Objective

Students will be able to:

- Describe the carbon cycle in more detail:
  - Learn about the importance of carbon and the role it plays in photosynthesis and cellular respiration,
- Identify elements of ecosystems that allow particular organisms to survive (ex. Nitrogen):
  - Learn about the nitrogen cycle,
- Learn about the positive things agriculture does for the land:
  - Learn about agro-ecosystems, and succession (the gradual and orderly process of change in an ecosystem brought about by the progressive replacement of one community by another) and relate this concept to agriculture,
- Describe the methods used to control soil erosion (loss of soil organic matter), and recognize the importance of soil conservation, and
- Learn about the historical changes in prairie soil organic matter (See Cluster 4: 7-4-11)

Key Concepts

Teach students about the carbon cycle. Ask them if they have ever heard of it before and to describe it. Learn about how and why greenhouse gases are important when considering the interactions within an ecosystem (the carbon cycle/nitrogen cycle). Introduce the concept of photosynthesis and cellular respiration. Ask them to think about the positive things agriculture does for the land and teach them about it. Discuss soil erosion and recognize the importance of soil conservation when considering greenhouse gases. Teach children about the historical changes in prairie soil organic matter and discuss changes in land use practices over the years.

Cluster 1: Interactions within ecosystems

7-1-02 Define ecosystem, and describe various examples that range from the microscopic to the entire biosphere. Include: a place on Earth where living things interact with other living things as well as non-living things.

An ecosystem is defined as a biological community of interacting organisms and their physical environment. The components of an ecosystem range from things that are microscopic to the entire biosphere. Atmospheric gases, for example, are defined as components of the abiotic (non-living) ecosystem. The most important gases used by plants and animals (biotic component) are oxygen, carbon dioxide and nitrogen.
• Oxygen: used by all living organisms during respiration
• Carbon Dioxide: used by green plants during photosynthesis
• Nitrogen: made available to plants by certain bacteria and through the action of lightning

Do you remember? Each of these gases is what makes up greenhouse gases! Talk about greenhouse gases (see Grade 5 Lesson Plan 5-4-13 and 5-4-18) and the carbon cycle (see Grade 6 Lesson Plan 6-1-07) in more detail.

How do living and non-living components of the ecosystem interact? Example: The Carbon Cycle:

Out of the three gases listed above, carbon is a part of all organisms. It is the building block of life.

As you should already know, carbon dioxide is a greenhouse gas that is made naturally. Remember: A greenhouse gas is a gas that traps the Earth’s radiation inside the atmosphere warming the Earth up (other greenhouse gases are methane and nitrous oxide).

Carbon affects all life on Earth. The carbon cycle consists of four major interconnected reservoirs of carbon; the atmosphere, the oceans and water bodies, the terrestrial biosphere (soil, plants, animals), and sediments and rocks.
The carbon cycle is the big circle the carbon travels in and is defined as the series of processes by which carbon compounds are interconverted in the environment. In agriculture, this involves the incorporation of carbon dioxide into living tissue by photosynthesis and its return to the atmosphere through the decay of dead organisms (plant material), and respiration of plants and animals. Therefore, agriculture affects the global carbon cycle since agricultural practices and land use alter the amount of carbon stored in plant matter and soil, and consequently, the amount of carbon dioxide (CO₂) that is released into (or taken up from) the atmosphere.

Plants, including agricultural crops, play a role in the carbon cycle. Carbon dioxide from the atmosphere is taken up by vegetation (crops, trees). These plants use carbon dioxide to make their own food in a process known as photosynthesis. During photosynthesis atmospheric carbon dioxide is converted into a usable form of chemical energy (sugar), and the carbon is separated from the oxygen. Oxygen gets released back into the air and some carbon gets stored in the soil. As well, as the plants use the sugar’s energy, some of the carbon is released back into the atmosphere as CO₂, and the rest of the carbon is used by the plant to grow new biomass. The carbon embodied by terrestrial plants can then replenish the carbon in soil, for example, through the decomposition of fallen leaves.

http://www.c2es.org/technology/overview/agriculture

Plants that contain carbon are eaten by humans and animals. The plants are digested by the animal and passed out of their system as manure. The carbon in the manure then goes into the soil. The carbon that enters the soil increases soil organic matter. Soil organic matter is the organic matter component of soil, consisting of plant and animal residues at various stages of decomposition.

Other ways in which carbon can enter the soil is through the root system of a plant, or a decomposing plant. These things help increase soil organic matter, a mix of carbon, nutrients and dead materials.

A high soil organic matter usually means that there is more nutrients in the soil making it fluffier and better for plants to grow in. This would be soil of a black or brown colour and be very sticky when wet. In the Prairies, our natural Chernozem soils had high soil organic matter content because of the native grassland.

A low soil organic matter means that there is a low amount of nutrients to the soil. This soil is often very sandy and not very good for growing plants. The soil is often tan in colour and very sandy or perhaps a clay.

7-1-03 Identify abiotic and biotic components of ecosystems that allow particular organisms to survive.

(Connection: Carbon and nitrogen cycles)

Carbon is the building block of life; it affects all life on Earth. Describe the carbon cycle and use agriculture as an example (see above (7-1-02) for information on the carbon cycle and how it relates to agriculture). Discuss and tie this into the concept of greenhouse gases and why controlling emissions is
important. Greenhouse gases affect the climate which affects life on Earth (see Grade 5 Lesson Plan 5-4-13 and 5-4-18).

Give examples of abiotic components of ecosystems that allow organisms to survive: Oxygen is a gas and is part of the abiotic (non-living) component of an ecosystem. We need oxygen to breathe. Oxygen helps us (biotic component; living) to survive!

The nitrogen cycle, similar to the carbon cycle, is defined as the series of processes by which nitrogen and its compounds are interconverted in the environment and in living organisms. The natural nitrogen cycle consists of fixation of nitrogen from the atmosphere, changes among nitrogen forms in the soil, and loss of certain nitrogen molecules back to the atmosphere. During these natural processes, these nitrogen-containing substances are made useful to living things.

Most plants get the nitrogen they need from soil. Many farmers use fertilizers or manure to add nitrogen to the soil to help plants grow larger and faster. This is because we remove nitrogen from the ecosystem when we eat the food, and without using fertilizer to replenish it, the soil would not be fertile.

All living things, including us, require nitrogen to build proteins. However, because of the chemical nature of nitrogen gas, we cannot obtain nitrogen directly from the air. Instead, we must depend on the nitrogen cycle to obtain nitrogen indirectly. For example, we eat plants or eat plant-eating animals.
7-1-05 Identify and describe positive and negative examples of human interventions that have an impact on ecological succession or the makeup of ecosystems.

Examples: positive — protecting habitats; negative — preventing natural fires, draining wetlands for agriculture

(Connection: Positive things agriculture does for the land)

In agroecosystems, humans determine succession through their decisions on land use. An example of this is crop rotation; the method of planting different crops in a given field every year or every several years. Crop rotation gives diversity to the ecosystem. It also does a good job of reducing the build-up of pathogens and pests, and can also improve soil structure and fertility.

So our agroecosystems are human managed to balance the need for food production and sustainable ecosystem health. This management is highly variable and depends on location. For example, rangelands for cattle grazing may stay as a consistent ecosystem for many decades. In this ecosystem, cattle play a role in managing the grassland, just as bison did hundreds of years ago. For greenhouse gases, this system would also have emissions that are similar before European's settled the Prairies; with carbon being stored by grasses and methane being emitted by bison/cattle.

In some other agroecosystems, crop rotations are regular with crops repeating perhaps every 3 or 4 years. Depending on the crop, greenhouse gas emissions will vary among years because of different rates of carbon uptake and amounts of nitrogen fertilizer applied.

7-1-08 Compare photosynthesis to cellular respiration, and explain how both are part of the cycling of matter and the transfer of energy in ecosystems. Include: photosynthesis: water + carbon dioxide + light energy = sugar + oxygen in the presence of chlorophyll; cellular respiration: sugar + oxygen = water + carbon dioxide + energy.

(Connection: The role carbon plays in photosynthesis and cellular respiration and the carbon cycle)

Carbon dioxide is an important greenhouse gas. You already know that carbon is important to all living things and have already learned about the carbon cycle. Carbon has many roles to play in an ecosystem. Here, we will look at the role carbon plays in photosynthesis and cellular respiration.

Photosynthesis is defined as the process by which green plants use sunlight to synthesize foods from carbon dioxide and water. During photosynthesis, plants take in carbon dioxide through their leaves and water through their roots. Using light energy from the sun, and a special pigment known as chlorophyll, plants are able to convert the carbon dioxide and water into sugars and oxygen.

As you already know, plants (including agricultural crops) play a role in the carbon cycle. Carbon dioxide from the atmosphere is taken up by vegetation. During photosynthesis, oxygen gets released back into the air and carbon gets stored in the soil. As well, as the plants use the sugar’s energy, some of the carbon is released back into the atmosphere as CO₂, and the rest of the carbon is used by the plant to grow new biomass. The carbon embodied by terrestrial plants can then replenish the carbon in soil, for
example, through the decomposition of fallen leaves. This is the reason why plants are so important when considering the reduction of carbon dioxide (a greenhouse gas) in the atmosphere. This serves as part of the solution to reducing the effects of greenhouse gas emissions.

Cellular respiration, on the other hand, is defined as the metabolic process whereby organisms obtain energy from organic molecules; processes that take place in the cells and tissues during which energy is released and carbon dioxide is produced and absorbed. Cellular respiration requires oxygen (which is the by-product of photosynthesis). The processes involved in cellular respiration produce carbon dioxide, which is used in photosynthesis. In this way, photosynthesis and cellular respiration are linked in the carbon cycle.

**Cluster 4: Earth’s Crust**

7-4-07 Identify geological resources that are present in Manitoba and Canada, and describe the processes involved in their location, extraction, processing, and recycling. Include: fossil fuels, minerals.

*(Connection: The importance of carbon and the carbon cycle in agriculture)*

See 7-1-02 for information on the carbon cycle

7-4-10 Describe methods used to control soil erosion, and recognize the importance of soil conservation. Ex: economically important to the agri-food industry, important for controlling the flow of water, necessary for plant growth.

Soil is very important to farmers as it is the top layer of the earth’s surface that is capable of sustaining life. Farmers depend on soil to provide abundant, healthy crops each year. One major problem in agriculture is soil erosion. Soil erosion is defined as the deterioration of soil by the physical movement of soil particles from a given site. This can be due to natural, animal, and human activity (wind, water, ice, over grazing, over cultivation, forest clearing, mechanized farming, and the use of other tools by humans are some examples). Soil erosion is a natural process and usually does not cause any major problems. It becomes a problem when human activity or a severe natural event (like a severe storm) causes it to occur much faster than under normal conditions; it can result in land infertility and can lead to flooding.

Soil conservation is the reduction of soil erosion. It involves farmers managing the land to reduce the amount of soil loss. Some activities that farmers follow are:

- Planting perennial crops, like grasses, on sensitive soils so the soils are never bare,
- Reducing the amount of tillage, often leaving the standing plant material and planting the new crop directly into the undisturbed soil,
- Not farming areas that are very close to streams and rivers, so that natural vegetation can hold the soil,
- Planting a second crop to increase plant cover to reduce erosion and to add more carbon to the soil,
- Keeping vegetation on steep slopes to prevent water erosion.
- Adding coarse organic matter as a mulch to prevent soil loss.

Soil erosion affects agricultural greenhouse gases because farmers will need to restore the soil fertility if they lose the top layer of soil. For example, they would need to add more nitrogen, which could increase nitrous oxide emissions.

7-4-11 Identify environmental, social, and economic factors that should be considered in making informed decisions about land use. (The levels of carbon in the soil and carbon sequestration; the practices producers used to carry out compared with the ones they currently carry out, many of which create fewer emissions)

The amounts of carbon (an important greenhouse gas) in agricultural soils, as well as land use and management practices influence greenhouse gas emissions to the atmosphere. As the students should already know, high concentrations of greenhouse gases in the atmosphere lead to climate change and it is very important for us to be aware and control our greenhouse gas emissions.

Farmers focus on ways in which they can retain carbon as organic matter in soils. This is because organic matter helps soils hold water, increases soil fertility, and creates a better environment for soil organisms. Our Prairie Chernozem soils are dark in colour because they have lots of organic matter. Farmers can increase the organic matter in soil by using less tillage, growing crops each year that have a high yield, adding nitrogen to the soil, using more perennial crops, and planting cover crops that will be tilled back into the soil as organic matter.

On the prairies, the start of agriculture caused our soils to lose carbon. This was because we replaced a grassland that had perennial plants that were always present on the landscape. The use of annual crops meant that the spring and fall periods did not have plants, so carbon was not being gained by the soil, and could be lost. Early farming practices also used summer fallow, which is leaving the land without plants in some years and usually tilling the soil to kill weeds. This resulted in carbon loss. However, over the past few decades, farming practices have changed and many areas are now increasing their carbon content in the soil. This carbon is removed from the atmosphere, so it decreases atmospheric greenhouse gases.