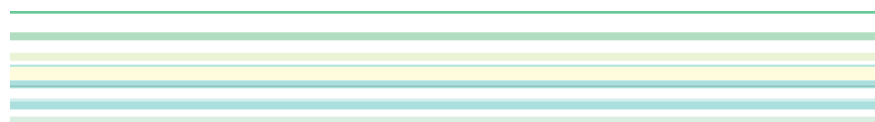


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# Chapter 1

## The nature and variety of living organisms

**Figure 1.1** A golden jackal feeding on its prey to obtain nutrients



### 1.1 Characteristics of living organisms

Biology is the study of living organisms and living systems. All living organisms display, or have the potential to perform, the **eight characteristics of life**.

#### Nutrition

**Nutrition** is the obtaining of nutrients from the environment. Nutrients are required by living organisms for:

- energy
- growth and repair
- maintaining proper metabolic function

## Respiration

**Respiration** is the controlled release of energy from food to produce the molecule **ATP**. Energy in food is released and stored temporarily in ATP, which then provides the energy to cells. Energy released by respiration can be used for:

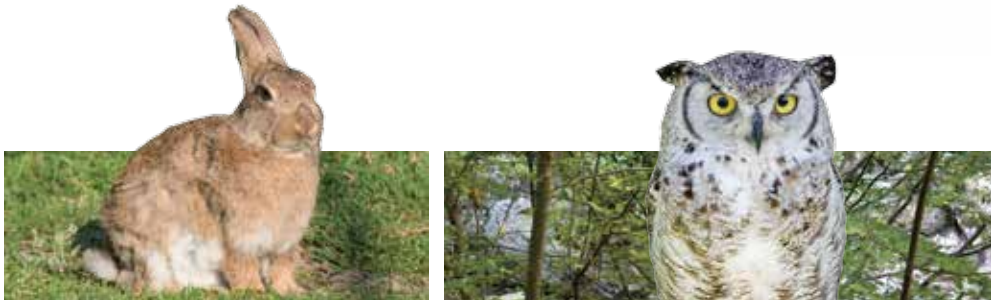
- growth
- movement
- reproduction

## Growth and development

**Growth** is an increase in size, mass or number of cells, while **development** is an increase in complexity (Figure 1.2). Growth and development allow an organism to function in ways that help it to survive.

## Sensitivity

**Sensitivity** is the ability of an organism to detect and respond to **stimuli** (singular: *stimulus*) which are changes in the environment. For example, to catch a fly, a frog has to see it and then move towards it (Figure 1.3).



**Figure 1.3** Rabbits (left) have good hearing to detect predators while owls (right) have keen eyesight to spot prey.

## Movement

**Movement** is a change in position or location. Organisms move in response to changes in the environment. For example, to catch a fly, a frog has to move towards the fly first.

## Homeostasis

**Homeostasis** is the maintenance of a **constant internal environment**. This allows an organism's bodily functions to operate even when its environment changes. Factors that are maintained by homeostasis in humans include:

- blood glucose concentration
- body temperature
- water balance



**Figure 1.2** A caterpillar grows and develops into a butterfly



**Figure 1.4** Flowering plants produce seeds (top) that grow into new plants, while mammals give birth to live young (bottom).

## Reproduction

**Reproduction** is the production of new individuals of the same **species** (Figure 1.4). Organisms have to produce new individuals so that the species can continue to exist, otherwise the species will die out and become **extinct**.

## Excretion

**Excretion** is the removal of **metabolic wastes**, toxic substances and excess substances from the body. These substances are harmful to the body if they accumulate to high levels. Examples of substances excreted by the human body include:

- urea (a molecule formed from the breakdown of amino acids)
- carbon dioxide
- excess water
- excess salts

## 1.2 The variety of living organisms

Living organisms on Earth exist in many different forms, but they can be classified as either **eukaryotic** (pronounced: 'you-carry-otic') or **prokaryotic**. The cells of a eukaryotic organism have a **nucleus** (plural: *nuclei*) but a prokaryotic organism has no nucleus. Organisms can also be classified as **unicellular**, which are made of only a single cell, or **multicellular**, which are made of many cells. Plants, animals, fungi (singular: *fungus*) and protoctists are eukaryotic, while bacteria (singular: *bacterium*) are prokaryotic.

### Plants

- Plants are multicellular organisms.
- Their cells contain **chloroplasts** to carry out **photosynthesis** to produce food.
- They have cell walls made of **cellulose**.
- They store carbohydrates as **starch**.

Examples: flowering plants such as maize (a cereal) and pea (a herbaceous legume) (Figure 1.5).



**Figure 1.5** A pea plant (top) and a maize plant (bottom)

## Animals

- Animals are multicellular organisms.
- Their cells do not have chloroplasts (and hence cannot carry out photosynthesis).
- Their cells do not have cell walls.
- They store carbohydrates as **glycogen**.
- They usually have nervous co-ordination.
- They can move from one place to another.

Examples: fox (a mammal) and mosquito (an insect) (Figure 1.6).



Figure 1.6 A mosquito (left) and a fox (right) are both animals.

## Fungi

- Some fungi are unicellular and some are multicellular.
- Their cells do not have chloroplasts.
- They have cell walls made of **chitin**.
- They store carbohydrates as glycogen.
- They secrete extracellular digestive **enzymes** to digest the food they live on, and absorb the digested nutrients. This is known as **saprotrophic nutrition**.
- The body of multicellular fungi is made of thread-like structures called **hyphae** (singular: *hypha*) organised into a **mycelium** (plural: *mycelia*). A hypha is formed by fusion of multiple cells and has multiple nuclei in the cytoplasm (**multinucleated**). The structure of a hypha and the mycelium of a multicellular fungus are shown in Figure 1.7 and Figure 1.8 respectively.

Examples: yeast (unicellular), *Mucor* (multicellular)

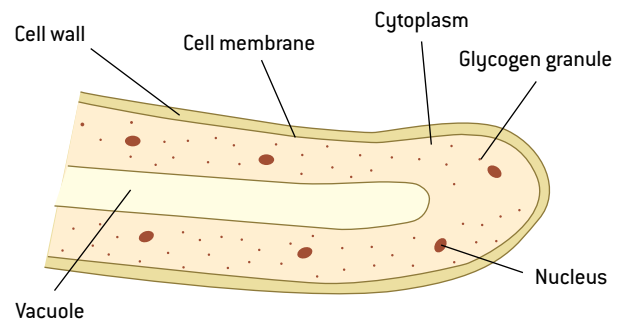


Figure 1.7 Structure of a fungal hypha



Figure 1.8 Mycelium of a multicellular fungus

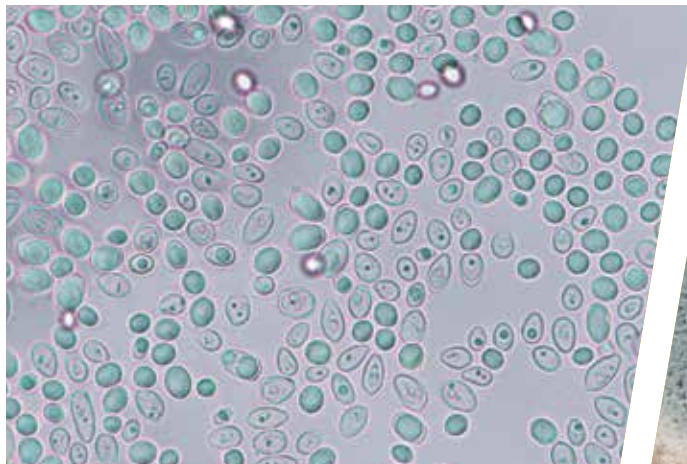


Figure 1.9 Yeast (left), and *Mucor* on bread (right)

## Protoctists

- Protoctists are unicellular.
- Some protoctists resemble animal cells, while others are like plant cells.

Examples: *Amoeba* (animal-like) that lives in pond water, *Chlorella* (plant-like) that carries out photosynthesis, *Plasmodium* that causes malaria (Figure 1.10).



Figure 1.10 *Chlorella* (left), *Amoeba* (centre) and *Plasmodium* (right)

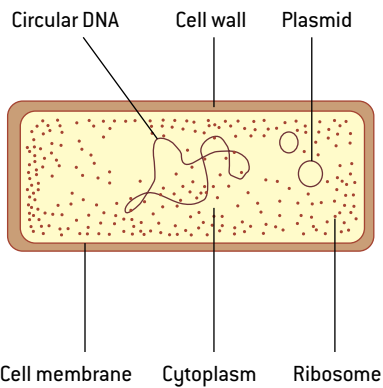


Figure 1.11 Structure of a bacterial cell

## Bacteria

- Bacteria are unicellular.
- They have a cell wall.
- They have **circular DNA** but no nucleus (i.e. they are prokaryotic), as well as smaller DNA rings called **plasmids** (Figure 1.11).
- Some can carry out photosynthesis while others feed on other living or dead organisms.

Examples: *Lactobacillus bulgaricus* (rod-shaped) used to make **yoghurt**, *Pneumococcus* (spherical) that causes **pneumonia** (Figure 1.12).



Figure 1.12 *Lactobacillus bulgaricus*, a rod-shaped bacterium (left), and *Pneumococcus*, a spherical bacterium (right)

## Viruses

- Viruses are not living organisms.
- They are very small, even smaller than bacteria.



- They show a wide variety of shapes and sizes.
- They do not have cellular structures, but only a **protein coat** containing **nucleic acid** (Figure 1.13).
- They may contain either **DNA** or **RNA**.
- They can only reproduce inside living cells, and are therefore **parasitic**.

Examples: tobacco mosaic virus (Figure 1.14) that causes leaf discolouration in tobacco plants by preventing the formation of chloroplasts, influenza virus that causes influenza (flu), and HIV (Figure 1.15) that causes AIDS.

## Pathogens

**Pathogens** are organisms or viruses that cause disease. They include viruses, bacteria, fungi and protocists. Examples of pathogens and the diseases they cause are shown in Table 1.1.

Group	Pathogen	Disease
Viruses	Influenza virus	Influenza (flu)
	Human immunodeficiency virus (HIV)	Acquired immunodeficiency syndrome (AIDS)
Bacteria	<i>Pneumococcus</i>	Pneumonia
Protocists	<i>Plasmodium</i>	Malaria
Fungi	Yeast	Candidiasis

Table 1.1 Examples of pathogens and the diseases they cause

## Summary

- All living organisms share eight characteristics of life: nutrition, respiration, growth and development, sensitivity, movement, homeostasis, reproduction, and excretion.
- Organisms can be classified into five groups: plants, animals, fungi, protocists, and bacteria. They show differences in the presence or absence of a nucleus, cellular organisation, mode of nutrition, cell wall, and the type of storage of carbohydrate.
- Plants, animals, fungi and protocists are eukaryotic, while bacteria are prokaryotic. Plants and animals are multicellular, whereas protocists and bacteria are unicellular. Some fungi are unicellular but some are multicellular.
- Viruses are made of only a protein coat enclosing nucleic acid. They are not living organisms and require other organisms to reproduce.
- Pathogens cause diseases. Pathogens include viruses, and living organisms such as fungi, bacteria and protocists.

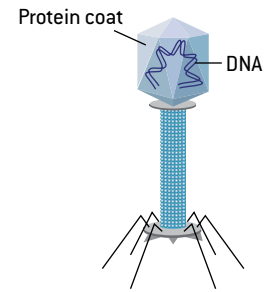


Figure 1.13 A phage, an example of a virus



Figure 1.14 Leaf discolouration caused by tobacco mosaic virus

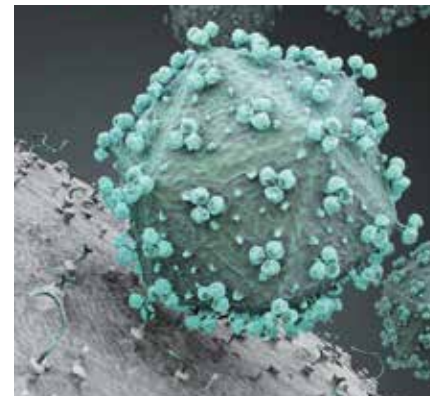


Figure 1.15 An HIV particle infecting a cell