

**SB13U-C**



Why Plants Are Important

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## Introduction

Plants are one of the two major kingdoms of life forms. There are about 300 000 plant species on earth. Plants are the only life forms that can produce their own food using energy from sunlight. Plants produce almost all of the oxygen in the air that humans and other animals breathe. Plants are also an important source of food, building materials, and other resources that make life possible.

Plants are necessary for the health and well-being of all the organisms that live on earth. Humans always have been and always will be dependent upon plant life. In this lesson, you will learn how plants are important for a number of reasons: food production, economic value, medical potential, habitat and food for various animals, aesthetic value, production of oxygen, and removal of carbon dioxide from the atmosphere. Plants may also provide a solution to the climate change problem by acting as carbon sinks and through the production of biofuels that are carbon-neutral.

## Planning Your Study

You may find this time grid helpful in planning when and how you will work through this lesson.

Suggested Timing for This Lesson (hours)	
Plants Are the Basis of Life	1¼
How Plants Shape the World	1
Plants and Agriculture	¾
Plants in Industry and Medicine	½
Key Questions	1

## What You Will Learn

After completing this lesson, you will be able to

- describe the importance of plants to the growth and development of Canadian society
- describe ways in which different societies or cultures have used plants to sustain human populations while supporting environmental sustainability
- use appropriate terminology related to plants
- explain the process of ecological succession, including the role of plants in maintaining biodiversity and the survival of organisms after a disturbance to an ecosystem

# Plants Are the Basis of Life

Perhaps the greatest contribution of plants to life on earth is their ability to capture solar energy and convert it into the sugar called glucose. This process, called photosynthesis, is the basis for most life on earth because glucose is the building block used to make the organic molecules that make life possible. Plants turn the glucose they make into complex molecules that are used to make their tissues and fuel their growth. Animals eat the plant tissues and convert those molecules into their own tissue. In this way, plants serve as the base of the food chain from the arctic to the tropics to the oceans. Without plants, no animals—including us—could exist.

## Photosynthesis

Nearly all the energy that fuels an ecosystem comes from the chemical energy stored in the tissues of green plants. Green plants are autotrophs, meaning that they produce their own food. Only green plants, algae, and some bacteria are able to capture the sun's energy and transform it by photosynthesis into chemical energy in the form of organic molecules including sugars, starches, proteins, and fats. The catalyst for this reaction is the green pigment chlorophyll, which absorbs light energy and passes the captured energy on to chemical reactions. In simple form, the process can be summarized in the following chemical equation:

6 carbon dioxide + 6 water + light energy → glucose + 6 oxygen

This equation says that 6 molecules of carbon dioxide combine with 6 molecules of water, using the energy in light, to form 1 molecule of glucose and 6 oxygen atoms. Thus, green plants do not produce energy, but convert light energy into chemical energy, which is stored in the form of organic molecules. Plants synthesize about 85 billion tonnes of organic material per year, much of which is consumed by animals. Plants also produce the oxygen that animals breathe.

## How Plants Shape the World

Plants do even more than provide the food that is the basis for all life on earth. Their actions actually change the biosphere in ways that make life possible. Plants create soil and the physical conditions that turn bare rock landscapes into complex ecological communities by a process called ecological succession. Plants also help regulate the amount of carbon dioxide in the atmosphere, and thus play a major role in stabilizing the earth's climate system.

## Plants Create Ecosystems through Succession

Plants help create the terrestrial ecosystems that sustain biodiversity through the process of ecological succession. Through this process, lifeless patches of rock, sand, and clay can gradually become diverse forests, providing ecological niches for millions of other species. Succession is a directional change in the types of species that occupy a given area through time.

This happens because, as plants live and die, they create soil and change the growing conditions so that other types of plants can then grow in their place.

Succession begins when an area becomes partially or completely devoid of vegetation because of a disturbance. A disturbance can be any event, either natural or caused by humans (anthropogenic), that changes the conditions of an ecosystem. Examples of naturally-occurring disturbances include wildfires, storms, volcanic eruptions, outbreaks of insects and disease, landslides, floods, and droughts. Examples of anthropogenic disturbances include pollution, clear-cut logging, climate change, application of herbicides, dams, and open-pit mining (Figure 16.1).

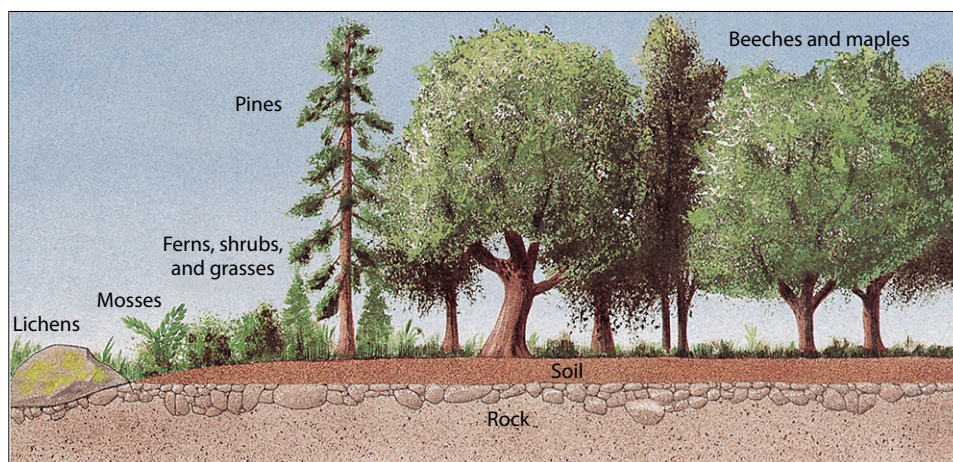


**Figure 16.1:** Photograph of an open pit mine, which is an example of anthropogenic disturbance

Source: Wikimedia Commons

## Stages of Succession

Most successions contain a number of stages that can be recognized by the collection of species that are dominant at a given point in the succession. Figure 16.2 shows a typical succession sequence for a patch of land in southern Ontario.



**Figure 16.2:** Stages of succession in chronological order, left to right

Source: McGraw-Hill Biology 11

The first stage is called primary succession. It involves the establishment and development of an ecosystem where soil and life do not currently exist, such as on a recent lava flow or a heavily disturbed mining site. The first plants involved in primary succession are called pioneer species, and include lichens and mosses that can grow on bare rocks. Some characteristics of pioneer species include rapid growth and the ability to survive harsh sunlight, extremes of temperature, and dry conditions.

The presence of the pioneer species modifies the environment. Pioneer species will die and break down after some time, creating new soil. While alive, they also provide shade, moderate soil temperature, and trap moisture for the next species. Therefore, they open the way for other species to establish themselves in the same place.

The second stage of succession usually consists of grasses, ferns, herbs, and small shrubs. These plants may live only one year, and spend the greatest part of their energy producing huge numbers of seeds. Species of this kind are known as opportunist species because they disperse widely to find open habitats where they can reproduce with little competition. Grasses are a common example of an opportunist species, which is why you see them so often in disturbed areas beside roadways.

Plants that make up the second stage also die, decompose, and contribute to the growing layer of soil. Eventually, the soil becomes able to support more complex plants, such as larger shrubs and small trees including poplar, spruce, oak, and pine. These plants gradually take over from earlier communities since they are taller, have more leaves, and can capture more sunlight than the smaller, simpler plants could.

In the final stages of succession, taller trees begin to grow. They, in turn, block out the sunlight needed by the earlier, smaller trees, and gradually replace them. The final stage of ecological succession is known as a climax community, the stage at which an ecosystem becomes stable and no longer undergoes significant changes. The climax community in southern Ontario may consist of a forest composed of sugar maple and beech trees. Biodiversity—the variety of living beings and the biomass of an ecosystem—tends to increase as the succession progresses, and it stabilizes when the climax stage is reached. Depending on the prevailing climate conditions, the process of succession takes place over years, decades, and centuries. In wet tropical areas, forests may re-grow from bare ground within a few years, while in the high Arctic, it may take centuries for soil to develop sufficiently to support even a small shrub.

Another type of succession is called secondary succession. It is the series of community changes that take place on a previously colonized but disturbed or damaged habitat. This habitat's soil base remains largely intact, but most of the surface vegetation has been removed. Examples include areas that have been cleared of existing vegetation by logging, grazing, or farming, or damaged by events such as fires or hurricanes. Secondary succession is much quicker than primary succession because there is an existing soil layer ready to support new plant growth. Also, root systems and other plant parts lying undisturbed in the soil from previous stages can rapidly regenerate into new plants.

## Plants and Climate Change

The earth's climate is changing. There is strong evidence that the average global temperature is increasing and that weather patterns are becoming less predictable and more turbulent. The increase in temperature is generally attributed to the effect of carbon dioxide and other gases accumulating in the atmosphere. These gases trap the sun's heat and produce conditions similar to those found in greenhouses; this is why these gases are referred to as greenhouse gases.

The main causes for the increase in carbon dioxide are the burning of fossil fuels and the clearing of forests. Reducing the level of carbon dioxide in the atmosphere has become a critical international issue, and we are turning to plants to help find a solution. Plants naturally absorb carbon dioxide from the air during photosynthesis and convert the carbon into complex molecules. Plants are called "carbon sinks" because they store carbon for long periods of time in their tissues. This is especially true for trees whose wood may store carbon for centuries. Plants can also be used to produce biofuels, which do not contribute a net increase of carbon dioxide into the atmosphere. You will learn more about biofuels later in this lesson.

### Support Questions

**Be sure to try the Support Questions on your own before looking at the suggested answers provided.**

57. Distinguish between primary and secondary succession.
58. How does a pioneer species affect the process of succession?
59. The table shown below represents the number of species growing in an area that was covered by a lava flow near Hawaii that has now cooled. Data was collected periodically over 65 years.
  - a) Describe the changes occurring in vegetation type and species diversity over the 65 years.
  - b) What does the pattern of change tell you about what is happening in this area?
  - c) Explain how the data supports your conclusion.

Type of vegetation	Years after lava flow that the area was sampled				
	1	5	30	45	65
Lichens	0	32	31	15	12
Mosses	0	0	16	25	15
Grasses	0	0	0	18	55
Shrubs	0	0	0	0	16
Total species	0	32	47	58	98

## Special Topics in Plant Science

Plants impact many areas of Canadian society. When assessing the impact of certain issues on society, it can be helpful to use a table to sort your research. A sample is provided below.

Topic	Notes
Special topic	
History of special topic (how it developed)	
Current trends or status of special topic	
Future direction of special topic	
Other notes	
Sources of information	

When researching how using plants as a source of food has impacted society, the table could look like this:

Topic	Notes
Special topic	Plants as a source of food
History of special topic (how it developed)	<ul style="list-style-type: none"> <li>- plants have been the basis for agriculture and farming for about 10 000 years</li> <li>- over the years, yields from agricultural plants have also been improved by selective breeding, grafting, and cloning</li> <li>- the term Green Revolution was coined by news reporters in the 1960's as they saw a dramatic increase in world wheat and rice production because of an increase in agricultural research</li> <li>- part of the process of increasing efficiency included increased use of fertilizers</li> <li>- as people got better at growing high yield plants they started growing less different types of plants. This means humanity now lives off less different types of plants and some have gone extinct.</li> </ul>
Current trends or status of special topic	<ul style="list-style-type: none"> <li>- large number of pesticides, herbicides being used to keep these crops alive are contaminating soil</li> <li>- water is running out in areas due to using water for irrigation</li> <li>- fertilizing, irrigation and spraying takes lots of energy</li> <li>- stress on pollinators and other beneficial species due to pesticide use</li> <li>- loss of wetlands and wildlife habitat</li> <li>- reduced genetic diversity in plants</li> </ul>



Future direction of special topic	<ul style="list-style-type: none"> <li>- a new approach called sustainable agriculture is being promoted</li> <li>- the goal of sustainable agriculture is to produce lots of food without depleting the Earth's resources or polluting its environment</li> <li>- using crop rotation</li> <li>- increase number of conservation areas to protect plants that are different than the ones mass produced</li> <li>- store samples of crops (seeds) to preserve genetic diversity</li> </ul>
Other notes	
Sources of information	<p><a href="http://www.scientificamerican.com/article.cfm?id=agricultures-sustainable-future">http://www.scientificamerican.com/article.cfm?id=agricultures-sustainable-future</a></p> <p><a href="http://www.dandc.eu/articles/070224/index.en.shtml">http://www.dandc.eu/articles/070224/index.en.shtml</a></p> <p><a href="http://en.wikipedia.org/wiki/Agriculture">http://en.wikipedia.org/wiki/Agriculture</a></p> <p>When using Wikipedia, be sure to check the sources of information that were used to create the page. Each page has a list of resources at the bottom. If these resources are not appropriate or are incomplete, do not use the information from Wikipedia.</p>

## Support Questions

60. Using the table provided below to organize your research, assess the impact on society of using plants for medicine. Use the Internet and/or books to research the topic. You can start by using search terms such as “plants medicine” or “history medicinal plants”.

Topic	Notes
Special Topic	
History of special topic (how it developed)	
Current trends or status of special topic	
Future direction of special topic	
Other notes	
Sources of information	

## Key Questions

Now work on your Key Questions in the [online submission tool](#). You may continue to work at this task over several sessions, but be sure to save your work each time. When you have answered all the unit's Key Questions, submit your work to the ILC.

(19 marks)

- 50.** List four reasons that plants are important. (4 marks: 1 mark for each point)
- 51.** The table shown below represents the number of species growing in an area that was logged using clear-cutting 45 years ago in Temagami, Ontario. Data was collected periodically over 45 years.
- Describe the changes occurring in vegetation type and species diversity over the 45 years. (4 marks)
  - What does the pattern of change tell you about what is happening in this area? (1 mark)
  - Explain how the data supports your conclusion. (2 marks)

Type of vegetation	Years after clear-cut logging that the area was sampled				
	1	5	15	25	45
Grasses	32	28	24	31	35
Shrubs	0	4	5	8	18
Trees	0	0	0	16	24
Total species	32	32	29	55	77

- 52.** Using the table provided below to organize your research, assess the impact on society of using plants for biofuel. You can find information by searching the Internet and/or books. Use search terms like “plants biofuel”. (8 marks)

Topic	Notes
Special Topic	
History of special topic (how it developed)	
Current trends or status of special topic	
Future direction of special topic	
Other notes	
Sources of information	

**This is the last lesson in Unit 4. When you have completed all the Key Questions, submit your work to the ILC. A teacher will mark it and you will receive your results online.**