## **4.1a Cells and Simple Transport**

Cells are the basic unit of all forms of life. In this section we explore how structural differences between

types of cells enables them to perform specific functions within the organism. These differences in cells

are controlled by genes in the nucleus. For an organism to grow, cells must divide by mitosis producing

two new identical cells.

If cells are isolated at an early stage of growth before they have become too specialised, they can retain

their ability to grow into a range of different types of cells. This phenomenon has led to the development

of stem cell technology. This is a new branch of medicine that allows doctors to repair damaged organs

by growing new tissue from stem cells.

### **4.1 Cell Structure**

**4.1.1.1 Eukaryotes and prokaryotes**Plant and animal cells (eukaryotic cells) have a cell membrane, cytoplasm and genetic material enclosed in a nucleus.

Bacterial cells (prokaryotic cells) are much smaller in comparison. They have cytoplasm and a cell membrane surrounded by a cell wall. The genetic material is not enclosed in a nucleus. It is a single DNA loop and there may be one or more small rings of DNA called plasmids.

Demonstrate an understanding of the scale and size of cells and be able to make order of magnitude calculations, including the use of standard form.

**4.1.1.2 Animal and plant cells**

Explain how the main sub-cellular structures, including the nucleus, cell membranes, mitochondria, chloroplasts in plant cells and plasmids in bacterial cells are related to their functions.

Most animal cells have the following parts: A nucleus, cytoplasm, cell membrane, mitochondria, ribosomes.

In addition to the parts found in animal cells, plant cells often have: chloroplasts, a permanent vacuole filled with cell sap and a cell wall made of cellulose, which strengthens the cell.

**Required practical activity 1**: use a light microscope to observe, draw and label a selection of plant

and animal cells. A magnification scale must be included.

**4.1.1.3 Cell specialisation**

Explain the importance of cell differentiation.

As an organism develops, cells differentiate to form different types of cells.

• Most types of animal cell differentiate at an early stage.

• Many types of plant cells retain the ability to differentiate throughout life.

In mature animals, cell division is mainly restricted to repair and replacement. As a cell differentiates it acquires different sub-cellular structures to enable it to carry out a certain function. It has become a

specialised cell.

**4.1.1.5 Microscopy**

Students should be able to:

• understand how microscopy techniques have developed over time

• explain how electron microscopy has increased understanding of sub-cellular structures.

An electron microscope has much higher magnification and resolving power than a light microscope. This means that it can be used to study cells in much finer detail. This has enabled biologists to see and

understand many more sub-cellular structures.

Carry out calculations involving magnification, real size and image size using the formula:
*Magnification = size of image/size of real object.*

Express answers in standard form if appropriate.

**4.1.3 Transport in cells
4.1.3.1 Diffusion**

Substances may move into and out of cells across the cell membranes via diffusion.

Diffusion is the spreading out of the particles of any substance in solution, or particles of a gas, resulting in a net movement from an area of higher concentration to an area of lower concentration.

Some of the substances transported in and out of cells by diffusion are oxygen and carbon dioxide in gas exchange, and of the waste product urea from cells into the blood plasma for excretion in the kidney.

Explain how different factors affect the rate of diffusion.

Factors which affect the rate of diffusion are:

* The difference in concentrations (concentration gradient).
* The temperature.
* The surface area of the membrane.

A single-celled organism has a relatively large surface area to volume ratio. This allows sufficient transport of molecules into and out of the cell to meet the needs of the organism.

Calculate and compare surface area to volume ratios.

Explain the need for exchange surfaces and a transport system in multicellular organisms in terms of surface area to volume ratio.

Explain how the small intestine and lungs in mammals, gills in fish, and the roots and leaves in plants, are adapted for exchanging materials.

In multicellular organisms, surfaces and organ systems are specialised for exchanging materials. The effectiveness of an exchange surface is increased by:

* Having a large surface area.
* A membrane that is thin, to provide a short diffusion path.
* (in animals) having an efficient blood supply.
* (in animals, for gaseous exchange) being ventilated.

**4.1.3.2 Osmosis**Water may move across cell membranes via osmosis. Osmosis is the diffusion of water from a dilute solution to a concentrated solution through a partially permeable membrane.

Students should be able to:

* Use simple compound measures of rate of water uptake.
* Use percentages.
* Calculate percentage gain and loss of mass of plant tissue.

Students should be able to plot, draw and interpret appropriate graphs.

**Required practical activity 2:** investigate the effect of a range of concentrations of salt or sugar solutions on the mass of plant tissue.

**4.1.3.3 Active transport**Active transport moves substances from a more dilute solution to a more concentrated solution (against a concentration gradient). This requires energy from respiration.

Active transport allows mineral ions to be absorbed into plant root hairs from very dilute solutions in the soil. Plants require ions for healthy growth.

It also allows sugar molecules to be absorbed from lower concentrations in the gut into the blood which has a higher sugar concentration. Sugar molecules are used for cell respiration.

Describe how substances are transported into and out of cells by diffusion, osmosis and active transport

Explain the differences between the three processes.