



## Advantageous adaptations

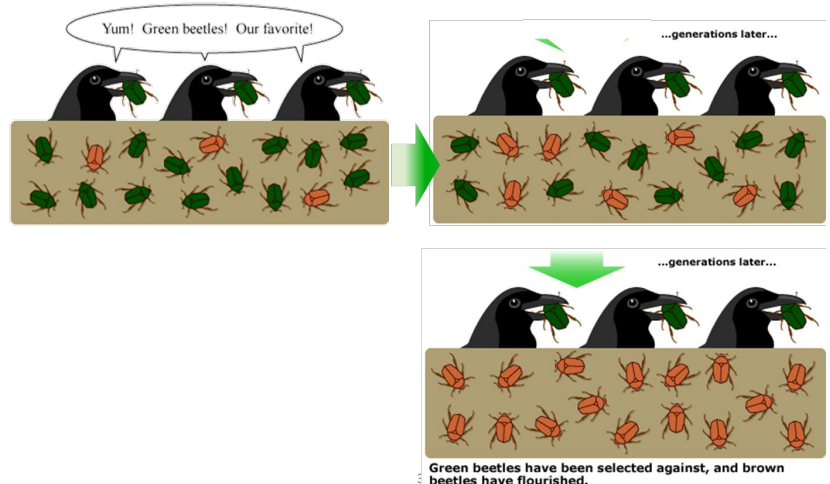


Organisms vary and that some variations give advantages over others in a given environment. Individuals of a species occupy a **niche** and they have **adaptations** to survive in their habitats. The adaptations may help them to best obtain food, seek mates, raise offspring, find shelter or escape predators.

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.

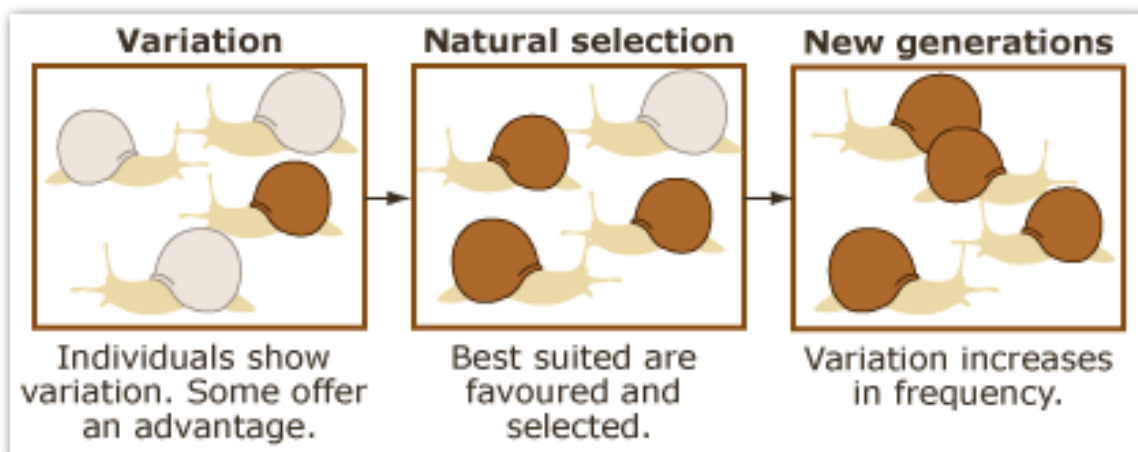
Variations caused by genes can be passed on to offspring and genes giving advantageous adaptations are more likely to be passed on than others are

When there is a higher chance of survival for an individual with a 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.

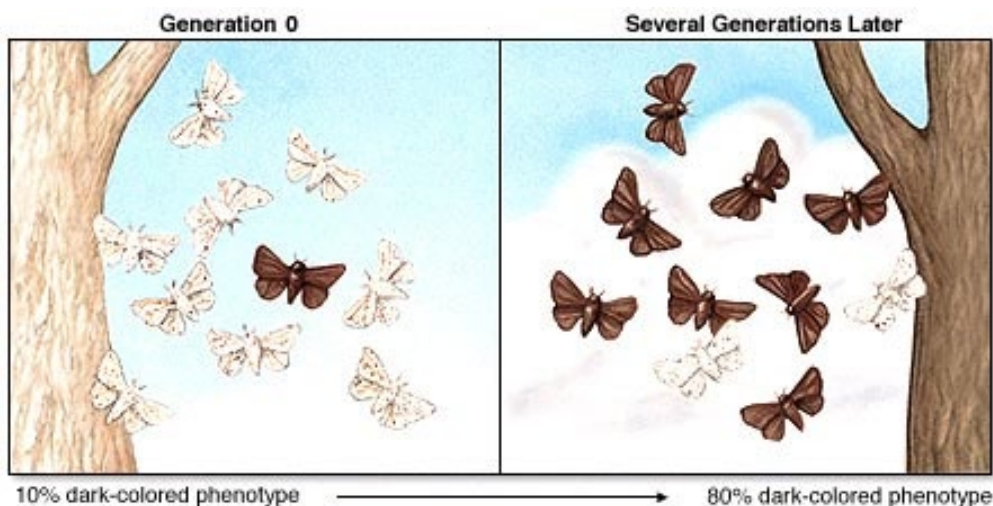


## Natural Selection

**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



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

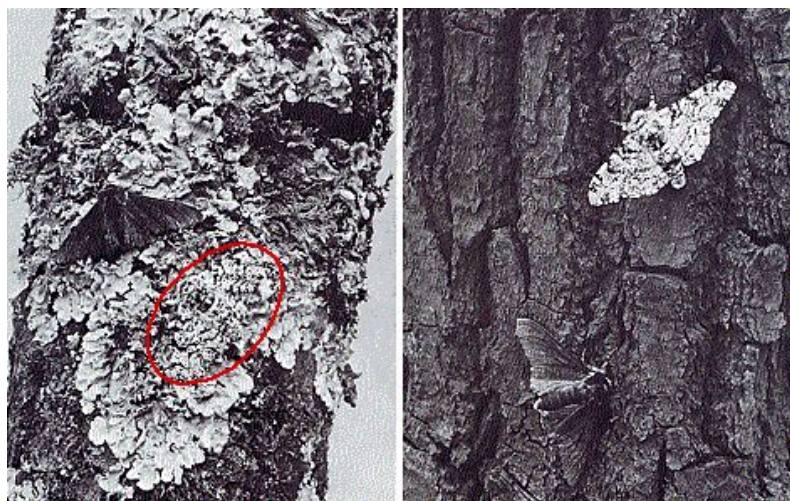
Natural selection occurs due to environmental factors (called **selection pressures**) acting on the natural variation that occurs in a group of individuals of the same species.

**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 pass 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

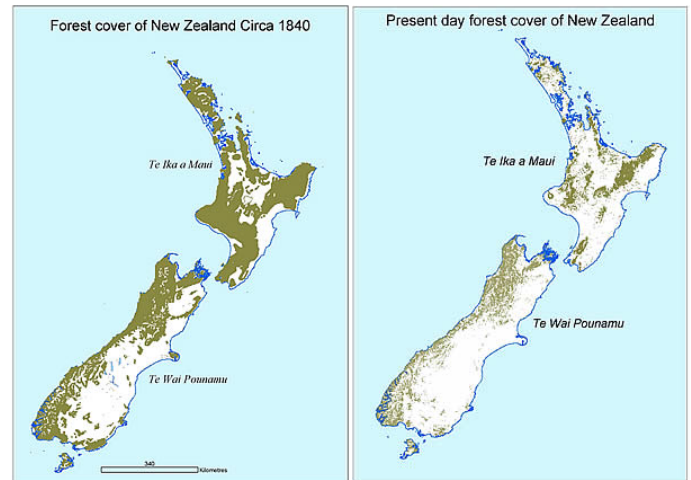
In some parts of England two centuries ago, coal started to be burnt in large amounts to power steam engines and provide heating in homes. The coal soot from the burning polluted the air and many once light-coloured tree trunks around polluted areas were turned dark from the soot. A species of moth had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



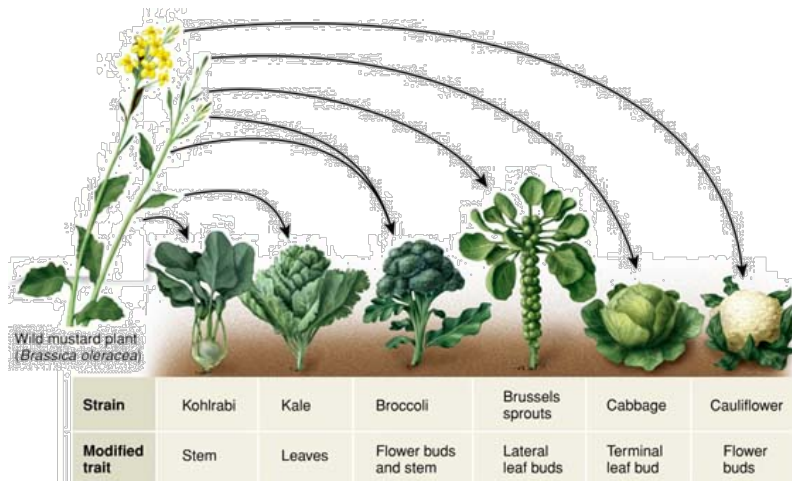
## Environmental changes may occur naturally or be human induced

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.



## 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**.

### 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.

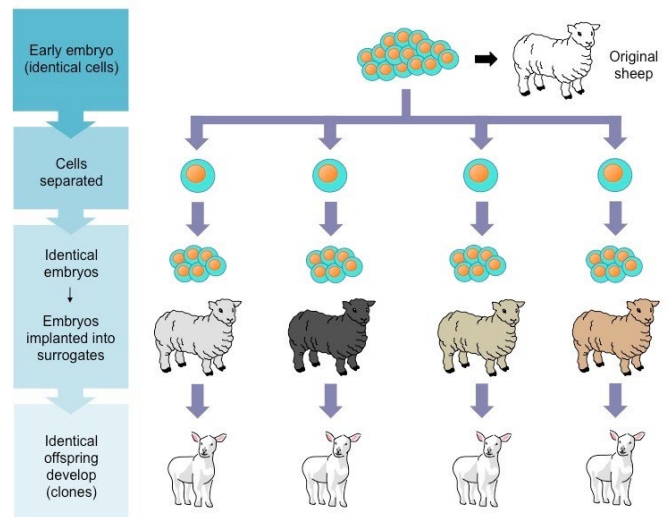


## Cloning is making copies of living things by copying their DNA.

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

Clones can occur naturally such as identical twins, 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



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.

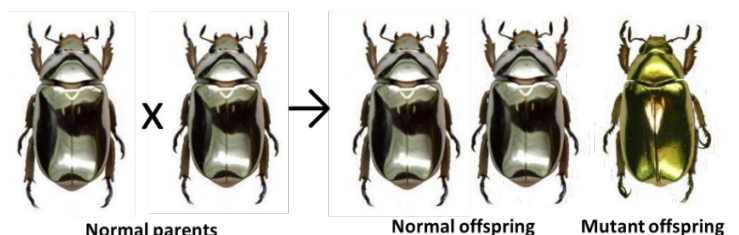
Therapeutic cloning involves the cloning of cells for research or production of chemicals such as insulin. The main ethical issue with therapeutic cloning is the status of the cloned embryo, which is created solely for destruction.

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.

## 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.

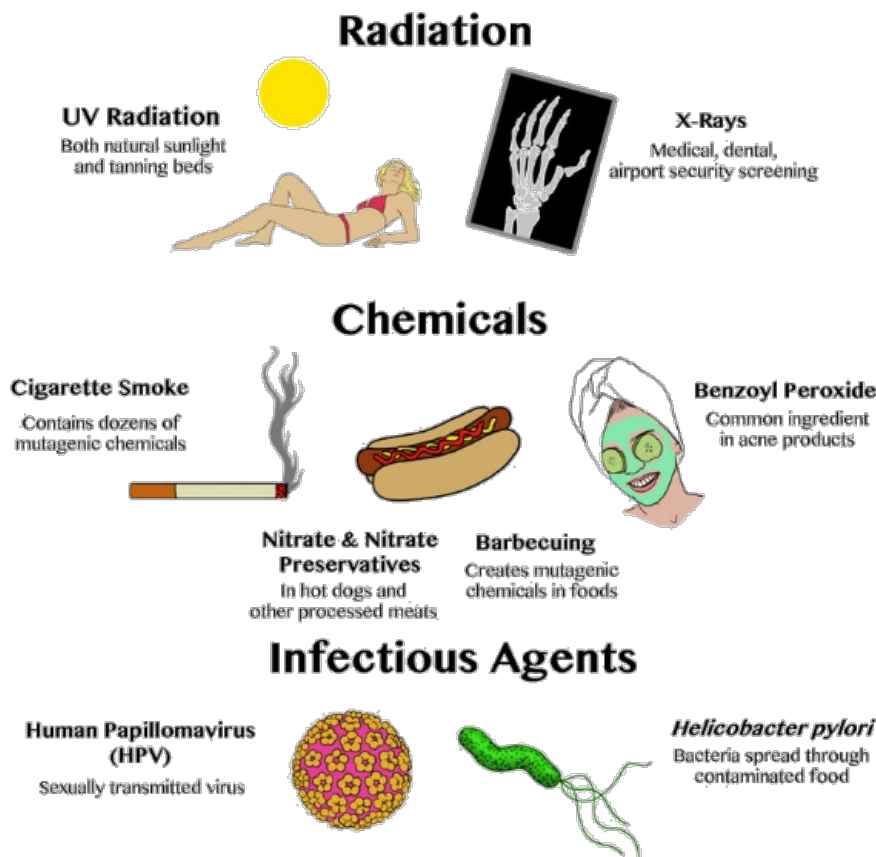


Mutations are caused by a random change in the sequence of bases in the DNA.

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 caused 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.



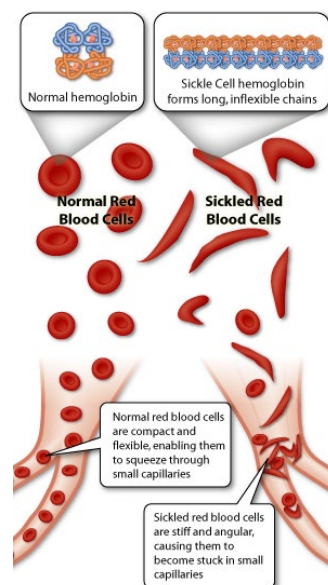
**Inheritable Genetic disorders** in humans are caused by one or more mutations in the genome (full set of genes) and is present from birth. Most genetic disorders are very rare. Mutations can be caused by random mistakes during DNA replication and meiosis or by mutagens like chemical or radiation exposure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

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.

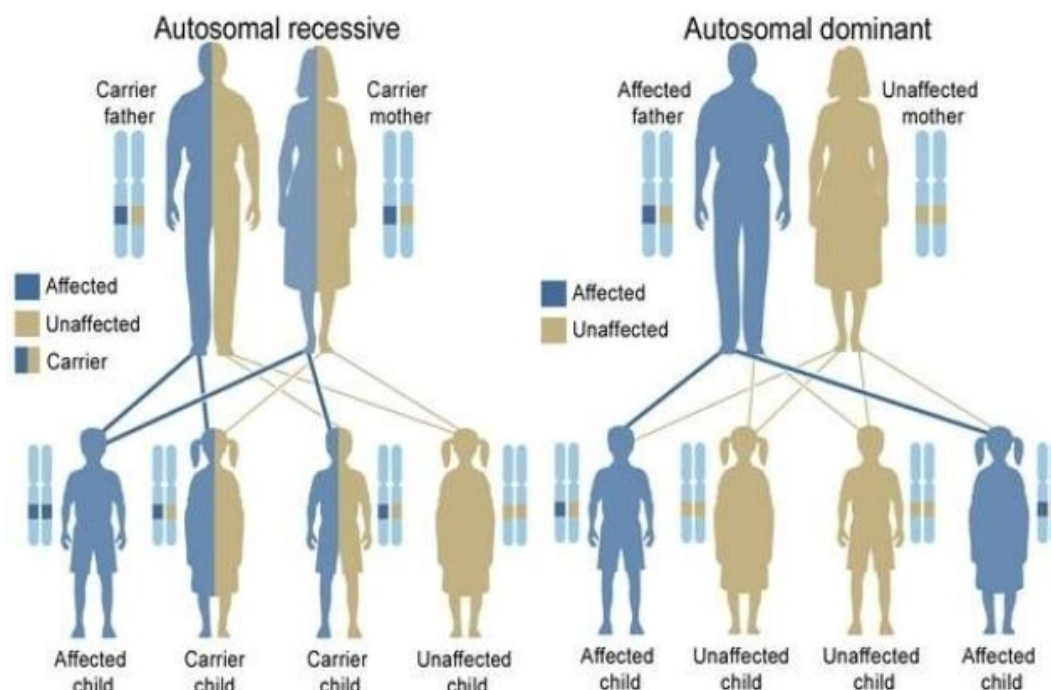


## Other Human genetic disorders

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.

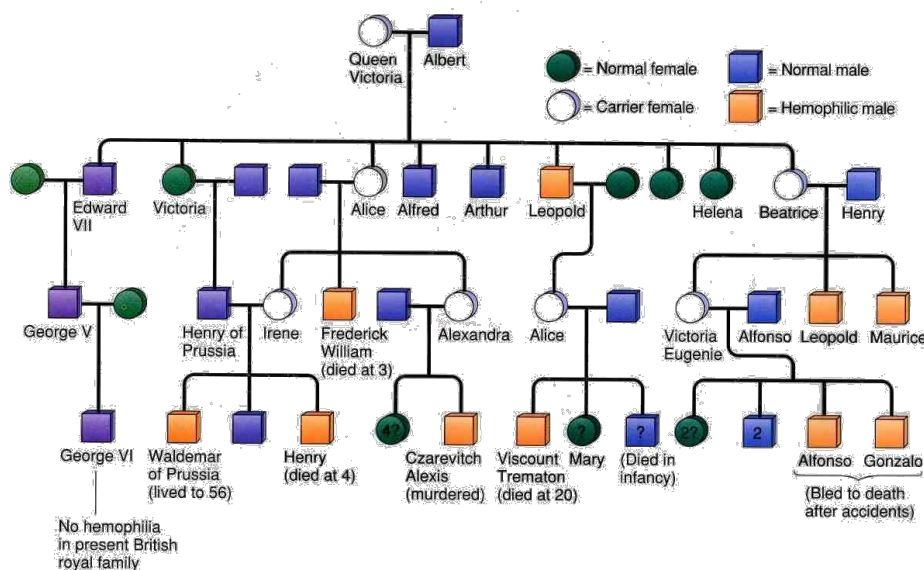
This are called sex-linked disorders. Haemophilia is an example and carried on the X chromosomes. Males without an extra X chromosome (a healthy chromosome to “block”) show the mutation.



## Using Pedigree charts to predict genetic disorders in offspring - EXTENSION



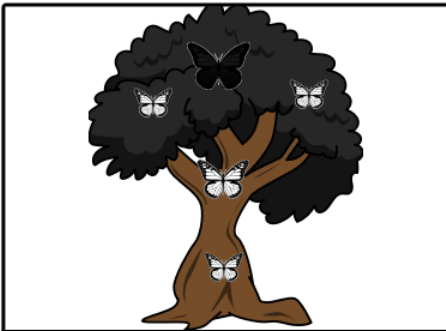


A pedigree chart can be used to predict the likelihood of offspring receiving a mutation from parents as well as look for where the mutation has come from.

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.





1. Use the following story to answer questions about Natural Selection

 <p>The trees are bright and are clean this means the white moth can blend in with the tree</p>	 <p>Therefore the birds eat the black moths</p>	 <p>In 1820 the industrial revolution started to use machines and factories it produced black smoke which stained the trees a darker colour</p>
 <p>because the tree is dark the dark moth now camouflage in and the white moths stand out</p>	 <p>The birds now ate the light coloured moths and the population of dark moths increased.</p>	 <p>Now when the clean air act came in to place in 1956 the white moths overtook the black moths and returned to how it was</p>

<https://www.storyboardthat.com/et/storyboards/eab31f27/peppered-moth>

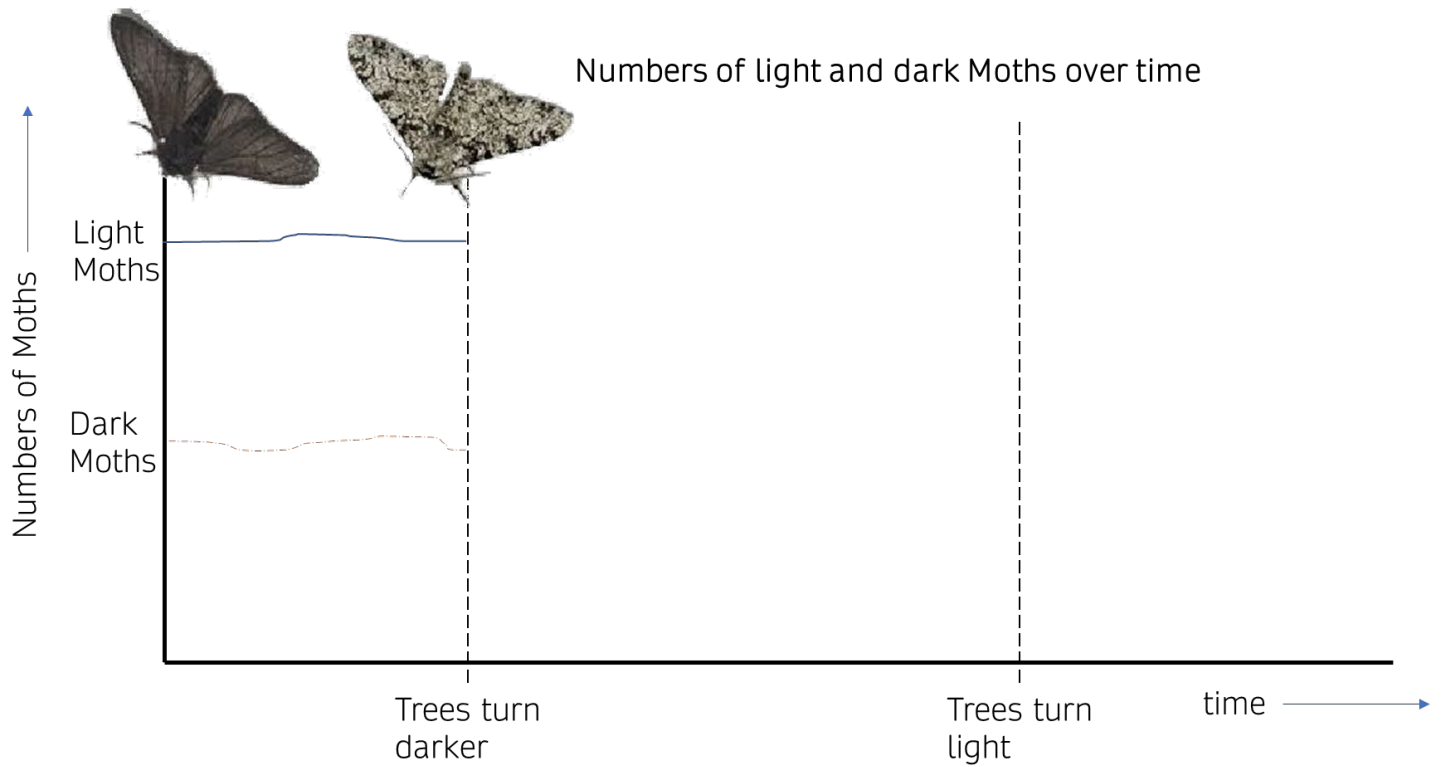
1a. What controlled the moth's physical characteristic of black or white colouring?

1b. What were the **environmental factors** that caused natural selection to occur?

1c. What do you think might have possibly happened to both the moth population AND the birds if the trees had remained dark and polluted?

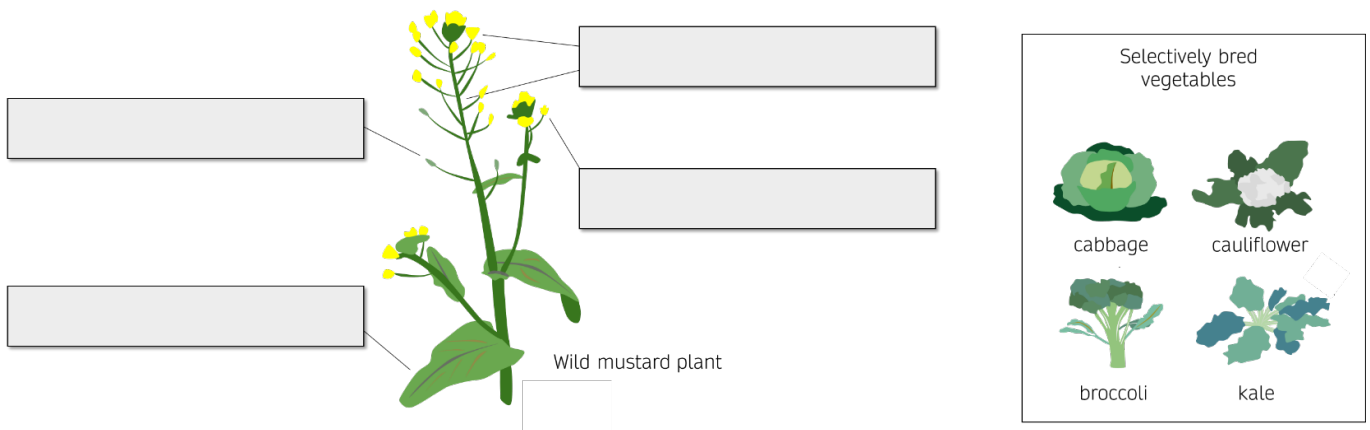


1d. Complete the graph to show what happens to the black and white moth population over time.



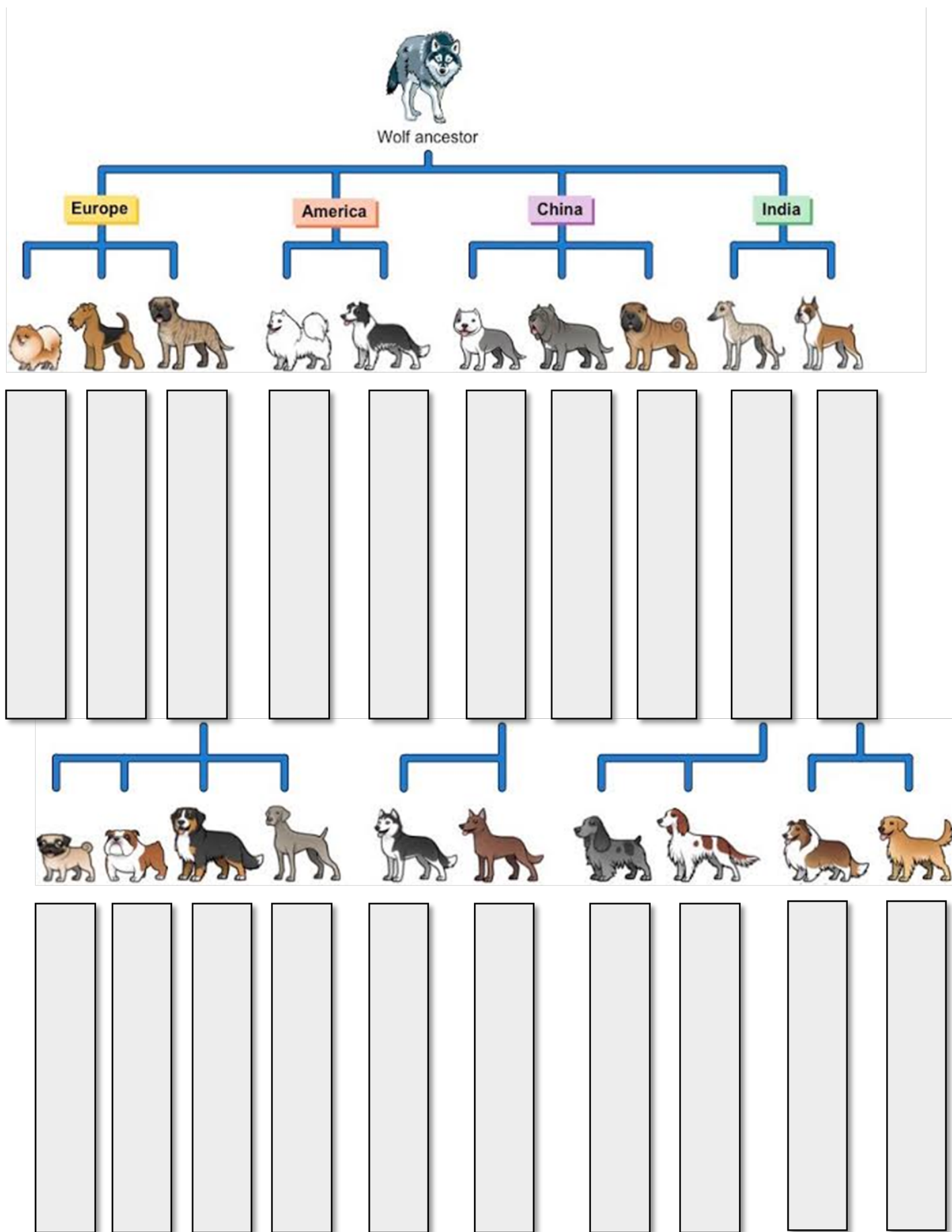
1e. Using the conditions of natural selection in the notes above, explain why there was a change in numbers of moths. Use the terms: allele frequency and advantageous adaption.

2. Mustard plants were selective bred by humans to enhance parts of them as vegetables. Label the correct vegetable to the part of the plant

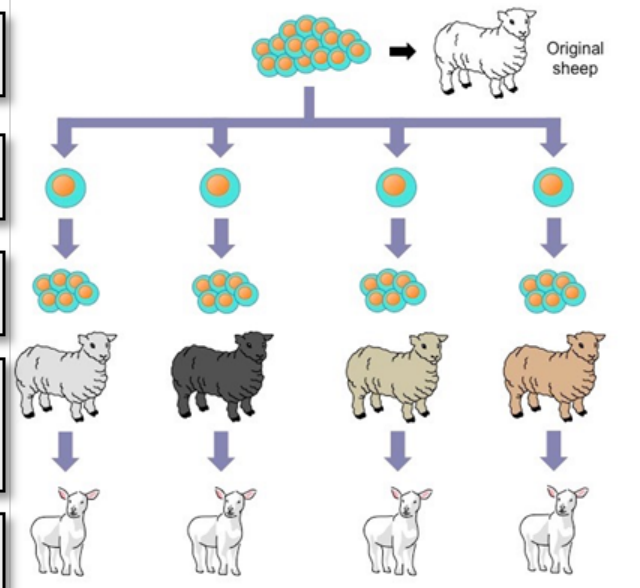




3. The chart below shows how our domesticated dogs were selectively bred from wolf-like ancestors. How well do you know your dog breeds? Try and name as many as you can. You may need to research

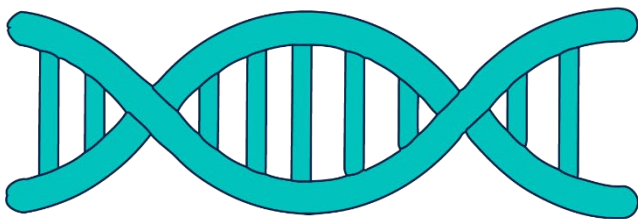


4. **Cloning** is used by humans to create identical offspring. In your own words, explain what is happening at each step of the cloning process.

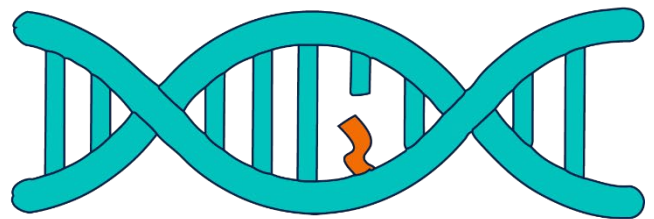


5. Genetic mutation occurs when there is a change in the base sequence of DNA. This may lead to new physical characteristics in the offspring.

### Normal Gene



### Mutated Gene



5a. Where does the mutation need to occur in order to be passed onto offspring?

5b. What do genetic mutations produce, that natural selection does not?

**EXTENSION: 5c.** Explain in your own words, why many genetic mutations are often fatal (cause death) in living animals. Link to the process of a base sequence producing a particular physical trait (characteristic)