

CURRICULUM CONNECTIONS
GRADE 5 MODULE



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- Lesson #1** Growing Plants in Greenhouses
- Lesson #2** Greenhouses as Structures
- Lesson #3** Greenhouses – Plants and Flowers
- Lesson #4** Greenhouses on Mars
- Lesson #5** Building a Flower Garden

Introduction

In grades five and six, students learn about the elements of structures and how external forces affect these structures. In addition, teachers are also encouraged to have students analyse the social and environmental impacts of forces that act on these structures.

This series of lessons deals with greenhouses as structures and projects student knowledge and understanding about greenhouses to the development of similar structures in different locations on Earth ... and ... on the surface of an interplanetary body – Mars.

A practical exercise – building a garden – has also been included for your reference; although it is not tied directly to the grade 5 curriculum expectations, this is an exercise that could have school-wide implications.

Curriculum Expectations

The focus in grade five is on structures. Greenhouses are excellent examples of simple structures that can be seen and analyzed for their characteristics. The Ministry of Education curriculum expectations require students to:

- Analyze social and environmental impacts of forces acting on structures;
- Investigate forces that act on structures;
- Consider different perspectives when looking at ways in which structures can be modified to best achieve social and environmental objectives.

Appendices

- 5.1 How Greenhouses Work
- 5.2 Life Support Systems
- 5.3 Comparing the Environments of Earth and Mars
- 5.4 Student Copy – Comparing the Environments of Earth and Mars
- 5.5 Technology in the Greenhouse
- 5.6 Blank Mind Map
- 5.7 Alternate Blank Mind Map
- 5.8 Building a Greenhouse on Mars (student copy)

Photos

- 5.1 – 5.10 Ten photos of Greenhouse Interiors



Teacher Background Information



Greenhouses

Greenhouses create an artificial environment, sheltered from the "outside" environment that may be too cold, too hot or too variable for the growing of plants. Greenhouses use their glass enclosures to trap solar radiation; the radiant heat enters through the glass or plastic covering and warms the air, soil and plants inside. This warm air rises and is replaced by cooler air that in turn is warmed up; this cycle raises the temperature quickly. The heat created by the solar radiation, plants and from the soil is "trapped" by the glass. Sometimes, the air inside can be overheated and has to be vented out. As you drive by a greenhouse, you may see the glass panels on top open to vent out the warm air vertically. Venting can also occur horizontally through side fans and vents. The venting also keeps the air in the greenhouse moving, allowing for a more even temperature throughout and cycling the carbon dioxide that plants need to grow. Most modern greenhouses have automated systems to regulate the temperatures inside.

The "heat" which is generated often comes from the sun. However, in really cold climates, heat is added to the air or to the soil.

In addition to the "heat component", plants in greenhouses also require water. Many greenhouses use an automated irrigation system to keep the growing media moist and flowering plants supplied with needed water. Hydroponic systems, that don't use soil to "hold" moisture, supply water directly to the roots on a more frequent basis.

Although a greenhouse may appear to be a simple structure, the key components of any human-made structure are present; in a greenhouse, these include

- a strong foundation,
- a sturdy frame to maintain the glass (or plastic) panels,
- flooring that varies from simple dirt to concrete, wood or stone,
- "glazing" - glass or other synthetic covering to allow in solar radiation and to help to provide insulation,
- a system for watering of the plants and flowers.

[note: this information is available as a one-page supplement for duplication – Appendix 5.1 - How Greenhouses Work]

Teacher Background Information



Life Support Systems

In human history, humans moved from a “hunting and gathering” nomadic life to become inhabitants of a fixed place with the cultivation of plants and the domestication of animals – the beginning of agriculture. The basics of life support – air and water – are provided by the Earth’s ecosystem.

In the past ...

However, humans have learned to “modify” small portions of the Earth’s biosphere with the creation of GREENHOUSES. It is speculated that the earliest greenhouses may have been developed in ancient Rome, nearly 2000 years ago ... to grow vegetables year-round for the demanding Roman emperors! At this point, glass had not been invented, so small sheets of the mineral mica were used.

In the 13th century, greenhouses were built in Italy to grow the exotic plants that explorers brought back from the tropical areas that they visited.

In the 17th century, the first greenhouses made with glass emerged in Europe to propagate tropical plants in the colder environment of the area. Later, greenhouses for people evolved (called solariums), to provide warmer environments for human habitation.

Greenhouses may have been developed in the Far East in the 15th century, in both China and Korea. In Korea, greenhouses were used to grow mandarins using an active soil heating system.

The concept of greenhouses also appeared in Netherlands and then England in the 17th century. Today, the Netherlands has many of the largest greenhouses in the world, some of them so vast that they are able to produce millions of vegetables and flowers every year. The botanist Charles Lucien Bonaparte may have built the first practical modern greenhouse in Leiden, Holland during the 1800s to grow medicinal tropical plants. In France, greenhouses were used to grow both oranges and pineapples, plants that could not withstand the harsh climate of northern Europe without some form of modification.

An elaborate greenhouse was built to accompany the Palace of Versailles just outside of Paris in the 17th Century; it was 150 metres by 13 metres and exceeded 14 metres in height.

At the same time, in the United Kingdom, elaborate greenhouses were established including several in Key Gardens and The Crystal Palace.

In the 20th century, the geodesic dome was added to the many types of greenhouses including the Eden Project In southwest

England, and the Climatron in the Missouri Botanical Gardens in St. Louis.

The availability of polyethylene (the most common form of plastic) as a replacement for glass was one of the main developmental features of the late 20th century. The early versions of polyethylene did not stand up to the UV rays of the sun very well; however, their durability was increased with the development of effective UV-inhibitors in the 1970’s and 1980’s.

In recent years, greenhouses with two or more connected bays have been developed; they use a common wall or a row of support posts. Most of the greenhouses in Southern Ontario are in this form.

In the future ...

Because of the lack of a suitable biosphere on either the Moon or Mars, the habitants of these new environments will have to create their own! This will be a CLOSED life support system that includes plants and microorganism – a greenhouse on Mars. A greenhouse isolates plants from the adverse conditions of the Martian environment.

[note: this information is available as a one-page supplement for duplication -- Appendix 5.2 - Life Support Systems]

Teacher Background Information



The Martian Environment

The Martian Environment Compared to Earth's Environment		
Component	MARS	EARTH
Atmosphere	95% Carbon Dioxide	77% Nitrogen, 21% Oxygen, .038% Carbon Dioxide
Pressure	7.5 millibars	1,013 millibars
Gravity	.375 that of Earth	2.66 times that of Mars
Surface temperature Average	-63°C	14°C
Surface temperature Range	-12°C to +20°C	-88°C to +58°C
Surface Material	No organic material – mostly silicon dioxide, iron oxide and “rocks” similar to those on Earth; no surface water	Varies with region – soil contains both organic and inorganic materials
Relationship with the Sun	Thin atmosphere – high levels of radiation	Earth's atmosphere is similar to a greenhouse – blocking radiation and moderating temperatures

[note: this information is available as a one-page supplement for duplication – Appendix 5.3 – The Martian Environment]

Teacher Preparation and Materials

RESOURCES PROVIDED

How Greenhouses Work [appendix 5.1]

Teacher Background Information on Greenhouses [Appendix 5.2]

The Martian Environment Compared to Earth's Environment [Appendix 5.3]

Comparing the Environments of Earth and Mars - blank [Appendix 5.4]

Technology in the Greenhouse [Appendix 5.5]

Blank Mind Map [Appendix 5.6 and Appendix 5.7]

Photographs of Greenhouses (10)

RESOURCES PROVIDED BY THE TEACHER

Atlas

LESSON #1

Growing Plants in Greenhouses



- 1. Use the photos of greenhouses (10) to determine what is needed to grow plants in greenhouses.**
 - 1.1** From these photographs and diagrams, list the elements that are needed to grow plants in a greenhouse?
 - 1.2** Are these the same elements that would be needed to grow plants outdoors?
 - 1.3** If your response to 1.2 was “yes”, why do we need to grow plants indoors? Think of as many reasons that you can for using greenhouses to grow flowers or potted plants rather than having them grown outdoors.
- 2. Outside, farmers may use tractors, cultivators, sprayers and crop harvesters to help them with the operation of a farm. Indoors, where spaces are smaller, this machinery might not be that useful.**
 - 2.1** From the photographs, list the technology that is used by greenhouse growers. (e.g. overhead irrigation).
 - 2.2** From your list, indicate the function of each item (e.g. the irrigator shown in photo 5.3 provides needed water for the plants).
 - 2.3** What are the main advantages of using advanced technology in the greenhouse industry where potted plants and flowers are grown?
 - 2.4** Thinking about the future, suggest some new technological advances that might be seen in the greenhouse industry in the next 25 years.
- 3. From the photographs of the interior of the greenhouses ...**
 - 3.1** Identify the flowers that are being grown.
 - 3.2** Have you ever had any of these flowers in your home?
 - 3.3** Who purchased the flowers?
 - 3.4** Were the flowers for a special occasion? If so, what was the occasion?
 - 3.5** Are there other reasons for having flowers in the house in addition to the celebration of special occasions?
- 4. One of the attractions of flowers and potted plants are their colours as seen in these photographs. What are some of the other attractions of flowers and potted plants for us as humans?**

LESSON #2

Greenhouses as Structures



1. Examine the attached photographs of greenhouses. Describe the structures that are shown in the photographs of both the interior and exterior of the greenhouses.
2. What are some of the common elements of the structures shown in the photographs? (e.g. all the greenhouses shown have)
3. Identify the materials used in the building of the greenhouses.
4. For each material identified, suggest one or two reasons why that material was used for that particular purpose. (e.g. concrete floor – to provide a strong foundation for the structure)
5. Although you cannot tell the whole area covered by these greenhouses, how would you describe their size?
6. What is being grown in the greenhouses?
7. What other plants are often grown in greenhouses?
8. Re-examine the photographs.
 - 8.1 Describe any greenhouse-related features that you cannot identify.
 - 8.2 List any items that you see that you can explain in terms of the greenhouse operation?

LESSON #3

Greenhouses – Plants and Flowers



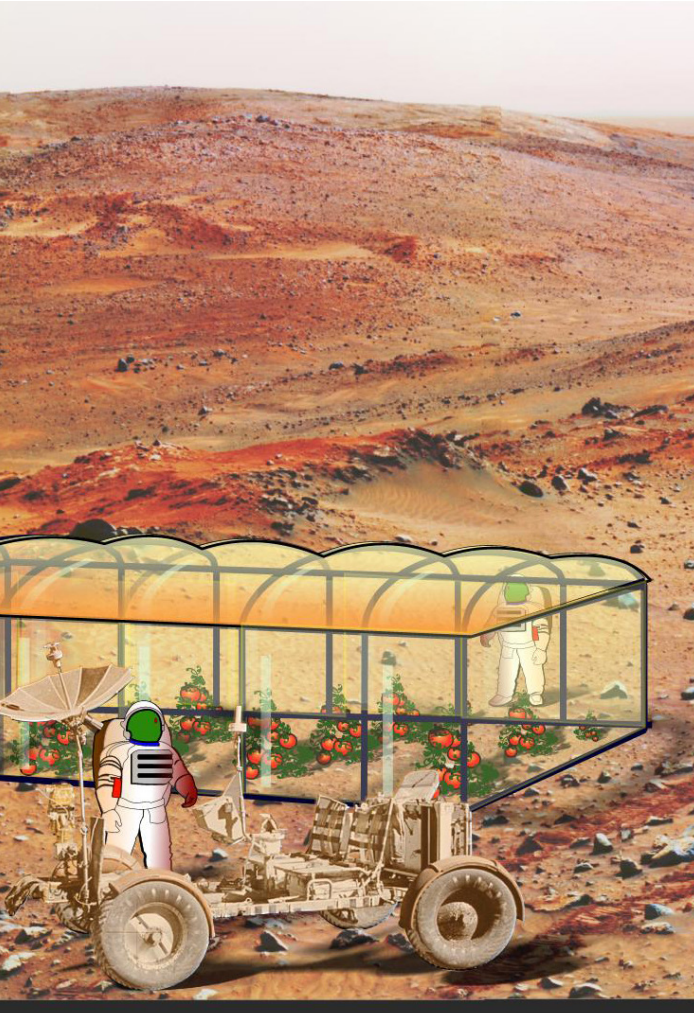
1. Examine the photographs of the interior of the greenhouses. There are several different plants that are growing in these photographs. Which photo illustrates:
Hydrangeas _____ Lilies _____
Helleborus _____ Mini pot roses _____
2. During the Christmas season, many people adorn their homes with particular types of plants.
 - 2.2 Why would these plants have to be grown in greenhouses in Southern Ontario?
 - 2.3 Other flowers are associated with particular seasons or celebrations. Match the flowers that you associate with the following seasons or events.

Valentine's Day	Azalea
Easter	Poinsettia
Mother's Day	Roses
Weddings	Tulips
Christmas	Roses
Chinese New Year	Lillies
3. Now, focus on the greenhouses themselves.
 - 3.1 What different materials are used in the construction of the greenhouses illustrated?
 - 3.2 Assume that you want to build a "mini" greenhouse. Make a list of the materials that you would need to build your mini-greenhouse.
 - 3.3 How would you control the temperature in your greenhouse?
 - 3.4 What other materials would you have to provide in order for you to grow potted plants in your greenhouse?
 - 3.5 Identify any indicators of automation in the photographs.
 - 3.6 Identify any machinery which is used to assist with "modifying the environment" inside a greenhouse.
4. Automation – using machines to do the work – has become more common in industry in Canada. Using Appendix 5.5 – Technology in the Greenhouse, compare the advantages and disadvantages of using machines – or people – in a greenhouse environment.
5. Assume that the greenhouses shown in the photographs are in Southern Ontario.
 - 5.1 What are some of the "weather-related" items that a greenhouse will have to withstand in a typical year in Southern Ontario.
 - 5.2 If the greenhouse was located in a different part of the world as indicated below, what other factors might have to be considered when building a greenhouse? [You will need to use an atlas to locate these places and then research information about the conditions at each place.]

Inuvik, North-West Territories	Arica, Chile (in the Atacama Desert)
Prince Rupert, British Columbia	Llisa, Tibet (China)
 - 5.3 Re-examine the photographs of the greenhouses and suggest some problems (and solutions to those problems) that might be encountered in the four areas above.

LESSON #4

Greenhouses on Mars



In lesson #3, you looked at how greenhouses might have to deal with extremes of the environment in a number of locations.

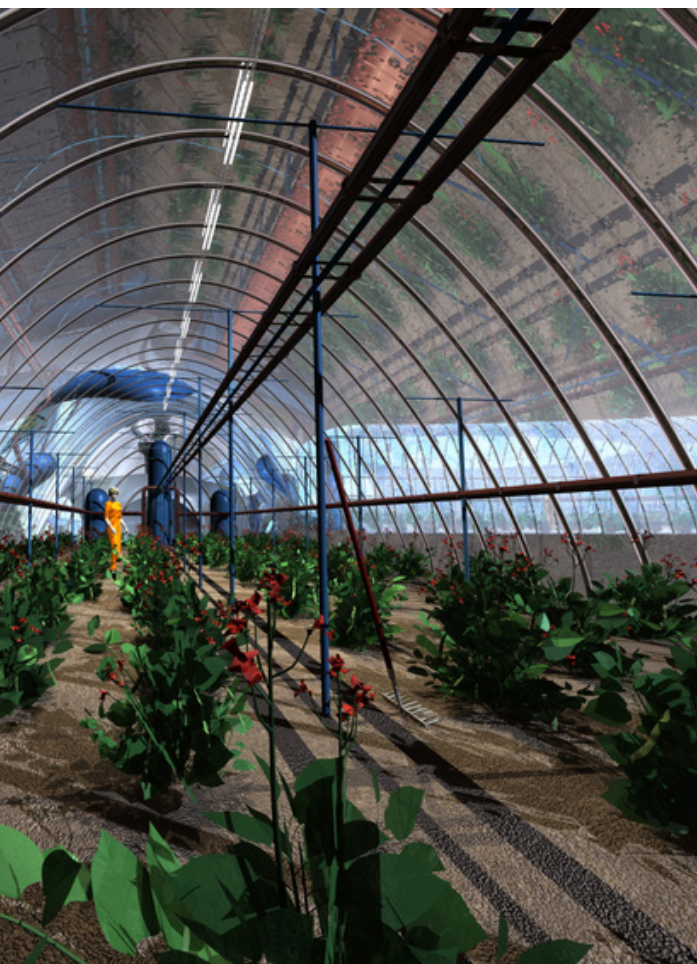
In Inuvik, in Canada's North West Territories, greenhouses could be extremely beneficial to the local population by providing needed plants throughout the year, but they may also have to be adapted to the permafrost of Canada's north. Structures built here have to be specially designed to protect the ground underneath from thawing. Similarly, greenhouse structures and how they operate would have to be adapted for desert areas, areas with lots of precipitation but little sunlight, and for locations at high altitudes.

In this lesson, you will look at an environment which is much more severe – the landscape of the planet Mars.

1. Research the planet Mars to investigate the characteristics of the planet's environment. Summarize your findings in the chart provided.
2. Examine the eight characteristics of Mars' environment (Appendix 5.3). In a small group, discuss the differences and make sure that you understand each of the differences.
3. As a group, suggest what changes would need to be made to a typical greenhouse on Mars so that it would grow plants there. For example, there is no surface water on Mars.
 - 3.1 What will this mean to the operation of a greenhouse that needs water to grow plants?
 - 3.2 Where would the water come from?
 - 3.3 What are the alternatives to surface water?
4. Think about having flowers and potted plants in your house. What are some of the reasons that we keep flowers and potted plants in our homes?
5. Now, transfer your thoughts to a "colony" on Mars. Which of the reasons identified in #4 would still be important in a greenhouse on Mars?
6. If you were going to do research on "agriculture on Mars", where on the surface of the Earth might be a good location to "substitute" for at least SOME of the characteristics you might encounter in a Martian environment?

LESSON #4

Greenhouses on Mars



Culminating Activity

1. You are going to be among the first people to inhabit the planet Mars. After 7 – 9 months travel, you arrive on Mars and start to work on growing plants in a greenhouse.
 - 1.1 List all of the things that you will have to do before you start growing plants.
 - 1.2 List all of the materials that you will need.
 - 1.3 Prioritize (put in order from “most important” or “do this first” you list of things that will need to be done. Do this in chart form using Appendix 5.8 – Building a Greenhouse on Mars.
 - 1.4 Draw a fully-labeled diagram of the interior of your greenhouse

Extension

1. Using Appendix 5.6 or 5.7–Mind Map, develop a mind map to indicate the consequences, requirements, needs, problems, etc., related to building a greenhouse on Mars. Start by writing “building a greenhouse on Mars” in the middle of the map

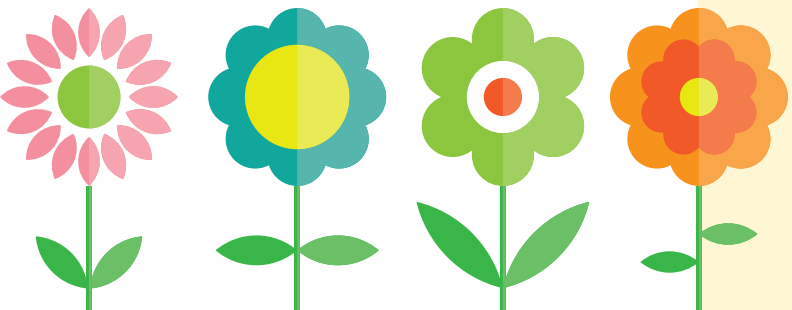
Assessment Suggestion

Below is a rubric for a diagram of a greenhouse structure on Mars, which is part of the culminating activity for this section. It can be modified to reflect your particular situation.

CRITERIA	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
Knowledge and Understanding of the Key Features of a Greenhouse Structure on Mars	Diagram contains limited amount of factual information; many facts are missing; diagram shows little understanding of the Martian environment	Diagram contains some factual information; Some facts are missing; diagram shows student knows that the environments on Earth and Mars are different	Diagram contains an acceptable amount of factual information; Most facts are evident; diagram shows strong evidence of different environments on Earth and Mars	Diagram contains a great deal of factual information; No significant facts are missing; diagram illustrates a full understanding of the differences in the environments between Earth and Mars
Visual Presentation	Visuals or icons are missing or those used are not helpful	Visuals or icons are used somewhat effectively to enhance the diagram	Visuals or icons are used quite effectively to make the diagram pleasing to the eye	Visuals or icons are used in an extremely effective manner and made the diagram eye-catching and believable
Layout and Organization	Lack effectiveness	Somewhat effective	Quite effective	Extremely effective

LESSON #5

Building a Flower Garden



Lesson Overview

Building a flower garden will enable students to develop both knowledge and skills related to the needs and characteristics of living things.

Building a flower garden will help students to learn about the value of these spaces, and the significance of pollinators such as birds, bees, butterflies, bats, beetles, and flies as well as other natural forces such as wind.

Curriculum Expectations

Students will :

- Identify personal action that they themselves can take to help maintain a healthy environment for living things, including humans;
- Describe changes or problems that could result from the loss of some kinds of living things that are part of everyday life (e.g., if we lost all the insects, all the bats, all the trees, all the grasses), taking different points of view into consideration;
- Identify the physical characteristics (e.g., size, shape, colour, common parts) of a variety of plants and animals (e.g., sunflowers are tall, with a long stalk, leaves, and big, round, yellow flowers with hundreds of seeds;

Describe how showing care and respect for all living things helps to maintain a healthy environment (e.g., leaving all living things in their natural environment; feeding birds during cold winter months; helping to plant and care for plants in the gardens that attract birds and butterflies; caring for the school and the school-yard as an environment).

Background Information

Building a flower garden on the school property – or as part of a garden at home – can be a very meaningful experience for students. There are many different organizations that can provide initial assistance in terms of actually building a sustainable flower garden. These include:

Canadian Gardening
canadiangardening.com

Gardening Know How
gardeningknowhow.com

Better Homes and Gardens
bhg.com

Flower Gardening Made Easy
flower-gardening-made-easy.com



LESSON #5

Building a Flower Garden



Teacher Preparation and Materials

Background information about types of flowers and the value of flowers will help students understand the importance of a flower garden, particularly in an urban setting. For the amateur home gardener, the rewards of growing flowers can be both recreational and emotional. Growing flowers is one of the most popular pastimes – from “urbanites” who grow flowers in window boxes to individuals growing house plants, to individuals or groups of people developing a garden in a vacant lot.

Flowers are considered as symbols of both grace and elegance; as well as being used for birthday and religious holiday presents and wedding adornment, flowers are used to cheer up people who are ill and are often used at funerals. What makes them so attractive in these many situations is their beauty and fragrance; consequently, people who grow flowers can benefit greatly from their results. Recent studies from Rutgers University have shown that flowers have a significantly larger effect on happiness than previously thought, suggesting that if you want to be happier, having flowers in your life is one possible way.

Gardens & Pollinator Health

Flowers are probably any garden's best friend! Not only do they add beauty and colour to a garden area or to a newly planted area, but they also play an important role in the overall health of plants.

The flower, of course, is the reproductive organ of a plant. Following pollination, it produces even more seed so that more of the same plant will grow in the future. The nectar and pollen produced by the flower is what is eaten by many insects – especially bees, but also birds and bats. A “pollinator-friendly” flower garden provides an opportunity for us to help to turn around the loss of pollinator habitats and promote the health and vitality of all manner of pollinators. A well-planted and maintained flower garden will attract beneficial insects including pollinators, but also ones that eat other harmful insects; for example, lacewings and ladybugs are helpful in reducing the number of aphids in a garden.

It is difficult to overestimate the importance of pollinators to our society. Not only do bees pollinate flowers, but they are also significant for our food supply. Although much of our grains are pollinated by the wind, it has been estimated that bees perform nearly 80% of all pollination on a global scale. A single bee

colony may visit up to 250 000 flowers each day. They are also important for the pollination of vegetables, fruits and nuts.

In recent years there has been a decline in the number of bee colonies world wide, including in Canada. It is not yet evident what the exact cause of these pollinator problems is, however, it is likely a combination of several different factors including parasites, weather, disease, pesticides, in-adequate nutrition and a loss of habitat. It is with the problem of declining habitats that you too can help. With increasing urbanization, parks and backyard gardens often become the sole source of food for pollinators in urban areas. A small pollinator garden in every back yard would go a long way towards restoring pollinator populations across the province.

In summary, then, the development of a flower garden may be of real significance to the restoration of bee colonies in the area. In a small way, a flower garden could be an individual's contribution to the continuance of a vibrant agricultural economy in this province. A garden of diverse flowers will provide the bees with a habitat that provides both pollen and nectar to feed the bees themselves and the hives in which they live. For an easy to use guide to pollinator friendly flowers, please visit <http://www.flowerscanadagrowers.com/pollinator-poster>

LESSON #5

Building a Flower Garden



Where to Plant?

Flower gardens can be planted at the school, at home, or in association with local community gardens. One of the problems associated with school gardens is proper care during the hot (and often dry) summer months.

When to Plant?

Plan, Plan, Plan ...

Teachers are encouraged to research the growing of flowers and identify what is needed. This is especially important when developing a flower garden for the first time. The websites identified in this section are particularly helpful in terms of providing guidance for the actual development of the garden site. Although not overly complicated, the emphasis still remains on the need to plan for the garden well in advance.

Most sites recommend beginning the development of a flower garden in the late summer or early fall for planting the following spring. This lends itself well for the school year – “build” the garden site in the fall and plant the flower gardens in the spring of the same school year.

What to Plant?

Some of the best flowers for both beauty and usefulness include marigolds, nasturtium, chamomile, morning glory, sunflower and Wisconsin fast plant. A full list of pollinator friendly flowers, as well as helpful tips, is available at <http://www.flowerscanadagrowers.com/pollinator-poster>.

How to Plant?

When the garden has been established, seeds should be sprinkled loosely on top of the soil, watered lightly and covered with a shallow covering of soil using either hands or a small rake. Try and keep the soil loose (not compacted down) as this will allow excess water to drain away after some has been absorbed by the seed. Seeds need water to germinate! This is the critical element for a garden. Too much water will encourage the growth of mould and fungus and can also “drown” the roots of the plant.

How to tell if seeds need water is the most difficult part of the growing process ... but it can be quite simple. Poking a hole about 2 – 3 cm deep should indicate the amount of water in the soil. If the soil at the bottom is dry, it needs more water.

LESSON #5

Building a Flower Garden



The Size of the Garden

The preparation for this “lesson” and the materials required will vary tremendously with the commitment to develop a flower garden either for the school or for a home setting. Size, of course, will be a major consideration as the garden could be anywhere from a “mini-garden” made up of several flower pots to a large plot. If the flower garden is to be in a home setting, an area of 1 metre x 1 metre might be a good size for the students. It can, of course, be attached to a vegetable garden and can be beneficial for vegetables in that the flowers will attract pollinators.

On average, honey bees can travel up to 8 km to find food. If we build more gardens in our communities, the more bees will be fed. Several factors can affect the health of honey bees including:

- the weather (long cold winters)
- parasites (the varroa mite)
- viruses
- pesticides
- INADEQUATE NUTRITION
- Monoculture food sources (food diversity is important for pollinators)
- Loss of Habitat

By planting a diverse flower garden, individuals can help to keep the bee population of Canada healthy; this, in turn, has tremendous advantages for agriculture.

A new diverse flower garden can have a tremendous influence on the way students perceive their local environment, and may help students to understand the significance of flowers and the “creatures” that pollinate our flower gardens.

Where can I get help?

There are many different organizations that can provide initial assistance in terms of actually building a sustainable flower garden. These include:

**Canadian Gardening
Gardening Know How
Better Homes and Gardens
Flower Gardening Made Easy
Bees Matter**

**canadiangardening.com
gardeningknowhow.com
bhg.com
flower-gardening-made-easy.com
beesmatter.ca**