BioMedical Admissions Test (BMAT)

Section 2: Biology

Topics B1 and B2 - Cells and Movement Across Membranes

Topics B1 and B2 - Cells and Movement Across Membranes

Cells

The basic units that all living things are made from are called cells. **Unicellular organisms** contain only **one cell**, whereas multicellular organisms are made of many.

Eukaryotic cell structure

All eukaryotic cells (e.g. in plants and animals) contain a cell membrane and cytoplasm. Most eukaryotic cells contain a nucleus, except for mature red blood cells. Plant cells also have a cell wall and a sap vacuole and certain plant cells contain chloroplasts.

Sub-cellular structure	Function
Cell membrane	• **Partially permeable** layer • Contains cell contents • Controls movement of substances in and out of the cell, e.g. allows CO_2 to leave
Cytoplasm	• The **site of chemical reactions** • Holds the cell organelles, e.g. nucleus and mitochondria • Contains enzymes and food reserves, e.g. starch • Contains dissolved salt ions and sugar
Nucleus	• Contains DNA in the form of **chromosomes** • Found inside the cytoplasm • Regulates cell functions
Mitochondria	• Controls production of energy from **aerobic respiration** • Contains an inner and outer membrane
Chloroplast (plants only)	• Contains **chlorophyll** to trap light energy and convert to chemical energy through **photosynthesis** • Found inside the cytoplasm of plant cells
Vacuole (plants only)	• Stores water-soluble chemicals • Helps to keep plant cell firm • Found inside the cytoplasm • Fluid-filled (**sap**) containing sugars and salts
Cell wall (plants only)	• Outer layer made of **cellulose** • Provides protection and rigidity to the cell

Prokaryotic cells

Prokaryotic cells are smaller than eukaryotic cells and DNA is not found in a nucleus.

Subcellular structure	Function
Cell membrane	• As above
Cytoplasm	• As above
Chromosomal DNA	• **Circular coiled** molecule of **double-stranded DNA** • Not found in a nucleus, but freely suspended in the cytoplasm • Carries genetic information and regulates cell processes
Plasmid DNA	• Small molecule of **double-stranded circular DNA** • Carries genetic information for particular specialist functions, e.g. antibiotic resistance • Can replicate separately from the chromosomal DNA • Can be moved between bacterial cells • This is the section that is used when bacteria is a vector for **genetic engineering.**
Cell wall	• Provides protection and structural support to bacteria • Freely permeable to small molecules so does not control movement of substances • Made of **proteins, lipids and sugars** - different from plant cell walls • Some bacterial cells also have a **slime capsule** around the cell wall

Levels of Organisation

- ➔ A **tissue** is a group of similar cells with a similar structure and function, working together to do a particular job, e.g. muscle
- ➔ An **organ** is made from a group of different tissues that work together to do a particular job, e.g. liver
- ➔ An **organ system** is made of a group of different organs that work together to do a particular job, e.g. circulatory system containing the heart, different blood vessels etc.

Specialised Cells

Differentiation describes the process of eukaryotic cells becoming specialised to a particular function. Here are some examples of important specialised cells:

	Function	Adaptations
Red blood cells	Oxygen transport	• **Concave** shape to increase the surface area to volume ratio • Contains **haemoglobin**, which allows them to carry oxygen • No **nucleus** to increase available volume for haemoglobin • Mature RBC have no **mitochondria**
Egg cells	Reproduction	• Large **food store** in order to build molecules for the developing embryo
Sperm cells	Reproduction	• Long **tail** and streamlined head • Many **mitochondria** in order to provide the energy for swimming
Root hair cell	Absorption of water and mineral ions from soil	• **Long** hair-like structure to provide large surface area

Movement Across Membranes

Diffusion is the spreading out of particles from an area of **high concentration to an area of low concentration.**

- This is a **passive process** as it does not require energy.
- Factors affecting rate:
    - Concentration gradient - greater difference will have a faster rate of diffusion
    - Temperature - higher temperature increases kinetic energy so increases rate
    - Distance - the further the particles need to travel, the longer it takes to diffuse
    - Size of particles - smaller particles diffuse faster
    - Surface area - large surface area will increase the rate of diffusion.

Osmosis is the net movement of water molecules across a **partially permeable membrane** from a region of **higher water concentration to an area of lower water concentration**.

- Cells in water
    - When a cell is placed in pure water, there is a higher water potential outside the cell than within, causing water to enter the cell.

    - Plant cell - this flow of water will exert pressure on the cytoplasm, which will press against the cell wall. This is called **turgor**.
    - Animal cell - does not contain a cell wall and therefore the membrane will **burst** from the pressure.
- Cells in a more concentrated solution
    - Concentrated salt solution has a lower water potential than the cytoplasm so the cells will lose water.
    - Plant cell - becomes **flaccid** as pressure reduces and cell membrane and cytoplasm shrink away from cell wall.
    - Animal cell - become **crenated** as cytoplasm decreases.

Active transport allows molecules to be moved **against a concentration gradient**, using energy released by respiration.

- Cells using active transport tend to have lots of mitochondria for energy.
- Thought to be achieved by carrier proteins that are found in the membrane.