Evolution

Mechanisms for speciation

Term	Definition
Species	A population of organisms similar enough to breed and produce fertile young.
Genetic drift	The change in allele frequencies in a population that occurs if the Hardy Weinberg equilibrium does not occur.
The founder effect	When a small population has become separated from the original population and so genetic drift occurs more readily.
Speciation	Allele changes can significantly alter the phenotype of the isolated population so that they can no longer breed with the original population to give fertile young. A new species has been formed.

Speciation by natural selection

Natural selection is a mechanism proposed by Charles Darwin and Alfred Russel Wallace for evolution. The mechanism describes how phenotypes in a population can be maintained or changed to be optimal in the environment. Evolution is the modification of ancestral species in this way.

- Mutations in alleles lead to changes in allele frequencies.
- **Variation** in phenotypes due to different alleles.
- Many offspring are produced and there is **competition** for limited resources.
- **Selection pressures** from the environment give some phenotypes a survival advantage and they survive long enough to **breed**.

Selection pressures e.g. selective predation can confer survival advantages to phenotypes that show camouflage or mimicry.

- Successful phenotypes pass on their alleles increasing their frequency in the population.

Mechanisms for isolation

Allopatric speciation

Evolution of a new species from demes isolated in different geographical locations.

Speciation caused by any mechanism of geographically separating demes e.g. species isolated by mountain ranges, deserts, oceans, rivers etc.

Demes

A sub-group of a population that interbreed more frequently, reducing gene flow with the rest of the population.

Sympatric speciation

Evolution of a new species from demes sharing the same geographical location.

Behavioural isolation

Demes with differing courtship rituals will not interbreed and become isolated.

Morphological isolation

If the genitalia of demes are incompatible, they cannot interbreed.

Seasonal isolation

Demes with different breeding seasons cannot interbreed and become isolated.

Hybrid sterility

When two different species are similar enough to breed, they can produce hybrid offspring, but these are often sterile and unable to breed themselves.

This could be due to an uneven chromosome number e.g. Mules have 63 chromosomes which cannot form homologous pairs during prophase I in meiosis and so gametes cannot be formed.

Hybrid fertility

Some plants can double their chromosome number by endomitosis to become fertile.

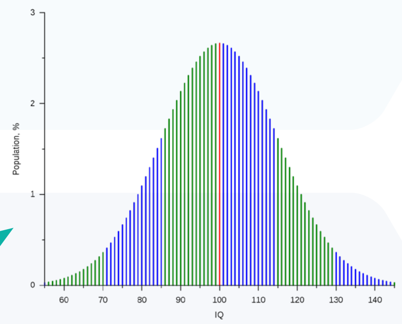
Variation

Variation - The phenotypic differences between members of the same species.

Heritable (can be passed on to offspring)	**Non-heritable** (cannot be passed on to offspring)
Genetic differences caused by • Crossing over • Independent assortment • sexual reproduction (mixing of 2 parental genotypes).	Differences caused by the environment.
Epigenetic differences.	

Continuous variation

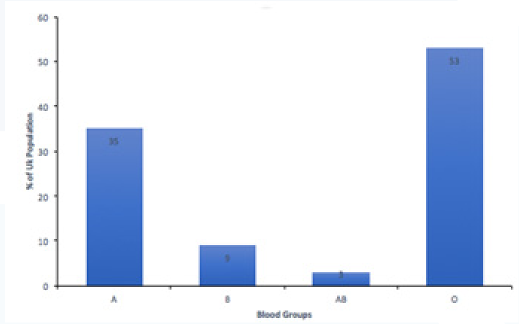
- Characteristics have many possible values.
- Generally polygenic (being controlled by many genes).
- Gene expression is influenced by the environment.
- Forms a normal distribution curve.



Discontinuous variation

- Characteristics are discrete and have no intermediates.
- Monogenic (controlled by a single gene).
- Gene expression not influenced by the environment.

Usually drawn as a bar chart.



Hardy Weinberg - an equation that estimates the allele frequency in a population.

$$p^2 + 2pq + q^2 = 1$$

where,

p = frequency of the dominant allele (A)

q = frequency of the recessive allele (a)

$p + q = 1.0$

Using this equation if you know either p or q, you can calculate the other and all allelic frequencies in the population. i.e.

p^2 = frequency of AA (homozygous dominant)

$2pq$ = frequency of Aa (heterozygous)

q^2 = frequency of aa (homozygous recessive)

If a population is stable i.e.

• **Large population • no migration • no mutation • no selection pressure** then the allele frequency will stay the same from generation to generation. The population is said to be in **Hardy Weinberg equilibrium.**

Competition and selection pressure

The **competition** for limited resources could be:

Intraspecific - Between members of the same species.

Interspecific – Between members of different species.

The phenotype of an organism could give an advantage in the competition for resources, and that would increase the prevalence of the alleles that code for that phenotype in the population as **the organism survives to breed and pass on the successful allele.**

Selection pressure is the effect of selective agencies on the phenotypes in a population.

Selective agencies such as:

• Food availability • Breeding sites • Climate • Human impact.

Selection pressure for:

Phenotypes have an advantage in competition so the alleles that code for them are selected for.

Selection pressure against:

Phenotypes do not have an advantage and are unable to compete successfully. So, alleles that code for them are selected against.

Gene pools and Genetic drift

Gene pool - All the alleles of all the genes of all the individuals in a population of sexually reproducing organisms.

Genetic drift

Genetic drift describes the change in allele frequency in a population by chance.

This is most significant in small or isolated populations.

Allele frequency

Population genetics is concerned with all the alleles in the gene pool and describes the proportions of alleles present at any one time.