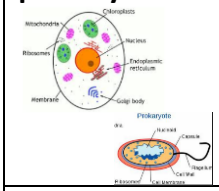
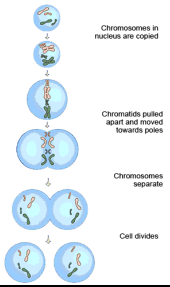
4.1 Cell biology

4.1.1	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.** Use prefixes centi 1/100, milli 1/1000, micro1/10^6 and nano 1/10^9.
4.1.1.2 animal and plant cells	Most animal cells have the following parts: a **nucleus for control**, **cytoplasm – chemical reactions take place, a cell membrane – controls what enters and leaves, mitochondria – release energy by respiration, ribosomes – protein synthesis.** In addition to the parts found in animal cells, plant cells often have: chloroplasts, a permanent vacuole filled with cell sap. Plant and algal cells also have a cell wall made of cellulose, which strengthens the cell.
4.1.1.3 cell specialisation	Cells may be **specialised** to carry out a particular function: • **sperm cells, nerve cells** and **muscle cells** in animals • **root hair cells**, **xylem** (water transport) and **phloem** cells (sugar transport) in plants.
4.1.1.4 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	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. $$magnification = \frac{measured\ size}{actual\ size}$$
4.1.2	**Cell division**
4.1.2.1 chromosomes	The **nucleus** of a cell contains **chromosomes** made of **DNA molecules**. Each chromosome carries a large number of **genes**. In body cells the chromosomes are normally found in pairs.
4.1.2.2 mitosis and the cell cycle 	Cells divide in a series of stages called the **cell cycle**. During the cell cycle the **genetic material is doubled** and **then divided into two identical cells**. Before a cell can divide it needs to **grow and increase the number of sub-cellular structures** such as ribosomes and mitochondria. The DNA replicates (copies itself) to form two copies of each chromosome. In **mitosis one set of chromosomes is pulled to each end** of the cell and the nucleus divides. Finally the **cytoplasm and cell membranes divide** to form **two identical cells**. Cell division by mitosis is important in the growth and development of multicellular organisms.
4.1.2.3 stem cells	A **stem cell** is an **undifferentiated cell** of an organism which is capable of giving rise to many more cells of the same type, and from which certain other cells can arise from differentiation. Stem cells from **human embryos** can be **cloned** and made to **differentiate** into most different types of human cells. Stem cells from **adult bone marrow** can form many types of cells including blood cells. **Meristem tissue in plants** can differentiate into any type of plant cell, throughout the life of the plant.

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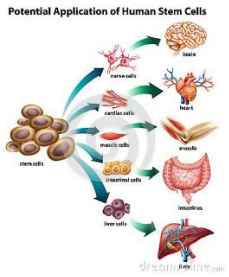
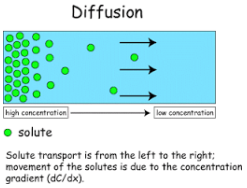


Treatment with stem cells may be able to help conditions such as diabetes and paralysis.
In **therapeutic cloning** an embryo is produced with the same genes as the patient. **Stem cells** from the **embryo** are **not rejected** by the patient's body so they may be used for medical treatment.
The use of stem cells has potential risks such as transfer of viral infection, and some people have ethical or religious objections.
Stem cells from meristems in plants can be used to produce clones of plants quickly and economically.
• Rare species can be cloned to protect from extinction.
• Crop plants with special features such as disease resistance can be cloned to produce large numbers of identical plants for farmers.

4.1.3 Transport in cells

4.1.3.1 diffusion

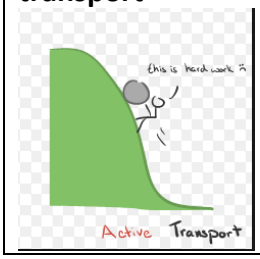


Substances may move into and out of cells across the cell membranes via diffusion.
Diffusion is the spreading out of the particles of any substance in solution, or particles of a gas, resulting in a net movement **from an area of higher concentration to an area of lower concentration.**
Some of the substances 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.
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.
In multicellular organisms, surfaces and organ systems are specialised for exchanging materials. This is to allow sufficient molecules to be transported into and out of cells for the organism's needs. The effectiveness of an **exchange surface** is increased by:
• having a **large surface area (e.g. gills in fish, alveoli in lungs)**
• 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**.
(Or you can phrase it as: **Osmosis** is the diffusion of **water** from a **high water concentration to a low water concentration** through a **partially permeable membrane.)**

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.