Mitochondria

Mitochondria are small, often between 0.75 and 3 micrometers and are not visible under the microscope unless they are stained.

Unlike other organelles (miniature organs within the cell), they have two membranes, an outer one and an inner one. Each membrane has different functions.

Mitochondria are split into different compartments or regions, each of which carries out distinct roles.

Some of the major regions include the:

Outer membrane: Small molecules can pass freely through the outer membrane. This outer portion includes proteins called porins, which form channels that allow proteins to cross. The outer membrane also hosts a number of enzymes with a wide variety of functions.

Intermembrane space: This is the area between the inner and outer membranes.

Inner membrane: This membrane holds proteins that have several roles. Because there are no porins in the inner membrane, it is impermeable to most molecules. Molecules can only cross the inner membrane in special membrane transporters. The inner membrane is where most ATP is created.

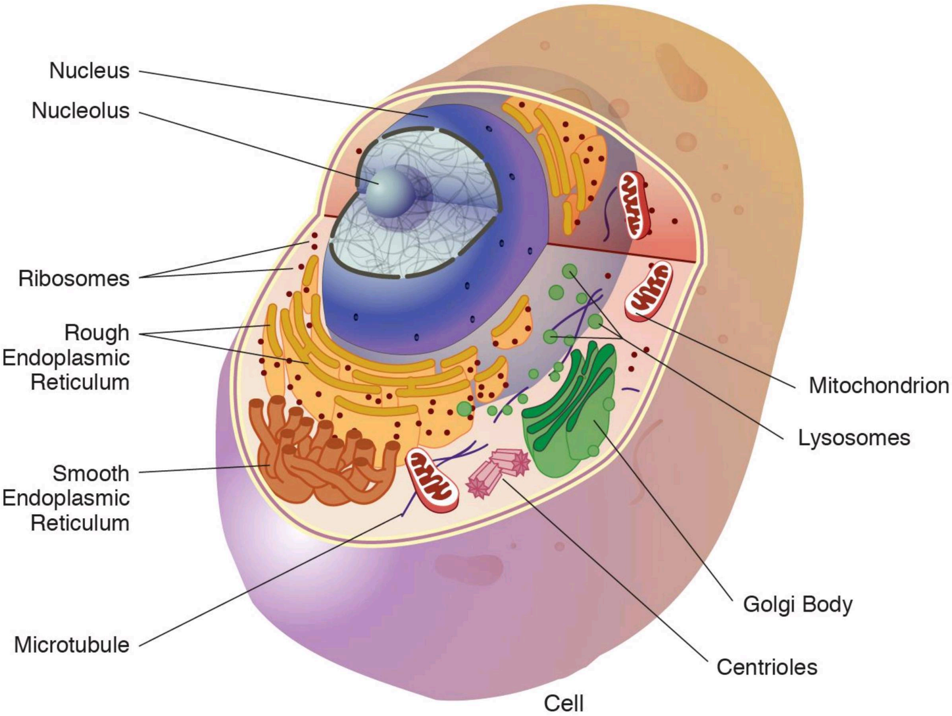
Cristae: These are the folds of the inner membrane. They increase the surface area of the membrane, therefore increasing the space available for chemical reactions.

Matrix: This is the space within the inner membrane. Containing hundreds of enzymes, it is important in the production of ATP. Mitochondrial DNA is housed here

Structure of the Chloroplast

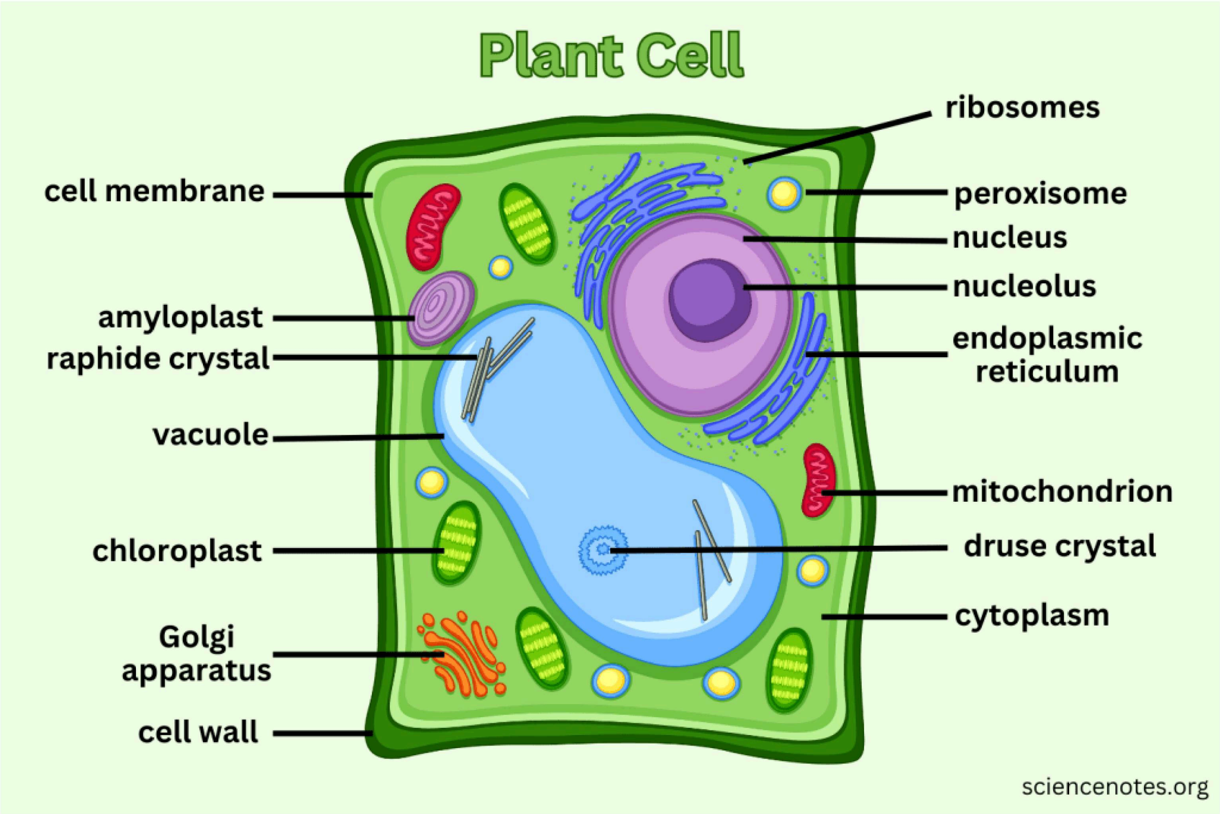
Chloroplasts are specialized organelles found in plant cells and some other Eukaryotic organisms. They play a central role in Photosynthesis, the process by which plants convert sunlight, water, and carbon dioxide into glucose and oxygen. This structural organization allows chloroplasts to efficiently carry out photosynthesis, making them crucial for plants and other photosynthetic organisms.

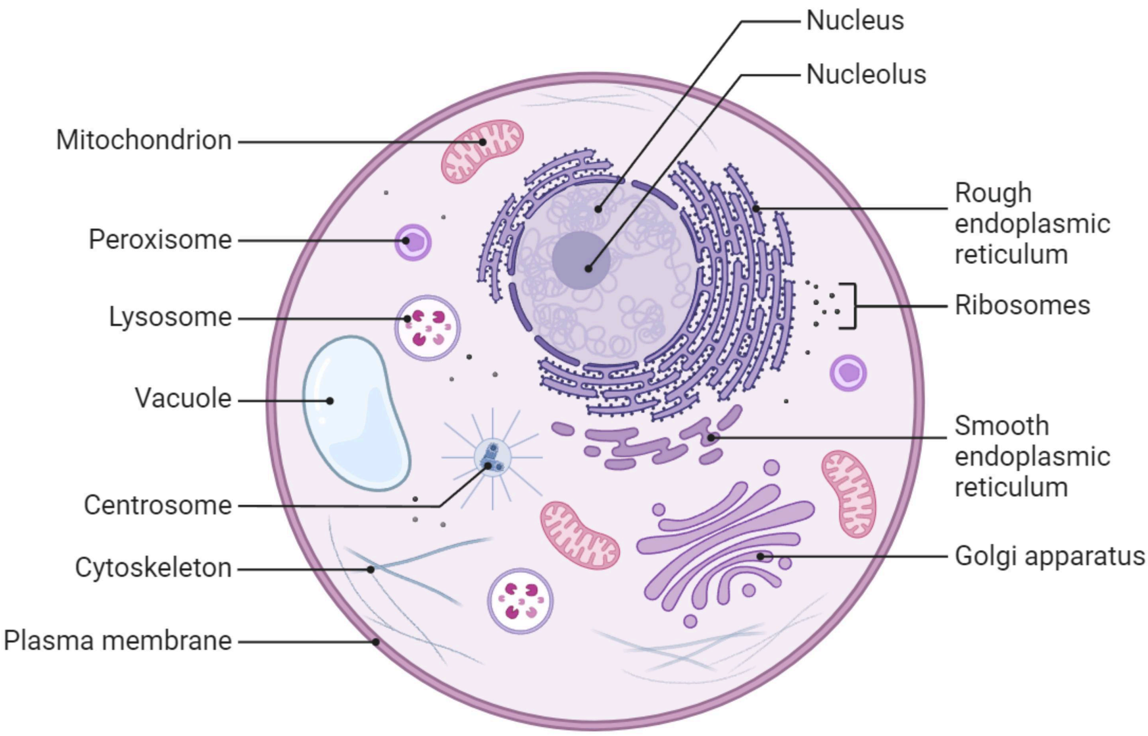
Different structures of a Chloroplast	
Chloroplast Structure	**Description**
Double Membrane	The double membrane is the outer membrane that separates chloroplast from cell cytoplasm; the inner membrane encloses the stroma.
Thylakoid Membrane System	The Thylakoid Membrane system consists of flattened sacs called thylakoids, organized into stacks (grana); containing chlorophyll pigments.
Stroma	Stroma is the semi-fluid substance inside the inner membrane; containing enzymes for photosynthesis reactions.
Chlorophyll	Chlorophyll is the pigment molecules embedded in thylakoid membranes; that capture light energy for photosynthesis.
DNA and Ribosomes	DNA and ribosomes are chloroplasts that contain their own genetic material (DNA) and ribosomes for protein synthesis.


Nucleus
Nucleolus
Ribosomes
Rough Endoplasmic Reticulum
Smooth Endoplasmic Reticulum
Microtubule
Mitochondrion
Lysosomes
Golgi Body
Centrioles
Cell

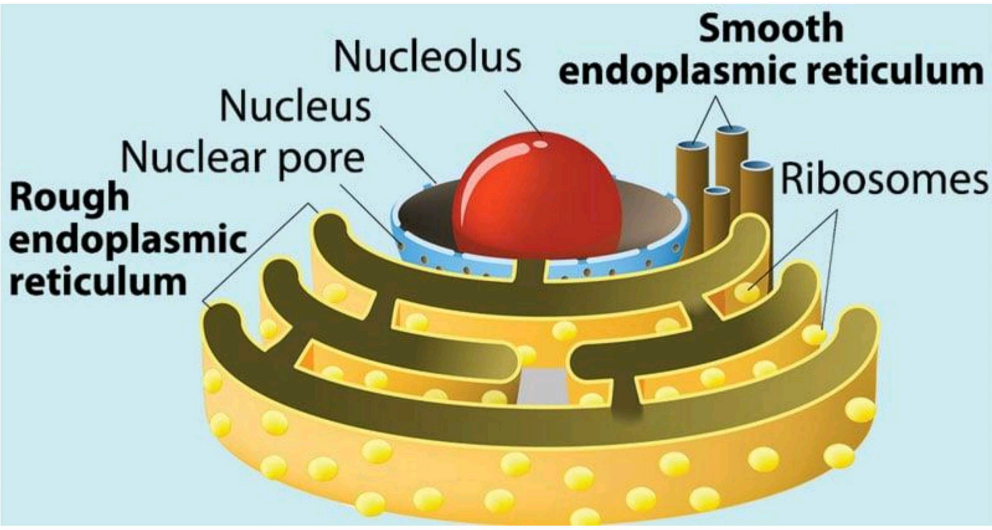
Organelle	Cell Type	Function
Nucleus	Eukaryotic	Stores genetic information
Nucleolus	Eukaryotic	Makes ribosomes
Cytoplasm	All cells	Contains the contents of the cell
Cytosol	All cells	Gel-like matrix that holds water and nutrients
Cytoskeleton	Eukaryotic	Structure, support and transport
Ribosome	All Cells	Makes protein
Rough Endoplasmic Reticulum	Eukaryotic	Makes proteins for the endomembrane system
Smooth Endoplasmic Reticulum	Eukaryotic	Detoxifies the cell and makes lipids
Golgi Apparatus	Eukaryotic	Sorts and ships proteins

Mitochondria	Eukaryotic	Makes energy
Lysosome	Eukaryotic, animal cells only	Removes unwanted material and waste
Peroxisome	Eukaryotic	Regulate biochemical pathways that involve oxidation
Vacuoles	Eukaryotic	Store water and nutrients
Vesicles	Eukaryotic	Transport materials around the cell
Cell Membrane	All	A thin flexible barrier that separates the cell from its environment
Cell Wall	Plants, fungi and prokaryotes	Rigid barrier that protects the cell
Large Central Vacuole	Plants only	Stores water and regulates turgor pressure
Chloroplasts	Plants only	Makes food using the process of photosynthesis


Plant Cell
ribosomes
cell membrane
peroxisome
nucleus
nucleolus
amyloplast
raphide crystal
endoplasmic reticulum
vacuole
mitochondrion
chloroplast
druse crystal
cytoplasm
Golgi apparatus
cell wall
sciencenotes.org


Nucleus
Nucleolus
Mitochondrion
Rough endoplasmic reticulum
Peroxisome
Ribosomes
Lysosome
Vacuole
Smooth endoplasmic reticulum
Centrosome
Cytoskeleton
Golgi apparatus
Plasma membrane

Animal Cell

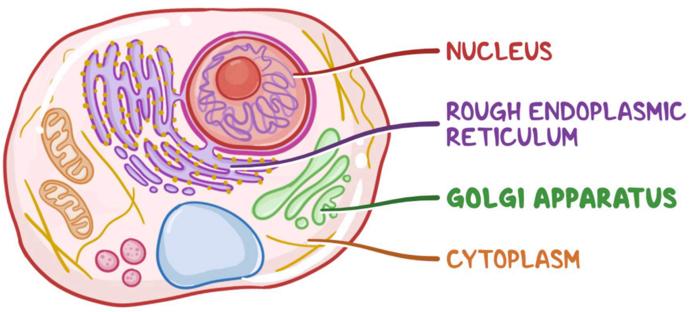


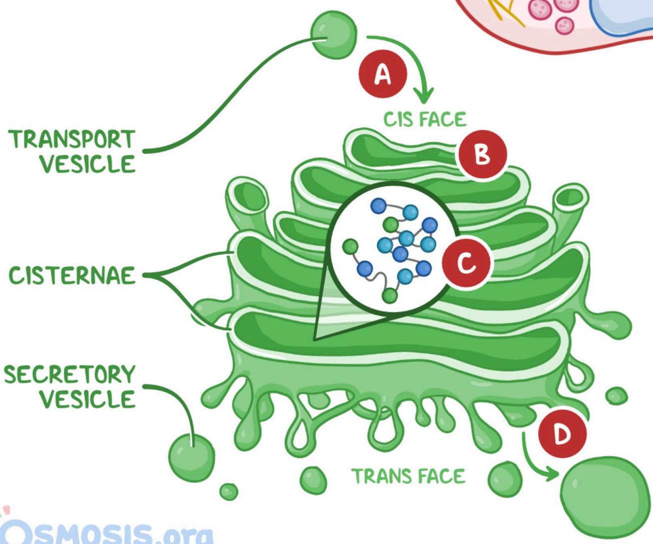
Function :

The ER is the largest organelle in the cell and is a major site of protein synthesis and transport, protein folding, lipid and steroid synthesis, carbohydrate metabolism and calcium storage

BACKGROUND

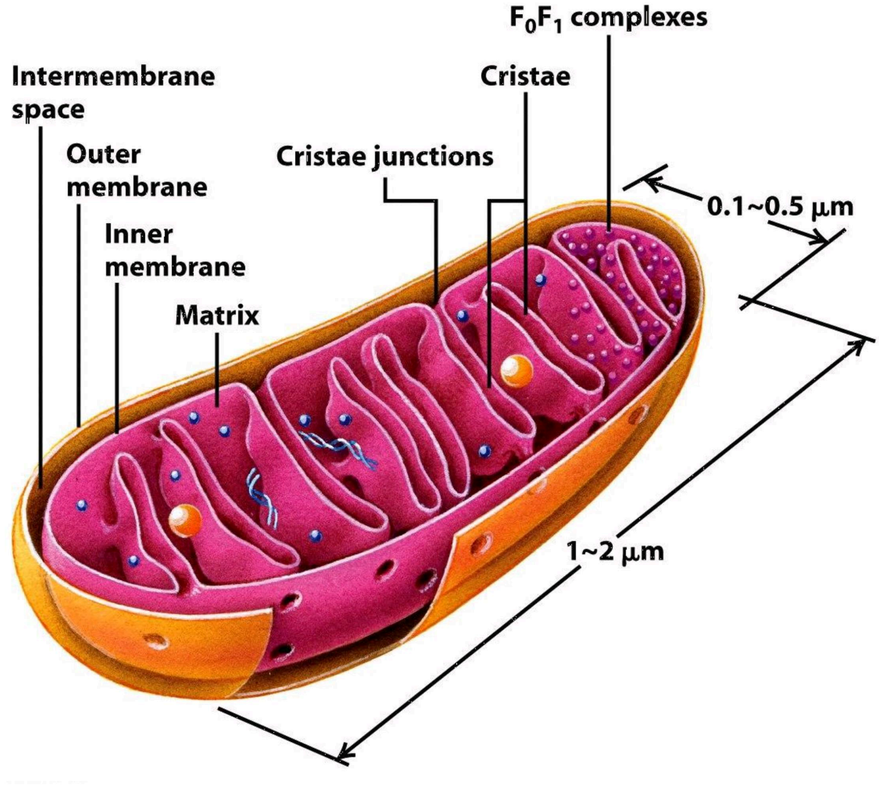
* TYPE of ORGANELLE in EUKARYOTIC CELLS
* PROCESSES & PACKAGES PROTEINS & LIPID MOLECULES
  ~ aka GOLGI BODY or COMPLEX



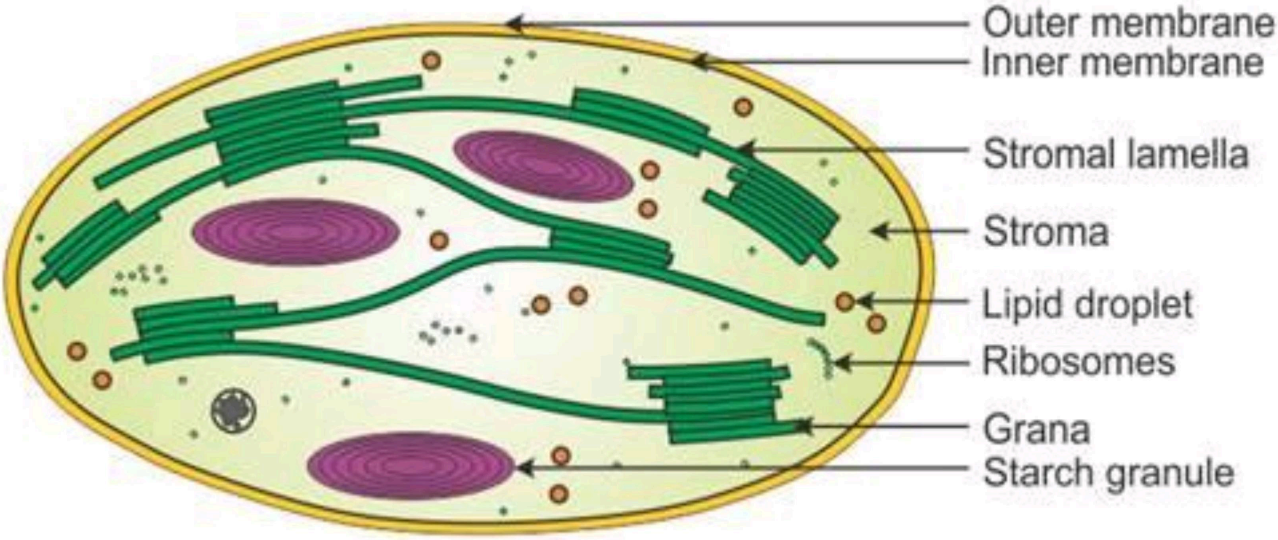


FUNCTION

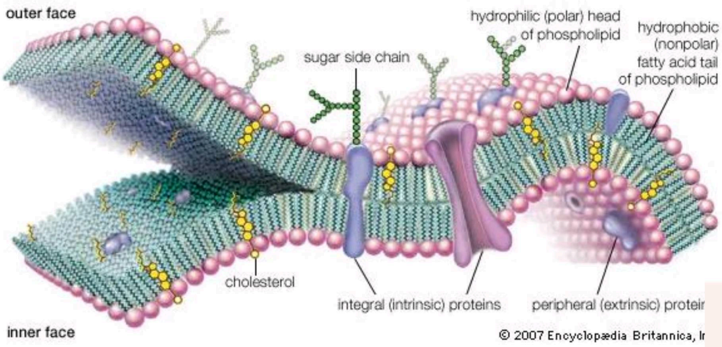
- **A** TRANSPORT VESICLES BRING MOLECULES from ROUGH ENDOPLASMIC RETICULUM
- **B** MOLECULES FUSE with MEMBRANE & are SORTED BASED on DESTINATION
- **C** MOLECULES UNDERGO REMODELING & MODIFICATIONS in CISTERNAE
- **D** MODIFIED MOLECULES are SECRETED OUT of CELL or to ANOTHER ORGANELLE



Mitochondria



Electron micrograph of a section of chloroplast


outer face
hydrophilic (polar) head
of phospholipid
hydrophobic
(nonpolar)
fatty acid tail
of phospholipid
sugar side chain
cholesterol
integral (intrinsic) proteins
peripheral (extrinsic) protein
inner face
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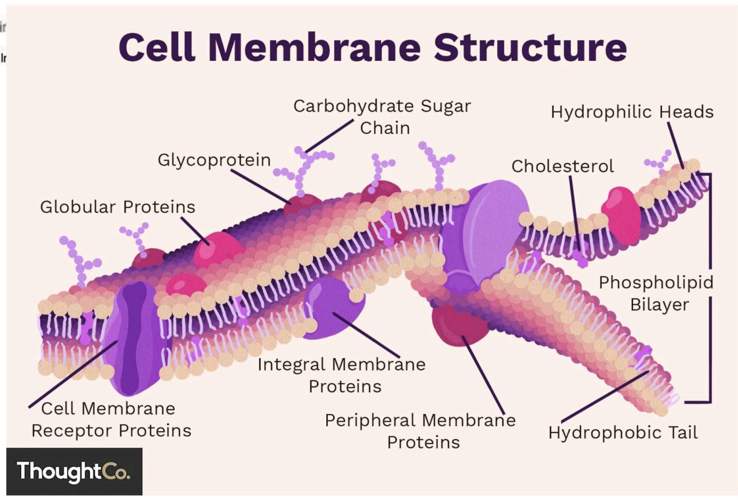

Cell Membrane Structure
Carbohydrate Sugar
Chain
Hydrophilic Heads
Glycoprotein
Cholesterol
Globular Proteins
Phospholipid
Bilayer
Integral Membrane
Proteins
Cell Membrane
Receptor Proteins
Peripheral Membrane
Proteins
Hydrophobic Tail
ThoughtCo.

Simple microscope

A **simple microscope**, also known as a **magnifying glass**, is an optical instrument used to magnify small objects. It consists of a **single convex lens** with a focal length of a few centimeters. When an object is placed close to the lens, between the focal point and the lens, it produces an **erect virtual image** of the object near the lens[1]. Let's explore the key aspects of a simple microscope:

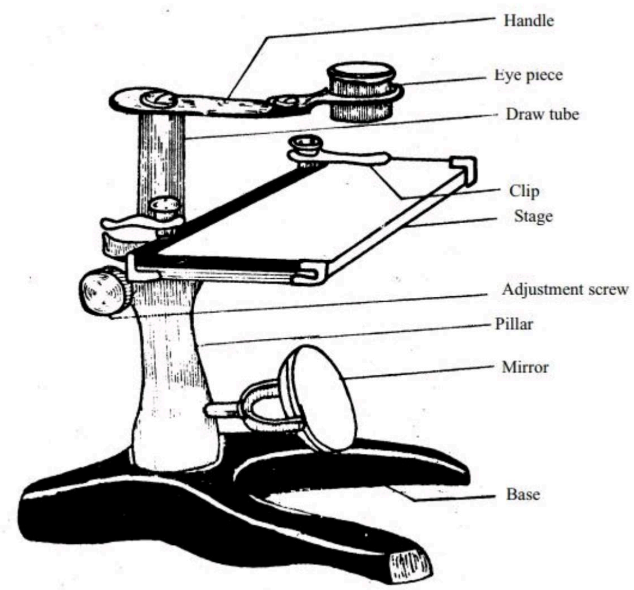


Fig. P.2A Simple Microscope

1. **Parts of a Simple Microscope**:
   - **Eyepiece**: The lens used to study samples, typically with a magnification of 10X to 15X.
   - **Base**: Provides support to the microscope.
   - **Tube**: Connects the eyepiece to the objective lenses.
   - **Diaphragm**: Controls the amount of light passing through the stage.
   - **Stage**: Platform for placing slides with samples.
   - **Stage Clip**: Holds slides in place.
   - **Adjustment Knob**: Used for scanning focus.
   - **Arm**: Supports the tube and connects to the base.
2. **Magnification of Simple Microscope**:
   - The magnifying power formula for a simple microscope is given as:

     $M = 1 + D/F$

     where,
     - (M) represents magnification.
     - (D) is the least distance of distinct vision.

        - (F) is the focal length of the convex lens.
3. **Difference Between Simple and Compound Microscope**:
    - **Simple Microscope**:
        - Uses a single objective lens.
        - Adjusting knobs include a small hollow cylindrical knob.
        - Has one adjustment screw for focusing.
    - **Compound Microscope**:
        - Uses two to four objective lenses.
        - Adjusting knobs include a curved knob.
        - Has a coarse adjustment screw for fine focus[2].

In summary, a simple microscope provides a straightforward way to magnify objects, making it useful for various applications, from examining small specimens to everyday tasks like reading fine print.

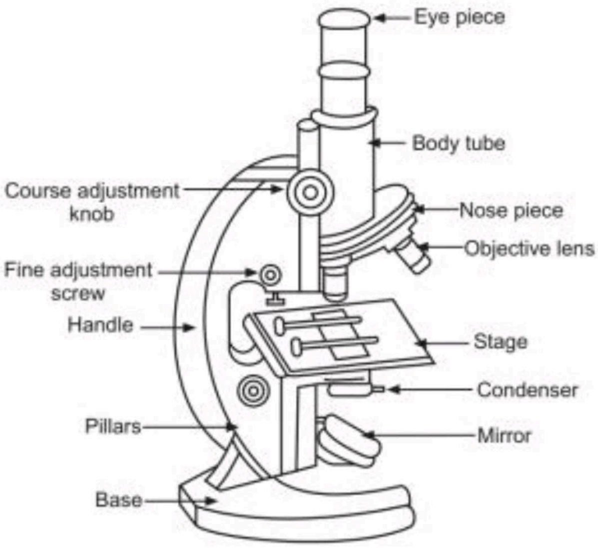
Uses of Simple Microscope

- It is used in pedology (a study of soil particles)
- It is used by a dermatologist to find out various skin diseases.
- It is used in microbiology to study samples of algae, fungi etc
- It is used by the jewellers to get a magnified view of the fine parts of the jewellery.

Compound microscope

The **principle of a compound microscope** is based on how light behaves when it passes through a specimen. Let's explore the key aspects:

1. **Light Refraction and Magnification**:
    - When light travels through the specimen, it gets **refracted** or bent, revealing hidden details.
    - A **compound microscope** uses a combination of lenses to manipulate and magnify the light, allowing us to see the specimen more clearly[1].



2. **Parts of a Compound Microscope**:
   - **Mechanical Parts**:
     - **Foot or Base**: A U-shaped structure that supports the entire weight of the compound microscope.
     - **Pillar**: A vertical projection that stands by resting on the base and supports the stage.
     - **Arm**: A strong, curved structure that handles the entire microscope.
     - **Stage**: A flat, rectangular plate connected to the arm's lower end. The specimen is placed on the stage for examination, and it has a central hole for light passage.
     - **Inclination Joint**: Allows tilting of the microscope.
     - **Clips**: Upper stage parts that hold the slide in position.
     - **Diaphragm**: Located below the stage, it controls and adjusts the light intensity (can be disc or iris type).
     - **Nosepiece**: A rotating metal part connected to the body tube's lower end, holding the objective lenses.
     - **Body Tube**: A hollow, tubular structure in the upper part of the arm, which can be shifted up and down using adjustment knobs.
     - **Fine Adjustment Knob**: Smaller knob for precise focusing.
     - **Coarse Adjustment Knob**: Larger knob for moving the body tube to bring the object into focus.

2. **Optical Parts**:

- **Eyepiece Lens (Ocular)**: Planted at the top of the body tube, it magnifies the real image. Markings like 5X, 10X, etc., indicate the magnification power.
- **Mirror**: Attached to the pillar or the lower end of the arm, it has a concave mirror on one side and a plain mirror on the other.

The **working principle of a compound microscope** involves the interaction of lenses to magnify and reveal intricate details of microscopic specimens. Let's explore this principle in detail:

1. **Objective Lens and Eyepiece**:
    - A compound microscope uses two types of lenses:
        - **Objective Lens**: Positioned close to the specimen, it collects light emitted by the sample and magnifies it to form a **real image**.
        - **Eyepiece (Ocular Lens)**: Further magnifies the real image, creating a **virtual image** that we observe through the eyepiece.
2. **Light Path and Image Formation**:
    - Light passes through the thin, transparent specimen placed on the stage.
    - The objective lens produces a magnified real image of the specimen.
    - This real image is formed just beyond the focus of the eyepiece.
    - The eyepiece (ocular lens) then magnifies the real image even more, creating a virtual image that we view.
3. **Bright-Field Microscope**:
    - The compound microscope is also known as a **bright-field microscope** because light passes directly through the specimen.
    - The illumination source (usually located below the stage) provides bright light.
    - The two lenses (objective and eyepiece) work together to create a well-lit field of vision, allowing us to observe the specimen clearly.
4. **Magnification Calculation**:
    - The total magnification of the compound microscope is calculated by multiplying the magnification of the objective lens by the magnification of the eyepiece.
    - For example, if the objective lens has a magnification of 40X and the eyepiece has a magnification of 10X, the total magnification is 400X.

Advantages and Disadvantages of Compound Microscope

Advantages of Compound Microscope

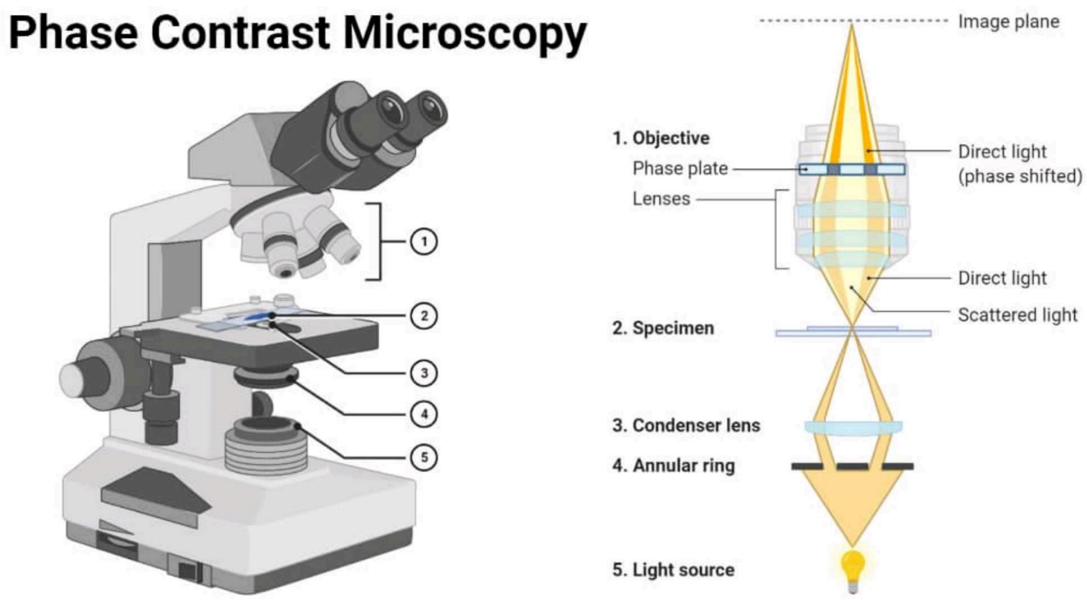
- Due to the usage of multiple lenses, one can obtain detailed information about the sample.
- These microscopes have their own sources of light.
- This microscope is user-friendly and easy to handle.

Disadvantages of Compound Microscope

- The magnification of the sample is possible only to a certain extent, once this limit is reached the sample cannot be viewed.

Uses of Compound Microscope

- The identification of diseases becomes easy in pathology labs with the help of a compound microscope.
- Forensic laboratories use compound microscopes for the detection of human fingerprints.
- The presence of metals can be detected with the help of a compound microscope.
- The study of bacteria and viruses becomes easy with the help of a compound microscope.
- Schools use compound microscopes for academic purposes.



The Working of Phase contrast Microscopy

1. Partially coherent illumination produced by the tungsten-halogen lamp is directed through a collector lens and focused on a specialized annulus (labeled condenser annulus) positioned in the substage condenser front focal plane.
2. Wavefronts passing through the annulus illuminate the specimen and either pass through undeviated or are diffracted and retarded in phase by structures and phase gradients present in the specimen.
3. Undeviated and diffracted light collected by the objective is segregated at the rear focal plane by a phase plate and focused at the intermediate image plane to form the final phase-contrast image observed in the eyepieces.

Parts of Phase contrast Microscopy

Phase-contrast microscopy is basically a specially designed light microscope with all the basic parts in addition to which an annular phase plate and annular diaphragm are fitted.

The annular diaphragm

- It is situated below the condenser.
- It is made up of a circular disc having a circular annular groove.
- The light rays are allowed to pass through the annular groove.
- Through the annular groove of the annular diaphragm, the light rays fall on the specimen or object to be studied.
- At the back focal plane of the objective develops an image.
- The annular phase plate is placed at this back focal plane.

The phase plate

- It is either a negative phase plate having a thick circular area or a positive phase plate having a thin circular groove.
- This thick or thin area in the phase plate is called the conjugate area.
- The phase plate is a transparent disc.
- With the help of the annular diaphragm and the phase plate, the phase contrast is obtained in this microscope.

- This is obtained by separating the direct rays from the diffracted rays.
- The direct light rays pass through the annular groove whereas the diffracted light rays pass through the region outside the groove.
- Depending upon the different refractive indices of different cell components, the object to be studied shows a different degree of contrast in this microscope.

Applications of Phase contrast Microscopy

To produce high-contrast images of transparent specimens, such as

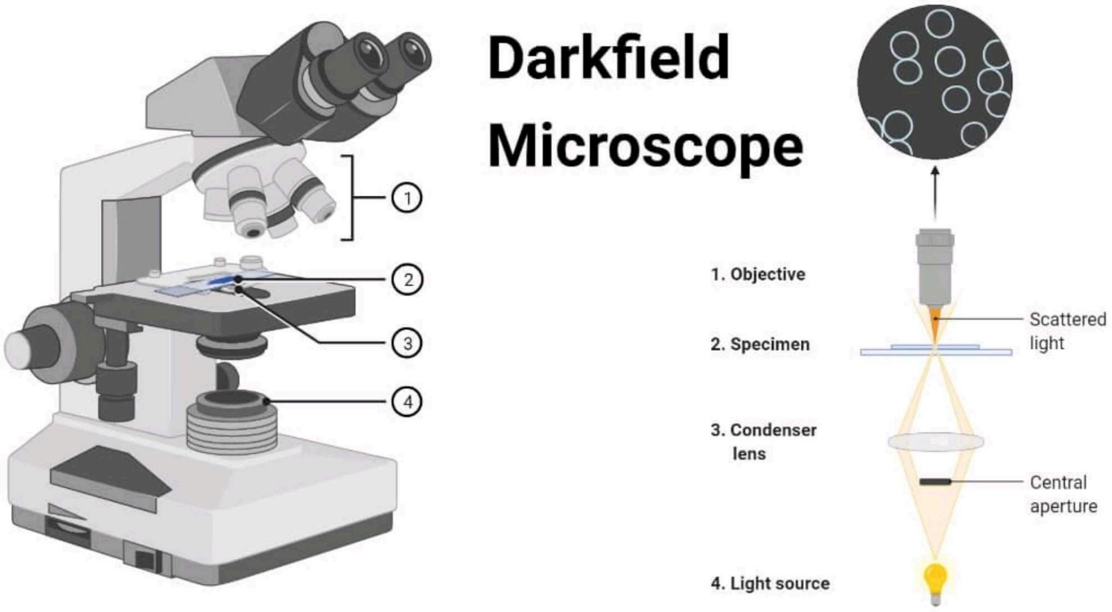
1. living cells (usually in culture),
2. microorganisms,
3. thin tissue slices,
4. lithographic patterns,
5. fibers,
6. latex dispersions,
7. glass fragments, and
8. subcellular particles (including nuclei and other organelles).

Applications of phase-contrast microscopy in biological research are numerous.

Advantages of Phase contrast Microscopy

- Living cells can be observed in their natural state without previous fixation or labeling.
- It makes a highly transparent object more visible.
- No special preparation of fixation or staining etc. is needed to study an object under a phase-contrast microscope which saves a lot of time.
- Examining intracellular components of living cells at relatively high resolution. eg: The dynamic motility of **mitochondria**, mitotic chromosomes & vacuoles.
- It made it possible for biologists to study living cells and how they proliferate through cell division.
- Phase-contrast optical components can be added to virtually any brightfield microscope, provided the specialized phase objectives conform to the tube length parameters, and the condenser will accept an annular phase ring of the correct size.

Darkfield Microscope



Principle of the Darkfield Microscope

- A dark field microscope is arranged so that the light source is blocked off, causing light to scatter as it hits the specimen.
- This is ideal for making objects with refractive values similar to the background appear bright against a dark background.
- When light hits an object, rays are scattered in all azimuths or directions. The design of the dark field microscope is such that it removes the dispersed light, or zeroth order, so that only the scattered beams hit the sample.
- The introduction of a condenser and/or stop below the stage ensures that these light rays will hit the specimen at different angles, rather than as a direct light source above/below the object.
- The result is a "cone of light" where rays are diffracted, reflected and/or refracted off the object, ultimately, allowing the individual to view a specimen in dark field.
- The dark-ground microscopy makes use of the dark-ground microscope, a special type of compound light microscope.
- The dark-field condenser with a central circular stop, which illuminates the object with a cone of light, is the most essential part of the dark-ground microscope.
- This microscope uses reflected light instead of transmitted light used in the ordinary light microscope.
- It prevents light from falling directly on the objective lens.
- Light rays falling on the object are reflected or scattered onto the objective lens with the result that the microorganisms appear brightly stained against a dark background.

Uses of Darkfield Microscope

The dark ground microscopy has the following uses:

- It is useful for the demonstration of very thin bacteria not visible under ordinary illumination since the reflection of the light makes them appear larger.
- This is a frequently used method for rapid demonstration of *Treponema pallidum* in clinical specimens.

- It is also useful for the demonstration of the motility of flagellated bacteria and protozoa.
- Darkfield is used to study marine organisms such as algae, plankton, diatoms, insects, fibers, hairs, yeast and protozoa as well as some minerals and crystals, thin polymers and some ceramics.
- Darkfield is used to study mounted cells and tissues.
- It is more useful in examining external details, such as outlines, edges, grain boundaries and surface defects than internal structure.

Advantages of Darkfield Microscope

- Dark-field microscopy is a very simple yet effective technique.
- It is well suited for uses involving live and unstained biological samples, such as a smear from a tissue culture or individual, water-borne, single-celled organisms.
- Considering the simplicity of the setup, the quality of images obtained from this technique is impressive.
- Dark-field microscopy techniques are almost entirely free of artifacts, due to the nature of the process.
- A researcher can achieve a dark field by making modifications to his/her microscope.

Limitations of Darkfield Microscope

- The main limitation of dark-field microscopy is the low light levels seen in the final image.
- The sample must be very strongly illuminated, which can cause damage to the sample.