Topic 1 - Biological Diversity and Survival

The entire collection of living organisms, each with their own unique characteristics, makes up the Earth's biodiversity. **Biological diversity** refers to the number and variety of species and ecosystems on the Earth and the ecological processes of they are a part of.

A Wealth of Diversity

Interdependence of many different species stresses the need to protect what species we currently have on the Earth.

A **species** is a particular group of organisms that have the same structure and can reproduce with each other. Of the 30 – 100 million possible different species of living things, there are over 1.5 million species of animals and 350.000 species of plants that have been identified by biologists.

Taxol, found to be effective in controlling different types of cancers, is extracted from the bark of the Pacific Yew tree.

The most successful life form seems to be the insect. There are many different species that can potentially help other species, like the Pacific Yew tree, by producing medicines. Biological diversity is important for the health and survival of natural communities.

The **main components of biodiversity** include:

- **Ecosystem diversity –** the different types of living communities and the environments, such as marshes, lakes, streams and forests, in which they are found
- **Community (***populations of different species living in the same area***) diversity** – occurs within **populations (***members of a species that live in a specific area and share the same resources***)** of organisms living within a particular ecosystem
- **Species diversity** – occurs within individual organisms of the same species
- **Genetic diversity** – occurs within organisms at a cellular level, as it describes the variety of genetic material in all living things.
- **Species Distribution** – Plant and animal species are not distributed evenly throughout the various eco-regions of the world. Most of the different species of plants and animals can be found in tropical regions and, more specifically, in the rainforests. As you move closer to the poles of the Earth, there is less biological diversity.

Variations for Survival

Every organism needs to adapt in order to survive in its environment. There are two types of adaptations. Physical features of an organism are structural adaptations, whereas, actions are behavioral adaptations.

The Value of Variation

Having variation in an ecosystem enables some of the organisms in that ecosystem to survive because of their higher level of resistance and survival adaptations, when certain species die off. This is important in order to maintain the ecosystem. Sacrificing one part of the ecosystem to save the main parts is also necessary sometimes. This is why foresters might decide to burn one part of a forest to save the part of the forest that they know will be able to survive other factors that are threatening to destroy the entire forest.

Mountain Pine Beetle

Destroys pine trees by spreading a bluestain fungal disease as it bores through the tree.

The tree eventually dies.

Measuring Biological Diversity

To determine the biological diversity of an area, biologists use a measurement called a diversity index. This compares the diversity of species in a certain area with the total number of organisms in that same area, or ecosystem. It is primarily used to check on the health of an ecosystem – a healthy ecosystem has a high diversity index.

Topic 2 - Habitat and Lifestyle

The Niche: What Makes an Organism Special?

A niche is the role an organism has within a particular ecosystem. An organism's niche includes:

- What it eats
- What eats it
- Its habitat
- Nesting site, range and habits
- What effect it has on the other populations
- What effect it has on the environment

A niche, for a particular organism, can change, depending on the environment in which it is located and the organisms with which it inter-relates.

Variation and Competition

When basic need resources (food, water, sunlight, habitat) are not plentiful, different species compete for the resource. This competition is often not fair – because one species may have a specific variation which will give it an advantage over other species. Adaptations play an important role when competition occurs, because the species that is best suited to survive will. The species who does not 'win' the resource will likely have to switch to a different, less desirable resource in order to survive.

Some species, like warblers, visit Alberta spruce forests and avoid direct competition for the same resource, by practicing resource partitioning. This resource sharing enables competing species to share resources by accessing these resources in different ways.
http://collections.ic.gc.ca/warblers/ident.htm

The Broad Niche

In northern Canada there are large populations of those species found there, but there are not as many different plant and animal species as there are in other parts of Canada. Large herds of caribou, polar bears, wolves and millions of arctic hare make up the majority of the animals you will find. The species of wolf, *Canis lupus*, and polar bear, *Ursus maritimus*, are also found in Russia and northern Europe. In contrast, hundreds of thousands of species (in small populations) can be found in the rainforests of Central and South America. The reason that Canada supports large populations, with less diversity is the extreme environment and seasonal variations, which restrict their food supply. Organisms living in this ecosystem have a broad niche with adaptations that enable them to survive the extreme changes occurring there. These species are considered to be generalists – able to spread over large areas.

Diversity in the Tropics: The Dangers of a Narrow Niche

In the tropics, where the temperatures are relatively constant and food supply is stable, organisms are specialists. They efficiently survive in their environment, because they have relatively narrow niches with adaptations directed toward competing for one dependable food source, type of soil or level of light. This specialization allows many different species to coexist in the same area, preventing one species from becoming dominant. The result of this is high diversity with low populations.

A specialist is well adapted to survive in one particular environment. This is considered to be the 'trap of specialization', because, as it is able to survive very well in one environment, it is not able to adapt to extreme change and may not survive when this occurs. The cutting down of the rainforests have meant a loss of diversity, because many organisms have been unable to adapt to this change.

Dependencies Between Species

Each and every species depends on many other species within an environment in order to survive and prosper. Food chains and food webs represent different types of ongoing relationships between and among all the organisms, within a particular environment.

Symbiosis
A different type of interdependence is an association, within a certain population, between members of different species.
There are different types of symbiotic relationships:

- ***Commensalism*** – in which one of the participating members benefits, but the other does not, and there is no harm done to that organism.
  (a bird using a tree to build its nest in) (barnacles on a whale)

- ***Mutualism*** – both organisms benefit from the relationship.
  (mychorrhizae (fungi) help plants absorb water and minerals from the soil, by increasing the surface area of the roots, when they attach themselves to the roots to draw nutrients directly from the plant, also protecting the plant from disease.

- ***Parasitism*** – one organism benefits while the other organism (the victim) is harmed. (the parasite usually doesn't kill the host, because the host represents the parasite's food supply.

(tapeworm in a human host) (Mexican bean beetle is a plant parasite)

- **Interspecies competition** happens when two or more species need the same resource. This type of relationship helps to limit the size of populations, of the competing species.

There are many examples of these types of symbiotic relationships, which show the importance of adaptations, helping particular species survive.

Life In the Extreme
Living in an environment at 110^{o}C or -35 ^{o}C - rare, but possible because of adaptations organisms have to live in these extremes.

Tube worms live on the ocean floor, near black smokers, where volcanic vents make the temperature extremely hot.

Antarctic springtail are arthrods that live in extreme cold, by producing a kind of antifreeze in its tissues.

Snow algae have cell membranes adapted to cold temperature, making their own food by photosynthesis. The red color protects them from the intensity of the sun on the snow.

Many organism have adaptations that defy our understanding of life. They therefore hypothesize that life may exist in the harsh environments on other planets.

Topic 3 - Passing It On

Characteristics are passed on from generation to generation through the reproductive process. Some characteristics, or traits, are inherited through genetic material. Living organisms display a wide variety of reproductive strategies for passing on their genetic information to their offspring.

Asexual Reproduction

Asexual reproduction involves only one parent who passes on the genetic information to their offspring. This sharing of genetic information makes the offspring identical to the parent. There are different types of asexual reproduction:

- **Binary Fission** - only single-celled organisms reproduce in this way. The cell duplicates its contents, including its nucleus and other organelles and then splits into two cells with each one being identical. (bacteria, amoeba, algae)

- **Asexual Spore Production** - spores are similar to seeds, but are produced by the division of cells on the parent, not by the union of two cells. One parent may produce many spores, each of which will grow into a new individual, identical to its parent. (fungi, green algae, moulds, ferns). Many spores are produced to ensure that at least some of the individual organisms will survive. Zoospores can also be produced by some fungi and green algae. They move using tail-like flagella.

- **Asexual Reproduction in Plants**
  A plants continues to grow throughout its life. The rapidly growing tips of roots and stems contain specialized reproductive cells called meristem. At a certain time these cells will specialize into cells that make up roots, stems and leaves. If parts of the plant are damaged, the meristem cells make repairs. Clones can be made from cuttings of a plant, because the meristem cells can specialize to reproduce the different parts needed to make a new plant. Asexual reproduction can produce many plants very quickly. This is an advantage in places where the environment doesn't change very much (bacteria). By building a large population of organisms very quickly the species is able to thrive. The great disadvantage is that when the environment changes, all of the organisms will die, if they do not have the ability to adapt to the change.

- **Budding** - the parent organism produces a bud (a smaller version of itself), which eventually detaches itself from the parent and becomes a self-sufficient individual - identical to the parent. Coral also reproduces in this way, but do not detach themselves (hydra, yeast, coral, sea sponge).

Sexual Reproduction

Sexual reproduction usually involves two individual organisms. The offspring that are produced from this union have a mix of characteristics, half from one parent and the other half from the other parent. Sexual reproduction does not always involve male and female parents, but can have specialized *gametes* (reproductive cells that have only one role - to join with another gamete during reproduction). Many organisms are capable of both sexual and asexual reproduction, like some moulds, such as *Rhizopus*, which produce spores. They can also produce *zygospores*, enabling them to reproduce sexually as well.

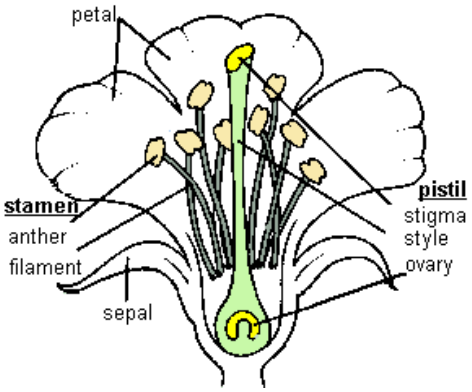
Sexual reproduction has the advantage of providing lots of variation within a species, helping it to survive when the environment changes. The main disadvantage is that this process takes a lot of energy. This means that they can only produce small populations.

Bacterial Conjugation

Bacteria are able to transfer genetic material directly from one cell to another through a process called bacterial conjugation. It is a primitive form of sexual reproduction, since two parent cells are involved. The benefit is that new combinations of inherited characteristics may result. Although this process is not actually reproduction, because there is no increase in the number of cells, it does result in genetic recombination. The newly created cell can then divide by binary fission, to create identical cells with the new genetic material.

Sexual Reproduction in Plants

Sexual reproduction in plants involves gametes as well, male gametes and female gametes joining, during fertilization, to produce a zygote and then an embryo. Most plants produce both male and female gametes, while some produce one or the other only.



Pollen contains the male gametes and is found on the stamen. Ovules contain the female gametes and are found in the pistil. Pollination occurs when pollen is transferred from the anther of the stamen to the stigma of the pistil. Cross-pollination occurs when pollen from one plant is carried to the stigma of another plant by wind, water or animals (bees or butterflies). Cross-fertilization occurs when a grain of the pollen forms a long tube (pollen tube), which grows down the style into the ovary. The gametes unite to produce a zygote, which then develops into an embryo. This usually happens inside a seed, which protects the embryo and provides food (cotyledon) for the embryo when growing conditions are right. Plants which are produced, as a result of cross-fertilization, are not identical to either plant.

Plants reproduce Sexually and Asexually

Sponges and hydra are organisms that can produce both sexually and asexually. Most plants that produce seeds can also reproduce asexually (cuttings, runners). Depending on the environmental conditions the amount of energy varies, enabling the plant organism to control its population.
Vegetative Reproduction - is the reproduction of a plant not involving a seed, including; cuttings, runners, suckers, tubers. (coleus plant, spider plants, strawberries, aspen, potatoes)
Mosses produce asexual spores in the early part of their life cycle and then egg and sperm cells are produced in a later part of the same cycle.

Sexual Reproduction in Animals

Sexual reproduction in animals involves gametes. The male gametes are called sperm cells, and the female gametes are called egg cells (ova). During mating, the sperm cell and the egg cell unite to form a fertilized combination of cells called a zygote. This zygote is the first of many cells of a new individual. This zygote will begin to divide into two cells and this continues to be repeated over and over resulting in the development of an embryo. This embryo develops into a multi-cellular organism inside the female (in most mammals) or, outside (in an egg shell) in other animals.

Topic 4 - Wearing Your Genes

Variation is one of the most critical aspects of species survival. This variation may not always be as easy to find as color usually is, because it may be a behavioral tendency or a genetic (cellular code) modification that enables some individuals within a species to survive, while others, of the same species, will perish.

Two Kinds of Inherited Variation

Inherited (heritable) characteristics are those traits which are passed on to offspring directly from their parents. These traits are passed on by way of the genetic material that is combined from the parents during the process of sexual reproduction. Heritable traits include, structural and distinguishing characteristics, such as eye color, hair type, skin color and earlobes.
Continuous variations are differences in characteristics that have a range of possible variations, such as height, shoe size, hand span, skin color, hair color, etc.
Discrete variations are differences in characteristics that have a definite form, with a limited number of possibilities. This includes those individuals, within a species, that have either one characteristic, or the single, other variation, of the characteristic. Examples include: tongue rolling ability, blood groups, earlobe attachment, hairline, etc.

(**Global Human Traits**: Variation in Human Characteristics Around the World)
http://edquest.ca/Projects/GHTS/ghts.html

Dominant or Recessive?

Traits are passed on from parents to offspring during sexual reproduction. Some of these traits are dominant and some are recessive. When they are mixed, a dominant trait will show up in the offspring. The frequency of a particular characteristic does not indicate whether it is dominant or recessive. Frequency varies from population to population. A dominant trait, such as having six fingers, is relatively rare.

Nature Versus Nature

Not all characteristics are inherited. Some depend entirely on the environment. Non-inherited characteristics are acquired and not necessarily passed on from generation to generation. Athleticism, artistic ability, leadership qualities are all learned during the early years of life. Some variations may be influenced by interactions with the environment. These variations are also non-inherited. Examples include: change in the pigmentation of skin color throughout the seasons due to the sun, height and weight can be influenced by diet. Scars, injuries, clothing, hairstyle, make-up, and cosmetic surgery may change a person's characteristics, but they are not caused by genetics. The interactions between a person's genetics and the environment are very complex and are constantly being debated. One way that scientists study the relationship between genetics and the environment is to observe the similarities and differences between identical twins that have been separated at birth and raised in different environments.

Changing Our Genetic Information

Factors in the environment, or random events can change genetic information contained in DNA. These changes are called mutations, and can cause changes in the structure of organisms, including people. Mutagens, such as X-rays, ultraviolet rays, cosmic rays and some chemicals can cause mutations to occur – some that have little visible effects and some that have dramatic effects. Some mutations can cause cancer, which promote rapid cell division and impair full normal cell development. The cancerous cells can interfere with other cells and prevent certain processes from occurring as they should. If mutations occur in the DNA of reproductive cells, the changes can be passed on from the parent to the offspring, increasing the variation within a species.

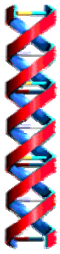
http://www.dnaftb.org/dnaftb/1/concept/

Topic 5 - When Plans Change

DNA: The Secret of Life http://www.dnai.org/index.htm

The blueprint that is passed on from the parents to the offspring is found in a molecule of the cell nuclei. This molecule, *deoxyribonucleic acid*, (DNA) is the inherited material responsible for variation. All living organisms contain DNA in their cells. DNA was discovered prior to 1944, by Swedish chemist Johann Miescher (1886). This simple substance is able to carry out all of the functions of genetic material, reproducing itself, moving from parent to offspring and controlling structures and functions of cells. DNA contains all the instructions, which create the organism's characteristics. The multitude of characteristics for each organism means that there is a lot of DNA in any one cell. This DNA is arranged in the cell in compact packages, called chromosomes.

The Structure of DNA http://www.dnaftb.org/dnaftb/15/concept/



All DNA molecules contain exactly the same chemicals, but the way the chemicals combine determines the characteristics of the organism. James Watson and Francis Crick unraveled the structure of DNA in 1953, revealing the key to the multitude combinations of variation that are possible.

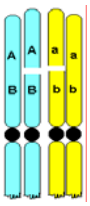
The DNA molecule is like a ladder twisted into a spiral (see image). The sides of the ladder are the same in all DNA molecules, but the rungs are what make the variations. Each rung pairs up two of the following chemicals: guanine (**G**), cystosine (**C**), adenine (**A**) and thiamine (**T**). The arrangement of these four chemicals creates the code that the cells are able to interpret. This is the genetic code of the organism.

The Genetic Code

Characteristics are passed on from one generation to another within a species through the genetic code of the parents. This genetic code is a unique sequence in each individual that provides the blueprint for each individual organism. Protein molecules make up much of the structure of cells and tissues in plants and animals. A section of the DNA molecule for a specific protein is called a gene.

The Dance of the Chromosomes

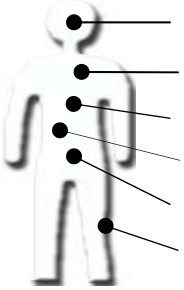
All human cells contain 46 chromosomes. In order to have a complete human organism, all 46 of the chromosomes must be present. Not all organisms have the same number of chromosomes (Dogs have 78, cats have 38). Every cell of a human contains 23 pairs of chromosomes (dogs 39, cats 19). Not all of the chromosomes from species to species are the same, which accounts for the different characteristics between the species. A single gene is an uninterrupted segment of DNA, which contains the coded instructions for the organism.



Genes are located in the chromosomes and come in pairs. Each chromosome has numerous gene locations. Both genes in a pair carry DNA instructions for the same thing. Specific characteristic genes occupy matching locations on the two chromosomes. DNA code may not be exactly the same in both locations. Offspring inherit genes from both parents. The genes exist in an array of possible forms that differ as to their exact DNA sequence. These variations in forms are called alleles. The ultimate combination of the chromosome pair is what makes the variation possible - combining the different variations of different characteristics to create a unique variation.

Normal Cell Replacement

Different human cells (somatic cells) have different life spans.



Brain cells	30-50 years
Red blood cells	120 days
Stomach lining cells	2 days
Liver cells	200 days
Intestine lining cells	3 days
Skin cells	20 days

Replication of the contents of each cell occurs and then. When the cell divides, the process of Mitosis ensures each cell ends up with a complete set of chromosomes, identical to each other and identical to the original cell.

Sex Cells and Genetic Variation

The sex cells are called gametes. Male gametes are sperm cells and female gametes are egg cells. Meiosis, the process of forming gametes occurs in the same way as somatic cells. Meiosis is a type of cell division that produces cells with only half the DNA of a normal cell. This process involves two cell divisions, not one. Each sperm cell and egg cell contains 23 chromosomes.
Tutorial: http://www.biology.arizona.edu/cell_bio/tutorials/meiosis/page3.html

When an egg cell is fertilized by a sperm cell a zygote is formed, which has a complete set of 46 chromosomes – 23 from the sperm cell and 23 from the egg cell. When the zygote grows and develops it becomes an embryo and then becomes a human at birth. This type of sexual reproduction increases variation within a species. In multi-cellular organisms the process that produces two new cells with the same number of chromosomes is called Mitosis. http://www.sci.sdsu.edu/multimedia/mitosis/mitosis_gif1.html

The Benefits of Variation

Life is relatively short and to ensure that a species will survive, reproduction must occur. Asexual reproduction produce identical members of the same species, so there is good chance that some will survive to reproduce and continue the cycle of life. Sexual reproduction produces variation

Technology and Variation

Moving pieces of one strand of DNA to other cells is a relatively new technique that has emerged. In the science of genetics, genetic engineering has enabled scientists to create individuals within a species with desirable traits. Biotechnologies are beginning to become controversial, now that the genetic code for many species has been unraveled. The question remains – Are we 'tampering too much with nature'? The debate rages on!

Biotechnology in Medicine

One of the first uses of modern biotechnology was to move the human gene for insulin into bacteria. By doing this, bacteria were able to produce large quantities of insulin in a relatively short time, as a waste product, which then was collected and used by diabetes patients. Bacteria are not the answer to everything, but they have motivated scientists to think about other more complex possibilities. Genetically modified, or transgenic, mammals are produced by adding human genes to the fertilized eggs of the mammal. Offspring that develop grow up with the human gene that can produce complex proteins, collected in the milk produced, purified and then used in the treatment of many human conditions, including iron deficiency, emphysema, hemophilia and blood clotting.

Biotechnology in Food Production

Genetic engineering has become an important technique for producing food, such as fish. Aquaculture is becoming an increasingly important method of fish farming mass production. Disease resistance genes, growth hormones and even antifreeze genes enable fish farmers to increase their yield with less chance of disease, in a shorter amount of time, and at all times of the year. But what happens if these 'special' fish make it out into the natural fish population? Will the natural populations of fish be able to compete with them?

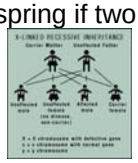
A Cost-Effective Crop

Most genetically engineered crops in Canada are altered for specific reasons – to lower costs, decrease pest problems, and to improve yields. The monoculture that is produced as a result has its own problems. A single event or pest can wipe out an entire crop. And, what about genetically engineered food you see in the supermarket – would you buy it?

Purebred VS Hybrid
To produce purebred organisms, a breeder would choose pure bred parents, those parents whose ancestors have produced only the desired characteristic they want (**true-breeding**). If a breeder chooses two different 'true-breeds' then a **hybrid** would be produced.

Dominant Traits
Crossbreeding two different true-breeds will result in all of the offspring having the same characteristic, that is, the **dominant trait**. Only the DNA instructions for the dominant trait will be carried out.

Recessive Traits
When crossbreeding hybrids, the average results will produce 75% of the offspring with the dominant trait and 25% of the offspring with the recessive trait, because there are only 4 possible combinations. One trait is recessive and therefore the allele is recessive. A recessive trait only appears in the offspring if two recessive alleles are inherited.

Punnitt Squares 
http://www.mansfieldct.org/schools/mms/staff/hand/genpunnettsquares.htm
http://library.thinkquest.org/20830/Textbook/Genetics.htm#Punnett%20Squares

Incomplete dominance occurs because the dominant-recessive pattern does not always prevail. When the alleles are neither dominant, nor recessive, an intermediate trait will occur (combining the two traits).

Offspring Unlike Either Parent.
More than one gene location and more than one allele may be responsible for specific traits. As a result, the complex mixing of the possible combinations for that particular trait may account for the variation of traits an offspring has.

Bonus Material: Biological Diversity Classification

The two-name Latin naming system for all living things was developed by Carolus Linnaeus in the 18th century, enabling scientists, around the world, to refer to the same species, by the same name. This classification system was much more reliable than previous systems, because he used structure, rather than habitat. Two words identify each organism. The 1st represents the organism's **genus** and the 2nd represents the organism's particular **species**.
Scientists earlier had developed a system, which classifies all organisms, based on their structural differences, into 5 kingdoms.

- **Animalia** (animals)
- **Plantae** (plants)
- **Fungi** (yeasts, moulds and mushrooms)
- **Protista** (mostly single-celled organisms)
- **Monera** *(bacteria)*

The 5 kingdom classification system can be further subdivided, with each sub-division having its own name.

Kingdom phylum class order family genus species

Specialists *refer to other sub-divisions as well, such as;*
subfamilies, super-orders, and sub-species or varieties*.*

http://www.ruf.rice.edu/~bioslabs/studies/invertebrates/kingdoms.html

Topic 6 - The Best Selection

Long before the science of genetics started, people tried to reproduce organisms with only the most preferred traits, by allowing only those organisms with the desirable traits to reproduce. This method was not always successful, but through time (trial and error), this practice of controlled breeding provided scientists with the information to determine which alleles were responsible for specific traits. http://www.mansfieldct.org/schools/mms/staff/hand/geneticspageone.htm
Artificial Selection is the process of selecting and breeding individuals with desirable traits to produce offspring with the desired traits. The selection process is simple. Only those individuals, with the desired trait, will be allowed to reproduce. This selection process also applies to plants, which can be bred to possess desirable traits. The main difference between 'natural' selection and 'artificial' selection is that, humans control the artificial selection process.

Artificial Selection in Agriculture (and Ranching)

The process of intervention to produce more desirable organisms has been going on for some time. This process takes a long time to see results - usually many generations.
Farmers, dog and horse breeders, along with scientists can now speed up the artificial selection process by using 'low-tech' or 'high-tech' technologies, such as;

- **cloning** (made from cells)
- **artificial insemination** (artificially joining the male and female gametes)
- **in vitro fertilization** (male and female gametes are selected and then allowed to fertilize in a controlled setting)
- **genetic engineering** (directly altering the DNA of an organism)

Plant breeding is an important part of agriculture. Selective breeding programs bring positive characteristics of two different varieties together to create a new variety that has more desirable characteristics, such as what was done to produce Western Red Spring Wheat. The flour fro m this grain is used to make pan bread. Canadian Western Durum is good for making pasta. Other varieties have also been engineered for specific purposes, such as resistance to disease, length of time to mature, resistance to extreme temperatures (hot or cold), and even taste.

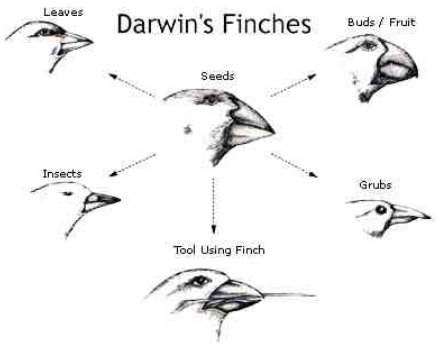
Accounting for Biological Diversity

The specimens and observations made by Charles Darwin about the diversity of life on the Galapagos Islands is detailed in his most famous book, *Origin of the Species by Means of Natural Selection*. Find out more about **Charles Darwin** and his work through the Mystery Scientist link: http://www.edquest.ca/content/view/227/

The Theory of Natural Selection

The diversity of life in the Galapagos Islands helped Darwin explain his theory of natural selection. It can be summed up in four statements:

1. All organisms produce more offspring than can possibly survive.
2. There is incredible variation within each species.
3. Some of the variations increase the chances of an organism surviving to reproduce.
4. Over time, variations passed on through offspring lead to changes in the genetic characteristics of a species.



Natural selection happens when factors in the environment determines, or 'selects' which individuals, within a species, will be able to survive. If they are able to live long enough to reproduce, then those individuals with their 'survival adaptations (characteristics) will have offspring with similar survival characteristics.
These observations and conclusions were supported by another biologist Alfred Wallace. The Galapagos finches provide the best example of this theory – how the fittest, or best-adapted, organisms for a specific environment survive.

Other Natural selection examples include Equus (Horse p. 64 Science Focus 9 textbook) and the Peppered Moth: http://www.millerandlevine.com/km/evol/Moths/moths.html

Topic 7 - The Sixth Extinction

In the last 600 million years there have been five major declines in the Earth's biodiversity. There has however, over the last 65 million years, been an increase in diversity greater than the rate of extinction. The rate of extinction is thought to be 1 species per day over the age of life on the planet. The rate today is 70 extinctions per day. Natural selection is a slow process. Even if there is a lot of variation within a species, sometimes the changes in the environment are so drastic and so quick, that none of the individuals within a species can survive. Natural extinction can occur as a result of:

- catastrophic events (volcanic eruptions, earthquakes, floods, fire)
- lack of food (due to overpopulation)
- disease

Not all extinctions happened millions of years ago. Diseases and natural events occur all the time and when they do, a species, within a particular area, can be extirpated very quickly. Sometimes organisms have adaptations that suit them only to a very narrow set of environmental conditions. This usually occurs in a relatively stable area, where the environment does not change for a very long period of time. This is called overspecialization and it is another cause of extinction. The giant panda is a species that is overspecialized, because it relies on bamboo, making it vulnerable to extinction, when the bamboo is scarce.

Extinction is the disappearance of every individual of a species from the entire planet. It is a natural part of the Earth's history. Scientists estimate that 99% of species that have ever existed on the Earth are now extinct (many by mass extinction - sudden environmental change, like the Ice Age). Most extinction take place over long periods of time, but the rate of extinctions is rising, and this is reducing the biological diversity of our planet.

Extirpation is a local extinction, or the disappearance of a species from a particular area. Most extinctions and extirpations today are caused by human activity, such as habitat destruction - as a result of – Urbanization, Construction, Agricultural development, Logging, Damming of rivers, Pollution, Pesticides, Herbicides and Fertilizers Extinctions and extirpations reduce biological diversity. When an organism disappears locally or globally, many other species are affected. The cycle of life is adversely affected. http://www3.gov.ab.ca/srd/fw/escc/aspsr.html
The General Status of Alberta Wild Species 2000

Human Impacts on Biodiversity http://www.nysm.nysed.gov/bri/process.html
The stresses of urbanization and habitat intrusion by farming and industry have resulted in a decline in genetic, species and ecosystem diversity. Extinction, population decreases and degradation of ecosystems all reduce biological diversity on the Earth.

Disappearing Habitats
As a bioindicator species, the Grizzly Bear helps us to determine the human impact on an ecosystem. This large carnivore's ability to survive or disappear is historically a sign that human interference in an ecosystem is occurring or not.

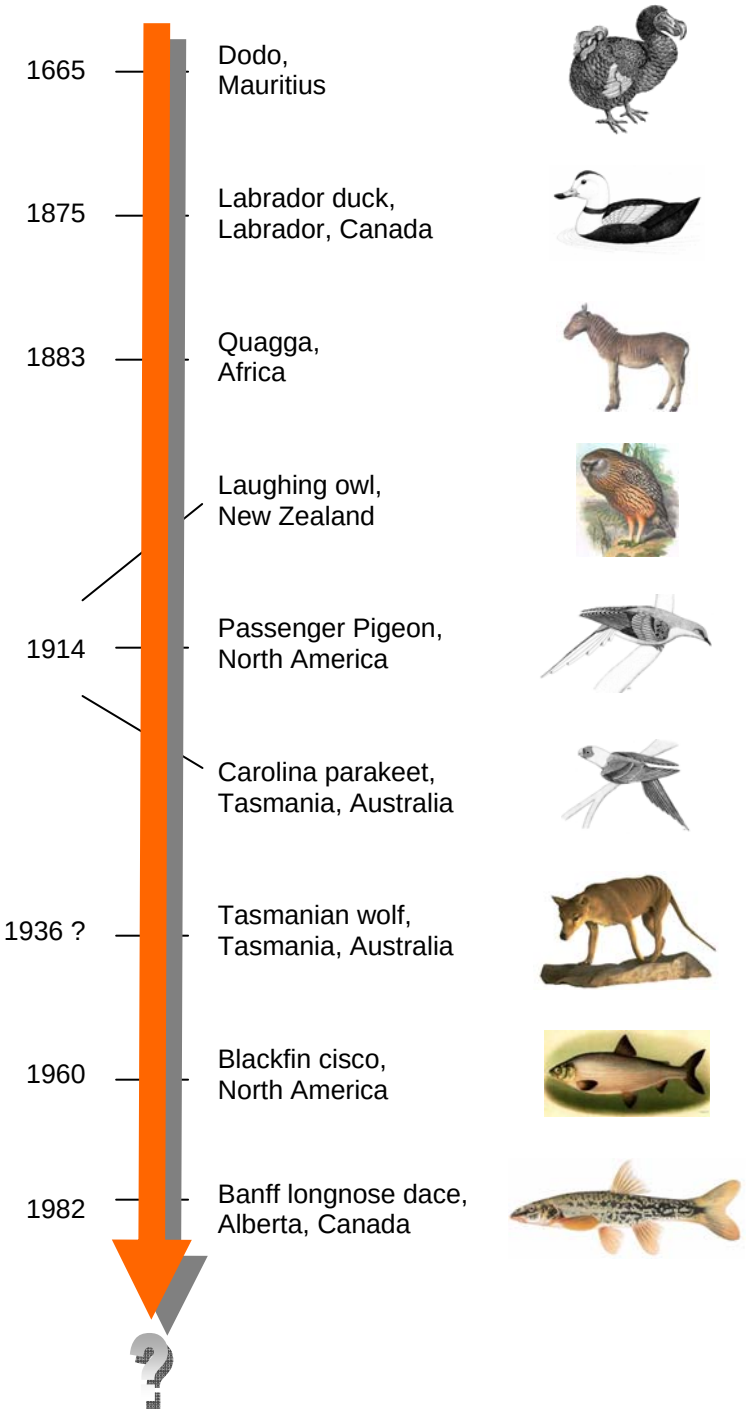
Human Impacts on Rainforest Ecosystems
The population globally is on the increase. With new methods of farming and better ways of preventing disease food and medicine are allowing people to live longer. This large population is putting pressure on the environment, because of increased human activities stated previously.

The Population Explosion
The impact of population is not shared equally around the globe. The hardest hit is developing regions where diversity is most threatened. Tropical rainforest are being clear cut to make way for farmland, cattle ranches, pineapple and coffee plantations, and fuel. Loss of rainforests, mean the extinction of specialized organisms depending on the forests for food and protection. Because the soil in a rainforest has few nutrients the farms and plantations are successful for only a short time and then it is difficult to repair the damage to the original rainforest. The loss of diversity is permanent.

Human Activities and Extinction

The impact of loss of diversity, through extinction, has been studied and our understanding of its importance has changed. When introduced species use the same resources, as native species, competition will cause a decline in the numbers of native species, simply because there is less to go around. The introduced species will have no natural predators to limit its population and will, in time, take over from the native species. Over-hunting was the major cause of the decline and eventual extirpation of the plains Bison, as well as the extinction of the passenger pigeon. Sometimes species are hunted to deliberately extirpate them. The black-tailed prairie dogs were considered a pest in the 1930's and were hunted to reduce their numbers.

Some Recent Extinctions



Topic 8 - Pains and Gains

The Role of Zoos in Preserving Biodiversity

Zoos were not originally started to preserve diversity. They were exotic collections for private collectors. They didn't become public until the early 1800's – in London. Today there are thousands around the world and we have one of the finest - right here in Alberta. The Calgary Zoo is known as one of the finest zoos in the world. Located on St. George's Island in the Bow River, it opened in 1929. It now is home to over 1100 species, including endangered species such as the Whooping Crane and the Siberian Tiger. Besides being home to a diverse group of animals and plants, the Zoo is an educational institution that runs school programs for K-12 students. It is also part of a worldwide network that is attempting to protect and preserve endangered species. Animal exchange programs help to increase the genetic diversity essential to species survival. Support for research is also a large part of their program. Zoos are visible evidence of our attempt to preserve and maintain biological diversity.

Preserving the Biodiversity of Plants

Preserving global biological diversity is a challenge that is receiving much attention.
Ex-situ conservation refers to conservation of components of biodiversity outside of a natural habitat. Examples include:

- The collection and storage of genetic resources, such as seeds (**IPGRI**) London, England's Royal Botanic Gardens is one of the world's largest seed banks. The goal is to collect 10% of the world's seed-bearing plants.
- Zoos (captive breeding programs) Calgary Zoo
- Sperm and Egg Banks
- Human Genome Project

A Global Effort

The preservation of biological diversity depends on local efforts and global efforts. The 1995 **Canadian Biodiversity Strategy** was created to preserve biodiversity in Canada. It will be done through the cooperation of many levels of government, along with many groups, agencies and individuals, who are dedicated to preserving our bio-diverse future.

- **Protected Areas** (National Parks, Provincial Parks, game preserves, natural areas)
- **Restoration Programs for Ecosystems and Species** (Governments and *Nature Conservancy of Canada* programs to purchase land for species habitat renewal, individual landowners giving habitat back - in the form of a naturally protected area, Ducks Unlimited *CARE* program, *Swift Fox* **-** restoration of a species - extirpated from Canada and now recovering)
- **Resource Use Policies** (Laws - *National Accord for the Protection of Species at Risk - Species at Risk Act - Wildlife Act, 1998*)
- **Controlling the Introduction and Spread of Exotic Species** (Information and teaching about the invasiveness of an exotic species is communicated to the public on a regular basis. Penalties and fines, as well as loss of desirable areas for recreational purposes, has improved the perception of the negative effect an exotic species can have on a local ecosystem.)
- **Global Treaties**: 1975 Convention on International Trade of Endangered Species (CITES) is aimed at preventing endangered plants and animals from being imported or exported. It is illegal to buy or sell animals or animal parts identified for protection by CITES.
- 1992 Convention on Biodiversity was signed by 180 countries to set up and maintain protected areas for threatened and endangered species.
- Canadian Wildlife Federation and Canadian Nature Foundation educate the public about biodiversity issues and lobby the government to conserve our Canadian biodiversity.