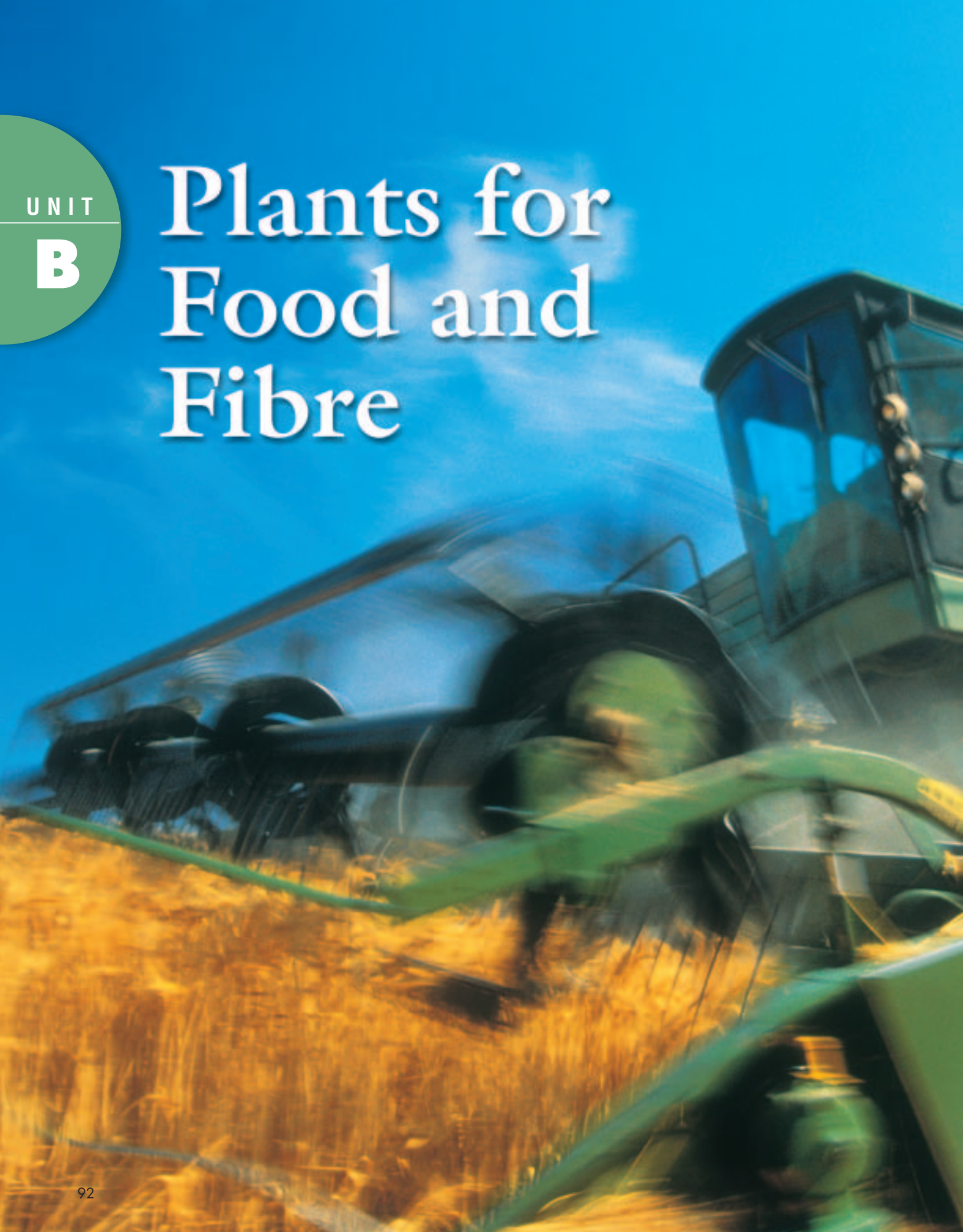
UNIT

B

Plants for Food and Fibre



In this unit, you will cover the following sections:

1.0 **Understanding structures and life processes of plants helps us to interpret their needs.**

- **1.1** The Body of Seed Plants
- **1.2** Plant Processes
- **1.3** Reproduction of Seed Plants
- **1.4** Plant Structures Vary to Adapt to Their Environment
- **1.5** Plant Needs and Growing Conditions

2.0 **Plants play an essential role in the environment and in meeting human needs.**

- **2.1** The Role of Plants in the Environment
- **2.2** We Use Plants in Many Ways
- **2.3** Natural and Managed Resources

3.0 **Soil is an important resource that human activity can protect or degrade.**

- **3.1** What Is Soil?
- **3.2** Our Practices Can Improve or Degrade Soil

4.0 **The ways that plants are grown and used are related to human needs, technology, and the environment.**

- **4.1** Modifying Environments to Increase Yields
- **4.2** New Plant Varieties Are Developed by Selective Breeding
- **4.3** Controlling Weeds and Pests
- **4.4** Consequences of Environmental Management

Exploring

Our planet would be a very different place without plants. In this unit, you will find out why plants are critical for all life on Earth. You will learn about the many ways we use plants, and the technologies we use to produce the plants we need. You will investigate how plants have adapted to different environmental conditions. You will take part in activities that will challenge you to come up with real-life solutions to problems that can be caused by the ways we grow plants. Understanding the consequences of the changes we make in growing plants will allow you to predict when these changes can harm the environment.

Surviving in the Wilderness

Many great stories have been written about people who have found themselves stranded and alone in a wild place. *Robinson Crusoe*, by Daniel Defoe, is one such story about a man who is shipwrecked on a deserted island and has to survive on what he can make or find.

Do you think you could survive in a wild place? The teenagers in this newspaper article found out the hard way that they could survive in the wilderness of northern Alberta!

Teens Found Alive in Bush

Rescuers airlift survivors to safety.

Elk Point, Alberta. – Wild berries and boiled leaves and roots kept three teens alive during a 24-day ordeal on a remote island on Frog Lake, 210 km northeast of Edmonton. The teens became stranded after the paddleboat they used to get to the island drifted away from the shoreline. The trio was unable to swim off the island, since the shoreline was an icy 300 m away.

The quick-thinking teens set to work searching for food and shelter. They made a lean-to and bedding out of pine boughs. They collected edible berries, roots, and leaves. The teens also collected twigs for firewood and were able to light a fire with a cigarette lighter.

The teens ate rose hips and slept on boughs.

Safety Caution!
Never eat any plant that you find in the wild unless you are sure what it is. Many plants can make you sick.

These young people were able to survive because they used plants for food, shelter, and warmth. The photographs above show two examples of plants that they used.

Our provincial flower, the wild rose, has many parts you can eat. The hips in particular can be an important survival food, since they are available throughout the fall and winter. One rose hip can contain as much vitamin C as an entire orange, as well as other important nutrients.

Balsam fir has soft needles that can provide wonderful bedding. The resin from this tree can also be used to relieve insect bites, sores, or rashes.

How about you? Would you know how to use plants to help you survive? With a partner, see if you can name two plants that you could use. At least one of them should be a plant you can eat.

Give it a **TRY** **ACTIVITY**

SURVIVOR!

You and your friends love to spend the weekend camping in the great outdoors. But while you are hiking in the woods, you take a wrong turn and can't find your way back. You're lost!

You might have to stay in the woods for a few days until someone finds you. All you have is the clothes you are wearing, a pocketknife, and anything you can find in the woods.

In a small group, discuss how you could use plants that grow in the woods in your area to meet your basic needs of food, warmth, and shelter. How long do you think you could survive?

Focus On Science and Technology

As you proceed through this unit, you will be asked to organize your thoughts around how technology can help us to grow and use plants in a way that doesn't harm the environment. Many human activities are a balance between these two things. You will be asked to think about these ideas as you perform activities and answer questions throughout this unit.

1. **How is the environment affected by the way we produce and harvest plants?**
2. **What technologies can help us to produce the plants we need and also minimize the impact we have on the environment?**
3. **What kind of knowledge must we have about plants and their environment to ensure we continue to produce the plants we need and keep our planet healthy?**

The answers to these and other questions about plants will help you understand how using plants for our needs relies on knowledge and the use of appropriate methods. The project at the end of the unit is a chance to apply what you have learned by designing and building a growth chamber for vegetable seedlings.

1.0

Understanding structures and life processes of plants helps us to interpret their needs.

Key Concepts

In this section, you will learn about the following key concepts:

- life processes and structure of plants
- plant propagation and reproduction

Learning Outcomes

When you have completed this section, you will be able to:

- describe the parts of a seed plant
- explain the processes that a plant uses to stay alive
- describe the life cycle of seed plants

Do you know what a plant needs to live?

You probably know a lot about plants. You might know that most plants have leaves, at least one stem, and roots. And lots of plants have flowers. But of course, not all plants are the same. Think how different a cactus is from a pine tree! Do you believe that they both have the same parts? It's true!

Is there anything that you've ever wondered about plants? There are so many questions we could ask. Why do they produce flowers? How does a seed work? Let's take a closer look at plants and see if we can find answers to some of these questions.

1.1 The Body of Seed Plants

In this unit, we are going to look only at those plants that make seeds, or **seed plants**. Some examples of seed plants that you might have seen are daisies, cottonwood trees, wheat, and orchids. As you can see, seed plants come in all shapes and sizes.

On a clean page in your notebook, sketch a seed plant. It can be any kind of seed plant you want. Label each part, then write down everything you know about the part in point form beside each label. As you work through this unit, you can look back to your sketch and your notes and add or change anything you want to as you go along.

Figure 1.1 Seed plants are the largest group of plants in the world.

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The Same, but Different

Although they look very different, the structures that make up these plants are the same. What are these structures?

Give it a **TRY** ACTIVITY

PLANT PART CHARADES

Do you think you could describe the parts of a seed plant without speaking out loud? Try it and see!

Your teacher will hand you a card that will have one of these plant parts written on it: stem, leaf, root, or flower. When you get your card, read what's on it and think about how you might act out your word.

Pick a partner and take turns acting out your words. After you get the correct word, discuss the function of the plant part with your partner.

Problem Solving Activity

Design a Model of a Seed Plant

Materials

- a collection of craft materials that could be used to make a model, such as construction paper, cardboard, tissue paper, pipe cleaners, craft sticks, modelling clay

Recognize a Need

You own a small company that makes displays for museums and science centres. One of your clients needs a model of the structures found in a seed plant. The model has to be simple enough for small children to understand, but it has to be accurate.

The Problem

Make a three-dimensional model of a seed plant.

Criteria for Success

For your model to be considered successful, it must

- contain all the parts of a seed plant
- have labels on all the parts

Brainstorm Ideas

1. With a partner, make a list of all the parts that must be included on your model.
2. Draw a sketch of how your finished model will look.
3. Make a list of the materials you might use to create your model.

Build Your Model

4. Gather your materials and construct your model.

Test and Evaluate

5. Look over your model and check how well it fits the criteria for success. Make any changes to your model that you think are needed.
6. Set your plant model up in an area designated by your teacher. Look over other students' models and compare them with your design. Assess how well the other models fit the criteria. Are all the models the same or different? Suggest a reason to explain this.

Communicate

7. With your partner, write a description of each of the plant parts that are on your model. Your description should be in a style that would suit a science centre display.

Each Plant Structure Has a Function

Seed plants not only have the same kinds of structures, but these structures do the same job in all plants.

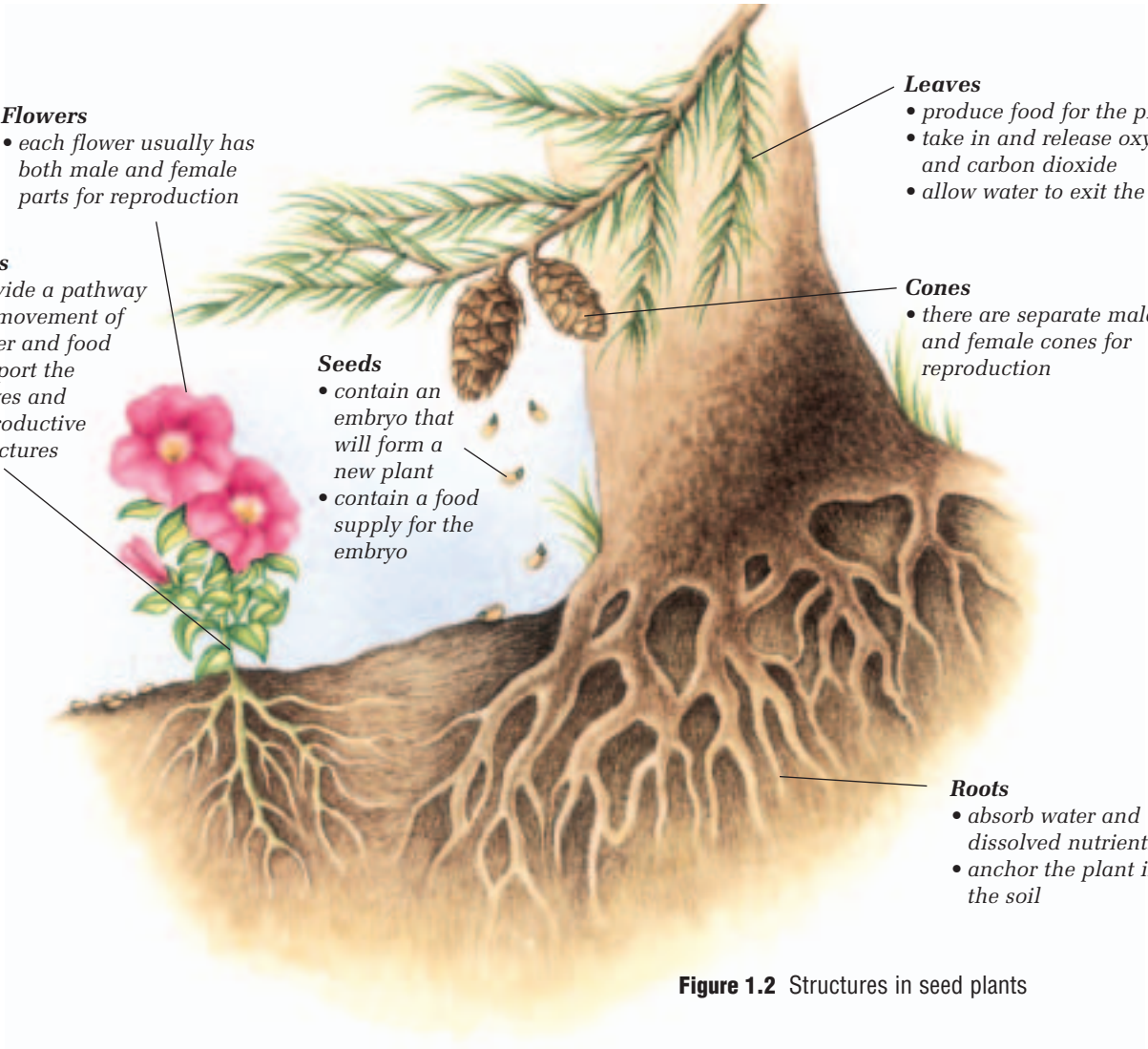

Figure 1.2 Structures in seed plants

Check and Reflect

1. What are the main parts of a seed plant?
2. Draw a diagram of a root or a leaf. Write two or three sentences below your diagram that describe the function of the structure you choose.
3. Why do plants produce seeds? Name one plant structure that can produce seeds.
4. Give three examples of seed plants that grow in your area. Do not use any of the examples from this book.

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Water Me!

More than 90% of the water a plant takes in is lost through its leaves. No wonder they need to be watered regularly!

1.2 Plant Processes

This tall tree has to move water up from its roots and food down from its leaves. How do plants transport these substances?

You have probably broken or cut a plant apart, so you will know that plants don't have a heart or a pump to move water and nutrients around. Discuss with a partner how a plant might move substances from one part to another. Have you seen any other examples of fluids moving without being pumped?

Figure 1.3 Do plants have a pump?

Give it a **TRY** ACTIVITY

MOVING IN THE RIGHT DIRECTION

Plants can move water from the soil up to their leaves. Animals move fluids around their bodies by the pumping action of their hearts. This experiment can help you understand how plants move fluids.

Put enough water in each beaker so that they are both about one-third full. Mix several drops of food colouring into the water.

Remove the leaves from one stalk of celery. Prop the celery in the beaker so its base is in the water. Place the other stalk that still has its leaves in the other beaker.

Place both beakers containing the celery stalks under a bright light or in a sunny spot for about three hours.

Remove the stalks from the water and cut cross sections from each stalk at several places so you can see how far the food colouring moved up the stalk.

Compare the distance the food colouring moved up in the two stalks. Why do you think this difference occurred?

Materials & Equipment

- water
- food colouring
- 2 400-mL beakers
- 2 stalks of celery with leaves
- small sharp knife or razor blade

A Process for Moving Water Up from the Roots

Water moves up a plant from the roots to the leaves by a combination of processes. These processes include the following:

- The main process that draws water up from a plant's roots is **transpiration**. Transpiration is the evaporation of water from the surface of the plant—mainly from the leaves. Water particles evaporate from the surface of the leaves, and more water particles move up within the plant to take their place. This process continues down through the plant with particles continually moving up from the roots.
- Another process that helps water move up through a plant is called **capillary action**. Water travels from the roots to the leaves through tiny tubes in the roots and stems. You may have learned in other lessons that water particles are attracted to one another. This attraction causes water particles to "stick" to one another. The water particles are also attracted to the sides of the tiny tubes. This attraction, along with the attraction between the water particles themselves, helps to move the water up inside the plant.
- Water from the soil enters root cells by a process called **osmosis**. When the concentration of water in the soil is greater than the concentration of water in the roots of the plant, water moves into the root cells. You will learn more about osmosis in this subsection.

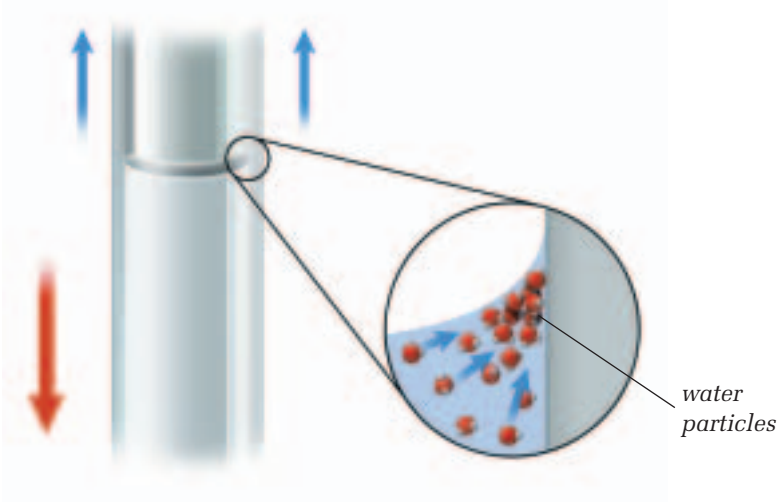

Figure 1.4 When tubes are very narrow, like this glass tube, the force of the attraction of the water particles to the sides of the tube is greater than the force of gravity, so the water moves up.

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Moving Up

Place a plastic bag over a plant and tie it shut. Leave it in a sunny window for a day. Explain what happens using the word "transpiration."

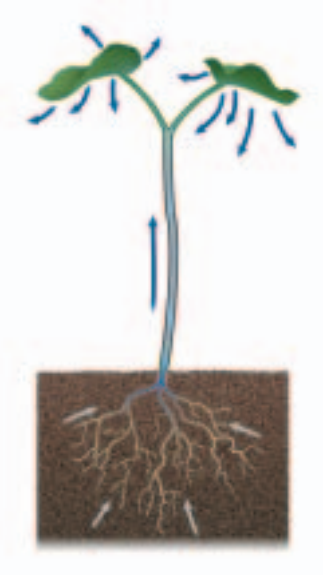

Figure 1.5 Water moves into root cells and then travels up tiny tubes to the leaves. Water particles exit through small holes in the leaves. If there is too little water in the soil, and the plant continues to lose water from its leaves, the plant wilts.

A Process to Make Food

Plants make their own food by the process of **photosynthesis**. Photosynthesis produces a type of sugar.

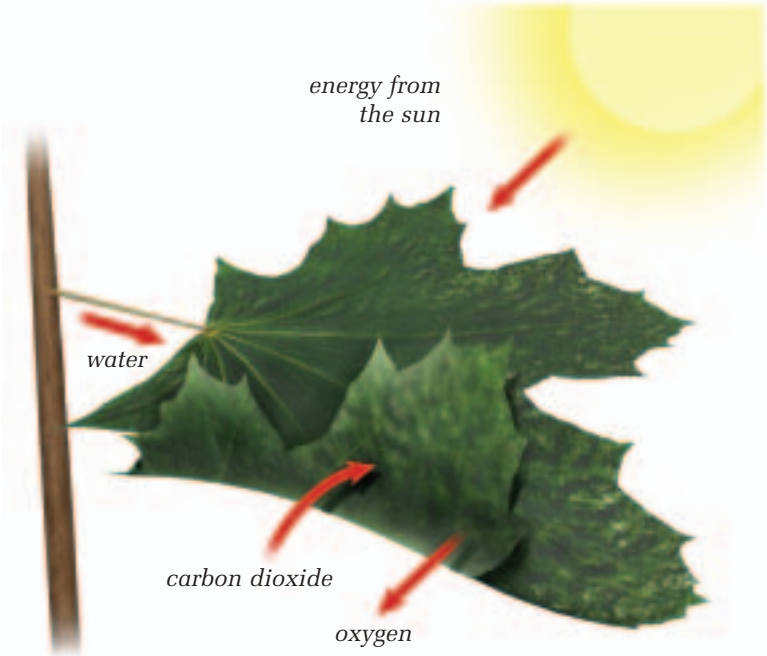

Figure 1.6 Plants use the energy from the sun to make their own food.

The leaves of seed plants usually do most of the photosynthesis. Photosynthesis takes place in structures inside the leaves called **chloroplasts**. The chloroplasts capture the sun's energy and use it to join carbon dioxide and water together to make sugar. This process also produces oxygen.

A Process to Use Food

When plants photosynthesize, they use energy to turn carbon dioxide and water into sugar. When plants use this sugar for food, they get energy and produce carbon dioxide and water as waste. This process is called **cellular respiration**.

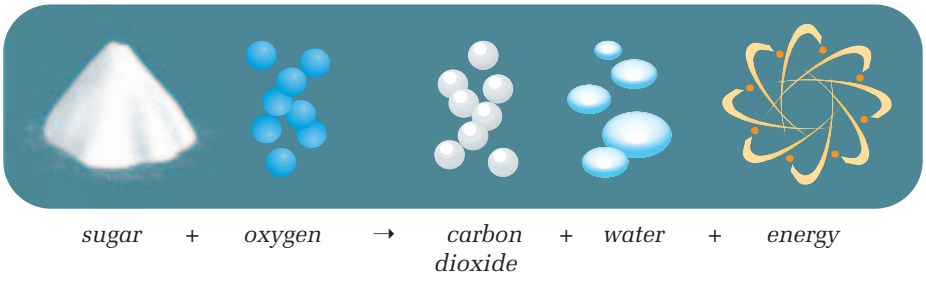

Figure 1.7 The word equation for cellular respiration.

Inquiry Activity

Plants at Work

The Question

How does transpiration move fluids from the roots?

The Hypothesis

If evaporation occurs from the surface of the plant, then fluids move up from the roots into the stems and leaves.

Materials & Equipment

- 2 plant cuttings wrapped in moist towelling
- graph paper
- 2 small beakers or clear vials
- 10-mL or 25-mL graduated cylinder
- water
- plastic wrap
- scissors
- a sunny window

Procedure

1. Collect two plant cuttings that are about the same size. Carefully remove all the leaves but one from one cutting. Keep all the leaves on the other.
2. Determine the volume of water that will fill the beaker to about 1 cm from the top. Measure the same volume of water and fill each of two beakers.
3. Stretch a sheet of plastic wrap tightly over the top of each beaker. Using a pencil, punch a hole in the plastic.
4. Cut about 0.5 cm off the bottom of each plant cutting. Place the stem of the cutting in each beaker of water through the hole in the plastic.
5. Put your cuttings in a sunny window and leave them overnight.
6. The next day, remove each cutting from its container. Be careful not to lose any of the water. Using the graduated cylinder, measure the amount of water that is left in each of the beakers. Record your findings.

Figure 1.8 Step 7

Collecting Data

7. Remove the leaves from one cutting. Carefully trace the outline of each leaf on a piece of graph paper.
8. Estimate the area of each leaf by counting the number of squares it fills. Count any square that is at least half inside the outline.
9. Estimate the area of all the leaves and record your findings. You may want to make a table or use a spreadsheet program.

Analyzing and Interpreting

10. Make a bar graph showing the amount of water that was in the two beakers on the second day. Make a second bar graph that shows the total leaf area of the two cuttings.

Forming Conclusions

11. Which of the cuttings lost more water? Compare the leaf area of this cutting with the other.
12. Water evaporates from pores on leaves. What do you think happens to the rate of evaporation if there are fewer leaves on a plant?

Applying and Connecting

Have you ever forgotten to water your house plants, and found that they wilted? Suggest a reason why this happens.

Processes to Move Substances In and Out of Plant Cells

After a plant has made sugar in its leaves by photosynthesis, it must transport this food throughout its body. It also has to move the water out of the stem into the rest of its cells.

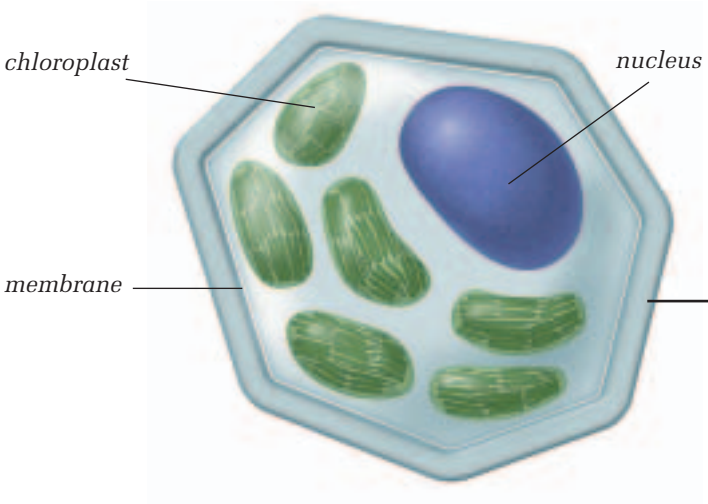

Figure 1.9 Under the cell wall in the plant cell is a cell membrane that has tiny openings. The size of these openings controls what particles can pass through. Particles of water and certain other substances can get in and out of the cell.

math Link

If you stirred 3 g of sugar into 9.3 mL of water, how many grams of sugar would be in each millilitre of water?

As shown in Figure 1.9, the plant cell is surrounded by a membrane that has **pores**, or tiny openings. Particles of some substances are able to move in and out of a cell through these pores. The cell membrane acts as a filter, keeping some substances inside the cell and allowing some substances to move in and out of the cell. Many processes take place to move substances in and out of plant cells. One of these processes is **diffusion**. Diffusion takes place when there is a difference between the **concentration** of a substance inside and outside a cell. Another process that does not require a difference in substance concentration is called **active transport**. Active transport uses energy to move substances in and out of plant cells.

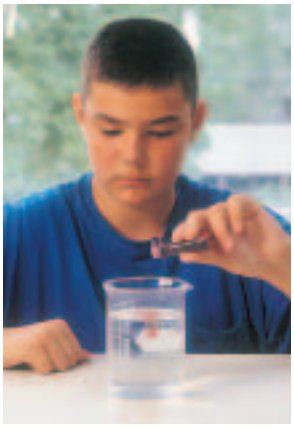

Figure 1.10 The food dye slowly mixes with the water due to diffusion.

Diffusion

When you put a drop of food dye in a glass of water, you get one small area with a lot of dye particles and a large area with none. In other words, there is a higher concentration of dye particles in the drop of food dye. Concentration is the number of particles of one substance in a certain volume of another substance. Diffusion is the movement of particles from an area of high concentration to an area of low concentration, until there is an equal number of particles everywhere. Particles that are small enough to fit through the membrane pores in a plant cell move in and out of the cell by diffusion.

Osmosis

Water is one of the substances that is vital to the survival and health of cells. The cell membrane in plant cells allows water particles to pass through. If the water concentration inside a cell is lower than the water concentration outside, water particles from outside move in through the cell membrane. If the water concentration inside the cell is higher than outside, the cell loses water to the outside. **Osmosis** is a special name given to the movement of water particles through a membrane. Osmosis moves water particles from a cell with a high water concentration to a cell with a low water concentration. Water usually moves out of the cells in the stem to the rest of the plant cells.

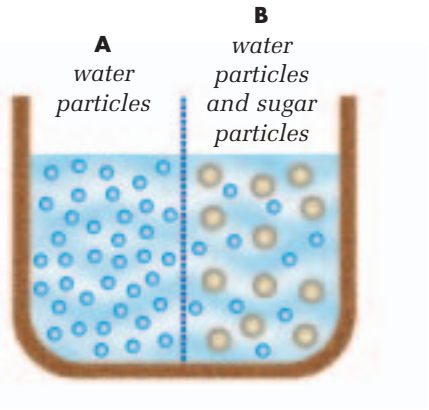

Figure 1.11 This membrane has pores that allow the water particles to pass through but not the sugar particles. The concentration of water particles is higher in side A than in side B, and water particles move from A to B through the membrane. This movement of water is called osmosis.

A Process to Exchange Gases

In the process of photosynthesis, plants use carbon dioxide gas and produce oxygen gas. In the process of cellular respiration, plants use oxygen and produce carbon dioxide. **Gas exchange** is the process of these gases entering and leaving the plant.

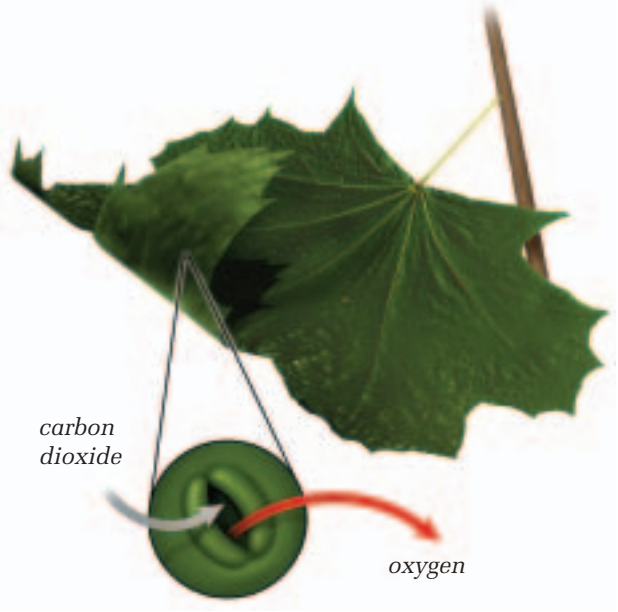

Figure 1.12 Oxygen and carbon dioxide diffuse through tiny openings in the leaf.

Check and Reflect

1. What raw materials does a plant require for photosynthesis? What are the products?
2. How are osmosis and diffusion related?
3. Describe three processes that allow water to move from roots to leaves.
4. What do you think would happen to transpiration if a plant were blowing in a hot, dry wind?

Experiment
ON YOUR OWN

Light and Plant Growth

Before You Start ...

Plants use light to photosynthesize and produce the food they need to grow. Farmers will sometimes clear their fields just to make sure that their crops get as much light as possible.

In this activity, you will design an experiment to test whether plants grow faster when they get more light.

The Question

Do plants grow faster when they get more light?

Design and Conduct Your Experiment

TOOLBOX

You may wish to use Toolbox 2: The Inquiry Process of Science to help you plan your experiment.

1. Make a hypothesis that will allow you to test the effect of different amounts of light on the growth rate of plants. (A hypothesis is a possible answer to a question or a possible explanation of a situation.)
2. Decide what materials you'll need to test your hypothesis. For example:
   a) What kind of plants will you use?
   b) How many plants will you need?
   c) Will you grow the plants from seed or buy plants?
   d) What will you use to supply the light?
3. Plan your procedure. Ask yourself questions such as:
   a) What evidence am I looking for to support my hypothesis?
   b) What steps will I follow to collect the data I need?
   c) Is the test I've designed fair? How do I know?
   d) How will I record my results? For example, do I need a data chart? a graph? both? neither?
   e) How long do I have to complete my experiment?
4. Write up your procedure. Be sure to show it to your teacher before going further.
5. Carry out your experiment.
6. Compare your results with your hypothesis. Did your results support it? If not, what possible reasons might there be?
7. Share and compare your experimental plan and findings with your classmates. Did anyone plan an experiment exactly like yours? similar to yours? How do your results compare with theirs?

Figure 1.13 How will you change the amount of light?

1.3 Reproduction of Seed Plants

Figure 1.14 These wheat seeds are about to begin their life cycle.

A farmer plants wheat seed in the spring and waits for the first shoots of the crop to appear. In a few weeks, the shoots begin to grow tall and green, and leaves may begin to sprout. By the end of the season, the field is covered with healthy plants that have rows of seeds on their stems.

When the wheat is ready to harvest, the wheat plants have gone through an entire life cycle. A **life cycle** is the stages that a living thing passes through to go from one generation to the next. For seed plants, the life cycle starts when a seed begins to grow into a plant and ends when that plant produces seeds of its own.

Think about crops grown in your area. Have they gone through all the stages in their life cycle when they are ready to harvest?

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Packaging Palms

This coconut will eventually grow into a tall palm tree.

Give it a **TRY**

ACTIVITY

THE SECRET OF SEEDS

You are going to look inside some different types of seeds. To make them easier to open, they have been soaked in water beforehand.

- Pick up one of each type of seed.
- Open each seed by splitting it carefully in half. Examine the inside.
- Make a diagram of the structures you see inside each seed. Label any parts you recognize.

Were all the seeds the same inside? From what you saw, can you explain what happens when a seed starts to sprout?

The Life Cycle of Seed Plants

The stages in a life cycle are often drawn as connecting points on a circle. Look at Figure 1.15. What are the stages in the life cycle of a seed plant?

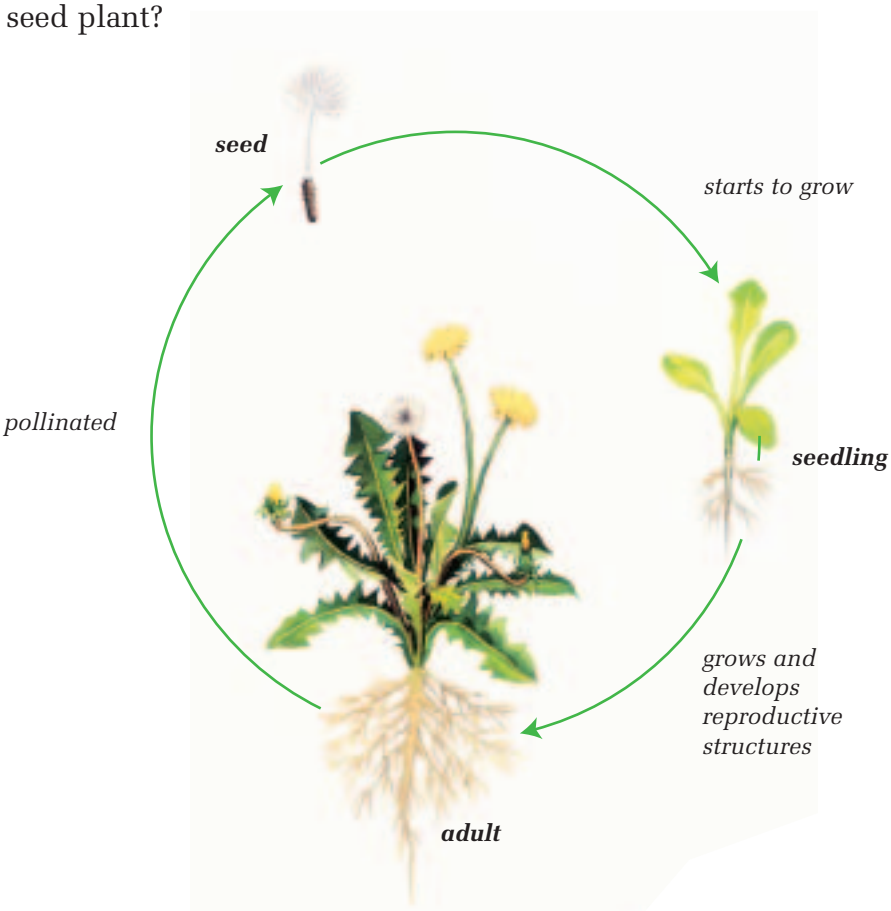

Figure 1.15 Seed plants have three stages in their life cycle.

Figure 1.16 Seeds contain enough food to start the new plant growing.

Figure 1.17 The seedling needs plenty of sunlight, nutrients, and water to grow.

Figure 1.18 This plant is an adult because it has flowers.

The Seed Stage

A seed has three main parts: the embryo, stored food, and a seed coat. The stored food surrounds the embryo in some plant species. In other species, food is stored in part of the embryo itself. The embryo uses this stored food to survive until it begins to photosynthesize and produce its own food.

The Seedling Stage

Plants in the seedling stage grow very fast and produce new leaves, roots, and stems. Seedling plants produce their own food by photosynthesis, but they also need nutrients from the soil to build their new parts.

The Adult Stage

A plant is an adult when it produces reproductive structures. For seed plants, these structures are either a flower or a cone.

Reproduction of Seed Plants

Pollination

Plants produce flowers and cones only so they can make seeds. To do this, the adult seed plant needs to undergo the process of **pollination**.

The diagram in Figure 1.19 shows the parts of a flower. The male part of the flower that is involved in pollination is called **pollen**. Pollen grains are small, sticky cells. One plant produces millions of pollen grains.

The female part of the flower is called the **ovary** and is usually in the centre of the blossom. The ovary contains the **ovule**. Pollination occurs after a pollen grain lands on the *stigma* of the flower, above the ovary (see Figure 1.19). The pollen grain produces a pollen tube that grows down from the stigma to the ovule. Through this tube, cells transfer from the pollen grain to the ovule. The ovule then grows into a seed.

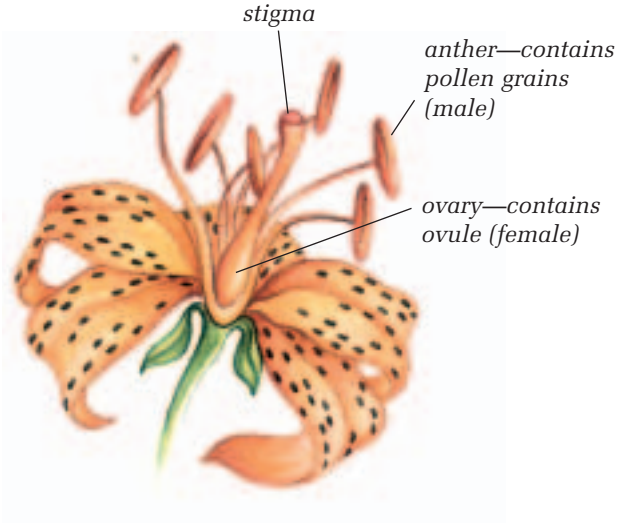

Figure 1.19 Flowers usually have both male and female parts.

Plants that produce cones (called conifers) usually have separate male and female cones. The male cones produce pollen, and the female cones contain the ovules. When the ovules are pollinated, seeds develop on the female cones.

Pollinators

Plants need a way to get the pollen to the ovules. Some plants release pollen in the air, where it is carried by the wind. Conifer trees and grain crops are pollinated by wind.

Many flowering plants rely on **pollinators**, which are organisms that carry pollen from one flower to another. Birds, insects, and even bats can be pollinators. Pollinators come to a flower in search of nectar, a sugary liquid that they eat. As the animal enters the flower, it becomes coated in pollen. When it leaves, it takes this pollen with it and transports it to the next flower.

Many of our crops such as grains and fruits must be pollinated. Growers have found ways to ensure that pollination takes place. Many plants, such as corn, are grown in rows a particular distance apart to help them be pollinated by the wind. Fruit growers will often keep beehives near their plants.

Figure 1.20 Many plants are pollinated by insects.

Problem Solving Activity

Germination and Growth

Recognize a Need

Space is scarce in the greenhouse where you and your colleagues work as research technicians. Improvements in the method for growing plants are required. There are three possible ideas under consideration. Your group will have one or more people investigate each idea. Once you are done, you can compare your results and determine the best method for growing seedlings in the greenhouse.

The Problem

One idea is to use plastic bags with moist inserts as a method for starting and studying seed growth. These bags can be attached to the wall and therefore will not require table or floor space.

The second idea is to use different packing densities for seedling growth. If you can pack more seedlings into a smaller space, there will be more available table and floor space.

The third idea involves determining the best treatment of seeds to prevent moulding. Because of the space problem, the treated seeds will be germinated in small plastic bags and tacked to the wall.

Criteria for Success

For this activity to be considered successful, you must

- decide as a group who will investigate each idea
- complete your investigation and collect appropriate data
- compare results and determine the best method for growing seedlings in the greenhouse

Brainstorm Ideas

1. Below are the task requirements and materials needed to investigate each idea. Read all of these so you are aware of what your partners are doing.
2. As a group discuss a plan for each idea using the materials available.
3. As a group decide how you will use the same process to measure and record plant growth.
4. Prepare a plan for the idea you are investigating. Have your teacher approve your plan before carrying it out.

Materials & Equipment

- bean and corn seeds
- small plastic bags
- absorbent material such as paper towel, cotton batting, coffee filters, vermiculite

Idea 1 – Using Plastic Bags

Task 1

To germinate (grow) seeds in a way that allows seedlings to be easily observed and transplanted to soil.

Idea 2 – Using Different Packing Densities

Task 2

To determine how many seeds can be planted in a confined space without adversely affecting their growth. Your plan should include growing different numbers of seeds (from 2 to 20) in the confined space of a small plastic bag or a 7-cm pot.

Idea 3 – Preventing the Formation of Mould

Task 3

To develop a process that prevents or reduces mould growing on seeds. Prepare a plan that will enable you to determine if briefly soaking seeds in vinegar or a baking soda solution is able to prevent mould from growing on the seeds during germination. Plastic bags with moistened inserts will be used to germinate the seeds.

Test and Evaluate

5 With permission from your teacher, carry out your plan in a safe manner.

6 Record your observations and data.

7 If possible, prepare a graph from your data.

Communicate

8 Work as a group to produce a report. The first section should be your recommended solution. Use data collected in your investigation to support your recommendation. The second section should be three individual summaries describing the work done by each group. For your summary, include observations and a graph if you were able to make one. How does your investigation solve the problem? Discuss any changes you would make to your investigation if you were to repeat it.

Materials & Equipment

Idea 2

- seeds such as corn, beans, radish, or lettuce
- plastic bags or 7-cm pots
- absorbent materials such as paper towel, cotton batting, coffee filters, vermiculite, loam soil
- ruler
- thumb tacks
- tack board or table

Materials & Equipment

Idea 3

- 30 corn seeds (about 10 seeds for each treatment and 10 untreated for comparison)
- small plastic storage bags
- absorbent material such as paper towel, cotton batting, coffee filters, filter paper
- vinegar
- baking soda solution
- thumbtacks
- tack board

Figure 1.21 These plants can use stems to reproduce.

Reproduction without Seeds

Seed plants don't always reproduce from seeds. Reproduction of plants that doesn't involve seeds is called **vegetative reproduction**. Plants produced by vegetative reproduction are genetically identical.

Some plants reproduce from stems. Some produce **runners**, which are long stems that grow along the surface of the soil. Other plants produce new stems that run underground called **rhizomes**. Other underground stems are produced close to the plant to make the structures we call bulbs, tubers, and corms.

Some seed plants reproduce from their roots. New plants that form on roots are called **suckers**.

Growers often use these other ways of reproduction to produce plants. The horticultural industry produces many of the plants you see in nurseries using vegetative reproduction. For example, the millions of spring bulbs sold each year are produced this way. Suckers are used to produce new plants of fruit trees and berry plants.

Figure 1.22 These plants can use roots to reproduce.

Technology to Reproduce Plants

Growers also produce plants from **cuttings** and by **grafting**. Cuttings are small pieces of a plant that usually have a part of the stem and a few leaves. Almost all plants can produce new roots from a cut stem under the right conditions. Grafting is attaching a part of one plant onto another plant. Usually, a small branch of one plant is grafted. The two sections eventually grow together.

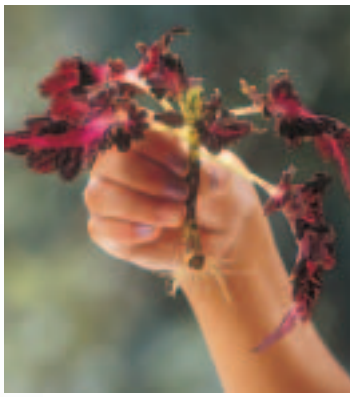

Figure 1.23 New roots come from the stem, making a whole new plant.

Figure 1.24 The cut pieces from another tree will eventually become a part of this one.

Check and Reflect

1. Draw a diagram of the life cycle of seed plants. Label each stage.
2. What is a pollinator? What attracts pollinators to flowers?
3. Describe two ways that a seed plant can reproduce without seeds.
4. Describe how a nursery might produce petunias to sell as bedding plants.
5. What did you learn about conifer trees in this section that you didn't know before?

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A Plant Puzzle

Many of the plants that humans grow are seedless, such as seedless grapes and oranges. How do growers reproduce these plants?

1.4 Plant Structures Are Adapted To Their Environment

After a day of cross-country skiing, wouldn't it be great to come home and refresh yourself with an orange picked fresh off your own tree? Of course, this could never happen. Orange trees don't grow outdoors in Alberta because it's far too cold. But other trees, such as cottonwood and white pine, are able to grow in cold climates.

Give it a **TRY** ACTIVITY

Beneath Your Feet

Seed plants come in many shapes and sizes. Even though plants may look very different, you can usually find roots, a stem, leaves, and reproductive structures.

Look at these photographs of seed plants. Identify all the plant parts you can find for each one.


Figure 1.25


Figure 1.26


Figure 1.27


Figure 1.28

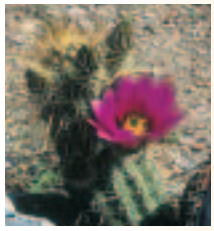
Figure 1.29


Figure 1.30

When you have identified all the plant parts you can, discuss with another student the differences in the plants in the pictures. What is different about the leaves? How about the stems?

Can you think of a reason why these structures are so different?

*info***BIT**

Needles and Leaves

Pine and fir trees have leaves shaped like needles. The leaves of raffia palm can grow up to 20 m long and 2.4 m wide!

Problem Solving Activity

Creating a Lesson About Flowers

Recognize a Need

You're a teacher for a class of grade 1 students. Your students are learning the names for the parts of plants. Some of them are having a really hard time. Every time you show them a plant they haven't seen before, they can't name any of the parts! You need to come up with a fun way of showing your students lots of examples of the parts of plants. You're going to work with a friend to come up with a plan for showing them variations in flowers.

The Problem

Create a fun and interesting way to present variations in flowers.

Criteria for Success

For your lesson to be considered successful, it must

- show five different kinds of flowers with their parts labelled
- be creative and fun to watch
- take no more than 10 min to present

Brainstorm Ideas

1. Discuss with your partner what kind of flower variations you will present. Decide which of your ideas is most interesting and unusual.
2. Write a list of things you might do to present your flowers. Be creative! Maybe you can make a video, or write a song. You might want to create a game for the children to play.

Prepare to Present Your Lesson

3. Find the examples of flowers you need and transfer them onto the media you plan to use. For example, you might need to print out pictures from the Internet, or make costumes that look like different flowers.

Test and Evaluate

4. Practise your lesson presentation. Depending on what you have decided to do, you will have to do this in different ways. You might need to rehearse a skit or test your game on other students.
5. Make any changes to your presentation that you want after you have finished testing. You might want to test it again if you have time.

Communicate

6. It's show time! Present your lesson to the rest of your class. How did it go? Be considerate and pay attention when other students are presenting their lesson. Take notes on what you liked most about the other presentations.
7. Write a paragraph on your experience creating a lesson. Compare your presentation with the other presentations. What was hardest about solving this problem?

Plants Are Adapted to Their Environments

When you walk into a plant nursery or go for a nature walk, you see all different sizes and shapes of plants. One of the reasons that plants are different is that they grow in different environments. To survive in a specific environment, plants must be adapted to that environment. That means that they have structures that help them survive in that environment. Figure 1.31 describes some of the many ways that plants are adapted to different environments.

Figure 1.31 How are these plants adapted to their environment?

In dry environments, plants have to save as much water as they can. The stems of cacti are thick because they store water. Cactus leaves are tiny spines that protect the stem and its stored water from predators.

Plants like grasses have narrow thin leaves, so they can get many individuals in one place. This helps them to be pollinated by the wind. The depth of grass roots helps grasses adapt to occasional drought conditions. Other plants, like the sunflower, have large, wide leaves to catch lots of sun. Many plants produce bright flowers and sweet nectar to attract insects like bees, which pollinate the plants as they go from flower to flower.

Plants such as white spruce trees have thin needle-like leaves with a thick resin coating. This protects the plant from drying out.

Some plants have fibrous roots, which form a thick mat that gathers water at the upper layers of the soil. Others have long taproots. These plants can get water deep down that others can't reach.

Adapted to short growing seasons, some native plants such as wild mustard produce seeds in less than two months.

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Plants in Extreme Environments

Even from a distance, the slopes of the Rocky Mountains above the treeline look barren and cold. Find out what types of plants live on or near the tops of the Rockies, and how they are adapted to this harsh environment.

Figure 1.32 The bird of paradise flower has a unique structure.

Plant Structures and Environments

In this subsection, you have looked at examples of variations in plant structures, such as leaves, stems, and roots. The wide range of differences in plant structures shows how plants are successfully adapted to different environments.

Check and Reflect

1. Sketch a plant with fibrous roots and a plant with a taproot.
2. Describe two examples of variations in leaves that make a plant better suited to a specific environment.
3. Why do cacti have thick stems?
4. What kind of environments do you think these plants are adapted to?

A B C D

1.5 Plant Needs and Growing Conditions

All plants need the right amount of light, water, nutrients, and space in order to survive. Seed plants also need to be pollinated and produce seeds. The seeds must germinate at the right time in a place that will supply all their needs.

The rice plants in Figure 1.33 look healthy because they have all the things they need. Rice plants must grow in water. Other plants, such as wheat and corn, could not survive in these conditions.

Figure 1.33 Rice plants

Give it a **TRY** ACTIVITY

PLANTING A VIRTUAL GARDEN

You and your friends are planning to grow a flower garden in a community park close to your school. The space you have been given is half in bright sunlight and half under the shade of a big tree. The park gets lots of rain, but you have noticed that the area under the tree stays dry for a long time.

Here are the tags from the plants that you and your friends like the most. Choose no more than two plants that you think would grow well in your garden.

Explain why you chose each plant and where you would plant it in your garden. Do you think you could plant your whole garden with just one of these plants? Why or why not?

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In the Hothouse

Plants grown in greenhouses grow faster, bigger, and produce more flowers or fruit than plants grown outside.

Plants Need Different Amounts of Light

All plants need light in order to photosynthesize and produce food. But they don't all need the same amount of light. Some plants need lots of light and others need shade. For example, a fern needs less light than a marigold does.

Plants Need Different Amounts of Water

You know that a plant will die if it doesn't get enough water. But plants can also get too much water. Plants that are adapted to grow in very dry conditions, like cactus, are easily damaged or killed by too much water. Others need lots of water all the time.

Plants Need Different Nutrients

Plants need nutrients from the soil for healthy growth. **Nutrients** are substances that provide the energy and materials that plants need to grow. The main nutrients that plants need are:

- nitrogen
- phosphorous
- potassium
- calcium
- magnesium

If plants do not get enough of these nutrients, they will grow slowly and will not develop properly. For example, if plants do not get enough nitrogen, their leaves will be yellow instead of green.

Not all plants need the same amount of nutrients. For example, plants such as beans, peas, and clover can take nitrogen from the air instead of the soil.

Plants Need Different Amounts of Space

All plants need enough space to grow. Some types of plants need more space than others. Small plants like the buttercups in Figure 1.34 require very little space for each plant. Huge trees like the redwoods in Figure 1.35 require large amounts of space to collect the sunlight and nutrients that they need to grow.

Figure 1.34 Buttercups

Figure 1.35 Redwood trees

Inquiry Activity

Investigating Growing Conditions

The Question

Does the amount of water a radish plant receives affect its growth?

The Hypothesis

Write a hypothesis about the effect of different amounts of water on how well a radish plant grows.

Materials & Equipment

- soil
- small containers for growing plants
- graduated cylinder or beaker
- radish seeds
- ruler or measuring tape
- water

Procedure

1. In your group, develop a fair test for your hypothesis. Read Toolbox 2—The Inquiry of Process of Science if you need help in developing a fair test. Remember to identify the manipulated and responding variables. You will need a method for measuring the change in your responding variable. For example, if your manipulated variable is the amount of water added to the plants, the responding variable may be the height of the plants. You will need a device to measure the height of the plants.
2. Write out your procedure. Remember to include a table or chart that will allow you to record your data over the next several weeks. Have your teacher approve your procedure.
3. Determine the materials you will need for your procedure.
4. Carry out your procedure. Make sure everyone in your group understands their roles and can carry out their part of the procedure when necessary. For example, measurements must be taken and recorded at set times.

Figure 1.36 What will "best" mean for the growth of your plants?

Collecting Data

5. Record your data in the data table you designed and your teacher approved.

Analyzing and Interpreting

6. Review the data you recorded. What volume of water created the best growing conditions for radish seeds? What volume of water created the worst conditions?
7. Was your hypothesis correct? Does it matter if your hypothesis was right or wrong?
8. Create a graph or chart illustrating your data. Your graph or chart should clearly show how much water was added to each plant and the results during the investigation.

Forming Conclusions

9. Write a short report describing your test and what you found. Include your graph or chart in your report. Describe any changes you would make to your test if you could do it again.

Figure 1.37 This plant got everything it needed to grow!

Growing Healthy Plants Requires Knowing the Best Growing Conditions

Knowing about the needs of different plants is an important tool for growing plants. If you know exactly what a plant needs at each stage of its life, you might be able to make sure it grows under exactly those conditions.

Check and Reflect

1. Do all plants need to get the same amount of light? Explain your answer.
2. Name two plants that need very different amounts of water.
3. You have a plant that needs lots of water and light. How will you give this plant the best growing conditions?
4. Give an example of a job that might require knowing a lot about the different needs of plants. Do you think you would like to do this job?

Assess Your Learning

1. Name the parts of a seed plant. For each part, write one sentence describing what that part does.
2. Describe the process by which plants make food. Where does this process take place?
3. Give two examples of variations in the structure of stems.
4. Look at the pictures of the plants below. How are these plants adapted to their environments?

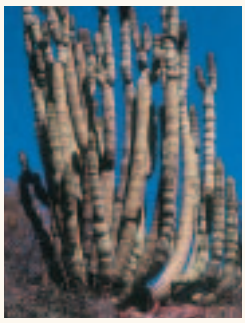

Figure 1.38

Figure 1.39

Figure 1.40

5. Choose a plant you are familiar with. Draw the stages in the life cycle of that plant.
6. Think about your backyard or a park near you. Suppose you are going to plant some flowers there. What do you already know about this area that would help you decide what kinds of flowers to choose? What things would you have to find out?

Focus On Science and Technology

In this section, you have studied the needs, structures, and life processes of plants. You have also examined different ways that plants adapt to their environments. Such scientific knowledge can lead to the development of new technologies. These technologies can be then used to make more scientific discoveries.

1. Describe why an understanding of the needs of plants is useful to humans.
2. Describe an example of a plant technology that was developed from an understanding of the needs of plants.

2.0

Plants play an essential role in the environment and in meeting human needs.

Key Concepts

In this section, you will learn about the following key concepts:

- needs and uses of plants
- resource management

Learning Outcomes

When you have completed this section, you will be able to:

- explain the role of plants in the environment
- describe ways that humans use plants
- describe natural and managed living resources in various areas
- identify examples of local and global change in living resources

We live in a world of plant life.

Plants live all around us. They grow deep under the ocean, on the sides of mountains, under arctic snow, and in hot, dry deserts. Plants are in almost every kind of environment on Earth.

Plants are necessary to all life on Earth, and they supply us with many things we rely on. To be able to meet our needs in the future, we must make sure that the things we do to grow and harvest plants do not interfere too much with the needs of the rest of the planet.

2.1 The Role of Plants in the Environment

Figure 2.1 What lives in the environment around your school?

Many living things make your schoolyard their home. Plants are an important part of this environment. For example, plants provide a home and food for many different types of birds and insects. But plants have much wider ranging effects as well. They even affect the air you breathe.

*info*BIT

Plants Across Canada

Vegetation (plant) cover in Canada can be classified into four categories: forest, tundra, barren, and agriculture. The remaining areas of the country are either non-vegetated areas (without plant cover) or water.

Give it a **TRY**

ACTIVITY

NATURE'S CONNECTIONS

Make two lists, one of the plants and one of the animals in these photographs. Discuss with a partner how each plant and animal might be connected. Draw lines on your lists between those you think are connected.

Share your work with another pair of students. Explain what you think the plants provide for the animals. Do you think these animals would survive without the plants?

Figure 2.2

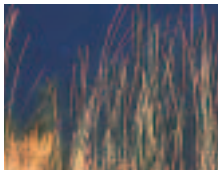

Figure 2.3

Figure 2.4

Figure 2.5

Figure 2.6

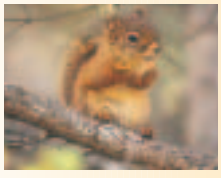

Figure 2.7

Problem Solving Activity

Why in the World Do We Need Plants?

Recognize a Need

A neighbourhood committee is improving the area around your school. Most people want to add more plants, but some committee members think it would be easier just to pave the area.

You've been asked to help convince everyone on the committee that plants are essential to the environment. They want you to find examples of plants around your school that are used for food by other living things, create oxygen and remove carbon dioxide from the air, provide shelter for living things, and make or protect the soil. You will prepare a written report for the committee.

The Problem

Explain the essential role of plants in the environment using examples from the area around your school.

Criteria for Success

For your presentation to be successful, it must

- have an example of each of the four ways that plants help the environment
- describe what would happen to the environment if plants were not present
- be creative and convincing

Brainstorm Ideas

1. Working with your group, discuss where you might find the examples you need. Will you look in one area, or in four different areas?
2. Decide how you will record the examples you find. Consider how you will present the information. Is it better to make sketches or prepare a table?

Caution!
Be kind to the environment when you make your observations. Do not remove anything, and be careful not to harm the living things you find.

Prepare and Evaluate

3. Find and record the examples you need. As you are working, evaluate whether you have chosen an appropriate method to record your observations. If not, modify your method.
4. Back in class, discuss as a group what would happen if plants were not present in each of your examples.
5. Decide on the best way to present your work.

Communicate

6. Prepare your report. Remember that it must convince people that plants are important to the environment.

Extending

Draw a map of your schoolyard that shows where different types of plants are found. Use a field guide or identification key to identify any plants you are not sure about.

Check and Reflect

1. Explain why animals need plants to survive.
2. Pretend that half of the plants on earth suddenly disappeared. What do you think might happen to the air?
3. Why are plants important for soil?

Figure 2.8 All organisms in this environment depend on plants.

*info*BIT

Help for Headaches

The bark of the willow contains a chemical that is similar to acetylsalicylic acid (Aspirin). Willow bark was one of many plants used by some First Nations and Inuit peoples as a source of medicine.

2.2 We Use Plants in Many Ways

Aboriginal people in Canada used many plants for food, fibre, and medicines. For example, paintbrush was used to treat rheumatism, and its flowers could be eaten as a sweet treat.

Plants provide us all with food, and with fibre that we use to make shelter, clothing, and other useful products. Plants can also provide us with medicine.

You use plants in different ways every day. All day long, you eat plants in every snack and meal. When you put on a cotton T-shirt, you're using a plant product. This book is made from plant fibres.

Figure 2.9 Paintbrush grows throughout Alberta.

Give it a **TRY** ACTIVITY

When Is a Tree Not a Tree?

You use plants every day. Maybe you eat some fruit, or play soccer on grass, or just enjoy a potted plant in your home. But there are lots of other uses for plants that you might not have thought about before!

Copy out the list below. For each item, write the name of at least one plant that can be used to make that item.

- pencil
- paper
- perfume
- skin care lotion
- baseball bat
- bread
- table
- throat lozenges
- T-shirt
- rope
- dog food
- house

When you have finished, exchange your list with a partner. Did you both name the same plants for every item? Discuss with your partner any answers you do not agree with.

Plants for Food

Plants can provide us with the food we need to stay healthy. A diet with lots of fruits and vegetables can help protect us from some diseases.

Plants for Fibre

Fibre from plants provides many of the materials we use for shelter and warmth. Most houses in Canada are made of wooden frames covered with sheets of wood. The fibres from some plants are used to make cloth. For example, cotton fibre is used in shirts and jeans. Plant fibre is also used to make paper and paper products. Your notebook and this textbook are made from plant fibre.

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Make Good Use of It

Some of the plants in your area might be used for food, fibre, or medicine. Use books, the Internet, and other sources to find what plants in your area are used for.

Figure 2.10 Plant fibres are used to make all these things. How much do you think our lives would change if we couldn't get fibre from plants?

Figure 2.11 The kinnikinick or buffalo berry plant was used by First Nations, Métis, and Inuit peoples to treat kidney problems.

Plants Can Be Used in Many Other Ways

Plants have always been an important source of medicine worldwide. In Canada, the Aboriginal people used more than 500 different kinds of plants for medicine. In 1535, Iroquois people cured Jacques Cartier's expedition of scurvy with a tea made from white spruce and hemlock. Scurvy is caused by not eating enough vitamin C.

There are many other uses for plants. Plants can be used to make glue and rubber. Plants are used to put the shine on glossy paper, the colour in this textbook, and the odour in perfume. Plants can even be used to clean up polluted soil!

Check and Reflect

1. Name two ways that we use plants. Give an example of each.
2. Describe two ways that plant fibre is used.
3. What kind of plant is used to make paper? Are there any other ways that this plant is used?
4. Was there any way that we use plants that surprised you?

Careers and Profiles

Syrup Producer

You've probably tried maple syrup that comes from sugar maple trees that grow in eastern Canada. Warren Bard of Edmonton makes syrup from birch trees. "It has a totally unique flavour," he says about his syrup.

Figure 2.12 Warren Bard has found a way to make a business out of the natural resources in his area.

Warren began to experiment after he read about a Yukon cook who opened a breakfast place during the Gold Rush. This cook had no sugar, but a First Nations woman taught her how to tap birch trees for the sweet syrup.

In 1998, Warren's birch syrup was used by Culinary Team Canada to create a dessert sauce that won a silver medal in an international cooking contest. His syrup is used in major hotels such as the Banff Springs Hotel and the Hotel MacDonald in Edmonton.

1. How might developing new uses for native plant species help the environment?
2. What people outside the school would you contact to help you start a new business?

2.3 Managing Living Resources

Figure 2.13 Forests are an important living resource.

Living resources are living things that can be used for human needs. Forests, like the one in Figure 2.13, contain living things that are part of Earth's living resources. These include not only the trees, but many other plants and animals found in forest environments. When we cut timber or use the forest as a place for recreation, we may affect these living things. Managing living resources like forests involves maintaining healthy populations of all the living things that make up those resources.

*info*BIT

Protecting Living Resources

Prickly pear cactus grows in the living resource of the Badlands in Dinosaur Provincial Park.

Give it a **TRY**

ACTIVITY

USING A LIVING RESOURCE

Working on your own, put a line down the middle of a piece of unlined paper. On one half of the paper, sketch a picture of an area that you think is a living resource. For example, you might draw a local woodland or a prairie grassland. Include as many different kinds of plants and animals as you can.

On the other half of the paper, sketch the area as it might look after humans begin to use the resources as a park.

Look over your finished sketches. Note three differences and write them down in point form below your sketches.

Problem Solving Activity

Communicating Ideas About a Managed Resource

Figure 2.14a) Mammals such as the pine marten use mature forests to meet their basic needs.

Figure 2.14b) Humans need forests to provide building materials and many other basic needs.

Recognize a Need

You are a member of a group called Students for a Healthy Environment. Your group is preparing a pamphlet to help people understand why managing the living resources of a forest is important. You want to explain that there are many different forest uses, and all the living resources in a forest must be looked after.

The Problem

Design an attractive and easy-to-read pamphlet that explains how a forest region is used. These uses include timber production, recreation, and habitat for plants and wildlife. You may focus your pamphlet on a region of Alberta or another part of the world. Explain why areas are set aside for particular uses. Describe ways that people can help look after the living resources of the forest.

Criteria for Success

For your pamphlet to be effective, it must

- present accurate information about the uses and living resources of forests
- include graphics that demonstrate the variety of uses
- give examples of human activities that work to restore forests as a sustainable resource

Brainstorm Ideas

TOOLBOX

1. In a group, list the facts you need for your pamphlet. Use your textbook, the Internet, or your school library to check any information you aren't sure about.
2. Decide as a group which facts can be presented as a graph. Use Toolbox 7: Graphing to help you decide.

Make a Pamphlet

3. Decide what materials you will need to make your pamphlet. Think about what size and shape would work the best.
4. Arrange the information you will be including in your pamphlet so that it looks attractive. Consider adding related pictures.

Test and Evaluate

5. Display your completed pamphlet in your classroom.
6. Compare your pamphlet with the pamphlets that other groups prepared. Are there any features in their pamphlets that work particularly well?
7. Evaluate your work. If you had time, is there anything you would change to make your pamphlet more effective?

Communicate

8. Post your pamphlet, along with the other pamphlets, in your class. Spend some time reading each of the pamphlets and taking notes. As you read each pamphlet, provide constructive feedback and suggestions for improvement.

Changes Caused by Human Activity

The first people to use living resources in Alberta were the Aboriginal peoples. They obtained the food and fibre they needed by hunting and gathering. Plants, such as the wild rose, were used not only as a source of food, but for medicine as well. They also developed methods for encouraging the growth of plants they needed by clearing some areas with fire. Aboriginal peoples developed a close relationship with the land because of their use of living resources.

Major changes in living resources began with the introduction of horses and guns for hunting. These new technologies allowed Aboriginal peoples to hunt buffalo and other animals more efficiently. Horses also competed for grazing with animals such as the buffalo. Both activities affected the living resources.

Figure 2.15 Siksika Nation people in Alberta used horses for hunting.

Figure 2.16 European settlers used larger amounts of living resources in different ways.

When European settlers came, they began to clear and farm land to grow food for themselves and others. They logged the forests to supply wood for building and fuel. With greater use of the living resources, the need to manage these resources became greater.

Figure 2.17 This map shows the amount of forest in Alberta today.

Managing Living Resources for Now and the Future

As the world's population keeps growing, so does the demand for natural resources. In some parts of the world, forest resources are being used more quickly than they are being replaced. This kind of use is said to be non-sustainable. This means that the amount being used now will not be available in the future.

Over time, people have used the forests to provide wood fibre for things such as building materials, paper, and fuels. The practice of managing forests has changed as our needs and demands on this sustainable resource change. People work to use forests in ways that will ensure a balance between meeting our needs and the needs of the many species that call forests home.

Agencies that manage forest resources establish methods and regulations that foresters follow when a forest is to be harvested. These regulations provide a framework to identify what species are to be harvested, how they are removed, and how the forest is restored and replanted after harvesting. This framework ensures that foresters can obtain the species they want for their products, and secures the forest to remain healthy and renewable. Human activities such as logging and replanting allow forests to pass through different growth cycles over time. Different plants and animals will use these changing environments as the forests develop from one stage to the next.

Figure 2.18 People manage forests to maintain a diversity of species and to keep the forest healthy and productive.

Check and Reflect

1. What is a living resource? Give three examples.
2. What are the challenges associated with managing a living resource such as a forest?
3. What did you find out about how humans affect the environment that you didn't know before? Is there anything in this section you would like to learn more about?

Assess Your Learning

1. Explain why plants are essential to the environment.
2. Name four ways that humans use plants. Provide an example of each use.
3. Think about the area where you live. Describe changes in the natural living resources that might have resulted from the following human activities.
   a) Aboriginal peoples collected food.
   b) European settlers cleared land to farm.
   c) New houses are built for new people coming to Alberta.
4. Do people depend on plants as much as they did in the past? Explain your answer.

Focus On Science and Technology

Through technology, we find new ways to grow and use plants. Think about what you learned in this section.

1. Explain two ways in which the practice of planting small trees after an area has been logged helps the environment.
2. What are some of the ways we produce plants? Have they changed as we have developed new technology?
3. The technology we use changes over time. Choose a tool used in agriculture or forestry such as a corn harvester, a plow, a chainsaw, or any other. Research using the Internet, books, and other sources. Explain how the tool has evolved.

3.0

Soil is an important resource that human activity can protect or degrade.

Key Concepts

In this section, you will learn about the following key concepts:

- fertilizers and soil nutrients
- resource management

Learning Outcomes

When you have completed this section, you will be able to:

- investigate and describe characteristics of soils
- identify practices that enhance and degrade soils

There is an important resource beneath this prairie.

Imagine you are out hiking across the prairie. All around you are grasses and wildflowers. Birds and insects buzz and chirp. As you walk along the trail, you think about the sun and the rain that makes all this possible. But would you remember the soil beneath it all?

Soil is a natural resource, like water and minerals. We depend on it to provide a healthy place for plants to grow. Many animals also live in the soil, from earthworms to prairie dogs. Think about the area where you live. What is the soil like? Do people affect the soil in any way?

3.1 What Is Soil?

When you think of soil, you probably think of brown dirt. You know that plants get nutrients and water from soil. You may even have noticed that soil can be very different in different places.

Think of some words that could be used to describe soil. Think about the colour and feel of different kinds of soil. How many words can you think of?

Figure 3.1 Soil has layers, each with different characteristics.

*info*BIT

Shifting Sands

The Sahara is getting larger every day. As the desert grows, the sand covers up fertile soil.

Give it a **TRY**

ACTIVITY

ALL SOILS ARE NOT CREATED EQUAL

Soils from different areas can have very different characteristics. Some soils are dry and can run through your fingers. Others are very wet and feel slippery.

Use three different types of soil: clay, loam, and sand. Filter 10 mL of water through 30 mL of soil. Collect and measure the water that comes through the filter for each soil. Record your observations in a table and draw a bar graph showing the results. (See Toolbox 7 if you need help with your graph.)

Which soil holds water best? Which soil is best for drainage? Which soil might be best to use when constructing earthen dams?

Figure 3.2

Figure 3.3

Figure 3.4

Problem Solving Activity

Designer Soil

Recognize a Need

Your family has just bought a new home. They have asked you to plant a vegetable garden. The soil is mostly clay and your first job will be to mix the clay with materials so that it is more like loam.

The Problem

How will you mix the materials available to you with clay soil to make it more like loam?

Criteria for Success

To be successful, your soil must

- form a moist, loose ball when squeezed
- show the characteristic of loam when you complete a drainage test similar to the one done in the Give it a Try on the previous page
- feel like moist cake

Sandy Soil

- runs freely
- moist soil will not form a ball when squeezed
- particles are mainly mineral
- does not hold water
- light brown

Clay Soil

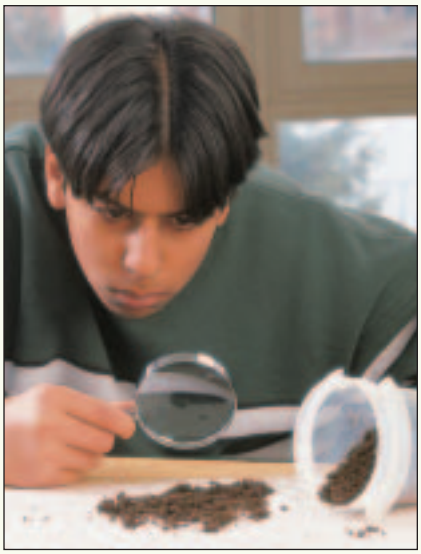
- feels sticky
- moist soil forms a tight ball when squeezed
- greater than 20% clay mineral particles
- holds a lot of water
- colour varies

Loam Soil

- feels like moist cake
- moist soil forms a loose ball when squeezed
- balance of organic and mineral particles
- holds some water
- dark brown to black

Brainstorm Ideas

1. Look at the available list of materials.
2. With a partner or on your own, decide what materials you will add to the clay. Also decide the amount of each material that you will use.
3. Decide how you will record your observations.



Make Your Soil

4. Using the available materials, create your new soil.

Test and Evaluate

5. Determine if your new soil is like loam soil. Use the soil characteristics that are listed in the margin.
6. Test your new soil for drainage using the technique from the Give it a Try on the previous page. If you didn't do this activity, your teacher will explain this test.
7. If you have access to a magnifying glass, look at the new soil under magnification and compare it with a magnified loam soil sample.

Communicate

8. Share your "recipe" for loam soil with your classmates.
9. What do the class mixtures have in common?
10. Which materials worked best to improve the drainage of clay soil?

Soil Contains Minerals and Organic Matter

Soil is not just dirt! When you look closely at soil, you see tiny particles with spaces between them. These spaces contain either air or water.

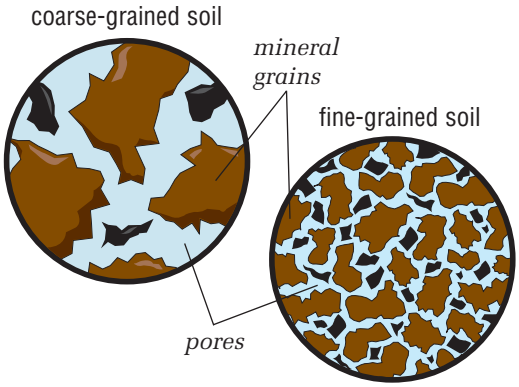


Figure 3.5 Soil is composed of different types and sizes of particles.

Soil has mineral and organic particles. The **mineral particles** are made from rock that has been broken down. Mineral particles make spaces in the soil that water can run through quickly.

The **organic particles** are made from plants and animals that were once living. When organic matter is partly decomposed, it is called **humus**. Humus provides plants with the nutrients they need. Humus also absorbs water.

Characteristics of Sandy Soil

Sandy soil runs between your fingers and has very few lumps. If you moisten sandy soil and squeeze it in your hand, the soil will not stay together. Sandy soil is light brown.

If you look at the particles of sandy soil with a hand lens, you will see that most of the particles are mineral particles and there is very little humus. Sandy soil therefore doesn't contain much food for plants. It also gets dry quickly, because water runs through it very fast.

Characteristics of Clay Soil

Clay soil feels slippery when it is moist and you rub it between your fingers. If you squeeze wet clay in your hand, it will stick together and form a tight ball. Dry clay is very hard. The colour of clay soil is determined by the type of mineral particles that compose it. The colour can vary.

Clay soil has lots of mineral particles and little humus. Because the mineral particles are very small (0.0002 mm), clay soil has a fine texture. The pore size (spaces between the particles) is also small. Clay soil can hold water and nutrients but air cannot easily penetrate, especially when the pores are filled with water.

Figure 3.6 The ingredients of soil

Characteristics of Loam Soil

Loam soil is crumbly, like a moist cake. If you squeeze wet loam in your hand, it will form a loose ball. It is not sticky. Loam soils are dark brown or black.

Loam soil has a balance between the amount of organic particles and mineral particles. It will absorb enough water to stay moist for a long time, but not so much that it will not have enough air in the spaces between the soil particles. Loam soil also has plenty of nutrients for plants to use. This soil is good for growing most plants.

RESEARCH

Vermiculite

Find out what the role of vermiculite is in potting soil, and how it is made.

Different Plants for Different Soils

Although you might think that loam soil is the best for all plants, there are some plants that would not grow very well in this type of soil. Remember that plants have adapted to their environment. If you put a plant that is adapted to clay soil in loam soil, for example, you might find that it isn't very healthy. Each plant will grow best in a different kind of soil.

Check and Reflect

1. What is soil made of?
2. Explain the importance of the spaces between particles in soil.
3. If you could choose the type of soil in your garden, what kind would you choose? Why?

TRY This at Home

Activity

How Does Your Garden Grow?

Many people change the type of soil they have in their gardens. They add things to the soil, or simply buy new soil altogether.

Has the soil been changed where you live? You can find out by looking at the type of soil in a flowerbed or vegetable patch, then comparing it with the soil in an area without a garden. This could be near a driveway or just under the lawn.

Discuss what you find with your class.

3.2 Our Practices Can Improve or Degrade Soil

Figure 3.7 The nutrients in this dead tree can be used by other organisms.

In a natural environment, nutrients are returned to the soil when plants and animals die and decompose. But when we harvest plants, we remove at least part of the plant and the nutrients in that part. Over time, the soil could be left with too few nutrients for plants to grow well.

*info*BIT

The Dirty Thirties

On the Canadian Prairies during the 1930s, drought and poor farming methods caused the topsoil to blow away.

Give it a **TRY**

ACTIVITY

HUMAN ACTIVITY AND THE SOIL

Managing any living resource includes both costs and benefits to that resource. Soil is an important resource that must be managed to keep it healthy.

Copy the list below into your notebook. Beside each item, explain how the action described could help or harm the soil. Think about these carefully—some actions may harm or help, depending on how you do them.

- A farmer puts manure on his fields.
- A potato farmer irrigates her crop.
- The stubble that is left when a grain crop is harvested is plowed into the soil.

When you have finished, share your list with others in your class. Did you label all the situations the same? Discuss any situations that you did not agree on.

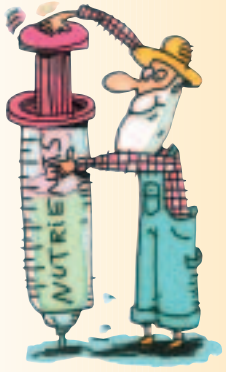


Figure 3.8 Soil helps this environment to stay healthy.

Soil Is an Important Natural Resource

We need soil to grow the plants we need for food and fibre. But soil is also important for other reasons. It supports the growth of wild plants that in turn feed and shelter animals. It also provides a home for a wide variety of soil-dwelling organisms.

Fertilizer Use

The soil nutrients that plants need can be provided by fertilizers. These are substances that are added to the soil. Organic fertilizers are made from sources such as animal or plant waste. Chemical fertilizers are mixtures of types of chemicals that promote plant growth. For example, potash is a chemical used in fertilizers to increase the potassium content of the soil. Urea and ammonia are both used as sources of nitrogen.

If the amount of fertilizer is not carefully measured, more nutrients may be added than the plant can use. This may harm the plant that the fertilizer was intended to help. Extra, unused nutrients may dissolve in rain or irrigation water and pollute the soil. The water in the soil can then carry them into streams, rivers, or lakes, causing pollution there as well.

Irrigation

Irrigation is widely used to grow plants in dry areas where there is too little rainfall overall or not enough at the right time of year. Irrigation helps farmers ensure that plants receive the right amount of water at the right time in their growth process. This can help to increase crop yields.

The use of irrigation requires careful management. If too much water is added to the soil, it will fill all the pores in the soil. With too little air in the soil, plants will not grow well.

Irrigation can also dissolve salts in the soil. In very dry areas, the evaporation of the water on the soil surface pulls the water and dissolved salts up to the surface. The topsoil may become too salty for plants to survive.

Clearing the Land

Before farmers plant new crops, they have to clear their land of plant cover. This makes it easier to plant seeds. It also reduces competition between their crop plants and other plants. Clearing farmland may involve removing most of the plant cover and plowing under any that remains. Or it could involve partial removal by leaving stubble on a field.

Foresters clear the land too. They will identify a desirable type of tree to harvest and establish tree age and size as part of the harvest criteria. As harvesting begins, those desirable species are removed, while other species are left to grow. After harvesting, foresters replant young trees to keep the forest sustainable.

If not carefully done, clearing land can expose soil to the weather. Without plant roots to hold it together, soil can be easily blown or washed away. Under a pounding rain, soil grains can squeeze together or compact, making it difficult for new plants to put down roots. The more plant cover that is left when land is cleared, the less soil erosion occurs. Plants also shade the soil, keeping it cool and moist.

Figure 3.9 The location, size, and shape of cut blocks can make a difference in the amount of soil erosion after trees are cut.

Decision Making Activity

Fertilizers and Soil

The Issue

Why are chemical and organic fertilizers both used? Which one is favoured in your community?

Background Information

All soil used for agriculture must have nutrients added to it, because the plants take nutrients out of the soil that are not returned. Some growers believe that using organic fertilizer, such as manure, is better for the soil. Other growers believe it is much better to use chemical fertilizers and will not use any organic fertilizers. The question of whether organic or chemical farming practices should be used can be a sensitive issue for particular communities and families. Here is a summary of the different ideas.

Figure 3.10 What kind of fertilizer should we use to keep this soil producing healthy plants?

Advantages of organic fertilizers

- improves soil structure by adding large particles of humus
- provides a source of food for useful soil organisms
- recycles animal waste
- is unlikely to add excess nutrients to the soil
- releases the nutrients slowly

Disadvantages of organic fertilizers

- some types have a low nutrient content
- each batch may have a different nutrient content
- it can contain disease organisms that can infect plants, livestock, or humans
- it can contain weed seeds
- it is difficult to spread evenly

Advantages of chemical fertilizers

- you know the exact amount of each nutrient you are adding
- you can match the amount of each nutrient you add to what your soil needs
- it is easy to apply evenly on the soil
- it does not bring in any disease organisms or weed seeds

Disadvantages of chemical fertilizers

- does not improve soil structure
- releases nutrients quickly and can be too concentrated
- can easily add more nutrients to the soil than the plants can use
- can hurt useful soil organisms
- can contaminate the groundwater, lakes, and streams with too many nutrients

Support Your Opinion

Decide for yourself if organic fertilizer is better to use than chemical fertilizer. Write a paragraph defending your views. Include your prediction of the effect of long-term use of both chemical and organic fertilizer.

Plowing Changes Soil

Plowing is the process of cutting into the soil and turning the top layer over. Plowing breaks up the soil, creating more air spaces and making it less compacted. Over time, plowing can damage the soil because it makes the soil particles smaller, and so the soil can become waterlogged and compacted more easily.

New equipment has been designed that will cause less damage. In the 1930s, farmers recognized that "trash cover" (stubble and other plant material) protected the soil from wind erosion. To benefit from the use of "trash cover," the farmers in southern Alberta needed a blade cultivator that would go under the stubble and kill the weed. In 1936, C.S. Noble from Nobleford, Alberta, developed a blade that replaced traditional plows. This blade cut below the ground while leaving the top of the ground with its stubble intact. Today, the Noble Blade and Drill is used around the world.

Figure 3.11 The Noble Blade and Drill

Crop Rotation Helps to Keep Soil Healthy

What do you think would happen to a soil if you grew the same crop year after year? If you answered that the soil would run out of the nutrients that the crop plant needs, you would be right. To keep growing that crop, you would have to add lots of fertilizer every year. Fertilizer is expensive, and the soil might also be polluted by the nutrients that the plants don't use.

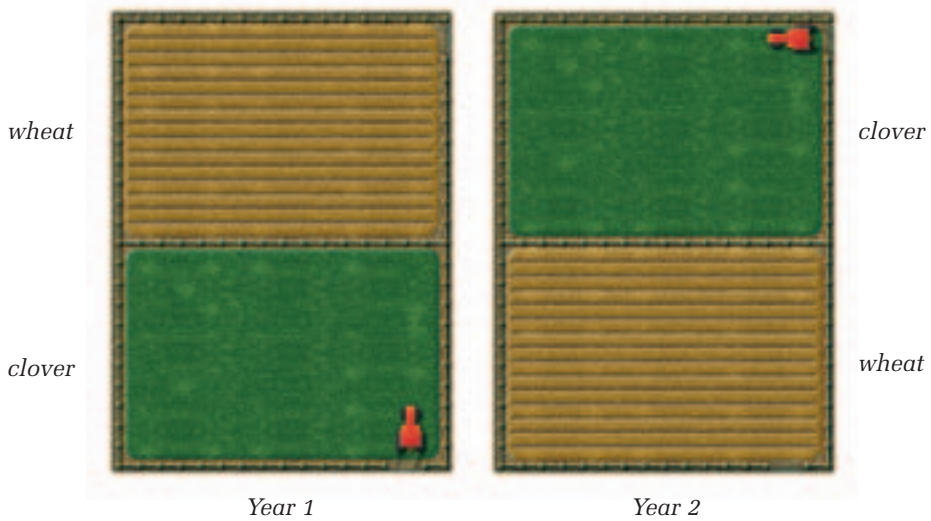


Figure 3.12 Planting more than one kind of crop can reduce the use of fertilizer.

reSEARCH

No-Till Farming

Crop scientists have developed a new method of growing crops that doesn't involve plowing. Find out about the advantages and disadvantages of no-till farming. You might want to start your search on the Internet.

Crop rotation is the practice of planting a different crop in a particular field every year. The kinds of plant that are rotated must be matched according to their nutrient needs. For example, if one plant uses a lot of phosphorus and very little nitrogen, it could be matched with a plant that uses very little phosphorus and a lot of nitrogen.

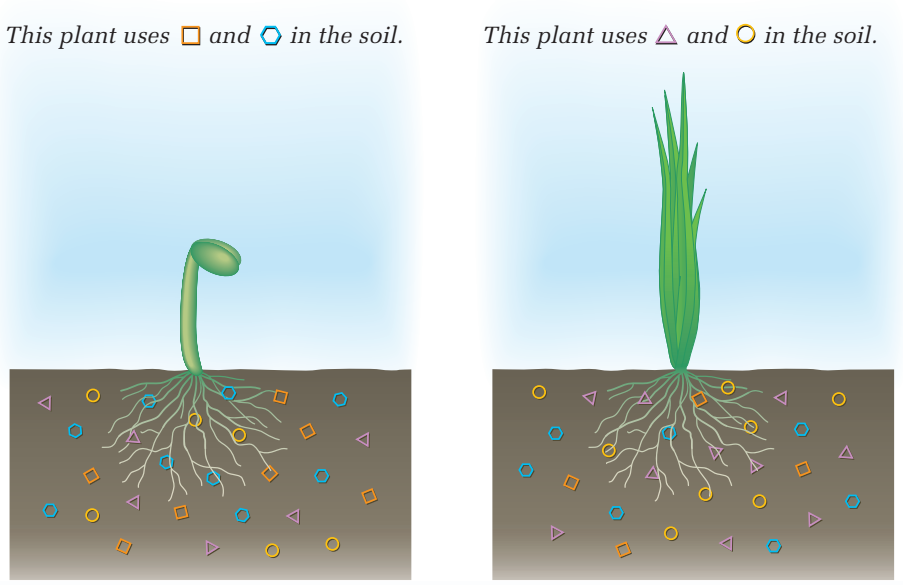


Figure 3.13 During crop rotation, one plant uses the nutrients that the other doesn't need.

Check and Reflect

1. Indicate which of the following statements are true, and which are false. Correct each false statement to make it true.
   a) Soil is only important to farmers.
   b) Using lots of fertilizer to grow plants is always helpful.
   c) Plants can help prevent wind erosion.
2. Describe an Albertan contribution to decreasing the impact a plow makes on soil.
3. Write a poem, paragraph, or story expressing how you feel about taking care of soil.

Assess Your Learning

1. Describe clay soil.
2. Give two characteristics you could use to identify loam soil.
3. Below are two examples of preparing the soil by plowing. Explain one advantage and one disadvantage for each method.

Figure 3.14 Plowing bare soil

Figure 3.15 Plowing plant material under

4. A farmer plants the same crop in the same field every year. How will this affect the soil?

Focus On Science and Technology

In this section, you found out that some of the practices we use to help plants to grow can harm the soil. Consider the following questions.

1. What changes have been made in technology to reduce the damage to soil?
2. Over the past 100 years, humans have used the soil for a variety of purposes. How does human use impact the soil now compared with 100 years ago?

4.0

The ways that plants are grown and used are related to human needs, technology, and the environment.

Key Concepts

In this section, you will learn about the following key concepts:

- plant varieties
- selective breeding
- monocultures
- resource management
- sustainability
- chemical and biological controls

Learning Outcomes

When you have completed this section, you will be able to:

- describe how plant varieties are developed
- investigate consequences of how we manage the environment
- identify intended and unintended consequences of environmental management
- evaluate the effect of different practices on sustainability of resources
- describe the consequences of using herbicides, pesticides, and biological controls
- identify practical problems and issues in producing plants in a sustainable way

Have you ever played the game Jenga? In this game, you keep pulling pieces out of the bottom and putting them on the top. You can probably see that eventually, the whole thing will come crashing down.

Some of the things we do to grow and harvest plants are like pulling the pieces from the bottom of the Jenga game. If we keep on in the same way, eventually we will make our environment collapse. What do you think would happen if we kept logging our forests and didn't plant any more trees?

4.1 Modifying Environments to Increase Yields

Figure 4.1 We all need products made from plants.

Our population is growing every day. All these people need more plants to produce enough food and fibre to meet their needs. Scientists and growers have developed technologies that increase the **yield** of plants. Yield means the amount of useful plant part per plant.

*info*BIT

A Change for the Better

Some islands in the Pacific Ocean have soil that contains large amounts of salt. People on these islands grow their crops by **hydroponics**, which doesn't use soil at all!

Give it a **TRY**

ACTIVITY

MAKING CHANGES

Growers and scientists have developed many technologies to change the environment to suit the plants we want to produce. Each of these pictures shows a different way of modifying the environment.

Figure 4.2

Figure 4.3

Figure 4.4

Figure 4.5

In each of these situations, what environmental condition is being changed?

Problem Solving Activity

Growing Plants without Soil

Recognize a Need

You want to start a small company that supplies specialty vegetables to restaurants. You know that the kinds of plants you need won't grow well in the outside environment. So you have decided to try to build your own indoor hydroponic system. A hydroponic system is an artificial environment that doesn't use soil.

The Problem

Build a working prototype of a hydroponic system.

Criteria for Success

To be considered successful, your hydroponic system should meet the following criteria:

- It must be constructed from materials in the classroom and from your home.
- It must use a nutrient solution in the place of soil.
- It must provide a seedling with a controlled amount of light and nutrients.
- It must operate for at least one week.

Brainstorm Ideas

1. In a small group, work together to develop ideas. Sketch out the suggestions as you work, and review what each part in your system is supposed to do.
2. Develop a list of materials that could be used to create your hydroponic system. Here are some things to start you off:
   - clean gravel or marbles to support the roots
   - aquarium air pump to keep air around the roots
   - large plastic tub in which to place the nutrient solution
   - liquid or soluble plant food to supply nutrients
3. Pick the idea that you think is most likely to meet the criteria for a successful hydroponic system. Prepare a step-by-step plan of what you intend to do and a list of everything you will need.
4. Show your plan and your list to your teacher. Be prepared to explain how your system will work. When your teacher has approved your plan, you can start to build your prototype.

Build a Prototype

5. Put your prototype together, following the plan that your teacher approved. Do not put a plant in your system until you have finished building it and have checked for leaks or other problems.

Figure 4.6 A simple hydroponic system

Caution!
Water and electricity do not mix! Do not plug in any device close to water.

Test and Evaluate

6 Move your completed system to the area set aside by your teacher. Put a seedling into your system. Be careful not to damage its roots as you do this. Turn on your system.

7 Check your system at least once a day over the next week. Make changes to your system to correct any problems you encounter.

Communicate

8 Present your system to your classmates. Explain how your system was supposed to work. Give an honest evaluation of how well your system did what it was supposed to do, and whether it meets the criteria for success.

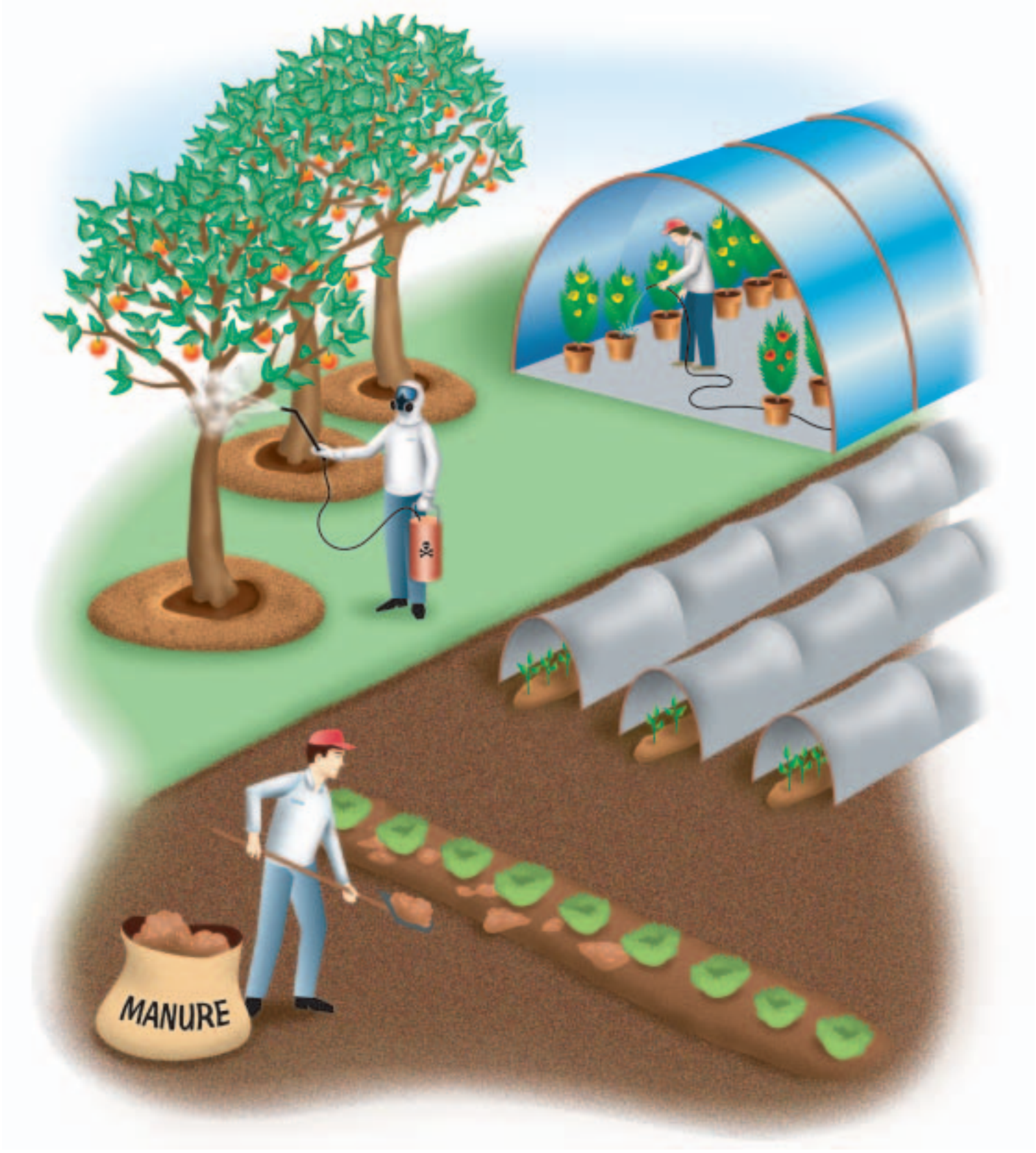
9 You might also want to share any changes you made to your system during the week. What would you do differently if you could build another prototype?

Extending

Your hydroponic system controls all the growing conditions for a plant. Design and carry out an experiment to test the effects of different nutrients on plant growth.

Technologies to Produce and Harvest Plants

To get the best yield possible, we have developed technologies that help provide the best growing conditions for plants. What kind of technologies can you find in this illustration?



Artificial Environments to Control Growing Conditions

Sometimes we produce plants in artificial environments, in which we control all the growing conditions. Greenhouses are one example of an artificial environment. Plants in a greenhouse always have the right temperature, light, and nutrients for their needs.

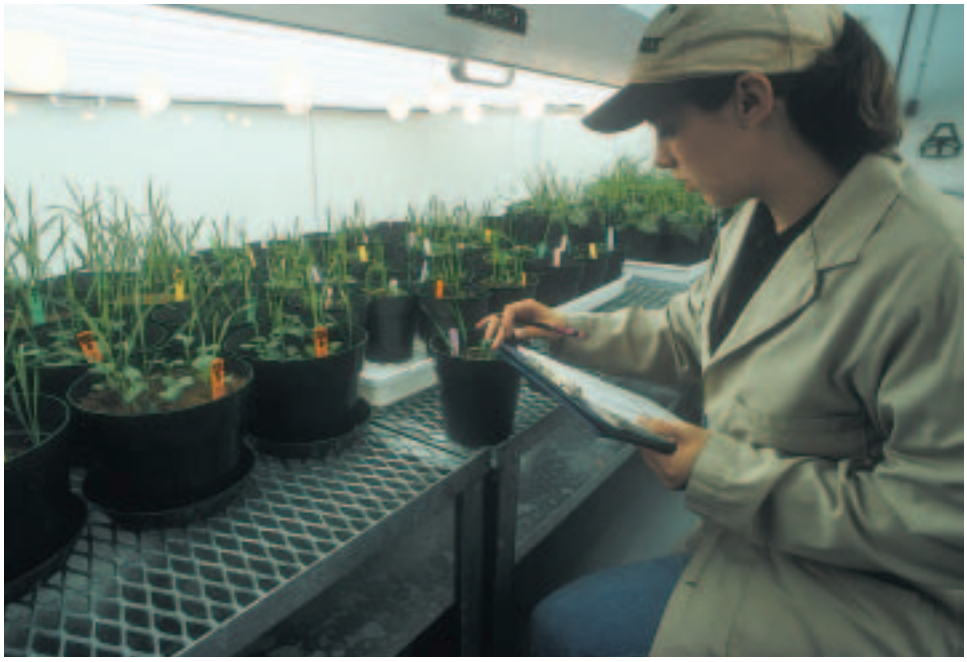


Figure 4.7 Plants can be grown without any soil at all.

A hydroponic system is another type of artificial soil environment. In hydroponic systems, plants are grown without soil. Instead, the roots of the plants are buried in gravel or coarse sand. Nutrient-rich water is then pumped through this material at regular intervals.

mathLink

A canola crop yields 1120 kg of seed per hectare when it is grown without irrigation. An irrigated canola crop yields 1160 kg per hectare. What is the percentage increase in yield?

reSEARCH

Modifying Environments

Find out about other ways to modify environments to increase plant yields.

Check and Reflect

1. What is yield?
2. Describe two methods to make sure plants have enough water.
3. What is an artificial environment?
4. Do you think hydroponics is a good way to grow all plants? Why or why not?

*info*BIT

Varieties of Lettuce

There are at least 40 different varieties of lettuce. Why do you think we have so many?

4.2 New Plant Varieties Are Developed by Selective Breeding

The next time you go into a grocery store, look at the wide variety of fresh fruits and vegetables that we can buy at any time of year. In the past, people had much more limited choices. For example, at one time, most Canadian grocery stores sold only one kind of lettuce. Today you can buy many different types of this leafy vegetable.

Figure 4.8 These two cobs were produced by different varieties of corn.

We grow many different kinds of plants. Most of them were developed by growers and scientists to meet specific demands. The carrot the local farmer grows may have been developed for the short growing season in Alberta. The carrot at the grocery store in the winter may have been developed to stay fresh longer.

Give it a **TRY**

ACTIVITY

A Rose by Any Other Name

The provincial flower of Alberta is the wild rose. Why do the roses that people give on Valentine's Day look so much different from the wild rose? People have been growing roses for centuries. They have reproduced only the roses that they liked the best. Over time, very special types of roses were developed.

Look at the pictures of roses.

Make a list of all the ways these roses are different from the wild rose. Make another list of the ways they are the same. Which characteristics do you think the growers chose to reproduce?

Figure 4.9 Wild rose

Figure 4.10 Taboo rose

Figure 4.11 Peace rose

Problem Solving Activity

The Key to Variety

Materials & Equipment

For each group:

- 1 sample of each of 5 different varieties of a plant (e.g., carnation)
- chart paper or Bristol board
- commercial classification key for reference (optional)

Recognize a Need

You are a plant breeder in a company that produces new plant varieties. Your job is to keep track of the new varieties by making a classification key. A classification key is a diagram or list that organizes the traits of different organisms in a way that allows someone to use it to identify a specific organism.

The Problem

Create a classification key that will distinguish between five different varieties of a plant.

Criteria for Success

For your classification key to be useful, it must meet the following criteria:

- It must distinguish each of the varieties by at least one unique trait.
- It must be clear and easy to use.

Brainstorm Ideas

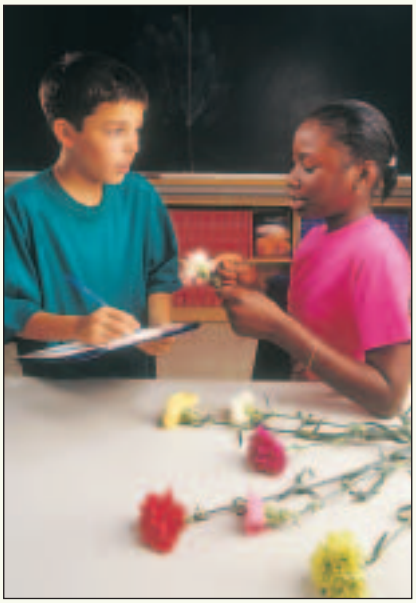
1. Pick up the plants that your teacher has supplied. List all of the traits that are the same and different.
2. Refer to Toolbox 9: Visual Organizers to review the different ways you can organize and present data. You might also look at a commercial classification key. Decide as a group how to organize your list so that it can be used to determine each variety.

Construct a Classification Key

3. Make a classification key using the visual tool you decided upon.

Test and Evaluate

4. Test if you can separate each variety from the other four using your key.
5. Make any changes to your key that are needed, based on the results of your test. Copy your completed key onto a sheet of chart paper or Bristol board.



Communicate

6. Post your classification key in your classroom and compare it with those of your classmates. Did everyone use the same traits? Was the visual tool that others used more or less effective than yours?
7. Write a paragraph describing the process you used to construct your classification key.

RESEARCH

Helpful Hybrids

Most of the plants and seeds you buy are hybrid varieties. Use your school library and the Internet to find out what a hybrid variety is, and why plants are sold this way.

We Grow Particular Varieties of Plants

A **species** is a group of organisms with similar traits that can reproduce with each other. A **variety** is a subset of a species. A variety has specific characteristics, or **traits**, that distinguish it from other varieties.

New plant varieties are produced to provide us with plants that have traits that we need or want. We may need plants that can grow in colder climates, or can tolerate salty soil. Some varieties are more able to fight diseases or attack by insects.

Varieties Are Developed by Selective Breeding

Growers and scientists use **selective breeding** to develop new varieties of plants. Selective breeding is the process of selecting plants with specific traits and reproducing them.

People have been using selective breeding since we first started farming. A farmer might notice that one plant grows taller than the rest. She plants seeds from this plant the next year, and gets more tall plants. If she does this every year, eventually all of her crop will be tall.

Today scientists can also change the characteristics of plants by **genetic engineering**. Genetic engineering is a process in which single genes are added to a plant's cells. A **gene** is a tiny piece of material in a cell's nucleus. Each gene in a cell is responsible for the inheritance of certain traits or characteristics. In genetic engineering, the added gene can come from other plants or from totally different living things.

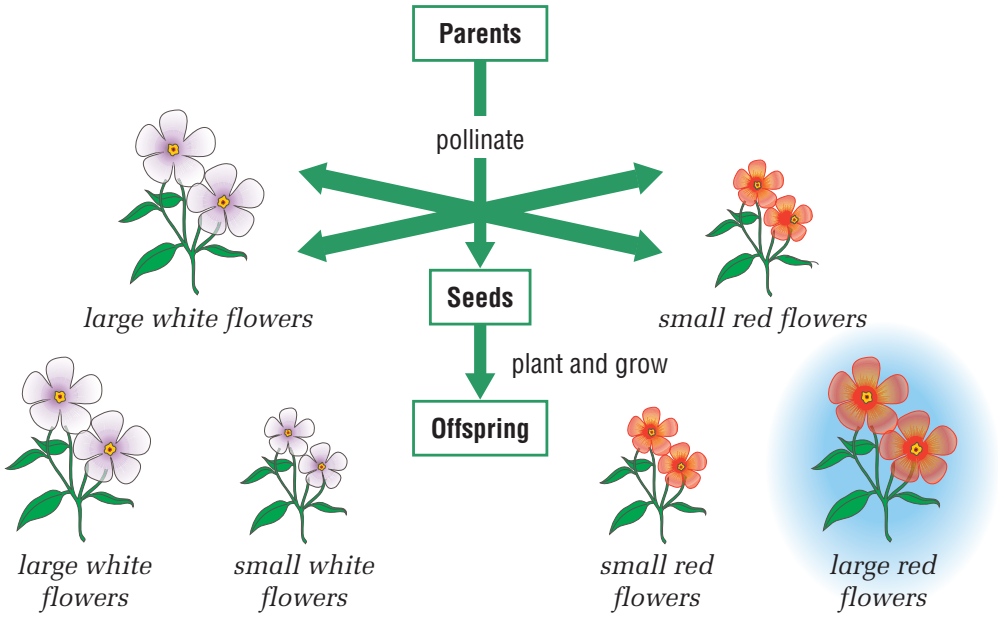


Figure 4.12 The traits of the parents are selected first, then the offspring. Some of the offspring of these plants will have flowers that are both large and red.

New Varieties Can Cause New Problems

Although new varieties have useful traits, they may also require more fertilizer or other special treatment. For example, an increased use of pesticides may be required if the new plant variety is more attractive to pests. This can be expensive for the farmer. As well, it may be harmful to the environment because the food web may be disrupted.

In western Canada, canola (an oilseed crop) is grown. The yellow flowers produce pods containing tiny round seeds. Each seed contains about 40% oil which is valued because of its health benefits. Through genetic engineering, canola plants can be protected against insect damage and some herbicides. There is some concern that canola plants might cross-pollinate with wild mustard and produce a "super weed." A super weed might not be easily controlled.

Figure 4.13 Some varieties are more attractive to pests.

Check and Reflect

1. What is a variety? Give an example.
2. Explain selective breeding.
3. You find a Saskatoon bush growing wild that has large, sweet berries. What could you do to produce more bushes that have exactly this kind of berry?
4. Why do we need to produce new varieties? Give at least two examples in your answer.
5. Why is it hard to produce new varieties of trees?

Careers and Profiles

Plant Pathologist

Allan Kuzyk is a plant pathologist in the Department of Agriculture and Agri-Foods at the Lethbridge Research Centre. Allan studies cereal diseases and tries to find new ways to fight them. He passes his results on to other scientists, agricultural workers, and the general public. Allan also helps to develop new varieties that do not get diseases very easily.

- People who study plant diseases can work in agriculture, horticulture, or forestry. Do you know someone who knows about plant diseases?

Figure 4.14 To create new varieties, Allan sometimes has to pollinate plants by hand.

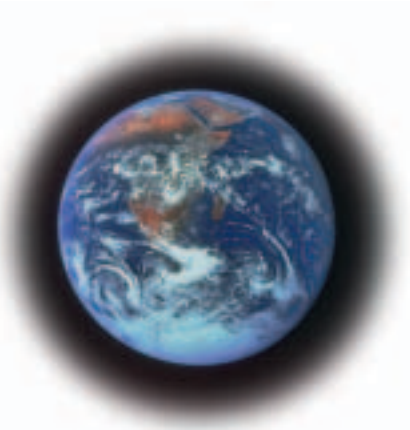


Figure 4.15 Many of the ways we grow and harvest plants can have global consequences.

4.3 Controlling Weeds and Pests

As you look at this picture of our planet taken from space, consider how all life on Earth shares the same global environment. Within this web of life, some living things are considered useful to humans. Other living things are considered harmful or at least a nuisance.

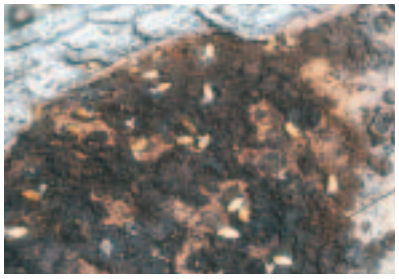
In commercial crops, plants that interfere with the growth of these crops are called weeds. For example, crop losses can result from weeds such as wild oats, quack grass, green foxtail, and smartweed. Animals that eat or affect the growth of commercial crops are called pests. For example, the army cutworm larva eats the leaves of many plants, including wheat, oats, barley, mustard, flax, alfalfa, peas, cabbage, and grasses.

Weeds and pests do have a role in the environment, but farmers must produce a variety of crops for human consumption. To meet consumer demands, farmers must maximize crop yield. To do this, they must control weeds and pests.

*info*BIT

Bark Beetles

Bark beetles damage many trees in Alberta. They tunnel under the bark of trees to lay their eggs. These tunnels allow diseases to enter the trees and weaken or kill them.



Give it a TRY — ACTIVITY

What's the Real Story Here?

Read the situations below. In a paragraph, write a story that links these situations together.

- Weeds grow in a field of oats, which reduces yield.
- Insects eat some of the weeds.
- Birds eat some of the insects.

Now add another paragraph to describe what happens when a farmer sprays a chemical to kill the weeds.

Did the farmer's action have any consequences?

Controlling Weeds with Herbicides

Herbicides are chemicals that kill plants. Gardeners use herbicides to kill weeds to produce beautiful lawns and flower beds. Farmers use herbicides to kill weeds and selected plants. This allows farmers to choose and grow a single crop in a field. One of the advantages of having one single crop is that the individual plants mature around the same time and make harvesting easier. However, herbicides can cause problems. For example, some weeds are the food source of other living organisms. Killing these weeds may cause those organisms to starve. The build-up of herbicides in the soil can make the soil less fertile for certain plants. Any herbicides that get washed into streams and lakes may be harmful to living things in these water environments.

Figure 4.16 Canola plants that are herbicide-resistant can pollinate with their wild relatives. These weeds are now resistant too, and are more difficult to control.

When a herbicide is used for a long time, some weeds become resistant to it. The next time the herbicide is used, the resistant weeds will have fewer plants to compete with and may take over. New herbicides must be developed to prevent this problem.

Controlling Insects with Pesticides

Substances that kill insects are called **pesticides**. Farmers use pesticides on their crops to protect them from harmful insects. Pesticides can sometimes kill helpful insects as well, such as those that pollinate crops. Used carefully, pesticides help farmers increase yields. Care must be taken not to contaminate the environment with pesticides.

When pesticides are used for a long time, some insects will become resistant, and the pesticide becomes less useful. New pesticides must then be developed to control the resistant insects.

Many pesticides are still on food when we buy it from the grocery store. This is why it is important to wash fruits and vegetables before eating them.

Figure 4.17 Pesticides used to control harmful insects on crops are killing many monarch butterflies every year.

rESEARCH

Controlling Mosquitoes

Some communities spend a lot of money trying to control mosquitoes. Using your school library, the Internet, or other resources, find out if mosquitoes are being controlled in your community. In your opinion, is your community doing the right thing? Explain your answer.

Figure 4.18 Ladybugs can be used to control aphids.

Biological Control

Sometimes, a natural predator is used to control a pest. This method of pest control is called **biological control**. Biological control tries to copy the way that population size is controlled in natural environments.

Biological control does not get rid of all the pests. Instead, the predator changes the balance in the environment so that there are fewer pests. Biological control also takes a while to work. This method isn't useful for large outbreaks of pests.

Check and Reflect

1. Explain what happens when a pesticide is used for a long time.
2. What are herbicides used for? Describe one consequence of using herbicides in agriculture.
3. Describe biological control.
4. Explain why you agree or disagree with the statement "Pesticides are more helpful than harmful."

4.4 Consequences of Environmental Management

Have you ever done something you thought would be a good thing, and then found out that you actually did something harmful? Maybe you decided to weed the flower garden for your parents and you pulled out some new prized seedlings along with the weeds. This is an example of an **unintended consequence**, or something that you didn't predict would result from what you did. Unintended consequences often happen when we don't know or don't think about all the factors in a situation.

Discuss with a partner any experiences you have had with unintended consequences. When you listen to your partner, think about possible reasons why things didn't turn out as expected.

Give it a **TRY** ACTIVITY

INTENDED AND UNINTENDED CONSEQUENCES

Sometimes when we try to be helpful, we end up doing things that just make more trouble. These unintended consequences might not have happened if we knew more about the situation or had taken more time to think about it.

For each of the situations in the list below, predict the consequence. Was this consequence intended or unintended?

- A large man is leaning out on a very small tree branch trying to reach his cat.
- A girl pushes a door open for her friend, but doesn't notice her teacher is on the other side.
- A community group decides to clean up a stream in the spring. They walk through the nesting area of an endangered bird as they are collecting garbage.

SOME PRACTICES HAVE UNINTENDED CONSEQUENCES FOR THE ENVIRONMENT

Environmental management is balancing the needs of humans with the needs of the environment. It can involve many different technologies and ways of using resources. When we use technologies to manage an environment, we need to look at all of the effects of the technology—not just the intended effects.

*info*BIT

A Pond Without Reeds

All the reeds and other water plants have been removed from this pond. Now ducks have nowhere to nest here.

Figure 4.19 Human activity in the wilderness may cause some animals to move away.

When forests are being logged, roads must be built to help bring in people and equipment. Animals such as elk and moose also use these roads, since they provide convenient paths from one location to another. For the same reason, predators may also use the roads. So, the introduction of roads often may have the unintended consequence of making the habitat less secure for some species.

People other than foresters also use motorized vehicles like snowmobiles and all-terrain vehicles on logging roads. Although they may be enjoying the wildness of these remote areas, their presence may cause some animals to move away from the area to avoid human contact. The repeated use of these areas by human activities may make the habitat less secure for a number of species. While humans can use these areas for various purposes, it is important that we be sensitive to other species that share the landscape.

Monoculture

In farm management, each planted field will often be used to support growth of just one variety of plant. This is called **monoculture**. All the plants are very similar or even identical to each other. Growing plants by monoculture can cut down on costs and fertilizer overuse. It can also make harvesting a crop a lot easier. These are the intended consequences of monoculture.

Unfortunately, monoculture can also give pests a huge supply of their favourite food. This can cause the population of pests to explode, and result in much more pesticide being used. Monoculture also reduces the **biodiversity**, that is, the number of different species, of the environment, since only one kind of habitat is available.

Problem Solving Activity

Reducing Our Impact

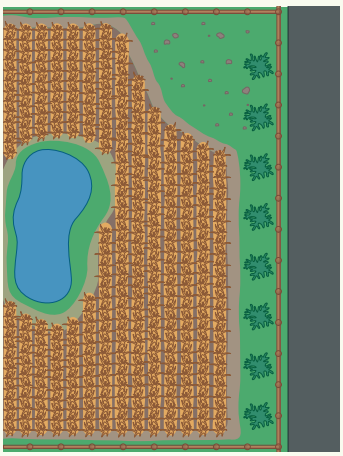


Figure 4.20 This year's barley field has some unused areas.

Recognize a Need

You are a grain producer with a large, independently operated farm. You just read a magazine article about the loss of biodiversity, or the number of different species, in Alberta. You've decided to review how you manage your barley field, and evaluate whether anything you do has the unintended consequence of reducing biodiversity. You then want to develop a strategy that will reduce this effect, but won't reduce the productivity.

The Problem

To identify one or more ways to improve habitat for wildlife without harming the productivity of a barley field.

Criteria for Success

To be successful, the proposed changes must meet the following criteria:

- Life-supporting habitat for wild species would be recovered.
- Barley production would not be affected.

Brainstorm Ideas

1. In a group, identify example species that would already occupy existing habitat (i.e., the pine trees, pond, and rocky area). Identify others that may not be present but might be supported through habitat change.
2. Generate a list of proposed strategies for habitat enhancement. Select two for testing.
3. For each habitat development strategy, propose what wild species might be positively affected by this habitat change.

Test and Evaluate

4. For each proposed habitat change, research and report on the needs of those animals as a way of providing evidence that the proposed habitat change would be effective for that species.
5. Identify particular strengths and weaknesses of this habitat for each species named.
6. Identify one or more habitat changes that your group suggests would have the maximum impact.

Communicate

7. Write a report that summarizes your work. Explain the reasons for all the decisions you made. You might want to use a map in your report too!

rESEARCH

More or Less?

For most crops being grown today, only a few varieties are grown worldwide. Use the Internet and other resources to find out about biodiversity, and what consequences growing a limited number of varieties could cause.

Sustainable Management

Unintended consequences are often difficult to predict. The more we know about the organisms in the environment and how they are linked to one another, the less likely we are to accidentally cause harm. We can then manage our plant resource in a way that can be continued, or **sustained**.

Economic and Social Effects

Sustainable ways of producing plants can also have some consequences other than helping the environment. Think about crop rotation. It breaks insect and disease cycles, improves soil structure, controls problem weeds, and improves yields by up to 15%. Rotating crops prevents the continued depletion of certain nutrients in the soil which would occur if the same crops were planted year after year. In western Canada, farmers are examining and growing alternative crops such as canola, lentils, and peas because of the potential benefits. Legumes (peas and beans) grown in the rotation increase a subsequent crop grain yield and protein content. Crop rotation makes economic sense.

Since crop rotation keeps the soil healthy, a farmer can keep producing crops for a long time. This can help to provide steady jobs for the people who work for the farmer. Because they can rely on their jobs, these people can stay in the area and help to build the community they work in. This is an example of social effects of sustainable practices.

Check and Reflect

1. What do we mean when we say something is sustainable?
2. What is monoculture? Give an example.
3. A grower decides to change from using pesticides to using biological control. Suggest one environmental, one economic, and one social consequence that his or her decision could have.
4. Describe at least one thing that you could do in your local area that might improve the environment. Do you think you might actually do this? Why or why not?

Assess Your Learning

1. What is selective breeding?
2. Give three examples of different species of plants. Give three examples of different varieties of plants.
3. Do you think that plowing an empty field is a good practice? Why or why not?
4. Why do we need to produce new varieties of plants? Use at least one real-life example in your answer.
5. Give an example of an unintended consequence of human activity in a managed forest.
6. Describe one intended consequence of monoculture.
7. Write a short paragraph of three or four sentences that describes sustainable agriculture.
8. Growing and harvesting plants in ways that sustain agriculture and the environment is very important for the whole planet. Do you agree with this statement? Why or why not?

Focus On Science and Technology

In this section, you were introduced to some examples in which a technology that was intended to be helpful also had harmful consequences. Although we can never predict all consequences, making sure we have "done our homework" and learned as much as we can will reduce how often this happens. Think about the knowledge that would be needed to use a herbicide or pesticide safely and effectively.

1. What would you need to know about the local environment?
2. What should you do to try to prevent unintended consequences of using a herbicide or pesticide?

SCIENCE WORLD

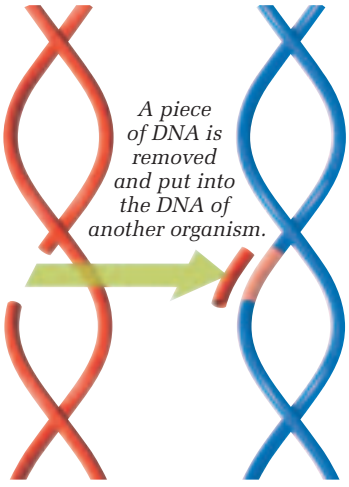
Case Study

Genetically Modified Organisms

The Issue

Some varieties of our crops were produced by genetic engineering. For example, some corn and potatoes are genetically engineered to have protection against insect damage. Corn, squash, and sweet potatoes have been "vaccinated" so that they are resistant to viral plant diseases. Some tomatoes have been treated to permit vine-ripening for better flavour and longer storage. Swiss researchers have produced a rice that will satisfy the daily requirement of vitamin A and provide more iron. This would help people in developing countries who have vitamin A and iron deficiencies. In the U.S. there are test fields of tobacco plants producing a potential AIDS drug.

Genetic engineering is a process in which a piece of **DNA**, or genetic material, is moved from one organism into an entirely different kind of organism. The piece of DNA gives the new genetically modified organism, or **GMO**, a new trait.



By moving around pieces of DNA, scientists can give plants new traits.

However, many people are concerned that GMOs will have unintended consequences. For example, the "super weed" described earlier in this unit developed when canola plants were grown as a crop.

Many countries are refusing to buy any products that have been genetically engineered. In fact, when a company from Winnipeg accidentally shipped canola seed that contained 0.4% of genetically modified seed to Europe, the farmers who received it ripped up their entire canola crop to prevent it from flowering.

Some people argue that GMO experiments are not safe because scientists do not yet fully understand the interactions between organisms and the ecosystems. They say that herbicide-tolerant plants encourage more reliance on chemical weed killers. This in turn puts more chemicals on our food and in the groundwater. Other comments have to do with the fear of altering genes in a food crop and changing the nutrient value or producing something poisonous or allergenic.

Go Further

Now it's your turn. Look into the following resources to help you form your opinion about whether Canada should continue to allow our farmers to grow GMOs in their fields.

- Look on the Web: Check out the rules Canada has about GMOs.
- Ask the Experts: Try to find an expert on genetic engineering. Experts can be found in many places: universities, environmental and agricultural organizations, or government agencies.
- Look It Up in Newspapers and Magazines: Look for articles about GMOs.
- Check Out Scientific Studies: Look for scientific studies about the safety of GMOs.

In Your Opinion

Summarize your findings as one of the following:

- an article for your local or school newspaper
- a speech to be presented at a forum on this issue
- a poster

Unit Summary: Plants for Food and Fibre

Key Concepts	Section Summaries
1.0 • life processes and structure of plants • plant propagation and reproduction	**1.0 Understanding structures and life processes of plants helps us to interpret their needs.** • Seed plants have roots, stems, leaves, and either flowers or cones. Each structure has a specific function. • To maintain their life, plants use the processes of photosynthesis, transpiration, and gas exchange. • Seed plants have three different stages in their life cycle. These are the seed stage, the seedling stage, and the adult stage. • For adult seed plants to produce new seed, they must be pollinated. Pollination is the joining of pollen and ovary. • Seed plants can be reproduced in ways that don't involve seeds. • The structures of seed plants are adapted to the environment they come from. These adaptations help the plant to get what it needs from the environment. • Different types of plants require different growing conditions. We have technology that can modify the environment to suit the plants we grow.
2.0 • needs and uses of plants • resource management	**2.0 Plants play an essential role in the environment and in meeting human needs.** • Plants supply oxygen and food to most of life on Earth. • Humans use plants for food, for fibre to make many of the things we need, and for medicines and other products. • As we use more plants, we convert natural living resources to managed living resources. There are fewer species in managed environments.
3.0 • fertilizers and soil nutrients • resource management	**3.0 Soil is an important resource that human activity can protect or degrade.** • Soil is composed of particles of minerals and organic material. The amounts of these particles determine if the soil is sandy, clay, or loam. • The methods we use to grow and harvest plants can improve soil or degrade it.
4.0 • plant varieties • selective breeding • monocultures • resource management • sustainability • chemical and biological controls	**4.0 The ways that plants are grown and used are related to human needs, technology, and the environment.** • New plant varieties are produced by selective breeding. New varieties have traits that we want, such as higher yield and pest-resistance. • New varieties can require additional fertilizer or water, which can lead to environmental problems. • Using herbicides and pesticides long term can lead to the development of resistance. It can also cause loss of helpful species or pollute the soil. • Sustainable practices balance our needs with the needs of the environment. We also must balance the social and economic consequences of changes that we make.

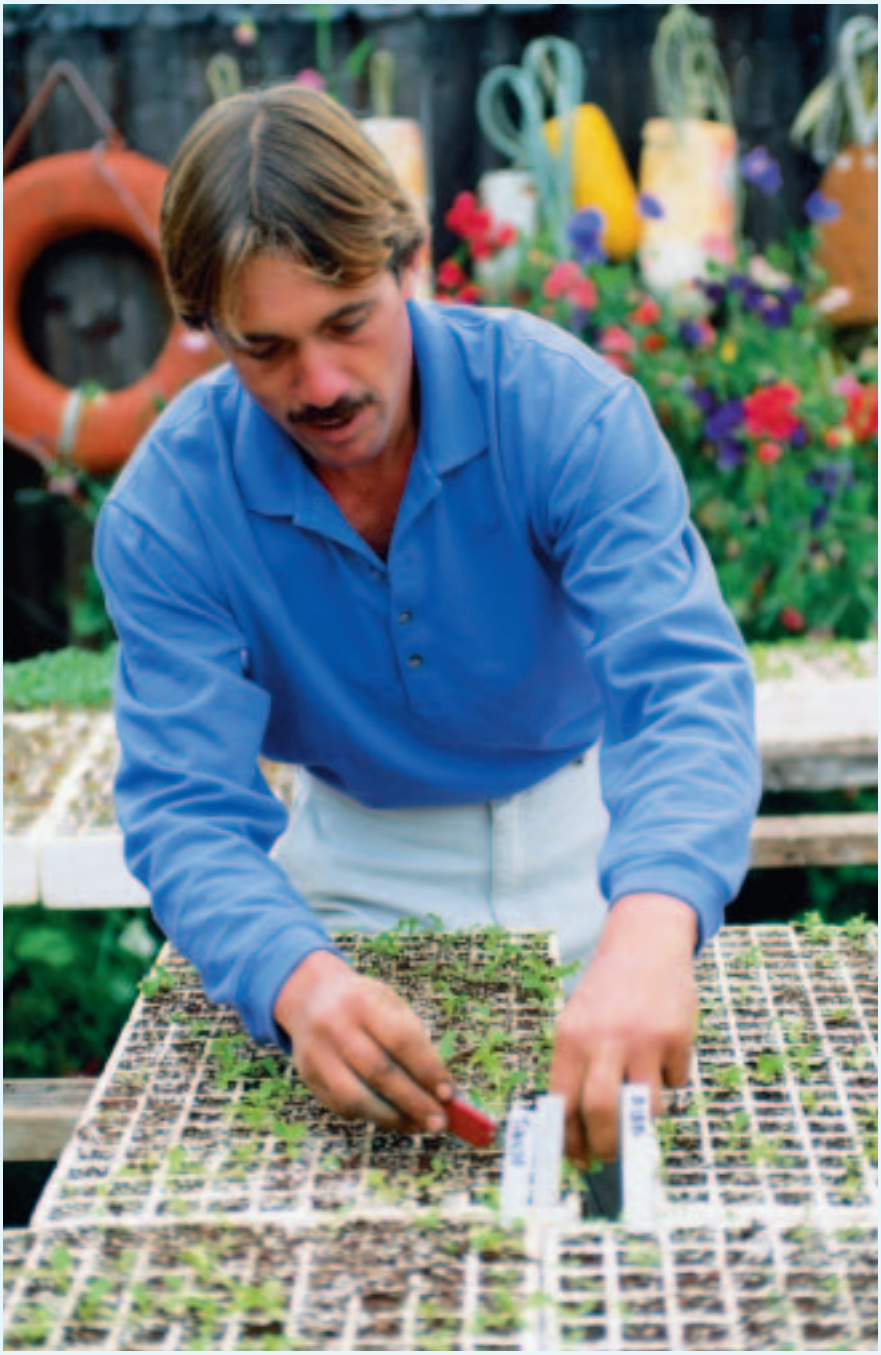
PROJECT

Design and Build a Growth Chamber

Getting Started

In this unit, you have learned that we need plants for food and fibre, and that plants also provide oxygen and food for most of life on Earth. You learned about the needs of some plants and some of the technologies that we use to modify the environment to grow plants.

Some of these technologies are very important to Albertans. Since you live in Alberta, you know the growing season is short. To get a head start on your vegetable garden, you could design and build a growth chamber. This chamber could then be used to grow some seedlings that would be transplanted into your garden at the appropriate time.



If growing season is short, many gardeners start their seeds indoors to get them growing.

Your Goal

Your goal is to design and build a growth chamber for vegetable seedlings and then determine how well seeds grow in your chamber.

What You Need to Know

There are two parts to this project.

First, you must plan and design your growth chamber. Some materials and equipment that might be useful include:

- seeds (beans, corn)
- hydroponic solution
- building materials such as cardboard, wood, cellophane or plastic wrap, tape, glue, hinges, nails, screws
- building tools
- plant pots and/or trays
- light source such as a window, a lamp, or fluorescent lights
- various soil types and additives such as perlite or vermiculite

For your growth chamber to be effective, it must

- be large enough to hold at least six vegetable seedlings
- have a light source
- provide a moist environment
- provide appropriate soil

Second, you must plant some seeds in your growth chamber and allow the seedlings to grow for at least three weeks.

Steps to Success

1. In a group, list the needs of plants for growth.
2. As a group, develop a safe plan or design for your growth chamber.
3. Draw a side view, front view, and top view of your plan. (See Toolbox 8 for help with drawing diagrams.)
4. Choose and safely use appropriate materials, tools, and equipment when building your growth chamber.
5. Once your chamber is built, plant your seeds.
6. Record your observations of the seedling growth in your chamber several times a week for three weeks.

How Did It Go?

7. Display your completed growth chamber in your classroom.
8. Compare your chamber with those of your classmates. Are there any features in their designs that work particularly well?
9. If you were to build the chamber again, is there anything you would change? If so, state what it is and explain why you would change it.
10. Write a report or prepare a poster that includes your labelled scale drawings, the soil mixture used, the plant growth over a three-week period, and comments on the success or failure of your design. You may want to include a graph of plant growth as well as a description of any features you would change if you were to build this again.

Unit Review: Plants for Food and Fibre

Unit Vocabulary

1. Write a short story describing the life cycle of a plant using the following terms:

   soil
   sandy
   root
   leaf
   flower
   pollinate
   pest control
   photosynthesis

Check Your Knowledge

1.0

2. Draw and label a diagram of a seed plant.
3. How do plants make their food?
4. What is transpiration?
5. What function takes place only in the adult stage of a seed plant?
6. Describe one way that a seed plant can reproduce without seeds.

2.0

7. Plants make two things that the rest of life depends on. What are they?
8. Why do humans need plants?
9. Why is a forest a living resource?
10. What do plants need to survive?

3.0

11. Draw and label a diagram that shows the characteristics of clay soil.
12. Does plowing help or damage the soil? Explain your answer.

4.0

13. A flower is growing in a dry area of your garden. Describe two ways that you could modify the environment to make sure the flower gets enough water.
14. Describe hydroponics. What is left out when plants are grown by hydroponics?
15. Selective breeding
    a) is a process used by scientists
    b) is a process used by growers in agriculture and horticulture
    c) both a) and b)
16. Logging provides us with many useful things, like paper and wood. Describe one unintended consequence of logging.
17. Is using pesticide for a long time sustainable? Explain your answer.

Connect Your Understanding

18. Last week, someone put all their paper in the garbage instead of recycling it. What effect might this have on the amount of natural forest in Alberta?
19. When you are shopping with your parents, you see some organically grown vegetables. They ask if you want to get some. What do you tell them? Why?

20. Great! There is a new variety that produces giant zucchinis.
   a) What plant structure is changed in this variety?
   b) What growing conditions do you predict would need to be changed to get a giant zucchini?

21. In the newspaper, you read that protesters are trying to stop a company from logging a forest.
   a) What will be the environmental consequences if they are successful?
   b) Will there be any economic or social consequences if they succeed? Explain.

Practise Your Skills

22. In Canada, most farmland is in the south, where lots of people live. You are a genetic engineer who is considering putting a gene into corn from a plant that grows well in cold weather. This would make corn that could grow in the Arctic, where there are fewer people.
   a) Would growing corn in the Arctic have any unintended consequences? Explain your answer.
   b) Would you eat genetically engineered corn? Why or why not?

Self Assessment

Think back to the work you did in this unit.

23. Are new technologies always developed by scientists and engineers? Provide an example with your answer.

24. Do you think that we are getting more careful or less careful about affecting the environment? Why?

Focus On — Science and Technology

In this unit, you investigated the role of science and technology in growing and harvesting the plants we need while maintaining the environment. Think about this in relation to the following questions.

25. Give two examples of technology that improved the amount or quality of plants that we grow or harvest.

26. Describe some methods of producing plants that have less environmental impact. Are these the fastest and easiest methods?

27. Reread the three questions on page 97 about the science and technology context. Use a creative way to demonstrate your understanding of one of the questions.