

Topic 7 – Genetics, population, evolution and ecosystems

Key words

Genotype – the genes present in an organism

Phenotype – the expression of the genes and their interaction with the environment

Alleles – different version of the same gene

Dominant – one allele is required for expression in the phenotype

Recessive – two alleles are required for expression in the phenotype.

Codominant – both alleles are expressed in the phenotype.

Diploid – are organism contains 2 alleles

Homozygous – the alleles at a specific locus are both the same – two dominant or two recessive.

Heterozygous – the alleles at a specific locus are both different – one dominant and one recessive.

Monohybrid – controlled by a single gene that has two alleles. For example, Bb

Dihybrid – the inheritance of two genes each controlled by two alleles. For example, BbGg.

Sex-linkage – genes are found on the sex-chromosomes. For example, X^hY

Autosomal linkage – two genes are present on the same chromosome and inherited together.

Multiple alleles – three or more alleles controlling a single gene. For example, C^w , C^B and C^g .

Epistasis – the interaction between genes that influence a phenotype.

Chi-squared test - this is to compare observed phenotypic ratios with expected ratios

Population – a group of organisms of the same species occupying a particular space at a particular time that can potentially interbreed.

Gene pool – the different genes in a population

Allele frequency – the frequency of any allele within a population.

Evolution – the change in allele frequency within a population

Community – the populations of different species within an area or habitat.

Ecosystem – the community and the non-living components.

Carrying capacity – the size of a population of a species an ecosystem can support

Niche – the role of a species within a habitat governed by the species adaptations to the biotic (living) and abiotic (non-living) conditions.

- 1) For **monohybrid** characteristics or sex-linked characteristics, you use a 2X2 Punnett square
 - a. For heterozygous alleles (that are not codominant) the phenotypic ratio will be 3:1.
- 2) For **dihybrid** characteristics that are either normal dihybrid inheritance, co-dominant or epistatic alleles you use a 4x4 Punnett square.
 - a. For heterozygous dihybrid characteristics (E.G. BbGg) the phenotypic ratio will be 9:3:3:1
- 3) For **Sex-linked** characteristics the alleles are only found on X chromosomes, no alleles are present on the Y chromosome. For example, X^HY
- 4) **Co-dominant** alleles are represented by a superscript letter. This is to show the allele is on the same gene. For example, C^w , C^B and C^g .

- 5) **Autosomal linkage**, genes are linked when two or more genes are presented on the same chromosome. This means they will be inherited together. This will mean the ratio will not be the expected ratio as the only way the alleles are inherited together is crossing over.
- 6) The **hardy-Weinberg** principle predicts the allele frequency
- 7) The **hardy-Weinberg** principle assumes
 - a. Every individual has an equal chance of mating with every other individual and the mating is totally random
 - b. There are no selection pressures
 - c. There are no mutations
 - d. No migration
 - e. Large population
- 8) The equation you need to use is $p^2 + 2pq + q^2 = 1$ and $p + q = 1$
- 9) P is the frequency of dominant alleles and q is the frequency of recessive alleles
- 10) Individuals within a population of a species show a wide range of **variation** in phenotypes
- 11) The **variation** is due to **genetic** and **environmental factors**
- 12) The main source of variation is caused by genetic mutations
- 13) During **meiosis** further variation is created from crossing over and independent assortment of homologous chromosomes. And the **random fertilisation** of gametes
- 14) Natural selection can cause:
 - a. **Stabilising selection** is when the mean characteristic is selected for. For example, birth weight, the mean birth weight is an advantage.
 - b. **Disruptive selection** is when both the extreme characteristics are selected for. This may eventually lead to the population being divided into 2 groups.
 - c. **Natural selection** results in a species that are better adapted to the environment.
- 15) **Natural selection** happens when, predation, disease or competition results in differential reproductive success.
- 16) **Natural selections**
 - a. Variation within the population
 - b. Differential reproductive success
 - c. The more successful can survive and reproduce
 - d. Pass on successful alleles to the next generation
 - e. This will affect the allele frequencies within a gene pool.
- 17) **Speciation** is when two species are created from one species
 - a. The population is reproductively isolated
 - b. There will be variation in the two new populations
 - c. This will lead to differential reproductive success
 - d. Natural selection will lead to differences in the gene pool
 - e. The two new populations can not interbreed to produce fertile offspring so there are now separate species
- 18) **Allopatric** – when organisms are geographically isolated
- 19) **Sympatric** – when organisms occupy the same space but are reproductively isolated.
- 20) **Genetic drift** – there is variation in the population and due to chance, the allele frequency changes in the gene pool
- 21) **Genetic drift** can occur in small populations

22) An ecosystem can support a certain size of population of a species this is called the **carrying capacity**.

23) The **population** size can vary as a result of the **abiotic** factors.

24) The **population** size can be estimated using

a. **Quadrats** for slow moving or non-motile organisms

i. **Random** – estimate the population

1. Split the area into a grid
2. Use a random number generator to select co-ordinates to be sampled
3. Put the quadrat into the selected co-ordinate and count the number of organisms inside the area.
4. Sample enough locations for the sample to be representative and calculate a mean per 1m².
5. Times the mean population by the area of the habitat being sampled.

ii. **Belt transect** – the effect of an abiotic factor on the distribution of a species

1. Lay down a transect line
2. Put the quadrat down at even distances away from the abiotic factor
3. Each time count the number of organisms within the quadrat.
4. Plot the number of species on a graph to look for correlations.

b. **Mark-release-recapture** is used for motile organisms

i.
$$\text{estimated population} = \frac{(\text{total number captured in 1st sample}) \times (\text{number marked in 2nd sample})}{(\text{total number recaptured in 2nd sample with mark})}$$

ii. Some organisms are trapped and are marked it is important that the mark doesn't hinder the organism.

iii. The organisms are released into the population, enough time needs to be left for them to randomly mix in the population before recapturing a second sample.

iv. This technique makes several assumptions

1. Each individual has an equal chance of being captured
2. Marking does influence an individuals chance of being recaptured.
3. No births, deaths or immigration

25) **Ecosystems** are **dynamic** systems, they constantly change.

26) **Primary succession** – where the environment has no vegetation present and there is no soil present for example, after a volcano or a glacier retreat.

27) **Secondary succession** – occurs when the ecosystem has been disturbed for example, after a forest fire.

28) **Succession** starts with pioneer species – plants that can grow in hostile environments

a. **Pioneer** species occupy the hostile area

b. The pioneer species will change the abiotic conditions environment that can result in a less hostile environment.

i. For example, forming more soil, adding more organic matter, increasing nutrients within the soil.

c. This allows other species to occupy the new niches created and survive

d. This changes the biodiversity – the new species may change the environment that makes it less suitable for the previous species.

e. This increases the stability and creates a less hostile environment

f. Eventually a **climax community** is reached

29) **Conservation** of habitats frequently involve management of succession for example, tress will not be allowed to grow in a grass meadow.