THE CLASSIFICATION OF LIVING ORGANISMS

Biodiversity

We know that the biosphere contain various living organisms which includes plants, animals and micro-organisms. The various living organisms in a specific area are known as biodiversity. An environment that has many types of plants and animals has high biodiversity, whereas an environment that has only a few plants and animals has low biodiversity.

All living organisms carry out the seven life processes and therefore are similar in some ways. However, they are also different from each other in structure and function.

Living Organisms have Similarities and Differences

Living organisms can be grouped according to the things that they have in common.

Classification is sorting living organisms into groups, based on their similarities. Living organisms are sorted and classified according to characteristics that they share.

Early-day classification systems were based on new discoveries of organisms from around the world. It was in the Renaissance period that scientists began to look carefully at organisms and tried to group them together, for example, grouping plants, by the structure of the seeds and fruit.

Carl Linnaeus (1707 to 1778) was a 28-year old Swedish botanist whose species classification is still used to this day. He presented a hierarchical structure for classifying organisms in the natural world. From this, the biological names of plants and animals were established.
Grouping Living Organisms

The Linnaean classification uses a hierarchy of groupings at seven different levels, from *Kingdom* down to *Species*, in a structured *taxonomy*.

**Kingdoms**

There are 5 main groups of organisms, known as *Kingdoms*. Living organisms are classified into Kingdoms according to how they obtain their food and their cell structure.
Only two Kingdoms were originally classified by Linnaeus – plants and animals, but in the 19th and 20th centuries, three other kingdoms were recognised – bacteria, fungi and protista (algae and other single-celled organisms).

So the five Kingdoms are:

- animals (animalia)
- plants (plantae)
- bacteria
- protista
- fungi

Kingdoms are further subdivided into Phyla/Divisions, then Classes, then Orders, then Families, then Genera and then the smallest group, which is Species.
Phylum
The Five Kingdoms are further divided into Phyla (singular: Phylum). The Animal Kingdom has 35 Phyla and the Plant Kingdom has 12. There are also Subphylums in some cases. When classifying plants, the Pylum is called a Division. For animals, the grouping is based on body form, such as body cavities and embryonic development.

**Arthropoda (Arthropods)** is an example of a Phylum of the Animal Kingdom. Arthropods share the characteristics of a segmented body, jointed limbs and an exoskeleton made of chitin. There are over a million species of Arthropods. They are by far the largest group of animals.

Examples of Arthropods

Class
The next groups are the Classes. These are the major parts of a Phylum. There are 108 Classes of animals and 2 major Classes of plants (Angiosperms and Gymnosperms) in the taxonomy. For animals, this grouping is based on body covering, for example, birds have feathers.

The **Chordata** (Vertebrates) Phylum, for example, splits up into the classes of: **Mammalia** (Mammals), Actinopterygii (Bony Fish), **Chondrichthyes** (Cartilaginous Fish), **Aves** (Birds), **Amphibia** (Amphibians) and **Reptilia** (Reptiles).

Some Members of the Mammalia Class
Order
The classes are then divided into various Orders, which are part of a Class. In mammals, this grouping is based on skeletal and teeth arrangement.

The class Mammalia (Mammals), splits into various orders including Carnivora, Primate, Artiodactyla and Rodentia.

Family
Orders are further classified into the Families, based on skeletal features. A family is a subdivision of an order, containing one or more Genera. There are over 5000 Families of animals and around 500 Families of plants. Humans belong to the Homindiidae Family.

The Carnivora order divides into families that include Felidae (Cats), Canidae (Dogs), Ursidae (Bears), and Mustelidae (Weasels).
**Genera**
Families are then divided into *Genera* (singular: *Genus*). This is the generic name or type of the living organism. This classification is based on size and also other specific characteristics that they have in common.

The *Canis Genera*, for example, falls under the *Canidae* (Dog) Family. This Genus includes the domestic dog, wolves, jackals, coyotes and many extinct species.

![Four of the Canis Genera](https://via.placeholder.com/150)

*Four of the Canis Genera*
*Wikimedia Creative Commons
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**Species**
The smallest groupings in the taxonomy are the *Species*.

This grouping of living organisms is the lowest and most specific grouping of living organisms. Organisms are placed in a species depending on their ability to breed with other organisms of the same species. There are approximately 2 million species of animals, of which only 3% are vertebrates and 97% are invertebrates.
Example of Classification of Big Cats

An example of classification is shown below:

**Kingdom**
Big Cats fall under the *Animalia* Kingdom (animals).

**Phylum**
Big cats fall into the *Chordates* Phylum.

**Class**
Big cats fall into the *Mammalia* Class (mammals).

**Order**
Big cats fall into the *Carnivora* Order (carnivores), as they have prominent canine teeth.
Family
Big cats are classified as *Felidae* Family (cats) because of the arrangement of bones in their feet.

Genus
Big cats are classified in the *Panthera* Genus, because of their size and other finer features.

Species
*Panther leo* (lion) and *Panthera tigris* (tigers) are Species of big cats.

The name of each animal is in Latin, so it can be understood throughout the world. The name consists of two words, the first word is the Genus and the second word is the specific Species.

**Example of Classification of a Tiger**

**Kingdom:** Animalia (Animal)  
**Phylum:** Chordata (Vertebrate)  
**Class:** Mammalia (Mammal)  
**Order:** Carnivora (Carnivore)  
**Family:** Felidae (Cat)  
**Genus:** Panthera  
**Species:** Panthera tigris (Tiger)

**Bacteria Kingdom**

The Bacteria Kingdom is also known as *Monera*. The singular of bacteria is *bacterium*.

Bacteria are the oldest form of living organisms. Fossils of bacteria have been found that are thought to be about 3,8 billion years old.

Bacteria are all around us; in the air, in the soil, on our bodies and throughout nature. Bacteria live in almost every possible habitat.

There are more individual bacteria in existence than any other living organism. They are micro-organisms, so cannot be seen without a microscope.

Some bacteria are helpful and some are dangerous. The bacteria in your digestive system help to break down food so it can be absorbed.
Bacteria called ‘pathogens’ can cause diseases in humans, animals and plants. For example, the bacteria that causes food poisoning, pneumonia, typhoid fever and other infections.

Bacteria in the soil act as decomposers and break down dead plant and animal material. *Rhizobium* bacteria, for example, help to fertilise the soil with nitrogen, which assists in plant growth.

Bacteria are also useful when making food such as cheese, yogurt and dried fermented products like salami.

**Characteristics of Kingdom Bacteria**

- Bacteria are the simplest living organism. They are single-celled microorganisms.
- Bacteria are extremely small and measure 1 micrometre long and 0.5 micrometres wide.
- They can live in extreme environments.
- Bacteria can be round in shape (*coccus*), spiral shape (*spirillum*) or rod shaped (*bacillus*).
Bacteria cells reproduce asexually by cell division, i.e. the cell divides in two parts. Division occurs very quickly. One bacterium cell can multiply into one billion new cells over a period of ten hours.

The Structure of Bacteria

- Bacteria are unique in that they do not have a nucleus, so the DNA is spread through the cell, suspended in cytoplasm and controls the activity of the cell. Cells without a nucleus are called prokaryotic.
- The capsule is the protective covering of the cell.
- The cell wall is similar to plant cells. The cell wall gives the bacteria its shape. It controls what enters and leaves the cell.
- Some bacteria have flagella (like a tail) to help them to move. They can have one, two or many flagella.
- Pili or fimbriae are structures that allow bacteria to stick to things.
*Escherichia coli* (E. coli) is a rod-shaped bacterium found in the human intestine that aids digestion. Some E. coli however produce toxins that can cause food poisoning. E. coli is a parasite and is also *heterotrophic*. It can move using its flagella.

**Protista Kingdom**

This Kingdom is made up of simple, single-cell organisms, such as algae, most of which live in water. The singular of protista is protist.

**Characteristics of Kingdom Protista**

- Protista are found in a variety of habitats, such as freshwater (rivers and ponds), marine (the seas and oceans), in the soil and even on the bark of trees.

- Some Protista are similar to plants and others are more animal-like. The plant protists have *chloroplasts* and are called *Algae*. Animal protists do not have chloroplasts and are called *Protozoa* (or Protozoans). Other protists are similar to fungi.
• Protozoans and the fungi-like protists are *heterotrophs* which get their food from dead matter or living organisms in the surrounding environment.

• Unicellular protists reproduce by *cell division*, i.e., the cell divides into two parts, like bacteria. The amoeba, for example, reproduces every few days by splitting into two parts. Other protista reproduce *asexually* by forming spores.

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**Structure of Protista**

• Protista are mainly *unicellular*.

• They consist of one cell that has a *nucleus* and *cytoplasm*.

• Their DNA is contained in a nuclear membrane.

• The *organelles* (mitochondria, vacuoles etc.) are not permanent; they change according to changes in the environment.
In the diagram of the amoeba on page 12:

- The **cell membrane** is a thin layer of fat that surrounds the cell, allowing some substances to pass through and blocking others.
- The **nucleus** is the major organelle and controls functions such as eating, growth and reproduction.
- The **food vacuole** is where food is digested.
- The **contractile vacuole** is a cavity that excretes water and waste.
- The **cytoplasm** is the jelly-like substance that fills the cell and surrounds the organelles.
- The **pseudopods** are temporary feet that the amoeba uses to move around, as well as to engulf food.

There are many different types of protista and they vary in the way they feed and move, as well as their shape and size.

Protista have been classified into four main types:

1. **Amoebas**

There are around 10,000 species of amoeba, found in freshwater habitats. Amoebas do not have chloroplasts and are **heterotrophic**, as they eat other protists, bacteria and algae. They engulf and absorb their prey through their cell walls and the food is taken to the food vacuole.
Some types of amoeba can cause an illness in humans called *Amoebic Dysentery*, through a person eating or drinking infected food or liquids. These amoebas live in the intestine in the human body.

2. Ciliates

This group have tiny hair-like projections called *cilia* which help them to move.

*Paramecium* is a ciliate which does not have chloroplasts and is more animal-like. It is found in freshwater, marine environments and stagnant water. Paramecium is often used in a laboratory when studying biology and is also used to treat sewerage, as they eat bacteria.

3. Flagellates

This group have one or more *flagella* on their body, which are longer than cilia and help them to move.

There are around 800 species of flagellates, found in fresh and saltwater. Most of them have *chloroplasts* and can photosynthesize. They take in nutrition *heterrophically*, like animals. They therefore have some features of both plants and animals.
An example of a flagellate is *euglena*, which is a single-cell protist.

![Euglena](https://wikimedia.org/creative-commons/attribution-share-alike:Deuterostome)

Another human illness is caused by the flagellate *Trypanosoma brucei*. It is a parasite carried by the Tsetse Fly and causes a serious disease called *Sleeping Sickness* in East Africa.

4. Sporozoans

These protozoa cannot move on their own as they do not have either flagella or cilia. They are a *parasite* so must live inside a host, often a human.
Plasmodium is a sporozoan which is more commonly known as the malaria parasite. It has two hosts in its life cycle – a mosquito and a vertebrate. The infected mosquito will bite a human and in turn infect them with the parasite which travels to the liver and then the red blood cells.

Fungi Kingdom

The Fungi Kingdom is also known as the Kingdom Mycota. There are an estimated 1.5 million species of fungi, although only around 70,000 have been identified.

The singular of ‘fungi’ is ‘fungus’, which means ‘mushroom’ in Latin.

For many years, it was thought that fungi were plants, but it is now known that fungi are different from plants in several important ways. Fungi are neither plants nor animals.

Fungi are found on land, in the air, in water, on humans, plants and animals.
Fungi are found on food, such as bread mould and mushrooms. **Yeast** is an important fungus which is used to make beer and bread.

Fungi are also used to produce medicines, such as **statins**, used to lower blood cholesterol levels. **Penicillin** is a type of fungi, which is used as an antibiotic to treat bacterial infections.

*Athlete’s foot* (a disease of the skin of the foot) and *ringworm* (a skin disease) are forms of fungi. Fungi can cause rust and mildew and destroy crops. An estimated 10 to 15% of the world’s crops are lost each year due to fungal attacks.

Fungi have an important role to play in the environment as they are *decomposers* that return nutrients to dead matter in the soil. They help to release carbon, nitrogen and oxygen into the soil and the atmosphere.

Types of fungi include:

- **Yeast** – these are tiny, single-celled fungi.
- **Mould** – these are fungi made of many threads that grow on exposed food sources, such as bread mould.
- **Mushrooms and toadstools** – these are large fungi that grow in soil.

*Penicillin*

**Characteristics of Fungi**

- **Blocks of Yeast**
- **Bread Mould**
- **Mushrooms**
• Most fungi live in dark and wet habitats on land.

• Fungi are eukaryotes, like animals and plants.

• Fungi can exist as single-cell organisms, but the multicellular form is the most common. So some fungi are microorganisms that can only be seen with a microscope, while others start from microscopic filaments and grow, so they can be seen with the naked eye.

• Fungi, unlike plants, cannot make their own food. They are heterotrophs as they depend on other organisms for their nutrition.

• Unlike animals, fungi do not ingest their food, rather they grow on the food source and secrete enzymes into it to digest it, and then absorb it into the cell.

• Some fungi live in symbiotic relationships with other living organisms and may be saprophytes or parasites.

• Fungi are sedentary throughout their lives, which means they cannot move from place to place.

• Fungi reproduce asexually by means of spores. Mushrooms are the reproductive parts of fungus and produce millions of spores which grow to make a new fungus.

• Some fungi have plant-like characteristics, but they do not contain chlorophyll.

• Some fungi are edible, but many are deadly poisonous.
The Structure of Fungi

- Fungi cells have a **nucleus**.
- The cell contains **vacuoles** and is filled with **cytoplasm**.
- Some fungi are **unicellular** (like yeast) whilst other fungi have **multicellular** filaments called **hyphae**, which break down and absorb food. This structure allows for maximum absorption of nutrients.
- They have a cell wall composed of **chitin**, rather than cellulose (plants).
- **Spores** are the reproductive cells produced by the **sporangium**.

![Structure of a Fungus Cell](image)

Plantaes Kingdom (Plants)

This Kingdom includes algae, ferns and mosses (plants that do not produce seeds), as well as conifers and flowering plants (plants that produce seeds).

![The Diverse Plant Kingdom](image)

Plants are multi-cellular, which means they have many cells.
Animalia Kingdom (Animals)

This Kingdom includes all multicellular animals such as jellyfish, worms, molluscs, arthropods, echinoderms, fish, amphibian, reptiles, birds and mammals.

Animals are also multi-cellular.

The Plant and Animal Kingdoms are described in the modules to follow.

Basic Differences Between Plants and Animals

Basic differences in processes such as movement, nutrition and reproduction, distinguishes plants from animals.

Movement

Most animals are able to move around freely, whether it is on land, in the air or in water. Plants on the other hand do not move around. They have roots that hold them in place in the soil. The roots absorb water and mineral salts from the soil which are used by the plants.
**Nutrition**

Animals obtain their food by eating other plants and animals. They cannot make their own food as they do not have any chlorophyll in their cells to produce food.

![Animals Obtain Their Food by Eating Other Plants and Animals](image)

Plants, on the other hand, contain chlorophyll and can make their own food during a process called **photosynthesis**. They use sunlight, carbon dioxide, water and mineral salts from the soil to make their own food. Through this process of photosynthesis, oxygen is released into the air.

![Plants Make Their Own Food Through Photosynthesis](image)

**Reproduction**

Animals give birth to live young or reproduce by laying eggs. Some animals give birth to babies that have grown and developed inside the mother's body, for example, dogs, cows and cats.
Plants, on the other hand, are able to reproduce vegetatively, whereby a part of the plant, for example, a piece of the stem or a leaf, is able to grow into a new plant. Reproduction in flowering plants occur using seeds, while plants like ferns produce spores.