CELL BIOLOGY

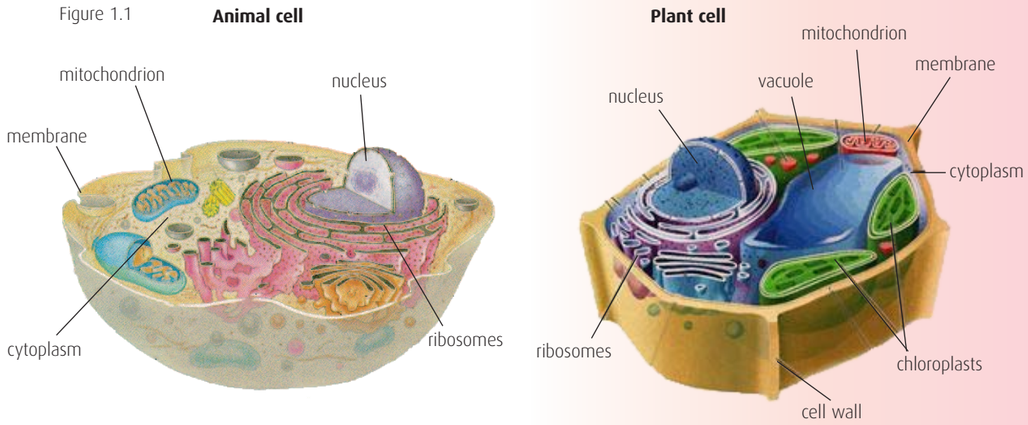
CELL STRUCTURE 1

CELL ORGANELLES IN PLANT AND ANIMAL CELLS

Powerful microscopes, called electron microscopes, show that cells are much more complex than they appear through light microscopes, such as those used in schools. The detailed structure of cells that is revealed using electron microscopes is known as the cell ultrastructure. The small structures found inside cells are known as organelles. Each type of organelle has a specific function although not all organelles are found in all cells.

The following diagrams show the organelles commonly found in plant and animal cells.

Figure 1.1



VIDEO LINK

www.youtube.com/watch?feature=endscreen&NR=1&v=IjSObTGCcJQ

All cells have a cell membrane which forms the boundary of the cell. The cell is filled with a jelly-like material called cytoplasm in which chemical reactions take place. The cytoplasm contains the organelles.

The following table describes the various organelles and their functions as well as where they are found.

Organelle	Function	Organisms they are found in
Nucleus	This contains the cell chromosomes which are made of DNA. These hold the genetic information which controls the cell activities.	Plants and animals
Cell membrane	This consists of phospholipid and protein molecules. It is selectively permeable and controls the entry and exit of materials in and out of the cell.	Plants and animals
Mitochondrion (Mitochondria – plural)	This is the site of aerobic respiration. They are found in greater abundance in cells with high energy demands e.g. muscle cells.	Plants and animals
Ribosome	This is the site of protein synthesis. They are found in the cytoplasm or attached to tubular structures in the cell.	Plants and animals
Chloroplast	This is the site of photosynthesis. They contain the green pigment, chlorophyll, which absorbs light energy.	Plants only
Vacuole	This contains cell sap which is a solution of salts and sugars. It is important in maintaining the shape of the cell.	Plants only

DON'T FORGET

Some diagrams show cell parts in 3D while others show them in 2D as 'cut-through' diagrams. It is useful to recognise both forms.

Plant cells also have an outer cell wall which is made from the carbohydrate, cellulose.

This supports the cell and gives a structure to plant tissue.

cont

VARIATION IN PLANT AND ANIMAL CELLS

Multicellular organisms are made up of a large number of cells which work together to allow the organism to function as a unit. The previous diagrams show the contents of typical plant and animal cells. Cells are, however, adapted to perform a particular function within an organism and therefore variation in cells exists. This will be explored further in a later chapter.

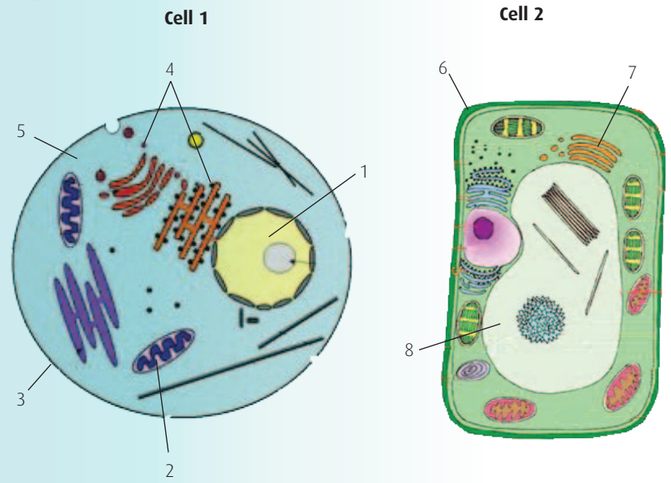
ONLINE TEST

http://cloud4test.com/hello/tests

THINGS TO DO AND THINK ABOUT

- Look at the following diagrams of cells and complete the table to identify the various organelles and their functions.

Figure 1.2



Part	Name	Function
1		
2		
3		
4		
5		
6		
7		
8		

CELL STRUCTURE 2

CELLS OF DIFFERENT TYPES OF ORGANISMS

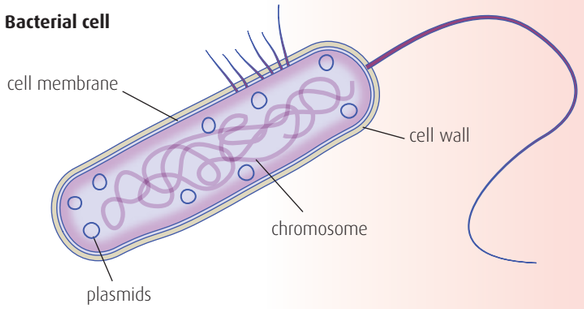
Unicellular Organisms

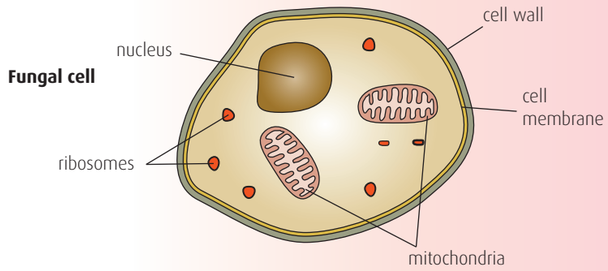
Unicellular organisms exist as single cells. Each of the cells must contain all of the organelles necessary for its survival. Unicellular organisms can be plant or animal. Some examples and their ultrastructure are shown below.

VIDEO LINK

http://www.youtube.com/watch?v=kjKyEdrVXJA

Bacterial cell





Bacterial cells

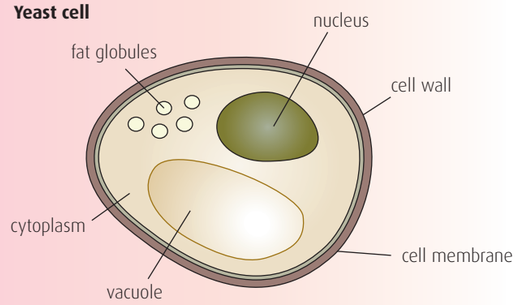
Bacterial cells differ from plant and animal cells in several ways. Although they have a cell wall, the material that it is made of is not cellulose. They do not have a nucleus to contain their genetic material. Instead they have one large loop of chromosomal material and several much smaller rings known as plasmids. Due to their size, plasmids can be easily removed from and re-inserted into bacterial cells. This technique is important in genetic engineering and will be explored in a later chapter.

cont

Fungal Cells

Fungal cells show some similarities and some differences when compared to plant and animal cells. Like bacteria, their cell wall is made of a carbohydrate which is not cellulose. One of the most familiar fungal cells is yeast, which is used in the process of fermentation.

Yeast cell



CELL SIZES

Cells vary greatly in size. As they are all microscopic, the scales of measurement normally used (metres, centimetres, millimetres) are too large to measure them. Therefore a smaller measurement known as a micrometre is used to measure cells. There are 1000 micrometres (µm) to 1 millimetre (mm).

Fungal and bacterial cell are much smaller than typical plant and animal cells.

The table below shows the sizes of some cells.

Type of cell	Approximate size (µm)
E.coli – a bacterium	2
Yeast	3
Human red blood cell	9
Typical animal cell	10–30
Typical plant cell	10–100
Small amoeba	90
Human egg	100

DON'T FORGET

Micrometers are also known as microns.

VIDEO LINK

http://www.youtube.com/watch?v=tXKAAgwR7cg

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THINGS TO DO AND THINK ABOUT

You should be able to compare relative sizes of cells and convert sizes between micrometres (µm) to millimetres (mm).

- A measurement in mm can be converted to µm by multiplying by 1000.
- A measurement in µm can be converted to mm by dividing by 1000.

Complete the following table.

mm	µm
0·33	
	85
0·76	

BIODIVERSITY AND THE DISTRIBUTION OF LIFE 1

Biodiversity refers to the range of different species present in an ecosystem. A full meaning of biodiversity would also include the different variations which exist *within* each species. Therefore biodiversity covers the whole range of genetic information present in any environment.

Biodiversity can refer to an individual ecosystem but it is sometimes used with reference to a larger system such as a biome or even the whole planet. The greater the biodiversity, the healthier and more stable the ecosystem.

Biodiversity can be affected by various factors.

THE EFFECT OF BIOTIC FACTORS ON BIODIVERSITY

Biotic factors involve living organisms. There are many ways in which organisms can affect other species in an ecosystem. If the effect is extreme, it may have an impact on the biodiversity of the ecosystem.

Grazing

Grazing animals can reduce or increase biodiversity by:

Soil erosion due to overgrazing in Mexico

Overgrazing – In severe cases, overgrazing can result in soil erosion causing a loss of plant species from the land.

A less drastic effect of overgrazing may be the loss of some of the less abundant plant species. As the grazing animals compete for diminishing food sources, such plant species may be eaten out of existence.

Under grazing – This can also reduce plant biodiversity. Vigorous plant species are able to grow unchecked and are able to dominate their surroundings at the expense of less vigorous species.

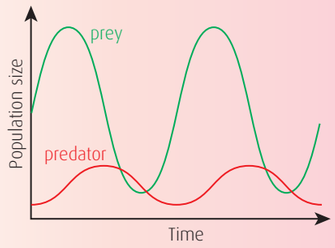
Moderate grazing – This can maintain or increase plant biodiversity in grasslands. This is because vigorous plant species will be eaten by the grazing animals and they will not become too dominant. Less vigorous species will be able to survive and spread in the area.

Predation

Predation is the feeding of one organism (the predator) on another organism (the prey). There are many different types of feeding relationships which may be described as predation but in true predation the predator kills and eats the prey.

Predators reduce the numbers of their prey and in extreme situations this can lead to the loss of a prey species. However, in a stable ecosystem predation results in fluctuations in the numbers of both the predator and the prey species in such a way that both species survive.

This can be seen in graphs which plot the populations of a predator and its prey. When the prey population is high, the predator population will increase because of the plentiful food availability. As predator numbers increase there will be increased predation and a resulting fall in prey numbers. The decrease in the prey population will mean less food for the predators and so their numbers will fall. The prey population will then start to increase, and so on.



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DON'T FORGET

An ecosystem includes all the components present in an area: the type of habitat involved, the conditions found there and the community of different plant and animal species living there.

VIDEO LINK

http://www.youtube.com/watch?v=6hGuallLPcM

The predators are obviously dependent on the prey for their survival but the prey also needs the predators. Without the predators, the prey population would increase to a point where their food supply would be completely used up. This could cause widespread starvation.

THE EFFECT OF ABIOTIC FACTORS ON BIODIVERSITY

Abiotic factors do not involve living organisms. They are the chemical and physical components of an ecosystem which can determine which species are able to survive there.

Chemical components include oxygen concentration, soil mineral concentration and water availability. Physical components include light intensity, pH and temperature.

pH

pH is a measure of the acidity or alkalinity of liquids. Most natural aquatic environments have a pH value in the range of 6 to 8, which is around neutral. Most fish are adapted to live in this pH range.

Many rivers, lakes and oceans are showing signs of acidification because of the effects of pollution. The changes are small because there are natural effects which buffer acidic pollutants and reduce their impact. However, long-term changes in pH will affect the distribution of fish in affected waters.

Some fish are adapted to live in very extreme pH conditions.

The Black Piranha lives in the Rio Negra which is a tributary of the River Amazon in Brazil. The waters there are acidic with a pH of 3·5 to 4·5.

The Magadi Tilapia lives in Lake Magadi in Kenya. The lake is alkaline with a pH of 10.

Black Piranha

Magadi Tilapia

Temperature

Oceans are undergoing rising temperatures as a result of climate change. This is having an effect on the distribution of some fish species.

In the North Sea some species such as sardines and anchovies, which are adapted to cold waters, have been reported to be moving further north as water temperatures increase. At the same time species which are adapted to warmer waters, such as red mullet and sea bass, are moving northwards into the North Sea.

THINGS TO DO AND THINK ABOUT

An owl pellet

Contents of a pellet

Owls regurgitate pellets which contain the undigested parts of the animals they have eaten. If the pellets are separated the bones they contain can be used to identify the prey of the owl.

This is an example of predation, a biotic factor affecting biodiversity. Can you think of any other examples of biotic and abiotic factors which affect biodiversity?

BIODIVERSITY AND THE DISTRIBUTION OF LIFE 2

Changes to habitat occur naturally as a result of changing environmental conditions. Natural changes normally take place slowly and organisms may adapt or evolve with the changes.

THE EFFECT OF HUMAN INFLUENCES ON BIODIVERSITY

Humans have been responsible for altering their environment for thousands of years and these changes have always had an impact on biodiversity:

- The development of agriculture has involved clearing forests and woodlands to make room for the cultivation of crops. Keeping herds of grazing animals has involved the removal of other grazers which would compete with domesticated cattle and sheep. It has also meant the elimination of natural predators such as wolves.
- The development of large towns and cities has reduced biodiversity in these areas.
- The rapidly increasing human population means that these pressures on the environment are becoming greater.

DON'T FORGET

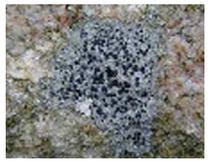
Carbon dioxide and methane are known as greenhouse gases. This is because of their effect in preventing heat escaping from the earth's atmosphere. By doing this, both gases are contributing to global warming.

AIR POLLUTION

Some of the main pollutants of the atmosphere are:

- Sulphur dioxide and oxides of nitrogen – these gases come from the burning of fossil fuels such as coal and oil. They combine with moisture in the air to form acids.
- Carbon dioxide and methane – the burning of many fuels produces carbon dioxide gas. Methane is released from a number of sources including sewage treatment, cattle breath, and landfill sites.

Lichens are simple organisms. Each species of lichen consists of a type of fungus growing with a type of algae. They often grow on tree branches and they are so sensitive to air pollution, particularly sulphur dioxide, that they are used as **indicator species** for air pollution. In heavily polluted air no lichen will grow on tree branches.



Crusty lichen: these will grow in polluted air

Squamous and Podetia lichen: these will grow in moderately clean air

Foliose lichen: these will only grow in clean air

Lung lichen: these will only grow in exceptionally clean air

WATER POLLUTION

Water pollution can be caused by many things including:

- *Untreated sewage entering a river:* the sewage provides a food source for micro-organisms and so their numbers increase in the water. They use up so much oxygen that larger organisms cannot survive.
- *Agricultural fertilisers:* these may be washed into water from neighbouring fields. They may produce a great increase in the growth of aquatic algae. These eventually die and decay causing similar effects to those of untreated sewage.
- *Acid rain:* sulphur dioxide and nitrogen oxides can dissolve in atmospheric moisture and fall as acid rain. This can make the water in rivers and lakes more acidic, preventing some species from surviving. Mussels are used as an indicator species to monitor coastal waters. Mayfly nymphs are used for freshwater.

INTERNET LINK

http://www.water-pollution.org.uk/

DEFORESTATION

Large scale deforestation of tropical rain forests has two main causes:

- Individuals or small groups of people burn areas of forest to clear space for the growth of crops. Unfortunately, the soil in these areas is poor and soon becomes too infertile for crop growth. This means that the people must move on and clear new areas of forest.
- Commercial companies are responsible for clearing large areas of forest for activities such as timber production and mining.

Deforestation of hillsides can make the soil unstable. Heavy rainfall can cause landslides because there are no tree roots to hold the soil in place. This can lead to the loss of all vegetation on the lower slopes of hills

Tropical rain forests are among the ecosystems with the greatest biodiversity. More than half of the world's estimated 10 million species of plants, animals and insects live in the tropical rainforests. Experts estimate that 137 species of animals, plants and insects are becoming extinct every day because of the deforestation of tropical rain forests.

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DESERTIFICATION

Marginal land that borders the world's deserts has plants that are adapted to survive in the dry conditions found there. These marginal areas act as buffers between the desert and cultivated areas.

In many places population pressure results in attempts to cultivate marginal land for crops or for grazing animals. Such attempts are very likely to fail because the soil is too poor or because the need to irrigate the crops may disrupt the water table below ground, making the soil barren. This allows the desert to extend into the areas that were once marginal but stable.

ENDANGERED SPECIES

The evolution of life on earth has always included the extinction of species. These extinctions may be the result of geological changes, climate changes or the evolution of more successful species.

Today, it is the effects of human activities such as those mentioned earlier that are the greatest cause of the extinction of species.

THINGS TO DO AND THINK ABOUT

There are about 200 species of plants and animals that are recognised as in danger of extinction in Britain. Scottish Natural Heritage has highlighted 23 of these species that are in danger in Scotland.

On this page are pictures of 5 of the 23 endangered species which can be found in Scotland. Try to identify the main influences which have led to the endangerment of one of these animal and plant species, could this endangerment have been prevented?

Lesser butterfly orchid

Red squirrel

Scottish wildcat

Capercaillie

Great yellow bumble bee