Evolution

Natural and Sexual Selection

1. Evolution is the change over time in the proportion of individuals in a population differing in one or more inherited traits
2. During evolution, changes in allele frequency occur as a result of natural selection, sexual selection (both non-random) and genetic drift (random)
3. **Variation** in traits arise as a result of mutation (the original source of new DNA sequences—these new sequences can be novel alleles)
4. Most mutations are harmful or neutral but, rarely, they can be beneficial to the fitness of the organism
5. Populations produce more offspring than the environment can support—individuals with variations that are better suited to the environment survive longer and produce more offspring, which then breed & pass on the advantageous alleles to the next generation
6. Selection results in the non-random increase in frequency of advantageous alleles and non-random decrease in the frequency of deleterious alleles.
7. **Sexual selection** = non-random process of selecting alleles that increases an individual's chances of mating and producing offspring
8. Sexual selection may lead to **sexual dimorphism** (when the 2 sexes of a species show different characteristics beyond sexual organs. Males are usually more conspicuous, females are less conspicuous as they are usually more involved in caring for young/eggs)
9. Sexual selection can be due to **male-male rivalry** (large size/weaponry increases access to females through conflict and **female choice** (females assess the fitness of males)

Selection pressures

1. Where selection pressure are strong, rate of evolution can be rapid
2. **Selection pressures** = environmental factors that influence which individuals in a population pass on their alleles
3. Selection pressures can be **biotic** (competition, predation, disease, parasitism) or **abiotic** (changes in light, humidity, pH, salinity, temperature)

Genetic drift

1. **Genetic drift** = when chance events cause unpredictable fluctuations in allele frequencies from one generation to the next
2. Genetic drift is more important in **small populations** as alleles are more likely to be lost from gene pool
3. **Population bottlenecks** occur when a population size is reduced for at least 1 generation
4. **Founder effects** occur through isolation of some members of a population from a larger population. The gene pool of the smaller population isn't representative of the original gene pool
5. A gene pool is altered by genetic drift as certain alleles may be under-represented or over-represented and allele frequencies change.

Hardy-Weinberg equilibrium (HW)

1. HW principle states that, in the absence of evolutionary influences, allele and genotype frequencies in a population will remain constant over generations
2. **Conditions for maintaining the equilibrium** are: no natural selection, random mating, no mutation, large population size, no gene flow (migration in or out)
3. The HW principle can be used to determine whether a change in allele frequency is occurring in a population over time. Changes suggest that evolution is occurring.
4. $p^2 + 2pq + q^2 = 1$

   Where:

   p = frequency of dominant allele

   q = frequency of recessive allele

   p^2 = frequency of homozygous dominant genotype

   2pq = frequency of heterozygous genotype

   q^2 = frequency of homozygous recessive genotype

Fitness

1. **Fitness** = an indication of an individual's ability to be successful at surviving & reproducing
2. It refers to the contribution made to the gene pool of the next generation by individual genotypes. It can be absolute or relative.
3. **Absolute fitness** = $\frac{\text{frequency of a particular genotype after selection}}{\text{frequency of a particular genotype before selection}}$
4. If absolute fitness = 1, frequency is stable. > 1 = increase in genotype. < 1 = decrease
5. **Relative fitness** = $\frac{\text{number of surviving offspring per individual of a particular genotype}}{\text{number of surviving offspring per individual of the most successful genotype}}$

Co-evolution

1. **Co-evolution** = process by which two or more species evolve in response to selection pressures imposed by each other
2. Change in traits of one organism acts as a selection pressure on the other. Frequently seen in species involved in symbiosis
3. **Symbiosis** = co-evolved intimate relationship between members of 2 different species.
4. **Parasitism** = parasite benefits in terms of energy/nutrients and host is harmed by loss of energy/nutrients (+/-)
5. **Mutualism** = both organisms are independent on each other for resources so both gain (+/+)
6. **Commensalism** = only one organism benefits, the other is unaffected (+/0)
7. **Red Queen hypothesis** = in a co-evolutionary relationship, change in traits of one species can act as a selection pressure on the other species. This means that species in these