upright plant because the stem is full of water

Warning! Too much water is bad for plants because it stops air getting to the roots. Plants need the correct amount — not too much and not too little.

Air

Two gases that are important for plants are found in air. They are **oxygen** and **carbon dioxide**.

1 Oxygen. All parts of a plant need oxygen so that they can carry out **respiration**. Stems and leaves get enough oxygen from the air around them, but roots must get their oxygen from air in the soil. Plants grow best in soils that have equal amounts of air and water in them.

poor root growth in waterlogged soil because roots have no air

good root growth in soil that contains air



no drainage holes in pot



drainage holes to let excess water out

2 Carbon dioxide. Carbon dioxide as well as water is used for the food building process called photosynthesis. If there is not enough carbon dioxide in the

air, plant growth slows down because less sugar is being made by photosynthesis. Plants grown outside do not have a problem, because their leaves get plenty of carbon dioxide from the air around them. Plants grown inside, for example, in a greenhouse, need **ventilation** so they will have enough carbon dioxide. We can get extra growth in greenhouse crops by adding carbon dioxide to the air inside the greenhouse.

Smaller plant has grown in air

lacking carbon dioxide.

fan to put carbon dioxide into the air

greenhouse

Questions

1 When does a plant grow well?

Larger plant has grown in carbon

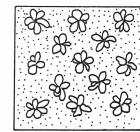
dioxide enriched air.

- 2 Name nine things that can affect plant growth.
- 3 Give three reasons why plants need water.
- 4 Explain why too much water is bad for plants.
- 5 What happens when a plant wilts?
- 6 Which two gases found in air are most important for plants?
- 7 Why do roots need oxygen?
- 8 Where do roots get oxygen from?
- **9** What process in plants uses carbon dioxide?

Light

Light is most important to plants because plants need light to help them make their food. The brighter the light, the faster they will make food. When a plant makes food quickly it will grow quickly.

However, some plants need to be shaded to prevent bright light burning their leaves. These plants are called shade plants. Plants should be grown with the right spacing between them so that they do not have to compete with each other for light.



A planting pattern
All plants are equal distances
apart. This means they can use
the light most efficiently.





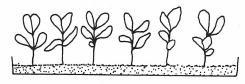
Plant grows upwards. Side shoots do not grow well.



Plants grow up and side shoots also grow.



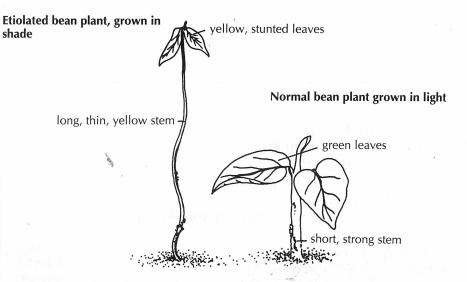
Plants grown close together Sunlight only reaches their tops.



Plants well spacedSunlight reaches all parts of the plants.

Weeds can stop light getting to plants. You should get rid of them.

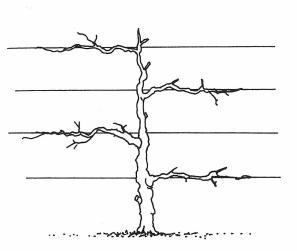
If you compare a plant grown in the shade with one of the same kind grown in the light you will see that they look very different. The plant grown in the shade has a long spindly stem, small stunted leaves, and both leaves and stem are yellow. The word for a plant in this state is **etiolated**. It seems to be 'searching for light'.



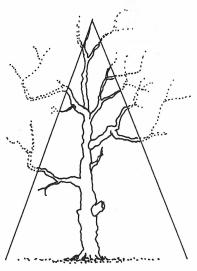
Seedlings that have been sown too close together may become etiolated if they are not thinned out soon enough.

By **training** a plant to grow to a certain shape or by **pruning** off parts of a plant you can make sure light gets to all parts of it.

Fruit on fruit trees grows bigger if it gets plenty of light. Some fruit may be removed by **thinning** so that the rest get light and grow bigger.



This apple tree has been trained to grow to a shape along wires.



This apple tree has been pruned to leave a pyramid shape.

Mineral nutrients

For healthy growth plants need **nutrients** from the soil to combine with the food they make themselves. If there is not enough of any of the nutrients in the soil the plant will not grow well.

Nutrients can be added to the soil in the form of **fertilisers**.



plant with yellow colour between the leaf veins because it lacks the element magnesium

Warning! Too much fertiliser is bad for plants because it can damage plant roots.

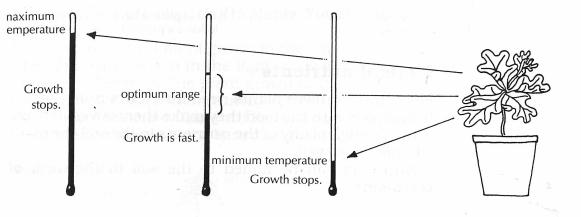
Questions

- 1 Why is light most important to plants?
- 2 Why should plants be grown with the right spacing between them?
- 3 Draw a planting pattern in which plants are spaced equally.
- 4 Draw and label an etiolated bean plant.
- 5 What are two things you can do to a plant to make sure light gets to all parts of it?
- 6 How can nutrients be added to soil?

Temperature

Heat and cold affect the rate at which a plant grows. Each type of plant has

- a maximum temperature, above which growth stops
- an **optimum** temperature range, in which growth is fast
- a minimum temperature, below which growth stops.



Some plants are killed or damaged by frost. Frost can cause damage to fruit crops, for example, apples and peaches, when the trees are in blossom or just after, because the young fruit may be killed or not form properly.

Plants need protection from extremes of heat and cold. Shade and ventilation will protect plants from heat. Shelter gives protection from cold.

Wind

Strong wind has four main effects on plants growing outside.

- Wind can cause damage by breaking stems and branches or battering flowers or buds.Wind can speed up the loss of water from leaves and
- **2** Wind can speed up the loss of water from leaves and soil and make plants lack water.
- **3** Wind can cool the plant and slow down growth.
- **4** Wind can slow down the activity of bees, which are needed for pollination.

Plants need protection from wind. Various forms of shelter may be used.

Wind batters plants.



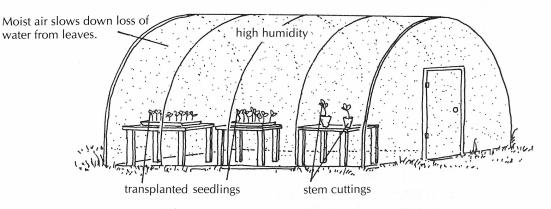
Bees do not fly far in wind.



- 1 What effect do heat and cold have on a plant?
- **2** How can plants be protected from heat?
- 3 Give two effects that strong wind can have on plants.

Humidity

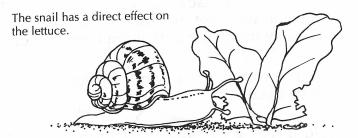
Humidity is the amount of moisture in the air. It is very important for plants that are growing indoors or in a greenhouse. If humidity is high it slows down the loss of water from the leaves. This is helpful for newly transplanted seedlings and for stem cuttings, which should be kept in humid air for a while.



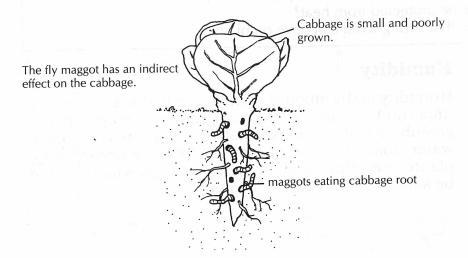
Warning! High humidity can also help disease organisms to grow and attack plants. This must be watched for and controlled.

Pests and diseases

Horticulturists want to grow the biggest and best crops they can, but pests and diseases can be their enemies. Pests and diseases can *directly* affect the wanted parts of plants, for example, a snail eating young lettuce leaves.



They can also act *indirectly*, by attacking parts that are not harvested. This can slow down growth or kill the plant. An example is the fly maggot, which eats cabbage roots.



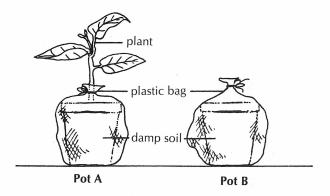
You need to know what pests and diseases are likely to affect your plants and how you can control them.

Questions

- 1 What is humidity?
- 2 What effect does high humidity have on water loss from leaves?
- 3 How can high humidity be harmful to plants?
- 4 Give an example of a pest that directly affects plants that are to be harvested.

REVISION QUESTIONS

- 1 'Too much can be as bad as too little.' Explain why this is true for
 - **a** water
 - **b** fertilisers
 - **c** humidity.
- 2 An experiment was set up by a student to show how the amount of water lost from a plant changes with the weather conditions.

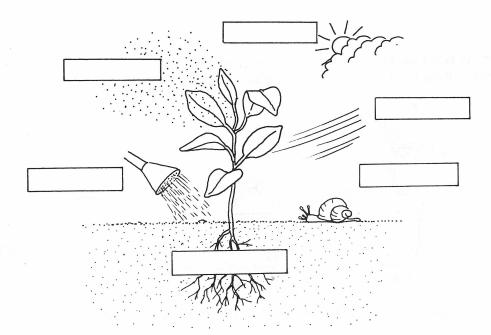


Both pots were weighed each day for eight days. These are the results.

	Days from start of experiment							
	1	2	3	4	5	6	7	8
Weather	cloudy	windy warm	mild	sunny	sunny	mild	cloudy cool	windy mild
Loss of weight of pot A	9 g	28 g	12 g	21 g	19 g	12 g	8 g	15 g
Loss of weight of pot B	0 g	0 g	0 g	0 g	0 g	0 g	0 g	0 g

- **a** Why were both pots covered with plastic bags?
- **b** Which day did pot **A** lose most weight?
- c What was the weather like that day?
- d Which day did pot A lose least weight?
- e What was the weather like that day?
- f Does the weather affect the amount of water lost by a plant? Explain your answer.
- **g** Why did the student set up pot **B**?

3 Copy this diagram of a growing plant. Fill in the boxes to show the things that may influence its growth.



Name two things that may influence plant growth that are not shown in the diagram.

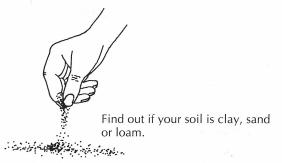
4: Planning a garden

A flower garden or a vegetable garden does not make itself. You have to plan it carefully so that you make the best use of the space you have available. There is a lot to think about! Here are some of the things you must consider.

Soil

You should find out what type of soil your garden has. Is it clay, sand or **loam**? You need to know this so you can decide what will grow well in it, and how you can improve your soil if you need to.

Some soils may need a lot of improvement. You may need to **cultivate** the soil and add fertilisers or organic matter. If your soil is acid you may need to add lime to it.



WORD LIST

ASPECT the direction in which a place faces

CROP ROTATION different sorts of plants following each other in the same patch of ground

CULTIVATE break soil into smaller pieces

HARVEST gather, pick or dig

IRRIGATION giving water to plants

LOAM a fertile soil that is a mixture of sand, silt and clay

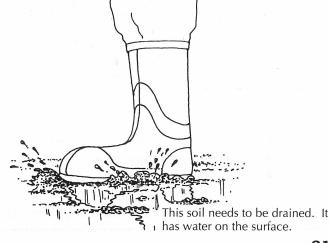
NUTRIENTS substances in soil needed by plants for growth

STAKES single upright supports for plants

SUCCESSIONAL SOWING frequent sowings with short gaps between them

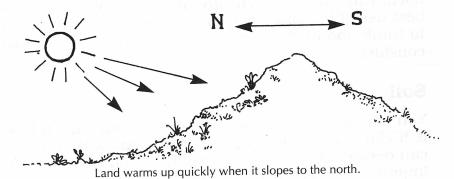
Drainage

Plants will not grow well in soil that is always wet, because their roots do not get enough air. If water stays on the surface of your garden in wet weather it may need drainage.



Aspect

The **aspect** of a place is the way it faces. In New Zealand, sloping land that faces north warms up sooner than flat land or sloping land that faces south. You should check how your garden lies in relation to the sun.



Shading

Your garden may be shaded by a wall, a building, trees or shrubs. Watch your garden for a whole sunny day and find out where the shady places are.



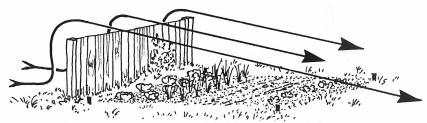
Some plants grow well in shade, but most prefer a place that is sunny most of the day.

Questions

- 1 Why must you plan a garden?
- 2 Why do you need to know what type of soil your garden has?
- 3 Give two ways that you can improve soil.
- 4 What is meant by aspect?
- 5 How can you find out about the shading of your garden?

Shelter

Most plants do not grow well in very windy places. Your garden will need some sort of shelter if you live in a very windy area. The shelter may be living, for example, a hedge or trees, or it may be non-living, for example, a fence or a wall.



Shelter will protect your garden from strong winds.

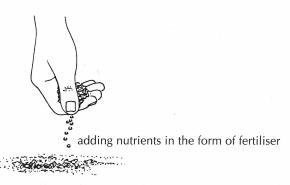
Irrigation

Irrigation is giving plants water. This is very important in summer when plants are growing strongly and need to take a lot of water in through their roots. Check that there is some way of getting water to your garden when it needs it.



Fertilising

Fertilising is adding **nutrients** to the garden. Plants need nutrients for good growth.



If your garden is on a patch of ground that has not been used as a garden before it may not need much fertiliser at first. But if a lot of plants have been taken from it the nutrients may have gone from the soil. You will need to replace them.

Control of pests and diseases

You are not the only one that is keen for your garden to grow! Pests of many kinds may want to feed on all parts of your plants.



Pests may enjoy your plants too.

You need to know what sort of pests are causing damage

to plants so you can control them.

Your plants may become infected with diseases. Sometimes these can be treated, sometimes not. You will have to decide what to do with diseased plants. It is possible to prepare for some problems by spraying your plants before the pests or diseases arrive.



Spraying early can prevent pests and diseases from attacking plants.

Weed control

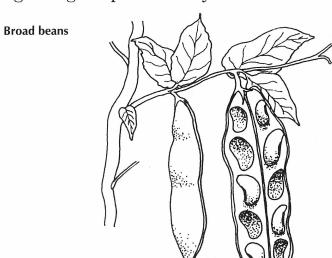
You should not let weeds grow in your garden because they take up space, nutrients and light that the plants should be getting. Get rid of them.

Questions

- 1 Give an example of living shelter.
- 2 What is irrigation?
- 3 Why do plants need nutrients?
- 4 How can you prepare for the arrival of pests and diseases?
- 5 Why should you not let weeds grow in your garden?

Growth seasons

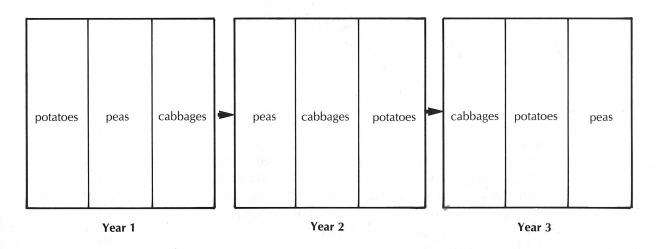
Tomatoes do not grow well outside in the middle of winter, but broad beans do. When you are planning your garden you have to work out the best months of the year for growing the plants that you want.



These plants grow well during the winter.

Crop rotation

If you grow the same type of plants in the same patch of soil each year, pests and diseases for that type of plant may build up in the soil. Try to plan your garden so that each year different sorts of plants follow each other. This is called **crop rotation.** For example, the place where you grow potatoes this year could have a crop of peas in it next year.



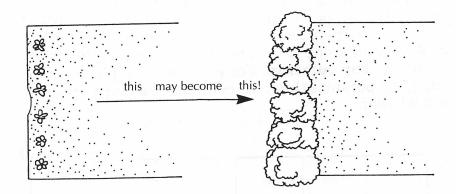
Successional sowing

Successional sowing is making frequent sowings of plants over a period of time. In this way you can have a fresh supply of the plants coming on all the time. Quickgrowing plants like radishes and lettuces should be sown like this.

	november								
	1	2	3	4	5 SON)5	7	8	
	9	10	11	12	13	14	15	16	
	17	185m	1)0	20	21	22	23	24	
distanta de la constanta de la	25	26	27	28	29	30	1.	2	

Planting distances

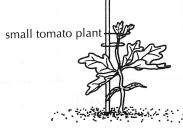
It is easy to overcrowd a garden! When you are at the planning stage remember that fully grown plants take up a lot more space than seeds. Read the instructions on the seed packet or find out about the plants you are growing before you plant them so that you can space them out correctly.



large stake

Staking

Your plants may need support when they have grown, especially if conditions are windy. If you know that they small tomato plant are going to need support later, plan to put stakes beside the plants while they are still small. In this way the roots can grow around the stake and are not damaged. Make sure the stakes are strong enough for adult plants to be tied to them.



Harvesting

One of the best times in your garden is when you gather the results of your hard work. Find out when and how to harvest the vegetables and flowers that you have grown.



Potatoes should be harvested with a fork so they are not damaged.

Questions

- 1 Give an example of a plant that grows well outside during winter.
- 2 What may happen if you grow the same type of plants in the same patch of soil each year?
- **3** What is successional sowing?
- 4 When should you put stakes beside plants?
- 5 What tool should you use to harvest potatoes?

REVISION QUESTIONS

- 1 Every year Mr Smith grows a row of tomatoes in exactly the same part of his garden. Explain why this is not a good idea.
- 2 Copy the following paragraph, then write one or two sentences for each of the underlined words to explain what it means.

People planning gardens need to think of many things. They must decide if the soil needs cultivation and whether fertilisers should be added. The aspect of the garden and the amount of shade and shelter it gets will affect the plants that are to be grown. In summer there should be a means of irrigating the garden and it may be necessary to spray to control diseases and pests. Successional sowing may be best for quickgrowing plants. Long-term plans should take into account the idea of crop rotation.

5: Tools

We use tools to help us do jobs more easily and quickly. Tools are most useful when you use them for the job they are meant to do. Do not try to make them do something else instead.

Uses of tools

Spade

The spade is used for digging. The **blade** is sharp and smooth and slips easily into the soil. Sometimes there is a **tread** on the spade. The tread makes it easier to push with your foot.

Fork

The fork is used to break soil down after digging. Large clumps of soil can be broken into smaller pieces with the back of the fork. The fork is also useful instead of a spade for digging heavy soil. The thin strong **tines** go into the heavy soil easily. You can keep ground between plants open using a fork. A fork is also useful for lifting plants or roots from the soil.

Rake

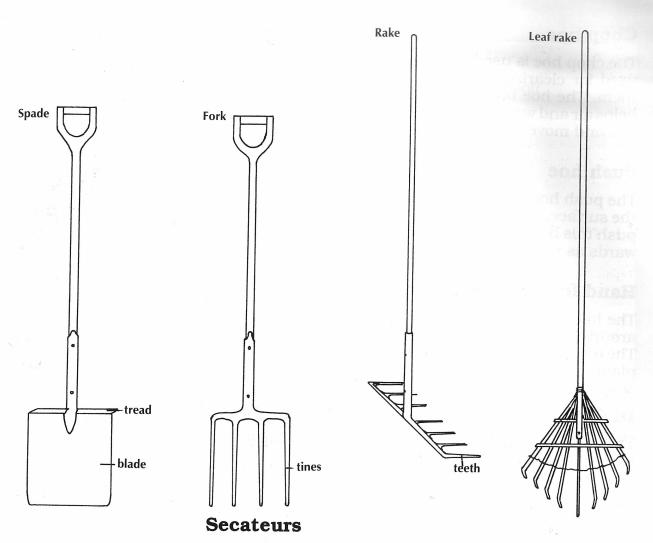
The rake is used to turn soil into very fine pieces just before planting. Small lumps of soil will crumble quickly when you draw a rake over them. You can make a **drill** to plant seeds in by turning the rake on one corner and pulling its edge through fine soil. After sowing seeds you can cover them with soil using a rake. Pull the rake towards you and never push the **teeth** of the rake into the soil.

Leaf rake

The leaf rake is used in the autumn to remove leaves from lawns and flower beds. It may also be used to rake up light rubbish.

WORD LIST

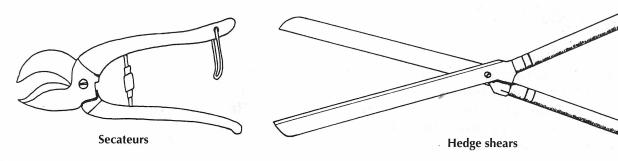
BLADE a flat cutting part of a tool
DRILL a shallow trench made in a line in the soil to put seeds in
TEETH sharp parts of a rake
TINES strong thin prongs on a fork
TREAD the part of a spade where you place your foot



Secateurs are used for cutting single stems and thin branches. They are an important tool for pruning and shaping plants.

Hedge shears

Hedge shears are used for clipping leafy parts of shrubs and hedges. You can also cut long grass with them. Do not use them for cutting stems and branches that are too thick.



Chop hoe

The chop hoe is used to hoe hard-packed soil. It is also used for clearing patches that have a lot of weeds in them. The hoe breaks up the surface of the soil. This helps air and water enter. You chop into the soil with this hoe and move forwards as you work.

Push hoe

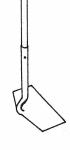
The push hoe is used to cut through the soil just below the surface. It kills weeds by cutting off their roots. You push this hoe backwards and forwards and move backwards as you work.

Hand fork and hand trowel

The hand fork is used when you are carefully weeding around plants by hand. It loosens small areas of soil. The hand trowel is used to make holes for planting small plants.

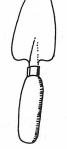
Dibber

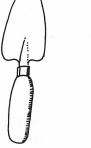
The dibber is used to make holes in fine soil before planting large seeds or small plants.

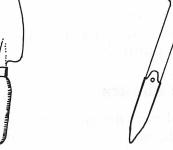


Chop hoe









Hand fork

Hand trowel

Dibber

Care of tools

When you have finished using tools you should clean them. First scrape off any dirt. Then wash and dry them. To stop tools from rusting you can wipe them with an oily rag. Do not damage the cutting edge of sharp tools. Have these tools sharpened when they begin to get blunt. Store tools in a safe dry place.

REVISION QUESTIONS

- 1 Which part of a spade makes it easier to push the spade with your foot?
- 2 Which tool has thin strong tines?
- 3 How would you use a rake if you wanted to make a drill to plant seeds?
- 4 Which tool is used to cut through the soil just below the surface?
- 5 Should you walk backwards or forwards when you are using a chop hoe?
- **6** When would you use a hand fork?
- 7 How should you care for tools when you have finished using them?
- **8** Where should tools be stored?
- **9** Write the name of the best tool to use for each of these jobs:
 - **a** breaking large clumps of soil into smaller pieces
 - **b** making a pile of dead leaves
 - c digging a hole to plant an apple tree
 - **d** trimming a hedge
 - e pruning a grapevine.

6: Types of plants

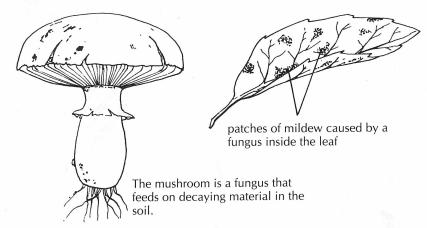
The plant kingdom can be divided into two major groups.

- 1 Plants that do not have flowers
- 2 Plants that do have flowers

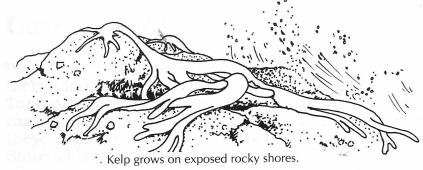
Non-flowering plants

These plants never have flowers.

Fungi are simple non-flowering plants. Examples of fungi are toadstools, mushrooms, moulds and yeasts. Fungi are not green. They do not have **chlorophyll**, so they cannot make their own food. Instead they feed on dead or decaying material in the soil. Some fungi feed on other living things. An example of a fungus that feeds on living things is the one that causes the disease called **mildew** in some plants.



Algae contain chlorophyll and so they can make their own food. Algae always live in water or in wet places.



WORD LIST

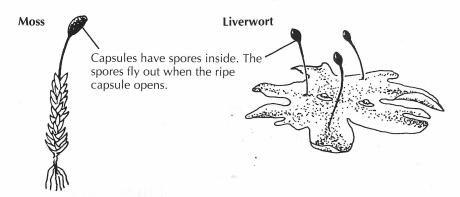
CHLOROPHYLL the green colour in plants
COTYLEDON the seed leaves
FRONDS leaves of ferns
MILDEW a furry-looking fungus, grows on leaves
PLANKTON microscopic plants that live in the sea
POLLEN male reproductive bodies of plants
SPORES reproductive bodies of many non-flowering plants

Those that grow in the sea are called seaweeds. Some algae, for example, **plankton**, are microscopic in size while others, for example, giant kelp, may grow to be many metres long.

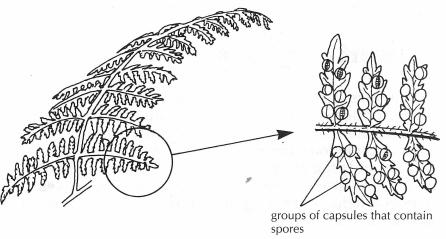
Questions

- 1 What are the two major groups of the plant kingdom?
- 2 Which group of plants cannot make their own food?
- **3** What do mushrooms feed on?
- 4. Give an example of a plant disease caused by a fungus.
- **5** Where do algae live?
- 6 Can kelp make its own food?

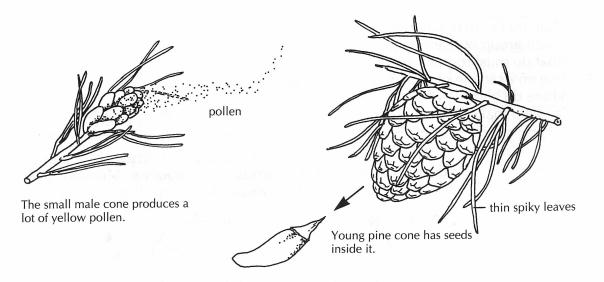
Mosses and liverworts are small plants that live in damp places. They reproduce by **spores**. Mosses have tiny leaves, while liverworts look quite flat.



Ferns are bigger than mosses. Their leaves are called **fronds**. Beneath the fronds the spores are formed in capsules. Groups of capsules look like brown spots under fern fronds. Ferns do not have flowers. They usually live in damp shady places.



Conifers have cones instead of flowers. There are two types of cones. Male cones are tiny and produce **pollen**. The pollen is carried by the wind to the larger female cones. Seeds form inside the female cones. The seeds fall out when the ripe cone opens up.



The leaves of conifers are usually small, or thin and spiky. Often conifers have gum or resin inside them. They can live in dry places.

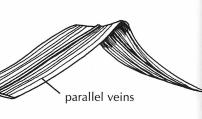
Questions

- 1 · In what way do mosses and liverworts look different from each other?
- 2 How do mosses and ferns reproduce?
- 3 Where do fern spores form?
- 4 Do conifers have flowers?
- 5 What is the function of the male cone of a conifer?

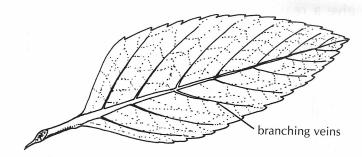
Flowering plants

The flowers of flowering plants are for reproduction. They produce seeds. There are two main types of flowering plants: monocotyledons and dicotyledons.

Monocotyledons are plants that grow from a seed with only one **cotyledon** or seed leaf. Examples of monocotyledons are grass, sweetcorn and flax. The leaves of monocotyledons are long and thin. The leaf veins run parallel to each other.



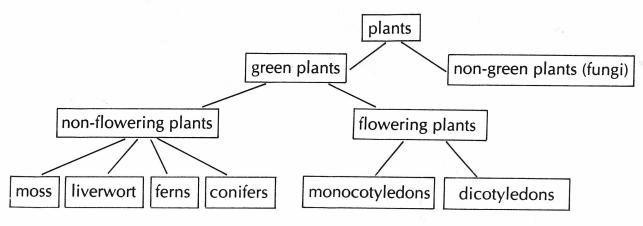
Dicotyledons grow from a seed with two cotyledons. Most flowering plants are dicotyledons. You know that a plant is a dicotyledon if its leaves have veins arranged in a branching pattern.



Questions

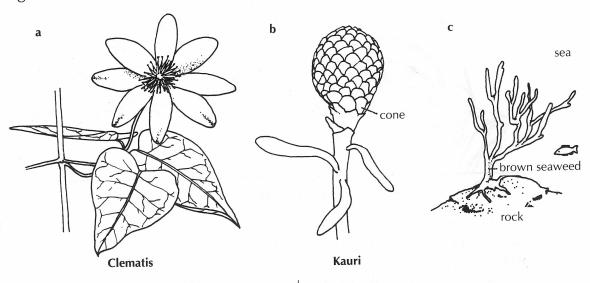
- 1 Why do flowering plants have flowers?
- 2 Name the two main types of flowering plants.
- **3** What is a cotyledon?
- 4 Give an example of a plant that is a monocotyledon.
- 5 Describe the leaf of a monocotyledon.
- 6 How many cotyledons does the seed of a dicotyledon have?
- 7 How do you know that a plant is a dicotyledon?

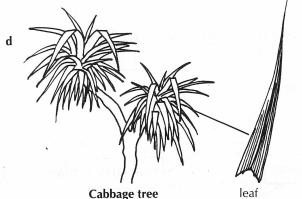
Summary diagram of the main plant groups

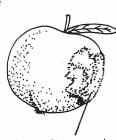


REVISION QUESTIONS

1 For each of the plants a to e say whether it is an alga, fungus, moss, liverwort, fern, conifer, monocotyledon or dicotyledon, and give a reason for each answer.







furry white growth on fruit

- 2 Choose one word from each list to complete these sentences.
 - a One plant which has flowers is . . .

moss fungi grass fern

- **b** Plants that have leaves with parallel veins are called . . . cotyledons dicotyledons monocotyledons
- c An example of a fungus is . . . seaweed mildew moss
- d Mosses, liverworts and ferns reproduce by . . . seeds flowers spores pollen
- 3 Give two important differences between a toadstool and a daisy plant.
- 4 Copy the summary diagram showing the plant groups. Draw a picture of one plant from each group.

7: Specialist plants

WORD LIST

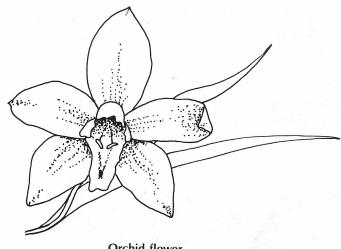
ADAPTATIONS features that help plants or animals to survive BONSAI TREES miniature versions of large trees EPIPHYTES perching plants that live on trunks or branches of trees FOLIAGE leaves NITROGEN element that forms part of plant and animal tissue TRICKLE IRRIGATION continuous trickling water supply

Each group of plants has its own way of life and its own special needs. If you are to grow plants successfully you must find out what conditions are best for them. Then you must supply those conditions.

Some groups of plants need very special treatment. These plants include orchids, water-lilies, ferns, bonsai trees, the insect-capturing plants and cacti. By looking up reference books or talking to people who grow these plants you can find out more about their needs.

Orchids

There are more than 25 000 known species of orchids. The main countries where native orchids are found are India, China, Japan and Indonesia, and the earliest records of these plants come from China and Japan.



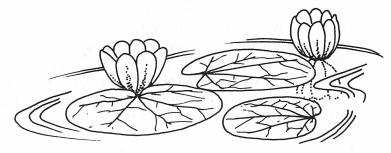
Orchid flower

In nature orchids either grow on the ground amongst forest trees or as epiphytes growing on the trees themselves. When we grow orchids in pots we try to give them conditions similar to their natural growing conditions.

Some types of orchid need to be kept very warm and can only be grown in greenhouses, while others prefer cooler conditions. A special potting mix that drains readily is needed and a mix containing pine bark is often used. You must water orchids well, but not too often, and make sure they have plenty of light and air.

Water-lilies

Water-lilies need to have their roots in water at all times and their flowers, stems and leaves are held up by water. The roots need a soil base to cling to so you must provide some soil, either on the bottom of the pond or in a suitable container, weighted down with small stones so it does not float to the surface.



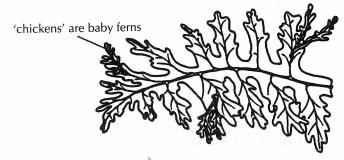
Water-lilies are held up by water.

Questions

- 1 Name three countries where native orchids are found.
- 2 Where do epiphytes grow?
- 3 What substance is often used in potting mix for orchids?
- 4 How are water-lily leaves and flowers held up?
- 5 Explain how to give water-lily roots a soil base to cling to.

Ferns

In nature, most ferns grow in shady damp places, so these are the conditions we try to provide if we want to grow ferns in the garden or as house-plants.

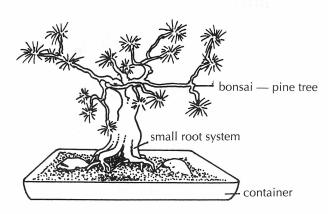


The hen and chickens fern makes a good house-plant.

Ferns need a constant supply of water if they are to grow well. **Trickle irrigation** with a continuous drip supply is a good way to water them. Most can stand some sun, but wind kills fern fronds very quickly so they need good shelter.

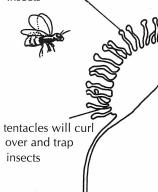
Bonsai

Bonsai trees are manmade miniature versions of large trees. They are produced by continual pruning of the roots of the young trees. The trees remain small and develop interesting shapes. Most are quite hardy but because they lack a large root system they must be watered frequently and kept in a sheltered place.



Bonsai is an art form in which the container and the area around the small tree are as important as the tree itself.

shiny tip with 'dew' to attract insects



Sundew plant

Insect-capturing plants

Insect-capturing plants have various **adaptations** for trapping insects. They may close up quickly when touched by an insect or have sticky hairs that the insect cannot escape from. The trapped insects are digested by the plant. This helps the plant to get the **nitrogen** it needs.

In nature many insect-capturing plants are found in swamps and bogs. They are quite small and do not need a lot of care or attention to grow well.

Questions

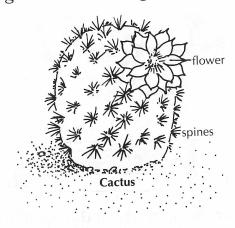
- 1 Where do most ferns grow in nature?
- 2 What is a good way to water ferns?
- **3** Why do ferns need good shelter?
- 4 How are bonsai trees produced?
- 5 What element do digested insects give to the plants that capture them?
- **6** Where do many insect-capturing plants grow in nature?

Cacti

Collecting and growing cacti is a popular hobby. Cacti can be raised from seed and come in many different shapes and colours. They have interesting spines and often spectacular flowers.

Most cacti come from Mexico and South America. Their native living-places are dry and hot, so they need

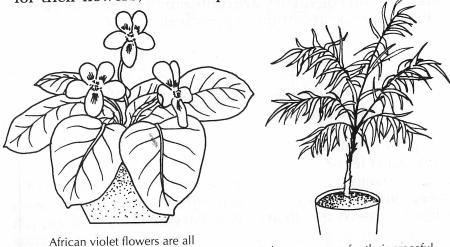
plenty of bright sunshine for good growth.



Cacti must be grown in soil or potting mix that drains freely, as their roots rot easily if they stay wet. Although cacti can go for long periods without water they must get an adequate supply during the growing period. They should never be watered while the soil is still damp.

House-plants

Plants grown indoors can add beauty to the rooms in which they are kept. Some indoor plants are grown for their **foliage**, for example, the palm. Others are grown for their flowers, for example, African violets.



Palms are grown for their graceful

You should choose plants that suit the positions where they are to grow. They will need adequate light and air and a steady temperature. Water is needed, but not too much. House-plants need less water in winter than in summer. Fertilisers may need to be supplied from time to time and repotting will be needed when a plant gets too big for its container.

Questions

- 1 Name one of the countries from which cacti originally came.
- **2** What sort of conditions do cacti prefer?
- 3 Why must cacti be grown in free-draining soil or mix?
- 4 Give an example of an indoor plant that is grown for its foliage.
- 5 What are five things you must do when caring for indoor plants?

REVISION QUESTIONS

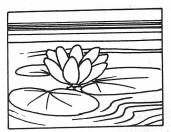
Choose a plant group that interests you. It may be a group that has been touched on in this chapter or some other group, for example, herbs or food producers. Find out as much as you can about your plant group, from books and magazines and other people. Prepare a poster to teach others about the group of plants you chose.

shades of pink, purple and blue,

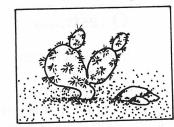
as well as white.

8: Plant structure

Flowering plants may look very different from each other. If you think of



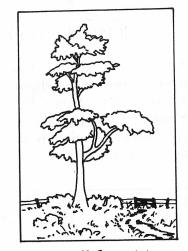
a water-lily in a pond



a cactus in the desert



grass in a paddock



and a tall forest tree,

WORD LIST

APICAL BUD a bud at the tip of a main stem AXILLARY BUD a bud growing at a node BUD a young undeveloped shoot DIOECIOUS separate male and female plants HERMAPHRODITE a flower that has both male and female sex organs INTERNODES the area between nodes on the stem LATERAL BUD a bud growing at a node LATERAL ROOTS side roots I FAF AXIL the angle between the stem and a leaf growing from it MONOECIOUS male flowers and female flowers on one plant NODES where leaves join the stem NUTRIENTS substances needed by plants for growth PETIOLE a leaf stalk PRIMARY ROOT the main TERMINAL BUD bud at the

tip of the main stem

you will realise how different they look.

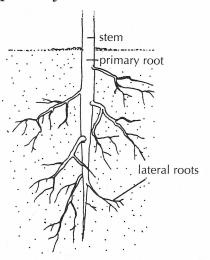
However, the basic structure of flowering plants follows a plan that is the same for all. The structure is divided into two main parts:

- the parts concerned with growth the roots and shoot
- the parts concerned with sexual reproduction the flowers.

The parts for growth

Roots

The roots form a branching system in the soil. The stem is attached to the main root. The main root is also called the **primary root**. Side roots, called **lateral roots**, branch off the primary root.

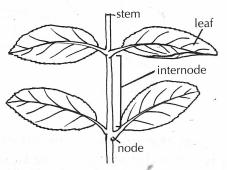


The main functions of the root are to anchor the plant in the ground and to absorb water and **nutrients** from the soil. Often the root also stores food.

Stem

The main functions of the stem are

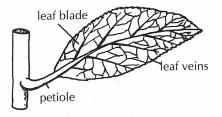
- to carry water from the root to the leaves and other parts of the plant
- to carry food from the leaves around the plant
- to hold up the leaves and flowers
- sometimes to store food.



Leaves are attached to the stem at places called **nodes**. The spaces on the stem between nodes are called **internodes**.

Leaf

The most important function of the leaf is to make food for the plant. The two main parts of a leaf are the leaf stalk, called the **petiole**, and the flat leaf blade. Inside the blade you can see a pattern of leaf veins. The veins carry food and water.

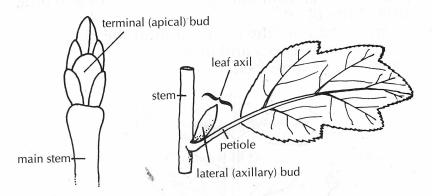


Questions

- 1 What is another name for the main root?
- **2** Give two functions of the root.
- 3 Give three functions of the stem.
- 4 What is the name given to the place where the leaf is attached to the stem?
- 5 What is the most important function of the leaf?
- **6** What do leaf veins carry?

Bud

A **bud** is a young undeveloped shoot. It will grow into either leaves or flowers. The bud at the tip of the main stem is called the **terminal bud**. It is also called the **apical bud**.



Buds grow also at the nodes of the stem, just above where the petiole joins the stem. These buds are called **lateral buds**. They are also called **axillary buds**. The part where these buds are found, between the stem and the leaf stalk, is called the **leaf axil**.

Questions

- 1 What is a bud?
- 2 What two things may a bud grow into?
- **3** Where is the terminal bud found?
- **4** What is another name for a lateral bud?
- 5 Draw a diagram to show a leaf axil and a lateral bud.

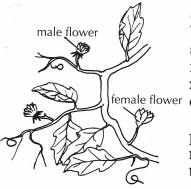
The parts for sexual reproduction

Flower

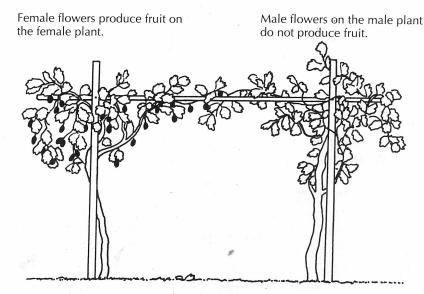
The flower carries the sex organs. Its function is reproduction. The sex organs produce seeds so that new plants can grow.

Some plants have flowers with both male and female sex organs in the same flower. These plants are said to be complete, or **hermaphrodite**. Other plants have separate male and female flowers. If the male and female flowers grow on the *same* plant, the plant is said to be **monoecious** (the word means 'one house'). An example of a monoecious plant is the cucumber.

If the male and female flowers grow on *separate* plants, the plant is said to be **dioecious** (this word means 'two houses'). An example of a dioecious plant is the kiwi fruit.



Cucumber plant



kiwi fruit plants

Questions

1 Explain what a hermaphrodite flower is.

2 If a plant has male and female flowers growing on the same plant, what is it called?

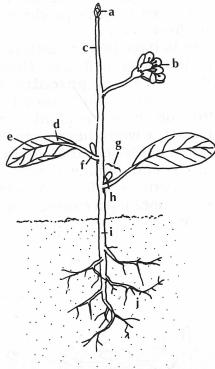
3 Give an example of a monoecious plant.

4 What is a dioecious plant?

5 Give an example of a dioecious plant.

REVISION QUESTIONS

1 Copy and label this diagram, which shows the main parts of a flowering plant.



2 'All the parts of a plant work together for the good of the whole plant.' Write a paragraph that explains this idea.

9: The root

WORD LIST

ADVENTITIOUS roots growing from a stem, often above ground

BACTERIA single-celled microscopic organisms

DICOTYLEDON plants with leaves that have a network of veins and seeds with two seed leaves

LEGUME member of the same plant family as peas and beans

MINERAL chemical element needed by plants for growth, for example, nitrogen

MONOCOTYLEDON plant with leaves that have parallel veins and seeds with one seed leaf

NITRATES the form in which nitrogen can be taken into plant roots

NITROGEN FIXATION making nitrogen into nitrates

NODULES swellings in the roots of legumes

NUTRIENTS substances needed by plants for growth

ROOT HAIRS long cells on the outside of roots that take in water and minerals

SUCKER a shoot that grows away from the parent plantoff an underground root or stem

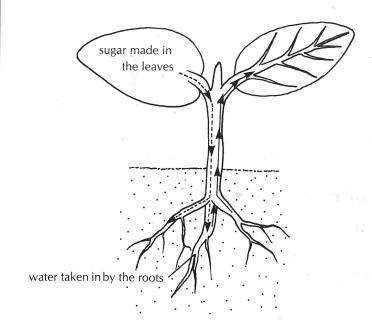
TUBER a swollen underground root used for food storage

XYLEM tissue that carries water

A plant has roots

- to hold it firmly in the soil
- to take in water and **nutrients** for the plant
- sometimes to store food that has been made in the leaves.

A plant must keep a balance between the size of the root system and the surface area of its leaves, so that the roots can give enough water and nutrients to the leaves and the leaves can make enough food for the roots.

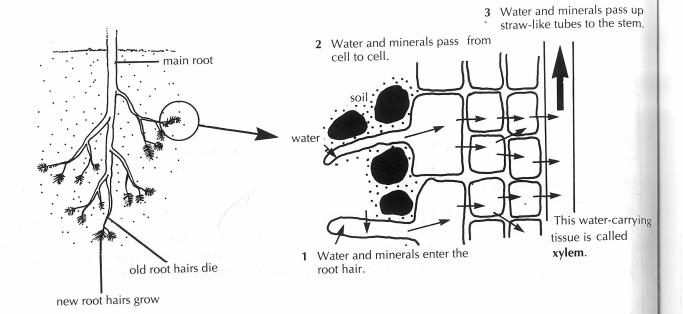


If you cut off too many leaves or damage the roots you upset this balance.

How water is taken in by roots

Roots take in water and **mineral** nutrients from the soil. The minerals are dissolved in the water that is taken in. The **root hairs** are where water and minerals enter.

In most plants root hairs only live for a few days or weeks. New hairs are forming as old ones die. As the root grows through the soil, fresh new root hairs come in contact with new soil particles and can take in the water and minerals surrounding them.

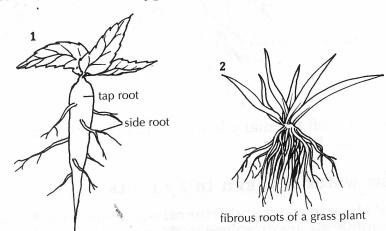


Questions

- 1 Give three reasons why a plant has roots.
- 2 With what must a plant balance its root system?
- 3 Which part of a root takes in water and minerals?
- 4 What does the tissue called xylem carry?
- 5 How long do root hairs usually live?

Types of root system

There are two main types of root system.



1 Tap roots have a single main root that grows down into the soil and smaller side roots that grow out from it. **Dicotyledons** have this sort of root system.

2 Fibrous roots have many roots growing out at the same time and side roots that grow from these.

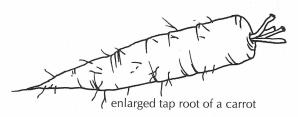
Monocotyledons have this sort of root system.

Roots that have special functions

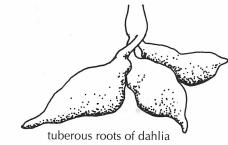
Some roots are used by the plant for special functions, such as food storage, reproduction and climbing.

Food storage

Some plants, for example, the carrot and parsnip, store food in the enlarged tap root.

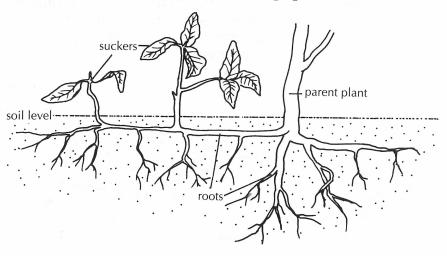


Other plants, for example, the kumara and dahlia, have **tubers**, which are very swollen roots, specialised for food storage.



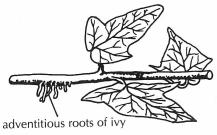
Reproduction

The roots of some plants can produce buds that grow into shoots called **suckers**, by which the plant reproduces itself. Some examples of plants that produce suckers are raspberry and silver poplar.



Climbing

Some plants climb towards the light by clinging to their support with small roots that come from their stems. These roots are called **adventitious** roots. An example is ivy.



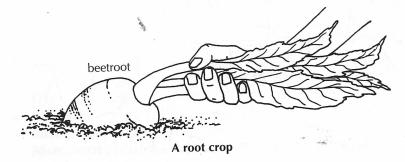
Questions

- 1 What type of root system is usually found in dicotyledons?
- 2 What sort of root system do grass plants have?
- 3 Give an example of a plant that stores food in an enlarged tap root.
- 4 Draw the tuberous roots of a dahlia.
- **5** Give two examples of plants that produce suckers.
- 6 What are small roots produced on the stem of climbing plants called?

Making use of roots with special functions

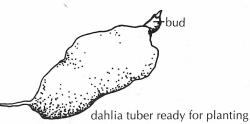
Food crops

The roots from plants that store food in their roots are used as food for people and the animals they keep. The plants store the food to keep them alive during winter, but we grow them to eat. Scientists try to develop bigger, tastier and more disease-resistant roots on these crop plants. Examples are carrots, beetroot, parsnips, turnips, swedes and kumaras.

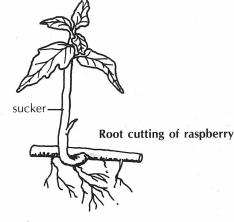


You can use tubers and suckers to grow new plants that are identical to the parent plant.

Plants with tubers can be grown by splitting the tubers and planting them separately. Make sure that each piece has a bud on it from which a new stem will grow.



Plants with suckers can be grown if you dig up the sucker with part of the root attached and plant it separately. Raspberries are often grown from root cuttings in this way.



Soil improvement

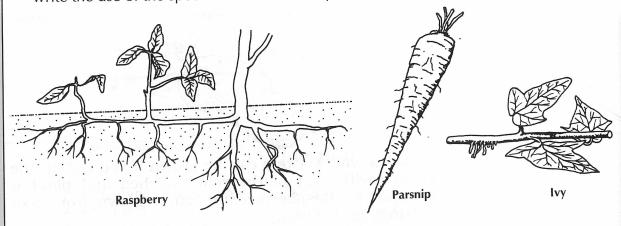
Plants that belong to the **legume** family have **bacteria** living in swellings called **nodules** on their roots. The bacteria turn nitrogen from the air into nitrates, which the plant can use. This process is called **nitrogen fixa**tion. Examples of legumes are peas, beans, clover and lupins. Crops of these plants are grown to improve the soil because they add nitrates to the soil through their root nodules.

Ouestions

- 1 Give four examples of plants whose roots are grown as food for humans.
- 2 What must be on each piece of tuber if it is to grow?
- 3 Draw a root cutting of a raspberry. Label the sucker.
- 4 How does a crop of legumes improve the soil it grows in?

REVISION QUESTIONS

- 1 Use a diagram to explain how water gets from the soil to the stem.
- 2 Draw these roots, each of which has special functions. Beside each write the use of the special function to the plant.



- 3 Imagine you are a scientist who is trying to develop a better type of carrot plant than is available at present. Write a paragraph explaining the features of a perfect carrot.
- 4 Copy and complete this paragraph using the words in the list below.

Plants like peas and . . . belong to the . . . family. They have swellings called . . . on their roots. The bacteria in the swellings turn . . . from the air into nitrates, which the plant can use. This process is called . . .

NITROGEN FIXATION NITROGEN CLOVER NODULES LEGUME

- 5 Explain carefully how you would growa dahlias from tubersb raspberries from suckers.
- **6** What are adventitious roots?

10: Stems

A plant has a stem

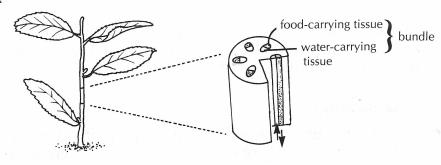
- to carry water and nutrients from roots to leaves, and food from leaves to roots
- to support leaves and flowers.

Stems may be either **herbaceous** or woody.

Herbaceous stems

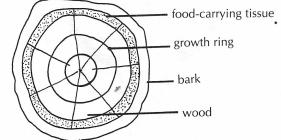
These stems have no rigid wood cells. They need water to keep them rigid and wilt when the plant is short of water. Herbaceous stems are found on herbaceous plants and the new growth of shrubs and trees. They are often green and they help the leaves produce food.

The tissues that carry water and food are in a ring of bundles near the outside of the stem. The tissue called **xylem** carries water. Food is carried in tissue called **phloem**.



Woody stems

These begin as herbaceous stems but special dividing cells in the stem produce new woody tissue each spring. This makes a pattern of rings, which you can see when you cut a large woody stem. On the outside of a woody stem grows **bark**. Bark protects the food-carrying tissue directly beneath it.



This tree is three years old. You can count the rings made each year.

WORD LIST

ASEXUAL reproduction without the production of seeds

BARK protective layer on outside of older stems

BULB stem and leaves adapted for underground food storage

CORM underground swollen stem

HERBACEOUS plants that never get woody

PHLOEM tissue that carries food

RUNNER a stem that grows along the surface of the ground and produces roots where it touches the ground

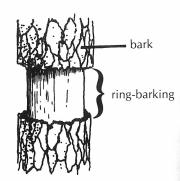
STEM TUBER a swollen stem for food storage

VEGETATIVE PROPAGATION the production of new plants by a method that does not involve seeds

XYLEM tissue that carries water

Ring-barking

If a plant has a piece of bark removed right around the main stem the plant will gradually die. The food-carrying tissue is removed with the bark, so food cannot get to the roots. They die and the whole plant dies. This is called ring-barking. Animals that, like possums, eat bark can cause ring-barking.



Questions

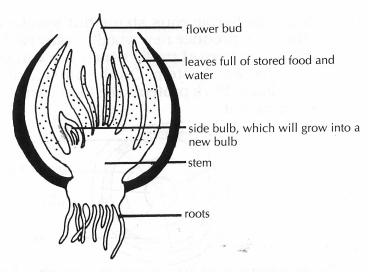
- 1 Give the two main reasons plants have stems.
- 2 What keeps herbaceous stems rigid?
- 3 Name the tissue that carries water in the stem.
- 4 Name the tissue that carries food in the stem.
- 5 Draw a diagram of a herbaceous stem.
- 6 How can you tell the age of a tree?
- 7 What is an important function of bark?

Stems that have special functions

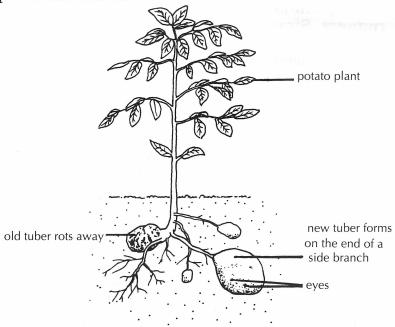
Some stems look quite different from the usual, upright stems. They are changed to carry out special functions, such as food storage, reproduction and climbing.

Food storage

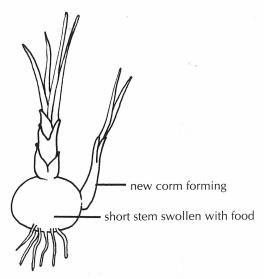
Some plants, for example, the onion and daffodil, store food in **bulbs**. A bulb is really a short flattened stem with fleshy leaves.



An example of a plant that forms a **stem tuber** is the potato. The enlarged parts of the stem give food to the growing plant. The 'eyes' on a potato are really buds that will sprout into leaves.



Some plants, for example, freesias, gladioli and crocuses have **corms**. Corms are short, fleshy underground stems in which food is stored.

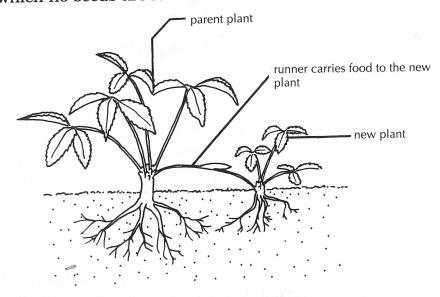


Plants make use of bulbs, corms and tubers to stay alive through winter and then to grow from in spring.

Gardeners use bulbs, corms and tubers to grow plants that are identical to the parent plant. Because food is stored in them they give the young plant a good start to its growth. This way of growing plants is one method of **vegetative propagation**.

Reproduction

In some plants stems grow *horizontally* above the ground. Where the stem touches the ground roots grow out and a new plant is formed. The horizontal stems are called **runners**. Strawberries and violets reproduce asexually using runners. **Asexual** reproduction is reproduction in which no seeds are formed.



You can cut the new plants away from the parent and plant them separately. This is another method of vegetative propagation.

Climbing

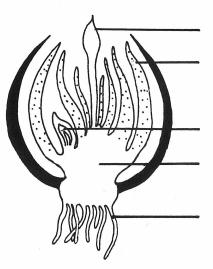
The stems of some plants twine around whatever they touch. These stems help the plants to reach the light. They get support from the things they twine around. Examples of plants with twining stems are honeysuckle and hops.

Questions

- 1 Name two plants that use corms for vegetative reproduction.
- 2 Give two reasons why gardeners grow plants by vegetative propagation.
- 3 What does a runner carry from the parent plant to the new plants?
- 4 Name a plant that produces runners.
- 5 What is asexual reproduction?

REVISION QUESTIONS

- 1 Explain what ring-barking is, and why it can cause a plant to die.
- You have been given some violet seeds and some violet runners. Which will form new plants that are *identical* to the parent plant? What will the others form?
- 3 Copy and label this diagram of a daffodil bulb.



4 Copy and complete this paragraph using words from the list below.

The main functions of stems are to carry water and . . . and to . . . leaves and flowers. Some stems are adapted for other functions, especially food . . . and vegetative . . . A . . . is an example of a stem that stores food and is a means of reproduction.

CORM FOOD REPRODUCTION STORAGE SUPPORT

11: Leaves

A plant has leaves

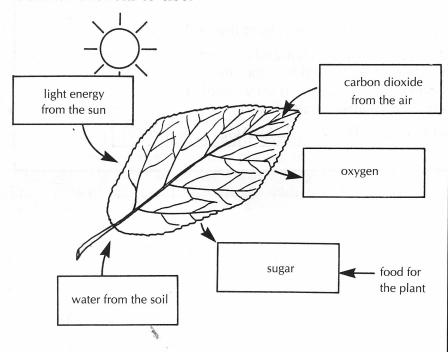
- to make its own food
- to help pull water through the plant from the roots.

Leaves are made so that they carry out these functions efficiently.

How a plant makes food

Green plants make their own food by a process called **photosynthesis**. In this process the leaf uses carbon dioxide from the air and water from the soil to make its food, which is sugar. Oxygen gas is also made during photosynthesis. It is released into the air.

Photosynthesis needs energy to make it happen. This energy comes from the sun. The green colour in plant leaves, called **chlorophyll**, traps light energy from the sun for the leaf to use.



This equation gives a summary of the process of photosynthesis.

WATER + CARBON DIOXIDE $\frac{\text{sunlight}}{\text{chlorophyll}} > \text{SUGAR} + \text{OXYGEN}$

WORD LIST

CHLOROPHYLL the green colour in plants

CHLOROPLASTS round bodies in plant cells, contain chlorophyll

CUTICLE waxy surface of

leaf
GUARD CELLS open and

close leaf pores IODINE chemical used to

test for starch IRRIGATION supplying

water to plants
PALISADE CELLS tall cells

inside leaf, near upper surface

PHLOEM tissue that carries food

PHOTOSYNTHESIS how green plants make their own food

SPONGY CELLS small round cells inside leaf

STARCH food storage substance in plants

STOMA tiny pore in a leaf TRANSPIRATION loss of water vapour from leaf

XYLEM tissue that carries water

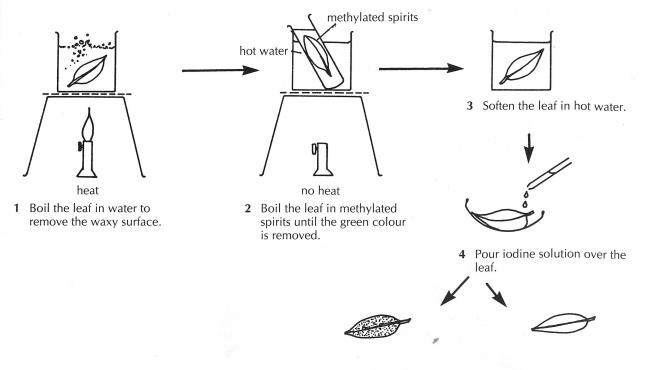
The sugar may be used immediately by the plant for energy or growth, or it may be changed into **starch**. The starch can be stored in the leaf or in other parts of the plant until it is needed. Then it can be changed back into sugar.

Questions

- 1 What is the name of the process by which green plants make their own food?
- 2 How does a green leaf make sugar?
- 3 Name the gas made during photosynthesis.
- **4** What is chlorophyll?
- 5 What does chlorophyll do?
- **6** What is sugar used for by the plant?
- 7 What is sugar changed into before it is stored in the plant?

Testing a leaf to see if it contains starch

When starch is mixed with a chemical called **iodine** a blue-black colour forms. You can use this fact to find out if there is starch inside a leaf. First you have to remove the green colour from the leaf so you will be able to see the blue-black colour if it forms. You can follow these steps.



If the leaf goes blue-black starch is present.

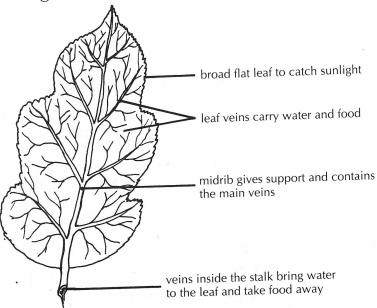
If the leaf goes a brown colour starch is not present.

Questions

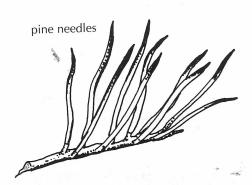
- 1 What colour forms when iodine solution is added to starch?
- 2 Why must you remove the green colour from a leaf before you test it to see if it contains starch?
- 3 What would you use to remove the green colour from a leaf?
- 4 If a bleached leaf turns blue-black when iodine is added to it what must the leaf contain?

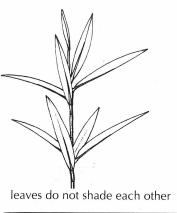
Leaf size and shape

Leaves are usually broad and flat so that they catch as much sunlight as they can.



Plants that have narrow leaves make up for it by having a great many of them. A pine tree is an example of a tree with many narrow leaves, which we call pine needles.





Leaf arrangement

Leaves are usually arranged on the plant so that they do not shade each other. Some plants turn their leaves to grow towards the sun.

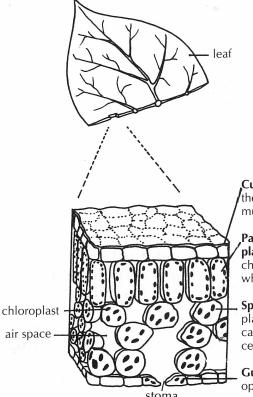
The Hebe is a good example of a plant whose leaves are arranged in a pattern so that each leaf gets plenty of sun without shading the others.

Questions

- 1 Why are leaves usually broad and flat?
- 2 How does a pine tree get enough sunlight?
- **3** What do leaf veins carry?
- **4** What is the function of the midrib?
- 5 How are leaves usually arranged on the plant?

Inside a leaf

It is difficult to see inside a leaf because leaves are so thin and flat. But if you cut a piece of leaf and put it under a microscope you can see that the inside is arranged in layers.



Cuticle on the outside protects the leaf and prevents it losing too much water.

Palisade cells have many chloroplasts, which contain green chlorophyll. Chloroplasts are where photosynthesis takes place.

Spongy cells also have chloroplasts. Air space leaves room for carbon dioxide to circulate to the

Guard cells change shape to open or close the stoma.

Leaf veins bring water to the leaf in xylem tissue and

carry food away in phloem tissue.

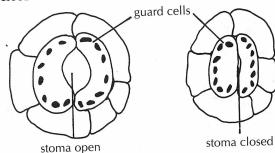
The palisade and spongy cells are where the sugar is made. Air containing carbon dioxide enters the leaf through the many small holes on the lower surface. Each hole is called a **stoma**. The cells on each side of the stoma are the **guard cells**. They open or close the stoma. Water vapour and oxygen leave through the stoma.

Questions

- 1 What instrument can help you to see inside a leaf?
- 2 Give two functions of the cuticle of a leaf.
- 3 Which two types of leaf cells contain chloroplasts?
- 4 What takes place inside chloroplasts?
- 5 Why are there many air spaces between the the spongy cells?
- 6 What name is given to each of the small holes in a leaf?
- 7 What two things leave the leaf through the stoma?
- 8 How does each stoma open and close?

Water loss from leaves

The small holes that allow gases to enter and leave the leaf also allow water vapour to escape. This loss of water is called **transpiration**. When the guard cells keep the holes open a lot of water is lost. When they are closed little water is lost.



Surface view of part of lower leaf surface, magnified

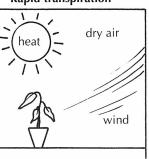
Transpiration is useful to the plant for four main reasons.

- 1 It helps to move water through the plant because as water is lost from the leaves more is pulled up from the roots by suction in the xylem. This pulls water to the leaves for photosynthesis.
- 2 Minerals are carried with the water to the leaves.
- 3 Water that is pulled up to the cells helps to support the plant.
- 4 Leaves are kept cool as water evaporates from them.

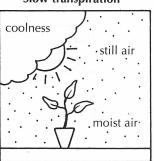
But if too much water is lost from the leaves the cells of the plant become limp and the plant wilts and can die.

Transpiration takes place most quickly on days that are sunny, warm, dry and windy. On cloudy, cool, wet and still days less water is lost from leaves. Plants must be supplied with plenty of water, sometimes by irriga**tion**, on days when transpiration is rapid.

Rapid transpiration



Slow transpiration



Ouestions

- **1** What is transpiration?
- 2 Where are the small holes on the leaf mainly found?
- 3 Draw a diagram of an open stoma. Label the guard cells.
- **4** Why is transpiration important to a plant?
- 5 What can happen if too much water is lost from the leaves?
- **6** Give four weather conditions that slow down transpiration.

Leaf cuttings

Leaf cuttings may be used to grow plants that have stems too short to provide stem cuttings. Most are house-plants.

If there is no stem at all you can cut the veins underneath the leaf and then lie the leaf flat on damp potting mix. Roots will grow where the cuts were made.



Cut a leaf from the plant with a clean blade.



Plant it in fresh damp mix. Keep it damp until roots grow.

REVISION QUESTIONS

1 Copy and complete the paragraph using words from the list below.

Green plants are able to make their own food. In the chloroplasts the green colour called . . . traps the . . . of the sun. Carbon dioxide and . . . are combined together to make their food, which is . . . The process is called . . . Often the sugar is changed to . . . so it can be stored.

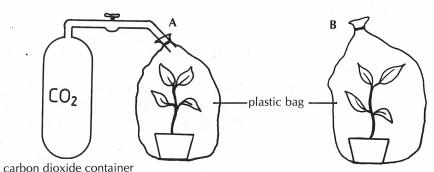
ENERGY CHLOROPHYLL WATER SUGAR PHOTOSYNTHESIS STARCH

- 2 A variegated leaf (part yellow and part green) was tested for starch after the plant it was growing on had been left in the sun for several hours. It was found that only part of the leaf had starch in it.
 - **a** Explain, with diagrams, how you would test the leaf for starch.
 - **b** Would you expect to find starch in the green or the yellow part of the leaf? Explain your answer.



A variegated leaf

3 Two pot plants were set up as shown in the diagram. Plant **A** was given a two-second burst of carbon dioxide every morning. Plant **B** was treated the same as plant **A** but was not given carbon dioxide. After a month both plants were weighed. Which plant should have weighed the most? Explain your answer.



- 4 Where does the carbon dioxide used up in photosynthesis come from?
- **5** Explain why green plants are often called producers.
- **6** Water weeds in an aquarium can sometimes be seen to be giving off bubbles of gas.
 - **a** What process in the water weed might have caused the bubbles to form?
 - **b** Which gas would you expect to be in the bubbles?
 - **c** Would water weed kept permanently in the dark still give off bubbles?
- 7 Why is transpiration usually more rapid in summer than it is in winter?

12: Flowers

WORD LIST

ANNUALS plants that complete their life cycle in one year

ANTHER part of the stamen that makes pollen

BEDDING PLANTS plants grown to be planted out in flower-beds

BIENNIALS plants that complete their life cycle in two years

CALYX protective layer of sepals

CARPEL female part of a flower

COROLLA all the petals FERTILISATION when a male cell fuses with a female cell in an ovule

FILAMENT part of the stamen that holds up the anther

NECTAR sugary substance made by petals

OVARY part of a carpel where ovules are made

OVULES contain female egg cells

PERENNIALS plants that grow for more than two years

POLLEN male sex cells of a plant

POLLEN TUBE grows from pollen grain to ovule

POLLINATION pollen grains are transferred from an anther to a stigma

POLLINATORS agents that carry out pollination

SEPALS make up the calyx outside the petals

STAMENS male parts of a flower

STIGMA part of a carpel where the pollen lands

STYLE joins stigma to ovary

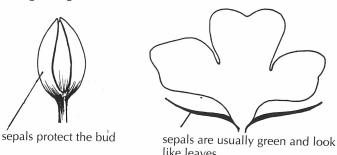
The flower is the reproductive organ of a flowering plant. Flowering plants reproduce sexually.

The parts of a flower

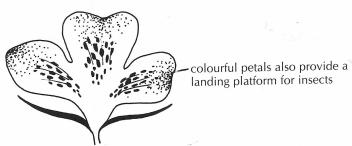
The parts of the flower are attached to the flower stalk in four layers.

A plant has flowers for only one reason - to reproduce.

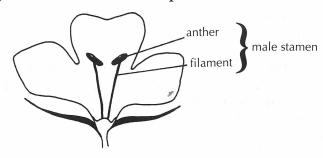
1 The outside layer is the **calyx**. It is made of **sepals**. The sepals protect the flower bud.



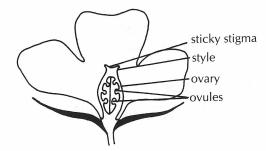
2 The next layer is called the **corolla**. It is made of petals. The petals may be coloured or scented, or have **nectar** at the base to attract insect or bird **pollina-tors**.



3 The **stamens** are the male organs. They are made up of an **anther**, which contains **pollen**, and a **filament** or stalk, which holds the anther up. The anthers often look yellow because of the pollen that is on them.



- 4 The carpel is the female organ. It is made up of
 - a sticky **stigma** to catch pollen
 - a style, which holds up the stigma
 - an **ovary** in which are **ovules**. The ovules contain female egg cells.

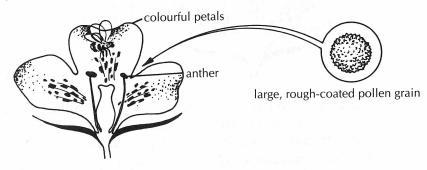


Questions

- 1 Why does a plant have flowers?
- 2 Which part of the flower protects the flower bud?
- 3 What is the corolla made of?
- 4 Give three ways petals are used by the flower to attract insects.
- 5 What are the male organs of the flower called?
- 6 Why do anthers often look yellow?
- 7 What is the function of the stigma?

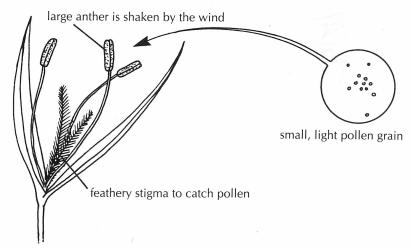
Pollination

Pollination is the process that takes place when pollen is carried from an anther to a stigma. Most plants need an outside agent to carry out pollination. The most important pollinators are insects, especially bees, and wind.



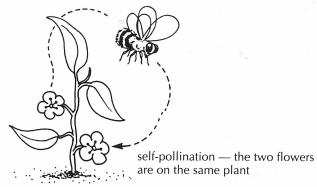
Insect-pollinated flowers are colourful or scented to attract insects. The pollen grains are large and have rough coats. They stick to the body of the insect and so get carried from the anther of one flower to the stigma of another flower when the insect moves from flower to flower. Some examples of the many flowers that are pollinated by insects are rose, apple, pea and bean flowers.

Wind-pollinated flowers are usually small. They have very small petals or none at all. There is no scent or nectar. Many small light pollen grains with a smooth surface are produced by the large anthers. They are carried by the wind to the feathery stigma of another flower. Examples of flowers pollinated by the wind are grass, sweetcorn, and oak-tree flowers.

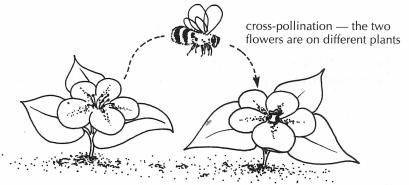


The two main types of pollination are self-pollination and cross-pollination.

Self-pollination occurs when pollen is carried to the stigma of the same flower, or of a flower on the same plant.

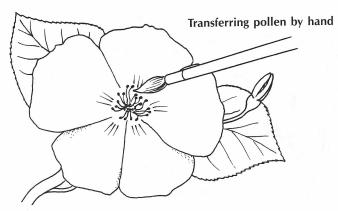


Cross-pollination occurs when pollen is carried to the stigma of a flower on *another* plant.



Many types of fruit, especially apples, plums and pears, must be cross-pollinated. You need two suitable plants that flower at the same time for cross-pollination.

Sometimes people can help the pollination process. They can transfer pollen to stigmas by hand, using a small paintbrush. This method may be used for pollinating roses.



Another method is to spray pollen that has been collected onto female flowers. This method is used for kiwi fruit.

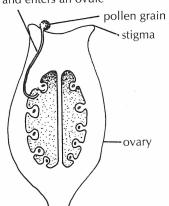
Questions

- 1 What is pollination?
- 2 What do the pollen grains of insect-pollinated plants look like?
- 3 Give an example of a plant whose flowers are pollinated by insects.
- 4 Give three differences between wind- and insect-pollinated flowers.
- 5 Give an example of a plant whose flowers are pollinated by the wind.
- 6 How is self-pollination different from cross-pollination?

Fertilisation

After pollination a pollen tube grows out from the pollen grain. It grows down from the stigma into the style and then into the ovary where it goes into an ovule. The process of **fertilisation** occurs when a male cell from the pollen tube fuses with the female egg in an ovule. After fertilisation the ovules turn into seeds and the ovary becomes the fruit. The rest of the flower dies.

pollen tube grows down the style and enters an ovule

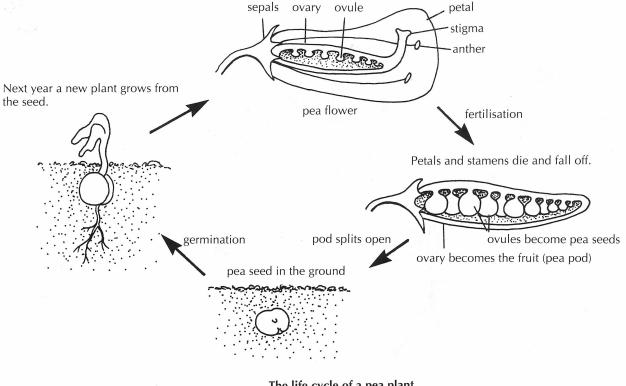


Questions

- 1 What happens to the pollen grain after it lands on the stigma?
- 2 When does the process of fertilisation occur?
- **3** What do ovules become after fertilisation?
- **4** What does the ovary become after fertilisation?
- 5 What happens to the stamens and petals after fertilisation?

The life cycles of flowering plants

At first the young flowering plant grows quickly. It gets bigger and it stores food. Then it produces flowers, followed by fruit and seeds. When the seeds germinate, the cycle starts again.



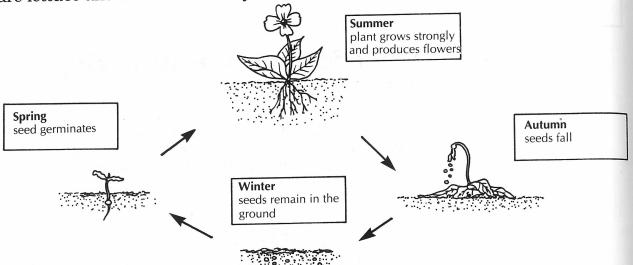
The life cycle of a pea plant

You can put flowering plants into three main groups depending on how long they take to complete their life cycle. The groups are annuals, biennials and perennials.

Annuals

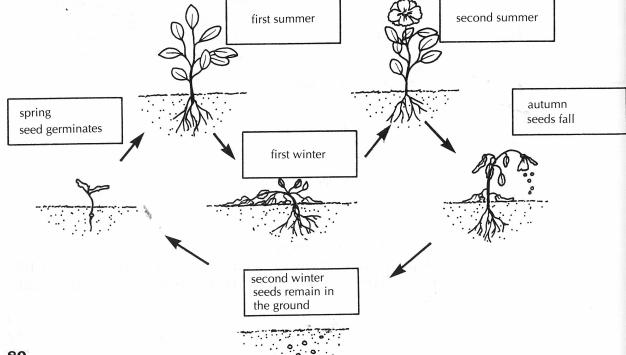
An annual is a plant that completes its life cycle within one year and then dies.

Examples of flowering plants that are annuals are petunias, marigolds and zinnias. Vegetable examples are lettuce and sweetcorn. Many weeds are annuals.



Biennials

A biennial is a plant that completes its life cycle in two years. In the first year the plant grows and stores food. In the second year flowers and seeds form. Then the plant dies. The foxglove is a flower plant that is a biennial. Vegetable examples are carrots, parsley and silverbeet.

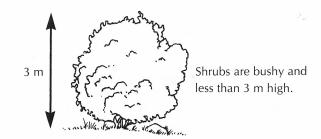


Perennials

A perennial is a plant that grows for more than two years. Perennials do not die after flowering and seeding. They keep on growing for as long as the climate and garden conditions are suitable for them. Perennial plants are divided into two groups.

- 1 Herbaceous perennials have soft, non-woody stems. They usually die down close to the ground at the end of each growing season and then grow new stems and leaves at the start of the next growing season. Examples of flowering plants that are perennials are peonies and chrysanthemums. Asparagus is an example of a vegetable that is a perennial. It grows up freshly from its roots each spring.
- 2 Shrubs and trees have woody stems. A shrub is usually bushy and less than 3 metres high while a tree is usually taller than a shrub and has one single main trunk.

Trees and shrubs vary in the age of the growth on which flower buds are produced and in the time of the year when they flower. For example, pear trees produce flowers and then fruit on wood that is two years old. while raspberry bushes produce them on newly formed wood. When pruning fruit crops you have to know on which wood the flowers will be produced so that you do not remove too much of the flowering wood.



Questions

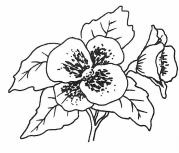
- 1 What is an annual?
- **2** Give two examples of flowering plants that are annuals.
- 3 How long do biennials take to complete their life cycle?
- 4 Is parsley an annual or a biennial?
- 5 How long do perennials grow for?
- **6** What sort of stems do herbaceous perennials have?
- 7 Give an example of a vegetable plant that is a perennial.
- **8** What are two main differences between trees and shrubs?
- **9** What must you know about the flowers when pruning fruit crops?

Plant breeding

Plant breeders are always working to provide improved annuals, biennials, and perennials for gardeners.

For annuals they try to obtain better growth, increased disease resistance, a wider range of colours, more uniform seedlings and better weather resistance.

For biennials they try to develop speeded-up strains that will perform like annuals by completing their growth cycle in one year.



brighter colours



speeded-up strains

For perennials they try to breed showier and hardier plants.



showier plants

Use of annuals and perennials

Annuals were once used mainly as **bedding plants**. They were planted in beds in groups or patterns. Perennials were mainly used in borders edged by lawns or paths. These days annuals and perennials are often planted together to give a garden that gets colour from the annuals and interesting detail from the perennials.

Questions

- 1 What are three ways in which plant breeders are trying to improve annuals?
- 2 How are plant breeders trying to change biennials?
- 3 How can a garden benefit from having both annuals and perennials planted in it?

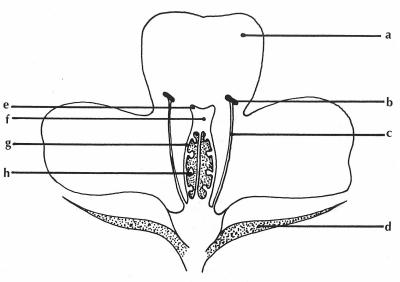
REVISION QUESTIONS

1 Copy and complete this paragraph using the words from the list below. A flower is pollinated when . . . is carried from an . . . to a . . . A pollen tube grows out from the pollen grain and down the . . . until it reaches

tube grows out from the pollen grain and down the . . . until it reaches an ovule. When the male cell joins with a female cell in the ovule, the ovule is . . . The ovule then becomes a . . . and the ovary becomes the . . .

STYLE	POLLEN	FERTILISED	SEED	STIGMA
ANTHER	FRUIT			

- 2 Explain clearly the difference between annuals, biennials and perennials.
- 3 Copy this diagram of a flower and put the correct labels on it.



- 4 Draw a diagram to show the life cycle of a biennial.
- 5 Copy this list of plants. Beside each plant say whether it is an annual, biennial or perennial.

lettuce

chrysanthemum

carrot

sweet corn

petunia

asparagus

silverbeet

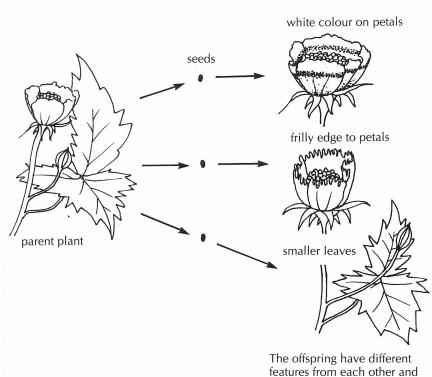
zinnia

13: Seeds

Seeds are formed as a result of **sexual reproduction**. Each seed comes from an **ovule** that has been **fertilised** by a **pollen grain**.

Raising plants from seed

The seed contains a complete set of instructions for the plant that will grow from it. Carrot seeds can grow only into carrot plants and violet seeds can grow only into violet plants. However, the seedlings that grow from seeds may not be *exactly* identical to the parent plant because all ovules are slightly different from each other and so are all pollen grains.



This fact is important for **plant breeders**. They can select the plants they prefer from the many they grow from seed. Then they continue breeding from the plants they have selected. They destroy the plants they do not want. For example, rose plants have been bred using this method to have larger flowers, brighter colours, deeper scents and fewer prickles than other roses. Raising plants from seed has the following advantages.

the parent plant.

WORD LIST

ANNUALS plants that grow, seed and die within a year COTYLEDONS structures in the seed that store food

DICOTYLEDON a plant whose seeds have two cotyledons

DISPERSAL when seeds are carried away from the parent plant

FERTILISED male and female sex cells have joined

GERMINATION when the seed begins to grow into a seedling

OPTIMUM TEMPERATURE most suitable temperature

OVULE part of a flower containing the female sex cell

OXYGEN the gas needed for respiration

PLANT BREEDERS people who produce new varieties of plants

POLLEN GRAIN the male sex cell of a plant

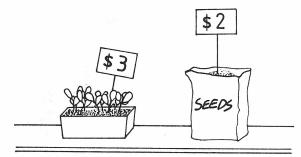
PROPAGATION the production of new plants

RESPIRATION chemical reactions inside living cells that give energy to them

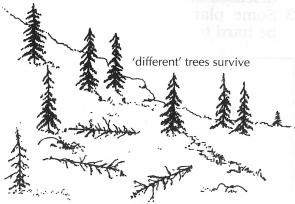
SEXUAL REPRODUCTION
reproduction in which male
and female sex cells join
VIABLE able to germinate

VIRUSES disease-causing micro-organisms, smaller than bacteria

1 It is often simpler and cheaper than other methods of **propagation**.



2 Because plants raised from seed are all slightly different from each other they are less likely to *all* be destroyed by a new pest or disease The strongest will survive. This is especially important in forestry work.



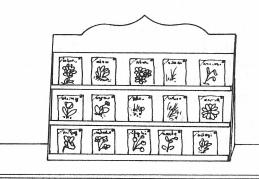
new disease kills some trees

3 Seed is usually easy to transport and store.





4 You can get a good choice of plants if you buy seed.

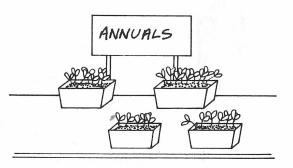


5 Seed is usually free of pests and diseases, especially **viruses**.



disease-free plant grew from seed

6 Some plants, for example, **annuals**, can be raised only from seed.



There are three main disadvantages when growing plants from seed.

1 Seedlings usually all vary slightly from each other and from the parent plant, so you cannot be exactly sure of what your new plants will be like.

2 Conditions must be kept very clean so pests and

diseases do not attack growing seedlings.

3 Some plants do not produce seed, or the seed may be hard to get.

Questions

1 What sort of reproduction forms seeds?

2 Why are all seedlings that grow from seeds not exactly identical to the parent plant?

3 Name two special features that have been bred into rose plants by raising

them from seed.

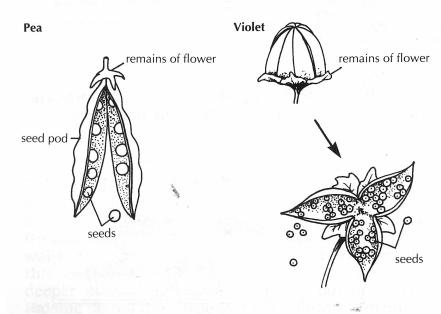
4 What are three advantages of growing plants from seed?

5 What are two disadvantages of growing plants from seed?

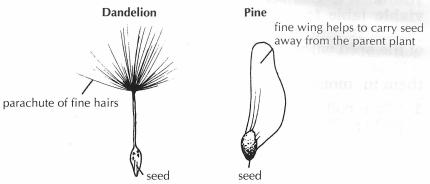
Seed dispersal

In nature, seeds must be carried away from the parent plant. This is called **dispersal**. If the seeds are dispersed away from the parent plant they will have enough light, water and space to grow next year. There are three main ways seeds can be dispersed.

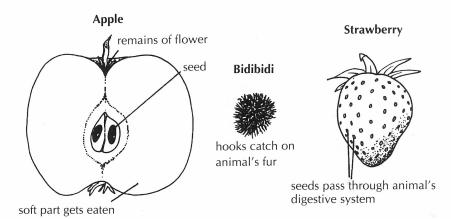
1 By the plant itself. When the seed pod dries it splits open. This scatters seeds away from the plant.



2 By the wind. These seeds are usually very light. They may have special structures to catch the wind.



3 By animals. Animals (and people) eat soft parts of fruits and leave the seeds behind. Sometimes the seeds go through the digestive system of an animal without being harmed. Some seeds catch on fur or clothing and are carried around in this way.



Questions

- 1 Explain why seeds are dispersed.
- 2 How does a violet plant disperse its seeds?
- **a** Name two plants that use the wind to disperse their seeds.
- **b** Explain how their seeds are suited to wind dispersal.
- 4 a How can animals help to disperse seeds?
 - **b** Name two plants that have their seeds dispersed by animals.

Harvesting seed

If you want to harvest seed for later use you may have to protect it from birds or animals by using netting. If it is seed that is dispersed by wind or by the plant itself you must pick it promptly when it is ripe.

Drying and storing seed

You need to give seeds conditions that will keep them **viable** (able to germinate) at the end of the storage period. To do this you must slow down the life processes of the seed without hurting the small plant inside.

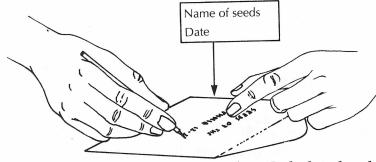
First dry the seeds in a warm dry place. Then keep them in moisture-proof containers in a cool dry place.

1 When collecting seeds bunch the flower stems together.





2 Hang them in a dry airy place in a paper bag, so the seeds will fall out.



3 Place the seeds in a paper packet. Label it clearly and store it in a cool dry place.

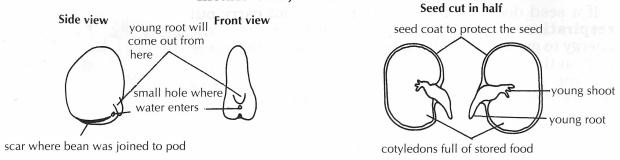
Questions

- 1 How can you protect seed that you want to harvest from being eaten by birds or animals?
- 2 What must you do to seeds to keep them viable?
- 3 What sort of place is best for drying seeds?
- 4 What sort of place is best for storing seeds?

Seed structure

The seed is really a young plant held inside a hard coat with a food supply.

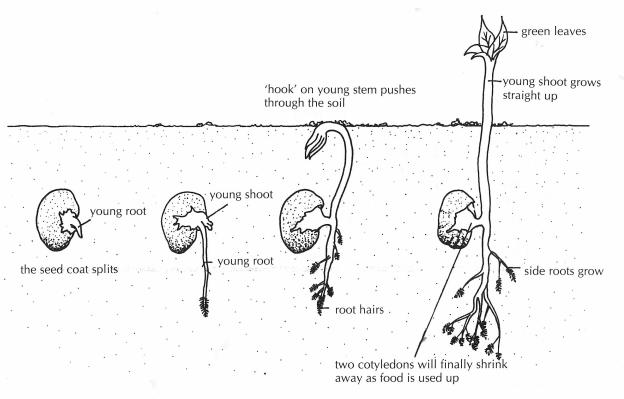
Example: broad bean seed. Food is stored in the **cotyledons** or seed leaves. A broad bean seed has two cotyledons. It is therefore called a **dicotyledon** ('di' means 'two').



Germination

Germination takes place when a seed grows into a seedling. For a broad bean it takes about eleven days from when the seed is planted until you see the young shoot come out of the ground.

Different kinds of seeds take different amounts of time.



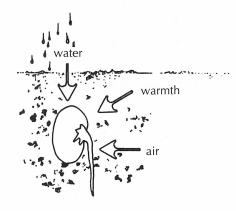
Conditions needed for germination

There are three things seeds need to germinate. They are water, air and warmth.

Before the seed can germinate, water must enter it. Water makes the seed swell so the coat splits. Water also starts chemical reactions inside the seed. The chemical reactions make the root and shoot grow.

If a seed does not have **oxygen** it cannot carry out **respiration**. If it cannot respire it will not have the energy to grow. Well cultivated soil has lots of air spaces in it so there is plenty of oxygen.

Some seeds can germinate at cooler temperatures than others, but all seeds have an **optimum temperature** for germination. Most seeds are killed by very high temperatures. Seeds do *not* need light to germinate and they do not need nutrients from the soil at first because all the food they need to begin growth is stored inside them.

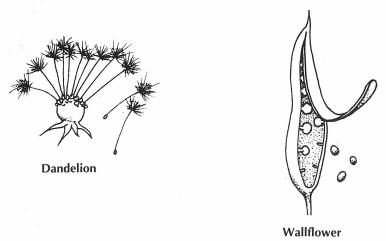


Questions

- 1 Where in a broad bean seed is food stored?
- 2 Why is a broad bean called a dicotyledon?
- 3 What does the seed coat on a broad bean seed do?
- 4 How does water get into a seed for germination?
- 5 Which part of a seed grows first: the young root or the young shoot?
- 6 Name three things seeds need to germinate.
- 7 Why must a seed have water before it can germinate?

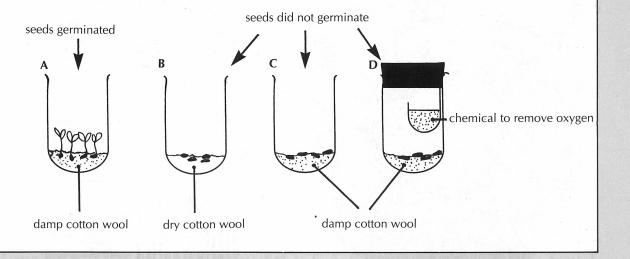
REVISION QUESTIONS

- 1 Give two examples of fruits that disperse their seeds by splitting open a pod.
- 2 These diagrams show two different types of seed dispersal.



Explain why the seeds of the dandelion will be dispersed further away from the parent plant than those of the wallflower.

- 3 Make a clear, labelled drawing of a seed to show as many parts as possible.
- **4** Write a paragraph to explain the advantages and disadvantages of raising plants from seed.
- 5 Why did some of the mustard seeds used for an experiment not germinate? Tubes **A**, **B** and **D** had been kept in a warm room for 10 days. Tube **C** had been kept in a refrigerator for 10 days.



14: Growing plants from seed

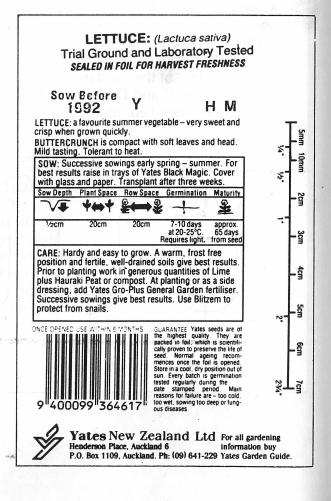
This is an inexpensive and important method of raising plants.

The seed packet

When you buy seeds from a nursery or garden centre they are usually in a sealed packet. Check the date on the packet to make sure that the seeds are not too old to germinate. Then follow the instructions on the packet. These will tell you how deeply to plant the seeds and the space that is needed between the growing plants. They will also tell you if any special conditions are needed and the sort of care you should give the young plants.

This is an example of a seed packet. It contains seeds of the small lettuce called Buttercrunch.





Questions

- 1 What is the scientific name for this sort of lettuce?
- **2** Why are the seeds sealed in foil?
- 3 Before what date should the seeds be sown?
- 4 Describe a Buttercrunch lettuce.
- 5 How deep should you sow the seeds?
- 6 How far apart from each other should the young plants grow?
- 7 What special condition do these seeds need for germination?
- 8 How long does it take for a mature lettuce to grow from seed?
- **9** What sort of care should you give these plants?
- 10 How long will the seeds remain viable once the packet is opened?

Sowing seeds

You can sow seeds directly outside or you can raise them in containers in a protected place, for example, a **green-house**, **cloche** or **cold frame**.

Sowing seeds directly outside

First make sure that the soil has been cultivated to a fine **tilth**. Small seeds, for example, those of lettuce and carrots, are sown in a shallow trench called a **drill**.

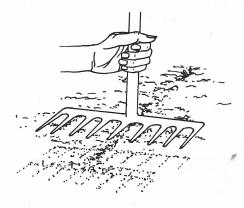
To make a drill you stretch a garden line between pegs at each end of the row. Then pull the corner of a hoe along the line to make a V-shaped drill. The drill should be twice as deep as the size of the seed.

Water the bottom of the drill and let the water drain away. Then sprinkle the seeds thinly and evenly along the drill.

Cover the seeds with fine soil using a rake and tap the soil lightly down with the back of the rake.

Label each row with the name of the plant and the sowing date.







Large seeds, for example, beans and sweetcorn, should be carefully spaced so that the plants will be the correct correct spacing for distance apart when they have grown. You can either make a drill or you can use a dibber or a trowel to make a hole for each seed. If you plant two or three seeds at each position at least one should grow. The others can be removed if necessary.



Questions

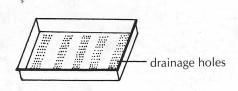
- 1 How should the soil be cultivated before you plant seeds outside?
- **2** What is a drill?
- 3 Explain how you would use a garden line and a hoe to make a drill.
- 4 How deep should the drill be?
- 5 What two details should you write on the label for the row?
- 6 Give an example of a plant that has small seeds that are sown thinly in a drill.
- 7 Give an example of a plant that has large seeds.
- 8 Why do you carefully space large seeds when planting them?
- **9** What tool could you use to make a hole for a large seed?
- 10 Why might you plant two or three large seeds in one place?

Sowing seeds in containers

Seeds that are difficult to germinate, or grow into very delicate seedlings that need special care, are usually sown in containers and placed in a controlled environment to help them grow. You try to give the seeds conditions that are ideal for germination, especially air, water and the correct temperature.

For raising seedlings you use a **medium** containing peat, bark or sawdust. The medium should be quite fine so that small roots can grow into it easily. It must not contain any weed seeds or disease organisms.

You put the medium in wooden or plastic boxes called trays or flats. Wooden trays are cheaper but plastic trays are easier to clean. Make sure there are drainage holes in the bottom of the tray so that too much water does not prevent germination.



WORD LIST

CLOCHE a small tent-like glass or plastic structure COLD FRAME a large box with a hinged lid of glass or

clear plastic

DIBBER pointed wooden tool used to make holes

DRILL a shallow trench made in a line in the soil to put seeds in

FLAT a wooden or plastic box used for raising seedlings

FLOAT a piece of flat wood with a handle

GREENHOUSE a building of glass or clear plastic

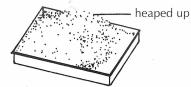
HUMID air that contains moisture

MEDIUM a mixture of materials used for growing in containers

SIEVE fine mesh to pass medium through to make it

TILTH finely broken up soil TRAY a wooden or plastic box used for raising seedlings

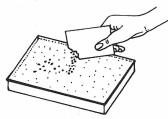
TROWEL tool used for making small planting holes



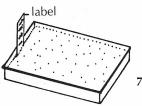
1 Fill the seed tray with medium until it is heaped up.



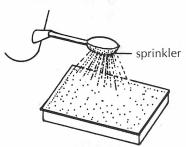
3 Use a **float** to level the medium to the rim of the



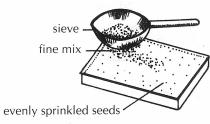
5 Sow seeds thinly and evenly by shaking them out of the seed packet. If you sow too thickly the seedlings will be hard to separate.



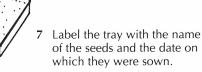
2 Push the medium into the base and corners of the tray.



4 Water the filled tray using a sprinkler. Wait until the water drains away.



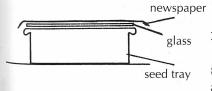
6 If the seeds are very fine do not cover them with seed mix, but if they are larger you can sprinkle them with a mix from a **sieve**. Make a fine, even covering over them.



Place the tray where the temperature will give quickest germination. This will usually be a place that has a warm, even temperature. Keep the tray covered to prevent the medium from drying out too quickly. You can use a sheet of glass covered with a newspaper to do

If the trays are kept in a **humid** environment you do not need to cover them.

Check the tray every day and uncover it as soon as the seedlings are showing, because they will become weak and spindly if left in the dark.



Questions

- 1 What sort of seeds are usually sown in containers?
- 2 What ingredients may be in a medium to be used for raising seedlings?
- 3 Why should the medium be quite fine?
- 4 What is a flat?
- 5 Why are plastic trays better than wooden ones?
- 6 What would you use to level the medium to the rim of the tray?
- 7 Why should you not sow seeds too thickly in the tray?
- 8 Why would you use a sieve to help cover seeds in a tray?
- **9** Draw a diagram to show how you would cover the tray to prevent the medium in the tray from drying out too quickly.
- 10 Why must you uncover the seedlings as soon as they are showing?.

Seed germination problems

Sometimes the seeds you plant will not germinate. This table tells you some of the reasons why the seeds might fail to grow and how to solve the problems. Check the possible reasons if your seeds are not growing.

Possible reason	Effect on germination	How to solve the problem
Soil too firm	Too much water so not enough air	Dig soil deeply when preparing it. Do not cultivate soil while it is wet.
Soil too loose	Too much air, dries out quickly	Push soil particles together before sowing seeds.
Seeds sown too shallow	Seeds dry out	Plant large seeds twice the seed thickness to protect them.
Seeds sown too deep	Not enough air, too cold	Fine seed should just be pressed into the soil surface.
Soil too cold	Too cold for growth	Do not sow too early in the growing season.
Soil too hot	Seeds die	Provide shading if needed.
Soil too dry	No germination	Provide constant water to keep soil damp but not wet.
Soil too wet	Not enough air — soil diseases can attack seeds	Drain soil or add organic matter to it.

REVISION QUESTIONS

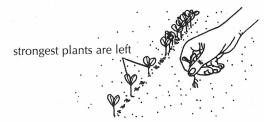
- 1 What are the three main conditions seeds must have in order to germinate?
- 2 You have been given some seeds of a very rare plant that has fine delicate seedlings. Would you plant them in a container or in the open ground? Explain your answer.
- 3 How can you prevent the medium in a seed tray from drying out?
- 4 A person who was trying to save money kept reusing the same seed raising mixture for batch after batch of seedlings. Explain why this was not a wise thing to do.
- A girl planted some pea seeds in the open ground. She made sure they were at the correct depth and gave them the right amount of water but they did not germinate. Suggest *two* possible reasons *and* for each say how she could solve the problem.

15: Care of seedlings

Once the seeds have germinated the young **seedlings** need to be helped to grow. How you do this depends on the type of plants you are growing and how the seeds have been sown.

Thinning

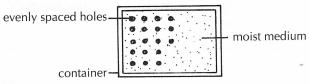
Most seeds that have been sown outside in a drill produce more seedlings than needed. The unwanted seedlings should be removed as soon as possible. Pull them out carefully by hand, leaving just the strongest ones at the correct spacing. Water the seedlings after **thinning** them out. If you allow them to stay overcrowded the seedlings will become long and weak. Then it will be easy for disease organisms to attack them.



Pricking out

Overcrowding must also be prevented with seedlings that have been grown in containers. **Pricking out** is the term given to the first transplanting of the tiny seedlings. It gives each seedling enough space and nutrients to grow. The best time to do it is as soon as the seedlings are big enough to handle, because least damage is done then. Seedlings are usually pricked out when they have grown two to four true leaves. At this stage the roots of the seedlings should not be tangled with each other.

You can prick out singly into pots or evenly into trays. Put the medium in the trays in the same way as for sowing seeds but make sure that there are enough **nutrients** in the medium for the seedlings to grow to the planting stage. The medium should be moist but not too wet. Make holes in the medium with your finger or with a small stick, called a **dibber**.



WORD LIST

COLD FRAME a large box with a hinged lid of glass or clear plastic

COTYLEDONS the seed 'leaves'

DAMPING OFF disease of seedlings cause by fungi

DIBBER small wooden tool used for lifting seedlings and making holes

FUNGI organisms with thread-like cells

HARDEN OFF gradually expose a plant to outdoor conditions

NUTRIENTS substances needed by plants for growth

PEAT POT pot made of compressed, partly decayed plant matter

PLANTER BAG plastic bag used for growing plants

PRICKING OUT moving seedlings from their first container to another with more space

SEEDLING young plant that has grown from a seed

THINNING removal of some plants from a row to leave room for others

TRANSPLANT plant a young plant in its final growing position

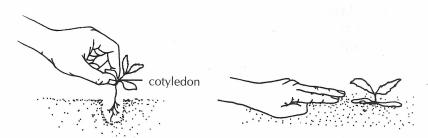
WILTING leaves and stems partly collapsing and drooping

dibber
two true leaves
cotyledon (seed leaf)
well-developed root system

Ease the seedlings out of the tray with a flat piece of wood slid under the roots or with your dibber.

Hold the plant gently by the **cotyledons** (if present) to prevent damage to the stem while you are putting it into the hole.

Firm the medium around the roots with your fingers. The lower leaves should be just above the medium surface.



Do not use any of the seedlings that look weaker than the rest. Try to put seedlings of the same size into the same container so that they will all be ready to transplant at the same time when they have grown.

Water the seedlings lightly: heavy watering might flatten them. Keep them in a lightly shaded place for a few days until they have recovered from having their roots disturbed and are growing strongly.



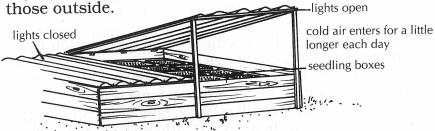
Questions

- 1 What happens to seedlings if they become overcrowded?
- 2 Why should seedlings grown outside be thinned out?
- 3 What term is given to the first transplanting of seedlings that have been grown in containers?
- **4** When is the best time to prick out seedlings?
- 5 Draw a seedling that is ready for pricking out.
- **6** What must you put in the growing medium to help seedlings to grow to the planting stage?
- 7 What garden tool can you use for pricking out?
- 8 What part of the seedling should you hold when pricking out?
- **9** Why should you not water small seedlings too heavily?

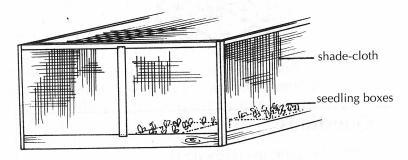
Hardening off

Seedlings growing in containers are usually placed in a controlled environment, for example, a greenhouse. This gives the seedlings good conditions in which to develop into healthy plants with strong root systems. When they are big enough they can be transplanted into their final growing position, but conditions outside may be so different from the conditions in the greenhouse that the plants would die if put outside suddenly. When we **harden off** seedlings we *slowly* expose them to outdoor temperatures and light conditions so the plants can get used to them.

In winter, plants can be hardened off in a **cold frame**, which has its lid or 'lights' opened for a little longer each day until conditions inside the frame are the same as



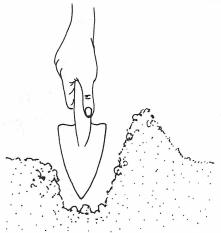
In summer, when it is warmer, the containers can be placed in a semi-shaded place outside, for example, a shade-house. The seedlings should stay there for a day or two before they are transplanted.



Transplanting

When the seedlings have been hardened off and are growing strongly they can be planted into their final growing places. This is called **transplanting**. They may be planted out in rows if they are vegetables, or in groups or rows if they are flowers. If you follow these rules you will not upset the growth of the plants.

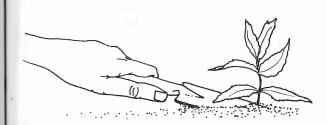
1 Water the plants the day before transplanting. This helps them to be full of moisture when you plant them. It also helps to hold the medium around the roots when you take them out of the container.



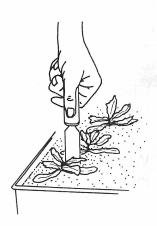
2 Make the planting hole deep enough to take the roots without bending them. Do this with a trowel.



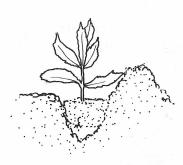
4 Lift each plant out with a block of the growing medium around its roots.



6 Put moist soil, rather than dry surface soil, into the hole and press the soil firmly around the roots.



3 Disturb the roots as little as possible. If the roots of several plants have joined in the container cut between them with a knife.



5 Set the plant in the soil slightly lower than it has been, but do not bury its leaves.

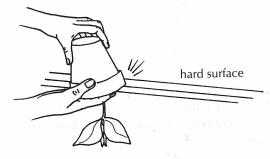
While planting, support the roots in your hand and do not hold the plant by its leaves or stem, because this might damage the plant. Water the plants after planting to help the soil to settle around the roots and then water each day around the bases of the plants until they are growing strongly again.

Questions

- 1 Give an example of a controlled environment.
- 2 What is done when we harden off seedlings?
- 3 How would you use a cold frame to harden off seedlings?
- 4 Where would you place seedlings in summer to harden them off?
- 5 What do you call the process of planting seedlings into their final growing places?
- 6 Give two reasons why you should water plants the day before trans-
- 7 How deep should the planting hole be?
- 8 What tool is used for transplanting?
- 9 How can you separate plants if their roots are joined?
- 10 Explain how to set the plant in the soil.

If the plants you are transplanting have been grown in separate pots you remove the plant from the pot like this:



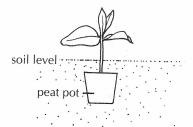


1 Put one hand on top of the pot with the stem of the plant between your fingers.



2 Turn the pot upside down and tap the rim on something hard while still holding the pot.

3 Lift the pot away while you hold the plant with your hand under the roots.



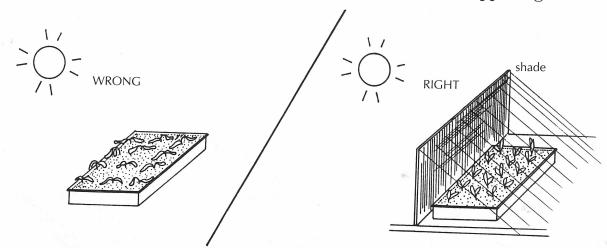
If plants are raised in **peat pots** you should plant the pot with the plant. Make sure the rim of the peat pot is covered by soil.

If plants are raised in **planter bags** made of plastic you cut the bag carefully away from the plant.

Problems

There are two main problems that may occur when you are taking care of seedlings. These are **wilting** and **damping off**.

Wilting happens quickly if the growing medium gets too dry. You must check the medium each day to see that it is moist but not wet. Full sunlight may also cause wilting even if the medium is kept moist, because the delicate seedlings may get too hot. Keep seedlings in a lightly shaded place to prevent this happening.



Damping off is a disease caused by **fungi**. The fungi attack the stem where it enters the medium and quickly spread and kill the plant. To prevent this use clean containers and fresh, disease-free medium for seedlings. Too much water helps fungi to grow, so do not over-water seedlings. A wet, humid environment is most likely to cause damping off.

Questions

- 1 Give the three steps you would go through to remove a plant from a pot.
- 2 What sort of pot do you plant in the soil?
- 3 How do you remove a plant from a planter bag?
- 4 What are the two main problems that may occur when you are taking care of seedlings?
- 5 What causes the disease called damping off?

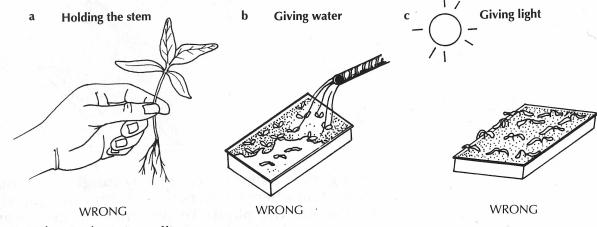
REVISION QUESTIONS

1 Copy and complete the paragraph using the words from the list below.

Seedlings that have been . . . in containers need to be . . . to prevent overcrowding. This gives them the space and . . . they need for growth. You use a tool called a . . . and prick the small plants out into pots or . . . Do not over-water seedlings, because this may help to bring about a disease caused by . . . , called damping off.

DIBBER FUNGI GERMINATED TRAYS PRICKED OUT NUTRIENTS

- 2 A girl planted a row of very fine carrot seeds outside. They germinated and many small seedlings were produced. The seedlings grew quickly and started to become overcrowded. What should the girl do?
- **3** A greenhouse is called a 'controlled environment'. Give three conditions that are usually 'controlled' in a greenhouse.
- **4** Each of the pictures shows a *mistake* being made in the care of seedlings. Draw the pictures showing the *correct* thing to do.



- **5** What is damping off?
- **6** What is the main difference between thinning and pricking out?

16: Stem cuttings

WORD LIST

CONIFER a tree that has cones

DECIDUOUS a plant that loses all its leaves in autumn

ELECTRONIC LEAF a device that automatically switches on a mist unit as needed

EVERGREEN a plant that does not ever lose all its leaves

HARDENING OFF gradually exposing a plant to outdoor conditions

HEATING CABLES electric cable like an element running through a greenhouse bench to provide heat underneath plants

HEEL piece of wood from the parent plant

HERBACEOUS plants that never get woody

HORMONE a chemical that helps growth

MIST UNIT pipes and nozzles with small holes that let out a very find spray of water

NODE the line on a stem where leaves branch out from it

PARENT PLANT the plant from which cuttings are taken

PEAT fibrous plant material used to make the mix more open

PLANTER BAG plastic bag used for growing plants

POTTING UP moving the cutting from where it was grown into a pot

ROOTING MIX the mixture you plant cuttings in

TIP the growing point at the top of a stem

WOUND where a strip of bark has been cut off

A stem cutting is a piece of stem that is cut off the **parent plant** and helped to form roots and shoots. There are four main advantages to growing plants from cuttings.

- 1 New plants are exactly the same sort as the parent plant.
- **2** Many plants can be grown from one parent plant.
- **3** It is quick and simple.
- 4 It does not cost very much.

The main problem when you grow plants from cuttings is that diseases can be carried on from the parent plants. You must make sure that parent plants used for cuttings are free of pests and diseases. Keep knives or scissors used for taking cuttings clean and sharp.

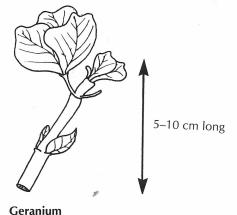
Types of cuttings

Softwood cuttings

You take softwood cuttings in spring and summer.

Herbaceous cuttings are made from soft juicy shoots of plants that never get woody.

Take the cutting from the growing end of a stem and keep the leaves on.



Tip cuttings are made from the young, growing tips of woody plants before they get woody.

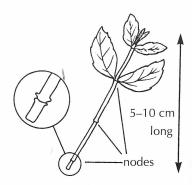
Trim the cutting to just below a **node**. Pull the leaves off the lower half of this sort of cutting to stop it losing too much water. Remove any flowers.

Do not choose *very* soft shoots for softwood cuttings, because they do not contain enough stored food and may die before they form roots.

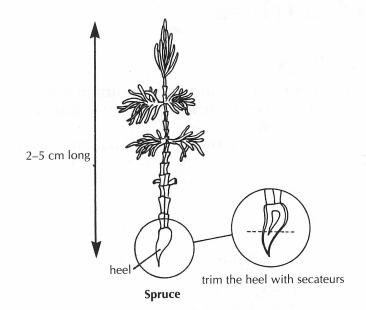
Semi-hardwood cuttings

You take semi-hardwood cuttings in autumn. They are thicker and firmer than softwood cuttings and contain more stored food. Many **evergreen** plants, including **conifers**, can be grown from semi-hardwood cuttings.

Tear the cutting from the parent plant so that a **heel** of the parent plant stays on the cutting. The heel is a piece of wood from the parent plant. The roots will grow from it. Trim the heel and remove some of the lower leaves.



Fuchsia



Questions

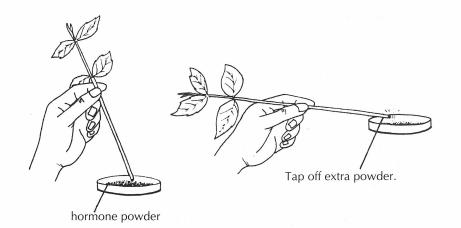
- 1 What is a stem cutting?
- 2 Give one advantage of growing plants from cuttings.
- 3 What is likely to be the main problem when you grow plants from cuttings?
- 4 How long should softwood cuttings be?
- 5 Why should you pull the leaves off the lower part of a tip cutting?
- 6 During which season of the year would you take semi-hardwood cuttings?
- 7 What is a node?

Treatment of softwood and semi-hardwood cuttings

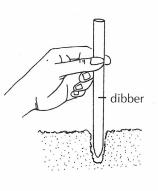
Softwood and semi-hardwood cuttings grow best if they are given the following five things.

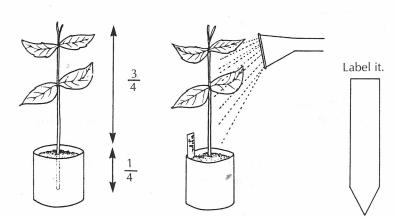
1 Rooting hormones. These are chemicals that help the stem to make new roots. One that is often used is called Seradix. You wet the base part of the cutting, then dip it into the **hormone** powder. Then you tap off any extra powder before you put the cutting in the **rooting mix**.



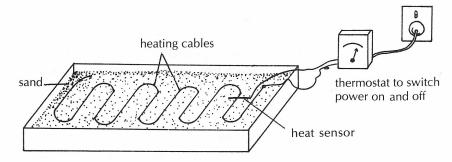


2 Open rooting mix. The mix that you put your cuttings in must contain large particles so that there is plenty of air in it. Young roots need air as well as water to help them grow. A half **peat** and half sand mix is good. Make a hole in the rooting mix with a small dibber. Put the cutting in to about one quarter of its length and firm the mix gently around the cutting. Water it gently. The right mix will drain well but hold adequate water in it. Label the cutting with its name and date.

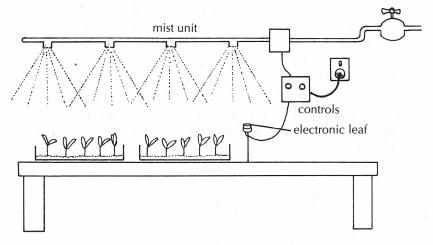




3 Bottom heat. If possible, the base of the cutting should be kept warmer than the leaves. This helps roots to grow but does not speed up water loss from the leaves. You can stand the planted cuttings on a bench that has **heating cables** in it.



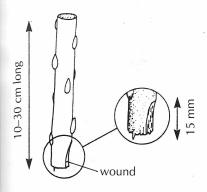
4 Water. Cuttings must never be allowed to dry out, because they have no roots at first. So it is not possible for them to take up much water through their stems. The mix they are in should be kept moist. The air around them should also be kept moist. This helps prevent too much loss of water from the leaves. One way to keep air moist is to use a **mist unit** in a greenhouse. This puts a fine spray of water into the air from time to time. An **electronic leaf** can be put in the same place as the cuttings. When it gets dry it turns the mist on automatically.



If you are rooting only a few cuttings you can tie a plastic bag over them to keep the air inside moist.

5 *Light.* Cuttings need enough light for their leaves to make food to help them grow.





Deciduous hardwood cuttings

You take **deciduous** hardwood cuttings in winter when the plant has no leaves. The cutting should be woody for its whole length. You cut off a hard, woody stem from the parent plant and cut it into pieces.

Use secateurs to make a cut just below a node at the base and just above one at the top. Have at least two nodes between these two cuts. **Wound** the cutting at its base by removing a slice of bark about 15 mm long.

Treatment of hardwood cuttings

Hardwood cuttings do not need special care. You can plant them directly into the soil outside. Plant them with half their length in the soil.

Questions

- 1 How do rooting hormones help cuttings to grow?
- 2 What is a good mix to allow air to get to the young roots of cuttings?
- 3 What tool would you use to make a hole in the rooting mix?
- 4 Why should the base of a cutting be kept warmer than its leaves?
- 5 Explain why cuttings must never be allowed to dry out.
- **6** Draw a diagram to show how you can keep the air around a few cuttings moist.
- 7 Give an example of a deciduous plant that will grow from cuttings.
- **8** What length should you make a hardwood cutting?
- 9 During which season of the year would you take hardwood cuttings?
- **10** What is a wound?
- 11 Why are hardwood cuttings easier to grow than other sorts of cuttings?

How to find out if cuttings have formed roots

There are three main ways that are used to find whether cuttings have formed roots.

- **1** Roots grow out through drainage holes in the pot.
- **2** New leaves begin to grow.
- **3** It is hard to *gently* pull the cutting upwards.

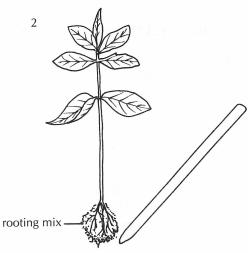
Once a cutting has made new roots it is ready to be **potted up** and **hardened off**.

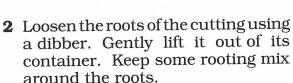
Potting up rooted cuttings

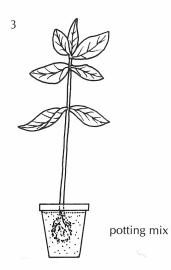
Once roots are forming you can take cuttings away from the special conditions they have been in to help roots grow. You can put them in the greenhouse while the root systems grow bigger. Then carry out the following steps.

1 Put moist potting mix into the bottom third of a suitable-sized pot or planter bag.









- **3** Place the cutting in the new pot or bag and add more potting mix. Firm the mix gently around the roots.
- 4 Put the pot or bag in the greenhouse and water it well.

Hardening off

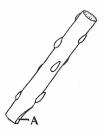
Plants need time to get used to outdoor conditions. After they have been in the greenhouse for a few days they should be placed in a shade-house or cold frame for a few more days then moved to their final growing places. The shade-house helps them to adjust to the outdoors.

Ouestions

- 1 What are the three main ways that are used to find whether cuttings have formed roots?
- 2 What is the first step when you are potting up a rooted cutting?
- 3 Where can you harden off plants?

REVISION QUESTIONS

- 1 Name four things that will help cuttings to grow.
- **2** Here are two types of cuttings. Name the parts labelled A and B.





- 3 Make a diagram of a tip cutting. Show how many leaves you would have on it and how long it should be. Label the nodes.
- **4** Copy and complete this table:

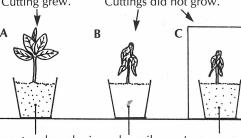
Type of cutting	Season of year	Length of cutting	Example
Herbaceous (softwood)	?	5-10 cm	?
Tip (softwood)	Spring and summer	?	Fuchsia
š.	Autumn	?	Conifer
Deciduous hardwood	?	10-30 cm	?

5 Copy and complete the paragraph using the words in the list below.

Each type of . . . has its own needs for forming a . . . system. Most cuttings (except . . . cuttings) require an environment that gives them . . . temperature, adequate light, and a . . . atmosphere. They like a rooting mix that is moist, free-... and contains plenty of ... to help roots grow.

ROOT AIR **CUTTING DRAINING** HUMID **DECIDUOUS HARDWOOD** WARM

- 6 Make a labelled diagram to show a mist unit in a greenhouse. What 'tells' it when to turn on?
- 7 What are the four main advantages of growing plants from cuttings?
- 8 Explain why some of the cuttings used for an experiment did not grow. Pots A and B were kept in a greenhouse for ten days. Pot C was kept in a dark cupboard. Cuttings did not grow. Cutting grew.



9 What is 'hardening off'?

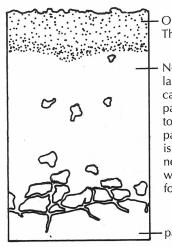
damp peat and sand mix dry soil

17: Soil

Soil is being made all the time. It is made from rock covering the earth's surface. This rock is broken into smaller pieces over vast periods of time by rain and wind and strong sun and frost.

Soil profile

If you dig a deep hole in the soil you will find that it is not all the same but is made of layers.



On top is a dark layer of **topsoil**. This is where most plants grow.

Next comes a lighter-coloured layer of clay and sand particles called the **subsoil**. This contains particles washed down from the topsoil and weathered from the parent rock. Beneath the subsoil is hard parent rock. You may need to dig a hole to find out whether an area of soil is suitable for a certain crop.

parent rock

Fertile soil

Plants grow well in fertile soils. A fertile soil is made up of:

- mineral particles (tiny pieces of rock) of different sizes
- **humus**, from the waste substances and dead remains of plants and animals; the more humus there is in soil the darker it looks
- water
- air
- living organisms, such as bacteria, fungi and worms.

WORD LIST

BACTERIA single-celled microscopic organisms

CRUMBS the way in which soil particles stick together DECOMPOSERS bacteria

and fungi

FRIABLE a light crumbly soil FUNGI organisms with

thread-like cells

HUMUS decaying material from plants and animals

LEACHING the washing away of nutrients from soil

LOAM a fertile soil that is a good mixture of sand, silt and clay

MINERAL PARTICLES tiny pieces of rock of various sizes

NUTRIENTS substances in soil needed by plants for growth

ORGANIC plant or animal material

PORE SPACES gaps between soil particles

STRUCTURE the way soil particles clump together in groups

SUBSOIL the layer of soil beneath the topsoil

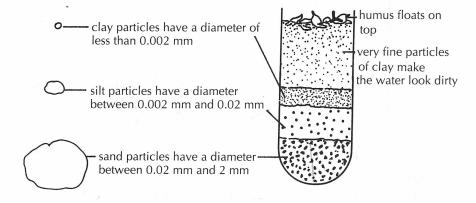
TEXTURE the proportion of sand, silt and clay in a soil

TOPSOIL the top layer of the soil, where most plants grow

What is in soil?

You can see what is in soil if you take equal parts of soil and water and shake them up together in a glass container. When the mixture has settled it will look like this. The mineral particles in soil are named according to their size.

Sand in a soil feels gritty, silt feels silky and clay is sticky when wet.



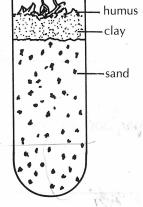
Questions

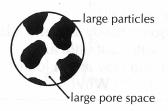
- 1 What five things are in a fertile soil?
- **2** Where does humus come from?
- 3 Draw a diagram to show what a sample of soil looks like when it has been shaken up with water and allowed to settle.
- 4 What diameter are sand particles?
- 5 A sample of soil feels silky when you rub it in your fingers. What does it probably contain?

Soil texture

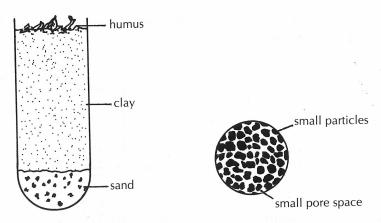
The **texture** of a soil is the proportion of sand, silt and clay that are in it.

Sandy soils contain large particles and have large **pore spaces**. Water moves quickly through the large pore spaces away from plant roots. The water washes **nutrients** out of sandy soils. This process is called **leaching**. Sandy soils contain plenty of air and they warm up quickly in spring.



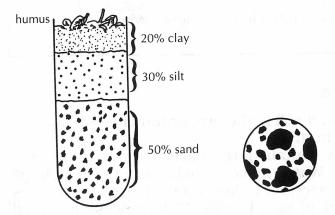


Clay soils contain small particles and have small pore spaces. The small pores hold much water and many nutrients, but little air. Clay soils warm up slowly in spring because they hold so much water that must be warmed up.



Loam contains about 50 percent sand, 30 percent silt and 20 percent clay. The kind of loam depends on how much sand, silt and clay is present. You can have a sandy loam, a silt loam or a clay loam.

Loam has the best features of both sandy and clay soils. It is well drained and contains plenty of air. It also contains plenty of water and the nutrients that plants can use. Loam is the most fertile sort of soil.

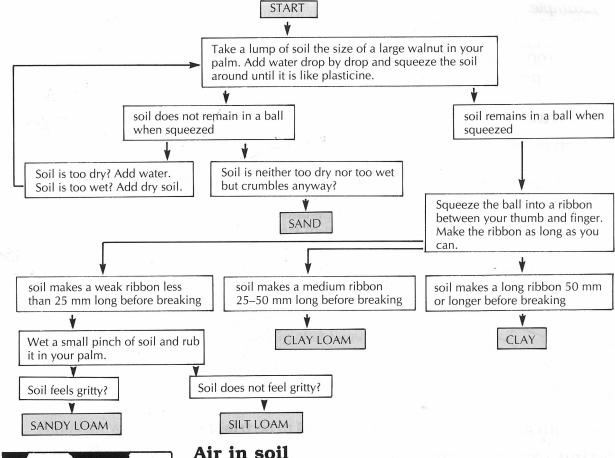


Questions

- 1 What is meant by the 'texture' of a soil?
- 2 Draw a magnified picture of some sandy soil and label the pore spaces.
- 3 What sort of soil holds much water but little air?
- 4 What proportions of sand, silt and clay are in loam?
- 5 Which is the most fertile sort of soil? Why?

Working out soil texture

You can use this flow chart to work out what soil texture you have in your garden. Follow it step by step.



mineral particles

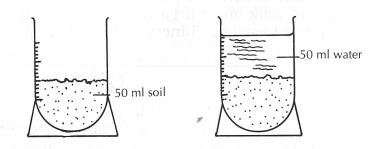
pore space contains air and water

decaying plant material

Air in soil

All soil contains some air in the pore spaces between the particles. Sandy soil has more air than clay soil. You can find out how much air is in a sample of soil by a simple experiment.

- 1 Place 50 ml of soil in a measuring cylinder.
- 2 Add 50 ml of water.
- **3** Shake well, but do not let any water escape.



- 4 Let the mixture settle and read what volume there is.
- **5** Work out the volume of air in the soil sample by subtracting the final volume from 100. This will be a percentage.

Example

- (i) 50 ml of soil and 50 ml of water settled to 98 ml total.
- (ii) 100 98 = 2
- (iii) 2 percent of the soil was air.

Soil structure

Soil **structure** is the way soil particles clump together in groups. In soil with bad structure the particles are packed together very tightly. This is bad for root growth. The best soil for plant growth has a structure in which the particles are held together in groups called **crumbs**. These vary in size from that of a grain of rice to that of a pea.

You can find out if your soil structure is good or bad by dropping a spadeful of soil on a hard surface and

watching how it shatters.

Poorly structured soil remains in big blocks.

Well structured soil has a good crumbly structure.

A soil with good crumbly structure is said to be **friable**.

Caring for soil structure

You can care for soil structure in the following ways.

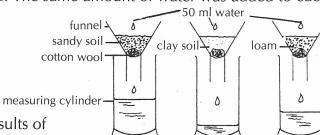
- 1 Add **organic** matter to the soil. This is animal or plant material, for example, straw, which gets worked on by **decomposers** to form humus. The humus helps to stick the mineral particles together in crumbs. You will find more about this in the chapter on soil improvement.
- 2 Do not over-cultivate the soil.
- 3 Try not to walk on your garden in wet weather.
- 4 Do not use heavy machinery on soil when the soil is wet.

Questions

- 1 What is meant by soil structure?
- 2 What size are the crumbs in soil with good structure?
- 3 Give two ways you can care for soil structure.

REVISION QUESTIONS

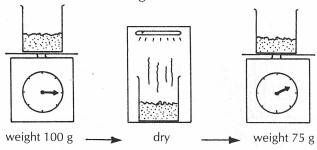
- 1 Give one living part and two non-living parts of the soil.
- 2 What are three differences between clay soils and sandy soils?
- In this experiment the same amounts of dry sandy soil, dry clay soil and dry loam were used. The same amount of water was added to each type of soil in a funnel.



This table shows the results of the experiments:

	Sandy soil	Clay soil	Loam
Total amount of water that drained through in 20 minutes	35 ml	5 ml	20 ml

- **a** Why was the amount of water that passed through each soil different?
- **b** Why was cotton wool put into each funnel?
- **c** What would clay soil be like to dig after heavy rain?
- **d** What could you add to sandy soil to stop the water draining through too quickly?
- **e** Which sort of soil would be best for plant growth?
- 4 Clay soils are not free-draining. What is one disadvantage of this?
- A student wanted to find out how much water a sample of soil contained. She weighed the soil sample on a balance. It weighed exactly 100 g. Then she dried it in an oven until all the water in it was gone. When she weighed it again it weighed 75 g.



- **a** How many grams of water were in the soil sample?
- **b** What *percentage* of water was in the sample?
- **6** Give two ways that poorly drained soil can affect the plants growing in it.
- 7 Why are sandy soils often infertile?
- **8** A student wanted to know how much air was in a sample of soil. He put 50 ml of soil in a measuring cylinder. Then he added 50 ml of water and shook the mixture thoroughly. When it settled he found only 90 ml of soil-water mixture in the measuring cylinder.
 - a How many millilitres of air had been in the soil?
 - **b** What percentage of the soil sample was air?
 - **c** Where had the air gone to?

18: Soil improvement

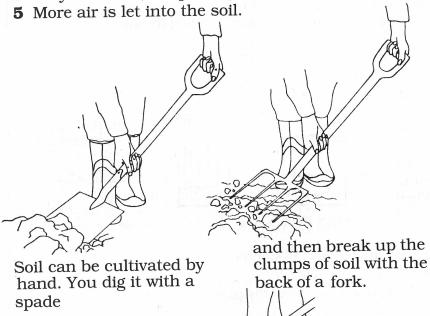
Soil does not always stay the same. It is changed by climate and by the plants that grow in it. You need to take care of the soil and sometimes you need to make it better for growing plants.

Cultivating

Cultivating breaks the soil into smaller pieces. The more you cultivate soil the more you break it up. Finely broken up soil is called **tilth**.

You need to cultivate the soil before planting for five main reasons.

- 1 You can easily make planting holes in loose soil.
- 2 The soil is fine enough to be in contact with the roots.
- **3** Fertilisers spread over the soil can be mixed deep into the root zone.
- **4** Very wet soil is helped dry out.



Finally you rake it to remove any remaining big pieces. 118

WORD LIST

ACID SOIL sometimes called 'sour' soil; organic matter rots slowly in acid soil

BACTERIA single-celled microscopic organisms

COMPOST specially prepared decaying organic matter

DECOMPOSE decay or rot ELEMENTS chemical substances

FERTILISER a substance prepared with the nutrients plants need for healthy growth

FUNGI organisms with thread-like cells

HUMUS decaying material from plants and animals

LEGUMES members of the same plant family as peas and beans

LIME a calcium compound that neutralises acid soil

MANURE organic matter made by animals

MULCH a covering over the soil surface

NITRATES the form in which nitrogen can be taken into plant roots

NUTRIENTS substances needed by plants for growth

ORGANIC animal or plant material

RESPIRE break down food to get energy

ROOT NODULES swellings on the roots of legumes

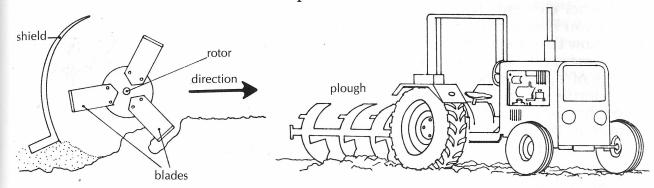
ROTARY CULTIVATOR machinery with blades that cultivate soil as they go around

STRUCTURE the way soil particles clump together in groups

TILTH finely broken up soil

When a lot of soil is to be cultivated it is easier to use machinery. You can use a **rotary cultivator** for small areas of ground or a tractor with a plough fitted to it for larger areas.

You should not cultivate heavy soil when it is very wet because this can cut the soil into lumps that will be hard to break up later.

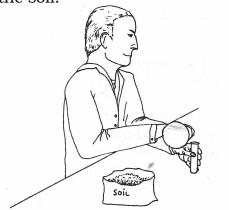


Questions

- 1 What does cultivating do to soil?
- 2 What is finely broken up soil called?
- 3 Give three reasons why you need to cultivate soil before planting.
- 4 What are three tools you might use to cultivate soil?
- 5 Draw a diagram to show how a rotary cultivator works. Label it.
- **6** Why should you not cultivate heavy soil when it is very wet?

Fertilising

Plants need **nutrients** for good growth. Carbon, hydrogen and oxygen come from air and water. Other nutrients are taken up from the soil by plant roots. The **elements** that plants need most are nitrogen (N), phosphorus (P), potassium (K), calcium (Ca) and magnesium (Mg). You need to make sure that there is enough of each of these in the soil.



You can find out what nutrients are in your soil and how much you need to add by having a laboratory soil test done on samples of your soil. A soil test will also tell

you how acid your soil is.

Fertilisers contain the nutrients you need to add to the soil, mainly nitrogen, phosphorus and potassium. These are chemical elements and they are combined with other elements that may or may not be nutrients. When you hear a person talk about 'applying nitrogen' you know that means applying a fertiliser that contains the element nitrogen joined to other elements. The same is true of 'applying potassium' or any other element.

All fertiliser bags show the amount of nitrogen (N), phosphorus (P) and potassium (K) that the fertiliser contains. This is called the NPK rating of the fertiliser. NPK values are always given in the same order. They tell you the number of kilograms of each nutrient in every

100 kg of fertiliser.

For example, urea is a fertiliser with an NPK rating of 46–0–0. This means it has 46 kg of nitrogen, 0 kg of phosphorus and 0 kg of potassium in every 100 kg bag.

Fertilisers should be stored in a dry place so they do

not get lumpy.

When you apply fertiliser over a small area you can carry it in a bucket in one hand and spread it over the soil with the other hand.

You should spread it evenly and at the correct rate. Then cultivate it into the soil to spread it to where the roots grow.

You should not apply too much fertiliser because

- too much fertiliser damages roots
- too much of one nutrient can stop roots taking up enough of another one
- fertiliser is expensive.





Questions

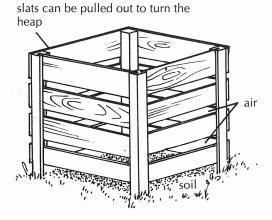
- 1 Which three plant nutrients come from air and water?
- 2 What elements that plants need most are taken up from the soil by plant roots?
- 3 Why do plants need nutrients?
- 4 How can you find out what nutrients are in your soil?
- 5 What do we mean if we talk about 'applying nitrogen' to soil?
- 6 A fertiliser has an NPK rating of 12–5–14. In 100 kg of the fertiliser how many kilograms would there be of **a** nitrogen **b** phosphorus **c** potassium?
- 7 Give three reasons why you should not apply too much fertiliser to soil.

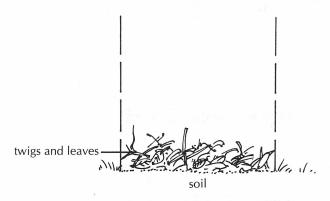
Adding organic matter

Soil needs to have good **structure** so it will hold water and make the water available to plant roots. Soil with good structure also has plenty of air in it. You can improve soil structure by adding organic matter to it. Organic matter also adds nutrients to soil after it is broken down by decomposers to form **humus**.

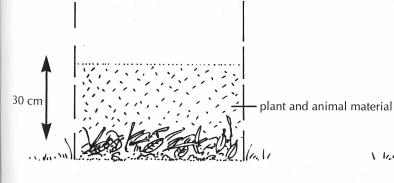
There are three main ways of adding organic matter to soil.

1 You can make **compost** and add it to your soil. For this you need a compost heap.

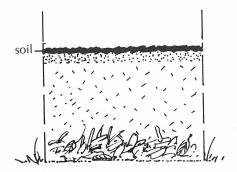




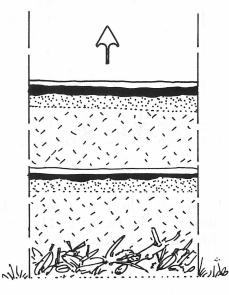
- **a** Use a container that can get plenty of air through it. Stand it directly on the soil.
- **b** First put a layer of coarse plant material like twigs and leaves on the soil at the bottom. This lets the air circulate.



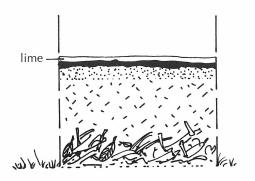
- c Add grass clippings, kitchen rubbish (both plant and animal material) and garden rubbish (but not diseased plants) until the pile is about 30 cm high.
- **d** If you can get some **manure** (sheep or cow manure is good), spread that on top.



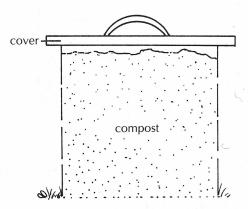
e Next spread a layer of soil over everything. Soil contains the bacteria and fungi that will decompose the material.



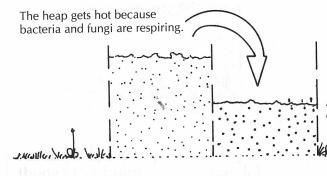
g You can go on building up the heap with these layers.



f A sprinkle of lime on top will stop the heap getting too acid.



h When the bin is full put a layer of soil on top and water it gently. Cover it to keep out rain because too much water will stop the decomposers working.



After 4-6 months the rich brown

i After eight weeks turn the heap into another bin to let air through.

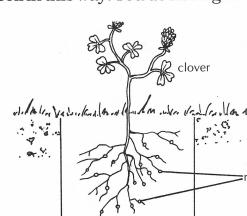
compost is ready to use.

While the material is decomposing the heap gets hot as the fungi and bacteria in it **respire**. The heat kills disease organisms and weed seeds.

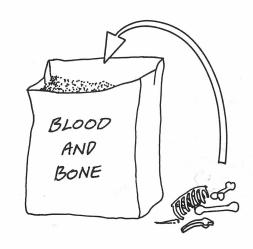
Start filling the first bin again. After four to six months the compost in the second bin will be a rich brown colour and it will have a pleasant smell. Add it to your soil and dig it well in.

2 You can plant a crop of **legumes**. Lupins are often used because they grow quickly. Just before the plants flower you dig them into the soil. As they decompose they add **nitrates** to the soil from their root nodules as well as improving the soil structure.

Even if you do not dig legumes in, the bacteria in the root nodules make nitrates, which go into the soil and improve it. Crops of peas, beans or clover will improve soil in this way. You do not dig these legumes



3 You can add **organic** fertilisers, which have been specially prepared from animal wastes. Examples are blood and bone and sheep manure.



Dig lupins into the soil



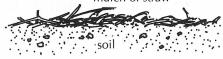
root nodules

Questions

- 1 Give two reasons why soil needs to have good structure.
- 2 What are two good things organic matter does to soil?
- 3 Draw a labelled diagram of a compost heap. Show five layers.
- 4 Why does a compost heap get hot?
- 5 Why do you need large material like twigs in a compost heap?
- 6 What do legumes add to the soil when you dig them in?
- 7 Give an example of an organic fertiliser.

Mulching

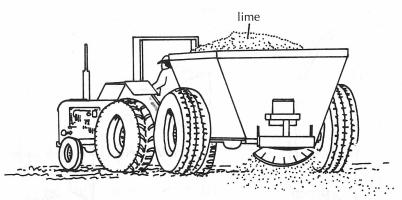
You can spread some organic substances over the surface of the soil without digging them in. This is called a **mulch**.



Useful substances for a mulch include sawdust (but make sure it is not from timber that has been treated with a preservative), bark and straw. A mulch will improve the structure of soil. It also helps keep water in the soil and stops weeds from growing.

Liming

Adding **lime** to soil will make it less acid. You may need to add lime if you have had your soil tested and found that it is too acid. It may also be needed if you want to grow plants that do not grow well in acid soil. Do not put on lime at the same time as fertiliser because they react with each other. Do not add too much lime at one time because it can damage plant roots. Lime encourages earthworms into the soil.

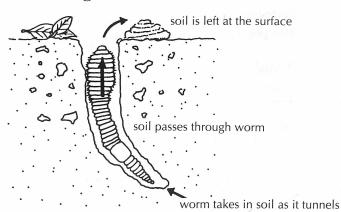


Large amounts of lime are spread using special machinery.

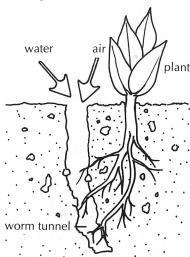
Earthworms

Earthworms are good for soil for four main reasons.

1 They tunnel through the soil. The fine soil that has passed through their bodies is left at the surface as worm casts. These get mixed with other soil.



- **2** Worms drag leaves and other plant material into their tunnels. This rots to form humus, which improves soil structure and adds nutrients.
- **3** When they tunnel, the humus and different layers of soil get mixed together.
- **4** The tunnels they make let air and water in.



Questions

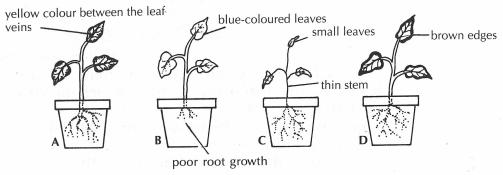
- 1 What is a mulch?
- 2 Give two ways a mulch improves soil.
- 3 What can you add to soil if you want to make it less acid?
- 4 Why should lime and fertiliser not be put on the soil at the same time?
- 5 Draw a diagram to show a worm in a tunnel. Label it.
- 6 How do earthworms help to let water and air into soil?
- 7 Name a substance that encourages worms into your soil.

REVISION QUESTIONS

1 Study the table, which explains what happens when plants have too little of certain elements.

Element	Too little causes	
Nitrogen	Small pale leaves, thin stems	
Phosphorus	Roots do not grow well, leaves look blue	
Potassium	Leaves look brown on the edges	7
Magnesium	Leaves turn yellow between their veins	

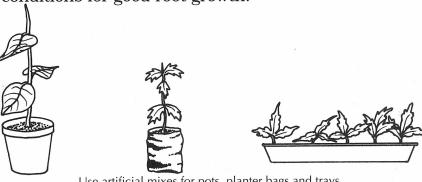
Copy these plant diagrams and beneath each write the name of the element the plant may be needing.



- 2 When you cultivate soil you break it into small pieces. Write a paragraph explaining how this helps plants to grow.
- 3 If a fertiliser has an NPK rating of 14–0–36 what major nutrient is *not* in it?
- 4 What elements needed by plants do the letters Ca and Mg stand for?
- Describe how you should apply fertiliser to a small area of soil.
- 6 A student tried to build a compost heap in his garden. He made a big pile of lawn clippings and added potato and apple peelings and some bones. Then he left it for two weeks. During the two weeks it rained every day. At the end of this time his heap was a mess!
 - a What are two useful things he left out of the heap?
 - **b** How could he have got air into the heap?
 - **c** What effect did the rain have on the heap?
 - **d** Draw a diagram of a better compost heap. Label it.
- Give two examples of legumes that we eat as vegetables.
- 8 Explain why earthworms are good for the soil.
- a How do plants with root nodules improve the soil?
 - **b** Name a plant that has root nodules.

19: Artificial mixes

Soil is not the only thing that plants can grow in. For plants that are growing in containers, for example, pots, planter bags or trays, it is often better to use artificial growing mixes so that you can give the plants the best conditions for good root growth.



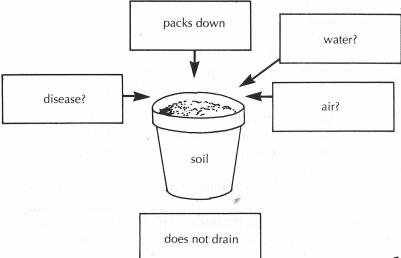
Use artificial mixes for pots, planter bags and trays.

The words **medium** (plural media) and **mix** mean the same: a mixture in which plants can grow.

Why not use soil in containers?

Soil is not the best material for use in containers for five main reasons.

- 1 Soils vary greatly in the amount of water and air they hold.
- **2** Soils vary in the amount of nutrients they contain.
- **3** Soil packs down very firmly in containers. 4 Soil in containers does not drain well.
- **5** Soil may contain disease organisms.



WORD LIST

FERTILITY amount of

nutrients present MEDIUM a mixture in which plants can grow MIX a mixture in which plants can grow PEAT decayed plant material from swamps PERLITE expanded, heated, volcanic material PUMICE powdered volcanic material SLOW-RELEASE FERTILISER fertiliser that releases nutrients over a period of time

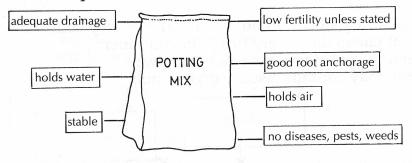
Characteristics of a good artificial growing medium

It is important to have a suitable medium in a container because there is less material for a plant's roots to explore than if it was growing in the open. This means that there are fewer nutrients and less water for the plant to use and not so many pore spaces for the roots to enter.

limited root space

A good container medium should

- provide good anchorage for roots
- allow adequate drainage
- hold enough water and air for the plant
- be free of diseases, pests, weed seeds and poisonous chemicals
- be stable, so that it will not break down while the plant is growing in it
- have low **fertility** so you can add whatever nutrients are required, in the correct amounts.



Questions

- 1 What do the words 'medium' and 'mix' mean?
- 2 Give three reasons why soil is not the best material for use in containers.
- 3 Name three things a container medium should be free of, apart from disease.
- 4 Why should a container medium have low fertility?

A good medium will provide the best conditions for plant growth at a price you can afford to pay.

Ingredients used in mixes

In New Zealand the materials used in container mixes include **peat**, sand, **pumice**, bark, sawdust and **perlite**. One or more of these bulky ingredients are used to support plants and to keep them supplied with water and air. For example, a mix of equal amounts of sand and peat is good for encouraging cuttings to form roots.

The table shows the good and bad points about these ingredients.

and the second s	Particle size	Cost	Weight	Water-holding capacity	Air spaces
Peat	small	expensive	light	very good	good
Ground bark	30-60 mm	cheap	heavy	medium	good
Sawdust	1-12 mm	cheap	medium	poor	quite good
Pumice	small	cheap	very light	poor	very good
Sand	1 mm	fairly cheap	very heavy	poor	good
Perlite	5 mm	very expensive	very light	good	good

Questions

- 1 Name three materials used in container mixes in New Zealand.
- 2 Which two ingredients shown in the table are expensive?
- 3 Which ingredient has very good water holding capacity?
- **4** Which is a very heavy ingredient?

The bulky ingredients of the mix do not contain nutrients, so you need to add fertilisers to supply suitable nutrients. You may also need to add lime if the mix is very acid.

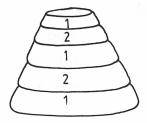
If you are making up media for raising seeds or growing cuttings only small amounts of fertiliser will be needed because the plants stay in them for a few weeks only. For plants that are going to stay in the same medium for a long time you can add **slow-release fertilisers**. These stay in the medium and release their nutrients slowly — over a period of several months or longer.

You can provide nutrients by mixing fertilisers with the bulky ingredients or by adding fertilisers to the water supply.

Mixing materials

If you are making up your own container mixes you must make sure that all materials and fertilisers are well blended before use so that they are evenly spread through the mix.

Combine the ingredients with a spade while they are dry. Then add water until the medium is moist enough to use. Always handle the mix with clean tools and use clean containers. Do not do the mixing on bare earth, because disease organisms may be introduced.



1 Put the ingredients in layers in a heap.



2 Add any fertiliser or lime to the top of the heap.



3 Mix with a clean spade from the bottom of the heap to the top.

4 Repeat the mixing from alternate sides until you can no longer see the layers.

Storage of mixes

Store mixes indoors in a moist condition. Once fertilisers have been added the mix should not be kept for too long because the nutrients may build up in them to levels that will be harmful to plants.

Questions

- 1 Why do you need to add fertilisers to a mix?
- 2 Why do seed-raising mixes only need small amounts of fertiliser?
- 3 How do slow-release fertilisers work?
- 4 Why must all materials and fertilisers be well mixed before use?
- 5 Where should mixes be stored?

revision questions

- 1 Choose the best answer for each of these questions. Copy the question and the correct answer into your notes.
 - (i) Soil is not used by itself in containers because:
 - a it does not contain nutrients
 - **b** it packs down tightly and it drains poorly.
 - (ii) Sand is often mixed with peat to:
 - **a** improve the 'wettability' of the mix and make it heavier
 - **b** sterilise the mix.
 - (iii) Perlite is mined from lava flows and is:
 - **a** very heavy and cheap
 - **b** very light and expensive.
 - (iv) Two ingredients that are often used to make a mix for rooting cuttings are:
 - a peat and sand
 - **b** pumice and perlite.
 - (v) You should store container media:
 - **a** dry, outside
 - **b** moist, indoors.
- 2 List six desirable characteristics of a container medium.
- 3 For three of your answers to question 2 explain *why* they are desirable characteristics for a container medium.
- 4 Imagine you are marketing a new brand of potting mix, specially prepared for rooting cuttings. Design a plastic bag to contain the mix. The words on the bag should tell the customer what is in the mix and why the ingredients are useful. The words on the bag should also give storage instructions for the mix.

20: Watering systems

Plants need water for

- support and shape
- making their food (photosynthesis) and growing
- transport of nutrients
- keeping cool
- germination of seeds.

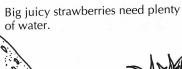
If plants get too little water they will wilt, growth slows down and there will be poor fruiting and flowering. Soil that has too little water is said to be at **permanent wilting point**.

If plants get too much water, leaves may go yellow and fall off, roots will be unable to get air for respiration and may rot, and disease organisms may affect all parts of the plant. Soil that has too much water is called **saturated**.

You need to give a plant the correct amount of water by the best method for that type of plant. Soil that has the correct amount of water is said to be at **field capacity**.

Some plants need more water than others so you need to know the water needs of the type of plants you are growing. For example, strawberries that are to be sold fresh need to be larger than strawberries for jam, so they are more likely to need **irrigation** when the weather is dry.

Big juicy strawberries need plenty





EVAPORIMETER instrument used to measure evaporation of water

holding the optimum amount of water

GERMINATION when the seed begins to grow into a seedling

IRRIGATION giving water to plants

LATERALS side branches of trickle system

MICROTUBE thin end-tube of trickle system

MULCH covering over the soil surface

NUTRIENTS substances needed by plants for growth

PERMANENT WILTING
POINT soil with too little
water so plants wilt

PERMIT written permission POROUS allows water

through

SATURATED soil with too much water in it

STOMATA tiny pores in a leaf

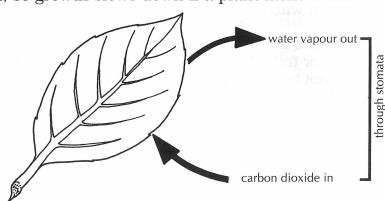
Small jam strawberries need less water.

Questions

- 1 Give three reasons why plants need water.
- 2 Give two things that may happen to plants if they have too little water.
- 3 Give two things that may happen to plants if they have too much water.
- **4** What is saturated soil?
- 5 What is soil called when it has the correct amount of water for the plants in it?

Wilting

Plants wilt when they lose water faster than they take it up from the soil. Before they wilt the small holes in their leaves, called **stomata**, close up. This lets less carbon dioxide in. Carbon dioxide is needed by the plant for growth, so growth slows down if a plant lacks water.

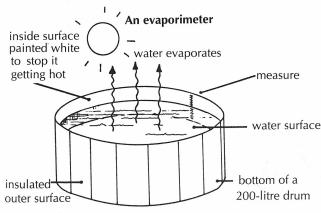


When to give water to plants

There are four main ways of working out when to apply water.



1 How the plants look. This a bad method, because once plants look wilted their growth has already slowed down.



3 Using an **evaporimeter**. You measure the amount of water lost from the drum each day and use this to work out how much has been lost from the soil.



2 The feel of the soil. You need a lot of experience to be accurate with this method.



- **4** Keeping a water budget. To do this you must keep records of
 - **a** how much rain there is
 - **b** how much water is lost from the soil and plants.

The newspaper prints information that can help you keep a water budget.

Water supplies

You can get irrigation water from

- rivers and streams
- wells and bores
- dams
- town water supply.

You need a **permit** to draw on underground or surface water or to build a dam. Town water may cost a lot and may not be freely available in summer when you need it most.

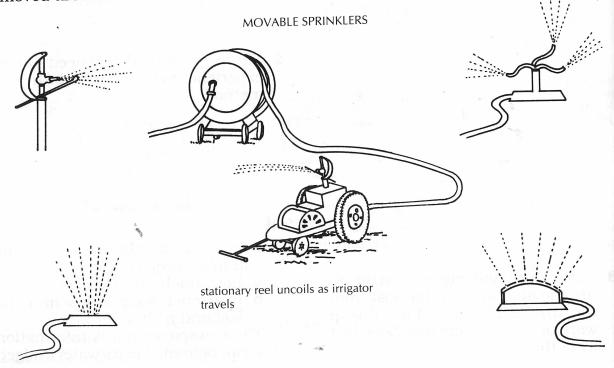
Questions

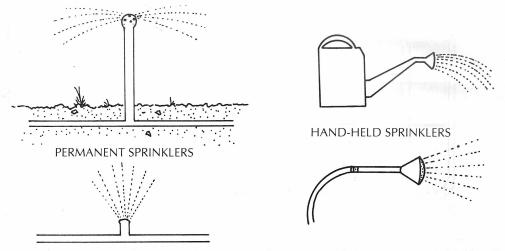
- 1 When do plants wilt?
- 2 What gas enters leaves through the stomata?
- 3 Why is carbon dioxide needed by the plant?
- 4 Why is the *look* of plants a bad method for finding out if they need water?
- 5 How would you use an evaporimeter?
- 6 Give three places you can get irrigation water from.

Watering systems

There are two main types of watering systems: abovethe-crop watering and ground-level watering.

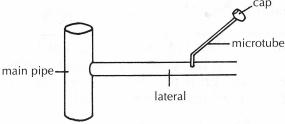
Above-the-crop watering uses sprinklers that are like rain. Sprinklers can be on permanent pipes or may be moved around.



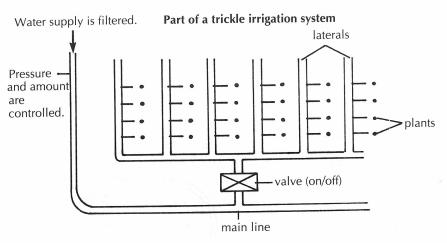


Advantage of sprinklers	Disadvantages of sprinklers
Cheap to set up.	Water is unevenly spread and sprinkled areas may overlap.
	Wetting leaves may help fungi and bacteria to grow and cause disease.
	Only work well if there is enough water pressure.
	Plants and soil can be damaged if too much water is put on.

For ground-level watering, water under low pressure drips onto the ground at a controlled rate. Trickle irrigation has a main pipe of polythene tubing into which are pushed **laterals** (thinner tubing) with lengths of **microtube** (also called 'whiskers') attached. Microtubes may have caps to prevent soil blocking them up.



How fast the water drips out of the microtube depends on the pressure of the water and the length and diameter of the microtubes. Short, wide microtubes and high water pressure give a greater flow than long, narrow microtubes and low water pressure.



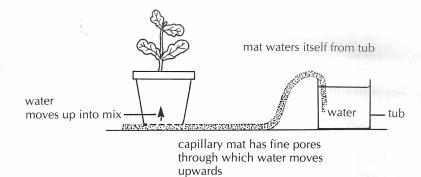
Advantages of trickle irrigation	Disadvantages of trickle irrigation
Only the area needed to be watered gets wet.	Expensive to set up.
Water spreads beneath the soil to the roots.	Blockages can occur.
Less water is used.	
Leaves do not get wet.	
Nutrients can be added to the water.	

Questions

- 1 What are the two main types of watering system?
- 2 Draw an example of a movable sprinkler, a permanent sprinkler and a hand-held sprinkler.
- 3 What is the main advantage of sprinklers?
- 4 Draw and label a diagram to show part of a trickle irrigation system.
- 5 What are microtubes?
- **6** What is the main disadvantage of trickle irrigation?

Drip lines are another type of ground-level watering. The simplest kind is a hose with a **porous** surface that lets water seep through it along its length. Some types have regularly spaced holes along them.

holes let water out of drip line



Capillary matting may be used to water plants in containers from underneath. You place the pots on a wet, spongy mat so that the mix in the pot is in contact with the mat. The mix soaks up water from the mat and stays damp. Special materials that do not rot are used for capillary matting.

Rules for watering home gardens

- **1** Water in the evening or early morning when evaporation from the sun is low.
- **2** Apply enough water, so it penetrates deeply around roots.
- **3** Avoid watering leaves if possible.
- **4** Water *before* planting seeds. If you water after planting, the soil may form a hard surface, which seedlings cannot push through.

Mulching

To keep water in the soil a substance like bark, sawdust or straw can be spread over the soil surface as a **mulch**. This also improves soil structure and helps to prevent weed growth.

Questions

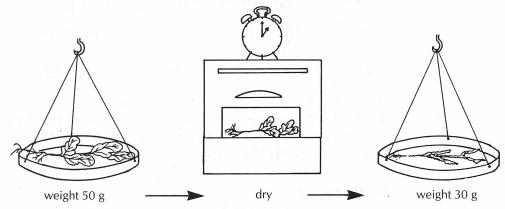
- 1 Describe the simplest kind of drip line.
- 2 Explain how capillary matting may be used to water plants in containers.
- **3** Give three rules for watering home gardens.
- 4 What is an example of a material that can be used as a mulch?

REVISION QUESTIONS

- 1 A friend wants to set up a trickle irrigation system in his garden. Explain the advantages and disadvantages of this system of irrigation.
- 2 A boy wanted to find the percentage of water in a small plant. This was his method:
 - **a** He weighed the plant.
 - **b** He dried it at 100°C in an oven for one hour to get rid of all the water.
 - c He weighed the plant again.

Here are his results:

Weight of plant before drying: 50 g Weight of plant after drying: 30 g



Calculate the percentage of water that was in the plant.

- 3 Draw a diagram to show the parts of a trickle irrigation system. Label the main pipe, lateral, microtube and cap.
- 4 Imagine that there is a water shortage in your area. Write a paragraph explaining how you can make the best use of the small amount of water that you are allowed for the garden each day.

21: Shelter

WORD LIST

condensation water vapour turns to water drops DECIDUOUS a plant that loses all its leaves in autumn GREENHOUSE building that lets light enter for plants HARDEN OFF gradually expose a plant to outdoor conditions HUMIDITY amount of moisture in the air POLYTHENE plastic film

Reasons for using shelter

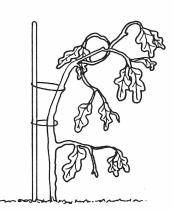
For plants to grow well they need conditions similar to those in their natural environment. Sometimes the conditions in an area may not be suitable for a crop until the grower provides shelter. Here are some of the reasons that shelter may be needed.

To protect plants from wind

New Zealand has a very windy climate. This can cause damage directly to plants, slow down growth, dry out soil and reduce the activity of bees, which pollinate flowers, unless shelter is provided.

To protect plants from too much sun

Some plants, for example, camellias, azaleas and ferns, grow best in shady conditions. Although they need light, too much bright sunlight can be harmful to them. Shelter that lets some light through but provides protection is best.



Frost kills tomato plants.

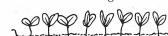
Ferns grow well in shady conditions.

To protect plants from frost

A frost happens when the air temperature falls below 0° C, which is the freezing point of water. Some plants, for example, tomatoes, will die if the temperature falls below a certain point. Ice forms on and in the leaves and kills them. A sheltered environment will protect them and enable frost-tender plants to be grown even in winter.

To help young plants get established

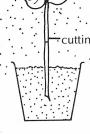
Young plants may need protection from wind, sun and pests until they get big and strong. Shelter will help tender seedlings to grow to the stage where they can be planted outside.





To provide a suitable climate for cuttings

Softwood and semi-hardwood cuttings must never be allowed to dry out and the air around them should be kept moist. This is most easily done in a sheltered environment.



moist air

Questions

- 1 What sort of conditions do plants need if they are to grow well?
- 2 Give three reasons why shelter may be needed.
- 3 What are four bad effects of New Zealand's windy climate?
- **4** What is a frost?
- 5 Why are sheltered environments most suitable for growing cuttings?

Shelter in outdoor areas

Putting shelter around an area of ground has the following good effects.

- 1 It reduces wind speed and moisture loss.
- 2 It increases soil temperature during the day, and so increases plant growth.
- **3** It reduces wind damage to plants.

BUT shelter can also have the following bad effects.

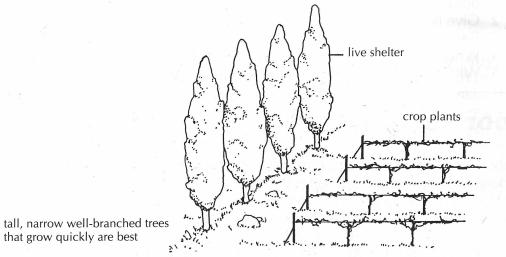
- 1 It may cause unwanted shading and frost may become more likely.
- 2 Pests and diseases may live in the shelter.
- 3 Shelter takes up space you could use for growing things.

There are two types of outdoor shelter: live shelter and artificial shelter.

Live shelter

that grow quickly are best

The most common form of live shelter is trees planted in a continuous line. These are called shelterbelts.

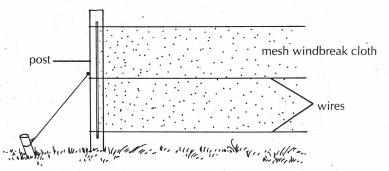


The trees may be deciduous (lose their leaves in autumn) or evergreen.

Advantages of live shelter	Disadvantages of live shelter
Cheap to set up.	Weeds must be controlled.
	May need irrigation.
	May need trimming
	Pests and diseases must be controlled

Artifical shelter

This is usually provided by netting attached to poles.



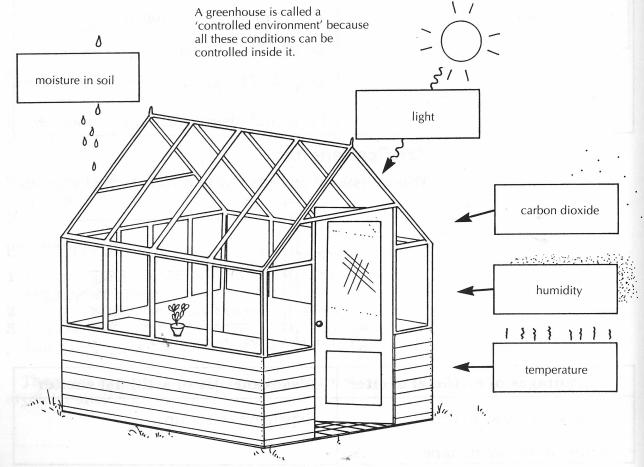
Advantages of artificial shelter	Disadvantages of artificial shelter
Quick and easy to erect.	Expensive to set up.
Little or no maintenance.	

Questions

- 1 Give three good effects of putting shelter around an area of ground outdoors.
- **2** Give two possible bad effects of outdoor shelter.
- **3** Draw a picture to show a live shelterbelt.
- 4 What happens to deciduous trees in autumn?
- 5 What is the main disadvantage of artificial shelter?

Indoor shelter

The only way to shelter a crop completely is to grow it in a **greenhouse**. Greenhouses collect heat from the sun or have artificial heating in them. They hold the heat to give warm growing conditions. Besides temperature the main conditions that a greenhouse changes are light, **humidity**, the amount of carbon dioxide in the air, and the amount of water in the soil. Because all these factors can be controlled, a greenhouse is called a 'controlled environment'.

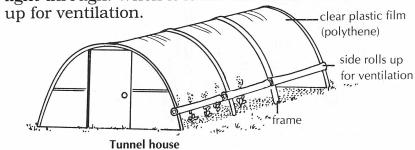


Types of greenhouses

The conditions that develop in greenhouses depend on how they are built and what they are made of. There are two main kinds.

1 Greenhouses covered with rigid material. These may be covered with glass or fibreglass or any solid material that lets light pass through it. When they are covered with glass they are called glasshouses.

2 Tunnel houses. These are covered with either a single or a double skin of clear **polythene** film, which lets light through. When it is hot the sides can be rolled up for ventilation



Advantages and disadvantages of greenhouse materials

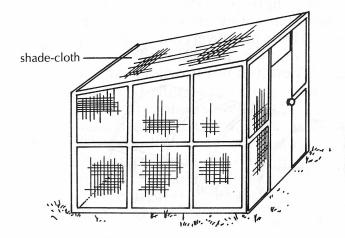
Greenhouses need to be built to let in as much light as possible without being very expensive.

Glass	Polythene
Best for keeping in heat Best for letting in light Easier to keep clean	Lets some heat pass through Lets in less light as it gets older Collects dirt quickly
Not so much condensation	Condensation collects on it and cuts out light
Expensive Breaks more easily Heavy — needs strong support	Cheap Does not break easily Light

- 1 What is the only way to shelter a crop *completely*?
- 2 What do we call a greenhouse that is covered with glass?
- 3 Draw and label a diagram to show a tunnel house.
- 4 Give two advantages of using glass as a greenhouse material.
- 5 Give two advantages of using polythene as a greenhouse material.

Shade-houses

Shade-houses provide protection from the sun as well as shelter from the wind. They are usually made from a frame covered with shade-cloth. They are used to **harden off** plants that have been taken from a greenhouse before they are planted out in the open. Delicate or shade-loving plants can be grown in them.

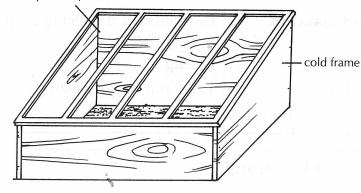


Small sheltered environments

Cold frames

A cold frame is simply a box with a sheet of glass over the top. The glass (or 'lights') can be opened for ventilation.

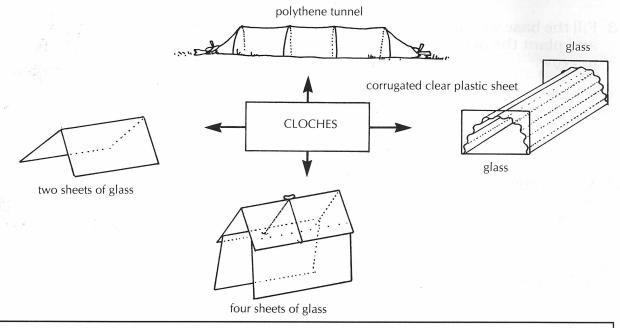
lights can be opened up to let air in



Inside the cold frame you grow plants that need protection from wind or cold. It is important that the cold frame is not too deep, so that small plants get plenty of light.

Cloches

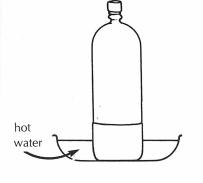
These come in various shapes and sizes. They are small movable structures made to protect plants *where they are growing*. They hold in heat and let light in. They need not be moved for watering because water runs down the sides and into the soil, where roots will grow towards it.



Questions

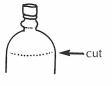
- 1 What is a cold frame?
- **2** How is a cold frame ventilated?
- **3** Why should a cold frame not be too deep?
- **4** What is a cloche?
- 5 Why do cloches not need to be moved for watering?

Making a bottle garden



You can make a simple sheltered environment from a soft drink bottle and use it for growing small plants. Follow these steps.



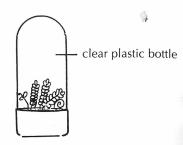


- 1 Soak the base in hot water to remove it. Make sure there are some small holes in the base.
- **2** Cut the heck off the bottle.

damp potting mix

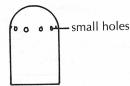






3 Fill the base with damp potting mix and plant the plants that you want to grow.





5 Make some small holes in the bottle so that too much moisture does not collect inside.

Now wait for your garden to grow. Do not leave your garden in direct sunlight because it will get too hot. Water it when it needs it.

REVISION QUESTIONS

1 Name three plants that grow best in shady conditions.

2 Live shelter must be maintained. Explain three things a grower may need to do to maintain live shelter.

3 Make a list of at least five growing conditions that are changed by a greenhouse.

4 Your friend wants to build a greenhouse but cannot decide whether to use polythene or glass. Write a letter explaining the good and bad points about both.

22: Training plants

WORD LIST

AXIL the angle between the stem and where a leaf grows out from it BUD young undeveloped shoot DISBUDDING removal of

lateral flower buds FLOWER BUDS buds which will become flowers

LATERAL BUDS buds growing just above where a leaf stalk is attached to the

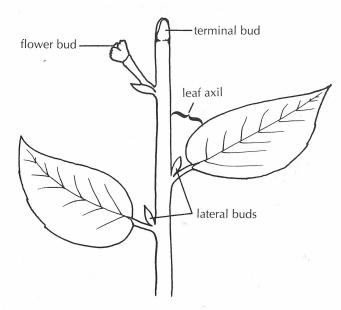
PRUNING the removal of parts of a plant; flowers, stems, leaves or roots
STOPPING removal of the

terminal bud
TERMINAL BUD bud at the
tip of the main stem

Training plants means using methods to control the direction, size and shape of growth.

Growing regions

The main growing regions of a plant are at the tip of the stem and in the angle between leaf and stem, called the leaf **axil**. **Buds** grow in these places. A bud is a young shoot. It may grow to become a leaf (or leaves) or a flower (or flowers) or a branch similar to the main stem.

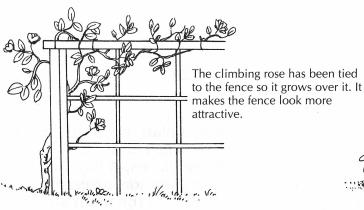


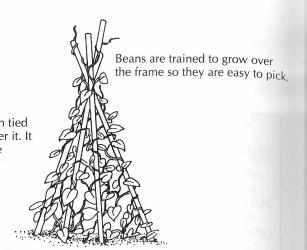
The bud at the tip of the main stem is called the **terminal bud**. Buds found just above the point where the leaf stalks are attached are called **lateral buds**. Buds that will grow into flowers are called **flower buds**. All buds are important because this is where cells are dividing and growing.

- 1 What is meant by 'training plants'?
- 2 What is the angle between leaf and stem called?
- **3** What is a bud?
- 4 Where is the terminal bud found?
- 5 Why are all buds important?

Reasons for training plants

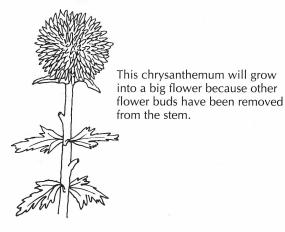
We may train plants

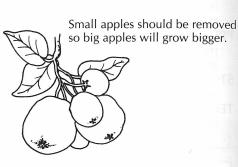




to give a more pleasing appearance

to make plants easier to manage





to give the sort of flowers that are wanted

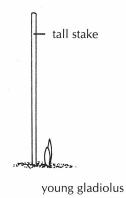
to give better fruit

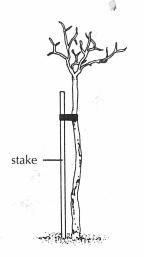
to protect plants from damage.

Methods of training plants

There are various methods you can use to make plants grow the way you want.

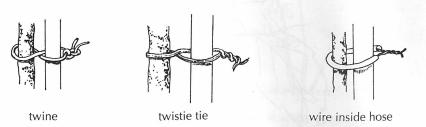
- 1 Staking and tying plants protects them from bad weather conditions. Some plants are staked because they look best when given support. You should follow these rules when you are staking plants:
 - Choose a stake that will be big enough for the fully grown plant.





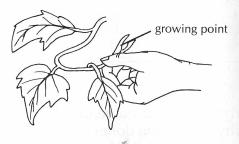
standard rose and its stake were put in the ground at the same time

- Put the stake deep in the ground so it will not move around and pull on the plant.
- Stake the plant at the time you plant it so that growing roots will not be damaged.
- Use a tie that will not damage the plant. Remember that the plant is going to grow, so the tie should be firm enough to prevent rubbing but not too tight.



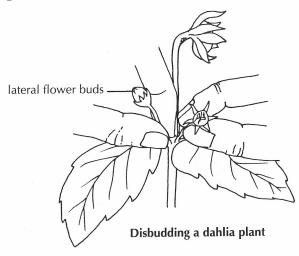
- Try to make stakes and ties blend in with the plant and with the surroundings if possible.
- Stake plants in a natural position if you can.

- 1 Give five reasons why we may train plants.
- 2 Why should you make sure a stake is deep in the ground?
- 3 How can you make sure that growing roots will not be damaged by staking?
- 4 What sort of tie should you use?
 - **2** *Stopping* is also called 'pinching'. It is the removal of the terminal bud at the tip of the stem. It is done to make the side shoots grow more strongly and give a bushier plant.



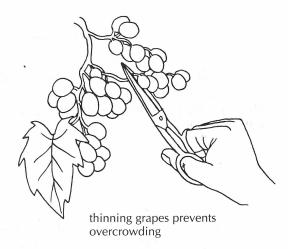
Pinching the growing point on a side branch of a marrow plant

3 *Disbudding* is the removal of lateral flower buds from a plant, to help large blooms with long stems to grow.



Some examples of plants that are often disbudded are dahlias, roses, carnations and chrysanthemums.

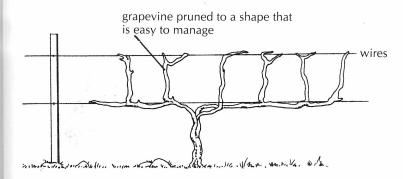
4 Fruit thinning is the removal of surplus fruit. This may be done by hand, by using tools called thinning shears or by using special chemicals. The fruit that remains is bigger, of better quality and better spread over the tree than if the fruit was not thinned.

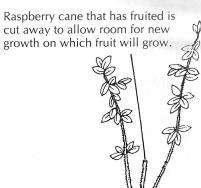


Questions

- 1 What is another name for 'stopping'?
- **2** Why is stopping done?
- 3 What is disbudding?
- 4 Give two examples of plants that are often disbudded.
- **5** Give two ways to thin fruit.

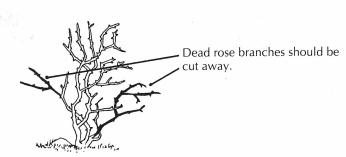
5 *Pruning* is the removal of parts of a plant. There are five main reasons for pruning plants:





to control the shape of the plant

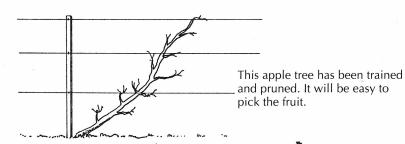
to improve flowering or fruiting



Pruning the apple tree lets light in to all branches.

- to remove dead or diseased parts

to let in more light



to help harvest fruit.

Before you start to prune a plant you should know how the plant normally grows, as well as where and how to cut it, to get the results you want.

- **1** Give a definition of pruning.
- 2 What are the five main reasons for pruning plants?
- 3 What are three things you should know before you start to prune a plant?

REVISION QUESTIONS

- 1 Draw a diagram to show the main growing regions of a plant. Label the terminal bud, a lateral bud and a flower bud.
- 2 Explain the difference between stopping and disbudding a plant.
- 3 We can train plants in different ways. Match up the training method with the desired result.

Training method pruning disbudding staking stopping

Desired result

to prevent wind damage a bushier plant larger blooms removal of diseased wood

- **4** What advice would you give to someone who was going to stake plants for the first time?
- 5 A student carried out an experiment on two identical rose plants. He removed all the lateral flower buds from plant **A** and left only one central bud on each main stem. He did not disbud plant **B** at all. Then he treated both plants exactly the same until they flowered. What difference would he have found
 - a between the flowers on the two rose plants
 - **b** between the flower stems on the two rose plants?

23: Pests

A pest is an animal that damages plants, usually by feeding on them. Pests may be large, for example, possums, rabbits and birds, or small, for example, insects and snails.

We need to be able to find out what pests are attacking our plants so that we can decide on the best way to control them. Sometimes the pest itself may be hard to see. Perhaps it is very small or lives inside the plant, or only comes out at night. If this is the case, there are two main clues to what pest it is.

- 1 The sort of damage that it has caused may tell what pest it is.
- 2 The sort of plant that is being attacked may give a clue because some pests are found mainly on certain types of plants. An example is the cabbage white butterfly, which lives mainly on plants of the cabbage family.

Effects on plant growth

There are two main ways that pests damage plants.

WORD LIST

CATERPILLAR larva of a moth or butterfly GRUB larva of a beetle INSECTICIDE chemical that kills insects

LARVA first stage in the life cycle of some animals; looks very different from adult

MAGGOT larva of a fly NYMPH stage in life cycle of some insects; looks similar to adult but cannot reproduce

PARASITE an organism that feeds on another living organism

PREDATOR an animal that kills other animals for food PUPA non-feeding stage between larva and adult in some insect life cycles.

Pests may chew plant parts. This causes holes in fruit, flowers and leaves.

A chewing pest has made holes in this leaf.

If the roots are eaten or stems are burrowed into, the plant may wilt, even though it has plenty of water.

2 Pests may suck plant sap. This may cause stunted growth, or leaves that curl or turn a different colour from normal.



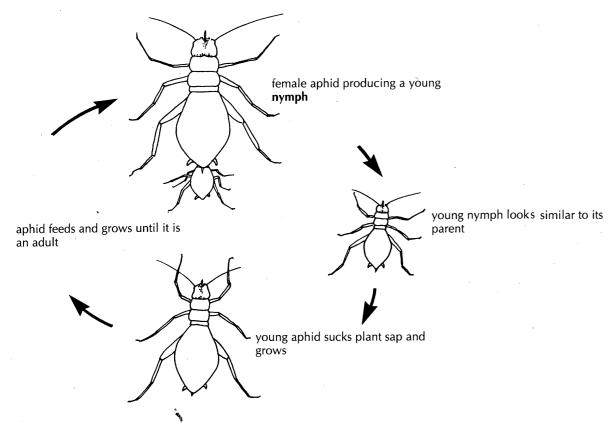
Questions

- 1 Give a definition of a pest.
- 2 Why must we find out what animals are attacking our plants?
- 3 Give three reasons why a pest may be hard to see.
- 4 If a pest is hard to see, what two clues can be used to help tell us which pest it is?
- 5 What are the two main ways that pests damage plants?

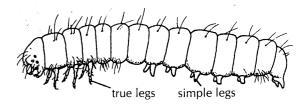
Pest life cycles

Insects and insect-like pests have two basic kinds of life cycle.

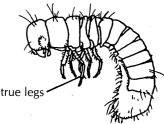
1 The egg hatches into young that look *similar* to the adult. The young insect grows larger until it becomes an adult. Aphids, leaf hoppers, vegetable bugs and mites have this sort of life cycle.



2 The egg hatches into young that look very different from the adult. The first stage is the larva. This is the main feeding stage and the stage that causes most plant damage. Moth and butterfly larvae are called caterpillars. They have biting mouthparts and three pairs of true legs just behind the head as well as some simple legs further back.



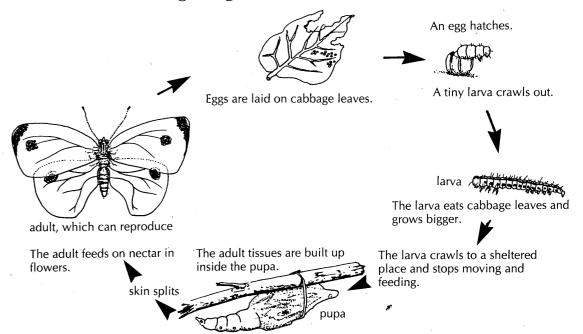
Beetle larvae are called **grubs**. They also have biting mouthparts, but they are different from caterpillars in that they have only three pairs of legs behind the head and none further back.



Fly larvae are called **maggots**. They do not have anything that looks like a head and they do not have any legs.

The second stage is called the **pupa**. During this non-feeding stage the tissues change into those of the adult.

The final stage is the adult. The adult feeds on food that is different from the larva and often does little damage. The adult mates and lay eggs and the cycle begins again.



Life cycle of the cabbage white butterfly

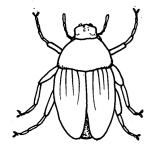
Questions

- 1 How does an aphid feed?
- 2 Give the scientific word that is the same for a grub, maggot and caterpillar.
- **3** Draw a picture of a beetle grub.
- 4 How is a beetle grub different from a caterpillar?
- 5 What does a pupa turn into?
- **6** Where does a cabbage white butterfly lay its eggs?
- 7 Which stage in the cabbage white butterfly life cycle causes most damage
- 8 What does the adult cabbage white butterfly feed on?

Types of pests

Pests that attack roots

Some butterflies, weevils, moths, beetles and flies lay their eggs in the soil. The larvae feed on the roots of plants. An example is the grass-grub beetle.





adult grass-grub beetle

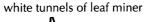
grass-grub larva

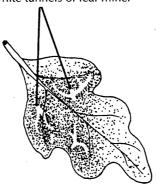
Grubs feeding on roots cause wilting, poor growth or dead plants.

Pests that eat stems and leaves

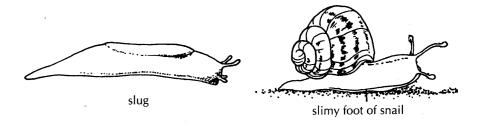
Holes in leaves and stems are usually caused by caterpillars, slugs, snails and slaters. These pests may reduce the weight of a vegetable crop or spoil the beauty of a flower crop. Caterpillars are often found underneath leaves. Leaf-roller caterpillars roll and web leaves together and live inside.

An example of a pest that eats leaves is the leaf miner. These are very small fly maggots that feed by making tunnels between the upper and lower leaf surface. The tunnels look lighter than the rest of the leaf. This pest is common on chrysanthemums and gypsophila.





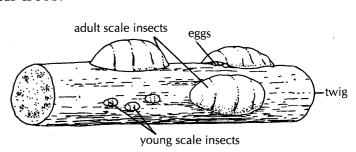
Other examples of pests that eat leaves are slugs and snails. They leave a slime around the eaten away tissue.



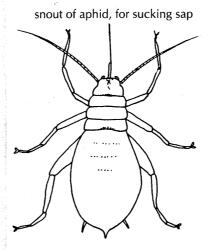
Pests that suck plant sap

Loss of sap weakens plants. Sucking pests also do damage by spreading disease through their piercing mouthparts. An example of a pest that sucks sap is the aphid. Sometimes aphids are called greenflies. They usually live in crowded colonies. They feed by sucking sap through a long snout. As they remove sap from leaves the leaves may curl over and this gives a clue that they are present.

Another example of a sucking pest is the scale insect. Adult scale insects are small and flat. They cling to leaves or stems in a fixed position, where they feed and fill their bodies with eggs. Then young scale insects hatch, crawl out and settle to feed not far from the parent. Scale insects are often seen on orange and lemon trees.



- 1 Give an example of a pest that attacks roots.
- 2 Name two pests that make holes in leaves and stems.
- 3 If you found rolled, webbed leaves on a plant what pest might have done the damage?
- 4 How do leaf miners feed?
- 5 Which pests leave slime around eaten away tissue?
- **6** What *two* sorts of damage can be done by sucking pests?
- 7 Which pest is often found on orange and lemon trees?
- **8** Explain how scale insects live.



Control of pests

Before you try to control a pest you must first find out what is causing the damage. You can use reference books to help you or you can ask an expert, perhaps an experienced gardener. From your knowledge of the pest you can then work out when is the best time to kill it and which method to use.

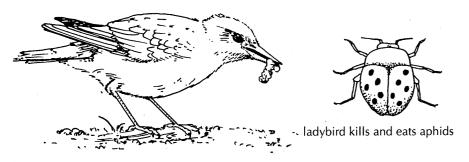
Large animals

Large animals like possums may need trapping. Birds can be scared away or netting put over plants to keep birds off them.

Biological control

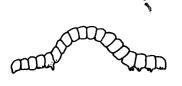
This form of control makes use of natural enemies feeding on the pest. These may be **predators**, which catch and eat a pest immediately or **parasites**, which live in or on the pest for some time and eventually kill it.

An example of a useful predator is the ladybird. The ladybird feeds on aphids. The starling is another useful predator as it eats grass-grub larvae.



starling eats grass-grub larvae

An insect that has been brought into New Zealand specially to control pests lays its eggs inside green-looper caterpillars. The larvae eat the caterpillar from the inside. This is an example of a useful parasite.



healthy looper caterpillar



parasitised looper caterpillar

Chemical control



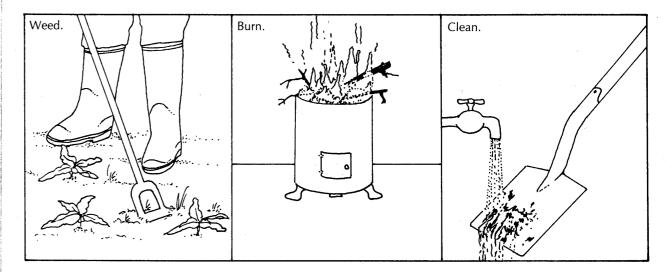
Special chemicals called **insecticides** are used to control insect pests. You must keep a close watch for pests and then use the right spray for the pest and apply it at the right time, before too much damage is done. For chewing pests it may be best to spray plants *before* the pest attacks, to prevent damage. Slugs and snails can be killed with poisoned baits.

One of the bad things about chemical control is that it can kill *useful* insects as well as pests, so sprays must be used carefully.

Preventing pests

You should try to follow these rules so that pests do not arrive on your plants.

- 1 Keep weeds away, because they can be a hiding place for pests.
- **2** Burn or compost all rubbish so that it does not attract pests.
- **3** Keep tools and containers clean when not in use.



- 1 Give two ways in which you could find out what pest is damaging your plants.
- 2 What does biological control make use of?
- 3 Explain the difference between a predator and a parasite.
- 4 What are chemicals used to control insects called?
- 5 Name one bad thing about chemical control.
- 6 How can you kill slugs and snails?

REVISION QUESTIONS

- 1 Give three rules that should be followed to prevent pest attack.
- 2 Copy and complete this paragraph.

Special chemicals called . . . are used to control pests, but one bad thing about chemicals is that they can kill . . . insects as well as harmful ones. Biological control uses . . ., which catch and eat pests, and . . ., which live in or on pests and eventually kill them.

I	PREDATORS	INSECTICIDES	USEFUL	PARASITES

- 3 Name the predator that eats aphids.
- 4 Copy and complete this table about pests.

Name of pest	Damage it causes	A control method
Possum	Eats leaves and shoots	?
;	Holes in leaves, slime left around tissue	?
Grass-grub larva	?	Eaten by starlings
Aphid	?	?
?	Tunnels between upper and lower leaf surface	Spray

- 5 All the following statements are *wrong*. Write out the statements *correctly*, changing the underlined word.
 - a The white butterfly <u>pupa</u> eats cabbage leaves.
 - **b** A parasite catches and eats insect pests.
 - c Chewing pests may cause leaves to curl or turn a different colour.
 - d Beetle larvae are called caterpillars.
 - e Maggots have many legs.
- **6** With the help of labelled diagrams describe the stages in the life cycle of the cabbage white butterfly.

24: Diseases

When a plant is diseased it has been damaged by a **micro-organism**. Each disease organism causes typical symptoms on the plants it infects. You can tell what disease a plant may have by these symptoms. You need to know what disease the plant has so you can treat it, often with chemicals.

The three most common micro-organisms causingplant diseases are **fungi**, **bacteria** and **viruses**.

Fungi

Fungi are small plants. They are not green and cannot make their own food. They rely on other things, living or dead, for their food. Some fungi attack living plants to get their food and this causes disease.



BACTERIA single-celled microscopic organisms FUNGI organisms with thread-like cells FUNGICIDE chemical that kills fungi HUMIDITY moisture in the MICRO-ORGANISM very small living thing RESISTANT not easily infected by disease ROTATE follow one crop with a different kind SPORES reproductive bodies of fungi and other nonflowering plants VEGETATIVE PROPAGATION the production of new plants by a method that

does not involve seeds VIRUS smallest diseasecausing organism Black spot on apple leaves and fruit is caused by a fungus that attacks apples.

Fungi reproduce by tiny **spores** that are spread by the wind. The spores need the right conditions if they are to grow. There must be moisture or high **humidity** and the correct temperature.

Some common types of fungal diseases are the leaf spots, rusts, mildews, moulds and wood rots. 'Damping off is caused by a fungus that infects young seedlings.

The most common groups of fungal diseases are shown on this table:

Type of disease	Symptoms	Examples of plants likely to
Leaf spot	Black dead areas on leaves, stems, fruit. apple leaf with black spot	be infected Apples, pears, roses
	apple lear mar steer sp	
Rust	Yellow or brown flat spots on upper leaf surface. Raised spots on lower surface.	Silver beet, poplar trees, chrysanthemums, stone fruit
	chrysanthemum leaf with ru	st
Powdery mildew	White spots that join on leaf surface to pumpkin leaf with powdery form a matt.	Apples, grapes, pumpkins, cucumbers, roses
Downy mildew	Pale areas on upper leaf surface and soft white growth on lower surface.	Grapes, onions, cabbage seedlings
Mould	Rotting of tissue, which goes grey or brown rot on peach brown.	Greenhouse crops, grapes, strawberries, vegetable crops, stone fruit
	grey mould on grapes	· 1553
Wood rot	Inner tissue of stems and branches are weakened. Leaves may turn silver. silver leaf of peach tree with wood rot	Stone fruit
Damping off	Seedlings rot and die. seedling	Young seedlings of many plants

Usually the sort of fungus that attacks one type of plant will not attack another type. For example, black spot of apples and black spot of roses are caused by two different sorts of fungi.

Questions

- 1 How can you tell what disease a plant has?
- 2 Why do you need to know what disease the plant has?
- 3 What are the three most common micro-organisms causing plant diseases?
- 4 How do fungi reproduce?
- 5 What conditions do spores need to grow?
- **6** What are the symptoms of the fungal disease called powdery mildew?
- 7 Give two examples of plants likely to be infected by rust.



tomato leaf infected with the bacteria that cause tomato canker

Bacteria

Bacteria are microscopic single-celled organisms. They rely on other living or dead things for their food and can infect many different sorts of plants.

Unlike fungal diseases, bacterial diseases are *not* spread by the wind. They are often spread by rain, washing or splashing them to another plant. Bacteria may also be carried by insects, or on infected seeds.

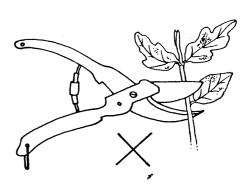
Diseases caused by bacteria are often hard to identify. Symptoms of bacteria are collapsed tissue, or smelly rotten areas on the plant.

Viruses

Viruses are too small to be seen without an electron microscope. Viruses can only live inside other living things. They quickly spread through all parts of any plant they infect.

Viruses may be passed from plant to plant in the following ways.

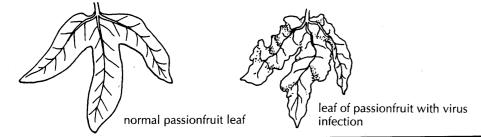
1 By **vegetative propagation**. If parts of an infected plant are used to grow new plants, for example, cuttings, the new plant will also be infected.



Do not take cuttings from infected plants:

- 2 By insect pests. Aphids can spread viruses by sucking the sap of an infected plant and then piercing another plant and injecting the virus into it from their mouth-
- 3 On tools and hands.
- 4 In seeds.
- **5** In the soil.

Diseases caused by viruses may be hard to identify. The symptoms are often stunted leaves, or leaves growing in curly or strange shapes. The leaves may have unusual colours or patterns on them.

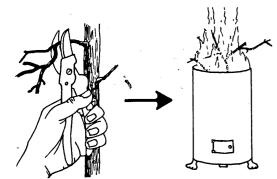


Questions

- 1 What are bacteria?
- 2 Give three ways in which bacterial diseases may be spread.
- 3 What is one symptom of bacterial disease?
- 4 How small are viruses?
- **5** Where must viruses live?
- **6** Give three ways virus diseases may be spread.
- 7 What is one common symptom of virus disease?

Control of diseases

First you must quickly find out what disease is infecting your plants. You can use reference books or people who are experts to help you. Then you can work out which method of control to use. The two main methods for control of fungi and bacteria are



cutting off the infected areas and burning them

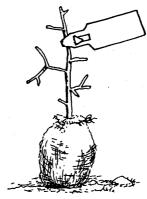


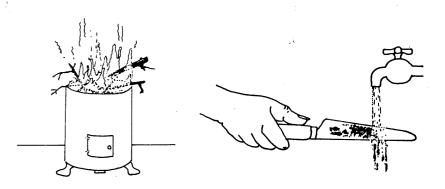
using special chemicals called **fungicides** to spray on infected plants and kill the disease organisms. These can be used to prevent disease occurring, or as soon as you see signs of disease.

There is *no cure* for virus diseases. Plants infected by viruses must be removed and destroyed.

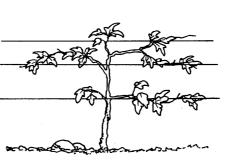
Preventing diseases

You should try to follow these rules so that your plants do not get infected by diseases.

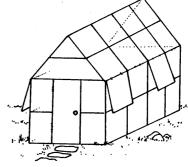




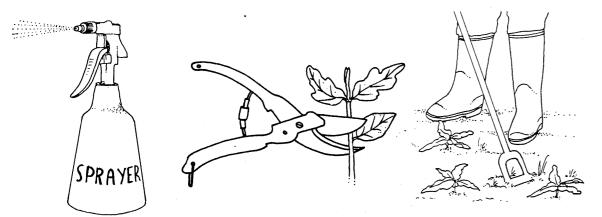
- 1 Plant resistant varieties of plants whenever possible. These will have been specially grown so they are not easily infected.
- **2** Remove and burn any **3** Keep tools, containers plants or plant parts that show symptoms of infection.
 - and hands clean.



4 Train, prune and space plants so that air can circulate.



- **5** Keep greenhouse humidity at a level at which fungi will not grow by controlling watering, heating and ventilation.
- - **6** Make sure soil is well drained.



- **7** Spray regularly to con- **8** Prevent injury to plants trol insect pests that may spread disease.
 - by providing suitable shelter from wind and taking care to make clean cuts when pruning branches or picking flowers or fruit.
- 9 Keep weeds away. They can create damp conditions where fungiand bacteria like to live, and they can carry diseasecausing organisms.
- 10 Rotate crops, that is, follow one crop with a different one so that diseases do not build up in the soil.
- 11 Provide good growing conditions. Strong healthy plants do not get infected as easily as weak, poorly grown plants.

REVISION QUESTIONS

- 1 Virus infection on strawberries makes plants very weak. What can a strawberry grower do to prevent virus infection?
- 2 Explain how weeds can increase the chance of disease in a crop.
- 3 You have a friend who has just built a small greenhouse at home to raise young seedlings, but she is worried about diseases affecting the seedlings. Suggest five rules she should always follow to prevent diseases occurring.
- 4 Which type of fungus disease may be causing each of the following symptoms?
 - **a** Grapes go grey and rotten.
 - **b** The leaf of a pumpkin plant has a white mat on its surface.
 - c Peach leaves have a silvery appearance.
 - **d** Black, dead areas form on the leaves of roses.
 - e Young flower seedlings rot and fall over.
 - f Silver beet leaves have flat brown spots all over the upper surface with raised brown spots on the lower surface.
- 5 Why must virus-infected plants always be *totally* destroyed?

25: Weeds

A weed is an unwanted plant.

Reasons for the success of weeds

Most weeds are successful because they have one or more of the following characteristics.

1 A high rate of reproduction.

WORD LIST

completes its life cycle in

DISINFECT use chemicals to

kill plant growth in soil;

soon after treatment HERBICIDES chemicals that

chemicals do not remain, so crops can be planted

kill plants, used to control

spread over the soil surface

PERENNIAL plant that grows for more than two years

STERILISE all plant growth is

killed for a long time, by

chemicals that remain in

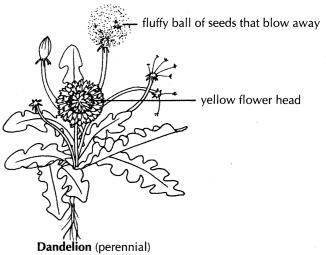
MULCH laver of material

ANNUAL plant that

one year

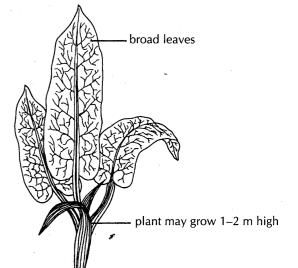
weeds

the soil



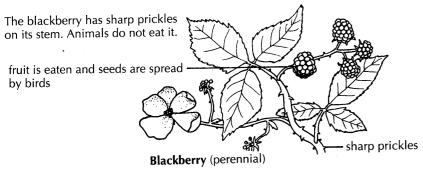
The dandelion is an example of plant with a high rate of reproduction. The dandelion head has many seeds on it. Each seed may become a new dandelion plant.

2 Vigorous growth. The dock plant grows strongly and puts a tap root down deep into the ground.



Dock (perennial)

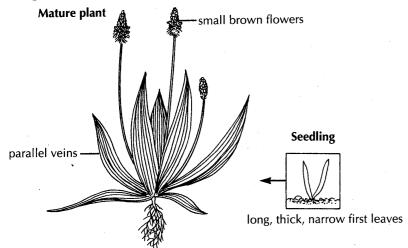
3 Protective mechanisms, which prevent them being eaten.



4 Seeds that survive for a long time.

Identifying weeds

You need to be able to identify weeds so you can decide on the best way to control them. It is helpful if you can identify the weeds when they are seedlings as well as mature plants so that you can kill them before they grow too big.



Narrow-leaved plantain (perennial)

The easiest way to identify common weeds is to match them up with drawings or photographs in books.

Questions

- 1 What is a weed?
- 2 Give one reason why the dandelion is a successful weed.
- 3 Give three other characteristics that may help weeds be successful.
- 4 Why do you need to be able to identify weeds?
- 5 What is the easiest way to identify common weeds?

Some common weeds flower stalk with seeds These drawings show five common weeds. There are many more! blue-green leaves bright green leaves twining stems can choke young plants roots can be broken up and Tough underground stems can be bulb-like swollen root spread during digging cut when digging. Each piece can grow into a new plant Oxalis (perennial) Convolvulus (perennial) Couch (perennial) purple flower small green flowers wind spreads thistle seeds

Questions

- 1 Which of the five weeds has a stinging poison in its stems and leaves?
- 2 Which weed has bulb-like swollen roots?

Nettle (annual)

Hairy leaves and stem. Hairs contain a stinging poison.

- 3 What bad effect does convolvulus have on young plants?
- 4 How can digging help couch plants to spread?
- 5 What spreads thistle seeds from place to place?

How weeds affect plant growth

Weeds can have the following bad effects on the useful plants they are growing with.

Californian thistle (perennial)

- 1 Weeds compete for growing space.
- 2 Weeds may block out light.

deeply lobed spiny leaf

3 Weeds take up water and nutrients from the soil and so reduce plant growth.

4 Weeds may carry pests and diseases that can infect

plants.



Preventing weed growth

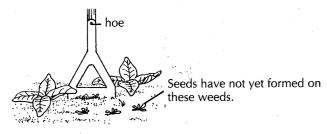
To help *prevent* a weed problem you should try to stop weeds from arriving near your plants. Here are some ways of doing this.

1 Do not bring in plants from a place where there is a

bad weed problem.



- **2** Keep tools and equipment washed and clean, especially if they have been used where there are weeds growing.
- **3** Control weeds *before* they produce seeds.



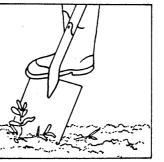
Questions

- 1 Give three bad effects that weeds can have on the useful plants they are growing with.
- 2 Give three ways you can help prevent a weed problem.

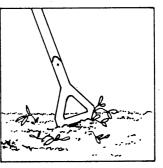
Controlling weeds

Weeds that have become established may be controlled by hand, by mulching, or by chemicals called **herbicides**.

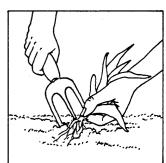
1 Controlling weeds by hand. On large areas of ground, soil may be ploughed or rotary-hoed to chop up and bury weeds.



Smaller areas can be dug with a spade to bury weeds



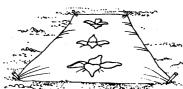
or hoed with a push hoe to disturb weeds so they die if conditions are dry enough



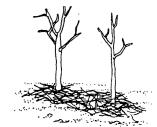
or weeded by hand, using a fork if necessary to loosen the roots.

Care must be taken so that these methods do not cause damage to crop roots and stems. Soil should not be cultivated when it is very wet or very dry, to avoid damage to soil structure. Digging can break up the underground parts of **perennial** weeds and spread them around, causing a larger problem. Perennial weeds should be removed by hand and dumped or burnt.

2 *Mulching.* A **mulch** is a layer of material that is spread over the soil surface. You can use bark, straw, black polythene or sawdust. Do not use sawdust from treated timber because it contains poisonous chemicals.



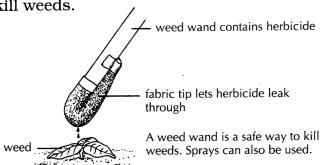
black polythene prevents weed



straw mulch around young trees

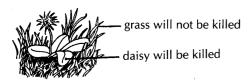
Mulching keeps out the light and so stops young weed plants from growing. Mulches do not usually stop the growth of perennial weeds, which have enough food reserved to keep growing and push through the mulch. Soil under a mulch should be moist, well cultivated and free of perennial weeds.

3 *Herbicides* are chemicals that kill plants. They are used to kill weeds.



There are two main types: selective herbicides and non-selective herbicides.

Selective herbicides kill weeds without harming other plants. For example, some herbicides will kill weeds in a lawn without killing the grass plants.



Non-selective herbicides affect most plants. These are often used to **sterilise** or **disinfect** soil before a crop is planted in it or for long-term weed control on paths and driveways.

The main advantages of using herbicides are

- it can be easier and cheaper than cultivation
- it does not damage the soil structure.

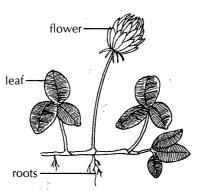
Which herbicide you use will depend on the plants you are growing and the weeds you need to control.

Questions

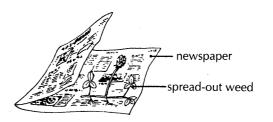
- 1 Give three ways of controlling established weeds.
- 2 What could be used on a large area of ground to chop up and bury weeds?
- 3 What is a mulch?
- 4 What are two materials you could use for a mulch?
- **5** What are herbicides?
- 6 What do non-selective herbicides affect?

Making a weed collection

If you want to be able to identify the weeds that grow in your area it is helpful to make a collection of weeds and name them so you can use them for reference. Follow these steps.



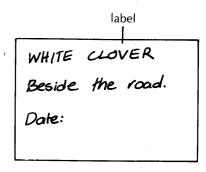
1 Collect a good example of the weed, if possible with roots and flowers as well as leaves.



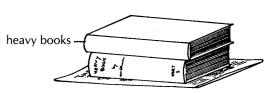
3 Put the weed and the label between some pages of newspaper. Spread the weed out carefully.



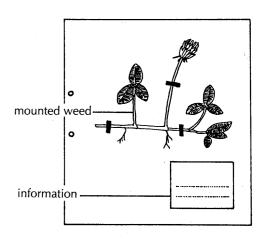
6 After about a week hold the weed near your cheek. If it does not feel cold it is dry.



2 Find out its name from a reference book and write it on a label with the place you collected it and the date.



- **4** Stand something heavy on the news paper to press the weed flat.
- **5** Every day put fresh paper around the weed so it does not go mouldy.



7 Use tiny bits of sticky tape to mount the weed on a sheet of paper. Write its name and where and when you found it.

A collection of 10 common weeds from your area would be useful.

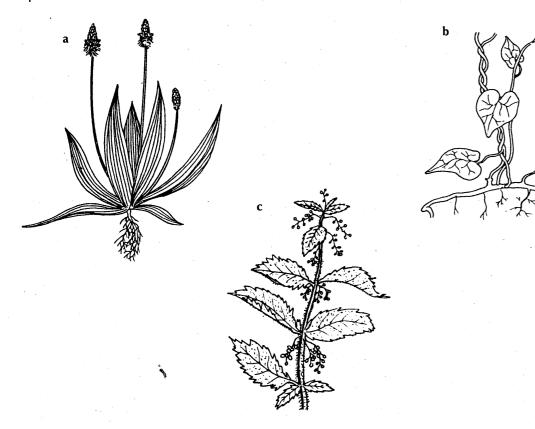
REVISION QUESTIONS

- 1 What sort of plant is likely to be a common weed?
- 2 Copy and complete the paragraph using the words below.

The dandelion is a common weed that is successful because it produces so many . . . A dock plant puts a deep . . . root down into the soil while . . . has a spreading underground stem. Weeds can compete with other plants for . . . and nutrients that plants need and may carry . . . and pests.

DISEASES WATER SEEDS TAP COUCH

- 3 Many people do not like using chemicals in their soil or on their plants.
 - **a** Write a paragraph explaining how it is possible to prevent and control weed growth *without* using any sort of chemicals.
 - **b** What special precautions would have to be taken by a grower who was not using herbicides?
- 4 What are two advantages of using herbicides?
- 5 Name each of these weeds and say for each if it is an annual or a perennial.



- 6 Explain the difference between
 - a selective and non-selective herbicides
 - **b** sterilising and disinfecting soil.

26: Sprays

Chemicals are sprayed on to plants to

- · control weeds, pests, and diseases
- supply nutrients
- influence plant growth, for example, to help fruit to set

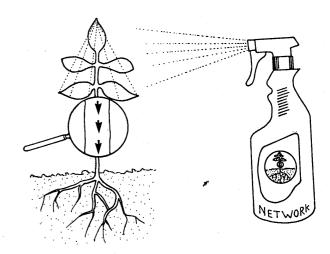


Chemicals that control weeds are called **herbicides** or weedkillers. Some herbicides kill all plants that they come in contact with. These are called non-selective herbicides. Others kill some plants but not others. These are selective herbicides.

Herbicides may be used on the ground *before* weeds grow. These are called pre-emergence herbicides. They leave a film near the surface of the soil that stops seedlings growing.



Other herbicides kill weeds that have already grown. These are called post-emergence herbicides. Some act by killing the plant parts that they touch. Others are carried to all parts of the plant inside it, and kill the whole plant, roots and all.



WORD LIST

BACTERICIDE chemical that kills bacteria

FUNGICIDE chemical that kills fungi

HERBICIDE chemical that kills plants

INSECTICIDE chemical that kills insects
PESTICIDE chemical that

kills pests
POLLINATE transfer pollen
between flowers

RESIDUE remains of spray on plants

SYSTEMIC spreads through the whole plant

Questions

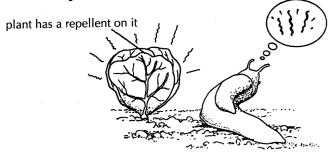
- 1 Give three reasons why chemicals may be sprayed onto plants.
- **2** What are herbicides?
- 3 When are post-emergence herbicides used?
- 4 Give an example of a herbicide that is carried inside the plant it is sprayed on.

Sprays that control pests

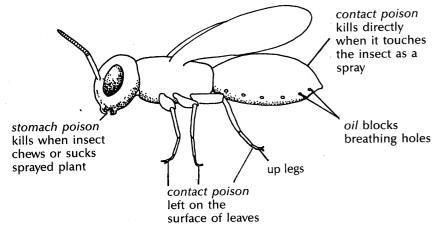
Chemicals that kill pests are called **pesticides**. There are various types of pesticides.

Repellents make a plant smell or taste bad to animals

that may want to eat it.



Insecticides kill *insects* by various methods.



Systemic pesticides are sprayed on plants to make *all* parts of the plant poisonous to the pest that is to be killed.

Sprays that control disease

Chemicals that kill fungi are called **fungicides**. Those that kill bacteria are called **bactericides**. Fungicides should be sprayed on to plants *before* fungi grow. They coat the plant with a poison that prevents fungal spores from growing if they fall on the plant.

Questions

- 1 What are chemicals that kill pests called?
- 2 How do repellents work?
- 3 What do insecticides kill?
- 4 How do systemic pesticides work?
- 5 When should fungicides be sprayed on to plants?

Problems that may occur through spraying

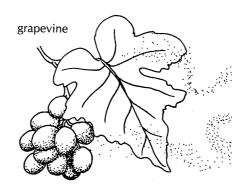
There are six main problems that may occur when growers are using sprays.

1 **Residues** may build up. Sprays used on vegetable or fruit crops may leave a residue, which is a poisonous deposit on the crop. This could be poisonous if the fruit or vegetables are eaten too soon after spraying. Many sprays have a waiting time after spraying when sprayed plants must not be harvested.



Do not pick these cherries during the waiting period.

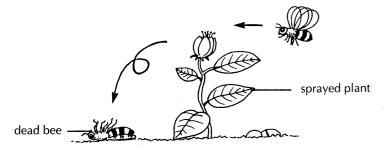
- **2** Crop plants may be damaged. The spray may harm the plant it was meant to protect if it is not used in the right amount or at the right time.
- **3** Other plants may be damaged. Some sprays, especially herbicides, may kill other plants as well as the weeds you want to kill. The wind can carry fine spray droplets quite a long way. Grapevines are easily killed by spray drift.







4 Useful insects may be killed. Insecticides that kill unwanted insects can also kill useful insects, for example, bees, which we need to **pollinate** crops.



5 There is danger from poisons. Herbicides and pesticides are poisonous to people. Some are so poisonous that getting them on your skin is dangerous.



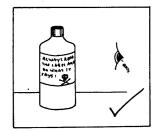
Questions

- 1 What is a residue?
- 2 Give an example of a plant that is easily killed by spray drift.
- 3 Give four problems that may occur through spraying.

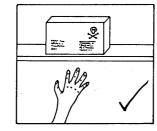
Safe use of sprays

POISONOUS SPRAYS MUST ALWAYS BE USED WITH CARE.

You should follow these rules.



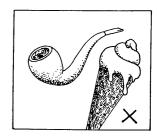
1 Always read the label and do what it says.



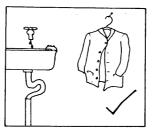
2 Keep sprays out of reach of children and pets, in a locked cupboard.



3 Never put sprays in a different container from their usual one. *Never* put sprays in drink bottles!

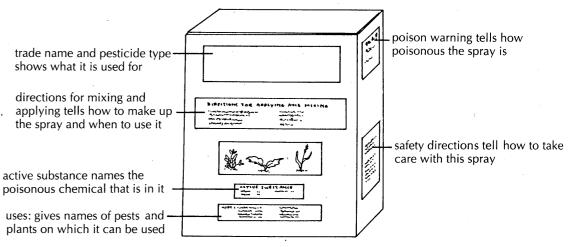


4 Do not smoke, eat or chew while spraying.



5 Always wash and change into clean clothes after spraying

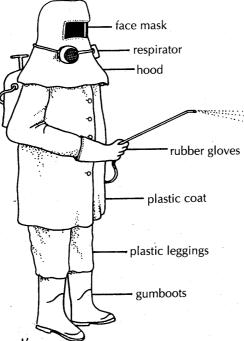
All labels have the same important information on them.



- 1 Write out five rules for the safe use of sprays.
- 2 Why should you never put sprays in drink bottles?
- **3** Give four things you would expect to find on a spray label.

REVISION QUESTIONS

1 This person is spraying a pesticide onto fruit trees. Explain why he is dressed like this.



2 Describe how pre-emergence herbicides work.

3 Design a poster called 'Safety with sprays!' to put on the wall in a garden shed.

4 This is an example of a spray label. Read it and answer the questions that follow.

- **a** What precautions should you take with this spray?
- **b** Give three examples of weeds that may be controlled with this spray.
- c How long does it take before you see the effects of the treatment?
- **d** Can Network be used as a preemergence weedkiller?
- e Why should you not spray in windy conditions?

Network SHARPSHOOTER

Precautions: Keep out of reach of children. Avoid contact with eyes and skin and avoid breathing the spray mist or vapour. Wash pesticide from skin and eyes immediately. Avoid working in spray mist. Wash exposed parts of body after use and before eating, smoking or drinking. Do not eat or smoke while spraying.

Caution: Network Sharpshooter is very active do not allow sprat to contact the foliage of desirable plant and shrub species do not spray in windy conditions

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General Information: Network SHARPSHOOTER is a foliage applied translocated herbicide that moves through the plant from the leaves into the root system. To be effective, treatment must be made when weeds are actively growing. Repeat treatments with need to be made to control plants arising from dormant underground plant parts or seeds. Poor results are likely if weeds are covered with dust or sill at the time of treatment.

Rainfall occurring up to six hours after application may reduce effectiveness. Heavy

Rainfall occuring up to six hours after application may reduce effectiveness Heavy rainfall within two hours after application may wash the chemical off the foliage and a repeat treatment may be required. Effects of the treatment will not become apparent for two or three weeks

Effects of the treatment will not become apparent for two or three weeks Network SHARPSHOOTER is non-residual in the soil. It will not control germinating

seedings.

Directions for Use: Hold the APPLICATOR approximately 0.5 metres from the target weed or foliage. Spray weed foliage uniformly to wet.

Conditions of Sale: In the manufacture of

Conditions of Sale: in the manulacture of his product every care is taken but as the use of this product is outside the control of the manufacturer or distributor it is a condition of sale that the buyer assumes all responsibility for the use of same and neither the manufacturer nor the distributor shall be liable for any loss or damage resulting from its use.

Manufactured by Shell Gardens NZ Ltd. P.O Box 1084 AUCKLAND



27: Roses

This chapter gives information for people who want to find out a lot about one sort of plant. If you are doing a project, pictures of roses are easy to find in magazines, or even on greeting cards.

Growing roses

Roses are very popular garden plants. They are not difficult to grow and make a colourful display in the garden. Some people prefer to grow roses in separate rose gardens, which makes it easy to care for the plants. Other people like to put different plants in the same garden as their roses, which prevents the garden from looking too bare in mid-winter when the roses have no flowers or leaves.

Uses of roses

Gardeners can make use of different types of roses for different purposes in the garden. Miniature roses can be used on the edge of borders and in tubs and pots. Climbing roses will disguise ugly fences or walls and can be trained to grow over archways. Standard roses are best in a formal situation. They need a permanent stake for support and should not be grown where it is very windy. Bush roses may be grown amongst other shrubs or as hedges. New roses have been bred that grow close to the ground and can be used as groundcover to help reduce the amount of weeding needed.

Florists and others concerned with floral work use roses as cut flowers. If treated correctly they will last for a long time in water and their beauty and scent are enjoyed by everyone. The best roses for cutting are the large-flowered bush roses, also called hybrid tea roses. The flowers of these roses have long stems and a classical shape. The cluster-flowered bush roses, also called floribunda roses, can be used for cut flowers but the flowers are usually smaller and have shorter stems. If you have roses in your garden they should supply you with cut flowers for at least six months of the year.

History of roses

Roses, in one form or another, have been known to man since the beginning of our civilisation. Monastery gardens might have a thick hedge of thorny roses around them for protection and gardens in medieval times would include arbours entwined with roses. The rose was the symbol of divine love and can be seen often in medieval paintings. It has frequently been used as a romantic symbol in poetry.

The earliest of our modern roses came from China.

Rose breeding

People have been trying to breed new varieties of roses for over 200 years. Now there are at least 20 000 named varieties of roses! Rose breeding involves growing new plants from seed, so it is a slow process that requires much patience. Important features that are considered by breeders include colour, scent, disease resistance, shape of flower and length of flowering time.

How to care for roses

Planting

Roses need a sunny place in which to grow. They should get sun for most of the day and be sheltered from the wind. Trees can be bad for roses if they grow too close. The tree roots will take water and nutrients that the roses need and the trees may throw too much shade on the roses.

Any average soil is suitable for roses. It is best if the soil is slightly acid, but not too acid. If the soil has a lot of clay in it or gets very wet, the addition of organic material, for example, straw, will help to improve it. If the ground is stony you can create raised beds with a mixture of good soil in them, on top of the stony soil. Sandy soils will need plenty of organic material added, and plenty of water throughout the growing season.

The beds that you are going to plant roses in should be prepared several months before planting, to give the soil time to settle.

Roses that have been grown in containers can be bought and planted at any time so long as they are kept watered while getting established. Bare-rooted roses, which have not been grown in containers, are usually planted in late winter so they are in place ready for their spring growth.

For each rose dig a hole about 30 cm in diameter and 30 cm deep. Then build the soil up in the centre of the hole to form a small mound. You spread the roots out over this mound to give them close contact with the ground. You should make sure that the area where stem and roots have been grafted together is just under the top of the hole. Then fill the hole in and tread down firmly on the soil to hold the plant in place. Standard roses should be staked before the roots are covered to prevent possible injury to the roots.

Roses that are planted in a dormant condition in winter do not require pruning when they are planted, except that any damaged or broken roots or stems should be trimmed.

Before the hot summer weather arrives you can put a mulch of peat or compost over the soil to keep moisture in.

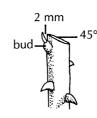
Planting a rose bush 30 cm 30 cm dig a hole make a small mound in the centre

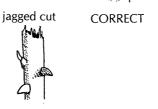
grafting area

spread the roots out over the mound

Pruning cuts

too close to bud 2 mm **WRONG**







WRONG too far from bud



WRONG

Pruning

Roses are pruned so that they will keep a good shape and produce more flowers. When a rose has been correctly pruned it has an open centre and the branches with flowers growing up and out. Roses are pruned in the winter when the bushes are dormant so that the sap will flow into the strong young branches in the spring.

These are the basic rules for pruning.

- 1 Always use sharp, clean tools.
- **2** Cut away all wood that is grey and dead.
- **3** Remove branches that cross the centre of the plant or rub against other branches.
- 4 Remove all suckers (growths coming from below where the stem joins the base of the plant).
- **5** Cut the strong young wood back to a bud that points away from the plant and is two or three outward facing buds up from the base of the stem.
- **6** All cuts should be made on an angle of about 45° about 2 mm above the bud and pointing downwards.

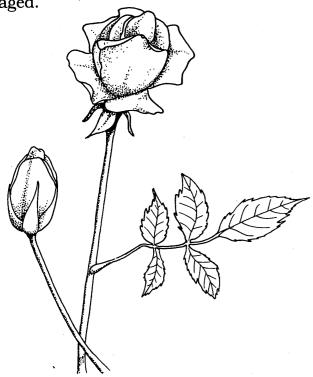
After pruning you should remove all old stems and leaves because they may contain disease spores or the eggs of insect pests.

Cutting roses

If you gather roses late in the afternoon and put them immediately into water they will last longer than if you pick them earlier in the day. Cut the stems just above where the first five-leaflet leaf branch leaves the stem. This will encourage further growth.

When roses have formed dead heads the heads should be cut off so that new buds will form new flowers. Always use sharp secateurs to cut roses so that the stems are

not damaged.



Control of diseases and pests

The main pests to attack roses are aphids, scale insects and thrips, and the main diseases are rust, black spot and powdery mildew. You should spray regularly with a good all-purpose spray from the time the first leaves appear to protect your plants from pests and diseases.

Appendix

1: HORTICULTURE Horticulture in your area

Aim

To become more aware of horticulture in your area.

What to do

- 1 Every day for a week, check your daily newspaper for articles or pictures about plants or the people who grow them.
- Cut out one item each day and stick it into your notebook.
- Alongside the item, write one or two sentences to say what it is about.

Challenge

How many other words can you make from the letters of the word H-O-R-T-I-C-U-L-T-U-R-E?

2: USES OF **PLANTS**

Research project

Use the school library or your public library to research one of the following topics:

- The timber industry in New Zealand.
- Harakeke (flax) and its many uses.
- Plants and medicine.
- Paper-making.
- Trees and the environment.

Present your findings in the form of a project.

Collage

Cut up old magazines to make a collage showing the many uses of plants. You could show

- plant foods
- timber houses and furniture
- beautiful plants
- items made from cardboard or paper and so on.

Display your collage in a suitable place.

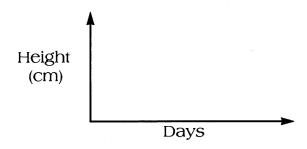
Light and dark experiment

Aim

To see how bean plants respond to growing in light conditions and in dark conditions.

What to do

- Plant several bean seeds in damp potting mix in two pots.
- 2 Cover one pot with a metal can to provide total darkness. Cover the other with a glass jar the same size as the can.
- 3 After the beans germinate, measure the height of the seedlings each day. Plot the results on a graph.



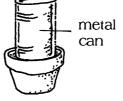
- 4 End the experiment when the seedlings become too large for the jar and can. Measure the area of the leaves by placing them on squared paper and counting the squares. Also measure the diameter of the stems. Finally wash the dirt from the roots, dry the seedlings thoroughly over low heat and weigh them.
- 5 Calculate the average leaf area, the average stem diameter and the average dry weight for the seedlings in each pot.
- **6** Write a statement about how bean plants respond to growing in light and in darkness.

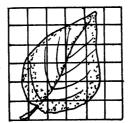
Graph interpretation

Some students decided to grow a hyacinth bulb in a pot. As soon as it sprouted they measured it by cutting a piece of string the same length as the shoot. They kept on measuring and cutting bits of string for several weeks. As they did so they glued the pieces of string on to paper to make a growth graph.



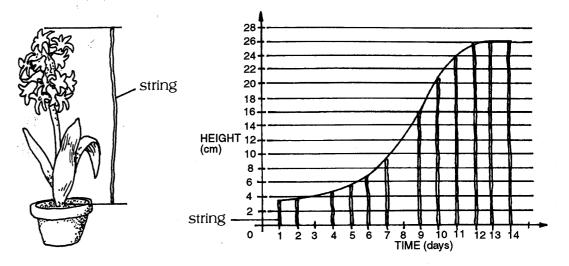






Look at the growth graph and answer the following questions.

Growth graph



Questions

- 1 During which days was the plant growing most quickly?
- 2 On which days were the students unable to measure the plant?
- 3 On what day did they stop the experiment?
- 4 Why do you think they stopped at this point?
- **5** What was the final height of the shoot?

Jumbled words

Each of the clues in list A gives the meaning of one of the jumbled words in list B. Write each corrected word with its meaning.

A
Gas needed for respiration
Substances needed for healthy plant growth
Amount of moisture in the air
A word meaning 'best'
Leaves and stems collapsing and drooping
Energy form needed by green plants
Process by which cells get energy
Plants make their own food by this process
Gas needed for photosynthesis
Energy rich food made inside green plants

rugas
hgtil
tiwingl
xongey
robnac eoxiidd
hpostotsiehnys
tsnituern
mptomiu
rtaioinpser
ihuymidt

Acrossword puzzle

By finding the best word to fit in the gaps in the sentences you can also solve the Acrossword Puzzle.

4.	Dr .		TE 70		
4:		MIN	IN	j A	
	GAF	WE	N		1. 1

1	soil does not drain easily.
2	You your crops when they are mature.
3	is a mixture of clay, silt and sand.
4	The of a site means the way it is facing.
5	is needed to give water to plants.
6	Planting seeds is called
7	Breaking soil into smaller pieces is known as
8	Without good soil becomes waterlogged.
9	are substances in soil needed by plants for
	growth.
10	You should plant seedlings at the right apart.
	Stakes give plants the they need.
	You may need to pests and diseases.

	1 C	П		
2	R			
3	0			
4	Р			
5	R			
6	0			
7	Т			
8	Α			
, 9	Т			
10				
11	0			
12	N			

Research project

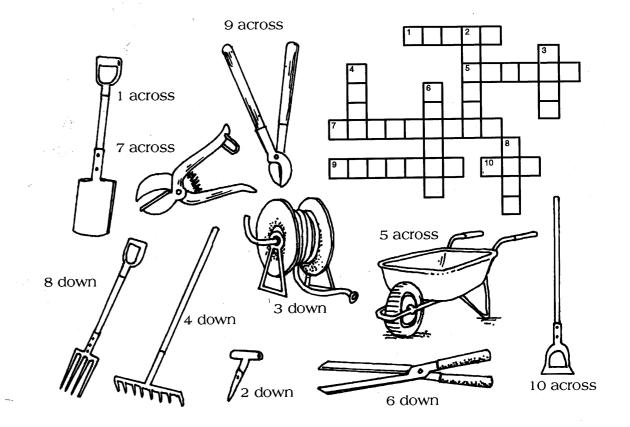
Use gardening magazines and advertisements (junk mail' from hardware shops is good) to make a collection of pictures of different types of tools.

Stick the pictures into your book. Beside each tool write what it is used for.

5: Tools

Crossword

Use the pictures to help you complete the crossword.



6: Types of Plants

Odd-one-out

Find the odd plant in each of these horticultural groups. In each case, say why the plant does not fit into its group.

- 1 moss fern pansy liverwort
- 2 mushroom seaweed toadstool mould
- **3** pine kauri macrocarpa peach
- 4 oak tree grass cabbage tree lily
- 5 carrot onion parsnip beetroot
- 6 oxalis dock thistle parsley7 rose blackberry thistle daisy
- 8 strawberry tomato raspberry blackberry
- 9 daffodil lily hyacinth dahlia
- 10 celery silverbeet lettuce beans

Investigation of a tree

Wherever you live you will be able to find trees. Trees are the world's biggest plants.

8: PLANT 7: SPECIALIST **PLANTS**

STRUCTURE

Plant parts

Copy and complete this chart showing the parts of some plants that we eat. The first one has been done for you.

PLANT	PICTURE	PARTS WE EAT
Silverbeet		Leaves and stems
Carrot		
Potato	400 000	Stem tubers (underground)
Section 1		Leaves and stems
Onion		Leaves of bulb
Pumpkin		

Flower collection

Aim

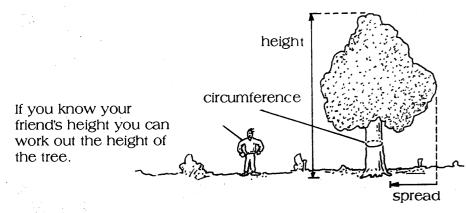
To make a collection of pressed flowers.

What to do

- 1 Collect ten (or more) different flowers that you think are attractive. They should be small enough to press easily.
- Arrange the flowers carefully on paper towels between sheets of newspaper. Put some heavy books on top.
- Change the paper each day until the flowers are dry.
- Mount the flowers on sheets of blank paper using small pieces of sellotape.
- **5** Label each flower with its name.

Choose one 'special' tree to make drawings of and keep records about. Look for:

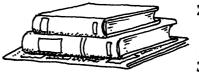
- 1 The shape of the tree. Make a sketch or take a photograph.
- The measurements of the tree. Estimate its height, the spread of its branches, and the circumference of its trunk at about one metre above the ground. Mark these measurements on your sketch.



Use a piece of rope to measure the circumference of the trunk.

- The bark. Fix some strong plain paper to the trunk with drawing pins. Rub the side of a crayon firmly over the paper to make a bark rubbing. Cut out the best bit of the bark rubbing for your records.
- Twigs. Make a coloured drawing of a twig. Show the shape of the buds and the marks on the stem.
- Flowers. Some tree flowers are very small. You will have to look carefully for them in spring. Make a drawing of any you find. Catkins are flowers.
- Leaves. Press a summer leaf of your tree between paper towels under a pile of heavy books. Find an autumn leaf as well.
- Fruit/seeds. Find and keep some fruits. Try to grow some in a mixture of soil and leaf mould in a pot. Keep a record of your results.
- Other plants. Do other plants grow on your tree?

Finally, use all the drawings and records to make a wall chart about your tree.



Root-leaf relationship

Aim

To observe the relationship between root systems and leaves.

What to do

- 1 From the nearest piece of waste ground collect four different weeds. Make sure all parts of each plant are collected.
- Carefully wash the roots to remove soil and spread the plants out to dry on some paper.
- Place the dry plants on some squared paper and draw their outlines. Show which parts grew above the ground and which parts grew below the ground.
- Use the squares to make a statement about the balance between roots and leaves.

Growing a kumara

Aim

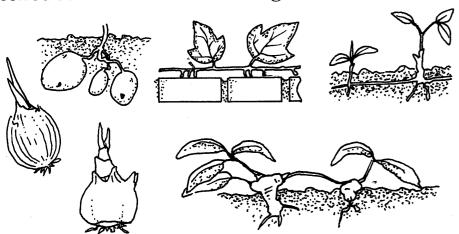
To watch the growth of a new plant from a tuber.

What to do

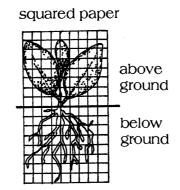
- Push some fine wire netting into a jar to form a basket.
- Put a small kumara tuber into the basket. Put enough water into the jar to touch the kumara.
- Keep the kumara in a light, airy place.
- Make a record of what happens to the kumara, using labelled diagrams.

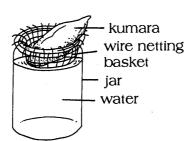
Jumbled stems and roots

Copy or trace the diagrams into your book. Unscramble the names of the structures you have drawn. Put the corrected names next to their diagrams.



9: THE ROOT





MORC

RECKUS

LBUB

VEADNTOUIST

OOTSR

UNERRN

ERBUT

10: STEMS

leafy celery

ink in

water

water conducting

stalk

celery stalk after cutting

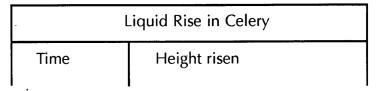
Conducting tissues

Aim

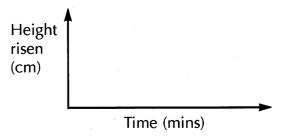
To see the water conducting tissues in a stem and to time how quickly liquid rises in the stem.

What to do

- 1 Put five leafy celery stalks in some water which contains a little red ink.
- Every three minutes, take one stalk of celery out of the water and slice it into 2cm sections using a sharp knife or razor. Look at the upper end of each section to discover how far the ink has risen, and where in the stem the ink is found.
- Record what you see in a table.



Finally draw a graph of your results.



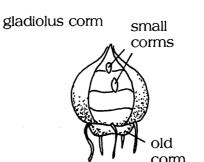
Bulb and corm structure

Aim

To study the structure of a bulb and a corm.

What to do

- Using a sharp knife and a chopping board, slice an onion from top to bottom.
- Draw the inside of the onion. Look for the roots, stem, storage leaves, scales and the bud which will develop into leaves and flowers.
- Label your diagram clearly.
- Repeat these three steps using a gladiolus corm. It will not have scales but it might have new corms growing on top of the old ones.





Transpiration

Aim

To observe the effects of transpiration.

What to do

- 1 Dig up a whole small weed plant with all its roots. A groundsel or milkweed plant would be suitable.
- Wash the soil away and place the weed in a small bottle of water. Mark the water level with a felt pen.
- **3** Block the neck of the bottle with plasticine.
- 4 Next day check how far the water level has fallen.
- 5 Put a plastic bag over the plant and fix it to the neck of the bottle with a rubber band.
- 6 Next day check the inside of the plastic bag.

Draw a diagram of the experiment and write an explanation of what you have observed.

Vein patterns

Aim

To make a study of vein patterns on leaves.

What to do

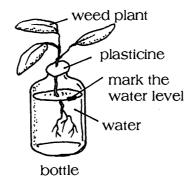
- 1 Collect five or more different leaves.
- 2 Use a separate piece of blank paper for each leaf.
- Put the leaf under the paper. Trace around its outline and then rub all over it using a soft pencil or crayon to record the vein pattern.
- 4 Arrange the leaves in groups according to their vein patterns.

Hidden word

Copy the chart. Then follow the directions and you will find the name of something which is vital for all life on earth.

	1	2	3	4	5	6	7	8	9	
A	В	R	A	Ŗ	С	В	Н	C	Е	
B	Ο	T	I	A	J	U	E	F	T	
\mathbf{C}	U	Α	Ο	S	В	С	F	G	I	
D	Α	Y	D	U	G	X	N	K	T	
E	Н	S	В	Е	Е	D	S	W	Ο	
F	K	С	J	С	Ο	В	T	V	Α	7
G	I	Н	S	F	В	Z	D	Ο	Α	





Directions

- 1 Cross out all vowels in row 9.
- **2** Cross out all vowels that are found in the word GUARD.
- 3 Cross out all consonants in row C that come before P in the alphabet.
- 4 Cross out rows F and 8.
- 5 Cross out all Bs and Ds.
- 6 Cross out all consonants in row 5.
- **7** Cross out everything except the last two letters of SPOT in row B.
- **8** Cross out all letters of the word SCRATCH in row 2.
- 9 Cross out any of the first six letters of the alphabet that are left in row 4.
- 10 Cross out all row 6.

Fill in the blanks with the remaining letters:

Flower families

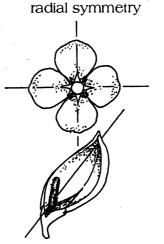
12: FLOWERS Flo

Aim

To use a simple key to identify some flower families.

What to do

- 1 From ten different flowering plants, collect a fully opened flower and a leaf. Label them so they do not get mixed up.
- 2 To find out which family each belongs to, follow these steps:
 - **a**. Examine the leaves to find out if the veins are parallel or branching.
 - **b**. Check the type of symmetry.
 - (A flower has radial symmetry if it is the same in all directions from a central point. It has bilateral symmetry if it can be divided into only two parts that are the same.)
- 3 Check if petals are joined or not joined.
- Use the table to find the group of families to which the plant belongs.



bilateral symmetry

Plant Characteristics

I Leaves with parallel veins

A Flowers with radial symmetry

B Flowers with bilateral symmetry

II Leaves with branching veins

A Flowers with radial symmetry

i Petals not joined

ii Petals joined

B Flowers with bilateral symmetry

i Petals not joined

ii Petals joined Flowers densely clustered in a disc.

Families

Lily

Iris, Orchid

Buttercup, Poppy, Rose Mustard, Mallow, Pink Primrose, Heather, Phlox, Honeysuckle, Morning-glory

Violet, Pea Snapdragon, Mint, Lobelia Composite (Daisy family)

13: SEEDS

Find the flowers

Use the code to work out the names of some common flowering plants.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
d	а	i	n	s	h	У	1	р	О	m	f	e	9	r

12357

1 2 9 6 14 13 1 2 6 8 3 2 8387

11 2 15 3 14 10 8 1

15 10 5 13 1 2 12 12 10 1 3 8

Parts of a seed

Aim

To see and draw the parts of a seed.

What to do

- 1 Soak some broad bean seeds in water over night.
- Next day, examine the seeds using a hand lens. Draw a seed before you open it up.
- Remove the seed coat from a seed and gently pull the two parts of the seed apart.
- 4 Draw diagrams to show what is inside the seed.
- 5 Use the text book to find labels for your diagrams.

14: GROWING
PLANTS
FROM SEED

thinned seedlings

unthinned seedlings

Aim

To compare the growth of plants grown in overcrowded conditions with those that are well spaced.

What to do

Use two containers of damp potting mix and a packet of radish seeds.

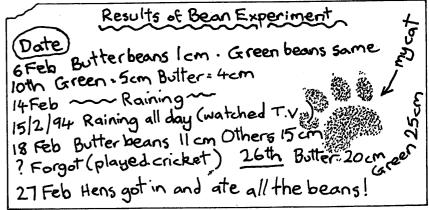
- 1 Sprinkle half the radish seeds closely in each container and cover with a little fine potting mix. Leave in a warm place to germinate and grow, watering gently when needed.
- When the seedlings each have grown two true leaves, pull out half of the seedlings from one container and throw them away. Leave the other seedlings unthinned.
- After about two weeks compare the appearance of the two sets of seedlings. Measure the height of ten seedlings from each group and find the average height. Draw a diagram of the leaves of a typical seedling from each group.
- 4 Make a statement about the results of this experiment.

15: CARE OF SEEDLINGS

Table and graph making

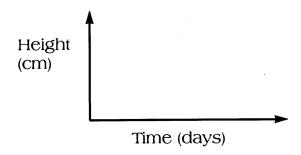
A student set up an experiment to see whether butter beans or green dwarf beans would grow more quickly in his garden. He planted a short row of each and treated them just the same. After the beans germinated he measured the height of each plant every few days. Then he found the average height for each row.

Here are his results. They are a bit messy because he was not very organised and the cat stood on them.



What to do

- 1 Make a table to show these results more clearly.
- 2 Draw a line graph to show the growth of the two sets of beans.



Growing a plant from a cutting

Aim

To grow a geranium plant from a stem cutting.

What to do

- 1 Cut a piece of stem 10cm long from a healthy geranium plant.
- 2 Trim off flowers and leaves until only two strong leaves are left.
- 3 Cut the base of the stem below a node (the line where the leaves came from).
- 4 Put the cutting in some moist potting mix. Cover the pot and cutting with a glass jar or a plasic bag to keep the humidity high.
- 5 Keep your plant watered in a place where there is plenty of light for three or four weeks. Then pull gently on the plant to see if the roots have grown. Plant the new plant in your garden.

Drainage

Aim

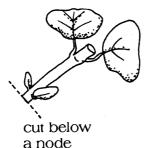
To compare drainage rates in different soil types.

What to do

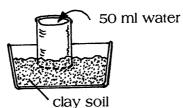
- 1 Use a tin opener to remove both ends from two tin cans.
- 2 Collect some clay soil in one icecream container and some sandy soil in another. Push a tin can 50mm into each soil sample.
- 3 Add 50ml of water to each tin and time how long it takes for the water to drain from each tin completely.

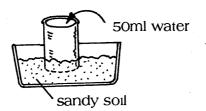


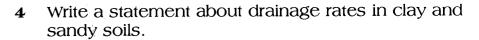
leave two strong leaves on the cutting





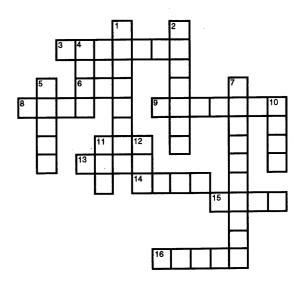






Soil crossword

Complete this soil crossword by writing the answer to each question in the correct place on the grid.



Across

- **3** A word used to describe a light, crumbly soil.
- 6 An animal that digs holes in soft soil.
- 8 A tool used to loosen soil after digging.
- **9** The layer beneath the topsoil is called the
- 11 is needed in soil for good root growth.
- 13 This soil has very small particles and small pore spaces.
- 14 A word meaning 'not difficult'.
- 15 in a soil feels gritty.
- 16 Decaying material from plants is called

Down

- 1 These tiny decomposers are found in all soil samples.
- 2 The of a soil is the proportion of sand, silt and clay that are in it.
- 4 At the bottom of a deep soil profile is parent
- 5 Healthy soil contains lots of these small animals.
- 7 Gaps between soil particles are known as
- 10 The best kind of soil for a garden is called
- 11 A three-letter word meaning 'the lot'.
- 12 A type of grass.

Calculation

The famous scientist, Charles Darwin, liked to study worms. He worked out that each worm brought over 500 grams of soil to the surface in a year.

Find the area, in square metres, of a flower bed in your garden or at school.

If there are approximately ten worms to every square metre, what weight of soil do the worms bring to the surface in that patch in a year, if Darwin's figures are correct?

Water-holding abilities

Aim

To see how much water is held by varying proportions of peat and pumice sand.

What to do

- 1 Make up five identical pots of mix containing peat and pumice sand in the following proportions:
 - **a** 100% peat
 - b 75% peat and 25% pumice sand
 - c 50% peat and 50% pumice sand
 - d 25% peat and 75% pumice sand
 - e 100% pumice sand

(Make sure the peat and pumice sand are mixed well together before the mixture is put in the pot.)

- 2 Stand each pot over a beaker to collect the water that passes through the mix.
- 3 Add 50 ml water to each pot and leave for ten minutes.
- 4 Use a measuring cylinder to measure the amount of water that has passed through each mix.
- **5** Write this experiment into your notes. Use the headings <u>AIM</u>, <u>METHOD</u>, <u>RESULTS</u>, <u>CONCLUSION</u>.

Water and seeds

Aim

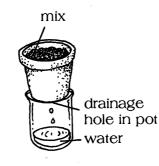
To see how much water is taken in by living seeds at the start of germination.

What to do

1 Weigh 25 bean or pea seeds and then soak them in water over night.



19: ARTIFICIAL MIXES



20: WATERING SYSTEMS



- Next day, dry the seeds gently on a paper towel and then weigh them again.
- Work out the average weight increase per seed by dividing the difference in the two weights by 25.
- 4 Write a conclusion for this experiment.

Different groups could use different types of seeds for this activity and then compare their results.

Presenting results

A student grew some green pepper plants in a greenhouse. Her friend grew some of the same plants in the garden outside. When the peppers were fully grown they each picked 20 from their plants. They measured the length and diameter of each pepper.

Here are their results:

Peppers

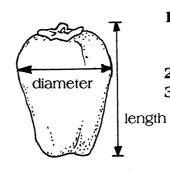
Greenhouse Length (cm)
Diameter

	1	2	,	4	,	U	,	0			• •									
1)	8.8	9.5	11	10.7	11	10.6	12	9.2	10.8	9	10.3	9.7	8.2	11.8	10	9.5	8.8	11.9	9	8.2
	5	7.5	9	6.8	7	7.7	9.9	8.3	7.7	5	8.6	7	5.8	7.5	6	7.8	6.2	9.8	7.2	5.2

Outdoor Length (cm)
Diameter

6	9.9	7.8	7	5.2	8.6	6.2	7	7.5	5.8	7.7	9	7.5	5	9.8	8.3	7.2	6.8	7.7	5
3	5.5	6.6	5	4.8	7.8	5.7	3.2	5.8	3	5.5	7	6.3	3.8	5.2	7.9	5	4.2	5.7	4
	1																		

What to do

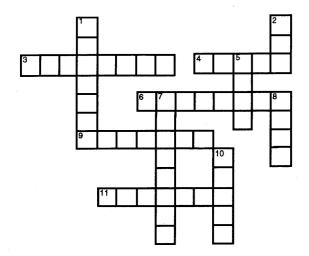


- Find the average length and the average diameter for each set of peppers by adding up each set of results and dividing the answer by 20.
- 2 Decide which set of peppers grew best.
 - Imagine you are writing an article for a gardening magazine about the use of shelter when growing peppers. Make a comparison graph or draw a picture to show the effect of shelter on the growth of peppers.

22: TRAINING PLANTS

Crossword

Complete the crossword about training plants by writing the answer to each question in the correct place on the grid.



Across

- 3 You can remove surplus fruit by doing this.
- 4 A stick used for support.
- 6 The removal of the terminal bud is called
- **9** The bud growing just above a leaf stalk.
- 11 Cutting away parts of a plant is known as

Down

- 1 You can the shape of a plant by pruning it.
- 2 Perhaps you need to how an expert prunes a tree.
- 5 The is the angle between stem and leaf.
- **7** The bud at the tip of the main stem is called the bud.
- 8 After disbudding, larger blooms will
- 10 Pruning a tree lets in more of this.

Aphid reproduction

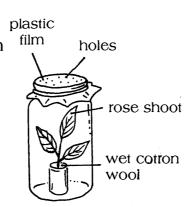
Aim

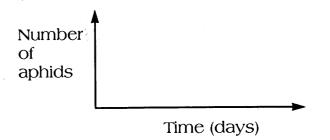
To see how quickly aphids reproduce.

What to do

- 1 Cut a young healthy shoot of a rose bush and wash it carefully to make sure it has no aphids on it.
- 2 Stand the shoot in wet cotton wool in a jar.
- 3 Transfer one fat aphid on to it with a paint brush.
- 4 Cover the jar with a plastic sheet which has tiny ventilation holes pricked in it.
- **5** Count how many aphids are in the jar each day.
- 6 Draw a graph of your results.

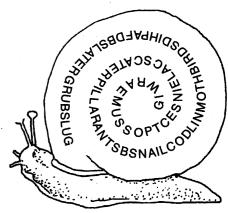






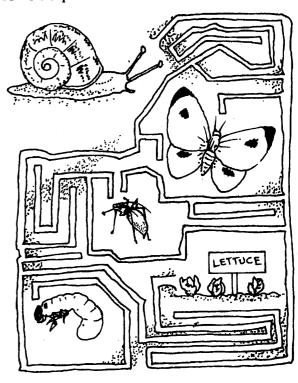
Wordfind

Find the names of twelve common garden pests hidden in this snail.



Find the trail

Find the route the snail had to follow to get to the tender young lettuce plants.



Diseases wordfind

All the words in the list below are somewhere in the wordfind buzzle. How many can you find?

1.4			A 100	
24:	Die	99	CA	•
24.		UU	P 1	9

Α	В	S	Р	R	Α	Υ	В	Ε	Н	S
R	N	Q	Н	R	0	Т	Α	Т	ш	F
Ε	М	0	C	L	D	D	O	ם	G	כ
s	1	F	М	S	F	J	Т	_	O	Z
П	L	٧	_	R	υ	s	E	s	0	G
s	D	С	D	R	Ν	Р	R	Ε	Z	_
Т	E	L	1	0	G	0	1	Α	Т	С
A	W	E	Т	T	Ι	R	Α	S	R	1
N	С	Α	Y	Κ	R	Ε	Р	Ε	0	D
T	D	N	L	R	U	S	Т	В	L	Ε

BACTERIA	MOULD
CLEAN	RESISTANT
CONTROL	ROT
DISEASE	ROT
FUNGI	ROTATE
FUNGICIDE	RUST
HUMIDITY	SPORES
MILDEW	SPRAY

25: Weeds

Weeds on bare ground

Aim

To investigate which weeds will grow on a piece of bare ground in your area.

What to do

First you will need to find a space which can be left untouched for several months. Spring is a good time to try this.

- Clear about one square metre of your area so that no plants are visible on it.
- 2 Mark the square with stakes and twine.
- 3 Leave alone.
- 4 Each week, investigate the area to see what has grown. You could take photos or draw diagrams to show what has happened.
- 5 After two or three months collect specimens of the weeds in your plot. Find out their names from reference books.
- **6** Write a summary of your findings.

KEEP OFF!

Weed success

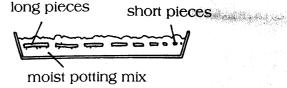
Aim

To see why some weeds are so successful.

What to do

a 1 Dig up the roots of some convolvulus and/or some couch grass.

- 2 Cut the roots into small pieces, from 3cm down to 2mm lengths.
- 3 Plant the pieces in a tray of moist potting mix, in order of size.



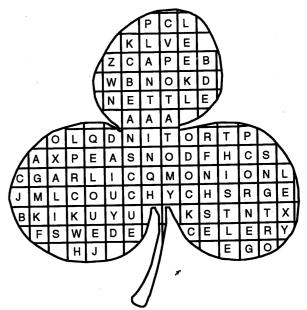
- 4 Keep moist in a warm, light place until shoots grow.
- Write a conclusion for this experiment.



- 1 Collect 100 ripe dandelion seeds.
- 2 Sow the seeds in moist seed-raising mix.
- 3 Count how many seeds germinate.
- c 1 Find a dandelion growing on some waste ground.
 - 2 Cut the dandelion off level with the soil.
 - Mark the place and look again in a week's time. Repeat.
 - 4 Write a statement about dandelion survival.

Weed wordfind

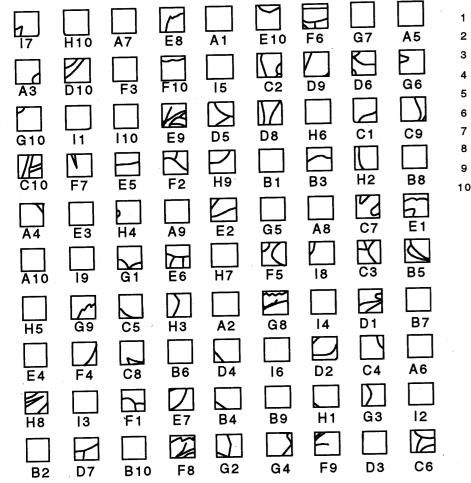
Vegetables and weeds are all mixed up in this clover leaf. Can you separate them into their groups? There are seven weeds and nine vegetables to be found.

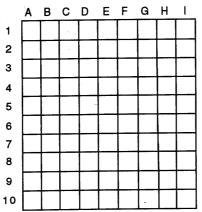


Picture mix-up

Carefully copy the lines inside the squares on to the correct places on the grid to draw a picture of something that grows best with the help of a suitable spray programme. Colour the finished picture.



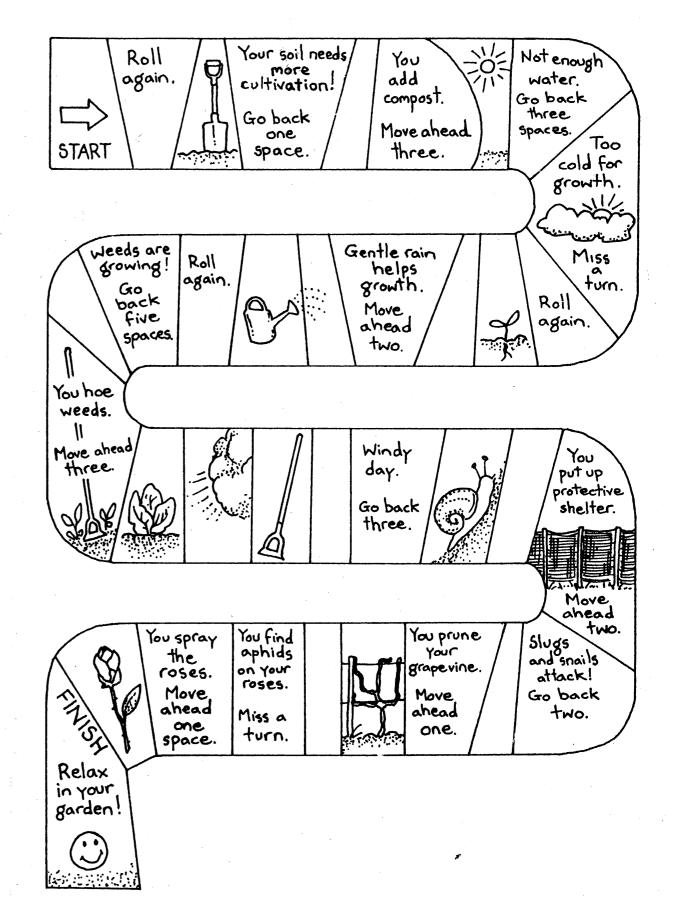




Garden game

See how quickly you can get to relax in your garden. Play this game alone or with a friend. You will need a die and coins or buttons to use as counters. Roll the die to see how many spaces to move and follow any instructions that may be in the square. The winner is the first across the finish line.

27: Roses



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