AQA Biology - Cell Biology Part 1 Journey of Knowledge

Context and introduction to the unit: In this section we will learn about the human digestive system which provides the body with nutrients and the respiratory system that provides it with oxygen and removes carbon dioxide. In each case they provide dissolved materials that need to be moved quickly around the body in the blood by the circulatory system. Damage to any of these systems can be debilitating if not fatal. Although there has been huge progress in surgical techniques, especially with regard to coronary heart disease, many interventions would not be necessary if individuals reduced their risks through improved diet and lifestyle. We will also learn how the plant's transport system is dependent on environmental conditions to ensure that leaf cells are provided with the water and carbon dioxide that they need for photosynthesis.
KS3: Cells – cell structure and function, microscopes, magnification, levels of organisation, specialised cells, Movement – bone marrow, organ systems, Breathing and Respiration – site of respiration.

CORE KNOWLEDGE

Eukaryotic cells are cells that contain a nucleus and other membrane-bound organelles, animal & plant cells are eukaryotic cells. Prokaryotic cells do not contain a nucleus or any other membrane-bound organelles, bacteria cells are prokaryotic cells. **Prokaryotic cells** are much smaller in comparison to eukaryotic cells. Animal cells contain a nucleus (controls the cell's activities and contains genetic information), cytoplasm (site where chemical reactions take place), cell membrane (controls the movement of substances in and out of the cell) and mitochondria (where respiration occurs to release energy). Plant cells also consist of a cell wall (more rectangular structure on outer part of the cell which provides structural support), vacuole (contains cell sap and keeps the cell turgid) and chloroplasts (oblong shape in diagrams, where photosynthesis takes place in plants, they contain a green pigment called chlorophyll). Bacteria do not have a nucleus, their DNA can be found free in the cytoplasm or in the form of plasmids. Bacteria cells can possess a flagellum, this is a tail-like part of the cell that can spin, propelling the cell forwards allowing it to move. Microscopes are used to observe small objects in detail.

An **electron microscope** has much higher magnification and resolution 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 and understand the structure & function of prokaryotic cells that cause disease. When using a light microscope, each objective lens offers a different power magnification, whilst the focus wheels allow us to gain a clear/focused image (resolution). We observe our object by looking through the eyepiece lens, and the stage is responsible for holding the microscope slide. Some light microscopes use mirrors, which allow us to direct light. We start by using the lowest power objective lens, gaining a clear image by adjusting the focus wheels, then increasing the objective lens again and repeating the process. We prepare a microscope slide by placing the specimen on the slide, ensuring this is only a thin layer to allow light to pass through. Stain the specimen so that the cells and organelles become visible, then add the cover slip at a 45-degree angle to the slide to avoid air bubbles. Scientific drawings can be used to show the cells that were observed using the light microscope. Cells should not be sketched or shaded, cell membranes should be complete and they should include a magnification. You would not expect to see structures such as mitochondria or ribosomes on a scientific drawing as they are so small. Magnification of an image can be calculated by using the below formula & FIFA method:

$$\text{magnification} = \frac{\text{length of image}}{\text{length of actual object}}$$

Specialised cells are those which have adapted (differentiated) to carry out specific functions (become specialised). Some specialised cells include: • Sperm cell (tail to swim). • Egg cell (cell membrane changes following fertilisation). • Red blood cell (biconcave shape to increase surface area for diffusion). • Nerve cells (long axons to transmit electrical impulses around the body quickly). • White blood cell (produces proteins to destroy pathogens). • Ciliated cell (cilia/hairs to waft mucus) • Muscle cell (many mitochondria to release energy). • Root hair cells (projection creates a large surface area to absorb water and mineral ions). • Palisade cell (many chloroplasts for maximum photosynthesis).

A **stem cell** is an unspecialised cell. In animals, stem cells can be harvested from embryos or the bone marrow. Embryonic stem cells are capable of differentiating into most different type of animal cell. Stem cells from adult bone marrow can form blood cells. In plants, stem cells can be harvested from the meristem (tip of the plant root or tip of the plant shoot). Meristem tissue in plants can differentiate into any type of plant cell, throughout the life of the plant. Treatment with stem cells may be able to help conditions such as Parkinsons, strokes 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.

The nucleus of a cell contains chromosomes made of DNA. Each chromosome carries a large number of genes (section of DNA). A body cell contains 23 pairs of chromosomes (46 in total). Cells divide for growth & repair of cells or tissues in a series of stages called **the cell cycle**. Before a cell can divide it needs to grow and increase the number of sub-cellular structures such as ribosomes (for protein-synthesis) and mitochondria (to release energy through respiration). The DNA also replicates to form two copies of each chromosome, this is stage 1 of the cell cycle and takes the longest amount of time. During mitosis (stage 2 of the cell cycle) 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 daughter cells (stage 3 of the cell cycle). The number of cells produced by mitosis can be calculated using the formula 2^n, where n = the number of cell divisions. E.g. after 2 cell divisions, 4 cells are produced (2^2), after 3 cell divisions, 8 cells are produced (2^3).

Disciplinary Knowledge

Microscopy Required Practical: use a light microscope to observe, draw and label a selection of plant and animal cells. A magnification scale must be included. WS 1.1, 1.2, 4.4

Vocabulary

Eukaryote, Prokaryote, Nucleus, Plasmid, Flagella, Chloroplast, Chlorophyll, Cytoplasm, Mitochondria, Ribosome, Cell Membrane, Cell Wall, Cellulose, Vacuole, Cell Sap, Cellulose, Differentiation, Specialised, Sub-cellular, Microscopy, Resolution, Magnification, Chromosome, Mitosis, Stem Cell, Unspecialised, Embryo, Meristem, Bone Marrow, Therapeutic Cloning, Diffusion, Osmosis, Active Transport

Reading is Power

Bacteria and Viruses

Where Next?

Organisation, Infection and Response, Bioenergetics, Inheritance and Variation

AQA Biology - Cell Biology Part 2 Journey of Knowledge

Context and introduction to the unit: In this section we will learn about the human digestive system which provides the body with nutrients and the respiratory system that provides it with oxygen and removes carbon dioxide. In each case they provide dissolved materials that need to be moved quickly around the body in the blood by the circulatory system. Damage to any of these systems can be debilitating if not fatal. Although there has been huge progress in surgical techniques, especially with regard to coronary heart disease, many interventions would not be necessary if individuals reduced their risks through improved diet and lifestyle. We will also learn how the plant's transport system is dependent on environmental conditions to ensure that leaf cells are provided with the water and carbon dioxide that they need for photosynthesis.
KS3: Cells – cell structure and function, microscopes, magnification, levels of organisation, specialised cells, Movement – bone marrow, organ systems, Breathing and Respiration – site of respiration.

CORE KNOWLEDGE

Diffusion is the movement of particles from an area of high concentration to an area of low concentration. In Biology, diffusion refers to the movement of substances into or out of a cell. 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. The rate of diffusion can be increased by increasing the surface area (space where particles can diffuse through), increasing the temperature (kinetic energy of the particles), decreasing the concentration gradient (difference in the number of particles) and decreasing the diffusion pathway (distance that the particles have to move). 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. The effectiveness of an exchange surface is increased by: • having a large surface area • a membrane that is thin, to provide a short diffusion pathway • (in animals) having an efficient blood supply to maintain the concentration gradient and decrease the diffusion pathway • (in animals, for gaseous exchange) being ventilated to maintain the concentration gradient. The villi in the small intestine of animals, alveoli in the lungs of animals, gills in fish & root hairs in plants are adapted to be efficient exchange surfaces.

Osmosis is the diffusion of water from a dilute solution (high water concentration) to a concentrated solution (low water concentration) through a partially permeable membrane. A partially permeable membrane is permeable to small molecules such as water but does not allow the passage of large molecules. To investigate how different concentrations of sugar or salt solutions affect the mass of plant tissue, potato pieces are weighed using a balance before and after being placed in various concentration solutions to observe water movement by osmosis. The size of the potato pieces, volume of solution and temperature should all remain the same. Potato pieces should be dried before measuring the final mass to remove excess water that may affect the results. By calculating the change in mass, students can determine whether water has moved into the potato (increase in mass) or moved out of the potato (decrease in mass) by osmosis. The concentration at which there is no net movement of water indicates the potato's isotonic point. Calculating change in mass may result in a negative value if water has moved out of the potato by osmosis, when plotting results on a line graph the y axis should extend past 0 into the negative region.

Active transport moves substances from a low concentration to a high concentration. This requires energy from respiration as particles are moving against the concentration gradient. Active transport allows mineral ions to be absorbed into plant root hairs from very dilute solutions in the soil. It also allows some glucose molecules to be absorbed from lower concentrations in the small intestine into the blood which has a higher sugar concentration. Where active transport occurs, it is usually always the case that diffusion has occurred first. Eventually the substances will be in equal amounts, and so active transport begins to take place with substances moving from low to high. This allows for maximum absorption of substances.

Diffusion, osmosis and active transport are all methods of cell transport that occur in both animals and plants. Diffusion and osmosis is the movement of particles along a concentration gradient (from high to low concentration) whereas active transport is against a concentration gradient (from low to high concentration). Diffusion and osmosis are passive processes (do not require energy) whereas active transport is an active process (does require energy). Diffusion and active transport is the movement of solutes whereas osmosis is the movement of water only.

Disciplinary Knowledge

Osmosis Required Practical: investigate the effect of a range of concentrations of salt or sugar solutions on the mass of plant tissue. WS 1.2, 1.5

Vocabulary

Eukaryote, Prokaryote, Nucleus, Plasmid, Flagella, Chloroplast, Chlorophyll, Cytoplasm, Mitochondria, Ribosome, Cell Membrane, Cell Wall, Cellulose, Vacuole, Cell Sap, Cellulose, Differentiation, Specialised, Sub-cellular, Microscopy, Resolution, Magnification, Chromosome, Mitosis, Stem Cell, Unspecialised, Embryo, Meristem, Bone Marrow, Therapeutic Cloning, Diffusion, Osmosis, Active Transport

Reading is Power

Bacteria and Viruses

Where Next?

Organisation, Infection and Response, Bioenergetics, Inheritance and Variation