NATURAL SELECTION

Content Statements:

D4.1.1	Natural selection as the mechanism driving evolutionary change
D4.1.2	Roles of mutation and sexual reproduction in generating the variation on which selection acts
D4.1.3	Overproduction of offspring and competition for resources as factors that promote selection
D4.1.4	Abiotic factors as selection pressures
D4.1.5	Differences between individuals in adaptation, survival and reproduction as the basis for natural selection
D4.1.6	Requirement that traits are heritable for evolutionary change to occur
D4.1.7	Sexual selection as a selection pressure in animal species
D4.1.8	Modelling of sexual and natural selection based on experimental control of selection pressures

NATURAL SELECTION

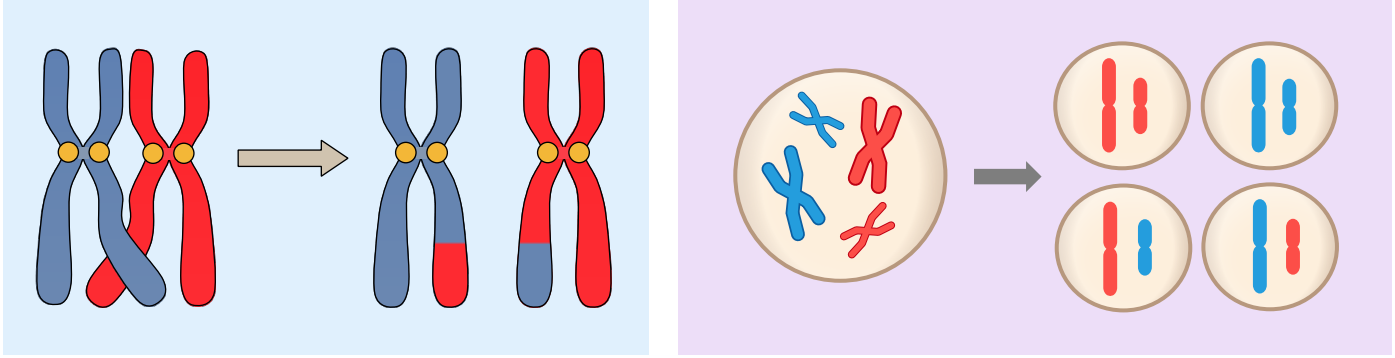
Natural selection describes the changes that occur in the composition of a gene pool as a consequence of **environmental selection pressures**. Natural selection requires a number of key conditions in order to occur (ICE AGE):

- **Inherited variation** must exist within a population (via mutations, etc.)
- **Competition** for survival results from an overproduction of offspring
- **Environmental selection pressures** lead to differential reproduction
- **Adaptations** which benefit survival will be passed on to the offspring
- **Gene pool composition** changes (there is a change in allele frequency)
- **Evolution** occurs within the population (a cumulative change in traits)

Mnemonic: ICE AGE

GENETIC VARIATION

Genetic variation can be created within a population via mutation and sexual reproduction. Random point mutations can generate **new alleles** within a population, while sexual reproduction promotes variation by creating **new gene combinations** in offspring. This recombination of traits occurs via meiosis and involves two distinct processes: crossing over (in prophase I) and random assortment (in metaphase I). Additionally, the subsequent fusion of male and female gametes is random, further increasing the variation of offspring.



Genetic Rearrangement via Meiosis: **Crossing Over** *(left)* and **Random Assortment** *(right)*

COMPETITION

Species have a natural tendency to produce more offspring than the environment can support, as this will improve the chances of survival and maintain continuity. When resources are abundant, populations grow exponentially (**biotic potential**). But as a population outgrows its resource base, **environmental resistance** sets in, causing growth to plateau as mortality increases – leading to a struggle for survival (competition).

SELECTION PRESSURES

Selection pressures describe the external agents that affect an organism's ability to survive in a given environment. These pressures can function to either reduce the frequency of a trait (by reducing survival prospects) or increase the frequency of a phenotype. Selection pressures include both **abiotic factors** (non-living conditions such as light intensity, temperature and pH) or **biotic factors** (living agents such as predators and pathogens). Selection pressures can be density-dependent or independent according to whether they are affected by population size. Some examples include: **P**redators, **A**vailable shelter, **N**utrients, **D**isease, **A**biotic factors (PANDA)

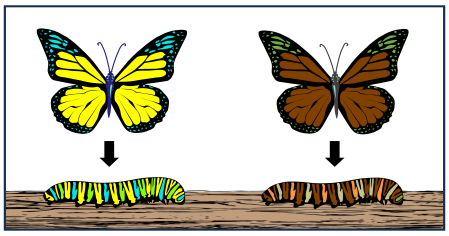
Mnemonic: PANDA

ADAPTATIONS

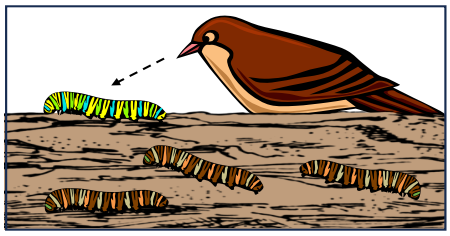
An **adaptation** is a feature that aids in the survival of an organism by suiting them to a given environment.

- **Structural adaptations** – Any physical difference in biological structure (e.g. the neck length of a giraffe)
- **Behavioural adaptation**s – Differences in patterns of observable activity (e.g. opossums feigning death)
- **Physiological adaptations** – Variations in the activity of internal organs (e.g. homeothermy, night vision)

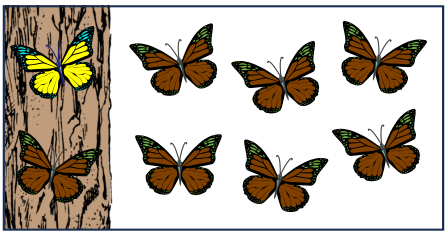
When exposed to a specific environmental selection pressure, organisms with *beneficial* adaptations will be more likely to **survive** long enough to **reproduce** and pass on the alleles. This will lead to a change in **allele frequency** within the population's gene pool (i.e. evolution). If environmental conditions change, then what constitutes a beneficial adaptation will also similarly change – meaning populations are constantly evolving.



Genetic Variation Exists



Selection Pressure (Predator)



Change in Allele Frequency

SEXUAL SELECTION

Sexual selection is a biotic pressure that results from the competition that exists in populations for mating. **Intrasexual selection** occurs when members of the same sex compete for mates (e.g. via combat or mating calls), whereas **intersexual selection** occurs when members of one sex choose individuals of the other sex for mating (based on factors like elaborate plumage or courtship rituals). Sexual selection may result in the development of characteristics that do not provide any survival benefit but maximise reproductive success. **John Endler** modelled natural and sexual selection by controlling the exposure of **guppies** to a predator. In the absence of the predator, guppies evolved bright spots (sexual selection) – but when predators were present, drab colouration became the predominant phenotype (natural selection). When guppies with drab colours were moved to regions without predators, the population evolved to favour brightly coloured fish.