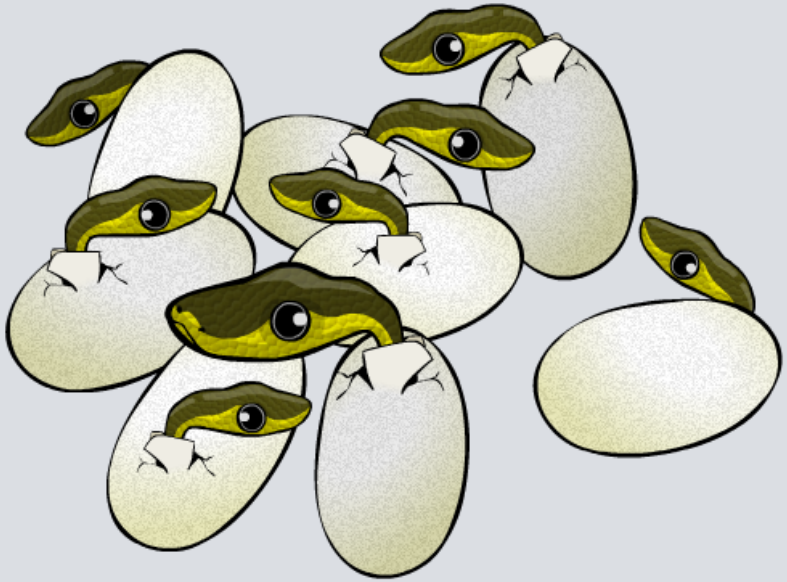
The Process of Evolution



Natural selection

The conditions for evolution

There are three factors needed for a population of organisms to be able to evolve:

- **Variation –** There must be differences between the individuals in a population.
- **Heredity –** The differences between organisms must be heritable.
- **Means of selection –** There must be a mechanism or pressure that selects some variables for the next generation at the expense of others.

Variation

All species exhibit variation between individuals.

discontinuous	continuous
limited number of traits, no intermediate forms	range or gradation of characteristics
controlled by a few genes usually with multiple alleles	controlled by many genes (**polygenic**)
environment has little effect on these characteristics	environment has a significant effect
e.g. human blood groups, antibiotic resistance	e.g. stem height in plants, milk yield in cows

Genotype and environment can both determine **phenotype.**

The origin of genetic variation

Genetic variation is heritable. It is this variation that natural selection acts upon. The causes of genetic variation are:

Mutation

- deletion, addition or substitution of a nucleotide
- deletion or translocation of part of a chromosome
- **aneuploidy** – loss or gain of a single chromosome
- **polyploidy** – the addition of whole chromosome sets.

Sexual recombination

- independent assortment of chromosomes in meiosis
- crossing-over during meiosis
- random fertilization.

Environmental causes of variation

Organisms can be affected by their environment. Variation caused by the environment is **not heritable**, so it is not subject to natural selection.

However, the ability of organisms to develop differently in different environments can be genetic. This means organisms can evolve to be flexible.

Plants are a good example of this. The number of leaves, growth pattern and size of any individual plant is dependent on the environment, e.g. availability of light and nutrients.

Darwin's observations and deductions

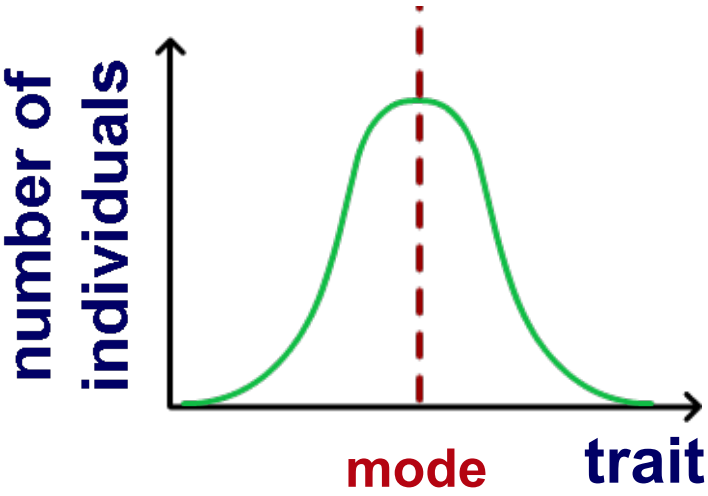
Types of selection

Selection causes some traits to survive and spread, while others are lost. A **selection pressure** determines which traits are successful.

There are three types of selection: **disruptive**, **stabilizing** and **directional**.

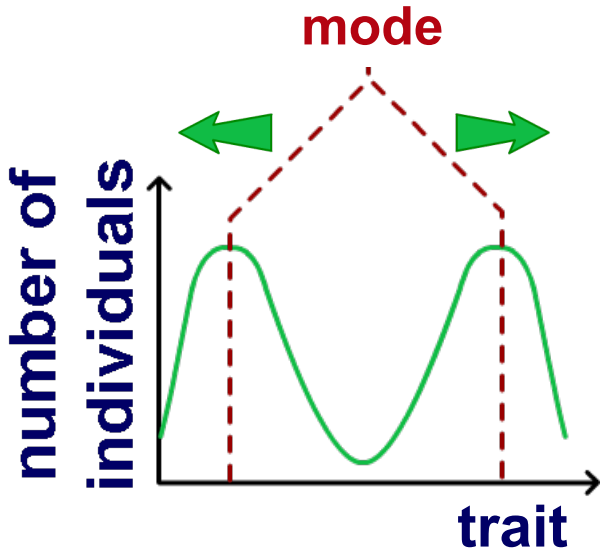
Selection can be represented using graphs showing the distribution of individuals with a particular trait.

Starting population has a **normal distribution** of traits.



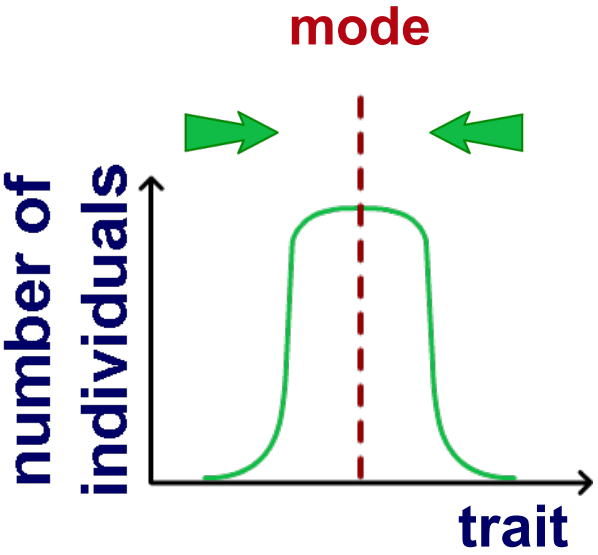
Types of selection

Selection can cause the mode and/or distribution to change.



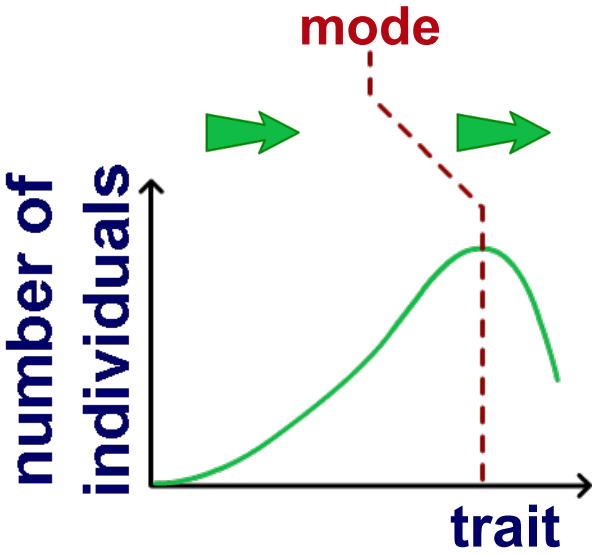
disruptive

Selection pressure toward the extremes creates two modal values.



stabilizing

Selection pressure toward the center increases the number of individuals at the modal value.



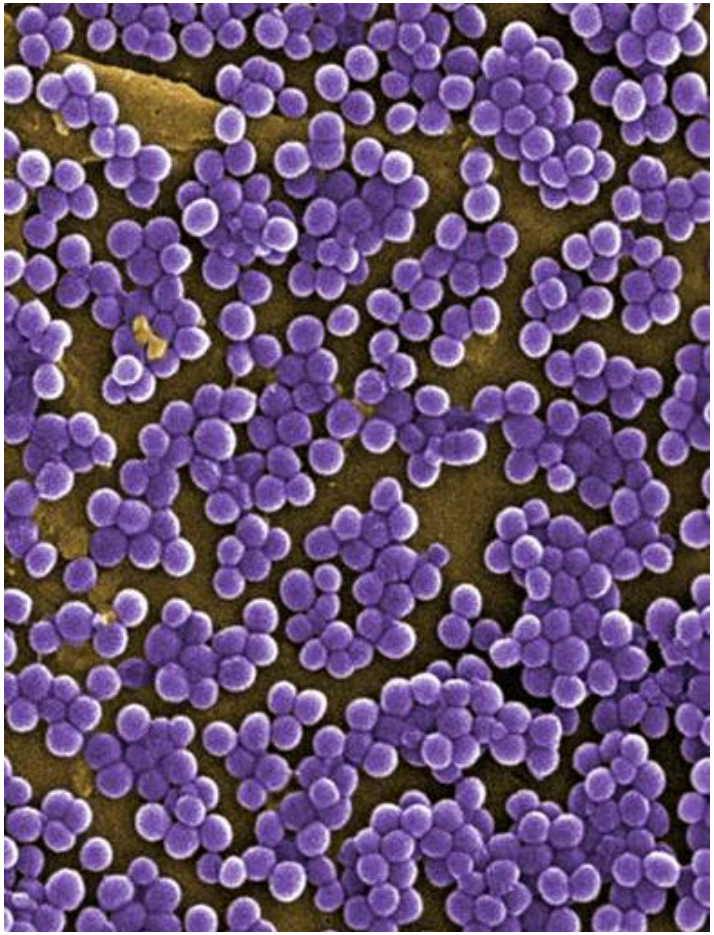
directional

Selection pressure toward one extreme moves the mode in this direction.

Selection pressures

Humanity as a selection pressure

Human activity provides some of the strongest selection pressures in the world today.



The widespread use of antibiotics has exerted a very strong selection pressure on bacteria. Any that can survive exposure to antibiotics can rapidly divide and produce a resistant population. MRSA is an example of an antibiotic resistant bacteria.

What are the implications of the evolution of antibiotic resistance for humans?

Inbreeding and artificial selection

In **artificial selection** humans decide which members of a population will breed.

This allows the alleles for desirable characteristics to be maintained in the population and others eliminated. This technique is used by farmers to produce animals and plants with a high yield.

Artificial selection can lead to **inbreeding**, which reduces genetic diversity. This can increase the risk of a disease affecting the whole population.