Biodiversity and Classification
Aristotle's Classification System

Living Things

Plants
- Small
- Medium
- Large

Animals
- Land
- Water
- Air

The Five Kingdoms of Life

- Plants
- Fungi
- Protists
- Animals
- Bacteria
Biodiversity of life on earth

There are a great variety of organisms (plants and animals) which co-inhabit the earth.

These organisms occur in many different forms and sizes. Some of them are invisible to the naked eye. What are these organisms called? Or they may be very large. Such as elephants and whales.

These different species can live in a variety of different habitats. Remember that they are also genetically different from each other.
Biodiversity of life on earth

The SSC indicates that there are a total of 1,642,189 different species of organisms.

What is the SSC and what does it stand for?

Remember this number only includes the known species i.e. species that have been studied and described.

There are many unknown species.

Can you tell why these species are described as unknown?

So this means that the number of species could actually be much larger!
This wide range of species and the number of organisms making up each species within communities is referred to as...

*biodiversity*
Biodiversity and endemism in southern Africa

**Indigenous**: species that occur naturally in a certain area. Remember that these indigenous species may be found in many different places on earth. If species are brought into an area they are called **alien** or **exotic species**.

Sometimes however species are indigenous to a particular area but they are found nowhere else in the world, such species are called **endemic**.

Endemism describes the number and range of species specific to a particular area.
Biodiversity and endemism in southern Africa

There are 8 different biomes in the southern African region, including Lesotho, Swaziland, Mozambique, Botswana and Namibia.

The vegetation in each biome differs.

These biomes are able to support a variety of life forms. Many of these life forms are endemic.
Biodiversity and endemism in southern Africa

South Africa occupies only 1% of the total land mass of Earth and 10% of the world’s biodiversity is found here.

For this reason South Africa is placed 3rd in the world in terms of biodiversity.

Our country is also very important because we have a large number of endemic species.

South Africa is the 24th richest country in the world in terms of endemic species.
Biodiversity hot spots

Three places in South Africa are recognized as international biodiversity hotspots. These are the Cape Floristic Region, Succulent Karoo and the Maputoland-Pondoland-Albany hotspot of Eastern Cape.

These areas are recognized as hotspots because of the variety of life forms they support and the large number of endemic species found in each area. However ... many of these life forms are threatened with extinction!
Something for you to do:

In this sub section we came across many terms.
Can you able to define the following terms.

1. Indigenous
2. Exotic
3. Endemic
4. Endemism
5. Alien
6. Biodiversity hot spot
7. Biodiversity
Solution

1. Species that occur naturally in that area
2. Species that are introduced to an area
3. Species that occur naturally in a particular area and nowhere else in the world
4. The number and range of species that are endemic to a locality
5. Species that are introduced to an area
6. Internationally recognized places of high diversity and rich endemism.
7. Wide range of species and the number of organisms making up each species.
Classification and taxonomy

**Classification** refers to the **grouping and sorting** of things according to similarities and differences. Life forms are **put into groups** as a result of classification. This makes it **easier** for the scientist to **study** these life forms.

**Taxonomy** refers to the **science of naming and classifying** a wide range of living things. This classification is recognized world-wide. Sub-groups are called **taxons**.
Aristotle's and Carl Linnaeus gave rise to the modern classification system. Aristotle (384-322 BCE) classified living organisms into two groups: plants and animals.

He further classified plants into three groups: herbs, shrubs or trees. Animals were classified into two groups: those with red blood and those without. He also classified animals according to the modes of locomotion: flying, walking or swimming. He classified about 1000 plants and animals.
History of classification of life forms: Carl Linnaeus – the father of modern taxonomy

He also classified living things into two groups: plants and animals.
History of classification of life forms

There were a large number of other scientist that classified living organisms.

Up until the middle of the 19\(^{th}\) century the physical appearance of the organisms was used as a criteria to classifying them.

The anatomy of different organisms were studied and organisms were placed into groups depending on similarities and differences.
History of classification of life forms: Charles Darwin

Charles Darwin published his book in 1859. It was called “On the Origin of Species”. In this book he put forward his theory of evolution.

His theory was accepted in the second half of the 19th century. From this point on scientist began to stress evolutionary relationships in their classification systems.
History of classification of life forms

Comparative anatomy was no longer the only criteria used in classification of living organisms. Evidence from paleontology and embryology was now also used.

Evidence from genetics and physiology became important for classification in the 20th century.

The use of evidence from molecular biology and genetics was also used in the middle of the 20th century and the beginning of this century.
Examples of classification systems

The three classification systems that are more common:

• Two kingdom system
• Five kingdom system (most commonly used today)
• Three domain system
Examples of classification systems: Two Kingdom classification system

All organism may be grouped as plants or animals. Therefore two kingdoms are present: Plantae and Animalia.

This is the classification system that Linnaeus developed.
Two kingdom classification system

The following characteristics are used to classify organisms as plant or animals:

❖ Plants are able to manufacture their own food by **photosynthesis**, while animals are unable to. Why?
❖ Plant cells are surrounded by an **outer cellulose cell wall**, while animal cells do not have cell walls. What do they have instead?
❖ Plants are **sessile or sedentary** creatures, meaning that they do not move, while animals are motile.
Diagram of Two kingdom classification system

All living organisms

Kingdom Plantae
- Are able to make own food
- Have a cell wall
- Sedentary

Kingdom Animalia
- Can't make own food
- No cell wall
- Motile
Two kingdom classification system

In 1645 Aton van Leeuwenhoek observed bacteria using a very simple microscope. As more and more complex microscopes were developed more microscopic organisms were discovered and some of them could not fit into the two kingdom classification system.

Some scientist tried to make them fit. Bacteria and fungi were described as plants because bacteria had a cell wall and fungi could not move.
Carl Linnaeus

He developed the **binomial system** of naming organisms.

In this system each organism is given **two names**: a generic name and a specific name. He developed a nested system or **hierarchical system** to show **similarities** between organisms.
Carl Linnaeus

According to the nested system:

Similar *species* are placed in the same *genera*
Similar genera are placed in the same *family*
Similar families are placed in the same *order*
Similar orders are placed in the same *class*
Similar classes are placed in the same *phylum*
Similar phyla are placed in the same *kingdom*. 
Carl Linnaeus: Example of nested system

<table>
<thead>
<tr>
<th>Kingdom</th>
<th>Animalia</th>
<th>Animalia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phylum</td>
<td>Chordata</td>
<td>Chordata</td>
</tr>
<tr>
<td>Class</td>
<td>Mammalia</td>
<td>Mammalia</td>
</tr>
<tr>
<td>Order</td>
<td>Primates</td>
<td>Primates</td>
</tr>
<tr>
<td>Family</td>
<td>Hominidae</td>
<td>Pongidae</td>
</tr>
<tr>
<td>genus</td>
<td><em>Homo</em></td>
<td><em>Pan</em></td>
</tr>
<tr>
<td>species</td>
<td><em>sapiens</em></td>
<td><em>troglodytes</em></td>
</tr>
</tbody>
</table>
Five kingdom classification system: terminology

Developed by Robert H. Whittaker in 1969. All living organisms were placed into 5 kingdoms based on certain characteristics.

Important information to know:
A true nucleus is a nucleus that is surrounded by a nuclear membrane. Organisms that possess true nuclei are called eukaryotes.
Five kingdom classification system: terminology

The organelles in eukaryotes are all bound by membranes. All organism with nuclear material not enclosed by membranes are called prokaryotes.

All the organelles found in prokaryotes do not have membranes.

The autotrophic organisms are those that are able to manufacture their own food by photosynthesis.

The heterotrophic organisms are those organisms that are unable to manufacture their own food.
Five kingdom classification system: terminology

The organisms that feed on dead and decaying matter are called saprotrophes.

The organisms that live of dead and decaying matter are called saprophytes.

Decomposers are those organisms that feed on dead material or the wastes of living organisms. As they feed they release important nutrients for recycling.

Organisms that are made up of only one cell only are called unicellular.

Multicellular are those organisms that are made up of many cells.
Five kingdom classification system: classification into the 5 different kingdoms

- Body structure (unicellular, multicellular, colonial)
- Cell structure (nucleus, organelles)
- Cell wall composition (cellulose, chitin, peptidoglycan, none)
- Motility (present, absent)
- Mode of nutrition (autotrophic, heterotrophic)
- Reproduction (asexual, sexual, embryonic development)
Five kingdom classification system: development

The organisms were separated in the following way: Into **prokaryotes** and **eukaryotes**.

All the prokaryotes were placed into one kingdom: **Kingdom Monera**.

Kingdom Monera is made up mainly of **bacteria** and the **blue green algae**.

Multicellular eukaryotes were placed into three kingdoms.
Five kingdom classification system: eukaryotes

These three kingdoms are as follows:

1. Kingdom Plantae: is made up of autotrophic organisms.
2. Kingdom Animalia: is made up of heterotrophic organisms (organisms that ingest food and digest it inside their own bodies).
3. Kingdom Fungi: these are also heterotrophic organisms, but they obtain food by secreting enzymes into the food and then absorbing the digested food. Many of the organisms found in this kingdom are decomposers.
Five kingdom classification system: Protists

However there were many eukaryotic organisms that did not fit into any of the three kingdoms. These organisms into the Kingdom Protista. Most of the organisms in this kingdom are unicellular.

There are certain characteristics or criteria that are used to develop the five kingdom classification system (see next slide).
All living organisms

Prokaryote
No true nuclei

Eukaryotes
true nuclei

Kingdom Monera

Kingdom Plantae

Kingdom Protista

Kingdom Fungi

Kingdom Animalia

Multicellular

Unicellular

Autotrophic

Heterotrophic

Food is digested and then taken it

Food is taken in then digested
Three domain system of classification

As more information becomes available, more debates occur about the relationship amongst the organisms.

Therefore classification systems are evaluated and changed.

Scientists have recently put forward the three domain system of classification
Three domain system of classification

According to the three domain system:

- All eukaryotes are placed in the Domain **Eukarya**
- The prokaryotes have been divided into **two domains**
  - Domain **Achaea** and Domain **Eubacteria**
  - The Domain Eubacteria consists of the **true bacteria**.
  - The Domain Archaea are made of prokaryotes that are **different from true bacteria** in both their genetic make up and their metabolism.
Something for you to do:

Provide the **biological terms** for the following:

1. Sorting and grouping things according to similarities and differences
2. Organisms that do not have a definite nucleus or other membrane enclosed organelles.
3. Heterotrophic organisms that feed on dead organic matter
4. The domain in which all eukaryotes are placed in the three domain system
Solution:
1. Classification
2. Prokaryotes
3. Saprotrophs
4. Eukarya
Something for you to do:

Answer the following question:

1. Name the 7 different categories or taxa developed by Linnaeus.
Solution to the question

1. Kingdom, phylum, class, order, family, genius and species.
Main Characteristics of each of the five Kingdoms: Kingdom Monera

Made up of the **bacteria and the blue-green algae.**

Bacteria are **unicellular and microscopic.**

Some bacteria are **colonial**, meaning that while they occur in groups each bacteria functions on its own.

Bacteria are **prokaryotes.**

Some bacteria are **autotrophic** therefore they are able to manufacture their own food by **photosynthesis** or **chemosynthesis.**
Kingdom Monera

Chemosynthesis means that they are able to manufacture food using energy released from chemical processes. Most bacteria are heterotrophic. Some of the heterotrophic bacteria are parasitic or saprotrophic. Some parasitic bacteria may be pathogenic. Some heterotrophic bacteria live on or in other living organisms and have close relationships with them. This type of relationship is called mutualism. Reproduce asexually by binary fission. Play an essential role in nutrient recycling.
Kingdom Protista

This kingdom includes the slime moulds, protozoan and algae.

Most are unicellular but some are multicellular. Therefore they may be microscopic or macroscopic. Some of the unicellular protists can be colonial. They are all eukaryotes.
Kingdom Protista

Protists are not identical in appearance. They also differ in the way in which they obtain their food. Therefore they are divided into 3 groups based on nutrition and appearance. These 3 groups are: algae, protozoan and slime moulds. The algae are plant-like and autotrophic. Can you suggest why they are described as being plant-like and how are they able to make their own food?
Kingdom Protista

The protozoans are animal-like and they obtain their food from other plants or animals or dead organic matter.

Why are they described as animal-like and why are they unable to make their own food?

The slime moulds are like fungi.

Why?

They are motile and reproduce sexually.
Kingdom Fungi (Mycota)

Mushrooms, yeast and mould found on bread and jam etc. are found in this kingdom. Some have plants-like features and some are different from plants.

Eukaryotes with cell walls. They are heterotrophic.

Some are parasitic while others are saprotrophic, mutualists or predators.

Fungi maybe unicellular and multicellular.
Kingdom Fungi (Mycota)

They all produce spores.

Some produce spores in sporangia.

Some produce spores in club shaped structures. These structures are usually found within the cap-like fruiting bodies: mushrooms.

Others produce the spores in sac like structures like *Penicillium*

Many consist of hyphae

Reproduce sexually as well as asexually
Kingdom Plantae

Organisms belonging to this kingdom are eukaryotes, all have cell walls, they are all multicellular and have chloroplasts. Does not include algae (Protista)

They are autotrophic.

Some plants are vascular: they have xylem and phloem which is used for transport of mineral salts and water.

Such plants have true roots, stems and leaves because they have vascular tissue.

Vascular plants may be divided into seed producing plants and non-seed producing plants.
Kingdom Plantae

Some plants do not have vascular tissue. These plants are called *thallus plants* because they do not have true roots stems and leaves.

They have *root-like structures* called *rhizoids*, stem-like structures and leaf-like structures.
Kingdom Animalia

These organisms occupy a variety of habitats. They are multicellular. They do not have cell walls around their cells. They do not have chlorophyll. Therefore they are heterotrophic.

There are huge differences in appearances. They can be subdivided into vertebrates and invertebrates. Do you know the differences between vertebrates and invertebrates.
# Difference between prokaryotes and eukaryotes

<table>
<thead>
<tr>
<th>Prokaryotes</th>
<th>Eukaryotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circular DNA free in cytoplasm</td>
<td>DNA inside membrane-bound nucleus</td>
</tr>
<tr>
<td>DNA is simple, circular</td>
<td>DNA forms chromosomes</td>
</tr>
<tr>
<td>Smaller ribosomes</td>
<td>Larger ribosomes</td>
</tr>
<tr>
<td>No ER</td>
<td>ER present</td>
</tr>
<tr>
<td>Very few organelles</td>
<td>Many organelles</td>
</tr>
<tr>
<td>Cell wall always present</td>
<td>Cell wall sometimes present</td>
</tr>
</tbody>
</table>
This wide range of species and the number of organisms making up each species within communities is referred to as biodiversity.

**Indigenous**: are species that occur naturally in a certain area. If species are brought into an area they are called **alien or exotic species**.

Sometimes species are indigenous to a particular area but they are found nowhere else in the world, this is called **endemic**.
**TERMINOLOGY**

*Endemism* describes the **number** and **range** of species endemic to a particular area. Internationally recognized places of high diversity and rich endemism are known as **biodiversity hot spots**.

*Classification* refers to the grouping and sorting of things according to **similarities** and **differences**.

*Taxonomy* refers to the **science of naming** and **classifying** a wide range of living things.
TERMINOLOGY

Organisms that possess true nuclei are called **eukaryotes**. All those organism with nuclear material that were not enclosed by membranes are called **prokaryotes**. The **autotrophic** organisms are those that are able to manufacture their own food by **photosynthesis**. The **heterotrophic** organisms are those organisms that are unable to manufacture their own food.
TERMINOLOGY

The organisms that feed on dead and decaying matter are called saprotrophs.

The organisms that live of dead and decaying matter are called saprophytes.

Decomposers are those organisms that feed on dead material or the wastes of living organisms.

Organisms that are made up of 1 cell only are called unicellular.

Multicellular are those organisms that are made up of many cells.
**TERMINOLOGY**

**Colonial** organisms are *unicellular* organisms that live in a group but each organism functions on its own.

**Vascular plants** are plants that have vascular tissue.

**Thallus plants** that do not have vascular tissue.
How species are named

• Each species is given two names which is the same everywhere in the world (binomial nomenclature)
• *Genus* (surname) *species* (first name)
• Type in italics or underlined when written
• Always in Latin
• Usually has a common name too
• Genus written with capital and can be abbreviated
Why do we use classical languages?

- History – Latin was used in the scientific world when taxonomy was developed
- Stability – to change now would result in chaos
- Neutrality – “dead languages” are politically neutral
Biological Keys

A series of questions that highlight visible characteristics of an organism. The answer leads to the next question and the field is subsequently narrowed to a final identification.

Biological keys are often based on a hierarchical classification and are very useful.

Activity 3 page 263 - 265