An Overview of Cell Biology

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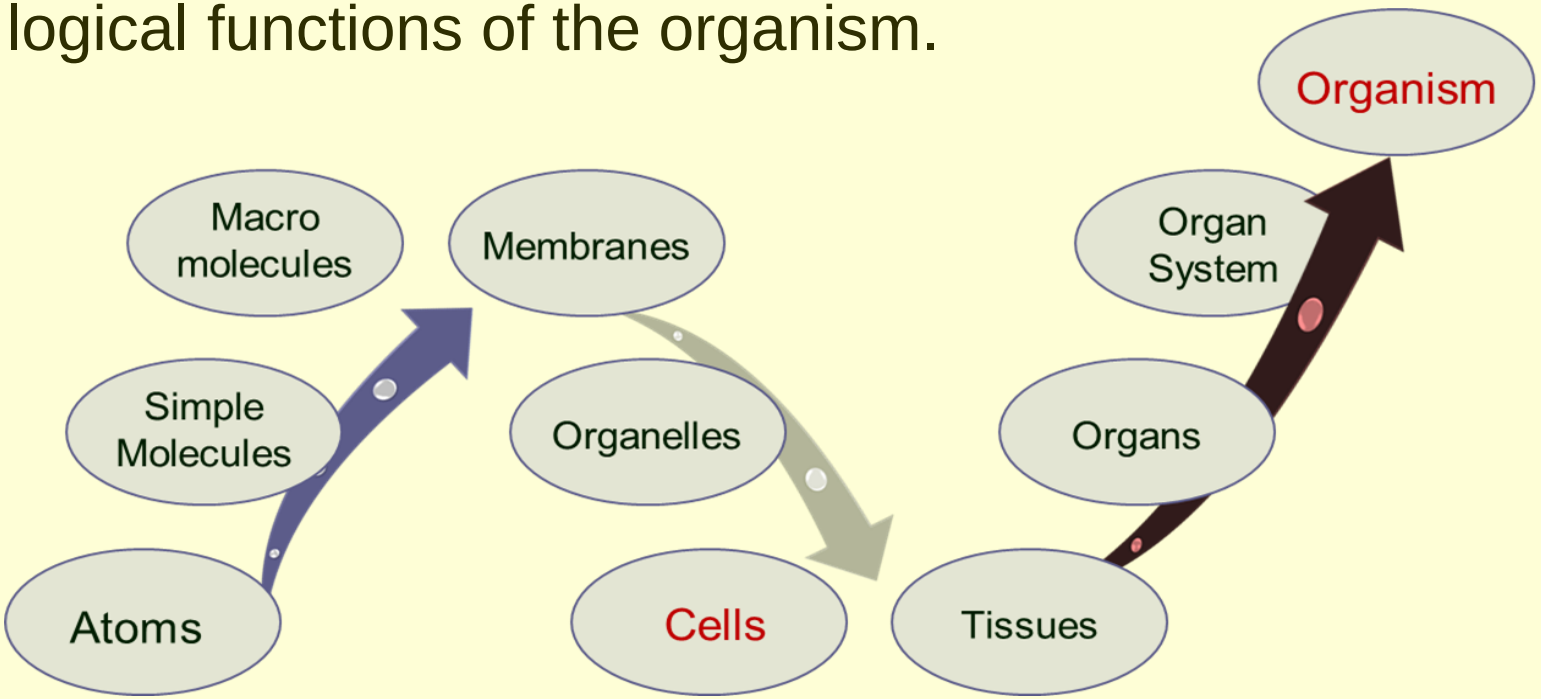
What is a Cell ?

Cell is the smallest unit of a living organism which is responsible for all structural, biochemical and physio-logical functions of the organism.



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Early History of Cell

Year	Scientist	Contribution
1590	Z. Janssen F. Janssen	Compound Microscope
1665	Robert Hooke	Coined the term 'Cell'
1674	Anton Van Leeuwenhoek	Studied Sperms, Blood Corpuscles & Protozoans
1839	Purkinje	Named 'Protoplasm'
1831	Robert Brown	Discovered 'Nucleus'
1839	Schleiden & Theodor Schwann	Formulated Cell Theory

Anton Van Leeuwenhoek

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- Techniques used to study a Cell

Microscopy :

Principle

A beam of light or electrons is passed on the object. The beam, reflected by the object, forms an image on eyes, photographic plate or television screen.

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Techniques used to study a Cell

Microscopy :

Resolution

The power to separate any two closely situated points after magnifying them, is called resolution power. Resolution (d) depends upon wavelength (λ) of light and numerical aperture (NA) of the objective lens.

Therefore, $d = \lambda / 2NA$

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Techniques used to study a Cell

Microscopy :

Magnifying Power

The power of a microscope to enlarge the image of an object as much as possible is called its magnifying power.

The magnifying power (X) of light microscope = power of its objective lens X power of its ocular lens.

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- Techniques used to study a Cell

Microscopy : Compound Microscope

Electron Microscope

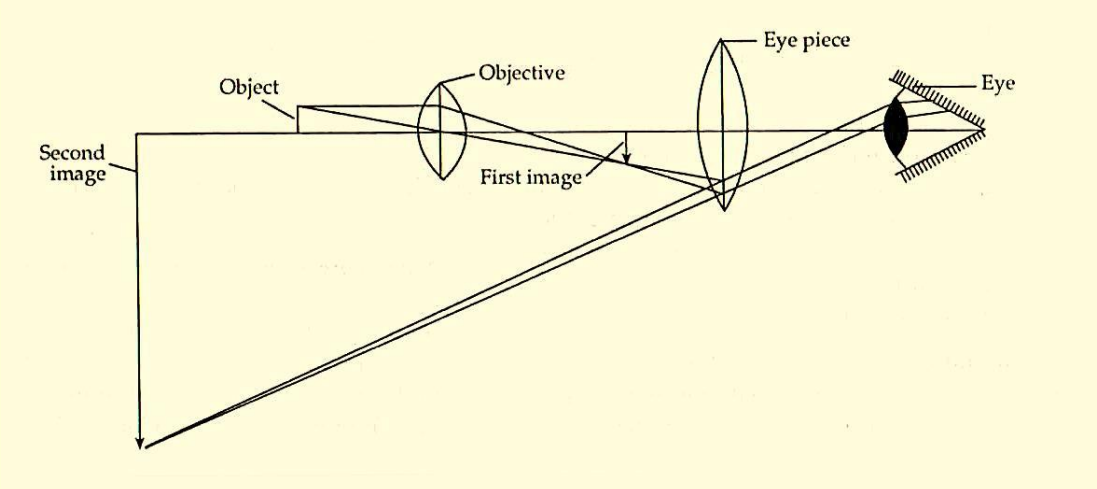

Image formation by a Light Microscope

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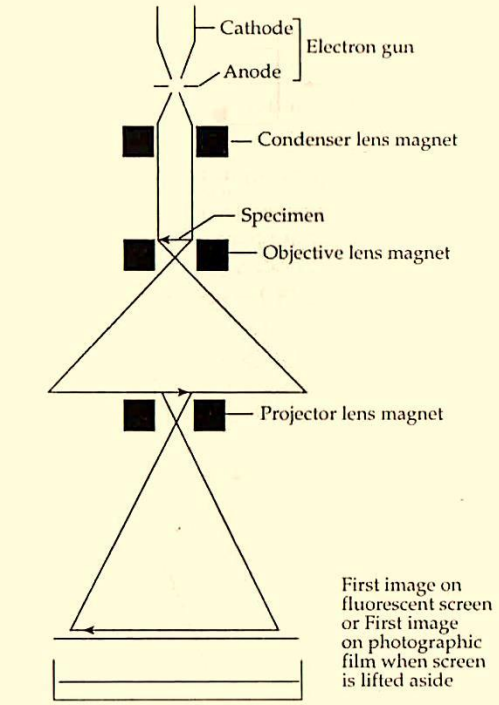
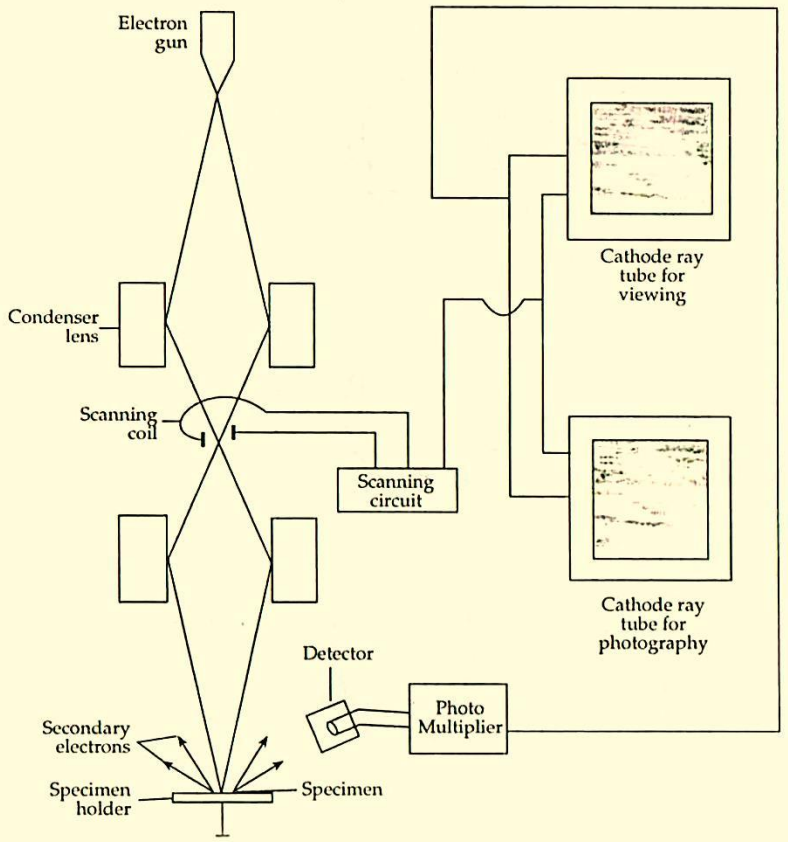
- Electron Microscopy



Transmission Electron Microscope



Scanning Electron Microscope

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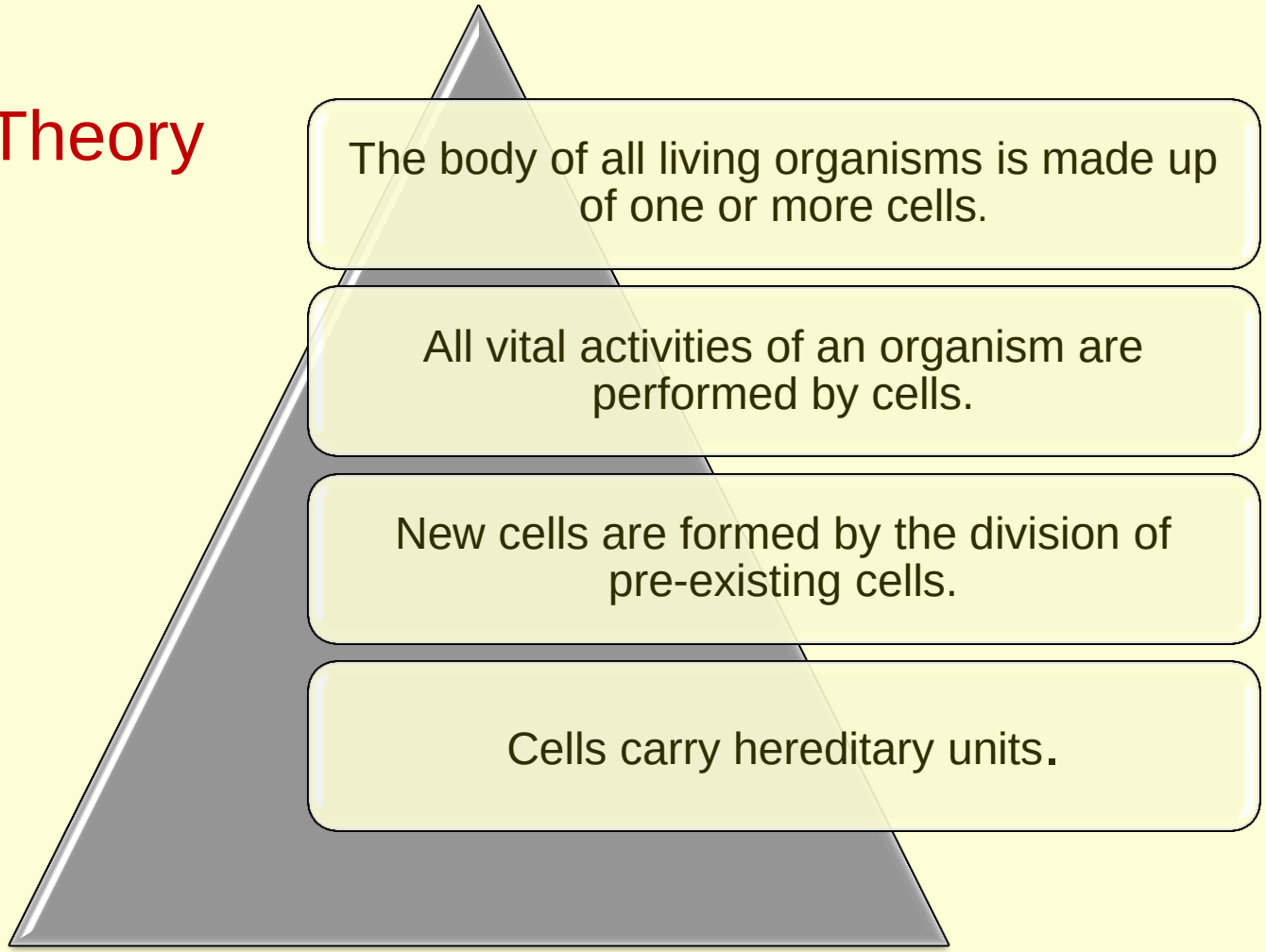
- Cell Theory



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- ## Types of Cell

  Prokaryotic (pro: primitive or before, karyon : nucleus)

  example : PPLO (Pleuro pneumonia like organism), Bacterium, Blue-green algae.

  Eukaryotic (eu : good, karyon : nucleus)

  example : all plants, animals and micro-organisms.

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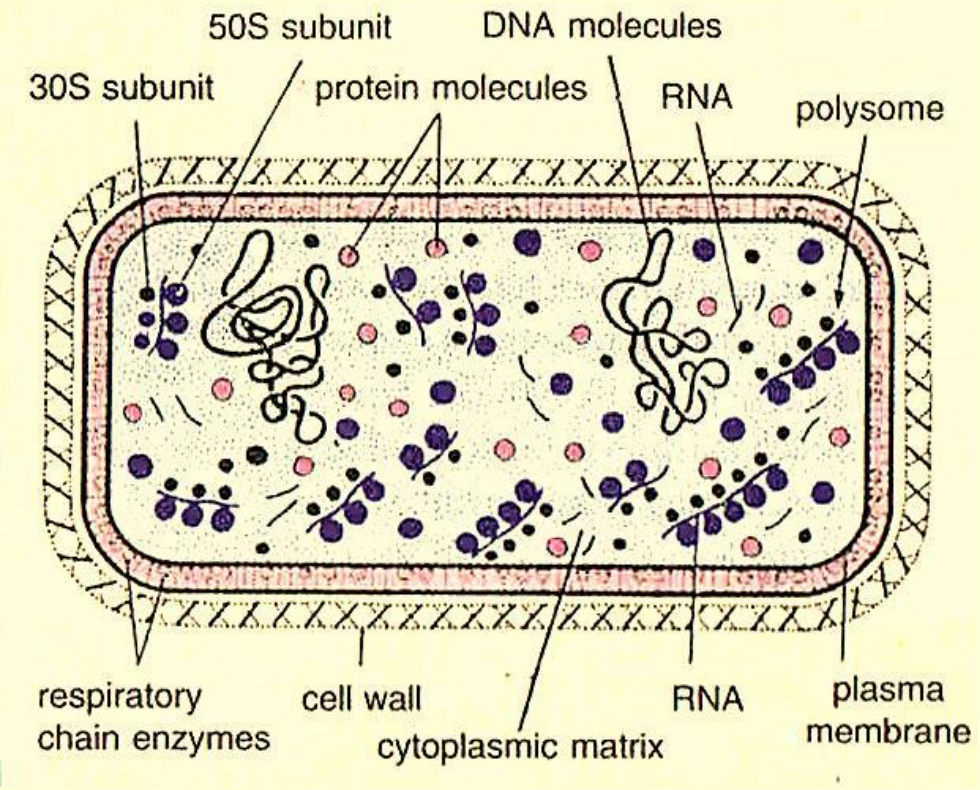
Prokaryotic Cell



- Nucleus incipient or absent.
- No nucleolus and nuclear envelop.
- Nuclear material not arranged in the form of chromatin, rather scattered in the cytoplasm.
- Membranous structure missing.

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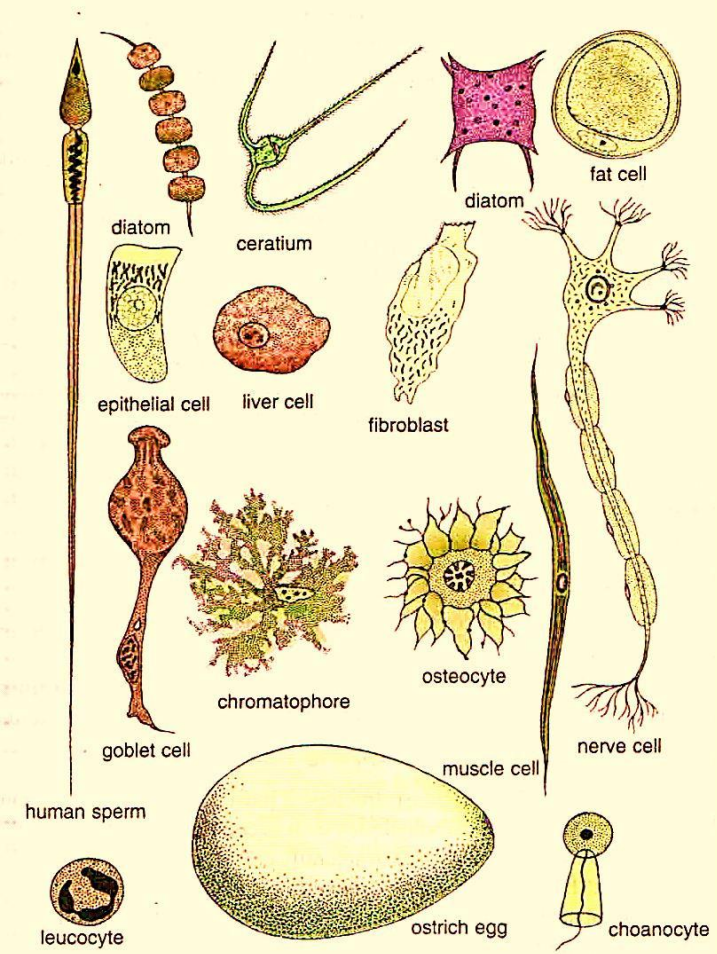
Eukaryotic Cell

- Eukaryotic cells are more complex than Prokaryotic ones.
- Nucleus enveloped by a distinct sheath - nuclear membrane.
- Nucleolus present.
- Cytoplasmic membrane organelles like Endoplasmic reticulum, Golgi bodies, Lysosomes, Mitochondria, etc. are also found.



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- Comparison between the two :

Prokaryotic Cell and Eukaryotic Cell

	Structures	Prokaryotic Cells	Eukaryotic Cells
1.	Cell wall	Present	Present in plant cells; absent in animal cells
2.	Plasma membrane	Present	Present
3.	Endoplasmic reticulum	Absent	Present
4.	Golgi bodies	Absent	Present
5.	Mitochondria	Absent	Present
6.	Lysosomes	Absent	Present

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- Comparison between the two :

Prokaryotic Cell and Eukaryotic Cell

	Structures	Prokaryotic Cells	Eukaryotic Cells
7.	Ribosomes	Present - 70S	Present - 80S
8.	Cytoskeleton	Absent	Present
9.	Centriole	Absent	Present (absent in higher plants)
10.	Cilia & Flagella	Simple structure of protein - flagellin	Complex 9+2 structure of tubulin
11.	Vesicles	Present	Present
12.	Vacuoles	Absent	Present

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- Comparison between the two :

  a Prokaryotic Cell and a Eukaryotic Cell

	Structures	Prokaryotic Cells	Eukaryotic Cells
13.	Nucleus	Absent	Present
14.	Nuclear membrane	Absent	Present
15.	Nucleolus with mitotic apparatus	Absent	Present
16.	Genetic material	Circular or linear; Double stranded DNA; genes are not interrupted by introns	Linear double stranded DNA; genes frequently interrupted by introns sequences
17.	Chromatin with histone	Present	Absent

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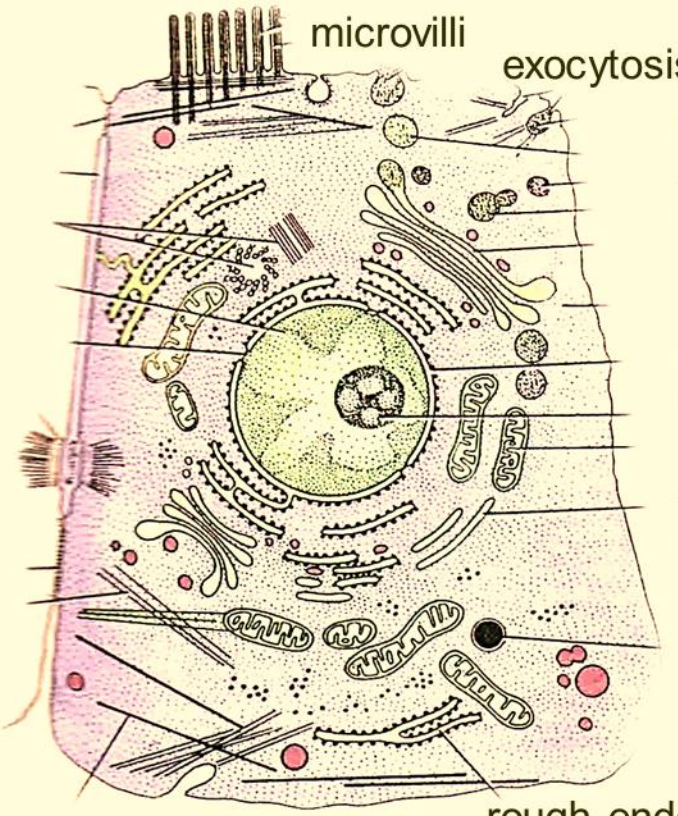
Animal Cell



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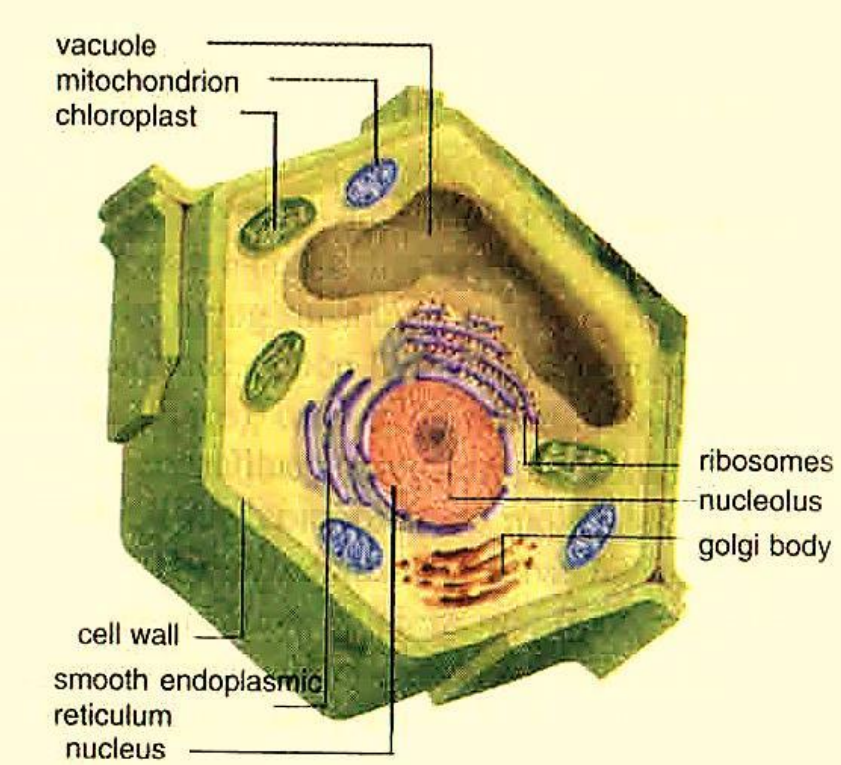
- Plant Cell



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Functions of Different Cell Organelles

	Organelles	Functions
1.	Plasma membrane	• To maintain the external shape of the cell. • To protect the protoplasm & its constituents. • To control the entry and exit of the material across the membrane.
2.	Endoplasmic reticulum	• To exchange materials between external environment and cell organelles. • ER tubules provide additional surface for metabolic activities • To synthesize steroid material.
3.	Mitochondria	• To produce energy by the oxidation of food material. • To provide energy for vital activities thus acts as power house of the cell.

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Functions of Different Cell Organelles

	Organelles	Functions
4.	Golgi bodies	• To collect enzymes & proteins. • To finish, package & dispatch a variety of compounds. • To form acrosome in sperms.
5.	Ribosomes	• To synthesize protein.
6.	Lysosomes	• To store enzymes for digestion of various fragments of cell, their proteins and carbohydrates. • To engulf bacteria and other toxic products entering into the cell.

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Functions of Different Cell Organelles

	Organelles	Functions
7.	Nuclear membrane	• To maintain shape of the nucleus. • To regulate the entry & exit of the material in the nucleus.
8.	Nucleolus	• To store RNA and to synthesize protein by it.
9.	Nuclear material or chromatic network	• To carry hereditary characters and pass them from one generation to another. • To regulate all vital activities of the cell.

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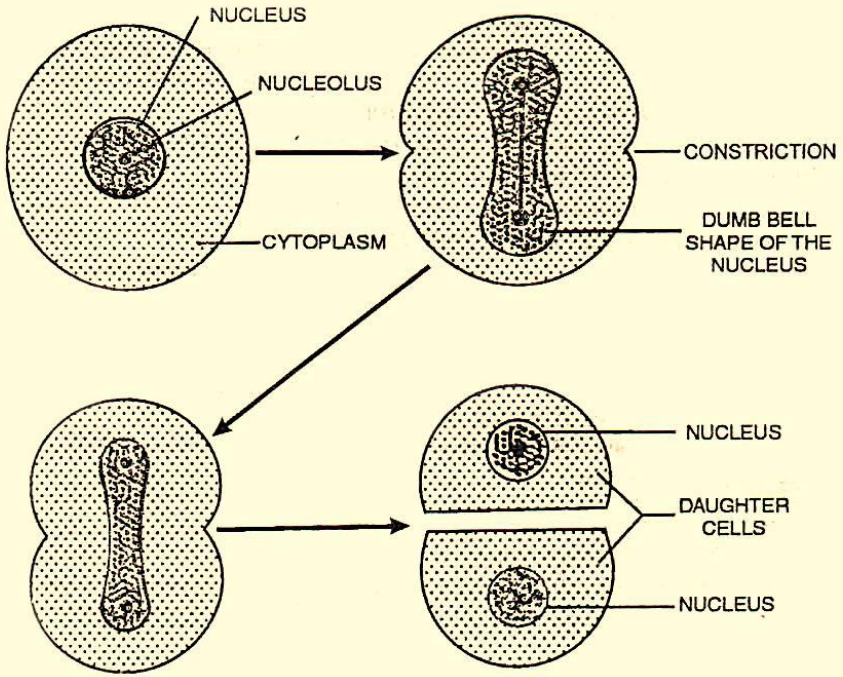
- Cell Reproduction

  Amitosis



Amitosis

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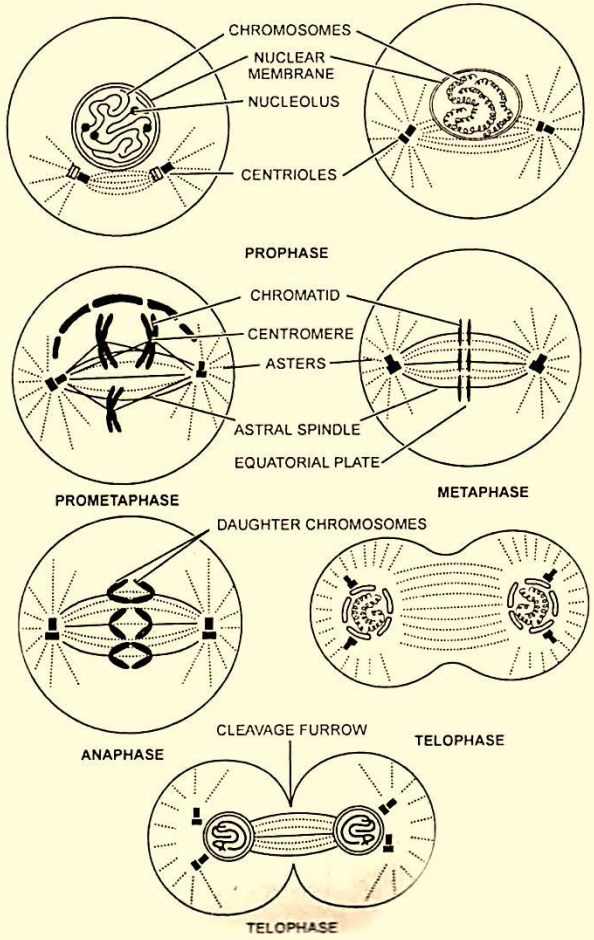
- Cell Reproduction

  Mitosis

- Interphase : G_1, S, G_2
- Prophase
- Metaphase
- Anaphase
- Telophase
- Cytokinesis



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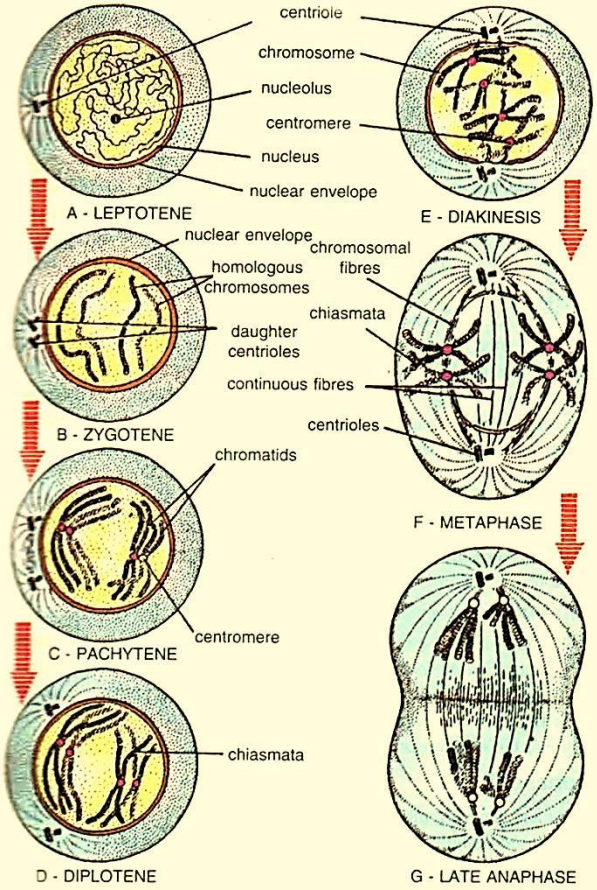
Cell Reproduction

Meiosis

- First Meiotic or Heterotypic
- Prophase - Leptotene
  - Zygotene
  - Pachytene
  - Diplotene
  - Diakinesis
- Metaphase
- Anaphase
- Telophase
- Cytokinesis



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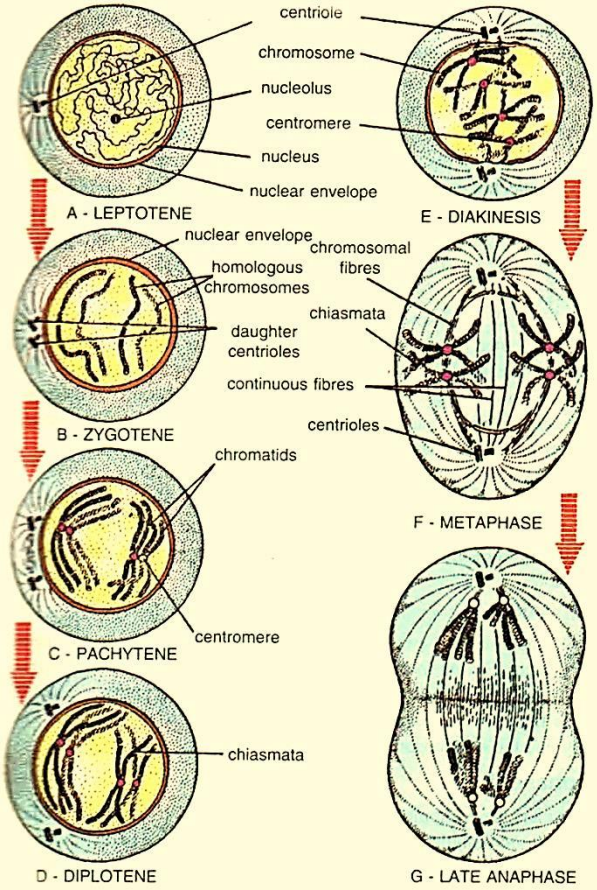
- Cell Reproduction

  Meiosis

  - Second Meiotic or Homotypic
  - Prophase
  - Metaphase
  - Anaphase
  - Telophase
  - Cytokinesis



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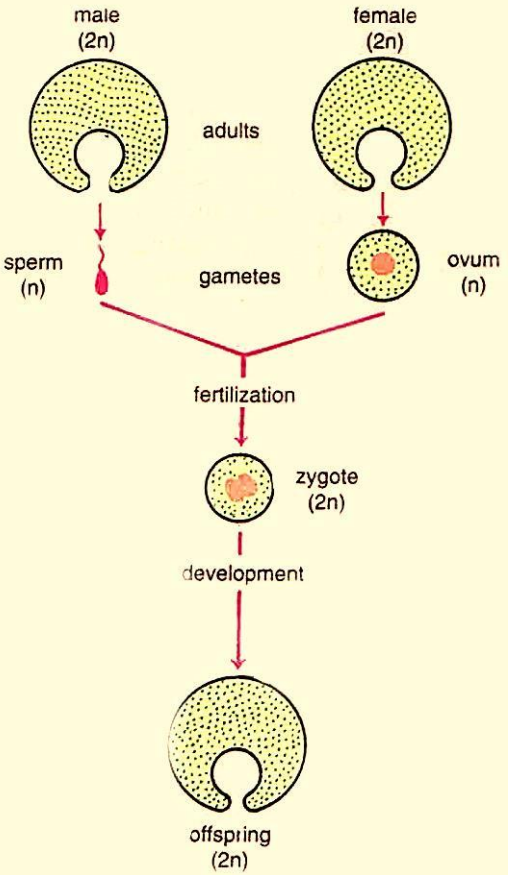
Significance of Meiosis

- Four haploid cells are formed
- During fertilization, one male and one female gamete fuses to form a diploid zygote. This is how the chromosome number of a species remains the same generation after generation.
- During the first meiotic division, crossing over between the homologous chromosomes allow chromatid exchange by which new hereditary combinations are developed.



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- Cell Death
  - Necrosis
  - Apoptosis

During the development of multicellular eukaryotic organisms (embryo-genesis, metamorphosis and tissue turn over), unwanted cells are eliminated through the process of programmed cell-death or apoptosis.

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Cell Death

Apoptosis involves the activation of a pathway that leads to suicide of the cell by characteristic process in which

- the cell becomes more compact;
- blebbing occurs at the membranes;
- the chromatin becomes condensed; and
- the DNA is fragmented.

Ultimately, the dead cell become fragmented into membrane bound pieces and are engulfed by surrounding cells.

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Cell Death

Apoptosis is important in

- tissue development;
- immune defense; and
- In the detection of cancerous cells;

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Course Content

Unit - 1

- History of Cell Biology
- Cell Theory, Prokaryotic & Eukaryotic Cells
- Microscopy : Principle & Applications, Electron Microscopy
- Structure & Transport across the plasma membrane
- Extra Nuclear Organization of Cell

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Course Content

Unit - 2

- Nuclear Organization of Cell
- Nucleo-cytoplasmic Interactions
- Cell Division : Amitosis, Mitosis & Meiosis
- Cell Death : Necrosis & Apoptosis