BIODIVERSITY

"Biodiversity is the variety of species and ecosystems on the Earth and the ecological processes of they are a part of."

All Living Things are:

made of cells,

need energy,

reproduce.

grow and develop,

get rid of their wastes,

and respond to their environment

with adaptations (*which suit them to the specific habitat in which they live*).

Ecosystem diversity – the different types of living communities and the environments in which they can be found.
Community diversity – occurs within populations of organisms living within a particular ecosystem.
Species diversity – occurs within individual organisms of the same species. 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 rainforests and coral reefs. Coral reefs reflect a great diversity of species. Like tropical forests, coral reefs support many different communities of organisms surviving on a small amount of nutrients, which are very efficiently recycled. The closer you get to the poles - biodiversity decreases.
Genetic diversity – occurs within organisms at a cellular level, as it describes the variety of genetic material in all living things

CLASSIFICATION

All organisms have been classified into 5 Kingdoms based on their structural differences

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

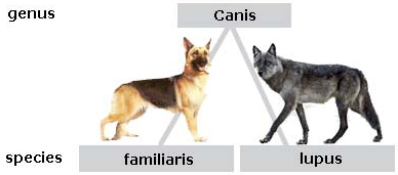
Each of these 5 Kingdoms are then further classified as …

Kingdom
phylum
class
order
family
genus
species

TAXONOMY

The two-name Latin naming system for all living things was developed by Carolus Linnaeus. 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 organisms genus and the 2nd represents the organisms particular species.



A species is a particular group of organisms that have the same structure and can reproduce with each other.

NICHES

A **niche** is the role of an organism within a particular ecosystem including:

- 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.
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:
Commensalism – in which one of the participating members benefits, but the other does not, and there is no harm done to that organism. (barnacles on a whale)
Mutualism – both organisms benefit from the relationship. (lichen (algae and fungi) growing in the Arctic Tundra benefit each other)
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)
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.
Resource partitioning is the action, which enables competing species to share the resources by accessing these resources in different ways, involving less direct competition.

Variation within a population, of a single species, is called variability.

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. Variability is important if the environment, in which the species lives, changes (suddenly or drastically). When a species has a great deal of variation, then, some of the individuals within that species will likely survive when there is change.

Examples of variability include:

- Red fox (color of coat)
- Antibiotic resistance (bacteria)
- Banded snail (color of shell)

Discrete and Continuous Variations

Discrete variations are differences in characteristics that have a definite form. This includes those individuals, within a species, that have either one characteristic, or the single, other variation, of the characteristic.

Continuous variations are differences in characteristics that have a multitude of variations, such as height, shoe size, etc.

Variation and the Environment

Some variations may be influenced by interactions with the environment. These variations are not 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.

Inherited and Non-inherited

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.

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.

Natural Selection happens when factors in the environment 'selects' which individuals, within a species, will be able to survive and live long enough to reproduce. Individuals with 'survival adaptations' will have offspring with similar survival characteristics.

Asexual Reproduction

Asexual reproduction involves only one parent. All of the offspring are identical to the parent.

Binary Fission - The cell splits into two cells and each one is identical. (only single-celled organisms reproduce in this way; bacteria, amoeba, algae)
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. (hydra, yeast, coral)
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. (fungi, green algae, moulds, ferns)
Vegetative - is the reproduction of a plant not involving a seed, including; cuttings, runners, suckers, tubers. (coleus plant, spider plants, strawberries, aspen, potatoes)

Sexual Reproduction in Plants

Sexual reproduction in plants 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, which grows down the style into the ovary. Gametes unite to produce a zygote, which then develops into an embryo. This usually happens inside a seed, protecting the embryo and providing 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.

Sexual Reproduction in Animals

Sexual reproduction in animals involves gametes (reproductive cells that have only one role - to join with another gamete during reproduction). 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.

Sexual & Asexual Organisms

Sponges 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.

Advantages and Disadvantages of Asexual and Sexual Reproduction

Variation usually helps a species survive when the environment changes.

Asexual reproduction does not require any specialized cells to produce a new plant. It can therefore 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.

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.

DNA

DNA is the blueprint that is passed on from the parents to the offspring and 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 is the inherited material responsible for variation. Characteristics are passed on from one generation to another within a species through the genetic code of the parents. This genetic code is called DNA.

Captive breeding programs enable scientists to control populations of species at risk of extinction. Using modern technology, geneticists and staff from zoos around the world can analyze the genetic code of the species they are trying to save and use it to introduce variation that will help the species survive when the environment changes.

DNA and the Genetic Code

DNA was discovered prior to 1944. 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, 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), cytosine (C), adenine (A) and thiamine (T). The arrangement of these four chemicals creates the code that the cells are able to interpret.

Chromosomes

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. Every human cell contains 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.

Genes

A single gene is an uninterrupted segment of DNA, which contains the coded instructions for the organism. Researchers found out that (by working on the fruit fly):

- Genes are located in the chromosomes
- Each chromosome has numerous gene locations
- Genes come in pairs
- 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.

Cell Division & Asexual Reproduction

Asexual reproduction involves only one parent. All of the offspring are genetically identical to the parent. In single celled organisms, binary fission enables the parent cell to split its contents equally between the two new cells. Prior to this division, the parent cell duplicates its DNA and when the split takes place each new cell receives a complete exact copy of the DNA, of the parent. In multi-cellular organisms the process that produces two new cells with the same number of chromosomes is called **Mitosis.**

Cell Division in Plants & Animals

Sexual reproduction usually involves two individual organisms. The offspring that are produced from this union have genetically different characteristics, half from one parent and the other half from the other parent - making a unique offspring. During sexual reproduction, the specialized sex cells (gametes) inite to form a zygote, which develops into the new organism. When a male gamete and a female gamete unite, meiosis takes place. **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.

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.

The Science of Genetics

To reproduce organisms with only the most preferred traits, allow only those organisms with the desirable traits to reproduce. This method is not always successful, but over time (trial and error), this practice of controlled breeding enabled scientists to determine which alleles were responsible for specific traits.

Patterns of Inheritance

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).

Purebred vs Hybrid

To produce purebred organisms, 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 vs Recessive 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. 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 traits is recessive and therefore the allele is recessive. A **recessive** trait only appears in the offspring if two recessive alleles are inherited. [Punnit Squares]

Environmental Factors can also determine how DNA is interpreted and developed. Fetal alcohol syndrome can be a direct result of alcohol consumption during the developing stages of the offspring. The 'normal' DNA is affected by the alcohol and will not develop normally. Taking drugs can also affect the DNA during normal development and defects in the organism can occur. (Thalidomide)

Biodiversity Reduction

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 reduces biodiversity.

Extinction is the disappearance of every individual of a species from the entire planet. It is a natural part of the Earth's history. 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.

Causes of Extinction and Extirpation

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 that and so quick, that none of the individuals within a species can survive.

Most extinctions, in the past, were due to:
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.

Habitat destruction - as a result of - Urbanization, Construction, Agricultural Development, Logging, Damming of rivers, Pollution, Pesticides, Herbicides and Fertilizers.

Introduction of Non-Native Species

Introduced species use the same resources, as the native species, the competition will cause a decline in the numbers of native species. The non-native species has no natural predators to limit its population and will take over from the native species.

Over-Hunting

This 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.

Effects of Extinctions and Extirpations

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.

Artificial Selection

The process of selecting and breeding individuals with desirable traits to produce offspring with the desired traits. 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.

Biotechnology

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)

Biotechnology and Society

Beneficial or *detrimental* to society? That is one of the pressing questions that many humans are struggling with, when it comes to biotechnology. There are many good things that can be produced, but what about the problems, including:

- risks in animals (reducing genetic variation within a specific population, less resistance to disease, birth defects and other abnormalities)
- risks in plants (resistance to herbicides)

Reducing Impact on Biodiversity

Preserving global biological diversity is a challenge that is receiving much attention. 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 (purchase land for species habitat renewal, individual landowners giving habitat back - in the form of a naturally protected area)

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 & teaching, penalties and fines, as well as loss of desirable areas for recreational purposes)

Conservation of Genetic Resources (*Ex-situ* conservation refers to conservation of biodiversity outside of a natural habitat.

- The collection and storage of genetic resources, such as seeds (IPGRI)
- Zoos (captive breeding programs)
- Sperm and Egg Banks
- Human Genome Project