

CELLS & TISSUES

Aim

To explain the human body at a microscopic level, including the structure and function of cells, tissues and membranes.

THE CELL

All living matter is composed of functional units called cells. At one end of the scale in the animal kingdom, there are unicellular organisms composed of a single cell (eg. Protozoa or Amoeba). In an amoeba all the vital processes of the animal take place inside a single cell.

Cells are capable of digesting food, growing, respiring, excreting, secreting, reproducing and responding to stimuli. All these things happen in a single-celled animal.

At the other end of the scale, there are the multi-cellular organisms such as the higher animals and humans. In these organisms, the cells become specialised, and one or more of these different functions may be lost.

Parts of the Human Cell

The various parts of the human cell and their functions are:

Cell Membrane

This is the outer layer of the cell. It gives the cell its shape and holds the liquid inside the cell. This membrane is a semi-permeable membrane which means it allows certain things to pass in and out of the cell.

Nucleus

The nucleus contains the nucleolus; this is the part of the cell which holds the genetic material, the chromosomes and chromatin which are concerned with reproduction of the cell.

Nucleolus

A spherical body inside a nucleus made of protein, RNA and DNA. The nucleolus is involved in the synthesis and storage of ribosomal RNA.

Cytoplasm

This is the fluid inside the cell which contains salts and sugars in solution.

Golgi Apparatus

This stores food inside the cell. Also note the fat droplets which float about in the cytoplasm and are also a means of storing food in the form of fats. Also called Golgi complex.

Lysosomes

These are digestive centres in the cell and help to digest and break down food material.

Centriole

This is concerned with cell division, the reproduction of the cell and the movement of cell chromosomes.

Mitochondrion

This is concerned with the respiration of the cell. As the end product of all respiration is energy, it is also a source of energy. (Plural + mitochondria).

Endoplasmic Reticulum

This is the part where protein is manufactured or built up from nitrogen.

Fibrils

These are concerned with nervous responses.

Microtubule

These are tiny tubes inside the cells.

Microvilli

Tiny finger like bumps in the surface of the cell (ie. bumps in the cell wall)

These serve to increase the surface area of the cell, hence improving the ability to absorb particles into the cell.

Cilia

Long hair or tail like structure projecting from a single cell, used to propel the cell (enables it to move or swim).

Chromatin

A mass of thread like genetic material, mainly DNA, present inside the nucleus when the cell is not dividing/reproducing.

Nuclear Envelope

Wall of material surrounding/containing the nucleus.

Glycogen

Complex polymer (compound) of glucose. This acts as a storage/supply of glucose on liver and muscle cells.

Peroxisome

Similar to lysosomes; an organelle containing enzymes that use oxygen to oxidise different organic compounds. These are common in liver cells.

Microfilament

A filament of protein. They are contractile units in muscle cells.
They provide support, shape and movement in non-muscle cells.

Free Ribosomes

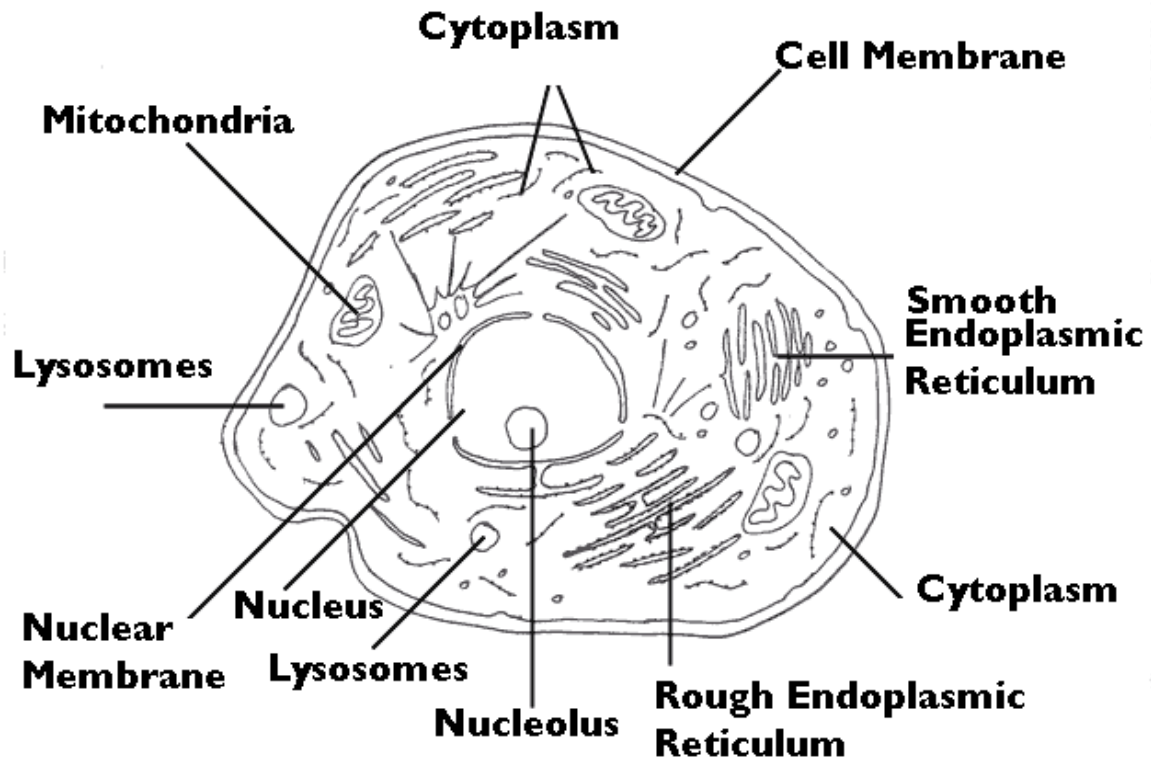
An organelle suspended in cytoplasm that synthesises proteins.
Contains ribosomal RNA and ribosomal proteins.

Secretory Vesicle

Tiny bladder or sac in the cell that secretes or expels unwanted material.

Although the cell is very, very small, you can see that it contains many different parts. It also carries out many different functions.

Organelles of the Cell



FROM CELLS TO BODIES

Humans are multi-cellular organisms. The single cells, many of which are specialised so that they can perform a particular function, are grouped together to form tissues. These tissues in turn form special groups called **organs**. The groups of organs make up a system, and the systems join together to form a living body.

HUMAN TISSUES

There are five basic types of tissue found in humans:

- Epithelial tissues
- Connective tissues
- Fluid tissues
- Muscle tissues
- Nervous tissues

Epithelial Tissues

These are formed from cells which join together to form covering layers, for example, the skin covering the body. This type of tissue also forms the covering layers of various organs in the body; the lining of the body cavities and the active parts of the glands of the body.

Epithelial tissues are made up of specialised cells of various shapes and are joined in different ways as shown. You do not need to memorise all the different types of epithelial tissue - just be aware they exist!

Connective Tissues

This is the tissue which joins other tissues together. Connective tissues give form and strength to many organs, and often serve for protection and leverage. Examples of connective tissue are: bones; tendons; ligaments; cartilage and fat.

Fluid Tissues

These tissues transport food nutrients and waste products around the body. Blood is a good example of a fluid tissue.

Muscle Tissues

There are three types of muscle tissues:

Striated or Voluntary Muscle Tissue

Is the type found in your arms and legs and which you can rest as you wish. Skeletal muscle is made up of striated muscle fibres supported by connective tissues attached to bone by tendons or an aponeurosis, and stimulated by nerves;

Smooth or Involuntary Muscle Tissue

Works automatically and cannot be controlled by you. Involuntary muscle tissue would be found in the muscle in the intestine which moves food along though the gut.

Cardiac Muscle Tissue

Is also involuntary and cannot be controlled by you. This type of muscle tissue is found in the heart.

Muscle tissue is made so that it can **expand and contract**.

You contract (shorten) the muscles of your arm when you pick up a brick and expand (lengthen) them when you stretch out your arm. The involuntary muscles of the body expand and contract on their own (think how your heart beats without your control).

Nervous Tissue

The nerve cells which make up this tissue are sensitive to stimuli, such as heat and touch. They can link up charges and transmit impulses through the nervous system.

These are the different types of tissues, but remember that, although they are different from each other because they perform different functions, **they are all made up of cells.** These cells are the basic units of life. They take in food or nutrients, utilise the nutrients and produce energy and waste products. That is the basic process of living - the breakdown of food into energy and waste products. This process goes on in plants and animals (including humans).

CELL DIVISION

Cell growth occurs by a single cell dividing to reproduce two cells. This process can occur by either of two different methods; either mitosis or meiosis.

Mitosis is a process involving one parent cell, where the new cells are identical copies of the cell which they came from (ie. the parent cell). This process is involved in normal growth processes of an organism such as an organism growing bigger throughout its life or an organism replacing dead or discarded cells (rejuvenation).

Meiosis is a process that occurs only during sexual reproduction.

It involves two parents, and two successive divisions or two phases, resulting in new cells which are NOT identical to the parents.

CELL PROCESSES

Osmosis and Filtration

Cells are enclosed by a special tissue or skin called a **semi-permeable membrane.** The word **permeable** means porous or penetrable. **Semi-permeable** means that the membrane only allows certain things to pass through it. The membrane around cells allows **water** and other items in **solution** (i.e. dissolved in water) to pass into or out of the cell.

OSMOSIS is the process whereby water can pass through a semi-permeable membrane **from a weak solution to a stronger solution.**

EXAMPLE:

A and B are two liquids separated by a semi-permeable membrane such as a cell wall. Liquid A is a solution of sugar and contains dissolved sugar particles (or molecules as very small particles are called). Liquid B is pure water, which is called distilled water, and this does not contain any dissolved matter at all. The movement which takes place is of water from Solution B through the semi-permeable membrane to Solution A. This causes Solution A to increase in volume and Solution B to decrease in volume. The pressure exerted by this movement is called **osmotic pressure.** As Solution B gets less and Solution A increases, this osmotic pressure will increase until water starts being forced back through the membrane from Solution A to Solution B. This counter pressure is called the **FILTRATION pressure.**

The movement with osmosis is always of water, **from a weak to a stronger solution**. If Solution A was a strong sugar solution and Solution B was a weak sugar solution, the water movement would go on until both solutions were of **equal strength**. At this point, movement would stop.

THE OBJECT OF OSMOSIS IS TO HAVE SOLUTIONS OF EQUAL STRENGTH ON EACH SIDE OF THE SEMI-PERMEABLE MEMBRANE.

Hydrostatic Pressure

This is the movement of very small particles of matter, or molecules, across a semi-permeable membrane because **the pressure on one side of the membrane is much greater than the pressure on the other side of the membrane**. A good example of this force is the blood pressure of the body which is caused by the heart pumping blood around the system. This causes the pressure inside the capillaries to be higher than that in the surrounding fluid. This higher pressure forces particles through the **capillary walls**.

Active Transport

This is the movement of particles or molecules across a semi-permeable membrane against the force exerted by osmotic pressure or hydrostatic pressure. This movement requires energy before it can take place as it overcomes existing forces.

Phagocytosis

In Greek, "phagos" means eating. Phagocytosis is the action of a cell when it reaches out, engulfs a molecule into a cell and digests it.

Pinocytosis

With pinocytosis, the molecule attaches itself to the cell wall. It is then drawn into the body of the cell although it is still surrounded by a part of the cell wall. The gap is repaired by the cell wall growing together.

ELECTRO-CHEMICAL GRADIENT

Some substances form ions when they are dissolved in water. An ion is a particle that has become electrically charged. For example, when common salt (which is called sodium chloride - NaCl for short) is dissolved in water it splits into sodium ions (positively charged) and chlorine ions (negatively charged)

Where there is an unequal number of positive and negative ions on either side of a semi-permeable membrane, the ions will move across the membrane until balance is reached. Balance occurs when there are equal numbers of positive and negative ions on either side of the membrane. The movement occurs because the attraction of the positive and negative ions sets up an electrical force.

NUTRIENT AND WASTE EXCHANGE IN CELLS

Having looked at the special properties of cells, we can now consider how nutrients pass from the arteries into the cells and how the waste products pass from the cells into the veins.

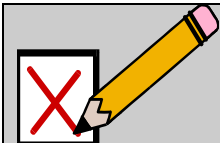
Both arteries and veins begin at the heart and spread throughout the body. To begin with, they are large tubes about the width of a little finger. They have thick walls. As they spread out, they divide into branches and get progressively smaller and narrower until finally they become very fine, thread-like tubes called capillaries. Capillaries have very thin walls.

The arterial system and the venous system connect up with each other through these capillaries.

Notice that between the capillaries and the cells to which they carry nutrients, there is a fluid called **interstitial fluid**. (Interstitial means "intervening space"). This fluid surrounds the cells and capillaries and acts as a connecting link.

The nutrients carried by the arteries pass through the walls of the artery capillaries; travel through the interstitial fluid and pass through the walls of the cells. Waste products pass in a similar way but in the opposite direction! They travel through the cell walls; into the interstitial fluid and through the venous capillary walls.

Although this sounds a simple procedure, it is a complex operation that makes use of all the special properties of cells (such as osmosis, hydrostatic pressure and the electro-chemical gradient).



SELF ASSESSMENT

Perform the self assessment test titled 'test 1.1'
If you answer incorrectly, review the notes and try the test again.



ASSIGNMENT

Download and do the assignment called 'Lesson 1 assignment'.