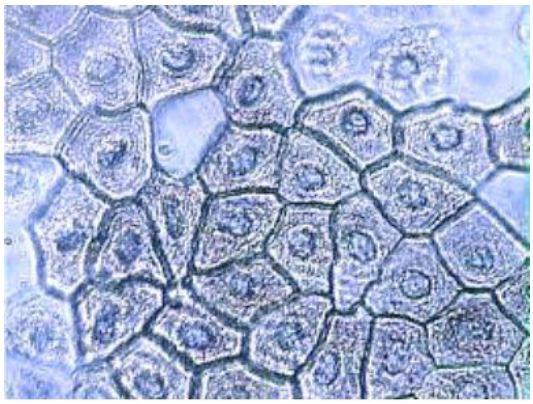
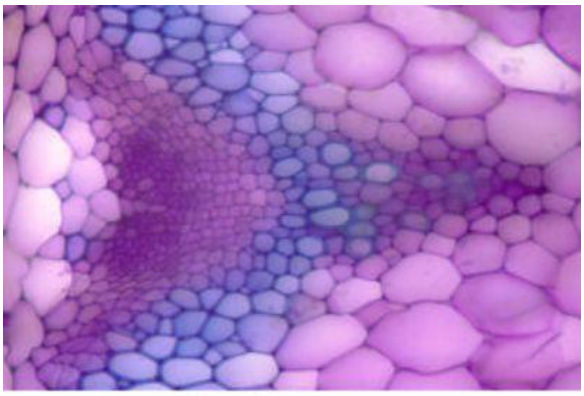
The Cell

Cell as the Basic Unit of Life

- The cell is the basic structural and functional unit of all living organisms. It is the smallest part of the body of an organism, is capable of independent existence and is able to perform the essential functions of life.



Cells of animal tissue

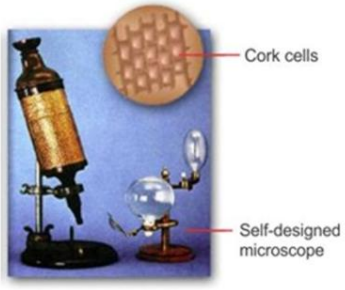


Cells of plant tissue

Discovery of cell

Robert Hooke

The history of cell science began in 1665, with the description of a thin section of bottle cork by English scientist, Robert Hooke. He observed the cork cells with a self-designed microscope. Hooke observed certain structures in the cork, which resembled partition boxes or compartments of a honeycomb. He also noticed that each compartment was separated by a wall. He regarded each compartment as a 'cell'. As cork is a dead material, the compartments were empty, without any content. Hooke's discovery was very important as it was the first indication that living organisms are made up of smaller structures or units.



Discovery of cell

Cell Theory

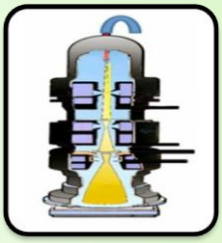
- In 1838, Matthias Schleiden and Theodor Schwann proposed the basic cell theory. In 1858, another scientist Virchow made an addition to the existing cell theory.

- The postulates of the modern cell theory are
  1. The cell is the smallest unit of structure of all living things.
  2. The cell is the unit of function of all living things.
  3. All cells arise from pre-existing cells.

Instruments used for studying cells

Light/Compound microscope

- Uses glass lenses
- Uses a beam of light to illuminate the object
- Internal vacuum is not required
- Magnifies the object to about 2000 times



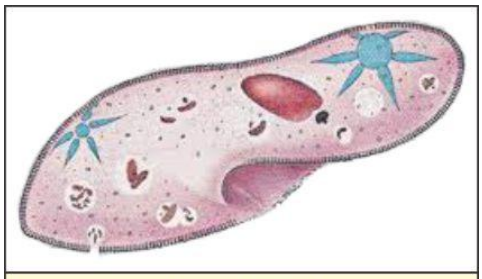
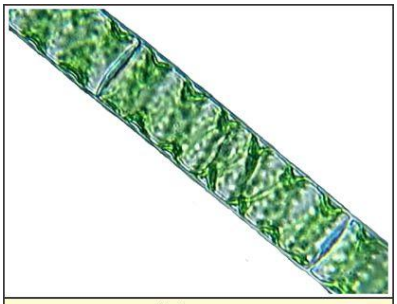
Electron microscope

- Uses electromagnets
- Uses a beam of electrons to illuminate the object
- Internal vacuum is essential
- Magnifies the object to over 200,000 times

Variety in Cells

On the basis of number of cells

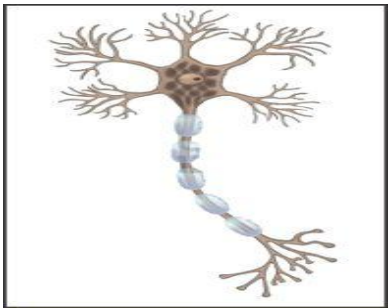
- Single-celled: Organisms made of a single cell. They are called unicellular organisms.
  Examples: Bacteria, Yeast, *Chlamydomonas*, *Amoeba*, *Paramoecium*
- Few-celled: Organisms made of few hundred to few thousand cells.
  Examples: *Spirogyra*, *Volvox*
- Multi-celled: Organisms made of millions to billions of cells. They are called multicellular organisms.
  Examples: Man, cow, mango tree, crow

Single-celled	Few-celled	Multi-celled
 Paramoecium	 *Spirogyra*	 Cow

The number of cells being less in small organisms does not in any way affect the functioning of small organisms. Although organisms are made of millions, billions or even trillions of cells, every living organism begins its life as a single cell called the fertilised egg cell or zygote.

On the basis of size of cells

- Smallest cell: Examples: Bacteria (0.3–5.0 µm), red blood cells (7 µm)
- Longest cell: Example: Nerve cell in the neck of a giraffe (>3 m long)
- Largest cell: Example: Ostrich egg (170 mm × 130 mm)

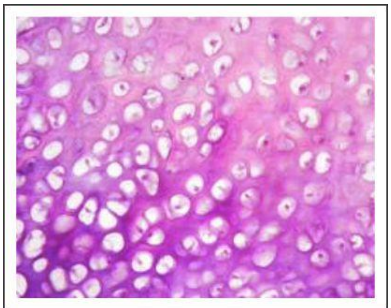
Smallest cell	Longest cell	Largest cell
 Red blood cells	 Nerve cell	 Ostrich egg

On the basis of shape of cells

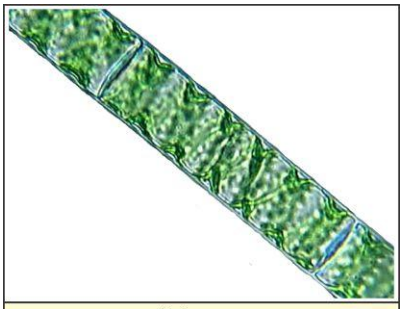
- Columnar: Epithelial cells
- Spherical: Human ovum
- Oval: Fat cells
- Spherical, biconcave: Red blood cells
- Rectangular: *Spirogyra*
- Spiral: Sperm cell
- Rod-shaped: Bacteria

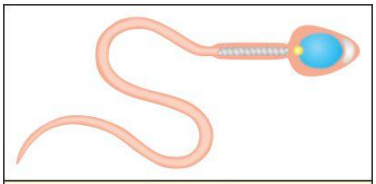
- C-shaped: Cartilage cells
- Cylindrical: Striated muscle fibre cells
- Branched: Nerve cells
- Spindle-shaped: Smooth muscle cells
- Bean-shaped: Guard cell from a plant leaf
- Irregular: *Amoeba*

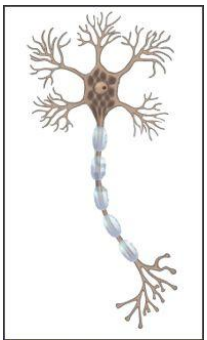

Epithelial cells


Cartilage cells

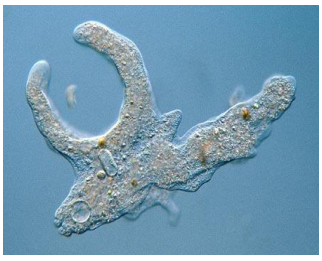

Guard cells


Spirogyra

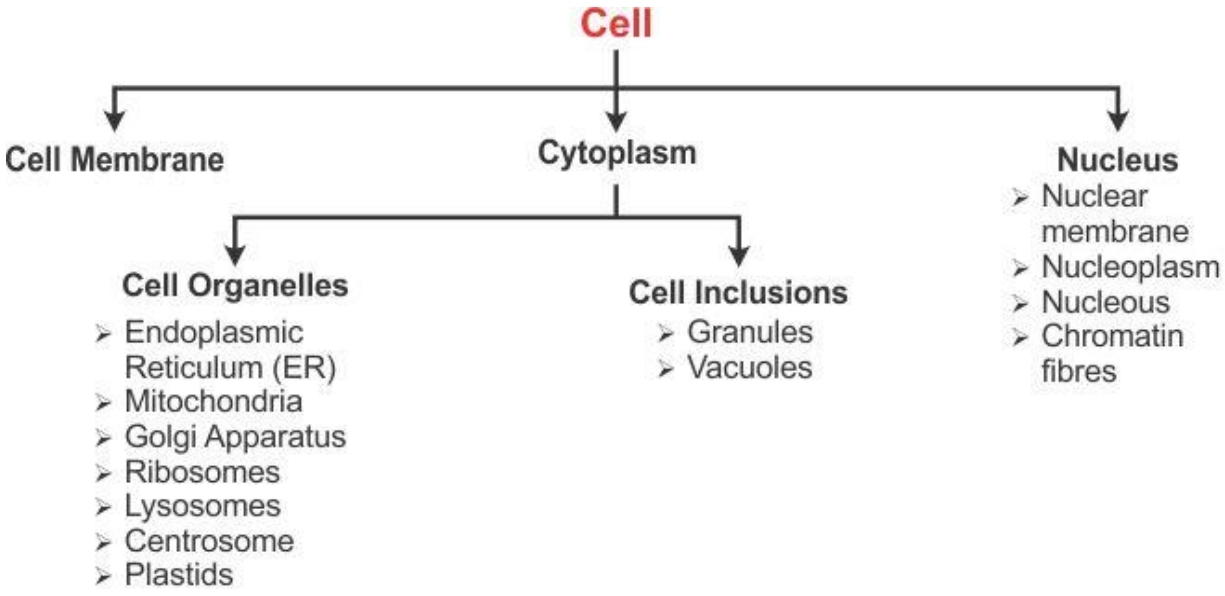

Sperm cell

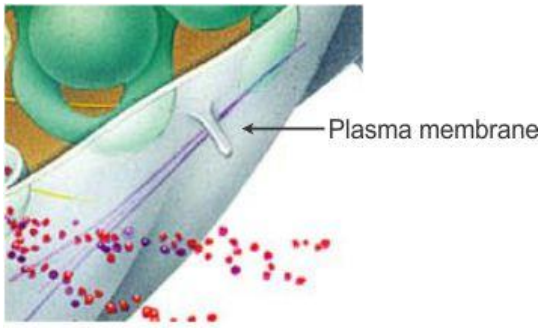

Nerve cell

Amoeba is irregular in shape. It changes its shape continuously due to the presence of pseudopodia. The change in shape helps *Amoeba* in movement and in capturing food.

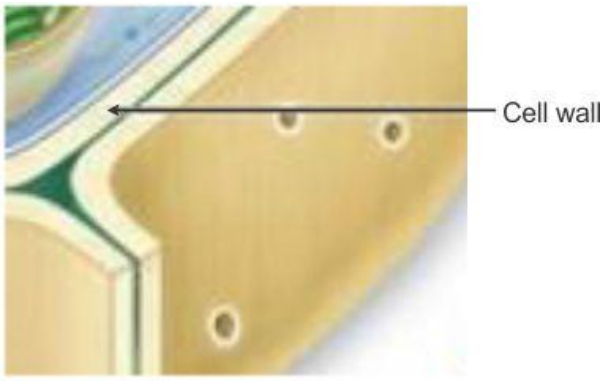


Structural Organisation of a Cell



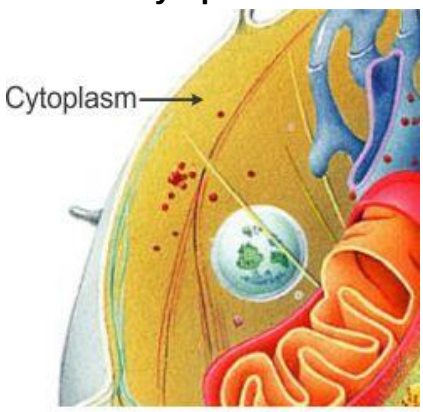
CELL ORGANELLES		
NATURE AND OCCURRENCE	**MAIN CHARACTERISTICS**	**MAIN FUNCTIONS**
Plasma membrane/Cell membrane 		
1. Forms the outermost covering in animal cells 2. Lies next to the cell wall in plant cells	1. Thin, flexible, delicate, living membrane 2. Possesses tiny pores	1. Separates cellular material from its surroundings 2. Acts as an effective barrier and regulates the entry of substances in and out of the cell 3. Maintains shape of the cell (in animal cells)

Cell wall (in plant cells only)



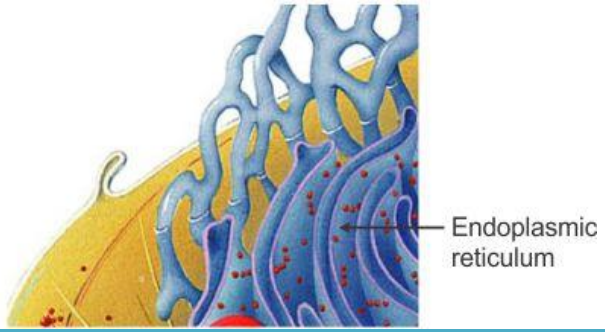
1. Non-living, rigid protective covering situated just outside the plasma membrane	1. Mainly composed of cellulose	1. Gives rigidity and shape to plant cells 2. Allows substances in solution to enter and leave the cell without any obstruction 3. Provides protection

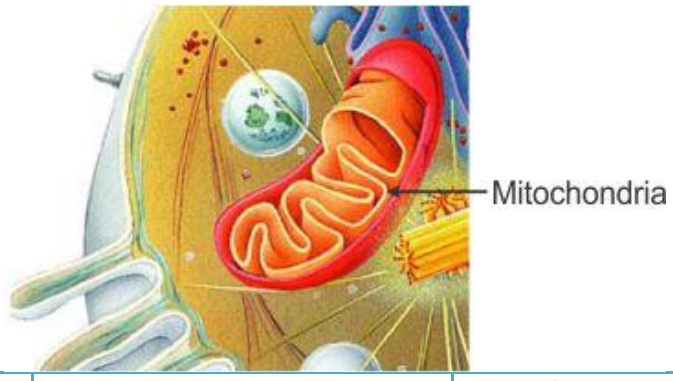
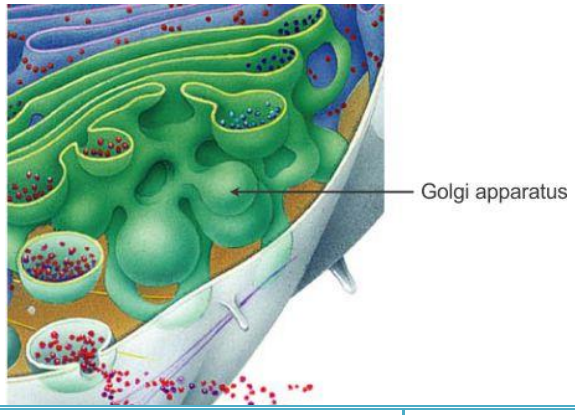
Cytoplasm



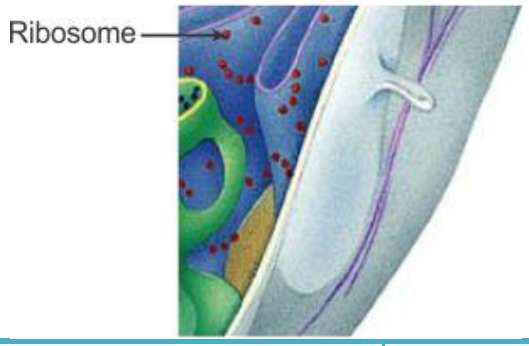
1. Content inside the plasma membrane, excluding the nucleus	1. Transparent jelly-like material 2. Contains a mixture of water and soluble organic and inorganic compounds and various cell organelles	1. Different organelles contained in it perform different functions 2. Centre of all metabolic activities

Endoplasmic reticulum (ER)



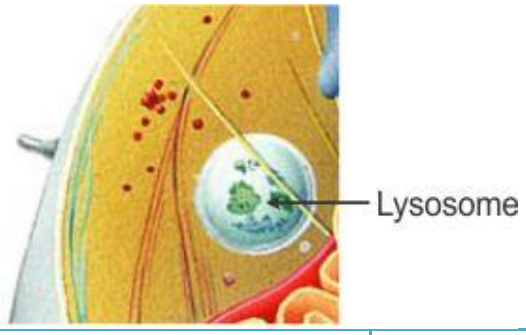
1. Irregular network of tubular double membrane	1. Continuous with the plasma membrane on the outside and nuclear membrane on the inside 2. May be smooth (SER) or rough (RER)	1. Supportive framework of the cell 2. RER synthesises proteins, while SER secretes lipids 3. Provides pathway for the distribution of nuclear material
Mitochondria  		
1. Have varied shapes, but usually are sausage-like	1. Tiny rod-shaped or spherical organelles 2. Double walled, inner wall thrown into folds called cristae	1. Release and store energy 2. Synthesis of respiratory enzymes 3. Synthesis of energy-rich compounds
Golgi Apparatus (in animal cells) **Dictyosomes (in plant cells)**  		
1. Stacks of flattened membrane sacs	1. Exist as an extensive network near the nucleus in an animal cell and are freely distributed in plant cells	1. Synthesis and secretion of enzymes and hormones 2. Involved in the synthesis of plasma membrane and cell wall

Ribosomes



1. Dense, spherical, small granules, either scattered in the cytoplasm or attached outside the ER	1. Single walled, dense spherical bodies composed mainly of RNA and proteins	1. Synthesis of proteins

Lysosomes

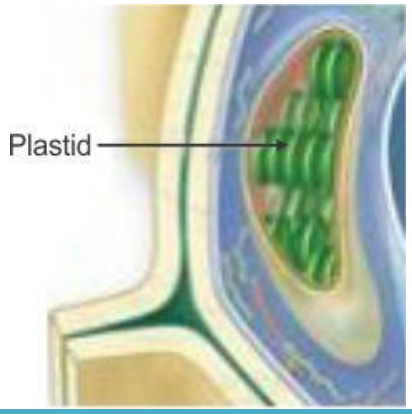


1. Simple, tiny, single membrane bound sacs 2. Evenly distributed in the cytoplasm	1. Membranous sacs budded out from Golgi bodies 2. Contain 40 different types of enzymes	1. Intracellular digestion 2. Suicide bags of the cell; rapidly destroy organelles in cell ageing or injury

Centrosome (in animal cells only)

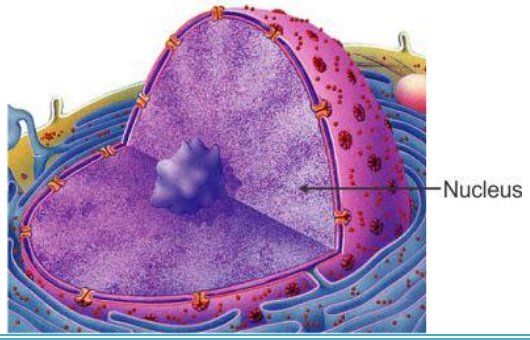
1. Region surrounding centrioles located near the nucleus	1. Contain one or two centrioles	1. Initiates and regulates cell division

Plastids (in plant cells only)



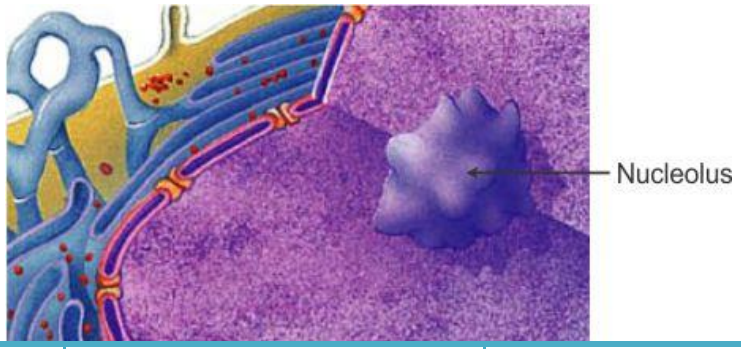
1. Have their own genome	1. Different kinds—chromoplasts, chloroplasts and leucoplasts 2. Possess disc-like structures called thylakoids containing chlorophyll	1. Chromoplasts: Impart colour to flowers and fruits 2. Chloroplasts: Trap solar energy for photosynthesis 3. Leucoplasts: Store starch

Nucleus



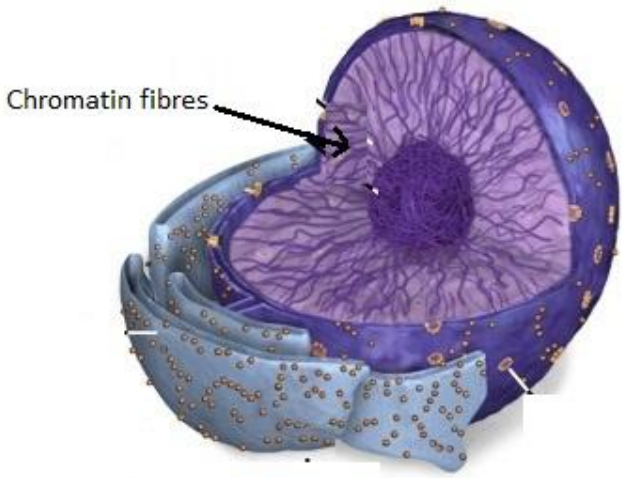
1. Centrally located spherical cellular component	1. Largest cell organelle 2. Mostly spherical and dense 3. Nuclear membrane with pores, which allow substances to enter and leave the nucleus	1. Regulates cell functions 2. Cell dies in the absence of nucleus 3. Contains chromosomes, made of genes, which control hereditary characteristics

Nucleolus



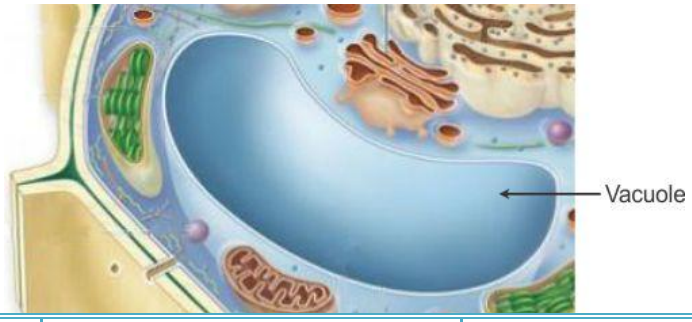
1. Embedded within the nucleus of the cell	1. One or more in number 2. Round in shape	1. Produces ribosomes 2. Participates in protein synthesis by forming and storing RNA

Chromatin fibres

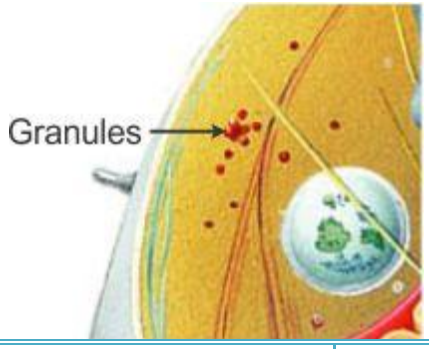


1. Embedded within the nucleus of the cell	1. Network of thread-like structures made of DNA	1. Chromosomes carry hereditary information or genes

Vacuoles

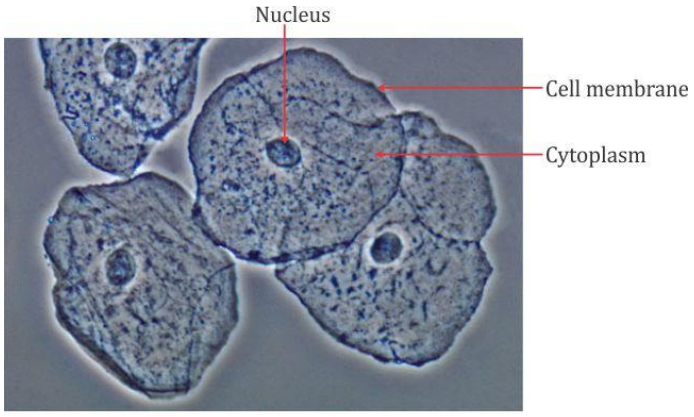


1. Fluid-filled or solid-filled and membrane-bound spaces 2. Kind of storage sacs	1. Non-living structures 2. Clear spaces with water or other substances in solution 3. Larger in plant cells and fewer and smaller in animal cells	1. Storage of water and other substances, food, pigments and waste products 2. Provides turgidity to the cells

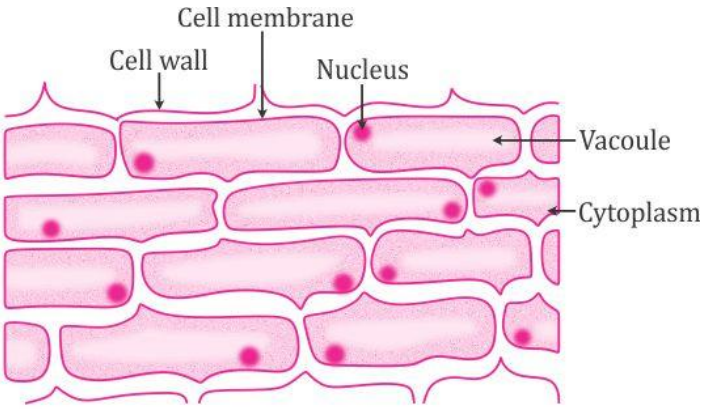
Granules		
		
1. Non-living structures	1. Small particles, crystals or droplets	1. Starch (in plant cells), glycogen (in animal cells) and fat-containing granules serve as food for the cell

The gene is a unit of inheritance in every living organism. It is responsible for the transfer of hereditary characteristics from parents to offspring. However, the offspring may receive different characteristics due to a different combination of genes from parents.

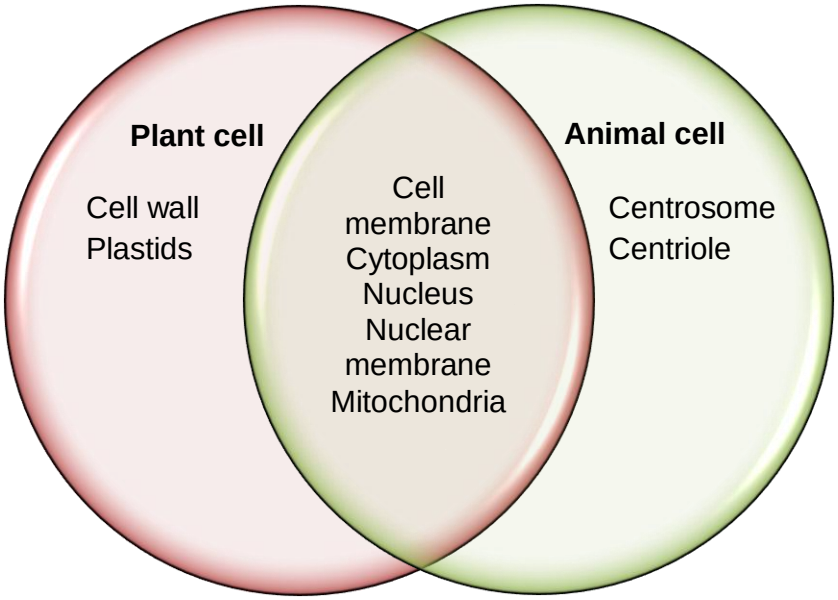
Study of Plant and Animal Cells



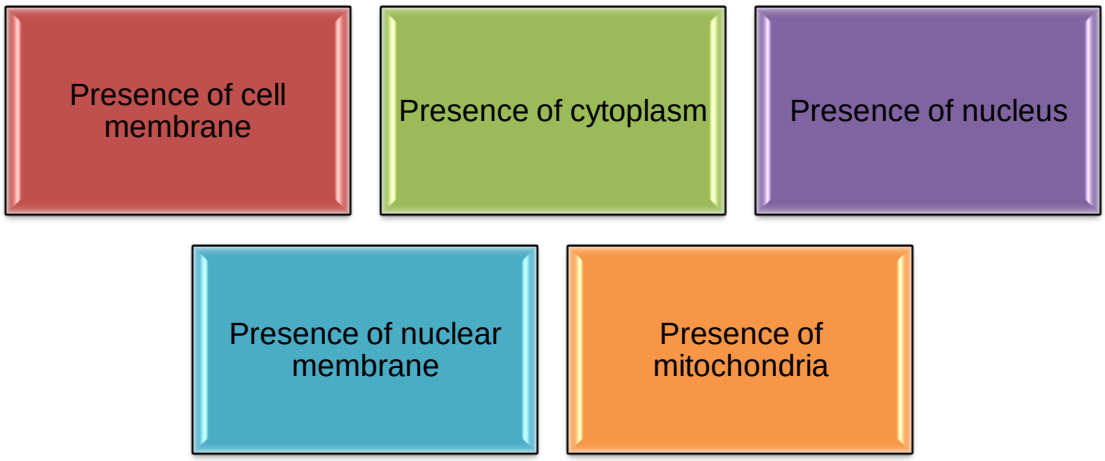
Cells of human cheek



Cells of onion peel



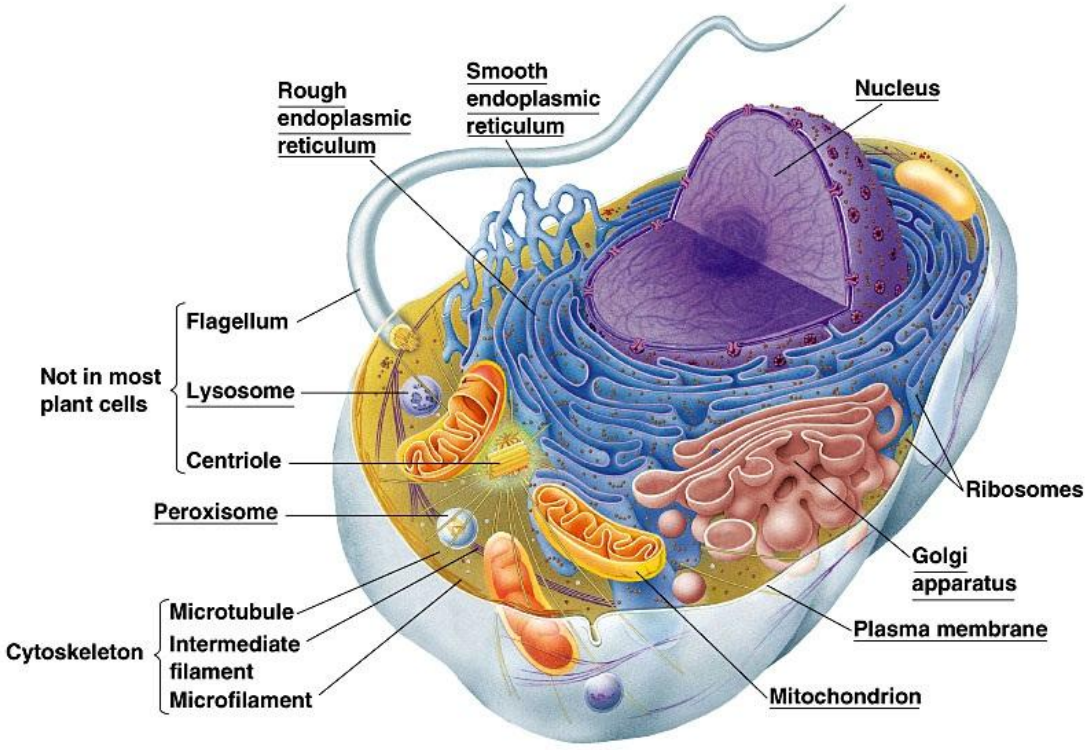
Similarities between Plant and Animal Cells



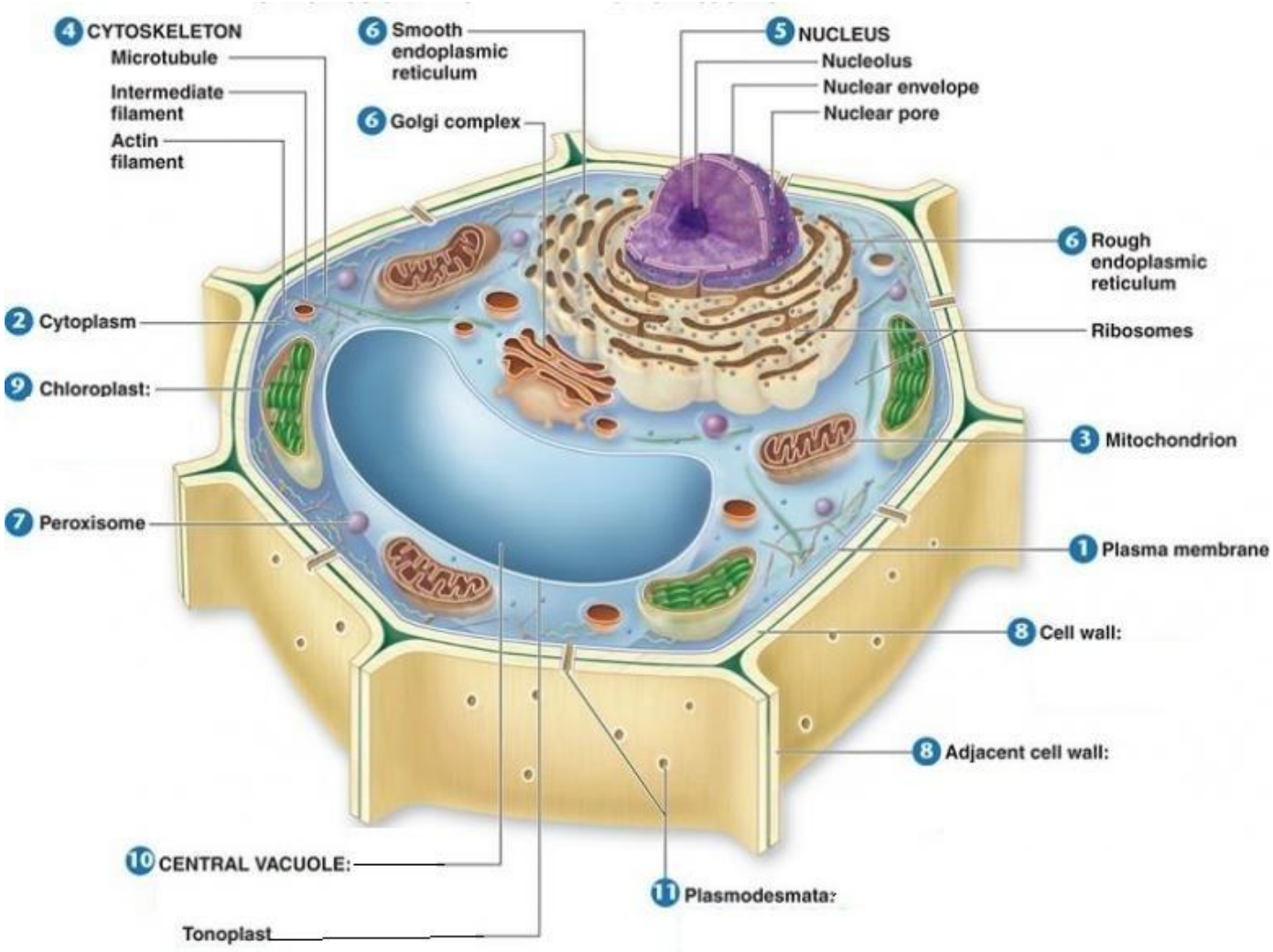
Differences between Plant and Animal Cells

PLANT CELL	FEATURE	ANIMAL CELL
Structural differences		
Presence of a definite cell wall made of cellulose	Cell wall	Absence of cell wall
Present internal to the cell wall	Cell membrane	Forms the boundary of the cell
Absence of centrosome	Centrosome	Presence of centrosome
Absence of centriole	Centriole	Presence of centriole
Presence of one or more prominent vacuoles	Vacuoles	Presence of small and temporary vacuoles
Presence of plastids	Plastids	Absence of plastids

Functional differences		
Usually larger with distinct outlines	Size	Usually smaller with less distinct boundaries
Not so dense	Cytoplasm	Denser and more granular
Only a thin lining of cytoplasm, which is mostly pushed to the periphery	Arrangement of cytoplasm	Cytoplasm fills up almost the entire cell
Other differences		
Rectangular	Shape	Spherical
Starch	Storage material	Glycogen

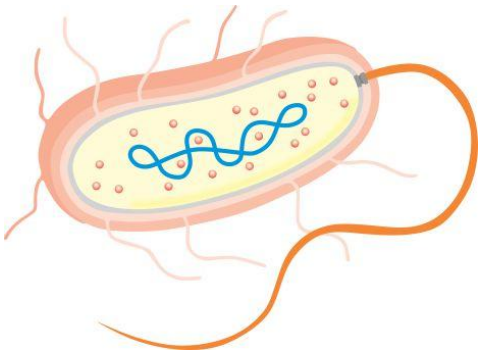


Animal cell



Plant cell

Prokaryotic and Eukaryotic Cells

PROKARYOTIC CELL	FEATURE	EUKARYOTIC CELL
		
Absence of well-defined nucleus	Nucleus	Presence of well-defined nucleus with a nuclear membrane
Absent	Nucleolus	Present

Presence of a single length of only DNA	Genetic material	Presence of several lengths of DNA wound around certain proteins
Presence of smaller ribosomes	Ribosomes	Presence of larger ribosomes
Absence of other cell organelles	Cell organelles	Presence of several other cell organelles such as mitochondria, ER, chloroplasts etc.
Cell division occurs by fission or budding but not by mitosis	Cell division	Cell division occurs by mitosis or meiosis
Bacteria, blue green algae	Examples	*Euglena*, *Amoeba*, plants, animals

About the scientist

Camillo Golgi

Golgi apparatus was first discovered by a German scientist Camillo Golgi. He was born at Corteno near Brescia in 1843. He studied medicine in the University of Pavia. He developed a staining technique known as 'Black Reaction'. This method uses a weak solution of silver nitrate and is particularly valuable in tracing the cell processes and most delicate ramifications of cells. He explored the nervous system using this newly developed technique. In 1906, he shared the Nobel prize with Santiago Cajal for their work on the structure of nervous system.

Levels of Organisation

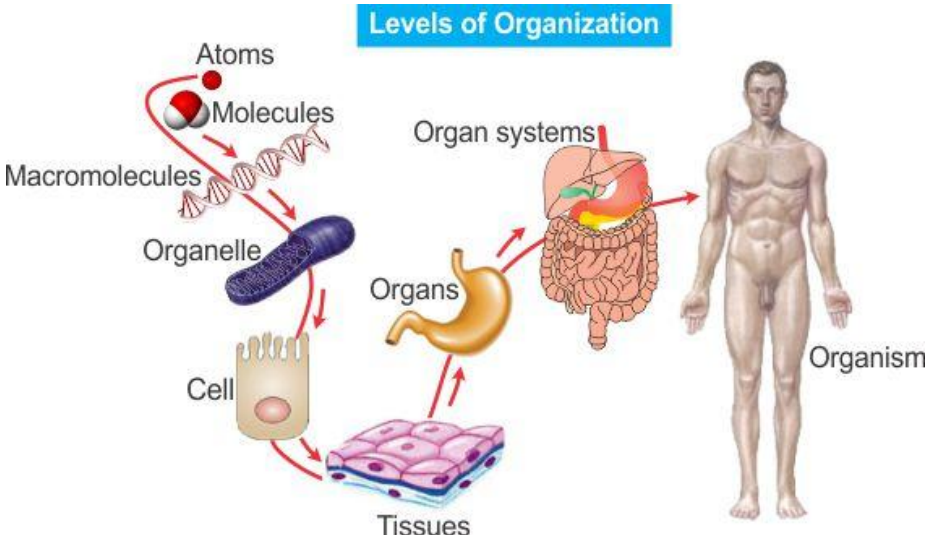
Cell
- A group of cells with a common origin, similar structure and function being held together by a cementing substance forms a tissue.
- Examples: Connective tissue, meristematic tissue

Tissue
- A group of cells with a common origin, similar structure and function being held together by a cementing substance forms a tissue.
- Examples: Connective tissue, meristematic tissue

Organ
- Different types of tissues working together and contributing to some specific function of the body constitute an organ.
- Examples: Stomach, heart

Organ system
- Different organs coordinate to perform a specific life process and form an organ system.
- Examples: Digestive system, nervous system

Organism
- Various organ systems working simultaneously together constitute an organism.
- Examples: Mango tree, man



The cells in the outermost layer of our skin are dead. An average adult carries about 2 kg of dead skin. Billions of tiny fragments of the skin are lost every day. Every time you run your finger on a dusty table, you shed a lot of old skin.