**Section 2.1 *Biogeochemical Cycles***

The biogeochemical cycles take place in the lithosphere, atmosphere and hydrosphere. These cycles provide a continuous supply of basic elements from which living tissue is formed. The basic structure of any biogeochemical cycle is as follows:

1. Plants obtain certain elements from the land, air and water and convert them into organic molecules.
2. Other organisms obtain these basic elements from plants or from other organisms
3. These elements are used as energy or to produce living tissue through the process of metabolism.
4. Organisms die and give off wastes. Decomposers aid in their breakdown and return these elements to the soil, water and atmosphere.

**Section 2.2 *Pesticides***

Pesticide: a chemical designed to kill a pest

Pest: any organism that people consider harmful or inconvenient

Eg. weeds, insects, fungi, rodents, etc

# 1. First-Generation Pesticides

1. naturally-occurring elements

* sulfur (500 B.C.)
* arsenic, lead and mercury (1600s)
* used on crops to kill insect pests
* by the 1920s, no longer used as these chemicals were found to be highly toxic to people

1. naturally-occurring compounds

* extracted from plants
* nicotene sulfate (1763)
* extracted from tobacco plants
* used to kill aphids (small insect)
* such chemicals are the plants natural defense against insects and other animals that would feed on them

1. *Second-Generation Pesticides*
   * Produced in a laboratory
   * Thousands have been developed
   * Classified according to their target
   * Insecticides, herbicides, fungicides, bactericides *(Table 1, p.53)*
   * Some pesticides decompose rapidly, while others persist in ecosystems for many years
   * DDT, a potent insecticide (1939)

***Bioamplification: Fig.4, p.54***

* A process that results in increasing concentrations of a toxin in the bodies of consumers as the toxin moves up the food chain
* DDT and many other pesticides dissolve in fat, not water, therefore they accumulate in the fatty tissues of animals (are not released in urine or sweat)
* DDT is now banned (in Canada & the U. S.) because of the bioaccumulation in predators, including humans

**Section 2.5: *The Carbon and Oxygen Cycle***

The Importance of Carbon and Oxygen

* Carbon is the key element in organic molecules such as *carbohydrates, lipids, proteins and nucleic acids.*
* Carbon dioxide is vital to photosynthesis
* Oxygen is vital to respiration

# Important Points

* Carbon dioxide is found in 0.03% of the atmosphere. It is mostly dissolved in the earth’s waters.
* Oxygen makes up 20% of the earth’s atmosphere.
* Carbon can exist in organic forms or inorganic forms (CO2).

# Terms

Photosynthesis: Uses carbon dioxide, water and energy from the sun to produce sugar and oxygen.

Carbon Fixation: This is the incorporation of inorganic carbon (CO2) into organic compounds.

Respiration: Uses oxygen to breakdown carbohydrates during metabolism to obtain energy for the organism. Releases CO2  and water.

## The Cycle

* Plants capture the energy of the sun during photosynthesis and produce organic compounds and oxygen for respiration. The organic compounds are used for energy, in life processes and to make plant structures.
* Organic compounds are ingested by other organisms and used for energy, in life processes and are incorporated into their tissues. These organic compounds are passed along a food chain.
* Plants and animals eventually die. Animals will also produce wastes. Decomposition of wastes and dead organisms will release carbon dioxide back into the atmosphere.
* Under certain conditions, the decay process may be delayed and organic compounds may become compressed underground for long periods of time to produce fossil fuels.
* Human activity in which fossil fuels are burned release CO2. This creates an imbalance and the atmosphere is able to absorb more radiation from the sun. The earth’s temperature increases and *global warming* results.
* Inorganic carbon (CO2) may be converted to carbonate compounds that form the shells and other hard structures of aquatic organisms. These structures can eventually become a part of sedimentary rock such as limestone. Volcanoes may eventually breakdown limestone and release CO2.
* Oxygen is required for the respiration of plants, animals and decomposers. Respiration will release carbon dioxide back into the atmosphere.
* Natural fires (or any form of combustion) require oxygen and releases CO2 back into the atmosphere.
* Excess CO2 can result from cutting down trees and destroying other forms of vegetation. With less vegetation, less oxygen can be produced.

**Section 2.6: *The Nitrogen Cycle***

The Importance of Nitrogen

* It is the basic component of amino acids which form proteins.
* It is the basic component of nucleotides which form nucleic acids (DNA,RNA)

# Important Points

* Nitrogen gas composes 80% of the atmosphere.
* Plants must use nitrogen in the form of ammonia (NH3) or nitrate (NO3). NO3 is most commonly used by plants.
* Plants have the ability to produce their own proteins and nucleic acids from nitrogen. Animals must ingest plants or other animals to meet their nitrogen needs.
* The nitrogen cycle mainly occurs in the soil and water. Most nitrogen is in compound form and only a small fraction is cycled through the atmosphere.

# **The Cycle**

# Nitrogen Fixation

Plants can not use nitrogen gas directly so they must convert into forms it can use through the process of nitrogen fixation. Nitrogen fixation may occur in two ways:

1. Lightening: Lightening reacts with nitrogen gas and oxygen in the atmosphere to produce nitrates. These nitrates will dissolve in rain or surface waters. They will dissolve in the soil and enter plants through their roots.
2. Nitrogen Fixing Bacteria: There are two types:
3. Free-living: These bacteria live in the soil and will convert nitrogen gas into ammonia. Ammonia may be used directly plants or may be converted by *nitrifying bacteria* into nitrates. A common free-living bacteria is *cyanobacteria* (blue-green bacteria).
4. Symbiotic Bacteria: These bacteria grow in nodules on roots of legumes such as clover, alfalfa, pea plants and bean plants. They convert nitrogen gas into ammonia or nitrate for plant use while the plant supplies them with needed sugar. These bacteria also produce an excess of ammonia and nitrates that move into the soil and may be used by other plants. *Rhizobium bacteria* are symbiotic bacteria.

## Nitrifying Bacteria

These bacteria convert ammonia to nitrite and the to nitrate. This process is called *nitrification*.

*Nitrification* can occur in two places along the cycle:

* Most of the nitrogen in decomposing organisms is released as ammonia.
* Some nitrogen fixing bacteria convert nitrogen gas into ammonia. Nitrifying bacteria will convert this ammonia into nitrate.

*Ammonification*

This is the conversion of amino acids from animal wastes and dead organisms by bacteria and fungi into ammonia.

## Denitrifying Bacteria

These bacteria convert nitrite and nitrates into nitrogen gas which is released back into the atmosphere. This may occur anywhere along the cycle where nitrites and nitrates exist.

*Chemical Symbols*

N2 (g) 🡪 nitrogen gas

NH3 🡪 Ammonia

NO3- 🡪 Nitrates

NO2- 🡪 Nitrites

**Section 3.1: Canadian Biomes**

Definition of a Biome:

A biome is a large geographical portion of the biosphere characterized by dominant plant and animal life. These areas have a certain climate and other physical factors that determine what type of organisms may be supported.

Abiotic factors such as altitude, temperature, precipitation and light will determine the type of biome that will exists.

## Tundra

* The tundra is located south of the polar ice caps of the Arctic. It is found in the northern parts of North America, Europe and Asia. It is not found in the southern hemisphere because the ocean takes up this area
* Winter will last from 6-9 months with temperatures below freezing. There can be darkness 24 hours a day.
* Summer is short with a growing season of about 60 days. The uppermost layers of the soil will thaw but the lowermost layers (*permafrost*) will remain frozen. Sunlight can be available 24 hours a day.
* The average precipitation is low with only 10-12 cm a year. Also, there are low average temperatures.
* The soil is composed of bogs and ponds. These develop because of a low rate of evaporation and, as well, melting snow can not drain into the ground because of permafrost.
* Vegetation consists of lichens, mosses, grasses sedges and shrubs. There are very few trees. Plant can rarely grow higher than 10 cm and only have small root systems.
* Animal life consists of reindeer, caribou, wolves, Arctic hare, Arctic fox, lemmings, snowy owls, ptarmigan and musk oxen.
* Many animals are migratory such as sandpipers, ducks, geese, songbirds and gulls. There are fewer predators in the tundra so it is safer to nest. Birds will feed uopn insects.
* Large numbers of flies and mosquitoes exist during the summer and survive the winter as eggs and pupae.
* In the Antarctica, a small amount of lichens and grass may exist at the edge of the continent. Migratory animals such as penguins, dolphins, whales, seals and seabirds will depend more upon the ocean for food.
* Parts of northern Labrador are tundra.

### Taiga

* The taiga is a continuous band of forests that lie south of the tundra. It extends across North America, Europe and Asia.
* There are long cold winters with precipitation in the form of snow. Precipitation is between 50-100 cm a year. The ground is covered by deep snow.
* Summers are longer and warmer that that of the tundra. The growing season is about 120 days and the ground completely thaws.
* The soil is largely bogs because of the low evaporation rate and the greater precipitation. The soil of bogs is very acidic. There are also many ponds.
* The dominant vegetation is coniferous trees such as spruce, pine and fir. They have flexible branches that allow them to bend easily under the weight of snow. A thick cuticle and needle-like leaves reduce evaporation. They retain their leaves all year round to carry out photosynthesis.
* There are also many plants that live on the forest floor that are accustomed to receiving little light. The forest floor is also damp and mossy. Vegetation on the forest floor consists ferns, bunch berries, Wild Lilly of the Valley, corn lily, twin flower and Indian Pipe.
* There are also many deciduous trees such as willows and birches. There are also shrubs and herbaceous plants.
* Vertical stratification of the taiga consists of the moss layer, herb layer, shrub layer and tree layer.
* Bogs contain insectivorous plants such as the Pitcher plant and the sundew. Bog laurel, cotton grass and Labrador tea are also common. Mosses, lichens and sedges are predominant. All plants are adapted to waterlogged, acidic soils. ATV’s can tear up plant roots and cause water to drain into ponds, destroying both the wetland and pond ecosystems.
* Animals of the taiga include: moose, wolves, bear, lynx, deer, elks, wolverines, martens, snowshoe hare, porcupines, red squirrels and many small rodents. There are also several species of birds such as blue jays, finches, osprey and kingfisher. Insects are also predominant such as flies, mosquitoes, bees, butterflies and dragonflies
* Many animals hibernate during the winter and live off the supplies of stored fat. There are also some migratory birds that feed off of insects in the summer.

# Temperate Deciduous Forest

* This biome is located south of the taiga in Eastern U.S., Central Europe and East Asia. It is also found in the southern hemisphere in Australia, New Zealand and South Africa.
* The winters are cold but are much shorter than that of the taiga. Summers are long, hot and humid. Rainfall is plentiful and averages 75-150 cm a year. The soil is rich in nutrients because of a layer of decomposing leaves called *litter*.
* The dominant vegetation is composed of deciduous trees that lose their leaves seasonally. Plants in the deciduous forest grow in a series of layers. This is known as *vertical stratification*. The 4 layers are known as follows:

1. Canopy: These are the tallest trees that make a leafy covering. Canopy tress are oak, maple, beech, hickory, chestnut and birch.
2. Understory: This consists of smaller trees such as redwoods and dogwoods.
3. Shrub Layer: This consists of various shrubs that receive less light.
4. Herb layer: This consists of mosses, ferns, and herbs that can tolerate shade. They are found close to the forest floor.

* Animals consist of gray squirrels, whitetail deer, black bears, raccoons, opossums, wolves, gray fox, bobcats, chipmunks and a variety of birds. A variety of insects and birds live in the upper layers.

## Grasslands

* In North America, the grasslands are called the prairies. They extend south from Central Canada to the Gulf of Mexico and west from the Mississippi River to the Rocky Mountains. Grasslands are also found in the interiors of Asia, South America and South Africa. Grasslands are found in both temperate and tropical areas.
* The grasslands usually receive between 25 and 75 cm a year of precipitation. The soil is deep and rich. Grasslands are usually the most productive farmlands on earth.
* The predominant forms of vegetation are grasses and wildflowers. In wetter areas, such as near rivers, vegetation may become more dense and some shrubs may grow.
* Low precipitation will not allow for the growth of trees. Strong, drying winds and fires caused by lightening also make it difficult for trees to grow.
* Grasses have adapted to dry conditions by developing extensive root systems. Over one half of the plant may be roots. Many grassland plants have underground stems so that they may easily grow new shoots in the event of fire.
* The soil is especially fertile from the decay of the many branched grass roots that hold the soil together. Many of the wildflowers belong to the legume family that work to fertilize the soil with nitrates.
* The types of animals found on the grasslands include coyotes, badgers, rattlesnakes, prairie dogs, jackrabbits and ground squirrels. Many are adapted to hopping or jumping over grasses. In the past, bison and antelope were common. They have been replaced by cattle and sheep. On the savannahs of Africa, zebras, giraffes, gazelles and lions are common.
* Birds found are meadowlarks, ring-necked pheasants, prairie chickens, hawks and owls. Birds are less common because there are fewer trees. Insects such as spiders and grasshoppers are common.

**Section 3.3: Components of Soil**

1. Soil Layers:
2. *Litter layer*

* Uppermost layer
* Made up mostly of partially decomposed leaves
* Helps to reduce temperature variations in the soil (insulation)
* Reduces water loss by evaporation

1. *Topsoil layer*

* Composed of small rock particles and *humus* (decaying plant and animal matter)
* Contains a rich supply of minerals and other nutrients necessary for plant growth
* Very porous, providing space for air and water. Dark in color

1. *Subsoil*

* Contains larger stone material and small amounts of organic matter
* Lighter in color than topsoil (because of less humus)
* May contain large amounts of some minerals (Fe, Al, P)

1. *Bedrock*

* Underlying rock layer

1. Water and the Soil:
2. *Surface water*

* water collecting or flowing on the earth’s surface

1. *Ground water*

* water beneath the surface located in soil and rock
* water flows downward through the porous soil due to gravity (*percolation*), and eventually reaches a saturated layer

1. *Water table*

* The boundary between the saturated layer and the porous layer

1. Soil pH

* Determined by the type of rock and the type of plants
* Newfoundland soils tend to be mainly acidic
* Acidic water in the soils can increase *leaching* of certain minerals such as Ca & K
* Lime (a base) is often added to reduce the acidity

## Leaching

* The removal of dissolved organic matter and minerals from the upper layers of soil due to water percolating through the soil

# Formation of Soil

1. *Describe the formation of soil. Give three steps. (page 98)*

|  |
| --- |
| (i) |
| (ii) |
| (iii) |

**Succession**

*Ecological succession* refers to the changes in plant and animal populations between colonization and the final community.

# Main Factors Responsible for Succession

1. **Climatic and Geographical Forces**: These include factors such as temperature, precipitation, soil, latitude, altitude, land forms such as mountains and slope. These factors will determine if the area will finally develop into a taiga, desert, grassland etc.
2. **Changes in a Community Caused by its own Inhabitants**: Lichens and mosses will invade first. They die, decompose and build soil making way for new inhabitants. Biomass and biodiversity eventually increase causing new organisms to invade. More vegetation provides shading from extreme sunlight and the improvement of soil conditions through the decay causes as change in the inhabitants.

# Definitions

**Dominant Species**: The few species that have a great effect on the environment and on other members of the community during the particular stage of succession.

* Ex. Lichens and mosses are predominant in a pioneer community
* Ex. Evergreens such as the pine, spruce and fir are common in the climax community of the taiga

**Pioneer Community**: The first plant and animal community to appear during succession.

* Ex. Lichens and mosses on land
* Ex. algal protists and cyanobacteria in aquatic habitats

**Climax Community**: The final, relatively stable community reached after succession.

* Ex. Evergreen forest in the taiga
* Ex. Temperate deciduous forest

## Types of Succession

**Primary Succession**: When succession occurs in an area in which there is no existing life such as on bare rock or in a new lake or pond. Bare rock may come from cooled lava from a volcano or may be left behind from a retreating glacier. This succession takes place over a long period of time, perhaps thousands of years.

**Secondary Succession**: This occurs in an area in which an existing community has been partially destroyed and its balance has been upset. This can occur in areas wher farmland has been abandoned or in forests that have been destroyed by fire, cutting, disease or other natural disasters. Since soil does not have to be reformed, this kind of succession will take a few hundred years.

**Succession on Land**

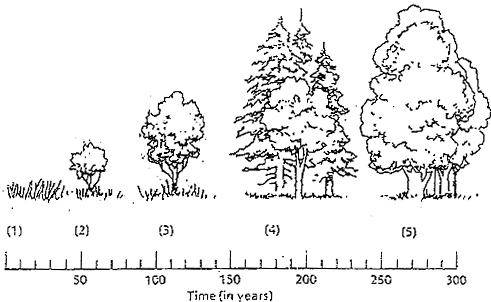
The pioneer community will begin with the emergence of lichens. Lichens are a hardy species that can resist full sunlight. Lichens secrete acid that will break apart rocks and improve soil conditions. They leads to the presence of mosses by reducing soil temperature, decreasing evaporation and holding moisture. Lichens die and produce soil. They are eventually shaded out by mosses.

Increasing soil will lead to the growth of small plants and grasses. These species are still able to tolerate full sunlight. The soil becomes further enriched and shrubs and tree seedlings appear. They will shade out the smaller plants and grasses. Roots of seedlings and shrubs will break up rocks further, improving soil conditions.

Trees will begin to grow and shade out the many shrubs and tree seedlings that are less tolerant of shade. Intermediate trees in Newfoundland consist of hardwoods such as birch and aspens. Trees of the climax community include spruce and Balsam fir.

Animal life will also change as the plant community changes.

Dominant plant forms may not always be trees. For example, if there is little moisture, perhaps, grasslands will develop.



# Succession in Lakes and Ponds

1. **Oligotrophic Lakes**
2. Bare Bottom: In this stage of succession, the lake is low in nutrients. It is deep cold and clear. Algal protists and cyanobacteria will first appear. They are followed by heterotrophic protists and small invertebrates. There are few producers. They are high in oxygen content. Trout and salmon are common.
3. Submergent Vegetation: Rain carries in more sediment and fallen leaves. Rooted plants such as pondweeds and lilies appear. The lake is becoming warmer and is not as deep (ie. It is changing to eutrophic.). There are more nutrients.
4. **Eutrophic Lakes**

### Submergent and Emergent Vegetation

#### There is more erosion and decaying plant and animal matter accumulate. There are many nutrients. There is a greater number of plants and the edges of the lake fill in with sphagnum moss, cattails, reeds and bulrushes. The lake is shallow and warm and the amount of dissolved oxygen has decreased.

1. **Shallow Pond**

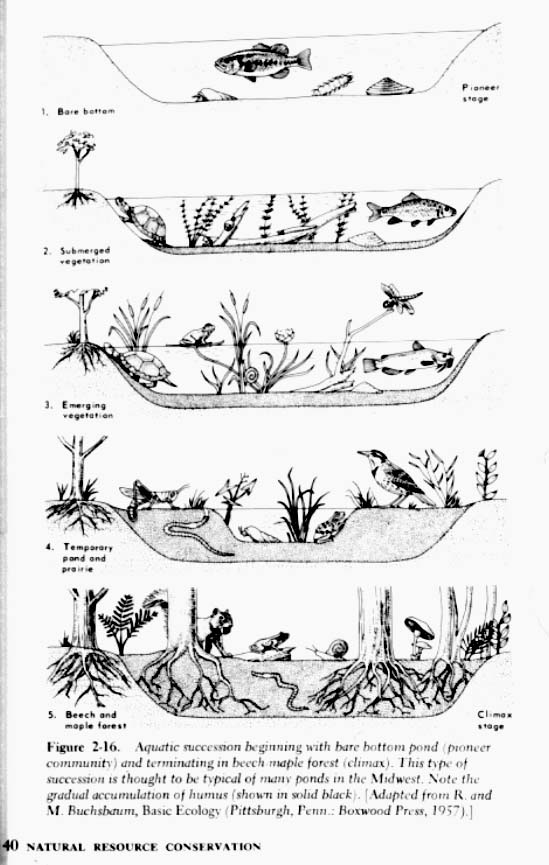
The pond is almost completely filled in by emergent and submergent vegetation and the number of plants is numerous. More sunlight is able to penetrate to the bottom. There is oxygen deprivation because of a great number of decomposers. Organisms consist of slug worms, insect larvae, worms, leeches, mollusks, waterfowl, frogs and bats.

1. **Marsh/Bog/Meadow**

These are waterlogged areas. The pond is completely filled in. There are no aquatic organisms. Tends to be high in peat (decomposing plant matter).

1. **Boreal Forest**

Larch and spruce are normally found because they are adapted to moist soil. Woodland animals are present.



***Eutrophication*** can sometimes be acceleratedby humans adding nutrient rich substances such as phosphates and nitrates. This can include sewage, fertilizers, detergents and other household and industrial products.