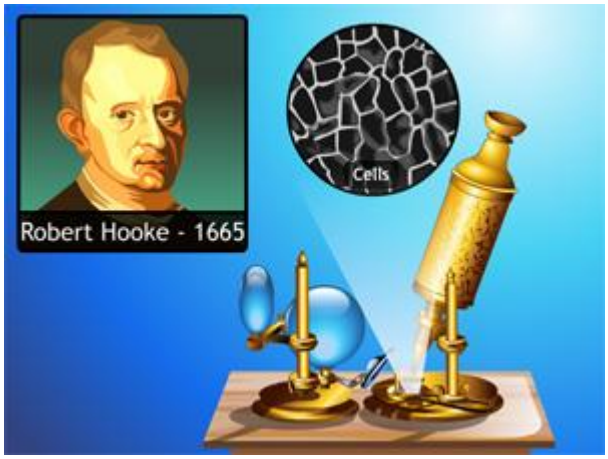
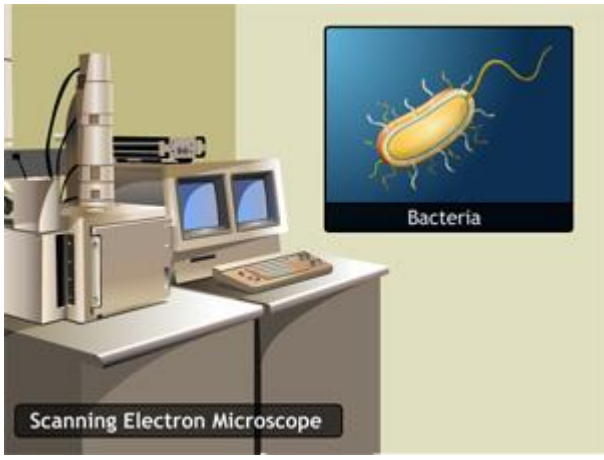
CELL – STRUCTURAL AND FUNCTIONAL UNIT OF LIFE

INTRODUCTION TO CELLS

With the help of a **microscope**, an English scientist, **Robert Hooke**, first discovered the existence of cells in 1665.**Scanning electron microscopes** are used to examine the external parts of various organisms. The **transmission electron microscope** is used to view the internal structure of a cell and its organelles. Organisms that are made up of a single cell and perform all their vital activities, like reproduction, locomotion and digestion, are called **unicellular** organisms. Organisms that are made up of more than one cell are called **multicellular** organisms. **Amoeba** uses small finger-like projections called **pseudopodia** for locomotion and to capture prey. **Paramecium** is a single cell and is built in such a way that it performs all its vital activities, like reproduction, locomotion, digestion, and so on. The **White Blood Corpuscle** (WBC) is the only animal cell that changes its shape. The branched structure of a **neuron** helps it to transfer messages to all parts of the body.
A **microscope** is an instrument used to see objects too small for the naked eye. An English scientist, **Robert Hooke**, discovered the existence of cells in 1665. He is known for his book Micrographia, and for first using the word cell to describe the basic unit of life.

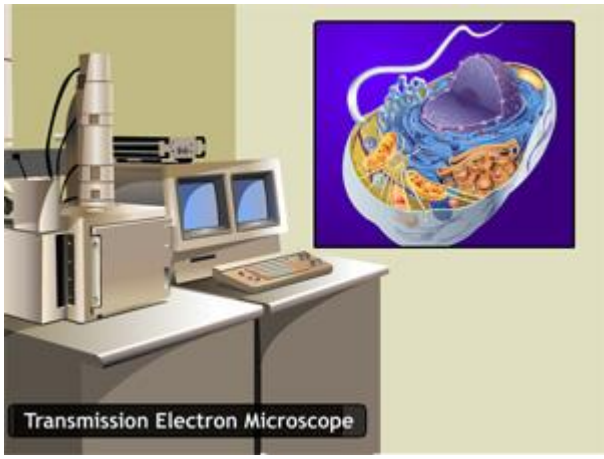


Scanning electron microscopes are used to examine the external parts of various organisms; It is a type of electron microscope that images a sample by scanning it with a high-energy beam of electrons in a raster scan pattern. The electrons interact with the atoms that make up the sample, producing signals that contain information about the samples surface topography, composition, and other properties such as electrical conductivity.

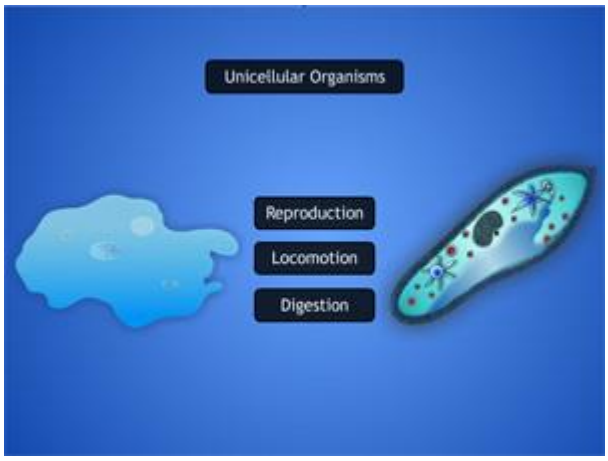


The **transmission electron microscope (TEM)** is used to view the internal structure of a cell and its organelles. **TEM** is a microscopy technique in which a beam of electrons is transmitted through an ultra-thin specimen, interacting with the specimen as it passes through it. An image is formed from the interaction of the electrons transmitted through the specimen; the image is magnified and focused onto an imaging device, such as a fluorescent screen, on a layer of

photographic film, or to be detected by a sensor, such as a CCD camera.

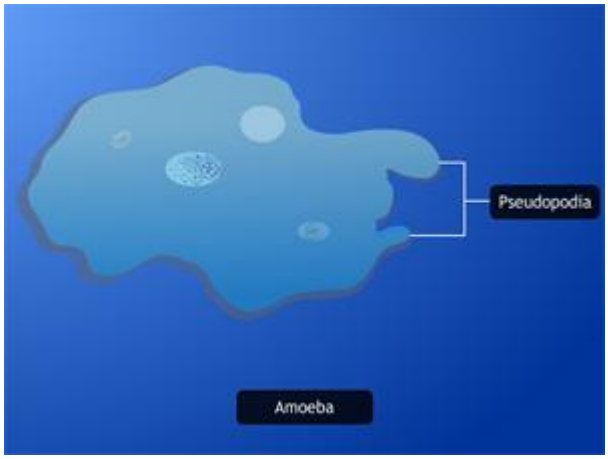


Organisms that are made up of a single cell and perform all their vital activities, like reproduction, locomotion and digestion, are called **unicellular** organisms. Unicellular organisms can be found everywhere. The oldest forms of life, unicellular organisms existed 3.8 billion years ago, if not longer.

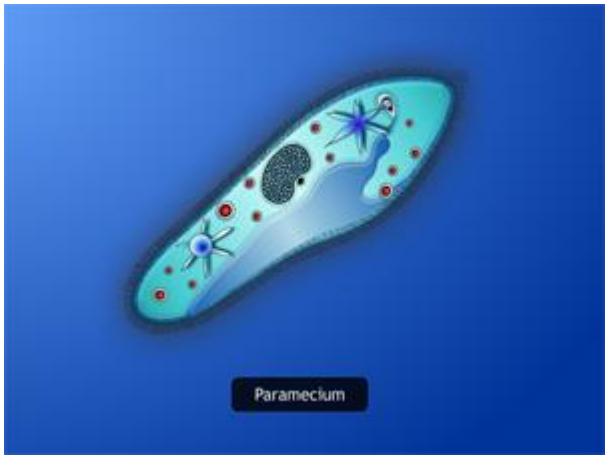


Organisms that are made up of more than one cell are called **multi-cellular** organisms. Most life that can be seen with the naked eye are multi-cellular, as are all animals and plants.

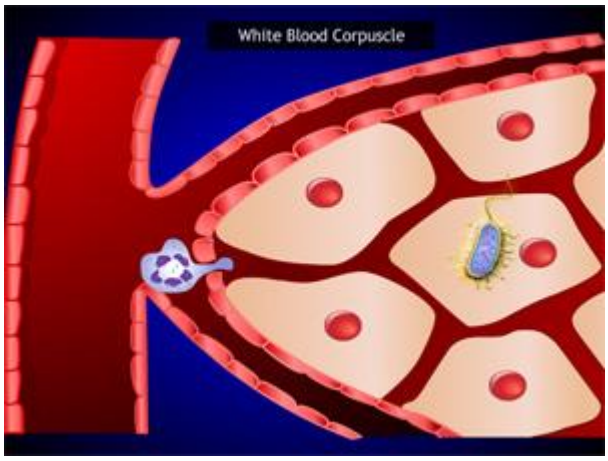
Amoeba uses small finger-like projections, called **pseudopodia,** for locomotion and to capture prey. Pseudopods or pseudopodia are temporary projections of eukaryotic cells. Cells with these structures are called amoeboid.



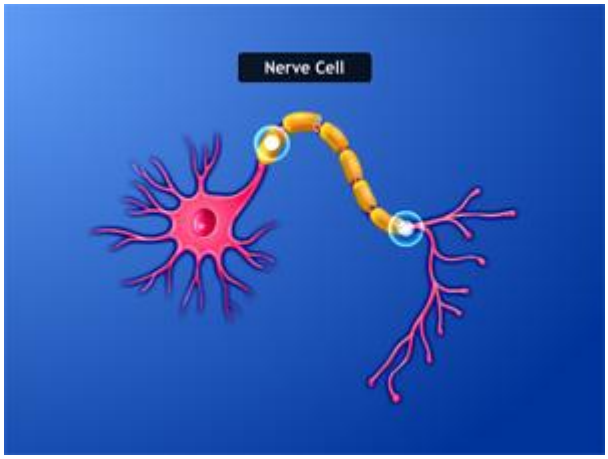
Paramecium is a single cell, and is built in such a way that can perform all vital activities, like reproduction, locomotion, digestion, and so on.



The **White Blood Corpuscle** (WBC) is the only animal cell that changes its shape. WBCs are responsible for protecting our bodies against invading bacteria and harmful micro-organisms. To find invading bacteria, they travel along with blood in blood vessels. Whenever they find invading bacteria, they squeeze through the blood vessels and intercellular spaces, catch the bacteria and kill it. To perform this task, WBCs change their shape using pseudopodia similar to those in an amoeba.



The branched structure of a **neuron** helps it transfer messages to all parts of the body. A neuron, also known as a nerve cell, is an electrically excitable cell that processes and transmits information by electrical and chemical signalling.



CELL STRUCTURE

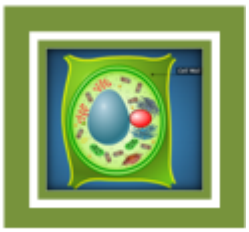
The cell is the fundamental and structural unit of life.

Eukaryotic cells

Eukaryotic cells are the cells which possess a definite nucleus with a distinct nuclear membrane. Let us observe the contents of a eukaryotic cell. The living structures of a cell are called as cell organelles.

Cell wall:

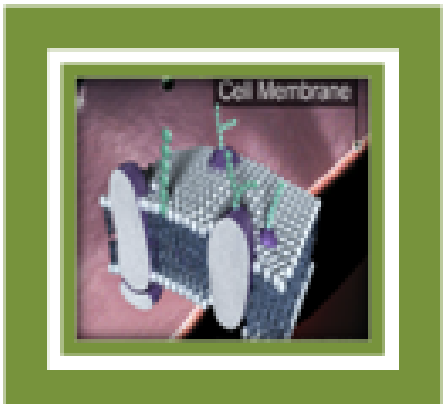
It is the non-living outermost covering of the cell. The cell wall is composed of cellulose and is permeable. It separates the contents of the cell from the surroundings. It gives shape and protection to the cell. It is present only in plant cells.



Functions of cell wall

- Cell wall provides rigidity and shape to the cell.
- Cell wall is a dead structure but permeable to substances.
- Cell wall is made mainly of cellulose.
- Cell wall is thick and protective in function.

Cell membrane:
It is also called as plasma membrane. It is present both in animal and plant cells. It is a thin living membrane made of lipoproteins. It comprises three layers, a lipid layer sandwiched between two protein layers. It is a selectively permeable membrane.



Functions of cell membrane

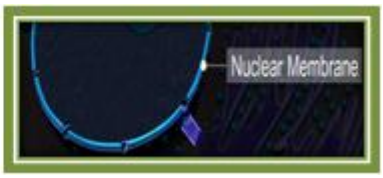
- It maintains the shape of the cell. It separates the cellular contents from the external environment.
- It helps in absorption of mechanical shocks and protects the cell from injury.
- It allows the movement of some substances into and out of the cell. Movement of substances through this semi-permeable membrane can be by the process of diffusion, osmosis etc.
- It forms the membrane for various cell organelles.
- It keeps the adjacent cells in contact.
- Its infolds help in absorption of materials by the process of pinocytosis or phagocytosis.
- Its out folds increase the area for absorption.

Difference between diffusion and osmosis

DIFFUSION	OSMOSIS
It is the process by which molecules spread from a region of higher concentration to a region of lower concentration.	It is a process by which solvent molecules move from a region of low concentration to theregion of high concentration through a semipermeable membrane.
Diffusion occurs in all the mediums. Diffusing particles can belong to either one of the states, solid, liquid or a gas.	Osmosis takes place only in liquid medium and only the solvent molecules can move from one place to another.
Semipermeable membrane may not be present.	Presence of semipermeable membrane separating the two liquids is necessary.
Different types of diffusion may include Brownian motion, facilitated diffusion etc.	Forward osmosis and reverse osmosis are the types of osmosis.

Nucleus:

A true nucleus acts as the control centre of the cell. It is covered by a two layered, perforated nuclear membrane allowing substances to enter and leave the nucleus. Nucleus is filled with semifluid colloidal substance called as nucleoplasm in which float the nucleolus and the chromatin fibres. The nucleus contains chromosomes, which are composed of Deoxyribonucleic acid (DNA) and proteins.



Functions of nucleus

- Nucleus controls all the activities of the cell.
- As the nucleus carries genetic information in the form of DNA, it plays a major role in cell division and cell development. The functional segments of DNA are called genes.
- Nucleus plays an important role in protein synthesis and transmission of characters from one generation to another generation.

Cytoplasm:

CYTOPLASM	NUCLEOPLASM
It is a jelly like homogeneous substance.	It is a transparent fluid present in the nucleus.
Protoplasmic part which lies outside the nucleus.	Protoplasmic part which is present inside the nucleus.
Cell organelles and inclusions are suspended in the cytoplasm.	Chromatin fibres and nucleolus are suspended.
Both inorganic and organic molecules are present.	Composition is rich in nucleotides.

Cytoplasm:

It is a jelly like viscous substance occupying entire cell except the nucleus. The cytoplasm supports and protects the cell organelles that perform different metabolic functions. Cell organelles include

endoplasmic reticulum, Ribosomes, Golgi apparatus, Mitochondria, Plastids, Lysosomes, and Vacuoles. Inclusions are the non-living substances present in the cytoplasm.

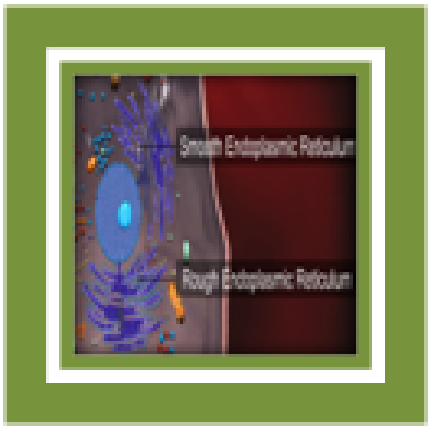
ROUGH ENDOPLASMIC RETICULUM	SMOOTH ENDOPLASMIC RETICULUM
These are rough at surface and are associated with ribosomes.	These are smooth at surface and are associated with Golgi bodies.
These are responsible for the synthesis of proteins and enzymes.	These are responsible for the synthesis of glycogen, lipids etc.
These provide structural framework for the cell.	These take part in the synthesis of fats in adipose cells.
These also act as channels for quick transport.	These can also detoxify drugs and some poisons.

These helps in the synthesis of membranes.

These helps in the formation of rhodopsin from vitamin A.

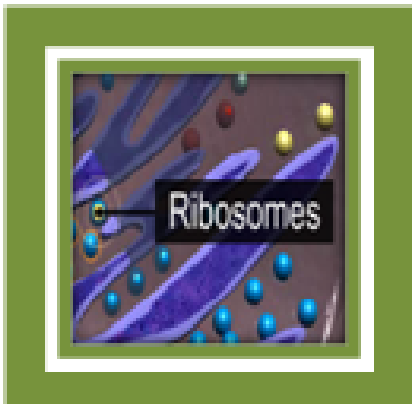
Endoplasmic reticulum:

It is a network of tubules and flattened sacs perform various activities in the cell. The space inside the endoplasmic reticulum is called as lumen. Endoplasmic reticulum serves as a channel for the transport of proteins between various regions of the cytoplasm. Two types of endoplasmic reticulum are Rough Endoplasmic Reticulum (RER) and Smooth Endoplasmic Reticulum (SER).



Ribosomes:

These are naked granules with no membrane. They are found scattered in the cytoplasm or attached to the outside of the endoplasmic reticulum. They are the biofactories of proteins. Ribosomes can be free ribosomes scattered in the cytoplasm or bound ribosomes seen attached to endoplasmic reticulum. Ribosomes are made up of two subunits, the larger subunit and the smaller subunit. 70s ribosomes are present in prokaryotes and 80s ribosomes are present in eukaryotes.



Functions of ribosomes

- Ribosomes are considered to be the bio factories since they are the sites of protein synthesis.
- They are the lodging sites for many enzymes participating in the process of protein synthesis.

Golgi apparatus:

These cell organelles are named after the biologist, Camillo Golgi, who first described it. The Golgi consists of a stack of membrane-bounded cisternae located between the endoplasmic reticulum and the cell surface.

Functions of Golgi apparatus

- It synthesises certain biopolymers.
- It also consists of some processing enzymes which alter some proteins and phospholipids synthesised by endoplasmic reticulum.

Mitochondria:
These are cellular organelles termed as ‘power houses of the cells’. These are bounded by a double membrane. The outer membrane is smooth while the inner membrane is thrown into folds called as cristae. The cristae increase the area of cellular respiration. Cristae on their surface possess structures called oxysomes. Oxysomes are rich in ATP syntheses enzyme. Both the membranes are separated by intermembrane space. Mitochondrial matrix is rich in respiratory enzymes. Mitochondria have their own DNA, RNA and ribosomes to synthesise respiratory enzymes. The enzymes in the mitochondria oxidise glucose molecules to produce energy in the form of Adenosine Triphosphate or ATP.

Functions of mitochondria

- These synthesise energy rich ATP molecules.
- These help in the synthesis of fatty acid, amino acids, steroids by providing them with biological intermediates.

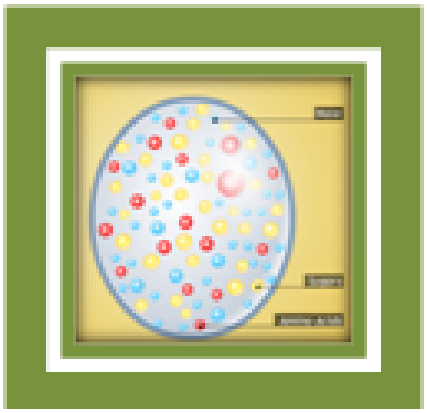
Lysosomes:
Lysosomes are membranous sacs filled with enzymes. The enzymes are hydrolytic enzymes which are capable of digesting cellular macromolecules. When the cell gets damaged, the lysosome may burst and its enzymes may digest the cell itself. Hence, lysosomes are called as ‘suicidal bags’.

Functions of lysosomes

- Help in killing foreign cells referred to as pathogens.
- Help in destroying the diseased cells.

Vacuoles:

Vacuoles are membrane bound compartments present in both plant and animal cells. These organelles store water, waste products, and substances like amino acids, sugars and proteins. The fluid in the vacuoles is called ‘cell sap’. A vacuole is covered by a living membrane called “tonoplast”. Vacuoles also provide buoyancy to the cell.



Functions of vacuoles

- They help the cell to maintain its buoyancy and turgidity.

- They play an important role in the growth of the cell

Plastids:
These are major organelles found only in the cells of plants and algae. These are of three types namely, Chloroplasts, Chromoplasts and Leucoplasts.
a) Chloroplasts are one kind of plastids present mainly in plant cells. Chloroplasts contain green pigment called as chlorophyll. Chlorophyll absorbs energy from the sunlight necessary for photosynthesis.
b) Chromoplasts are the organelles which provide bright colours to the plant structures like buds, flowers etc.
c) Leucoplasts are the organelles which store starch, oils and protein granules.

Functions of plastids

- Plastids are responsible for synthesis of food.
- Plastids are responsible for colouration of different parts of the plant.
- Plastids are responsible for storage of food molecules.

Difference between plant cells and animal cells

PLANT CELLS	ANIMAL CELLS
Plant cells possess cell wall.	Animal cells do not possess cell wall.

Chloroplasts are present in plant cells.	Animal cells do not possess chloroplasts.
Plant cells are almost rectangular in shape.	Animal cells are round in shape.
Plant cells possess large vacuoles.	Animal cells have many small vacuoles.
Cilia rarely occur in plant cells.	Cilia are present in animal cells.
Higher plants do not possess centrioles.	Animal cells do contain centrioles.
Plant cells have no or less number of lysosomes.	Animal cells possess many number of vacuoles.

STRUCTURE AND FUNCTION OF CELL

The black layer or the scab that you see on the wound is a result of the aggregation of dead **Red Blood Cells (RBCs)**. The nose and the lungs form part of an organ system, the **respiratory system**. All **organ systems** work together to form a complex organism.

The **cytoplasm** is a jelly-like fluid present between the nucleus and the cell membrane. The **cell membrane** allows the movement of minerals and other substances in and out of the cell.

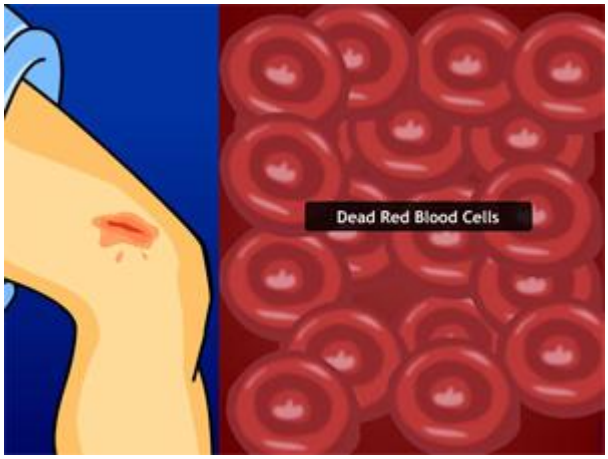
The **nucleus** controls the activities of a cell. **Methylene blue** is the stain placed on plant and animal cells to differentiate the nucleus under a microscope. Chromosomes are called vehicles of heredity

because they carry genes and help in the **inheritance** or transfer of characteristics from the parents to the offspring.

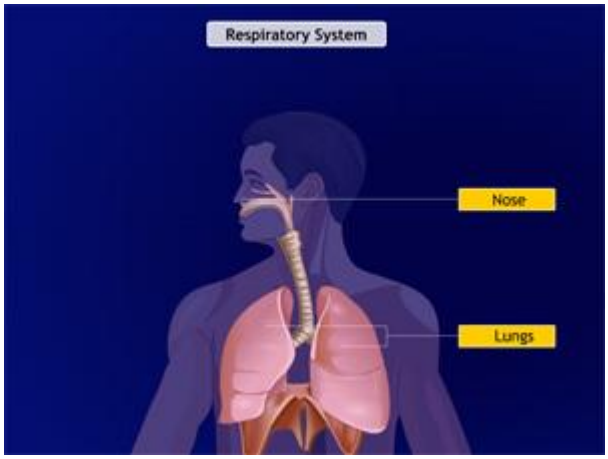
Bacteria and blue-green algae that contain nucleoids are called **prokaryotes**. Organisms that have a well-organised nucleus are called **eukaryotes**. The nuclear material in unicellular organisms does not contain a nuclear membrane, and hence is called a **nucleoid**.

The **nucleolus** is a small, spherical body in the nucleus.
Chloroplast is a type of **plastid** involved in photosynthesis in plants.
A **vacuole** is present in both plant and animal cells, but it looks much smaller in animal cells.

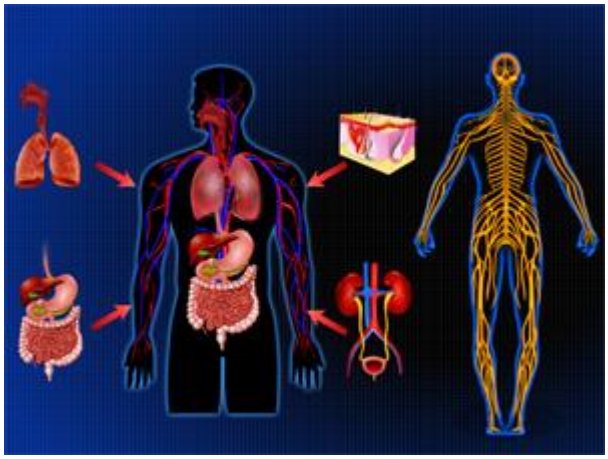
The black layer or **scab** (a hard coating on the skin formed during the wound healing reconstruction phase) that you see on a wound is a result of the aggregation of dead **Red Blood Cells (RBCs)**.



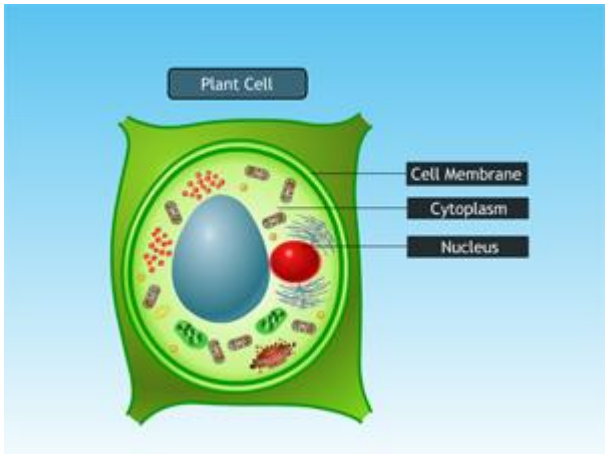
The human respiratory system consists of the nostrils, nasal passage, internal nares, pharynx, larynx, trachea, bronchi, bronchioles and alveoli. Alveoli are the functional units of the lungs.



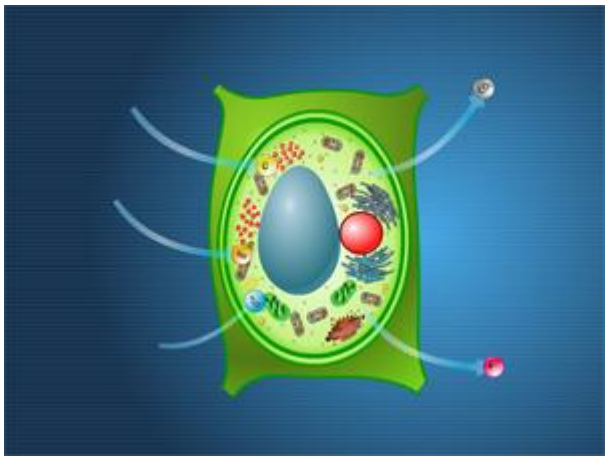
All organ systems work together to form a complex organism. Organ systems include the digestive system, respiratory system, circulatory system, excretory system and nervous system.



Cytoplasm is a thick liquid in a cell that holds the organelles, except for the nucleus. All the contents of the cells of prokaryote organisms are contained within the cytoplasm. Within the cells of eukaryotes organisms, the contents of the nucleus are separated from the cytoplasm.

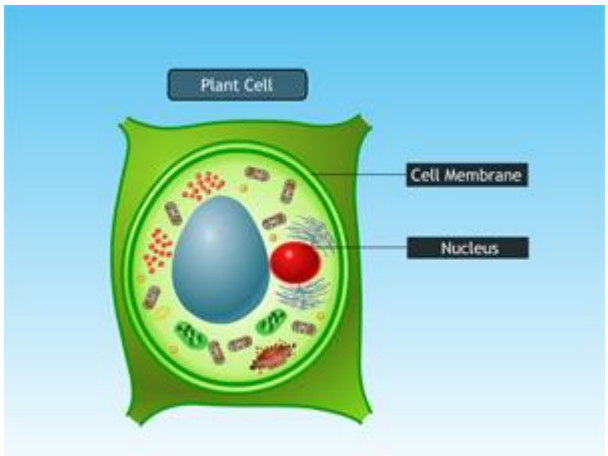


The **cell membrane** is a biological membrane that separates the interior of all cells from the outside environment. The cell membrane is selectively permeable to ions and organic molecules and controls the movement of substances in and out of cells. It consists of the phospholipid bilayer with embedded proteins. Cell membranes are involved in a variety of cellular processes, such as cell adhesion, ion conductivity and cell signalling, and serve as the attachment surface for extracellular material and intercellular cytoskeleton.



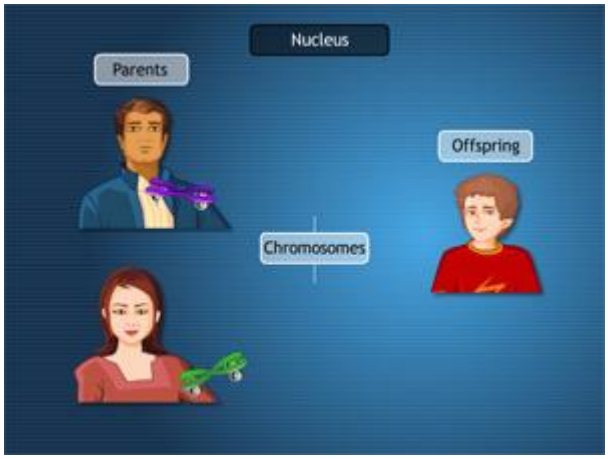
The **nucleus** controls the activities of a cell. The **nucleus** is a membrane-enclosed organelle found in eukaryotic cells. It contains most of the cell's genetic material, organised as multiple long linear DNA molecules to form chromosomes. The genes within these chromosomes are the cell's nuclear genome. The function of the

nucleus is to maintain the integrity of these genes and to control the activities of the cell by regulating gene expression. The nucleus is, therefore, the control centre of the cell.

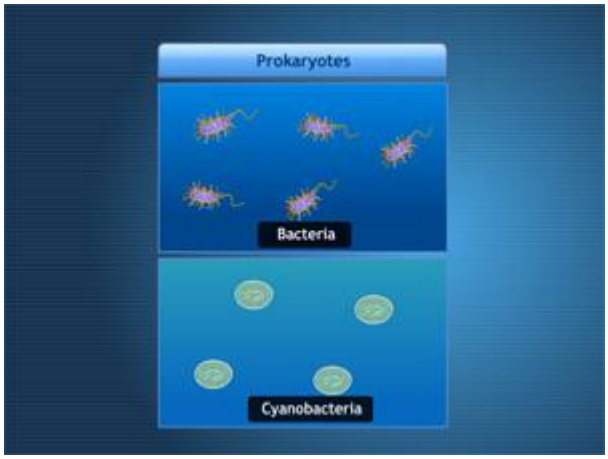


Methylene blue is the stain placed on plant and animal cells to differentiate the nucleus under a microscope. Solutions of this substance are blue when in an oxidising environment, but will turn colourless if exposed to a reducing agent.

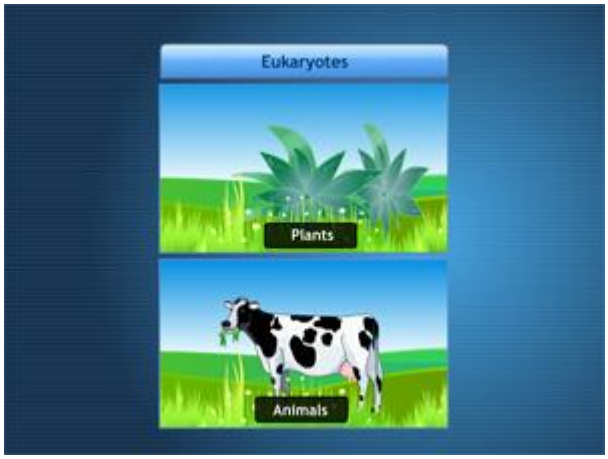
Chromosomes are called the vehicles of heredity because they carry genes, and help in the **inheritance** or transfer of characteristics from the parents to the offspring. A **chromosome** is an organised structure of DNA and protein found in cells. It is a single piece of coiled DNA containing many genes. Chromosomes also contain DNA-bound proteins, which serve to package the DNA and control its functions.



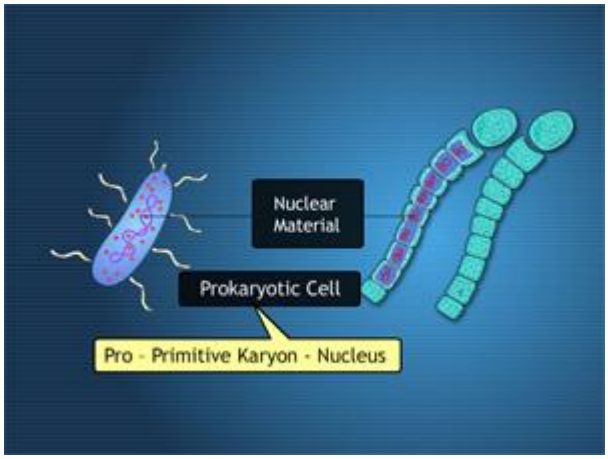
Bacteria and blue-green algae that contain nucleoids are called **prokaryotes**.



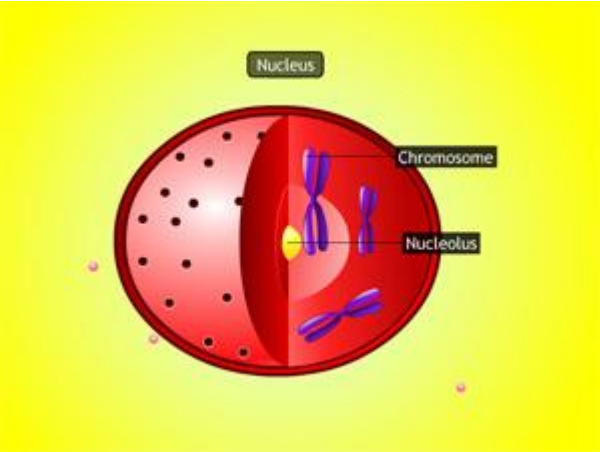
Organisms that have a well-organised nucleus are called **eukaryotes**. The defining membrane-bound structure that sets eukaryotic cells apart from prokaryotic cells is the nucleus, or nuclear envelope, within which the genetic material is carried. The presence of a nucleus gives eukaryotes their name, which comes from the Greek *eu*, meaning "good", and *karyon*, meaning "nut" or "kernel". Most eukaryotic cells also contain other membrane-bound organelles.



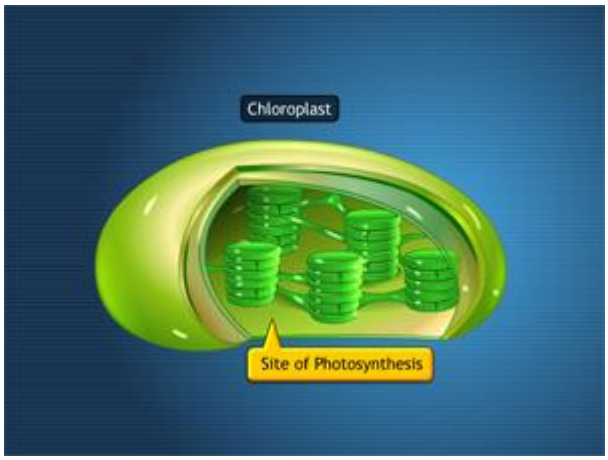
The **nucleoid** is an irregularly-shaped region within the cell of prokaryotes, which has nuclear material without a nuclear membrane.



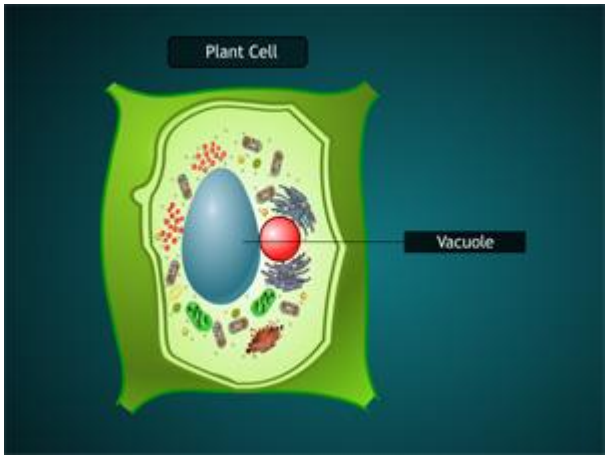
The **nucleolus** is a small, spherical body in the nucleus. It is a non-membrane bound structure composed of proteins and nucleic acids. Ribosomal RNA is transcribed and assembled within the nucleolus.



Chloroplast is a type of **plastid** involved in photosynthesis in plants. These are specialised organelles found in all higher plant cells. These organelles contain the plant cell's **chlorophyll**, providing the green colour. They have a double outer membrane. Within the stroma are other membrane structures, the **thylakoids** and **grana** where photosynthesis takes place.



A **vacuole** is a membrane-bound organelle present in all plant, fungal cells, and some animal and bacterial cells. Vacuoles are essentially enclosed compartments filled with water containing inorganic and organic molecules, including enzymes, in solution. In certain cases, though, vacuoles may contain solids that have been engulfed. Vacuoles are formed by the fusion of multiple membrane vesicles, and are effectively just larger forms of these. The organelle has no basic shape or size, and its structure varies according to the needs of the cell.


Plant Cell
Vacuole