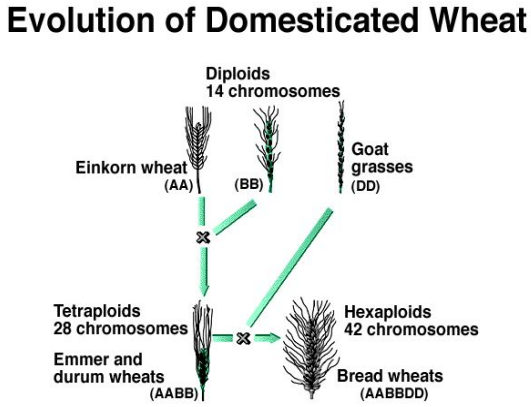
Chapter 3

What is a Species?

This can be defined in two ways:

1. Members of one species are **similar to each other, but different from members of other species.**
2. Members of one species **normally breed with each other, to produce fertile, viable offspring**.

Speciation: New species arise in two ways – both relying on (different) mutations to occur:



1. **Hybridisation of two existing species.**

   Normally such offspring (e.g. mules) are sterile, since their chromosomes cannot form homologous pairs in meiosis. However, if the number of chromosomes doubles, then fertility is restored. **This can only occur in plants**, and is known as **polyploidy.** This is how modern **bread wheat** (6n), has evolved (*see right*). The older Durum wheat (4n) is still used to make pasta.

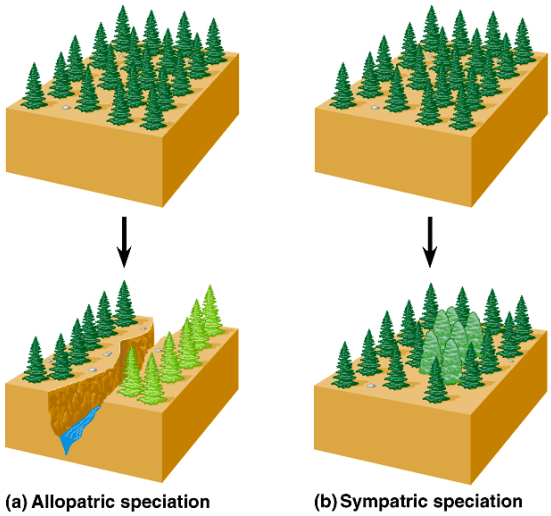
2. **By separation of groups of one species.**

   This is the **only** method by which new animal species can arise. Over time, the reproductive isolation of the two groups leads to their genetic isolation too, and mutations and changes to the allele frequency (in response to environmental changes) will differ. Thus two separate species form. (*see defn. 2, above*)

The essential part of this process is **the isolation of the groups**. This, too, can occur in two ways:

1. **Allopatric speciation.** This occurs if the two groups are **geographically isolated**, such as on an island, or by mountains, desert, or seas. It was whilst observing the unique animals on each of the Galapagos Islands that Darwin first formulated his Theory of Evolution.

2. **Sympatric speciation.** This occurs when two overlapping species do not interbreed due to some other factor, usually a change in breeding season. Most species are only fertile for a short time, so a small change in timing can easily lead to **reproductive isolation**. Alternatively, species may inhabit **different areas within the same region**. Birds often nest at different heights and feed on different food, leading to the **selection of different alleles** for different beak sizes and shapes and, eventually, to new species. Even if mating does occur, the gametes of the two groups may not fuse, or the zygote may not develop, or be infertile. These factors would all **prevent interbreeding**, and so ensure that **reproductive isolation** continues and so the new species remain distinct.



If the distributions of **two species overlap**, and **there are fertile hybrids found in this region**, then **they are not separate species**; if, however, **no fertile hybrids are found**, then **two separate species exist.**

The Five Kingdom Classification

This is the system of classification that you are required to know, though it has long been superseded as the preferred system by biologists. The study of classification is known as **taxonomy**, and each group of organisms within a group is known as a **taxon**. [*Note the Latinised versions of these names are preferred by AQA over the English equivalents*]. The 5 kingdoms are:

Prokaryotae (Prokaryotes (all bacteria). NB – taxonomists now split this group into two)

Protoctista

Fungi

Plantae

Animalia

Each of these **K**ingdoms is then sub-divided into 6 hierarchical taxons, so that the final system is:

Kingdom; Phylum; Class; Order; Family; Genus; Species

(Keep **P**onds **C**lean **O**r **F**rogs **G**et **S**melly)

When writing the scientific name of a species, it is *typed in italics*, with the **G**enus having a **C**apital **L**etter and the **s**pecies having a **l**ower-**c**ase **l**etter. *(*e.g. *Homo sapiens*). When *hand-writing the name it is underlined* – *Homo sapiens.*

You need to remember the key differences between Prokaryotes and Eukaryotes (Module 1):

Feature	Prokaryotes	Eukaryotes
Size	**Small** (1-10μ)	**Larger**, (10-100μ)
Structure	**Capsule** may be present Cell wall – made of **murein** **No** membrane-bound organelles **70S ribosomes**	**Never** have a capsule Cell wall **may** be present (Plants & Protoctista – **cellulose**; Fungi – **chitin**) **80S ribosomes**
Genetic material	**'naked' ccc DNA** Found free in cytoplasm as **nuclear body**	DNA coated with **histone proteins** **DNA linear**, in chromosomes Chromosomes in membrane-bound **nucleus**
Cell division	**Binary fission** – **no spindle**	**Mitosis** or **meiosis**, involving a **spindle**
Metabolism	Very variable - Can be **photosynthetic** (many methods, some using sulphur); **May or may not require oxygen**	All similar – **respiration based on glucose** **Photosynthesis mechanisms all similar** All **require oxygen** (though some fungi can tolerate anaerobic conditions)

You need to learn the main features (at least **two each)** for each of the 5 Kingdoms, but, **other than that**, this topic is largely ignored by the examiners:

Prokaryotae: (NB, these known by everyone but AQA as **Monera**):

Unicellular or colonial; have a cell wall (**murein**); 70S ribosomes; **no** nucleus (have a **nuclear body**); 'naked' cccDNA, not linear; **no** chromosomes.

Protoctista:

Eukaryotic; may be unicellular, colonial or multicellular; classified here if cannot be placed in any of the other Kingdoms.

Fungi:

Eukaryotic; have **chitin cell wall**; made of **tubular hyphae**, forming a thread-like **mycelium**; **never** have cilia or flagellae; heterotrophic nutrition; reproduce by **spores**, produced by **mitosis**.

Plantae:

Eukaryotic; have **cellulose cell wall**; **photosynthetic**; have a complex life-cycle, with 2 stages – a haploid sexual stage (**gametophyte**) and a diploid spore-forming stage (**sporophyte**).

Animalia:

Eukaryotic; no cell wall; heterotrophic nutrition; zygote forms a blastula (hollow ball of cells); have nervous systems.

The **probable evolution** of these different groups is shown here (*right*). The Prokaryotes have been split into two groups – those bacteria with a metabolism similar to all other life-forms (**Eubacteria**) and those that clearly must have existed earlier, when the Earth was very different from today. (**Archaebacteria**).

This latter group includes the key organisms in the Nitrogen cycle and also many others that respire in unusual ways. Most extraordinary of all are those that live around deep-sea volcanic vents, which are found where the Tectonic plates are moving apart - such as the mid-Atlantic Ridge. Here life exists at over 300C and at extraordinary pressures – but, uniquely, does not depend on the Sun for energy.