Unit 1
Characteristics and classification of living organisms

Welcome to the exciting and amazing world of living things. Go outside and look around you. Look at the sky, the soil, trees, plants, people and animals. Nature is all around you if you have the eyes to see it. Count how many living things you can see.

What is it that makes living things different from things that are not alive?

Biology is the study of living things. It deals with what all living things can do, how they do it and why they do it. In Biology, there is always a relationship between the structure of an organism, its function, and its adaptation to its function or environment. Biology also tackles the important topics such as population, environmental issues as well as health issues.

In this course, you will learn to identify different kinds of living things and how to classify them. Most of the six activities in this unit will take you only five to ten minutes to complete.

This unit is divided into five sections:

A	Characteristics of living organisms
B	Classification of living organisms
C	The hierarchical classification system
D	Binomial system of naming species
E	Simple dichotomous key

When you have studied this unit, you should be able to:

- list and describe the characteristics of organisms
- define the terms nutrition, excretion, respiration, sensitivity, reproduction, growth and movement
- outline the use of a hierarchical classification system for living organisms
- classify living organisms into kingdoms, orders, classes, families, genera and species
- define and describe the binomial system of naming species
- construct dichotomous keys
- use simple dichotomous keys based on easily identifiable features.

A Characteristics of living organisms

Activity 1 will help you think about what makes living things different from non-living things.

ACTIVITY 1

This activity should take you about five to ten minutes.

What makes living things different from non-living things? Look at Figure 1. Look at the living and non-living things which you can see in the picture.

Figure 1

Answer these questions in your notebook.

1 List three different living things which you can see in Figure 1.

2 List five different non-living things which you can see in Figure 1.

It is obvious that people are living things. Most of us realise that plants are living too, but what about a car? Cars need fuel, and can do many of the things that animals and plants can do.

An individual living thing, such as an animal or a plant, is called an **organism**. The term 'living organism' is usually used to describe something which displays all the characteristics of living things.

Characteristics of living things

There are seven activities which make organisms different from non-living things. These are the seven **characteristics** of living organisms.

1 Nutrition

Living things take in materials from their surroundings that they use for growth or to provide energy. Nutrition is the process by which organisms obtain energy and raw materials from nutrients such as proteins, carbohydrates and fats.

2 Respiration

Respiration is the release of energy from food substances in all living cells. Living things break down food within their cells to release **energy** for carrying out the following processes.

3 Movement

All living things **move**. It is very obvious that a leopard moves but what about the thorn tree it sits in? Plants too move in various different ways. The movement may be so slow that it is very difficult to see.

4 Excretion

All living things **excrete**. As a result of the many chemical reactions occurring in cells, they have to get rid of waste products which might poison the cells. Excretion is defined as the removal of toxic materials, the waste products of metabolism and substances in excess from the body of an organism.

5 Growth

Growth is seen in all living things. It involves using food to produce new cells. The permanent increase in cell number and size is called growth.

6 Reproduction

All living organisms have the ability to produce **offspring**.

7 Sensitivity

All living things are able to **sense** and **respond** to stimuli around them such as light, temperature, water, gravity and chemical substances.

Learn these seven characteristics of living organisms. They form the basis of the study of Biology. Each one of these characteristics will be studied in detail during the course. Whilst many other things carry out one or more of the above processes, only **living organisms** possess **all** of these characteristics.

ACTIVITY 2

This activity should take about five minutes.

A motor car needs petrol and air in order to move. It produces waste gases.

a Which characteristics of living organisms are similar to those of a motor car?

b Why is a car not a living organism?

ACTIVITY 3

Spend about ten minutes on this activity.

1 Some yeast, sugar and water are mixed in a test-tube. The diagram shows the test-tube at the start and after one hour.

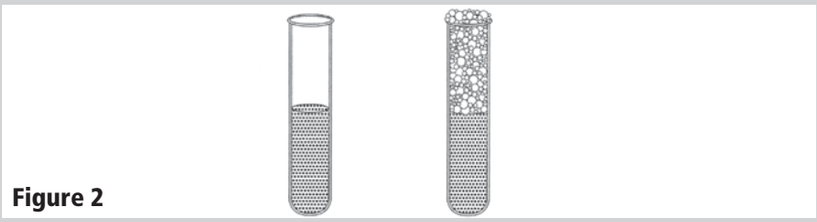


Figure 2

a Which process causes this change?
- **A** growth
- **B** irritability
- **C** reproduction
- **D** respiration

b Excretion, irritability and reproduction are characteristics of:
- **A** all animals and plants
- **B** animals only
- **C** plants only
- **D** some animals and some plants only

c Which one of the following functions is carried out by green plants but not by animals?
- **A** excretion
- **B** growth
- **C** photosynthesis
- **D** respiration

d Figure 3 shows how fish react when the glass on one side of an aquarium tank is tapped with a finger.

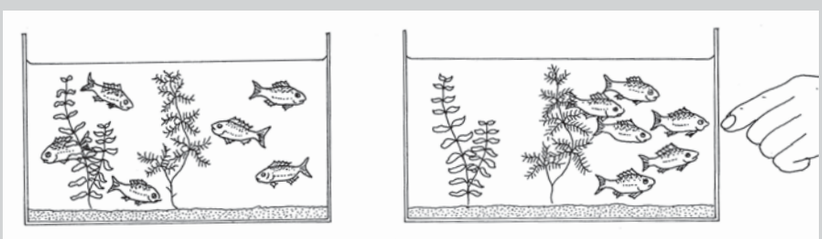


Figure 3

What characteristics of living organisms does this demonstrate?
- **A** excretion and movement
- **B** excretion and nutrition
- **C** growth and irritability
- **D** irritability and movement

2 Complete the passage below by choosing the words from this list:
excretion growth irritability movement nutrition organisms reproduction respiration

A Living things are often called _____.
B All living things release energy from their food in a process called _____, which happens inside their cells.

C Some of the energy is used for _____, which usually happens more quickly in animals than in plants.
D The food from which the energy is released is taken into the body in a process called _____.
E All living things get bigger as they get older. This process is called _____.
F The production of young is called _____.
G Waste substances are removed from organisms by the process of _____.
H The seventh characteristic shown by all living organisms is _____, which means that they are sensitive to things around them.

B Classification of living organisms

If you have ever been to a library, you will know how much easier it is to find a book on a particular subject if the books are arranged in subject groups. When the librarian has a new book to add to the library, he or she will group it with books on a similar topic, according to a classification system.

The use of the hierarchical classification system

Glossary
CLASSIFICATION – grouping organisms according to structural similarities

CLASSIFICATION helps us to impose order and a general plan on the diversity of living things. Scientists have always tried to organise and classify the objects, including living organisms, around them. Classification can be defined as grouping organisms according to their structural similarities. This means that organisms that share similar features are placed in one group. These groups are arranged from the largest group of organisms to the smallest group of organisms. The groups, from largest to smallest, are arranged as follows: kingdom, phylum (plural phyla), class, order, family, genus (plural genera) and species. The species is the smallest group of organisms.

Hint
In print, Latin names are written in *italics.*

As you go through the classification hierarchy, you will see that scientists have used broader features to put organisms into kingdoms, which are the largest groups of organisms. When you move down towards the species, which are the smallest groups of organisms, features become specific. In other words, two organisms that belong to the same species share more features than those in the same kingdom but in different species.

Hint
Living things are called organisms.

A species can be defined as a group of organisms with similar features, and these organisms are capable of breeding and producing fertile offspring. You are probably aware of the fact that horses and donkeys belong to the same kingdom, phylum, class, order, family as well as genus but they are from different species. Therefore, if a donkey and the horse happen to breed, they produce an offspring called a mule. The mule is infertile, meaning that it cannot reproduce offspring because it is a product of organisms of different species.

Classification hierarchy has many uses. First, it helps scientists to sort organisms in order. Second, it helps them to identify new organisms by finding out which group they fit. Third, it is easier to study organisms when they are sorted into groups.

C The hierarchical classification system

There are various sizes of groups into which living organisms are put. The largest group is the **kingdom**. There are five kingdoms: prokaryotes (which includes bacteria), protoctista, fungi, plants and animals.

Hint
one phylum, many phyla
one taxon, many taxa
one genus, many genera

Each kingdom is further divided into smaller groups called **phyla**, based on a few features that are shared by some organisms. For example, the arthropod phylum contains all the animals without a backbone that also have jointed legs and a hard covering over their body, such as insects, crustaceans and spiders.

Hint
These names are given to help you understand classification. You do not need to learn this type of detail.

A phylum is then subdivided into **classes**, **orders**, **families**, **genera**, and finally **species**. In this system of classification the various groups are called **taxa** (singular: taxon).

This chart shows the hierarchical system of classification.

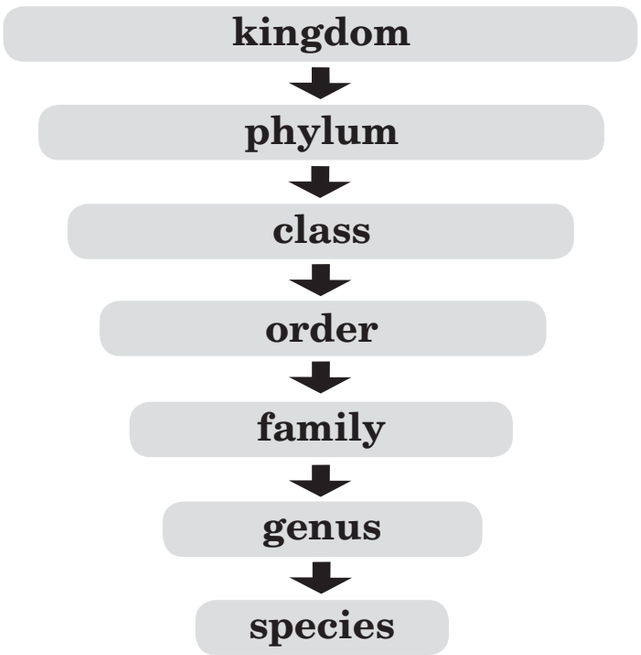


Table 1 shows how this system can be used to classify a human being.

Kingdom	*Animalia*	all animals, same as zebra
Phylum	*Chordata*	all animals with a backbone
Class	*Mammalian*	animals with a backbone, which have hair
Order	*Primate*	mammals with hands and feet
Family	*Hominidae*	apes, primitive humans and modern humans
Genus	*Homo*	primitive humans and modern humans only
Species	*sapiens*	modern humans only
Scientific name	*Homo sapiens*	

Table 1 Classifying the human being

Two systems of classification

Classification can be based on two different systems, **natural** and **artificial**. We will look at natural classification first.

Natural classification

The hierarchical classification system described above is based on a **natural** classification system that uses common features shared by organisms. Natural classification is based on two ideas:

- homologous structures
- evolutionary relationships.

Homologous structures

Homologous structures are features of organisms that are **similar in structure** but may look very different from each other and may be used for different purposes. As shown in Figure 4, a horse's front leg, the human arm and a bat's wing are all **homologous** structures. They have the same number and arrangement of bones and this means that they probably evolved from a single type of structure that was present in a common ancester millions of years ago.

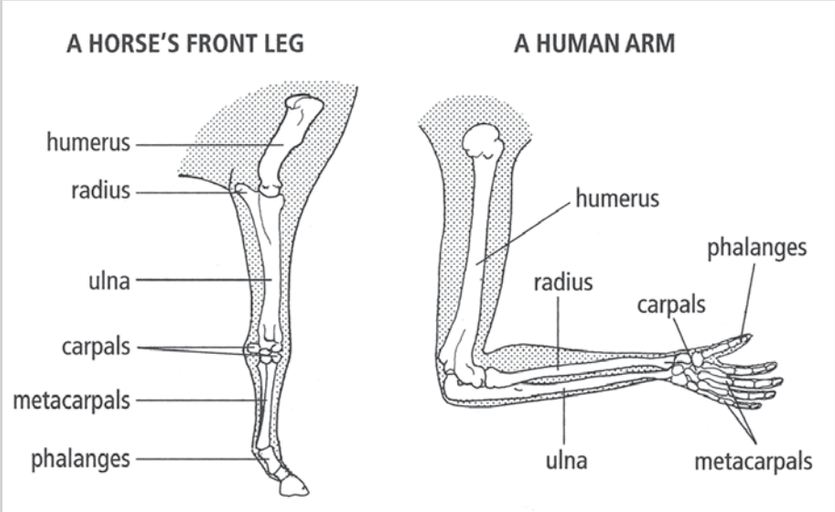
Hint
Analogues look the same but are really different, homologues look different but are really the same.

A fly's wing is not homologous with a bat's wing. It may look similar and do the same job but it develops from a completely different origin. The fly's wing has no bones and is not covered by feathers. A bat's wing and a fly's wing are termed **analogous**. A bat and a fly would not be grouped together!

ACTIVITY 4

Spend about 10 minutes answering these questions.

Look at Figure 4 that shows an example of three homologous structures.



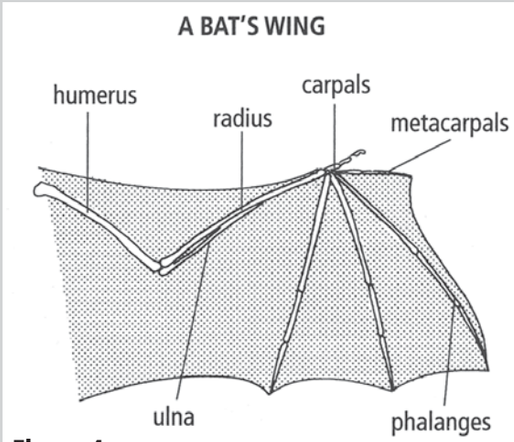


Figure 4

a Feel the bones in your own arm. Try to identify the bones shown on the diagram of the human arm. Put one hand on your lower arm and turn your lower arm over and back. You should be able to feel one bone twisting over the other.

b Each of the vertebrates shown has carpals, metacarpals and phalanges. Name three other bones shared by all three vertebrates.

c Describe how the metacarpals of the horse differ from those of the human.

d How do the phalanges of the bat differ from those of the human?

e Complete these sentences:

The human arm, the horse's front leg and the bat's wing are described as _____ structures. The wing of the bat and the wing of a fly are described as _____ structures.

Evolutionary relationships

If you look at photographs of people who share a common ancestor, such as a grandparent or great grandparent, you often see startling similarities in **appearance**. The people in the photos are obviously related to each other and have **inherited** some features from their grandparents.

In a **natural classification system**, biologists group together organisms which are structurally similar and share common ancestors. Natural classification produces a branching set of relationships as shown in Figure 5. This shows how the plants are divided into major subgroups such as mosses, ferns, conifers and flowering plants. Each of these subgroups can be divided further. In this diagram only the two main groups of flowering plants have been shown. Where organisms are divisions of the same subgroup, such as the monocotyledons and dicotyledons, they are more closely related and may share more similar features than with the mosses and ferns. Figure 5 shows the main subgroups of the plant kingdom.

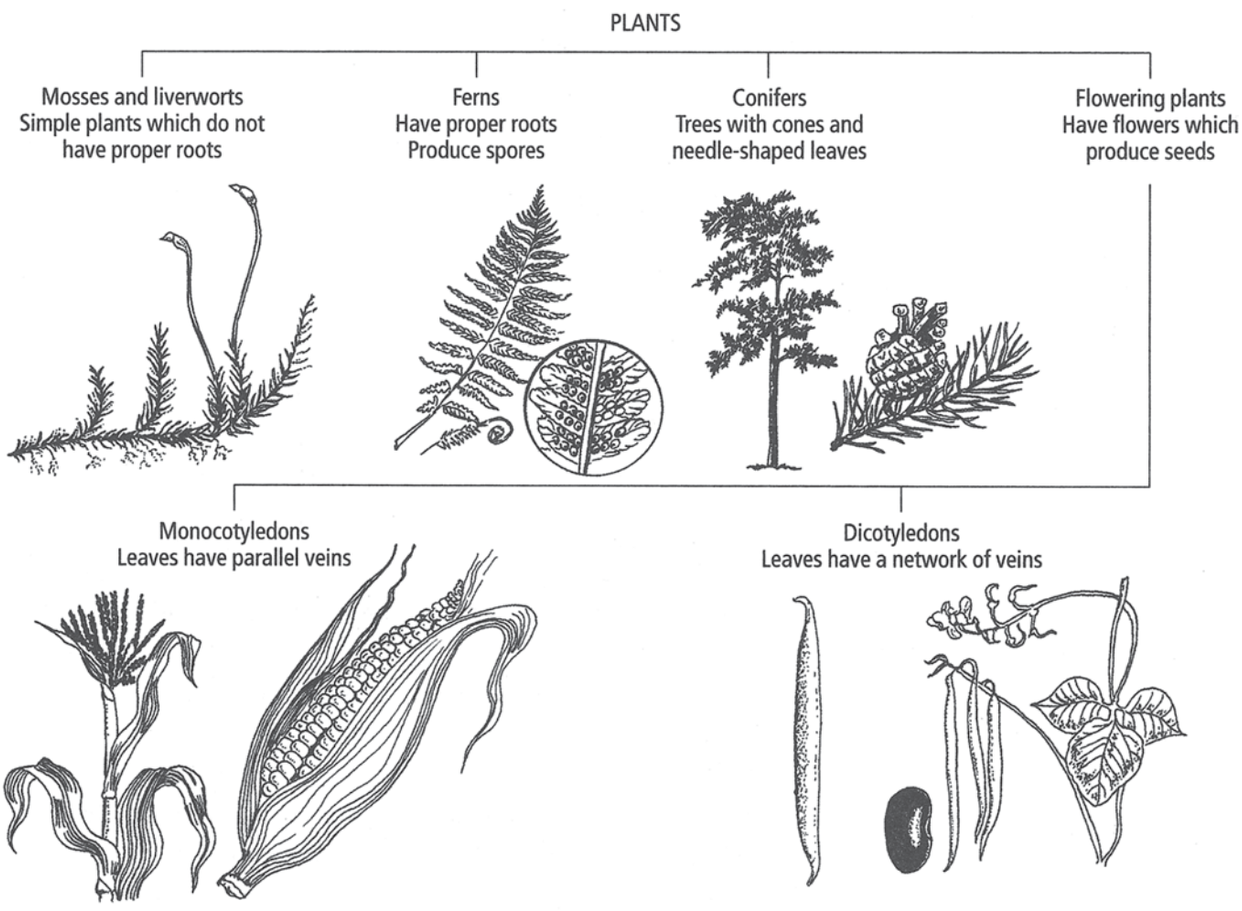


Figure 5 The main subgroups of the plant kingdom

In the animal kingdom, humans, *Homo sapiens*, are found, as is the cockroach *Periplaneta americanus*. Humans and cockroaches share a common ancestor, but that was more than 500 million years ago! You can see many structural differences between humans and cockroaches and so there is no natural relationship. Because of this we classify *Homo sapiens* and *Periplaneta americanus* into very different groups!

Artificial classification

With **artificial** classification you can use any grouping you like. You could put all the animals that fly in the same group. This group would then include birds, bats and many insects. You could put all animals that live in water and have streamlined, fish-like bodies in the same group. This group would then include fish and whales.

Artificial classification systems are also used as the basis for **dichotomous keys** that biologists use to identify organisms.

ACTIVITY 5

Spend about 10 to 15 minutes answering these questions.

In this activity you will see how an artificial classification works on the basis of using pairs of options; for example, *yes/no has/has not in/out*.

If it is not one thing then it must be the other!

Look at this list of organisms:
fish whale seal duck house-fly bat eagle owl mosquito

In your notebook divide these organisms into the following artificial groups.

1 Those organisms that can fly.

2 Those organisms that fly only at night.

3 Those organisms that swim.

4 A category of your choice.

D Binomial system of naming species

Carl Linnaeus, a Swedish botanist who lived from 1707 to 1778, introduced the hierarchical classification system that we have discussed so far. In addition to that, he gave each and every species a scientific name in Latin. The binomial system of naming species means giving organisms two names in Latin (scientific names). The term binomial literally means two names – 'bi' means two and 'nomial' means name. Linnaeus derived scientific names from the genus and the species to which organisms belong.

When writing a scientific name, the genus name is written first and starts with a capital letter, and the species name is written second and starts with a small letter. The scientific name ought to be printed in italics when typed and **underlined** separately when handwritten. The tiger belongs to the genus called *Panthera* and the species called *tigris*, therefore its scientific name will be typed as *Panthera tigris*, or handwritten as Panthera tigris.

Scientific names are universal because, for instance, every biologist will understand that *Felis catus* means 'house cat' without resorting to the dictionary, no matter what language they speak. Can you think of the scientific names for some more organisms?

ACTIVITY 6

Spend about five minutes on this activity.

1 In your notebook, write two reasons why living organisms are classified into groups.

2 Use your knowledge about classification system to classify a lion into kingdom, phylum, class, order, family, genus and species.

3 Look at the following three scientific names:
(i) *Merluccius Capensis*
(ii) *homo sapiens*
(iii) *Olea capensis*