UNIT I: SUSTAINABILITY OF ECOSYSTEMS

Text reference: Chapters 1-4

Ecosystem: the set of relationships among organisms living in a particular area and their interactions with the non-living components of that environment

Ecology
- The study of ecosystems
- Includes studying biotic and abiotic factors

Biotic factors (Living)
- Those caused by the presence and roles of other living things
- Eg: predator-prey relationships, competition, disease, decomposing animals, symbiosis

Abiotic factors (Non-living)
- Those created by non-living things
- Eg: space, amount of sunlight, temperature, water, soil nutrients, gases (oxygen, nitrogen, etc)

Sustainability: the ability to maintain something
http://www.youtube.com/watch?v=B5NiTN0chj

- *Example:* the sustainability of forest ecosystems in the face of economic pressures
    - Maintaining natural habitats is essential for the existence of many species of organisms
    - Harvesting trees is an important source of employment

Paradigm and Paradigm Shift:

Paradigm: a typical example or attitude

Paradigm shift:
- a change in attitude ie. a fundamental change in the way one thinks about something

- *Example*: Forests
    - Has our attitude toward forests changed?
    - What was the typical attitude in the past?
    - How has that changed?
    - Are there forestry practices now that aim to sustain the forests for the future?
    - Are these practices effective?

Biodiversity

- The number of different species within an ecosystem
- The extinction of one or more species may threaten the survival of other species in that ecosystem
  - Since the different species in a particular ecosystem are linked by food chains and food webs

  - *Example:* Sea otter (**p.18)**

    - How did the overhunting of the sea otter affect other species:

    ↓ Sea Otter → __Sea urchin → __ Kelp →__Fish

    - What interventions by humans helped to prevent a total collapse of this food chain?

  - The more diverse an ecosystem the better it may be able to handle the extinction of a species, especially if the predators of that species have other food sources

Ecotones

- Transition areas between adjacent ecosystems
- Contain organisms from both, therefore they have greater biodiversity and are less fragile
- Important in preventing extinction

<u>Causes of Extinction:</u>

Historically, major causes = natural phenomena

- Natural catastrophes
- Climate change
- Competition from other species
- Evolution (natural selection)

Last 100 years, major causes = human activities

- Competition from a newly introduced (exotic) species
- Global warming leading to climate change
- Loss of habitat
- Overhunting
- Pesticide use

Assign: Section 1.2 Read. p.14; Section 1.3, p.16-19, Q. 1-3; Section1.4, p.20-21, Q. 1-3; Section 1.5, p. 22-23, Q. 1-5

MAINTENANCE & CHANGE IN ECOSYSTEMS

In order for an ecosystem to be stable and self-sustaining there must be:

1. A constant source of energy – the sun

2. Producers – use the energy from the sun to make organic compounds

3. Food chains & food webs – to transfer energy & cycle matter

Ecosystems do change however, over time:

- **Ecological Succession**
  - Occurs in both terrestrial and aquatic ecosystems
  - Process by which an existing community is slowly replaced by another community

  Community – all the populations of different species living in a specific area

  Population – all of the members of the same species living in a specific area

Main factors responsible for succession:

1. Dominant species
   - The few species that have a great effect on the environment and on the other members of the community
   - In most cases plants are the dominant species
     - They determine the types of animals that can exist in a particular ecosystem

2. Climatic and geographical forces
   - Eg. volcanic eruptions, melting of glaciers, floods and fires

3. Human activities
   - Eg. clearing of land for farming, forestry, settlement, etc.

Types of Succession:
http://www.youtube.com/watch?v=k03vxRYsJ4Y&safety_mode=true&persist_safety_mode=1&safe=active

1. Primary Succession
   - Occurs in areas that have no existing life
   - Eg. barren rock
   - Takes thousands of years to reach a climax community

2. Secondary Succession
   - Occurs in areas where forests have been cut down or have been destroyed by fire, natural disasters or disease
   - Shorter than primary succession because soil already exists
   - Usually takes hundreds of years to reach a climax community

Climax Community
- The final stage of succession
- A mature, stable community that remains until it is destroyed by a major catastrophe
- Eg. a mature forest, a bog

Example of Primary Succession: after a volcanic eruption
- Lichens on bare rock (pioneer organisms)
- Weathering of rock creating thin, crude soil
- Mosses and small plants get established
- Soil thickens and develops a humus layer
- Grasses and small shrubs get established
- Eventually trees and a forest becomes established = climax community (Final type of vegetation in an area. It will remain constant for a long time if conditions remain about the same.)

NOTE: as the plant life changes in an area, there is also a corresponding change in the animal life.

ENERGY IN ECOSYSTEMS

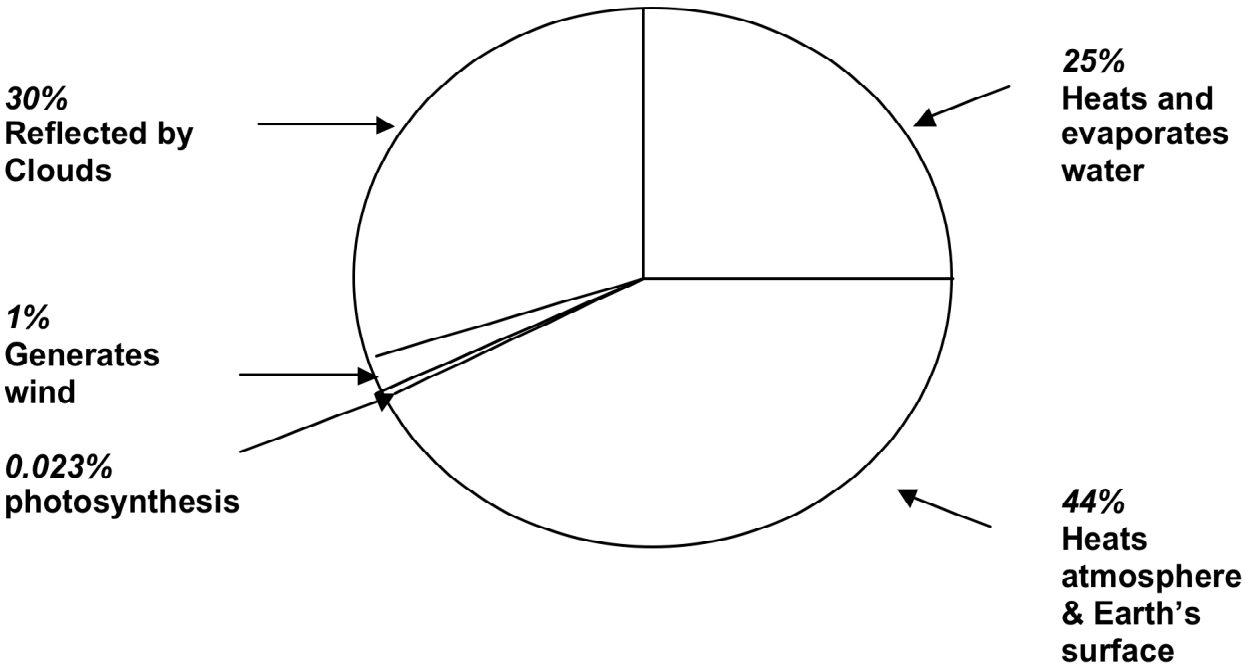
The sun is the source of energy for the *biosphere*
- It lights and heats the planet
- It causes evaporation of water (drives the water cycle and weather)
- It provides energy for green plants to make carbohydrates (via photosynthesis)

Biosphere
- Part of the earth inhabited by life
- Sum of all the ecosystems on Earth
- Includes the following layers:
    - Hydrosphere – water (thin layer)
    - Lithosphere – land (down a few meters)
    - Atmosphere – air (up a few kilometers)

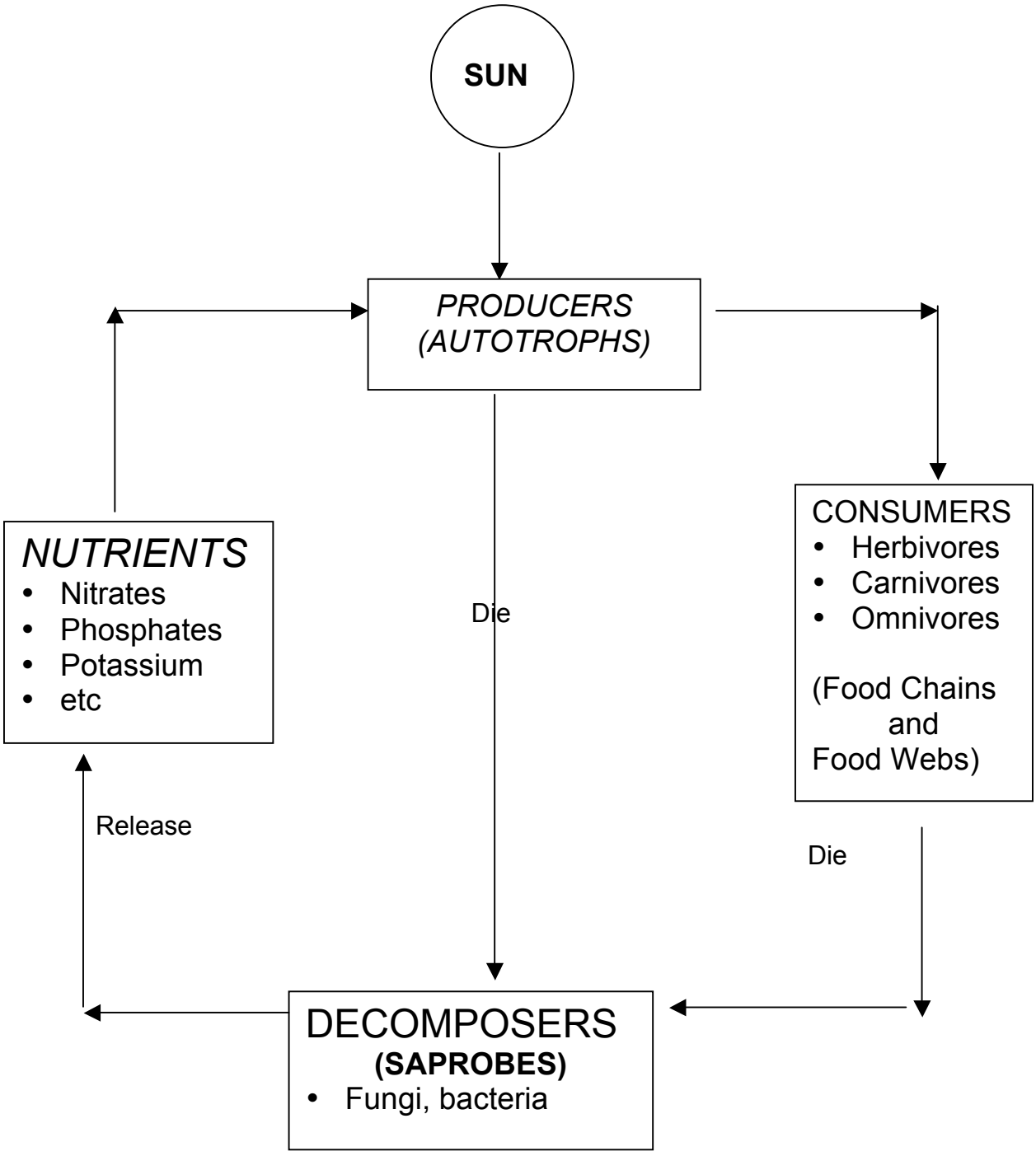
Of the energy that reaches the biosphere, 30% is reflected back by clouds and the surface
due to an Albedo effect

Albedo
- A measurement of the percentage of light an object reflects
    - Eg. snow has a high albedo, forests have a low albedo

Distribution of Sunlight reaching the Biosphere:



COMPONENTS OF ECOSYSTEMS



FOOD CHAINS & FOOD WEBS

Food Chain:
- The pathway by which food passes from one *trophic level* (feeding level) to the next.
- A straight line sequence: producer → primary consumer → secondary consumer → tertiary consumer → etc.
- It is a simplification of the actual feeding relationships within an ecosystem

Food Web:
- An elaborate representation of the interconnected feeding relationships among organisms in an ecosystem.
- These are more complex and realistic than food chains:

Eg: a) one type of primary consumer may feed on more than one species of plant

b) some organisms eat at more than one trophic level
- omnivores eat both plants and animals
- decomposers eat organic waste and dead organisms

Producer:
- These are *autotrophic* organisms ie. they produce their own food.
- They are usually plants.
- They are the base (bottom level) of the food chain.

Autotroph:
- These are organisms that obtain energy from the abiotic environment to build organic molecules.
- They use carbon dioxide, water, nitrogen, phosphate and an energy source to synthesize carbohydrates, lipids, proteins and nucleic acids, organic molecules that are vital to life.

- Autotrophs may use either *photosynthesis* or *chemosynthesis* to produce biological molecules.

Chemosynthesis:
- The production of organic compounds without the help of light.
- *Chemoautotrophs* depend on an energy source other than the sun to produce their own food.
  - obtain energy from the breakdown of inorganic substances such as sulphur or ammonia.
  - Ex. blue-green algae, nitrogen-fixing bacteria

Consumer:
- heterotrophic organisms

Heterotroph:
- These are organisms that obtain food or energy from autotrophs or other heterotrophs.
- They are not capable of producing their own food.

Decomposer:
- These are organisms that breakdown the remains and wastes of other organisms to obtain their own organic nutrients.
- They play a vital role in the recycling of matter.
- Decomposers consist of bacteria and fungi. They are considered to be heterotrophs or microconsumers.
- They may also be called *saprophytes* or *saprobes* when their food source is limited to dead tissue.

Detrivore (Detritus Feeder):
- These are organisms that feed on dead organic matter or wastes such as dead animals, dead leaves and intestinal wastes.
- Larger detrivores are called *scavengers.*
- Ex. ravens, vultures, carrion beetles, earthworms, maggots, bacteria and fungi.

Consumers can be categorized according to their specific trophic level as follows:

Primary consumer:
- Herbivores that obtain their nutrients directly from plants. Eg: A cricket that eats grass.

Secondary Consumer:
- Carnivores that feed on herbivores. Eg: A frog that eats a cricket

Tertiary Consumer:
- A carnivore that consumes a secondary consumer. Eg: An owl that eats a frog.

Top Carnivore:
- The final carnivore in all food chains. Eg: A hawk that eats an owl.

The following are some specific heterotrophic organisms:

Herbivores:
- Obtain their food exclusively from plants; primary (1^{st} order) consumers.
- Eg: insects, elephant, snowshoe hare, buffalo

Carnivores:
- Obtain their food from other animals, ie. eat herbivores and/or other carnivores
- Eg: tiger, wolf, lynx

Omnivores:
- Obtain their food from both plants and animals.
- Eg: humans and bears

Saprobes:
- Obtain food from dead and decomposing organisms.
- Eg: bacteria and fungi feeding on dead tissue.

Two special types of carnivores include:

Scavengers:
- Organisms which feed on primarily carrion; nature's clean up crew.
- They are considered to be larger detritus feeders.
- Eg: vultures and ravens

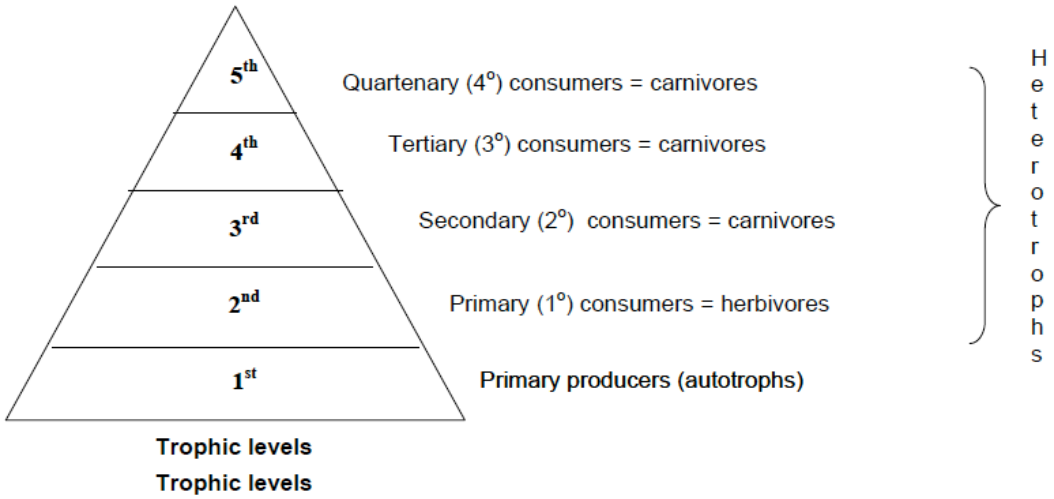
Predators:
- Any organism that feeds on or kills other organisms.
- Eg: wolf, bobcat, owl, hawk, dragonfly, robin

Assign: Section 1.1, read p.10-13; Answer Q. 1-4

STRUCTURE OF ECOSYSTEMS

Trophic Structure

- **A hierarchy of the different feeding relationships in an ecosystem**
- **All species are separated into *trophic levels,* based on their main source of nutrition**
- **This structure determines how** energy flows **and** matter cycles **through an ecosystem**



Trophic levels

Note: **Ecosystems will vary in the number of trophic levels**

- **The top level, no matter how many levels, will consist of *top carnivores***
- **There are rarely more than 5 levels because so much energy is lost at each level.**
  - **The amount stored in plants must be very high to meet the needs of higher levels**

Energy Flow in Ecosystems

The energy that flows from the sun through ecosystems must obey the *Laws of Thermodynamics*

- First Law**: *Energy cannot be created or destroyed but can be transformed (changed) from one form to another***
  - **Eg. chemical energy in the form of organic molecules can be converted to thermal energy (heat)**
- Second Law: ***During any energy transformation, some of the energy is converted to an unusable form***
  - **This form is mostly heat, which cannot be passed on to the next trophic level**
    - **Energy flows and cannot be recycled, thus a constant input is needed**

The flow of energy through an ecosystem occurs in a one-way direction, ie. upwards

- **The amount of energy available depends, either directly or indirectly, on the photosynthetic activity of producers**
  - **ie. how fast producers can make organic molecules, the energy source for organisms**
  - **not all this energy is available to consumers since producers must use some for their own metabolism and in the process much energy is lost as heat**

Ecological Efficiency

- **the percentage of energy that is available to the next (upper) trophic level**
- **ranges from 5 to 20%, rough average = 10%**

Why so much energy is lost from one level to the next:

1. **Not all food that is available is eaten**
2. **Not all the food that is eaten is digested – waste is produced**
3. **Some energy is used by the consumer for its own needs eg. movement, reproduction, maintaining body temperature, cellular respiration, etc**
4. **Waste heat is generated and lost to the surroundings**

ECOLOGICAL PYRAMIDS

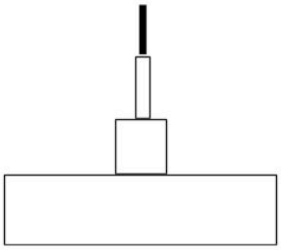
- **Graphs used to represent food chains**

1. ***Pyramid of Energy***
   - **Represents the amount of energy (in Joules or kilojoules) at each level**
   - **1 kJ = 239 calories**

2. ***Pyramid of Biomass***
   - **Represents the** standing biomass **(total dry weight), in grams or kilograms, of all organisms at each level**

3. ***Pyramid of Numbers***
   - **Represents the actual number of organisms at each level**

Example: **Pyramids for a grassland ecosystem**

Trophic level	Organism	Pyramid	Energy (kJ)	Biomass (kg)	Numbers
3° Consumer	Owls		100	10	10
2° Consumer	Rodents		1000	100	100
1° Consumer	Insects		10 000	1000	50 000
1° Producer	Grasses		100 000	10 000	100 000

Note:

1. **Values used are for demonstration purposes only**
2. **Although most pyramids narrow from producers to top carnivores there are some exceptions, particularly with pyramids of numbers** (see Figure 8, Page 37)

Assign: Section 1.11, p.34-39; Q. 1-15

COMPETITION

Habitat:
- the physical area in which an organism lives
- eg: earthworm in the soil

Ecological Niche:
- the role or function of an organism in an ecosystem

- includes the abiotic and biotic conditions that enable it to successfully survive
- It can include how it affects the survival of other organisms

Examples:
- Squirrels eat seeds & distribute them in their waste
- A water lily carries out photosynthesis, producing food for an aquatic ecosystem. The lily also provides habitat for insects and insect larvae.

Habitat = "address" Niche = "job"

Competition:
- the struggle among organisms for limited natural resources such as food, water and space.

Two types of competition:

1. **Interspecific Competition**:

    - involves competition among *different* species for the same limited resources

    - If two species occupy the same ecological niche, one will be eliminated.
        - *competitive exclusion principle*.

2. **Intraspecific Competition**:

    - involves competition between members of the *same* species for the same limited resources

    - The most well adapted individuals to the environment will survive
        - "*survival of the fittest*".

    - This can be caused by an increase in *population density* (number per unit area) and/or a reduction in the resources.

    - It can result in stress, reduced health, a decline in reproduction, as well as in emigration (moving out of the area)

Assign: Section 1.12, Read p.40-44, Answer Questions 1-4, p.44

Symbiotic Relationships

Symbiosis:
- long term interactions between two species.
- the Greek word meaning “living together”.

Three types of symbiotic relationships:

1. **Parasitism**:
   - an organism gains nutrition from tissues of another organism (host).
   - benefits the parasite but harms the host.

Examples of parasites: Tapeworms, Fleas, Lampreys

2. **Commensalism:**
   - One organism benefits from the relationship but neither harms nor helps the other organism.

Example: Remora on sharks that eat left over food

3. **Mutualism**:
   - Two organisms live together and both benefit

Examples:
- Legumes get nitrates from nitrogen-fixing bacteria, which, in turn, receive sugars from the plant.

- Lichens are made up of algae and fungus. The algae provides food via photosynthesis and the fungus provides a framework and moisture.

PESTICIDES

Section 2.2 *p.52-58*

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

a) 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

b) 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

2. 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 (they are not released in urine or sweat)

- DDT is now banned (in Canada & the U. S.) because of the bioamplification in predators, including humans

- Also called bioaccumulation or biomagnification

Assign: Section 2.2, p.58: 1,2, 4-7

CYCLING OF MATTER

- All matter on earth is recycled
- Matter moves from the atmosphere to ecosystems and back again
- The planet is essentially a "closed system" where nothing new enters (except solar energy)

"energy flows, matter cycles"

THE CARBON CYCLE *Fig. 1, p. 62*
http://www.youtube.com/watch?v=U3SZKJVKRxQ

- Carbon is the key element of living things

- Organic forms of carbon:
  - carbohydrates, proteins, fats and nucleic acids (DNA & RNA)
  - fossil fuels - formed from once-living organisms

- Inorganic forms of carbon:
  - carbon dioxide (CO_2)
  - calcium carbonate ($CaCO_3$)

Photosynthesis
- green plants (& other photoautotrophs) use the energy from the sun to convert inorganic carbon (CO_2) into organic forms (food molecules)

- overall process:

6 _____ + 6 _____ → _____ + 6 _____

(from air) (from soil) (carbohydrate) (into air)

Cellular respiration

- a process that is carried out by both plants and animals
- it breaks down organic forms of carbon to be used as fuel for cells and in the process releases carbon dioxide back into the atmosphere

- overall process:

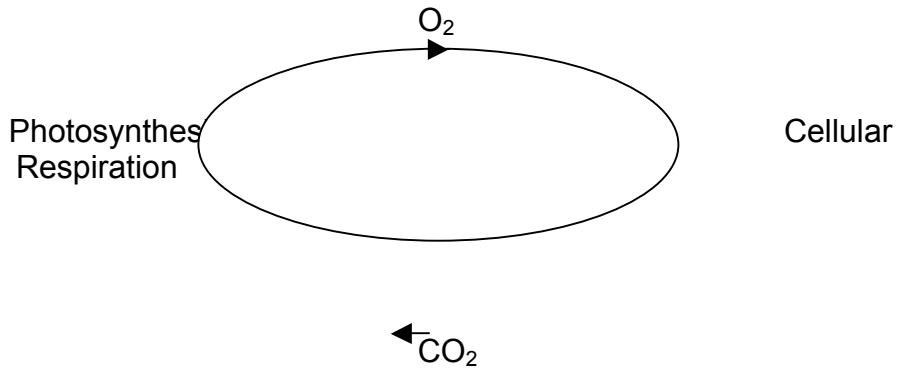
_____ + 6 _____ → 6 _____ + 6 _____ + _____

Note:

- Photosynthesis and cellular respiration are complementary processes since the products of one process become the reactants of the other, & vice-versa

- http://www.youtube.com/watch?v=mUVX5rg1E0I

- The 2 processes also show the link between the carbon cycle and the *oxygen cycle:*



Carbon Storage:

- Reservoirs of Inorganic Carbon
    - The atmosphere, the oceans and the Earth's crust (largest reservoir due to the presence of sedimentary rock eg. limestone = $CaCO_3$)

- Reservoirs of Organic Carbon
    - Bodies of living things
    - Fossil fuels eg. coal and petroleum (crude oil)
        - Form when dead plants and animals become covered in sediment producing an environment low in oxygen such that only partial decomposition occurs
        - Compaction over time forms coal from peat bogs and petroleum on ocean floors

Carbon Release:

- Carbon is returned to the atmosphere through the following processes:

    1. cellular respiration
    2. decomposition of body waste and of dead organisms
    3. volcanic activity
    4. burning of fossil fuels
    5. diffusion from the ocean
    6. weathering of rock sediments (eg. limestone = $CaCO_3$)

Human Impact on the Carbon Cycle:

Global Warming:

- the amount of carbon dioxide in the atmosphere is increasing due to human activities including:
    - mining
    - burning of fossil fuels and forests: combustion releases large amounts of CO_2
    - clearing vegetation for agriculture or settlement
        - reducing producers decreases photosynthesis and therefore reduces amount of CO_2 removed from the air.

- The excess CO_2 is causing the earth's average temperature to rise which can have devastating effects on the planet
    - Eg. melting of polar ice caps, flooding of low-lying areas, climate change, etc

Assign: p. 65, 1-7

THE NITROGEN CYCLE

http://www.youtube.com/watch?v=w03iO_Yu9Xw&feature=related

Nitrogen makes up approximately 80% of the atmosphere

- required for the production of organic molecules including amino acids (the building blocks of proteins), and nucleic acids (DNA and RNA)

Major Steps in the cycle:

- involves 4 major processes: *fixation, nitrification, decomposition, denitrification*

Nitrogen is not usable by plants in its atmospheric form of N_2 gas

- it must be converted to ammonium (NH_4^+) and nitrate (NO_3^-), 2 usable forms, through the processes of nitrogen fixation and nitrification

1. Nitrogen fixation:

a) Atmospheric Fixation
   - the energy of lightning breaks nitrogen molecules into nitrogen atoms which react with oxygen in the air to produce nitrogen oxides. These compounds then dissolve in rain to produce nitrates which seep into the soil.

b) Industrial Fixation
   - The Haber Process combines atmospheric nitrogen and hydrogen to produce ammonia (NH_3) which reacts with hydrogen ions (H^+) to give ammonium (NH_4^+)

These 2 types of fixation account for about 5% to 10% of usable nitrogen

c) Biological Fixation
   - Conversion of N_2 gas from the air, to ammonia (NH_3) and ammonium (NH_4^+)
   - Carried out by **nitrogen-fixing bacteria** found in the roots of legumes (peas, clover, alfalfa) and in the soil

2. Nitrification:
   - Conversion of ammonium (NH_4^+) in soil to nitrites (NO_2^-) and then nitrates (NO_3^-)
   - Carried out by **nitrifying bacteria**

   - Nitrate, the major source of usable nitrogen, (as well as ammonium) are taken up by plants from the soil and are used to make nitrogen-containing organic molecules which are, in turn, passed on to other organisms through food webs

3. Decomposition:
   - Organisms produce waste and eventually die. Decomposers break down nitrogen compounds into ammonia (NH_3) which reacts with hydrogen ions (H^+) to produce ammonium (NH_4^+), which, in turn, can undergo *nitrification* to give nitrates

4. Denitrification:
   - Nitrates are converted back to nitrogen gas and released back into the atmosphere
   - Carried out by **denitrifying bacteria**

Human Impact on Nitrogen Cycle

In agriculture, fertilizers are used to add nutrients including nitrogen, phosphorus and potassium (N, P, K) to the soil in order to increase plant growth

Problems:

1. *Highly acidic soils*
    - Too much fertilizer can make the soil too acidic (since nitric acid is produced when nitrates react with water)
        - High acidity can have a negative impact on soil organisms (including decomposers) as well as on the growth of plants

2. *Eutrophication*
    - The accumulation of dissolved nutrients in bodies of water
        - Can occur when fertilizer-rich soil runs into waterways in the spring (spring runoff)
        - Can lead to *algal blooms w*here algae use the nutrients to grow rapidly, which in turn can decrease dissolved oxygen available to aquatic animals
            - These blooms block sunlight needed for photosynthesis by aquatic plants and thus decrease oxygen production
            - When algae die, decomposers use a lot of oxygen to break them down

Assign: p.69, 1-6, 8&9; p.71, 1-5 (with reference to nitrogen only); p.72, a - g

BIOMES

Definition:

- A biome is a large geographical portion of the biosphere characterized by dominant plant and animal life.
- A collection of ecosystems that have similar characteristics (abiotic & biotic)
- Abiotic factors determine what type of plants can grow, which in turn determines the type of animals that can exist in a particular biome
    - Abiotic factors include temperature, precipitation, soil quality, length of growing season and altitude

Terrestrial Biomes

1. tundra
2. taiga (boreal forest)
3. temperate deciduous forest
4. grasslands

Aquatic Biomes

1. marine
2. freshwater
3. estuary

Tundra

- located south of the polar ice caps of the Arctic
- northernmost biome, “cold desert”
- Low precipitation: 10-12 cm/year (on average)
- Low average temperatures.
- Short growing season (about 60 days)
- Soil
  - The lowermost layers (*permafrost*) are permanently frozen
  - The thin, uppermost layer of the soil (*active layer*) will thaw during summer but is of poor quality because the cold reduces activity of decomposers (bacteria and fungi) so there is slow cycling of matter and little organic matter
- Plants
  - Most have shallow root systems and are rapid-flowering eg. mosses and lichens
  - Few grasses, shrubs or trees (except in most southerly regions)
- Muskegs (bogs) consisting of peat soaked with meltwater form because
  - melting snow cannot drain into the permafrost
  - decomposition is slow
- Low diversity of animal life due to the low diversity of plant life
  - Animals include caribou, wolverines, Arctic hare, Arctic fox, lemmings, snowy owls, ptarmigan and migratory birds
- Parts of northern Labrador are tundra.

Taiga (Boreal Forest)

- a continuous band of forests that lie south of the tundra.
- More precipitation than tundra.
  - Total precipitation = 40 cm or more per year.
- Harsh climate with rapid changes in temperature
- Warmer than the tundra
  - Longer growing season (about 120 days)
  - ground completely thaws (no permafrost) allowing growth of plants with deeper root systems (trees)
- Soil
  - Better quality than tundra because higher temperatures allow more rapid decomposition
  - Soil is often wet and is more acidic than the tundra

- Plants
  - dominant vegetation include *coniferous* (“cone-bearing”) trees such as spruce, pine and fir
    - trees have pyramid shape and flexible branches that allow them to bend easily under the weight of snow.
    - Leaves have a needle shape and a wax coating, both of which reduce evaporation
    - Most conifers retain their leaves all year round (“evergreen”) thus photosynthesis can begin early in spring
    - Seeds are in protective cones
    - Trees are adapted to grow in acidic soil
  - Shade-loving plants live on the forest floor eg. ferns and mosses

- Animals
  - More diversity than the tundra
  - moose, bear, wolves, lynx, deer, pine marten, snowshoe hare, squirrels, voles and seed-eating birds

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Temperate Deciduous Forest

- located south of the taiga in Eastern and Central Canada
- Highest precipitation of the 4 terrestrial biomes (up to 100 cm per year)
- Higher temperatures and longer growing season than tundra or boreal forest
- The soil is rich in nutrients because of a layer of decomposing leaves called *litter*.
- Dominant vegetation is composed of *deciduous* trees that lose their leaves seasonally.
- Most biodiverse biome because can support organisms in three layers: canopy, understory and litter (forest floor)
- Animals consist of squirrels, deer, black bears, wolves, rodents, many birds & insects

Grasslands (Prairies)

- Same latitude as deciduous forest biome, therefore same biotic factors, except lower precipitation (25-75 cm/year)
  - Low precipitation as well as frequent fires (in the past) mean few trees grow

- The soil is deep and rich, partly because fires (in the past) sped decomposition
  - Most fertile soil in the world

- *The predominant forms of vegetation are grasses and wildflowers*
  - Grasses have adapted to dry conditions by developing extensive root systems

- Biodiversity is lower than deciduous forest (fewer plant species: only one layer)
  - Animals include bison, wolves, snakes, hawks, rodents and grasshoppers.

Assign: Section 3.1: Q. p.93, 1-5, 7-9; Section 3.2: Q. p. 94-96, a-p; p.96, 1-3

Biogeography is the distribution of plants and animals across the earth's surface.

Climate is a major factor in biogeography.

Climate's major components: water, light, wind, temp.

Climate varies with:

1. Latitude----distance north or south of the equator.
2. Altitude -- distance above sea level.
3. Closeness to the ocean

Note: climatograph p. 94 and variations in temp and precipitation from one time of year to other.

SOIL *Section 3.3, p.97*

A. Soil Layers:

1. 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

2. 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

3. 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)

4. Bedrock
- Underlying rock layer

B. Water and the Soil:

1. *Surface water*
- water collecting or flowing on the earth's surface

2. *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

3. *Water table*
- The boundary between the saturated layer and the porous layer

C. 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