Section 8.1 – Studying inheritance

Genotype and phenotype

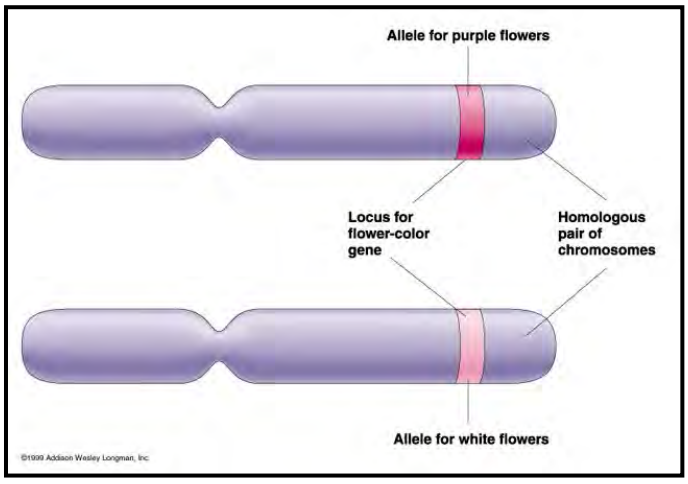
Genotype is the genetic constitution of an organism that describes all the alleles that an organism contains
The genotype sets the limits to which characteristics can vary
Any change to the genotype is called a mutation. This will be passed on to the next generation if it is present in the gametes
A phenotype is an on observable characteristic of an organism.
A phenotype will vary depending on the genotype and the environmental conditions.
A change to the phenotype is called a modification

Genes and alleles

A gene is a portion of DNA made up of a particular sequence of nucleotide bases that will relate to a certain characteristic
The gene will determine the proteins and compounds produced
The position of a gene on a chromosome is called its locus

An allele is one of the different forms of a gene
Only one allele of a gene can occur at the locus of any one chromosome
In sexually reproducing organisms, homologous chromosome pairs are found

If both the alleles of a gene are the same, the organisms is said to be homozygous
If both alleles are different, the organisms is heterozygous
The allele of the heterozygote that expresses its self is said to be dominant, while the other that is not expressed when heterozygous is recessive
When there are two alleles that are both either dominant or recessive, the organisms is said to be homozygous dominant or homozygous recessive
When both alleles contribute to the phenotype, they are said to be co-dominant



When there are two or more allelic forms, an organism is said to have multiple alleles for a character

Section 8.2 – Monohybrid inheritance

Representing genetic crosses

	G	g
G	GG	Gg
G	GG	Gg

Punnet squares such as this one are used to determine what the genotypes of offspring will like as well as the probability of producing offspring with certain genotypes.

Inheritance of pod colour in peas

Monohybrid inheritance, is the inheritance of a single gene
Consider pea pods which come in two different colours: green and yellow

When pea pods are bred only with one another until they consistently produce green coloured offspring, they are said to be pure bred.
The organisms in pure breeding are said to be homozygous

If pure breeding green pods are crossed with pure breeding yellow pods, then all of the offspring are referred to as the "first filial" or "F1" generation.
F1 generations are always heterozygous

When you breed pure bred organisms with one another you can then deduce which alleles are dominant and which are recessive
For example pure bred yellow pea pods bred with green pea pods will only produce green pea pods. This is means that all of the f1 generation have a yellow allele and a green allele. From this it is clear that the green must be dominant and the yellow recessive

Breeding two F1 generations will produce an F2 generation. In the F2 generation there will most likely be a ratio of 1:2:1 where the first one may be homozygous dominant, the 2 heterozygous and the other 1, homozygous recessive.

Section 8.3 – sex inheritance and sex linkage

Females have XX chromosomes whereas males have XY

Sex inheritance in humans

Males produce both X and Y chromosomes
It is which chromosome that combines with the female gamete that determines the sex of the offspring

Sex linkage – haemophilia

Any gene carried on the X or Y chromosome is said to be sex linked
The X chromosome is much longer than the Y, this means that most of the X chromosome doesn't have an equivalent portion on the Y chromosome
This means that recessive alleles found on this portion of the X chromosome will be more likely to be expressed; because of this recessive phenotypes are more likely to be present in men.
Haemophilia is for this reason almost entirely only present in men and not women
Males can only obtain the disease from their mother as they do not receive a Y chromosome from the father
Males cannot pass the disease on to their sons but they can to their daughters

Pedigree charts

A useful way to trace the inheritance of sex – linked characters is with a pedigree chart. In these:

A female is represented by a square
A male is represented a circle
Shading within the shape represents the presence of a certain character
A dot within a circle indicated a normal phenotype

Section 8.4 + 8.5 – Co – dominance and multiple alleles + hardy Weinberg

Co – dominance – both alleles are equally dominant
Multiple alleles - when there are more than 2 alleles, of which only two may be present in the loci of an individual's homologous chromosomes

Co – dominance

Both alleles are expressed in the phenotype
The snap dragon plant is a common example of co – dominance. This is shown when you observe how the plant can be of three different colours, red pink and white. If the alleles were not co – dominant only red a white plants would be able to be produced
If a snapdragon with red flowers is cross with a snap dragon with white flowers the offspring will have pink flowers
Crossing two pink flowered snap dragon plants will produce 50% pink flowered snap dragons, 25% white flowered snap dragons and 25% red flowered snap dragons

Multiple alleles

Sometimes a gene can have many different alleles. An example of this is the human ABO blood groups
Although there are three different alleles for the blood groups, only two can be present in an organism at any one time

Multiple alleles and dominance hierarchy

When there are multiple alleles, some are more likely to be more dominant than others. They are they then arranged in a hierarchy according to which alleles they are dominant over.

All the genes of all the people in a population is called the gene pool
The number of times an allele occurs in a population is called the allelic frequency

Hardy Weinberg principle

Mathematical model that is used to calculate allelic frequency
Let A = p and a = q. In a population that has just two alleles, $p + q = 1.00$ (100%)
As there are only 4 possible combinations of A and a (AA, Aa, aA and aa) then, $p^2+2pq+q^2 = 1.00$. This can be used to calculate allelic frequencies provided that:

- No mutations arise
- The population is isolate (no immigration emigration)
- There is no selective breeding
- The population is large
- Mating within the population is random

Section 8.6 – Selection

Not all alleles are equally likely to be passed on since some organisms may have characteristics that improve their chances of survival

Reproductive success and allelic frequency

The difference between the reproductive success of individuals affects the allelic frequency

All organisms produce more offspring than can be supported by the supply of food, light, minerals etc
Despite too many offspring, populations stay the same
This means there is competition between members of the same species to survive
There will be a gene pool within any population
Some individuals will contain certain alleles that allow the to be better able to survive
They are therefore more likely to produce offspring
The alleles that give the best competitive advantage are most likely to be passed on
Over years the number of individuals with the advantageous alleles will increase

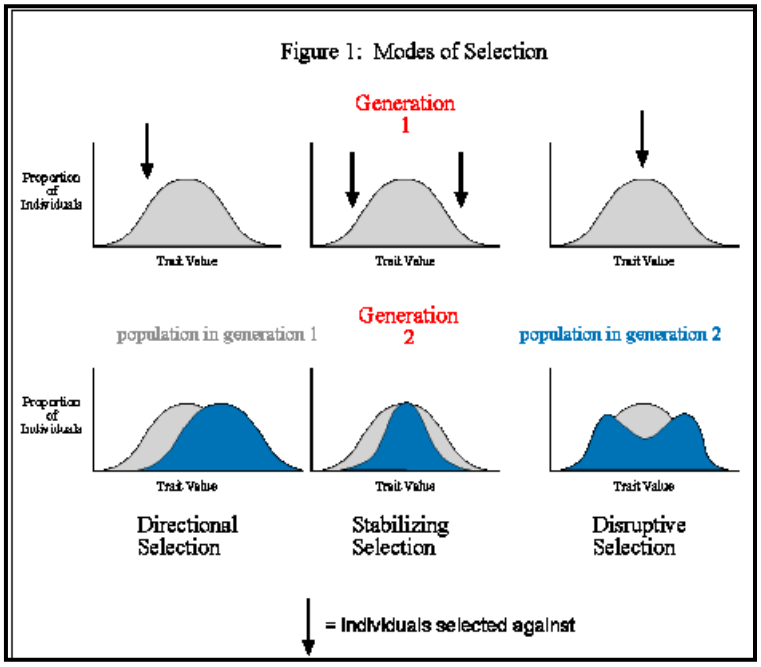
What is advantageous depends upon the environmental conditions

Types of selection

Depending on which characteristics are favourable, selection will produce a number of different results.

Selection may favour certain individuals that vary in one direction from the mean
Selection may favour average individuals that have characteristics closer to the mean

Directional selection most often occurs when there has been a change in the environmental conditions
Stabilising selection often takes place where the environmental conditions have remained the same. An example would be where temperature fluctuates throughout the year where organisms at each extreme will most likely survive.

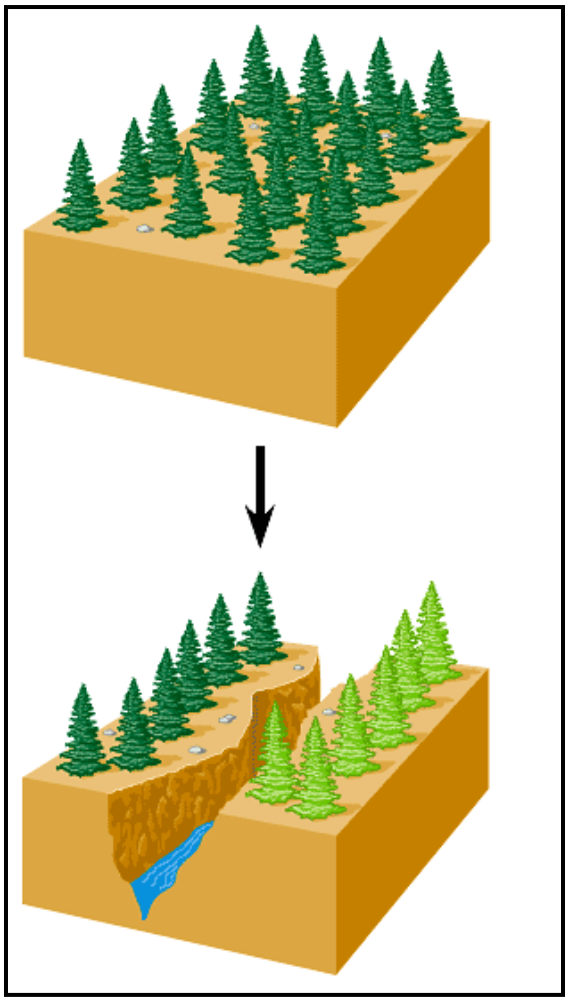


Section 8.7 – Speciation

Speciation is the evolution of a new species from an existing species
Organisms within the same population interbreed with one another and so share the same gene pool
If the population is split, the flow of alleles will not remain the same.
Each population may face different environmental conditions and so different alleles will be favoured, in time the frequency of the alleles in each species may be come so different that they can no longer interbreed and are effectively two different species

Geographical isolation

- Occurs when physical barriers prevent two populations from breeding with one another
- Imagine species X living in a rainforest:
- The individuals of species X form a single gene pool and can freely interbreed
- Climate changes over many years may lead to drier conditions that separate the species in to two different populations
- Further climate changes may cause one region to be colder and wetter whilst the other becomes warmer and drier
- In the first region, phenotypes that allow individuals to be better suited for colder and wetter conditions are favoured
- Whereas the opposite is true for the second region
- The type and frequency of the alleles in the gene pools may differ over time until they become so different that they are now in effect different species.



- If the species were reunited, they would no longer be able to interbreed