# Genetics and Evolution Junior Science

GZ Science Resources

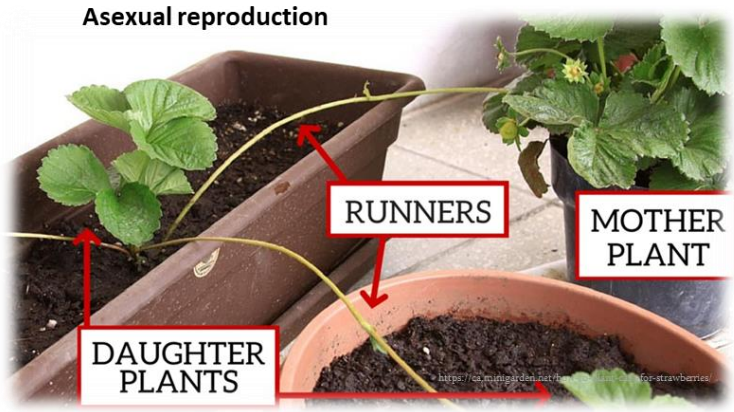
Reproduction

All organisms need to reproduce; to create offspring that carry their genetic information, as part of the life processes that defines them as living.

Some organisms reproduce sexually, and together with a mate of the same species produce offspring that have a combination of both parents genetic material. The offspring from sexual reproduction will show variation in their traits.

Other organisms are able to reproduce asexually, with no mate required and all of their offspring will have identical genetic material to their parents with no variation seen.

Some species can reproduce using both methods.





Sexual Reproduction

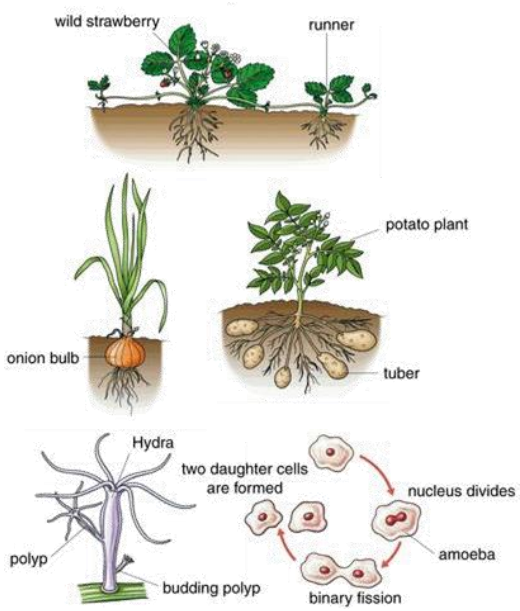
Organisms of a species that reproduce sexually are not identical therefore, they exhibit variation. Variation or differences in traits are caused by genetic factors (what genes you are born with) and environmental factors but only genetic variation can be passed onto the next generation by sexual reproduction.

Genetic material (DNA) carried in the egg & sperm (gametes) provide the inherited instructions for making offspring. The inheritance of this mixture of genetic material leads to variation in the offspring.

| Advantages | Disadvantages |
|---|---|
| Variation in offspring means that some will be better suited to changing conditions, and so will survive better. | Need two parents that are able to reproduce |
| Mates can be selected to pass on desirable traits to the offspring. | If conditions are stable, it could introduce variation, which may be counterproductive. |
| Humans can selectively breed traits in other species for their advantage. For example different rose types. | Involves energy in producing reproductive structures or phenotypes to attract mates |
| | If pollination is unsuccessful, then no seeds are produced – i.e. a waste of energy and time, as no genetic material will be passed on to future generations |
| | Time consuming compared to asexual reproduction (takes time to produce reproductive structures, attract pollinators etc.) |

Asexual reproduction produces identical offspring

Some organisms, more commonly bacteria and plants but also some animals, reproduce asexually. This type of reproduction does not involve the manufacture of sex cells (gametes) from two parents. Every new organism produced by asexual reproduction is genetically identical to the parent – a clone. The advantages are that there is no need to search for a mate. Asexual reproduction can therefore lead to a rapid population build-up. The disadvantage of asexual reproduction arises from the fact that only identical individuals (clones) are produced – there is no variation and an asexual population cannot adapt to a changing environment and is at risk of extinction.




Summary of Advantages and disadvantages of Asexual Reproduction

| Advantages | Disadvantages |
|---|---|
| Fast – do not have to spend time producing flowers or attracting mates | |
| No need to spend energy producing flowers or finding a mate | |
| No need to rely on pollinators/males | |
| Guaranteed success of producing offspring | |
| Can make numerous copies of plants through cuttings | Population overruns a food source quickly |
| All desirable traits are passed down | If parents have an undesirable trait then all offspring inherit it |
| All offspring are genetically identical and best suited to an environment if conditions remain stable | All offspring are identical so this creates vulnerability if the environment changes or pests/ diseases occur |

Asexual Reproduction vs Sexual reproduction

Asexual reproduction occurs when only a single individual passes on all its genes to the offspring. The offspring are genetically identical to the parent. Sexual reproduction occurs when two parents create offspring and pass only half their genes to the offspring. The offspring half a different/unique set of genes. Asexual reproduction is fast compared to sexual reproduction.

Advantages for asexual reproduction are that only one parent is needed and identical offspring are adapted to same environment as parent. An advantage of Sexual Reproduction is that variation can increase survival chances of a species if the environment changes.

Summary of Asexual Reproduction vs Sexual reproduction

| Asexual reproduction | Sexual reproduction |
|---|---|
| Single individual is the only parent | Two parents create offspring |
| The single parent passes on all its genes to the offspring | Each parent passes on only half of its genes to the offspring |
| The offspring are genetically identical | Each individual offspring has a unique combination of genes |
| Variation is only created by rare mutation | Variation is created in each individual |

Variation

As a species, Humans all have the same set of genes. However, each individual, except identical twins, has a different combination of alleles inherited from both parents and this creates variation. Variation of traits causes each individual to look different from another and in many cases behave differently from each other as well.

An individual within an ethnic group tends to have more similar traits in common to others within the same group.

Continuous and discontinuous variation

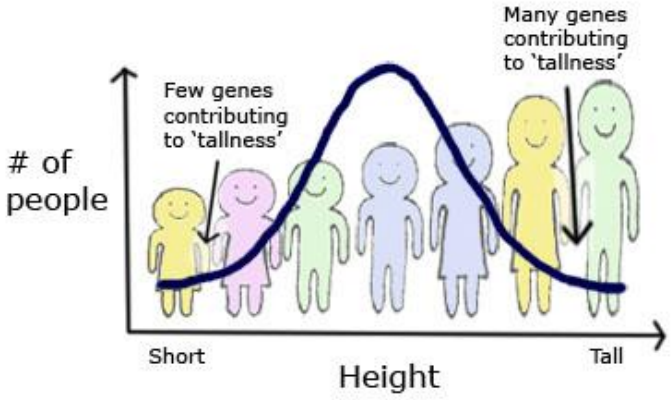
Variation of a trait in an individual can be continuous such as tallness where height can be either very tall or very short as well as any height in between. Offspring will most often show height half way between the two parents as alleles inherited from both parents have a combined effect.

Variation of a trait can also be discontinuous such as the ability to roll your tongue. You can either roll it or you cannot but you can't "half roll" it. Offspring will inherit their trait from one parent or the other but not both.

Continuous Variation

A group of genes creates traits that cause continuous variation. When random groups of people are measured for a particular trait the extremes tend to be expressed the least and the mid-point tends to be expressed the most. This creates a bell shaped curve when graphed.

In the example below, many more people tend to be of average height compared to being very short or very tall.



Discontinuous Variation

Discontinuous Variation produces an "either/or" trait (physical characteristic).

Every person inherits one allele (a version of a gene producing the trait) from each parent. This gives the person two alleles for each trait (their genotype)

If a person has one or two dominant alleles then they will also have the dominant phenotype (trait). A person can only have the recessive phenotype (trait) if they have two recessive alleles.

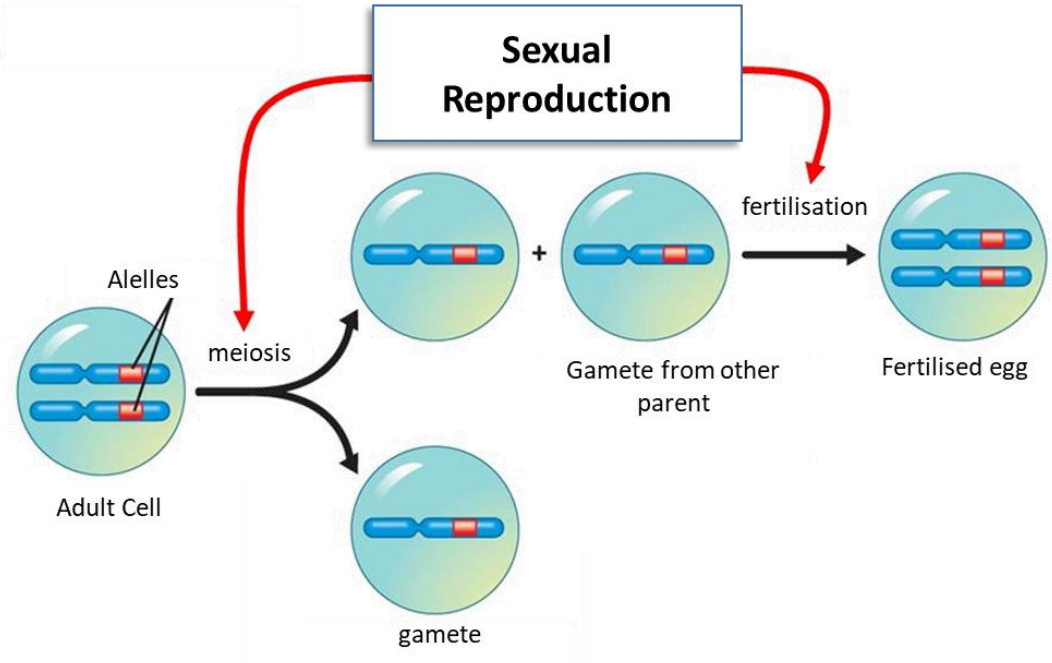
**Examples of inherited Traits for Discontinuous Variation**

| Dominant phenotype (trait) | Recessive phenotype (trait) |
|---|---|
| Cleft Chin | No Cleft |
| Widow's Peak | No Widow's Peak |
| Dimples | No Dimples |
| Brown/Black Hair | Blonde Hair |
| Freckles | No Freckles |
| Brown Eyes | Gray/Blue Eyes |
| Free Earlobe | Attached Earlobe |

*Variation is due to genes being passed on from parents to offspring during sexual reproduction*

Extension

*Gametes are produced by the parents – sperm in the males and eggs in the female. Genetic material (DNA) carried in the egg & sperm (gametes) provide the inherited instructions for making offspring. The inheritance of this mixture of genetic material leads to variation in the offspring.*

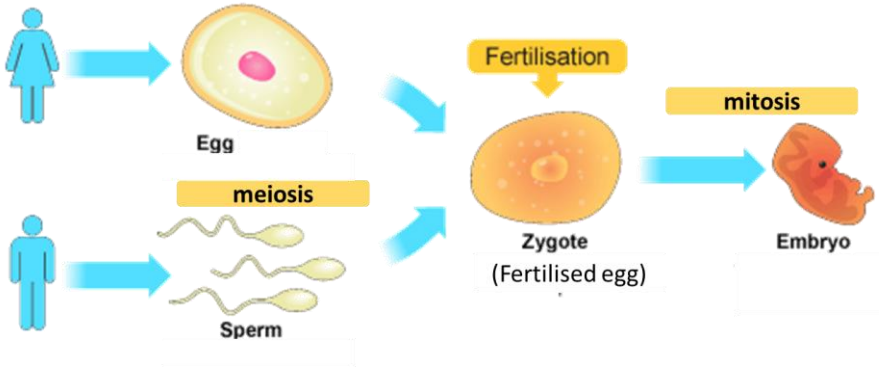


*Sexual reproduction involves a mobile male gamete (sperm) fusing with a stationary female gamete (egg)*

Extension

*Both males and females only donate half of their chromosomes (one from each homologous pair) to form gametes through meiosis. (Gametes = egg or sperm). When the chromosomes from the egg and sperm rejoin to form a zygote (fertilised egg) with the total number of chromosomes fertilisation has occurred.*

*Once fertilisation has produced a zygote then mitosis occurs throughout the remainder of the babies/person's lifetime for growth and cell repair.*



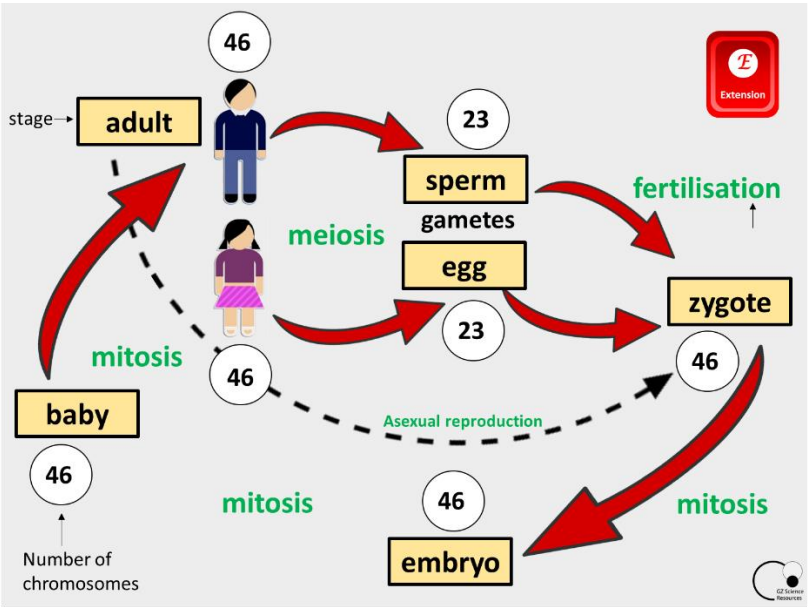

*Gametes contain half the normal number of chromosomes and fertilisation restores the normal number*

Extension

*Genes are passed on from parents when the DNA in each parents gametes combine to form an embryo during fertilisation, which then develops into a baby.*

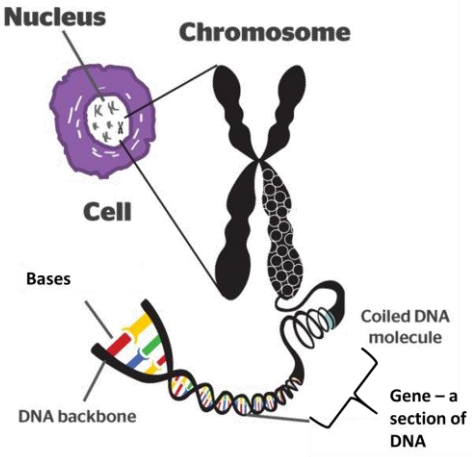
*Variation occurs when each parent's gametes are created – sperm in males and eggs in females – through a process of Meiosis. Meiosis randomly sort's one chromosome from each pair of chromosomes (there are 23 pairs or 46 individual chromosomes) contained in a cell and produces a gamete cell, which will contain 23 single chromosomes.*

*When the gametes combine during fertilisation, the 23 single chromosomes from each gamete re-join to form 46 or 23 pairs once more in the embryo cell.*



Genes are the sources of inherited information

All living things are made of cells. The nucleus of a cell contains chromosomes, which carry instructions for the physical characteristics of an organism. The chromosomes are made of long strands of DNA. The instructions are called the genetic code. A segment of the DNA that codes for a specific trait is called a gene.




DNA forms a Double Helix shape

DNA is arranged in a double helix shape. The up rights of the "ladder" consist of alternating sugar and phosphate molecules bonded together. Making up the "rungs" are two base molecules bonded to each other.

A nucleotide is one unit of DNA. DNA (deoxyribonucleic acid) is made from smaller repeating units called nucleotides, which consist of a sugar, a triphosphate and a base.

There are 4 bases

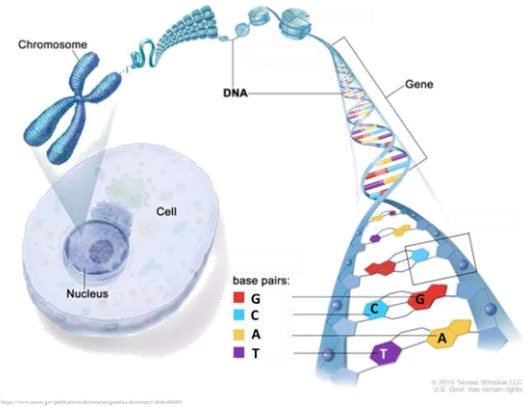
A, T, C, G

Complementary base-pairing rule

G bonds with C

A bonds with T

The order of these bases is the code for a characteristic.



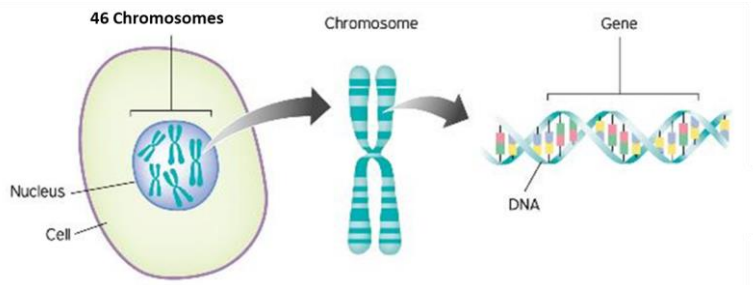

Extension

*The sequence of bases coding for a specific proteins, leading onto a trait, is called a gene.*

DNA is organised into chromosomes and genes

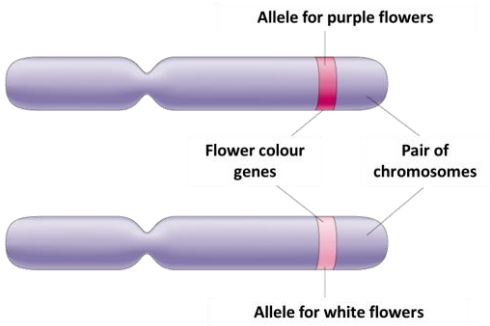
The human cell has 46 chromosomes arranged into 23 pairs of chromosomes. Each chromosome in a pair has the same genes, (called homologous pairs) although there may be variation between the genes of each pair, as one comes from the father and one comes from the mother.

Each gene is represented by two alleles, which are different varieties. The alleles can be the same or different but the body only uses one.




Alleles are different forms of the same gene

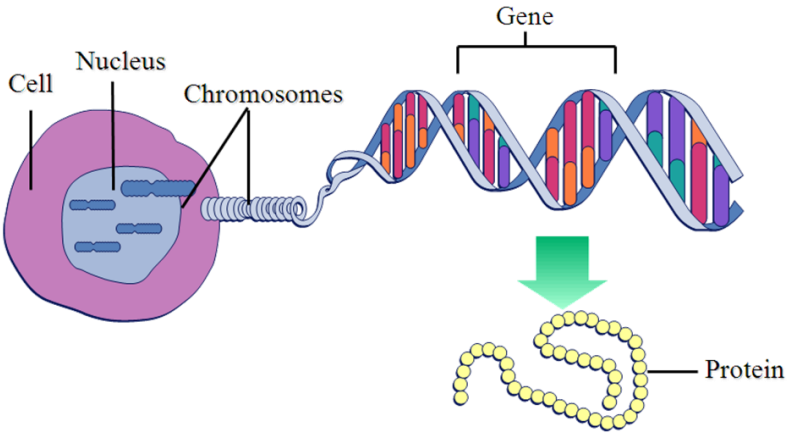
Chromosomes occur in pairs. These pairs of chromosomes have the same genes in them at the same place. The versions of genes are called alleles and they may be different from each other.




Summary: Cell, nucleus, chromosome, DNA, gene and protein

Chromosomes are found in the nucleus of each cell and are made up of DNA. DNA is a large molecule that is coiled into a double helix (twisted ladder structure). Along this molecule are bases. These bases pair up; A always pairs with T, and G with C.

A sequence of bases, which codes for a particular trait/characteristic (e.g., eye colour) is called a gene. The different versions of each gene are called alleles, and these show the different variations of each characteristic, e.g. brown / blue eyes. Because chromosomes come in pairs for each trait, there will be two possible alleles. These different versions of genes (alleles) occur because the DNA base sequence is different.

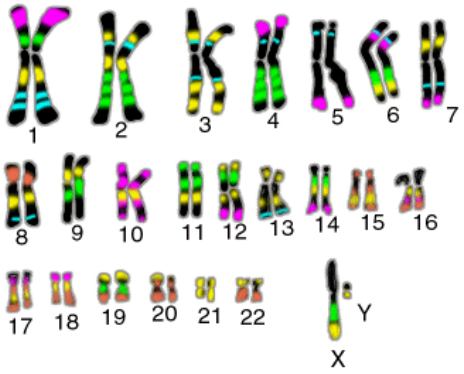



Extension

Genes code for **proteins** - the **genetic code/ base order** determines which particular **protein** is made and therefore which **characteristic** is coded for.

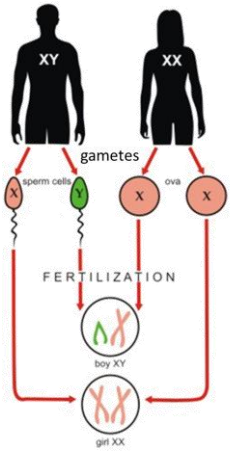
Chromosomes come in pairs

Chromosomes come in pairs. One pair is the sex chromosomes – XX in females and XY in males. A complete set of chromosomes of an organism placed into pairs of matching chromosomes is called a karyotype. The human karyotype consists of 23 pairs of chromosomes.




Sex determination

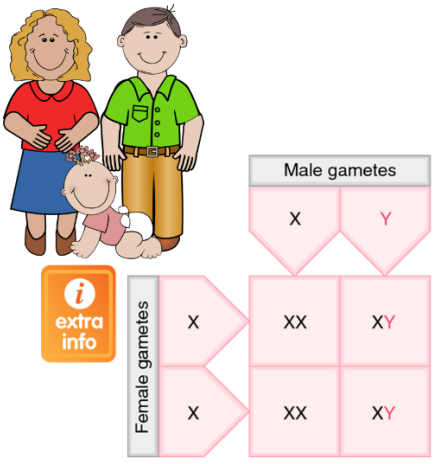
A pair of chromosomes are called the sex chromosomes. The female always has a homologous pair of two x chromosomes. The female can only donate a x chromosome. The male has a x and y chromosome. He can donate either an x or y chromosome to form a gamete. The male determines the sex of any children.




A Punnett square can be used to demonstrate that in any fertilisation there will be a 50% chance of either a boy or a girl.

If there are a small number of offspring then there is less chance that the actual ratio of male to female offspring will be the same as the predicted ratio.

Each new fertilisation is independent of any previous fertilisation episodes.

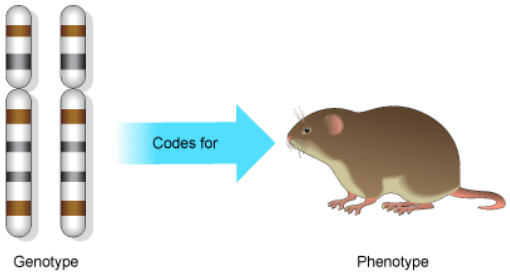


Phenotype and Genotype

The combination of alleles for each trait is called the genotype; this can be any combination of two of the available alleles.

The phenotype is the physical trait that is expressed because of the alleles.

The genotype determines the phenotype (the physical appearance) of the organism.

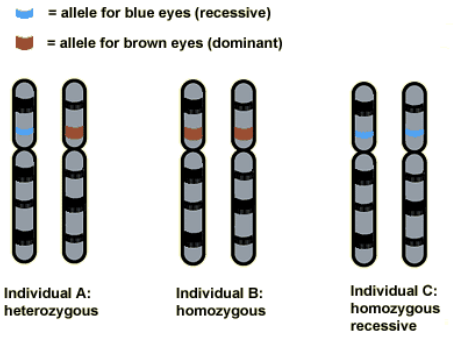



Dominant and recessive alleles

Alleles that are present in the pair are expressed. Dominant alleles (B) if present will be expressed over recessive alleles (b).

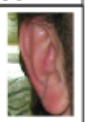
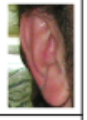
Only if there are no dominant alleles present in the pair will the recessive allele be expressed. Expressed means the protein is produced which determines the characteristic.

When there are two of the same allele, this is called homozygous and the cell could randomly use either allele. When there is two different alleles this is called heterozygous and the cell always uses the dominant allele. Pure Breeding is another term for homozygous.



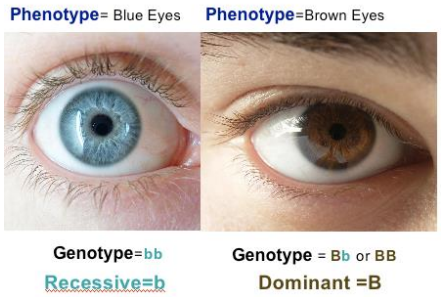

Recessive alleles need 2 copies present to be expressed in the phenotype. Dominant allele needs only 1 copy present to be expressed and is always expressed when present

Many letters can be used to represent dominant or recessive, such as Bb, Ee, Ff as long as the upper and lower case letters look different. The genotype determines the phenotype.

| Genotype | Phenotype |
|---|---|
| **EE** Homozygous dominant | Detached Earlobes  |
| **Ee** Heterozygous | Detached Earlobes  |
| **ee** Homozygous recessive | Attached Earlobes  |

Phenotype, genotype and dominance

When the phenotype is recessive then the genotype can only be homozygous recessive. If the phenotype is dominant then the genotype can either be heterozygous or homozygous dominant, as long as one dominant allele is present in the genotype.



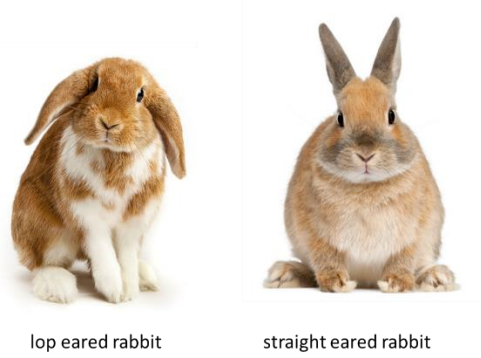

Lop eared rabbits – an example

Rabbit ears normally point straight up. Some rabbits have an allele for lop ears that cause the ears fold down. The allele that produces lop ears is recessive and was created by a mutation.
We can use the symbol R to show the dominant allele and r to show the recessive allele.

The genotype of the two rabbits if both are pure breeding are:

Lop eared rabbit genotype rr

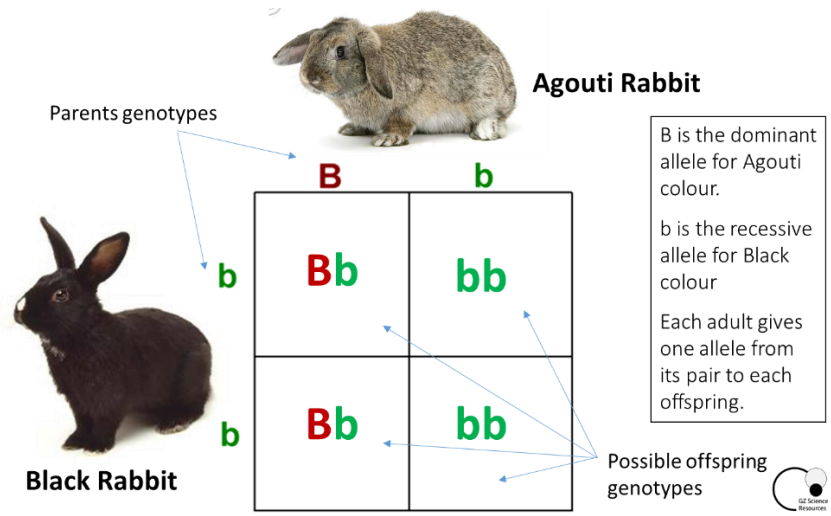
Normal eared rabbit genotype RR



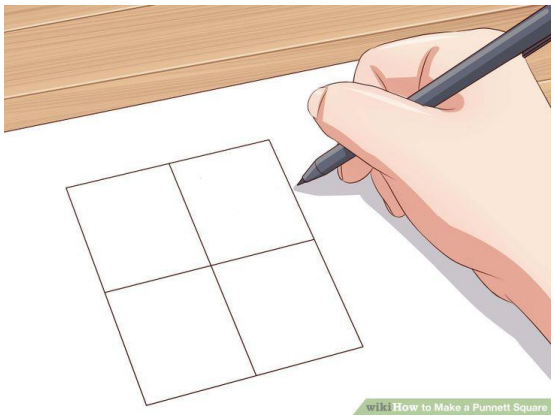
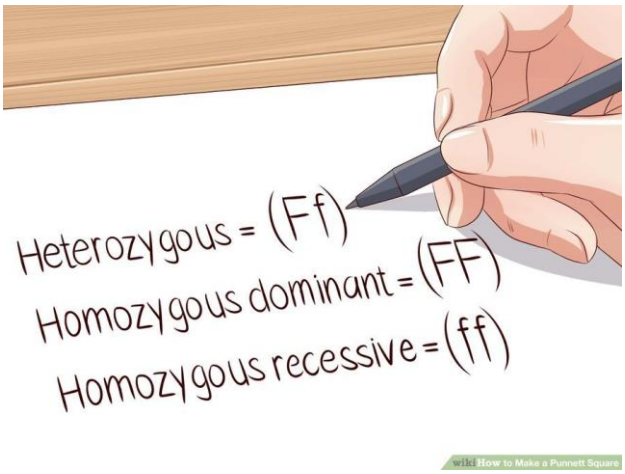
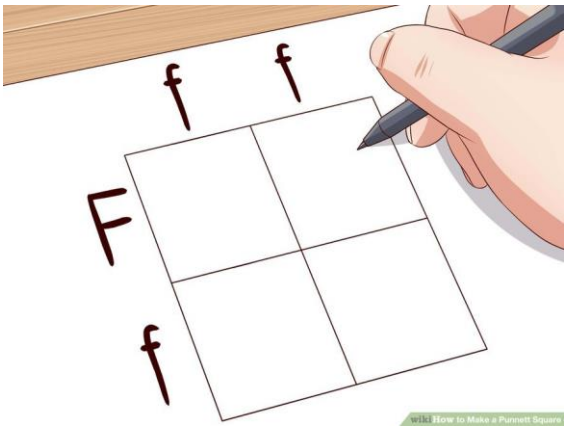
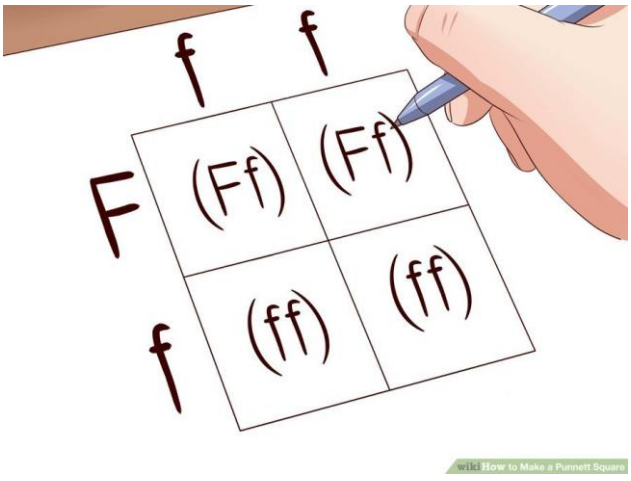
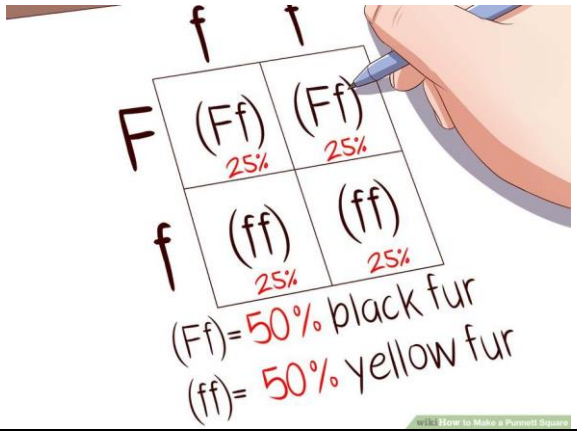
lop eared rabbit straight eared rabbit

Using Punnett squares to predict offspring

We use Punnett squares to predict the frequency of the genotypes of any offspring created when two organisms are mated, and therefore phenotypes.



How to use a Punnett squares to predict offspring

| | |
|---|---|
| 1. Draw a grid with 4 squares. Each square will represent 1 out of 4 offspring or 25% of offspring out of 100%<br>  <br> | 2. Write down the possible 2 phenotypes (physical traits) and label them with a capital letter for the dominant trait and lower case letter for the recessive trait.<br>  <br> |
| 3. Write down all 3 possible genotypes and their letter combinations.<br>  <br> | 4. Select the correct genotypes for each parent (they may be the same or different) and write them with one parent on the top and one parent to the left side.<br>  <br> |
| 5. Write each letter in the square below for one parent and squares to the right for the other parent. Each offspring will have a genotype of 2 letters.<br>  <br> | 6. Calculate the genotype ratio – the total percentage each genotype occurs (in this order FF: Ff : ff ) or total out of 4 squares.<br>Then calculate phenotype ratio – FF and Ff count as dominant and only ff counts as recessive (in this order dominant : recessive) can be % or out of 4<br>  <br> |

Using Punnett squares to predict offspring

The Punnett square is used to predict the probability of what the offspring's phenotype and genotype will be, which may or may not match up to the actual results due to the random nature of each fertilisation.

The phenotype and genotype ratios are only predictions.

Each time a new offspring is created through fertilisation it is a new event and the same probabilities apply regardless of the phenotype or genotype of previous offspring.

Calculating Phenotype and genotype ratios example

We can use the example of our straight eared and lop eared rabbit again when they breed, and all their offspring will have the genotype of Rr and phenotype of straight ears. If we cross two of their offspring (Rr) the genotype and phenotype ratios of their offspring (second generation) can be set out as below.

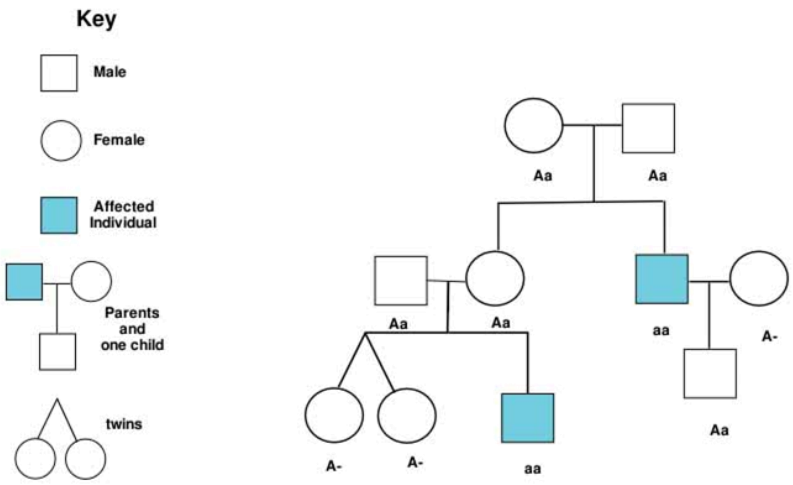
| | R | r |
|---|---|---|
| R | RR | Rr |
| r | Rr | rr |

| Genotype Ratios | | |
|---|---|---|
| RR | Rr | rr |
| 1 | 2 | 1 |
| **Phenotype Ratios** | | |
| Straight Ears | Lop ears | |
| **3** | **1** | |

*Using Pedigree charts to predict offspring*

Extension

*A pedigree chart is a diagram that shows inheritance patterns of a certain allele. A square represents a male and a circle represents a female. If a person's symbol is shaded in, this means that they have the phenotype. It if is half-shaded, then they are heterozygous but do not have the phenotype. If they are not shaded at all, they do not have the allele. Pedigree charts are good for showing the patterns of a recessive or dominant gene.*

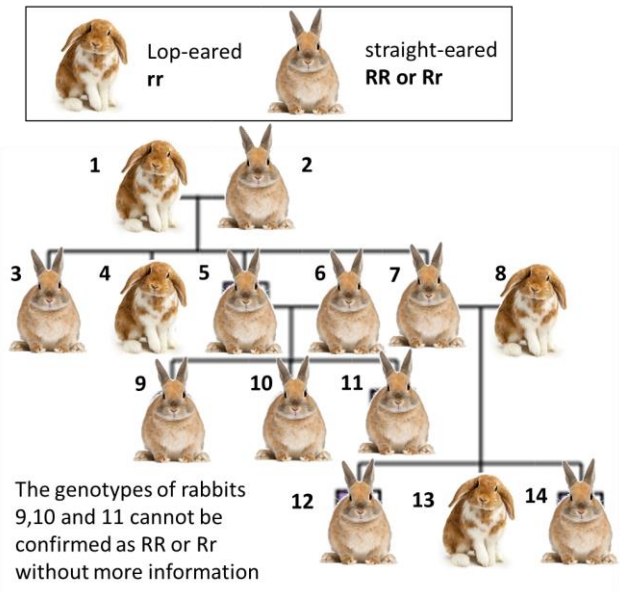


*Using Pedigree charts to predict genotype*

Extension

*When an individual has a recessive phenotype on a pedigree chart then the genotype must always be homozygous recessive (i.e. rr for the lop-eared rabbit 1)*

*To find out the genotype of a dominant phenotype you can look at either the parents of the offspring. (i.e. rabbit 7 is straight eared but had one parent who was a lop-eared rr so must have one r allele – genotype Rr. Also 13 is an rr (see above) so rabbit 7 must have at least one r allele to pass onto 13.*



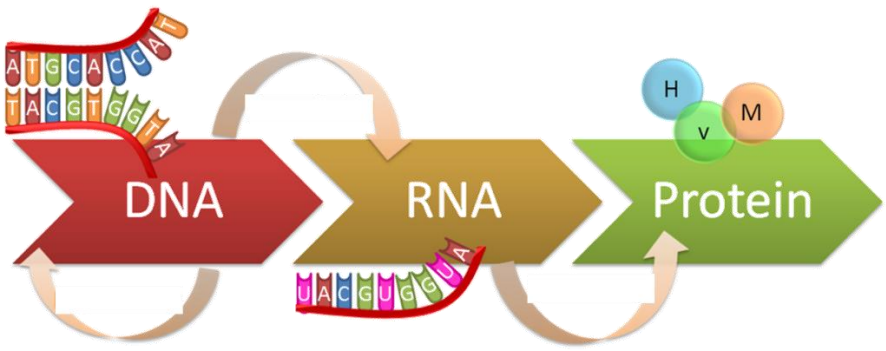

*How to make protein*

Extension

*The order that the bases are arranged in the DNA segment of a gene determine the type of protein that will be formed and therefore which characteristic will be expressed.*

*The bases are "read" in sets of three called codons. Codons are matched to molecules called amino acids, which are the building blocks of proteins.*

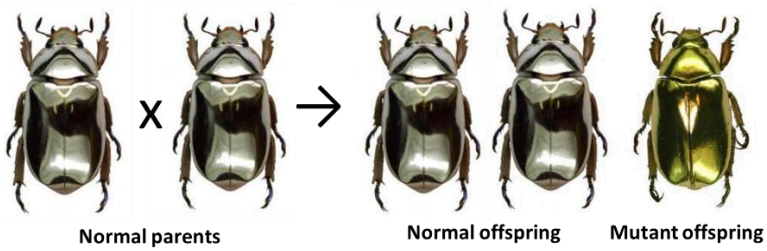
*A single stranded copy of DNA (called RNA) from a gene moves out of the nucleus into a part of the cell where protein is made and the codons (3 bases) code for different amino acids which link together to form a protein molecule.*



Mutation is the permanent change in the base sequence of DNA

Most mutations cause death because the gene in which the mutation occurs creates an incorrect protein. Very occasionally, mutations produce a new type of protein, which gives the organism an advantage over others in its species in adapting to its environment. The organism containing the mutation will have more chance of surviving than those individuals without it and it will pass the mutated gene on to the next generation more successfully.

Mutations increase variation in a population by adding new types of alleles.



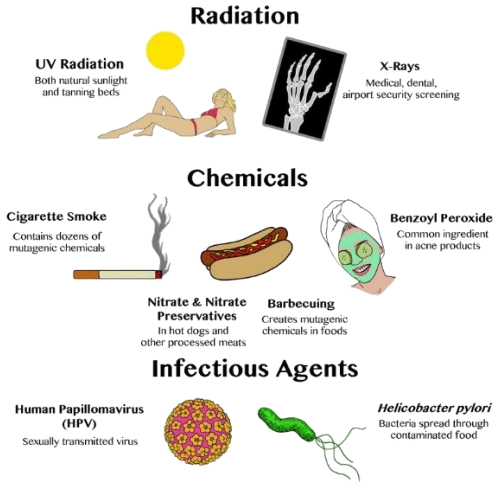

Mutations are caused by a random change in the sequence of bases in the DNA.

Mutations can either occur in individual cells of an organism such as cancer or during the process of Meiosis to form the gametes (egg or sperm cells) which causes every cell in the fertilised developing organism to contain the mutation.

Mutations can be cause by a single change in one base pair – either deleted, an extra added or a base changed, one segment of DNA or gene, or a whole chromosome added or deleted.

A mutagen is an agent that causes genetic mutation.

Inheritable Genetic disorders in humans are caused by one or more mutations in the genome (full set of genes), and is present from birth. Most genetic disorders are very rare. Mutations can be caused by random mistakes during DNA replication and meiosis or by mutagens like chemical or radiation exposure during gamete formation.



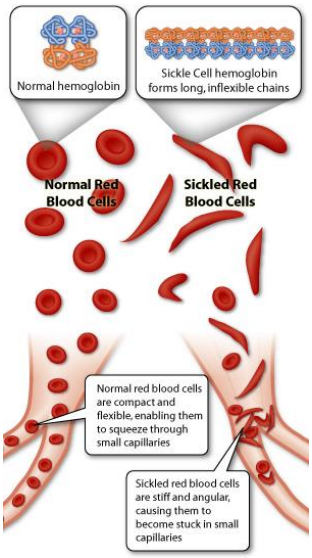

Humans can have specific genetic disorders caused by a mutation

Genetic disorders are passed down from the parents' genes. Some disorders occur through a mutation in an entire chromosome (or the addition of an extra chromosome) and cause a syndrome with many different parts of the body effected, such as Down syndrome. Other disorders are a mutation to only one part of a gene and cause a single change like sickle-cell anaemia does to the shape of red blood cells.

Humans can have specific genetic disorders caused by a mutation

Most disorders are recessive and require both parents to carry a copy of the mutation to show up in the offspring.

Some types of recessive gene disorders confer an advantage in certain conditions when only one copy of the gene is present, such as one copy of sickle-cell anaemia mutation gives resistance against malaria – a common disease in tropical countries.




Humans can also have mutations occurring in either their X or Y chromosome (sex chromosomes) and therefore only passed on to Male offspring - if on the Y, or to female offspring – if on the X and is recessive.

If the mutation is recessive and on the X chromosome a male parent will only be a carrier.

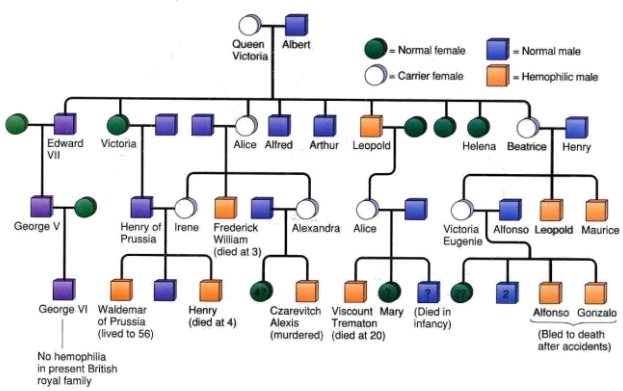
This are called sex-linked disorders. Haemophilia is an example and carried on the X chromosomes. Males without an extra X chromosome (a healthy chromosome to "block") show the mutation.

*Using Pedigree charts to predict genetic disorders in offspring*

extra info

*A pedigree chart can be used to predict the likelihood of offspring receiving a mutation from parents as well as look for where the mutation has come from.*

*A particularly famous pedigree of a mutation in family comes from the European royal family. The mutation is haemophilia (which prevents clotting of the blood) and can be traced from Queen Victoria.*



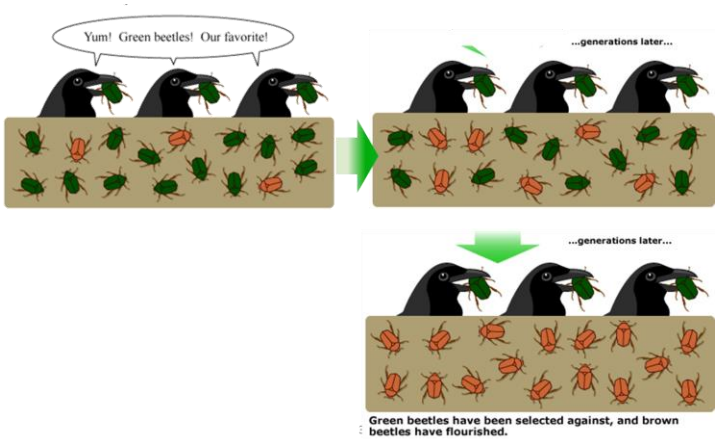
Organisms vary and that some variations give advantages over others in a given environment

Individuals of a species occupy a niche and they have adaptations to survive in their habitats. The adaptations may help them to best obtain food, seek mates, raise offspring, find shelter or escape predators.

Adaptations are physical characteristics (phenotypes) an organism can genetically pass onto their offspring. Because there is variation between individuals of a species, some individuals may have an advantage over others when one or more of their adaptations is better suited for survival in their habitat.

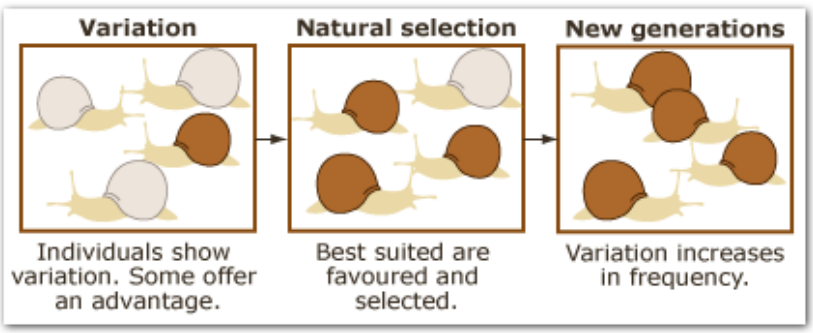
Variations caused by genes can be passed on to offspring and genes giving advantageous adaptations are more likely to be passed on than others are

When there is a higher chance of survival for an individual with an better adapted trait then there is also more chance that the organism is alive long enough to find a mate and produce offspring than other less advantaged individuals. A higher frequency of offspring with the inherited advantageous genes (genotype) will be born.




Natural Selection

Natural selection occurs when environmental factors may favour certain variations of physical characteristics (phenotypes) and selects for or against it, and its underlying genes (genotypes).



Conditions for Natural Selection to occur

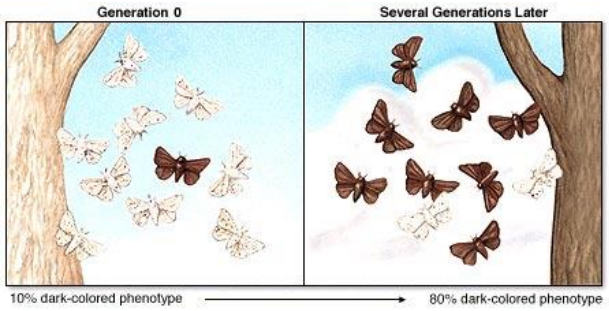
For Natural Selection to occur:

1. There must be variation in one or more physical characteristic in a population that gives an advantageous adaptation.

2. The individuals with the advantageous physical characteristic must be more successful in reproducing and producing more offspring.

3. The physical characteristics must be able to be passed on genetically to the offspring. (in the form of alleles)

4. The alleles responsible for the physical characteristic must increase in frequency in the population over time.




*Natural selection occurs due to environmental factors*

Extension

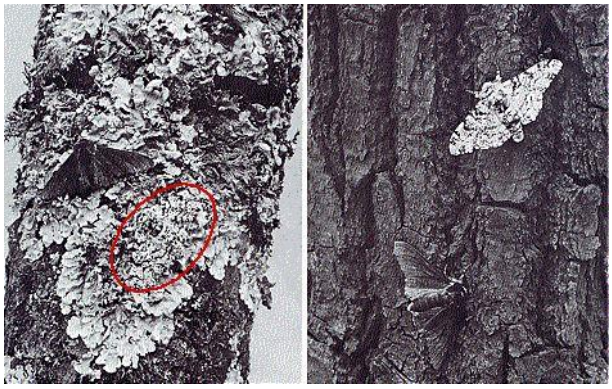
*Natural selection occurs due to environmental factors (called selection pressures) acting on the natural variation that occurs in a group of individuals of the same species.*

*Environmental factors can include drought and lack of food or water, disease, flooding and sudden climate change. If there are some individuals with a trait/s that are better suited to survive in the changed environment then they may be able to reproduce and past their genetic material onto the next generation to help the survival of the species.*

*Without variation in a species, any sudden environmental change can mean that no individual has a trait that allows it to survive, causing the species to become extinct.*

*Natural selection case study – Moths*

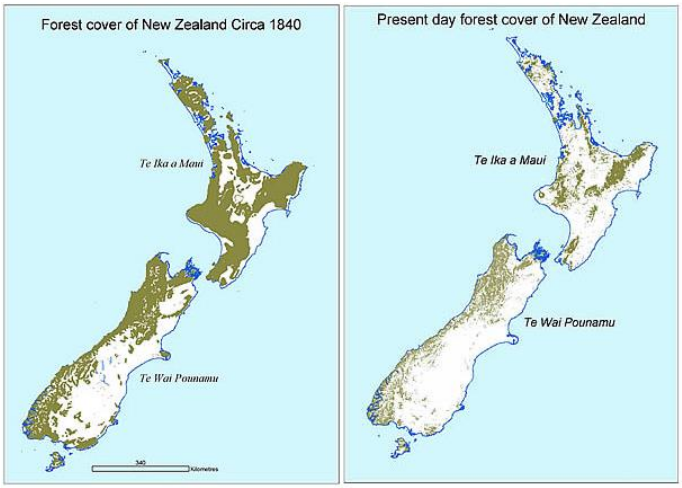
*In some parts of England two centuries ago, coal started to be burnt in large amounts to power steam engines and provide heating in homes. The coal soot from the burning polluted the air and many once light coloured tree trunks around polluted areas were turned dark from the soot. A species of moth had two traits, light and dark. Birds eat both light and dark moths. Light coloured moths now could be more easily seen by birds.*



Environmental changes may occur naturally or be human induced

Natural Environmental factors such as drought leading to lack of food or water, disease, flooding, volcanic activity and sudden climate change have been occurring since living organisms first appeared on Earth. In some cases these factors have been so extreme that worldwide extinction of many species has occurred.

Environmental factors can also be caused or induced by Humans such as the climate change occurring now, created in part by human pollution in the atmosphere. Cutting down trees and destroying habitats along with introducing animal and plant pests also have negative impacts on the native life.




The main threats to our native animals

What is killing our Native Animals?

- ❑ Introduced species such as rats, stoats and possums killing the birds and/or their eggs
- ❑ Introduced competing species such as rabbits and possums eating the birds food
- ❑ Human destruction of bird habitats

Our animals in New Zealand evolved in the absence of ground predators or mammals so they have not developed adaptations to defend themselves as well as other species in the rest of the world have. Our birds, that have become flightless, heavy and slow breeding, have been especially vulnerable to introduced predators. Large areas of our native forest have been burnt and cut down as well as wetlands drained to convert to farmland, since humans have arrived. Some of our endangered species are confined to small marginal areas of land.

The Kakapo case study

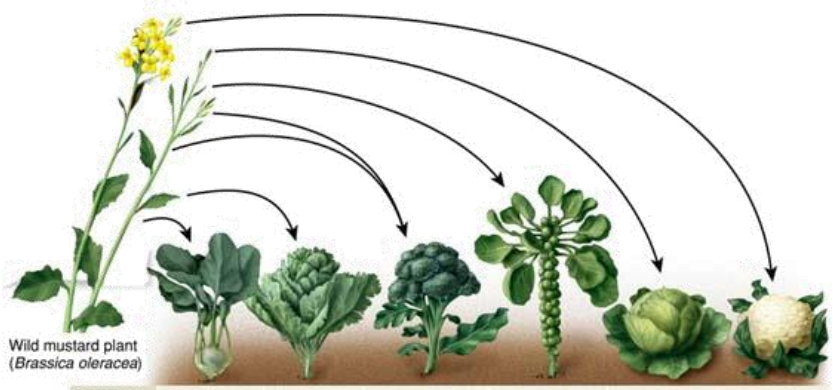
Kakapo were once spread all over New Zealand in large numbers before humans arrived on New Zealand. The species evolved without mammal predators. The nocturnal behaviour (active at night-time) and bush camouflage protected it from its main predator, the giant Haast eagle – that hunted in the day by sight.

The introduction of mammal pests that ate and killed kakapo as well as humans killing and eating kakapo, greatly reduced numbers of kakapo.

The destruction of the habitat and food of the kakapo by humans and pests also had an impact. Kakapo have not evolved to escape predators and they cannot fly to escape. They are more sensitive to predators than birds that have evolved with them. Kakapo are slow breeding and have small numbers of chicks – they cannot replace lost birds quickly. There is low genetic variation and diversity of the remaining birds so there are less healthy chicks produced and a low breeding rate. It is harder for males to find partner to mate with and a limited habitat to live in and get enough food, especially mast Rimu required during breeding.

Humans can exploit variation through selective breeding

Selective breeding produces new varieties of a species. Humans have been able to domesticate plants and animals by actively selecting advantageous traits in a wild species and repeatedly breeding those individuals that exhibit it. After many generations, the domesticated species looks distinctly different from the original wild ancestor. This process is known as artificial selection.




| Strain | Kohlrabi | Kale | Broccoli | Brussels sprouts | Cabbage | Cauliflower |
|---|---|---|---|---|---|---|
| Modified trait | Stem | Leaves | Flower buds and stem | Lateral leaf buds | Terminal leaf bud | Flower buds |

Selectively breeding cattle to produce more milk

Companies, such as LIC, breed and provide bulls sperm (for artificial breeding) to help dairy farmers produce female calves (heifers) with desirable traits including higher milk yield (production).

The companies may purchase a bull calf from a farmer whose mother cow has promising traits such as high protein percentage in milk or large volumes of milk.

The bull calf is raised, and then mated with cows who are tested for advantageous traits that farmers desire in their cows.

The best performing bulls are then offered to farmers who purchase the semen of the bull who is more likely to pass on advantageous traits in the offspring of their cows. The semen is inserted into the cow through artificial insemination by a technician.

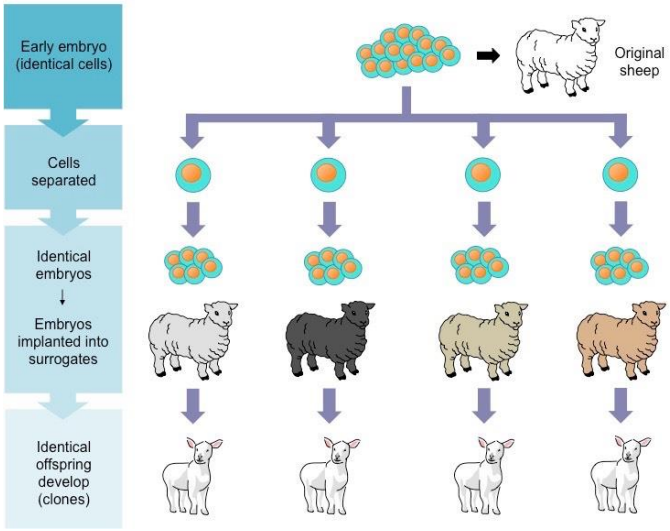
*Cloning is making copies of living things by copying their DNA.*

Extension

*Clones are organisms that are exact genetic copies of their parent, and their DNA is identical.*

*Clones can occur naturally such as identical twins are or they can be made artificially in the lab through modern cloning technologies.*

*Humans have manufactured clones for research but also everyday agriculture for food crops. Society faces ethical issues with cloning, where negative effects could cause harm.*




*Ethical issues of cloning*

Extension

*The cloning of simple animals has occurred for many years, but after the cloning of the first mammal, Dolly the sheep, ethical issues about whether it was right or wrong arose in the Scientific community.*

*Therapeutic cloning involves the cloning of cells for research or production of chemicals such as insulin.*

*The main ethical issue with therapeutic cloning is the status of the cloned embryo, which is created solely for destruction.*

*Reproductive cloning is when a live animal is produced.*

*The ethical issues with reproductive cloning include possible damage or mutation to the clone, health risks to the mother and very low success rates meaning loss of large numbers of embryos and young offspring.*