BIOLOGICAL DIVERSITY

When you are finished this unit, you should be able to ...

- define biodiversity and give examples at the local and global level
- investigate species dependence and niches
- recognize variations among species and discuss the factors that cause variations
- relate variations to asexual and sexual reproduction
- explain the basis of DNA and how it relates to genetics
- recognize the role that natural selection and artificial selection have in producing change
- identify and discuss human impact on species survival and variations
- take a personal stand on issues related to maintaining species survival

PREREQUISITE SKILLS AND KNOWLEDGE

Prior to beginning this unit, you should be able to ...

- recognize that plants and animals have variations
- realize that living things interact among themselves and with the environment
- know that life continues through the reproductive process
- make a connection between human activities and their effect on living things
- make predictions based on observations and data collected
- research information on ecological topics and issues
- interpret and graph population patterns and trends
- analyze environmental issues and biotechnological trends

Lesson 1 VARIATION AND ADAPTATION

NOTES

Variations—or differences—exist between individual organisms in nature. Not all plants or animals are exactly the same. Each flower is different from another as is each person. The difference is limited by the organism's ability to reproduce and survive.

Species are different from each other for various reasons. On the Galapagos Islands, a remote set of islands 1 000 km off the west coast of South America, animal and plant species have been studied because of the variations that exist within the same species on different islands. Each island has its own special features that have led to changes within a species. Survival of these species is based on both structural and behavioural adaptations.

Species: organisms with similar characteristics and genetics

BEHAVIOURAL ADAPTATION

A Behavioural adaptation is a change in the behaviour of a species that makes the species better able to reproduce and survive.

Behavioural Adaptation: a change in the behaviour of a species that makes the species better able to reproduce and survive

Organisms adapt their behaviour to the environment in which they live. These changing behaviours include mating, migration, sleep patterns, and daily routines. Adaptations occur over several generations of a species.

Genus: group of species that are behaviourally or physiologically distinct from a different group of species in the same taxonomic family

Several kinds of lizard on the Galapagos Islands are from the same genus, but the species have adapted to their specific environment. It is unlikely that these different species would ever be able to mate as a result of specific behavioural differences. It is almost as though they speak a different language, so communication and rituals of mating become confused. This prevents interspecies mating.

One thing that could affect the development of an adaptation may be the timing of the ripening of a particular type of fruit that makes up the diet of a lizard species. If this species is out looking for food, it will hardly notice other lizards. A visiting lizard acting out a different mating ritual at this time will be ignored. If these mating patterns continue over a long period of time, the chance of interspecies mating is decreased.

STRUCTURAL ADAPTATIONS

A structural adaptation is a change in the structure or function of a species that makes the species better able to reproduce and survive.

Structural Adaptation: a change in the structure or function of a species that makes the species better able to reproduce and survive

When an organism competing for food develops a more efficient body part, its chances for survival are improved. The long necks of giraffes are a good example of a structural adaptation. Shorter-necked animals cannot compete with giraffes for the leaves high in the trees.

NOTES

The whale populations of the world provide another example of easy to see that each species has different structures suited to its needs. Sperm whales have long narrow jaws and teeth along with a large sonar-sounding apparatus suited for deep diving and feeding. The humpback whale has a jaw that opens very wide. Instead of teeth, it has long narrow projections that filter out small organisms (krill) near the surface of the water. Both of these species of whale thrive in the same oceans but consume different prey. Each species has different structures adapted to a particular type of feeding habits.

MEASUREMENT OF VARIATION

Scientists use a measurement tool that helps to evaluate the different number of species that exist in a particular area. The number of natural species that cohabit an area is an indicator of the health of the area.

Environments are impacted when new species are introduced or during temporary periods of climate change. Nature usually adjusts with time, but if a new species of plant or animal is introduced into an area, the result can be destructive to the pre-existing species over the long term. A common result is that one species will dominate. This is the case with the common seven-spot ladybug that was not native to Alberta but has now taken over as the dominant ladybug in the province.

The tool used by scientists to measure the amount of change that occurs in populations is called the diversity index. The diversity index is a formula that compares the number of one type of producer, consumer, or decomposer with the total number of related producers, consumers or decomposers found in an area. The number of one type of organism is called the "number of runs." The number of runs is divided by the total number of related organisms to calculate the diversity index.

As an example, if we looked at the number of spruce trees in a 100 m^2 area and compared it with the total number of tree species in the same area, we would find the diversity index of the area. If there are 15 spruce trees and a total of 100 trees of all species in the whole area, we would have a biodiversity index of 15:100.

Another example of the effect of one species on an environment is the current pine beetle infestation in western Canada. This new species to North America has killed millions of trees. It has become a dominant species with little competition. Left unchecked, it will likely destroy the British Columbia forest industry within the next decade. The destruction of the coniferous forest will cause the loss of many species of animals. As the number of pine trees decreases, the number of other tree species may increase. The diversity index will decrease dramatically.

Lesson 2 HABITAT AND LIFESTYLE

NOTES

Narrow niche: Species range in one environment

Biomes: The major communities of the world, characterized by a predominant type of vegetation and kind of climate

Niche: A special role in an ecosystem

Broad niche: Species range through different environments

Each species has its own special place—called a niche—in the environment. Within its niche, the members of the species interact with other organisms. For example, the cougar is a carnivorous animal that preys upon deer and elk species in the ecosystem. The cougar has a territory in which it hunts and competes for available food. Even though it is at the top of the food chain, the cougar is affected by what happens in its surroundings. If the food supply becomes low, the cougar is in risk of starving. Within a niche, it is usually the old and weak organisms that die first; this ensures that the strong survive.

Variations occur in species as a result of both structural and behavioural adaptations to the environment. The number of species that live in a certain area can be limited by competition. In the foothills of the Rockies, white tail deer and mule deer compete for food. The herd that moves on will have to adapt to a new environment. In this instance, the mule deer will generally move because the white tail bucks are very aggressive and will drive off the mule buck during mating season. The result is that the mule deer adapt to a broader niche where they will eat a variety of plants in a variety of areas.

Some species have a narrow niche and survive on a single food source. These species are susceptible to environmental changes and can be eliminated by a simple change in one factor within their ecosystem. The spotted owl in British Columbia exists only where a specific species of fir tree is present. Logging of these trees reduces the food supply and may affect the spotted owl's chances of survival.

Animals in biomes like the desert are considered narrow niche species. As a result of the lack of food sources, they are restricted in what they eat. If the food source becomes depleted, the animals may starve.

Species can be affected not only by food sources, but also by different types of soil, the number of daylight hours, the amount of rainfall, and differences in temperature. For example, a Christmas cactus flowers when it receives less than 10 hours of sunlight while potatoes need over 12 hours of light.

It is usually a combination of rainfall, sunlight, and soil type that limits a species growth.

SYMBIOTIC RELATIONSHIPS

NOTES

Symbiosis is a relationship or interdependence between different species of organisms. Symbiotic relationships can be classified as relationships of mutualism, commensalism, or parasitism.

Mutualism: both organisms benefit from the relationship

In a mutualistic relationship, both organisms benefit from the relationship. In the case of the honeybee and flower, the honeybee obtains the nectar food supply from the flower. At the same time, the flower becomes pollinated.

Commensalism: one organism benefits and the other is not affected or harmed

In commensalisms, one organism benefits and the other is not affected or harmed. A woodpecker hollows out a tree nest. The following year, a cowbird uses the vacant nest to raise its offspring. The cowbird benefits from this relationship, but the woodpecker is not affected.

Parasitism: one organism benefits by harming the other

In a parasitic relationship, one organism benefits by harming the other. A tapeworm in a fish's gut obtains the nutrients required but may eventually kill the fish by depriving it of essential nutrients.

By necessity, species are dependant on each other. Humans must have certain types of bacteria in their digestive tract to be able to digest certain foods. Vegetable plants prefer to grow near small flowering pansies because they produce a natural insecticide. The pansies benefit from being near the vegetables by having animal droppings land and fertilize the area as animals consume the vegetable plants.

EXTREME CLIMATE HABITATS

Organisms that live in the extremes of climate and environment have a narrow niche. Certain plants and animals thrive in niches with extreme temperatures, altitudes, and precipitations.

The jungle teams with life adapted not only to heavy rainfall, but to living above ground. Some small monkey species of rainforests never touch the ground and yet rarely see the sky. They live and reproduce in an area between the canopy of leaves and the undergrowth close to the ground.

Musk oxen that live in northern Canada are structurally and behaviourally adapted to the extreme cold of the north. They are small stocky animals with a thick coat of hair and fur.

Desert plants produce leaves covered with a waxy cuticle. This prevents excess evaporation during hot days. Desert plants also have leaves with fewer stomata, or air pores, to prevent water loss through transpiration.

Lesson 3 ASEXUAL REPRODUCTION

NOTES

REPRODUCTION

For life to continue as we know it, all species within the animal and other kingdoms must reproduce. The reproductive process involves molecules of deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) being transferred to their offspring. This is the basis of reproduction.

DNA: deoxyribonucleic acid

RNA: ribonucleic acid

From a biological perspective, there are two main types of reproductive processes: sexual and asexual. Both processes are designed to pass DNA information to offspring.

ASEXUAL REPRODUCTION

In asexual reproduction, there is only one parent involved. Asexual reproduction results from cell division known as mitosis. In mitosis, one cell divides into two, two divide into four, and so on, until an individual identical to the parent is produced. Many one-celled protozoa, such as the paramecium, reproduce by splitting into two cells. This process is called binary fission.

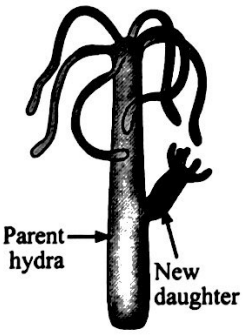
Asexual Reproduction: there is only one parent; offspring get all genetic material from the one parent

Another form of asexual reproduction is the production of spores. This is common in fungi and algae. A spore released by the parent organism lands on a suitable location and grows into a new individual.

Budding is another method of asexual reproduction through which a single-celled organism forms a new individual. A parent releases a "daughter" bud from its side. The hydra uses budding to reproduce.

Binary Fission: the splitting of a parent cell into two equal parts

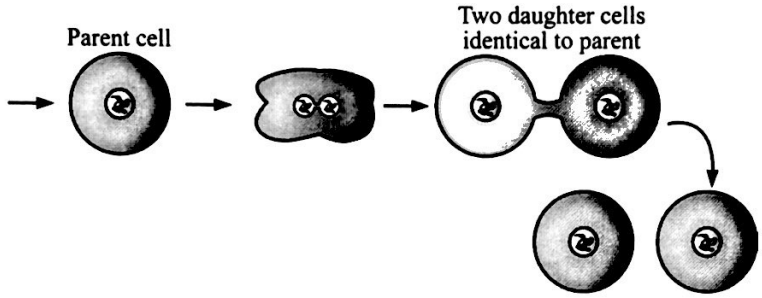
A Hydra Budding



Budding: a single-celled organism forms a new individual

NOTES

In plants, mitosis is used to reproduce roots and stems. Meristems (plant stem cells) reproduce quickly at the tips of roots and stems by dividing continuously.



A recently developed asexual reproductive technique is cloning. A parent cell is taken and cultured into a new cell. In this way, original cells may be reproduced en masse from one parent. This method has already been successfully used in the treatment of Parkinson's disease. Stem cells from a healthy person are cloned and reproduced in a lab, then injected into the problem area. As the cells begin to grow in the damaged area, they produce chemicals that signal a change to make healthy tissue cells.

Lesson 4 SEXUAL REPRODUCTION

NOTES

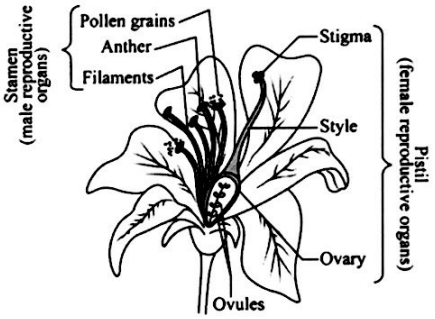
Sexual reproduction: there is one male parent and one female parent; offspring get genetic material from both parents

Sexual reproduction allows for a greater variety within a species than is possible in asexual reproduction. In sexual reproduction, two parents each contribute one-half of the genetic material. Cells must undergo a process through which the original DNA is split in half. The new cell is combined with a partner's cell that has undergone a similar split of DNA material. Sperm cells in the male and egg cells in the female are produced in this manner. This type of cell division, which produces cells with only one-half of the DNA material of normal cells is called *meiosis*.

Sexual reproduction involves the union of *gametes*, that is, the union of a male sex cell with a female sex cell. The male cat's sperm must unite with the female cat's egg cell or a flower's pollen must unite with an egg cell. This union of gametes is called *fertilization*. The first cell created by fertilization is referred to as a *zygote*.

REPRODUCTION IN PLANTS

The flower in a plant is a specialized reproductive structure.



Pollen produced in the anther of the stamen fertilizes the egg cell produced in the ovary of the pistil. This is made possible by self-pollination or cross-pollination. In self-pollination, the pollen drops to the stigma part of the pistil in the same flower. In cross-pollination, the pollen is carried by wind, water, or animals to the stigma of another plant. The fertilized egg cell becomes a zygote that develops into a seed. The cycle of life is again repeated, as the seed grows into a plant that produces a flower.

Many plants reproduce sexually by flowering and producing a seed. Some of these plants may also reproduce asexually by vegetative propagation. Grass, for example, can grow from underground stems. Strawberry plants can develop from runners. Irises can grow from underground bulbs.

REPRODUCTION IN ANIMALS

Most single-celled animals reproduce asexually. Most multi-cellular animals reproduce sexually. Fertilization can be external or outside the body. A female frog lays its eggs among grass blades. The male comes along and fertilizes the eggs externally by releasing sperm over the eggs. Fertilization in mammals, on the other hand, is internal. The sperm is delicate and needs protection. It is deposited into the female internally by the male.

Lesson 5 DNA AND GENETICS

Genetics is the study of heredity. Heredity refers to the traits or characteristics passed on to offspring. Genetic traits are carried in strands of DNA located in chromosomes. The strands, consisting of four base chemicals (cytosine, adenine, guanine, and thymine) are matched in pairs and coiled together to form a double helix. Each strand has genes that are responsible for carrying the genetic code or blueprint of the organism.

NOTES

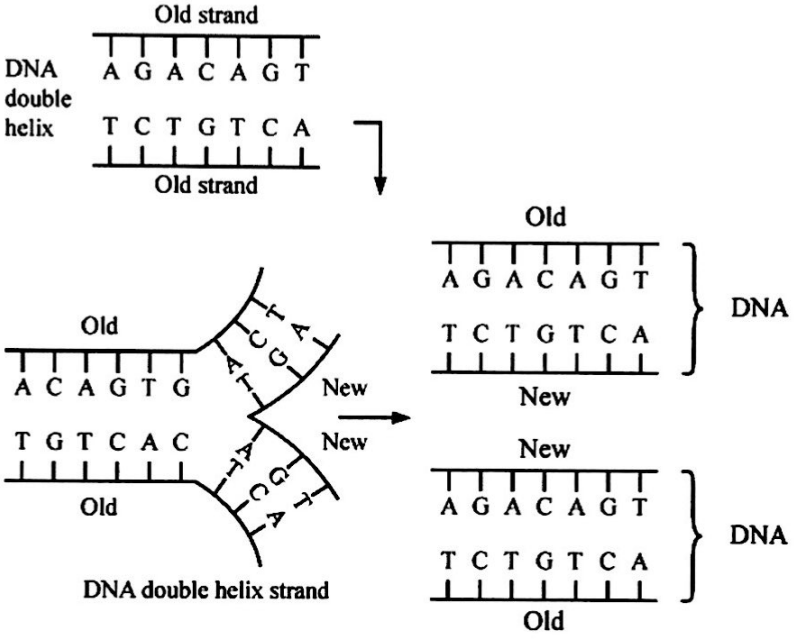
Genetics: The study of heredity

Heredity: The passing of traits from one generation to the next

DNA contains the genetic codes of an organism.

Double Helix DNA

DNA REPLICATION



Unzipped DNA with new proteins

The number of chromosomes in the sex cells is one-half the numbers in the organism itself. A human has 46 chromosomes, of which 23 chromosomes come from the male parent and 23 come from the female parent. Within each chromosome are smaller units called genes. Genes carry the code for a particular trait. Consequently, millions of combinations of genes are possible. This accounts for the variation that occurs during sexual reproduction. Generally, this explains why no two individuals look alike.

An example of this type of genetic sharing occurs in all plant and animal sexual reproduction. This allows species to adapt to change more readily because each piece of DNA genetic material produces a particular trait. When plant pollen is carried into a new area and comes in contact with a similar species, the joining of the DNA may produce a plant that is hardier and better adapted to live in the area. For example, the new genetic material may provide a resistance to disease by strengthening the plant cell wall.

NOTES

CHARACTERISTICS AND VARIATIONS

Variations among living organisms can be discrete or continuous. Discrete variations are differences that are distinct, ones that are "either/or". Either a baby has blue eyes or brown eyes. Either an individual is a tongue roller or a non-roller. Continuous variations are differences that show a range for one characteristic. The height of an adult can vary from 1.3 m to 2.2 m or the handspan of a two-year-old child can vary from 6 cm to 8 cm. Discrete variation occurs when one gene changes to produce a new single trait or phenotype.

Continuous variations: differences that show a range for one characteristic

When genes express information in the cell as the organism grows, specific phenotypes are created. Phenotypes are visible traits such as hair colour or arm length.

Discrete variations: differences that are distinct, ones that are "either/or"

One good example of discrete variation is when a change in a gene allows the organism to do something different, such as curl one's tongue. This simple isolated phenotype has little consequence to a human, but if it were to occur in an animal that requires something like antenna curling, it may be of great importance.

Some characteristics are passed on from one generation to the next. For example, son acquires blue eye colour from his father or a daughter acquires brown eye colour from her mother. Eye colour is transmitted from the parents to the offspring. Traits passed on from generation to generation are called heritable characteristics. Perhaps the son decides to dye his hair or the daughter decides to paint her nails. Such characteristics are acquired and are called non-heritable characteristics.

Phenotype: Specific visible traits

Each gene is responsible for one phenotype, like eye colour.

Heritable traits: Characteristics that are traits passed on from generation to generation

Non-heritable traits: characteristics that are acquired

Lesson 6 NATURE VS. NURTURE

Acquired, or non-heritable, characteristics are constantly changing. For example, the average height of men and women has increased over the past centuries. This is a result of changes in genetic makeup and nutrition. A mother who eats a nutritious diet during pregnancy is more likely to deliver a healthy baby. A mother who is malnourished during pregnancy may have a smaller than normal baby.

NOTES

Nature—through inheritance of specific genes—affects the growth of all organisms. The extent of the growth depends on the nurturing the organism receives. There are many cases where the lack of a growth factor, such as light for plants, fails to compensate for excellent genes and nutrition. The environment often acts as a stimulus to the genes of a cell or organism. Proper moisture and temperature in the correct quantities will start seed growth in the spring by activating the genes.

Environment also has an effect on the characteristics acquired by individual species. Plants produce viable and healthy gene pools if they are exposed to an environment of adequate water, nutrients, and sunlight.

Studies of sets of identical twins raised in different areas provide evidence of the relationship between nature (genetic traits) and nurture (environmental influence). In one example, Scandinavian children appear to be more susceptible to multiple sclerosis than other children. If one of the twins is separated from the other before the age of 15, and moved to a warmer climate, the likelihood of getting multiple sclerosis is decreased. Perhaps climate is a contributing factor to the disease.

MUTATIONS

Environmental factors contribute to a change in the genetic material or DNA of an organism. Such changes are called mutations. For example, an increase in ultraviolet light due to ozone depletion may cause a mutation to occur in the gene that protects against skin cancer. Without this gene, the individual is more susceptible to getting skin cancer. Other causes of mutations include exposure to X-rays cosmic rays and mutagen chemicals, such as benzene.

Mutations: natural or accidental genetic changes

Sometimes genetic mutations are difficult to explain. A human baby born with an extra chromosome develops Down syndrome. As this baby grows, it develops an abnormal appearance and has a shortened life span. Presently, there is no scientific evidence to explain why the baby acquires 24 pairs of chromosomes instead of 23 pairs.

Mutagens: factors that cause mutations

Lesson 7 CELL REPLACEMENT AND VARIATIONS

NOTES

Mitosis: cell division in the nucleus of a dividing cell that forms two new nuclei with the same number of chromosomes as the parent cell

Meiosis: cell division in gamete-producing cells where the number of chromosomes is reduced to one-half

CELL REPLACEMENT

Normal cell replacement in an organism requires asexual reproduction that is started by a signal. In plants, the signal may be sunlight or the presence of water. This signal activates the genetic material to produce molecules required for building more cells. The cells will replicate their DNA and go through mitosis, or cell division. These cells will continue to split and specialize as long as the signals are given and enough building materials for new cells are available.

When an organism reaches maturity, cell division for growth stops. After maturity, the only cells produced are those needed to replace old or dying cells.

In our body, red blood cells live for approximately three weeks before they are replaced by new red blood cells that have been produced in our bone marrow. This process continues all through life until the cells start to die off faster than new cells are produced. Our cells will continue to divide when needed until age signals stop the process naturally. It is believed that with old age, cells will no longer produce replacement cells fast enough. Keeping our bodies healthy prolongs our ability to make new cells and building blocks.

Disease, harmful chemicals, malnutrition, smoking, and stress all have a negative effect on cell health. When these conditions are present, unhealthy cells produce too many of a type of chemicals called oxidizers. These tiny molecules destroy normal cell processes and cause cell death. If we eat and exercise properly, we can stop and reverse the effects of the oxidizers and remain healthier longer.

VARIATIONS

Gametes or sex cells are copied by a process called meiosis. When the copies are made of the DNA during meiosis, only one-half of the double helix is passed on in the sex cell. When the two sex cells join during fertilization, the male DNA strand joins with the female mirror image strand forming a new double helix. This new zygote has DNA from both parents. The cells then continue to divide asexually to produce a new organism.

Variation occurs during fertilization because there are many (in humans, 2^{23}) possible combinations of chromosomes. This variation is good for all species as it provides opportunity for individuals to develop within the species. Sexual reproduction increases the variation and creation of individuals.

Interspecies fertilization will not result in a new organism because the genetic material from the parents is too different. Wolves may mate with coyotes but a new species will not arise as the DNA is too different to match up.

TRAITS

Genes are the basis of hereditary traits. Certain genes are dominant. They suppress or "mask out" other genes. In humans the brown-eyed trait appears more often than the blue-eyed trait because the gene for brown eyes is dominant over the gene for blue eyes. The blue-eyed gene is said to be recessive.

Dominant trait: a genetic trait that is expressed regardless of the nature of the other half of the allele

It was the work of Gregory Mendel, an Austrian monk, that is the basis of modern genetics. Mendel worked with varieties of peas and noticed that cross-pollinating tall peas could produce short peas. He concluded that there must be a hidden or recessive trait present in the tall pea's genetic makeup.

Recessive trait: a genetic trait that will only find expression if it represents BOTH halves of an allele pair

Example

How does Mendelian genetics work?

Solution

Genes appear in paired combinations called alleles. A black cat may have an allele pair represented by BB or Bb. The upper case "B" represents black fur and dominance. The lower case "b" represents white fur and recessiveness. The BB combination is called homozygous (purebred) while the Bb combination is referred to as heterozygous (hybrid). In an individual with a Bb allele pair, the dominant B determines that the cat will be black and the b indicates a non-expressed, or hidden, white fur gene that could appear in future generations.

Alleles: paired combinations of genes

This is the way it works.

A black male purebred cat is crossed with a black female purebred cat.

x	B	B
B	BB	BB
B	BB	BB

Mathematically, all combinations produce a BB offspring—a black purebred cat.

A purebred male cat is crossed with a hybrid female cat.

x	B	B
B	BB	BB
b	Bb	Bb

The possible combinations are BB, Bb, BB, Bb—all the offspring cats will have black fur, but two of them will carry the recessive gene for white fur.

NOTES

A hybrid male cat is crossed with a hybrid female cat.

x	B	b
B	BB	Bb
b	Bb	bb

Mathematically, the combinations possible are BB, Bb, Bb and bb.

Of the offspring, 75 % will have black fur (BB, Bb, Bb) and 25 % will have white fur (bb).

Therefore it is possible for two black cats to have a litter with a white-furred cat if the two black cats both have Bb alleles.

INCOMPLETE DOMINANCE AND CO-DOMINANCE

Occasionally, two dominant genes for a trait will combine in an organism. Both code for the same trait but neither becomes totally dominant. A cat carrying a B (dominant black gene) and an R (dominant red gene) would end up with reddish-black fur. This is called incomplete dominance. In other words, the traits are blended together in the new individual.

Co-dominance is another type of inheritance pattern where neither of the genes truly gain the upper hand. If the above example was used again with co-dominance, then a cat with B (dominant black) and R (dominant red) would be black and red in colour.

Example
Black with red spotting or red with black spotting.

Solution

	B	B
R	BR	BR
R	BR	BR

Due to the combinations of dominant traits, the dominant alleles may be expressed in different ways.

BR = a rust coloured cat rather than Black or Red (incomplete dominance)

BR = a black cat with red stripes or red with black strips (co-dominance)

Lesson 8 BENEFITS OF VARIATION

NOTES

The gene pool remains healthy when individuals from neighbouring species interbreed. The more a species inbreeds, the less likely it will remain healthy. Inbreeding of pure-bred Labrador retriever dogs has increased a condition known as hip displasia. Inbreeding in St. Bernards has caused the development of a brain disorder resulting in a more aggressive animal.

Through genetic variation, it is possible to alter a whole species if the offspring produced is better adapted to the environment or to a change in the environment. If these traits continue on for generations, a pure breed is developed. Pure breeds were created to help man live and work.
For example, physically, small aggressive dogs were genetically engineered hundreds of years ago to hunt rats in underground coal mines.

Human impact can play a role in altering the genetic makeup of a species. The insecticide DDT was developed in an attempt to eradicate the mosquito population that caused malaria. When the insecticide DDT was sprayed on a mosquito population, most of the mosquitoes died. Those that survived had a stronger immunity to the pesticide because of their genes. The genes produced molecules that helped the insect block the impact of DDT in each cell. Those mosquitoes mated with others and produced offspring that were more resistant to DDT. The result was that either stronger doses of DDT or a different chemical must be used to kill the malaria-carrying insects.

NATURAL SELECTION

Natural selection is the process in which the conditions in the environment are responsible for "selecting" which individuals will survive and reproduce. When doing his research in the Galapagos Islands, Charles Darwin detailed some important research in his book *The Origin of Species*. Amongst his findings was the observation that certain species of finches living on different islands had developed specific adaptations for the various food sources. Some finches have small, pointy beaks for catching flying insects, some have longer beaks for digging insects out of wood and brush, while still others have short, sturdy beaks for cracking open seeds. He concluded that they have a common genetic ancestry, but natural selection had determined that some physical characteristics were more successful than others in each, and therefore the population adapted accordingly.

Natural Selection: the process through which conditions in the environment are responsible for "selecting" which individuals will survive and reproduce

ARTIFICIAL SELECTION

Artificial selection is the process of selecting and breeding individuals to produce a species with desirable traits. Selective breeding of plants and animals produces hardier species. They are more resistant to the extremes. For example, in western Canada wheat has been genetically modified to resist insect infestation and mould. These changes are designed to increase food production.

Artificial Selection: the process of deliberately selecting and breeding individuals to produce a species with desired traits

NOTES

THE HUMAN GENOME PROJECT

In the human genome project, all human genes were coded. Geneticists study these sequences and are developing ideas on how to find and repair damaged genes in human embryos. Governments are now facing huge challenges as they must make the laws governing the use of genetic engineering.

GENETIC ENGINEERING

With specially designed instruments, scientists have the means to isolate and insert sections of genetic material into the DNA of other cells. As the new genes are placed into the cell, new traits are produced in the organism.

Since pigs have tough skin, the gene for this was isolated and put into a tomato cell. The result was a tomato that does not split open as easily and therefore, has a longer shelf life.

Genetic engineering, as valuable as it seems, may have a hidden problem. No one can accurately predict the result of long-term genetic engineering. If a dominant wheat species is developed to produce high yields but is totally dependant on fertilizers and pesticides for protection, what will happen if the pesticides are banned?

Lesson 9 BIODIVERSITY

NOTES

Biodiversity is important in many ways. Imagine a world with only one kind of tree, one kind of flower, one kind of animal and every person looks the same. Many organisms are linked in the ecosystems. Eliminate an organism and many others will suffer. In the field of medicine many substances are derived from the wide diversity of the ecosystem. A lack of biological diversity would have a serious negative effect on our medical field.

One way that humans affect biodiversity is by increasing the amount of heat in the biosphere. Global warming is having a dramatic effect on arctic animals by limiting their habitat. A decrease in the amount of ice present means that arctic animals will have to adapt or face extinction.

Another example of human influence on biodiversity is the cutting down of the Amazon rain forests, which has affected thousands of species of animals. Many species are so specialized in this biome that those which failed to adapt quickly enough are now extinct.

In several areas, populations of animals and plants have reached explosive numbers. When starlings were introduced to North America, they found a new environment totally suited to their survival. These aggressive birds multiplied quickly and chased away local birds. The takeover of a local species territory by another species is referred to as *bioinvasion.*

Seven–spot ladybird beetles (ladybugs) are not native to Alberta; they were introduced from the USA. They are now the dominant species of ladybug in the province of Alberta.

Even though there are over 20,000 species of invertebrates in Alberta, the loss of a few has far-reaching effects on the biosphere. Each species is unique and fills a special role in each ecosystem. The loss of one food source or consumer requires all of the related organisms to adjust. Most will be able to change, but some may not and must move or face death.

EXTINCTION AND EXTIRPATION

Naturally occurring extirpation and extinction of species can be caused by catastrophes such as volcanic eruptions, diseases, and overpopulation. When a population increases too quickly, it puts a huge demand on the food supply and territory. If a disease begins to develop, it can rapidly spread to neighbouring populations; for example, the Bovine Spongiform Encephalopathy (BSE) infection has threatened the cattle industry in North America.

Extinction: disappearance of species of living organisms

Endangered: facing risk of extinction

Extinctions also result from overspecialization of a species. Some species fail to adapt to change and are wiped out quickly. British Columbia spotted owls settle and breed only in particular stands of B.C. fir trees. As the trees are logged off, the owls' habitat and food supply shrinks. Thus, the size of the spotted owl population is decreasing.

NOTES

Extirpation: the localized extinction of a species

Extinction of some animals has been caused by over-hunting or slaughter by humans. Carrier pigeons and Tasmanian Tigers are two examples of species that are becoming extinct due to human activities.

Extirpations, or local extinctions, occur often. The grizzly bear and cougar populations of North America have moved to specific areas as a result of the encroachment of humans.

Seed banks have been started by individuals, companies, and governments to preserve original gene pools. With so much genetic engineering happening in the food production area, there is a fear that the original hardiness of species may be lost over generations of specialized breeding.

The main biodiversity problem in the Alberta area is loss of habitat to farming and ranching. Grasslands are being cultivated, which result in the loss of habitat for animals such as the Ord's kangaroo rat. Wetlands are being backfilled and drained for farmland. Waterfowl and shore birds lose their habitat because of the demand for farmland.

Fire management also has an effect on biodiversity. Fires are normally put out in forests as they threaten both communities and the logging industry. Naturally occurring fires occur every 50 to 75 years in untamed forests. These fires produce new grasslands that eventually grow into primary forests. Forest fires naturally allow the area to "rotate crops" from grasslands to primary forests. By suppressing forest fires, we keep older forests longer and prevent natural changes. In the long run, this limits the viability of an area and its gene pool.

Scientists of the world have recognized the effect we are having on the environment and are influencing governments around the world to do something about it. If we don't plan now, biodiversity will decrease. Attempts are made every few years to get more countries to limit the amount of CO_2 gas produced. CO_2 causes global warming and changes our environment. Governments must work together soon if we are to limit environmental change.

REVIEW SUMMARY

NOTES

- Biological diversity refers to the differences that exist among living things in their ecosystems. Species of living things show diversity in cellular makeup, method of reproduction, and adaptations.
- Linnaeus devised the *binomial nomenclature* system of classifying living things by placing species into groups according to similarities in structure. The system includes seven levels of classification: Kingdom—Phylum—Class—Order—Family—Genus—Species
- Each species is identified by its genus and species name. For example, the dog has the scientific *Canis familiaris,* while the wolf is *Canis lupus*.
- An ecosystem is made up of *biotic* (living) and *abiotic* (nonliving) factors. Organisms live in communities within an ecosystem and interact with one another and the air, water, and soil surrounding them. Such relationships may be beneficial or harmful. Bees and flowers are involved in a mutualistic relationship where by both the bee and the flower benefit. Sometimes only one organism in a relationship benefits and the other organism is not harmed. This relationship is referred to as commensalism. In other relationships, one organism is harmed and one benefits: the tapeworm is a parasite that harms its host. *Mutualism*, *commensalism,* and *parasitism* are types of symbiotic relationships.
- *Producers* use the sun's energy in the process of photosynthesis to sustain life. They become the basis of food for *consumers*. Eventually both the producers and consumers die and are decomposed back into nutrients by *decomposers.*
- The survival of a species is ensured by the ability of the members to reproduce offspring of their own kind. Simple organisms reproduce asexual. Bacteria simply split in half. Hydra develop buds that grow into new hydra. Many plants grow by vegetative propagation from roots and stems. Asexual reproduction requires only one parent and all offspring are identical to the parent.
- Other living organisms reproduce sexually. The sperm gamete produced by the male unites with the egg cell gamete produced by the female in the process of *fertilization.* A zygote is formed and grows during the process of *mitosis* into new individuals. Sexual reproduction involves two parents and results in offspring that are genetically different from the parents.
- The basic of organism diversity lies in the DNA. Sex cells contain millions of genes in their chromosomes. The genes contain strands of DNA that attach to one another in various combinations, thereby producing hereditary traits. Such variations can be discrete or continuous. Discrete variations are distinct; for example eye colour is either blue or brown. Continuous variations show a range; for example, the height of humans ranges from 1.2 m to 2.1 m.

NOTES

- Some individual traits appear more frequently in populations than others. For example, in humans brown eye colour is a dominant trait and blue eye colour is a recessive trait. Through artificial selection, plant and animal breeders are able to take desirable traits from one species to improve another species. For example, genes from jellyfish have been added to the genetic makeup of the tomato plant to produce a plant that can resist a certain fungus disease, thereby, producing a better yield. This is a form of genetic engineering.
- Nature, too, has a way of changing species. Generally, the strongest and the fittest member of a species survive and are able to pass on their traits to the offspring. Over time, organisms may modify their structures to adapt to changes in the environment. Changes that occur in nature is referred to as natural selection.
- The survival of living organisms is dependent on the state of its ecosystem. When the natural ecosystem becomes affected by human factors of urbanization, agriculture, and pollution, the organisms within are placed under stress. Their numbers decline. Many plants and animals have become extinct. Others are endangered. Some are vulnerable and threatened. Others have been extirpated and no longer exist in a certain area. As species are reduced in number and disappear, the biodiversity decreases.

