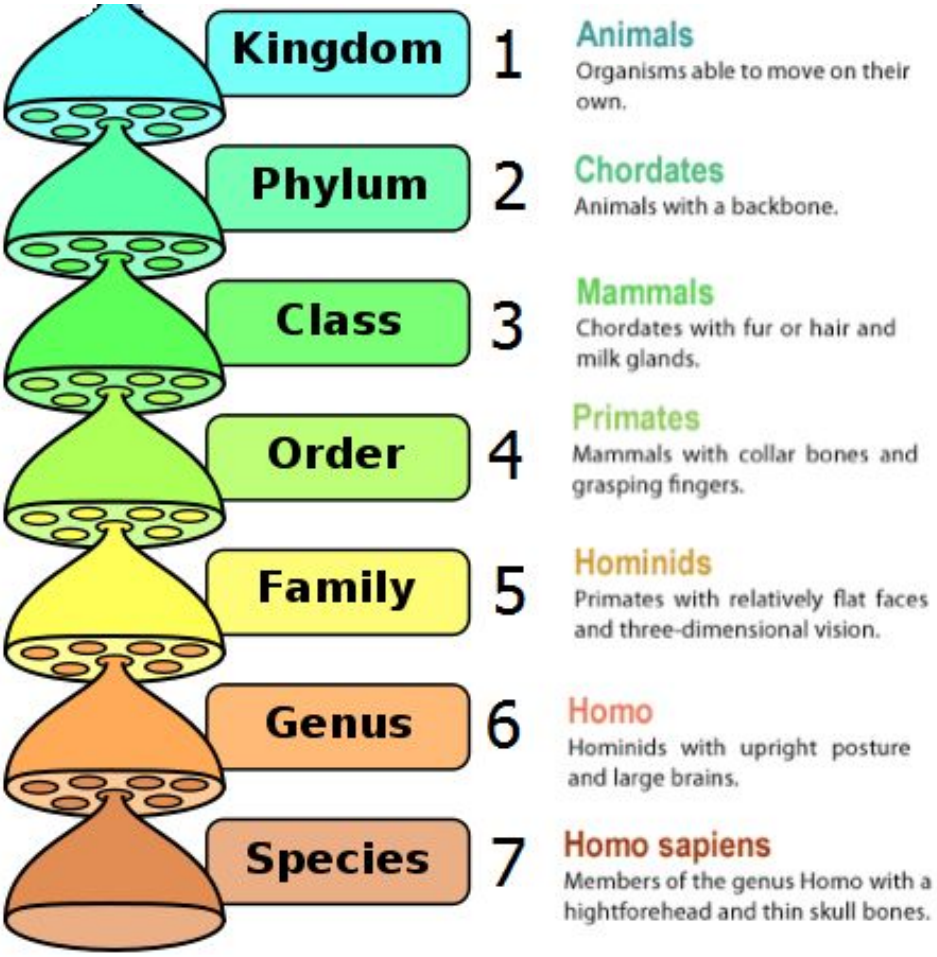
MEGA LECTURE

Edexcel (B) Biology A-level

Topic 3: Classification and Biodiversity

Notes

Classification is the process of **naming and organising organisms into groups based on their characteristics.** Organisms can be grouped into one of the five kingdoms: **Animalia, Plantae, Fungi, Monera (prokaryotes) and Protoctista.** They can then be grouped further into **phylum, class, order, family, genus and species**. Each species is named according to the **binomial system**, the first part of the name is the genus and the second part of the name is the species e.g. *Homo sapiens*.



The analysis of molecular differences in different organisms to determine the extent of their evolutionary relationship is known as **molecular phylogeny**. The data obtained by molecular phylogeny has been accepted by scientists and this gave rise to new taxonomic groupings – all organisms can be separated into one of the **three domains: Bacteria, Archaea and Eukaryota.**

An example of a technique used in molecular phylogeny is gel electrophoresis:

1. Make wells in agarose jelly.
2. Put DNA fragments cut with **restriction endonuclease enzymes** in them (known and unknown).
3. Dye the DNA with something that fluoresces (and moves faster than the DNA).
4. Turn on a current.

5. DNA is **negatively charged** so it moves towards the anode.
6. Turn the current off.
7. Turn the UV light on.
8. **Different bands** represent **different amino acids** and can be compared to known fragments.

Gel electrophoresis, as well as DNA sequencing and bioinformatics, can be used to distinguish between species and determine evolutionary relationships.

The scientific community evaluates the data in the following ways:

- The findings are published in **scientific journals** and presented at **scientific conferences**.
- Scientists then study the evidence in a process called **peer review.**

Species = a group of organisms which can interbreed to produce fertile offspring.
This is the accepted model of a species and is referred to as the **reproductive model.** However, the model has some limitations, as cross-breeding occurs and some members of the same species don't interbreed due to geographical isolation but would produce fertile offspring. There are also other models of a species, like the ecological, mate-recognition, genetic, and evolutionary models.

Biodiversity

Biodiversity is the **variety of living organisms.** Biodiversity can be measured in terms of:

- **Species richness** - the **number of different species in a habitat.**
- **Genetic diversity** - a measure of the **genetic variation** found in a particular species, in other words, the **number of alleles in a gene pool**.

Biodiversity can also be measured using the **index of diversity (D)** which can be calculated as follows:

$$D = \frac{N(N-1)}{\sum n(n-1)}$$

D = Diversity index

N = total number of organisms of all species

n = total number of organisms of each species

Σ = the sum of

Endemism is the state of a species being **unique to a particular geographical location,** such as an island, and not found anywhere else.

Conservation

Conservation can be in-situ (in an organism's habitat) or ex-situ (outside of an organism's habitat). Both methods of conservation have **risks and benefits.**

Ex-Situ:

- **Captive breeding programmes** in which endangered species are carefully bred to increase genetic diversity and population size. Genetic diversity is maintained via the exchange of organisms and gametes, keeping stud books, preventing inbreeding and use of techniques such as IVF.
- **Reintroduction programmes** aim to release animals bred in captivity into their natural habitat as well as to restore lost habitats.
- **Seed banks** store a large number of seeds in order to **conserve genetic diversity** and prevent plant species from going **extinct**. Storing seeds instead of plants means that a **large variety of species can be conserved**, and it is cheaper than storing whole plants as it takes up **less space**. The seeds are stored in **cool, dry conditions** as this maximises the amount of time they can be stored for and they are **periodically tested for viability**.

In-Situ:

- **Education programmes** which aim to educate people about the importance of maintaining biodiversity, captive breeding programmes as well as illegal trade of animal products.
- Initiatives such as **National Parks** and **Sites of Specific Scientific Interest** aim to conserve habitats and biodiversity.

One reason for conservation of ecosystems is that they provide Ecosystem Services. These services can be provisioning, regulating, supporting or culturing.

Natural Selection and Evolution

The **niche** of a species is **its role within its ecosystem/habitat**. Species which share the same niche compete with each other and the better adapted species will survive. The idea that better adapted species survive is the basis of **natural selection**.

Organisms are adapted to their environment in various ways:

- **Anatomical adaptations** are physical adaptations, either external or internal e.g. presence of long loops of Henlé which allow desert mammals to produce concentrated urine and minimise water loss.
- **Behavioural adaptations** are **changes in behaviour** which improve the organism's chance of survival e.g. mating calls.

- **Physiological adaptations** are **processes involving enzymes/hormones** that increase an organism's chance of survival e.g. regulation of blood flow through the skin.

Natural selection is the process in which **fitter individuals** who are **better adapted** to the environment are more likely to **survive and reproduce** and **pass on the advantageous alleles** to their offspring.
Evolution is the process by which the **frequency of alleles in a gene pool changes over time** as a result of natural selection.

Evolution via natural selection:

- A **variety of phenotypes** exist within a population due to mutations.
- An **environmental change occurs** and as a result of that, the **selection pressure changes.**
- Some individuals possess **advantageous alleles** which give them a **selective advantage** and allow them to **survive and reproduce.**
- The advantageous alleles are **passed on to their offspring.**
- Over time, **the frequency of alleles in a population changes**.

If two populations become **reproductively isolated**, new species will be formed. This is due to the accumulation of different genetic information in populations over time due to different environments and selection pressures. This is called **speciation.**

Speciation can be **allopatric** (where the isolation is geographic) or **sympatric** (another type of isolation e.g. temporal, behavioural, gametic etc.).

An example of evolution is the ongoing **evolutionary race** between antibiotics and bacteria as **pathogens evolve adaptations** which enable them to survive and reproduce. **Antibiotic resistance** is present in the population due to mutations. Antibiotics kill all non-resistant bacteria. This removes the competition for resistant bacteria, which survive, reproduce and pass on the resistance alleles to their offspring. Eventually, a completely resistant population is formed.