

Ultrastructure of Animal cell

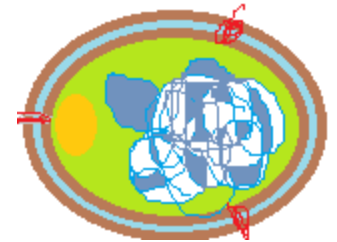
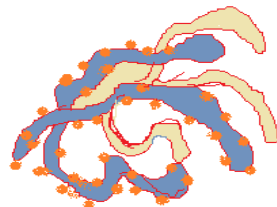
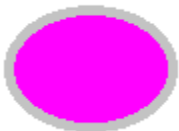
II YEAR –III Semester

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Learning outcomes/Objectives

- ❖ *To know about history and introduction about cell.*
- ❖ *To understand about structure and functions of the cell organelles in animal cell*

History

- The **cell** (from **Latin word** *cella*, means “ **small room** “)is the **basic structural, functional, and biological unit of all known organisms.**
- **Origin of cell on Earth** at **least 3.5 billion years ago.**
- **A cell** is the **smallest unit of life** .
- The study of cells is called **cell biology or cellular biology, or cytology.**
- The **structural unit is called cell** now known as **the unit of life.**
- But according to **Cell theory** the concept that **cell is the basic unit of life.**
- **1665 -The cell was first discovered by Robert Hook**
- **1674 – Leeuwenhoek discovered protozoa and saw bacteria** some 9 years later.
- **1833 – Brown described the cell nucleus in cells of the orchid.**
- According to **Matthias Jakob Schleiden** a **German botanist** in 1838 and **Theodor Schwann, German Zoologist** in 1839 described the **cell as a unit of structural and functional unit of biological life of an organism.**

History

- **1838** – *Schleiden and Schwann* proposed **cell theory**.
- **1840** – *Albrecht von Roelliker* realized that **sperm cells and egg cells** are also cells.
- **1856** – *N. Pringsheim* observed how a sperm cell penetrated an egg cell.
- **1858** – *Rudolf Virchow*, physician, pathologist and anthropologist, said that **cells develop only from existing cells** [cells come from pre-existing cells] **during cell division**
- **1857** – *Kolliker* described **mitochondria**.
- **1879** – *Flemming* described **chromosome behavior** during **mitosis**.
- **1898** – *Golgi* described the **Golgi apparatus**
- **1938** – *Behrens* used differential centrifugation to **separate nuclei from cytoplasm**.

Introduction

- The cell is **structural & functional unit of all living things**.
- Cells contain **hereditary information** which is passed from **cell to cell during cell division**.
- All **energy flow** (metabolism & biochemistry) **of life** occurs **within cells**.
- **All living organisms** are **made up of cells** and **make up their body structure**.

Introduction

- Some of these living things are **single-celled (unicellular)** and other organisms are made up of **more than one cell (Multicellular)**.
- **The cells that constitute an animal /any living organism called Animal cells .**
- An animal cell is a eukaryotic cell that **lacks a cell wall**, and it is **enclosed by the plasma membrane**.
- The **number of cells** in **animals varies** from **organism to organism**.
- **Human contains** somewhere around **40 trillion (4×10^{13})** cells. The **human brain** accounts for **around 80 billion** of these cells.
- The **shape of cell** in varies such as **flattened, cubical, columnar, fusiform, stellate, pyramidal, flask shaped** and so on.
- Eukaryotic Cell is **microscopic** and the size varies from about **$1\mu\text{m}$ to $275\mu\text{m}$** .
 $1\mu = 1000 \text{ millimicrons or } 0.001 \text{ millimeter}$
- The **longest cell is** human **nerve cell** measuring **about 3-3.5 feet**, the **largest cell** is the **egg of ostrich** with diameter of **175 mm.**, and **Amoeba** measures **about 1000 microns**.
- **Eukaryotic Cell of animal** consists of **Plasma membrane and Protoplasm** (means **cytoplasm along with Nucleus**).

Different types of microscopes

Robert Hooke's Microscope



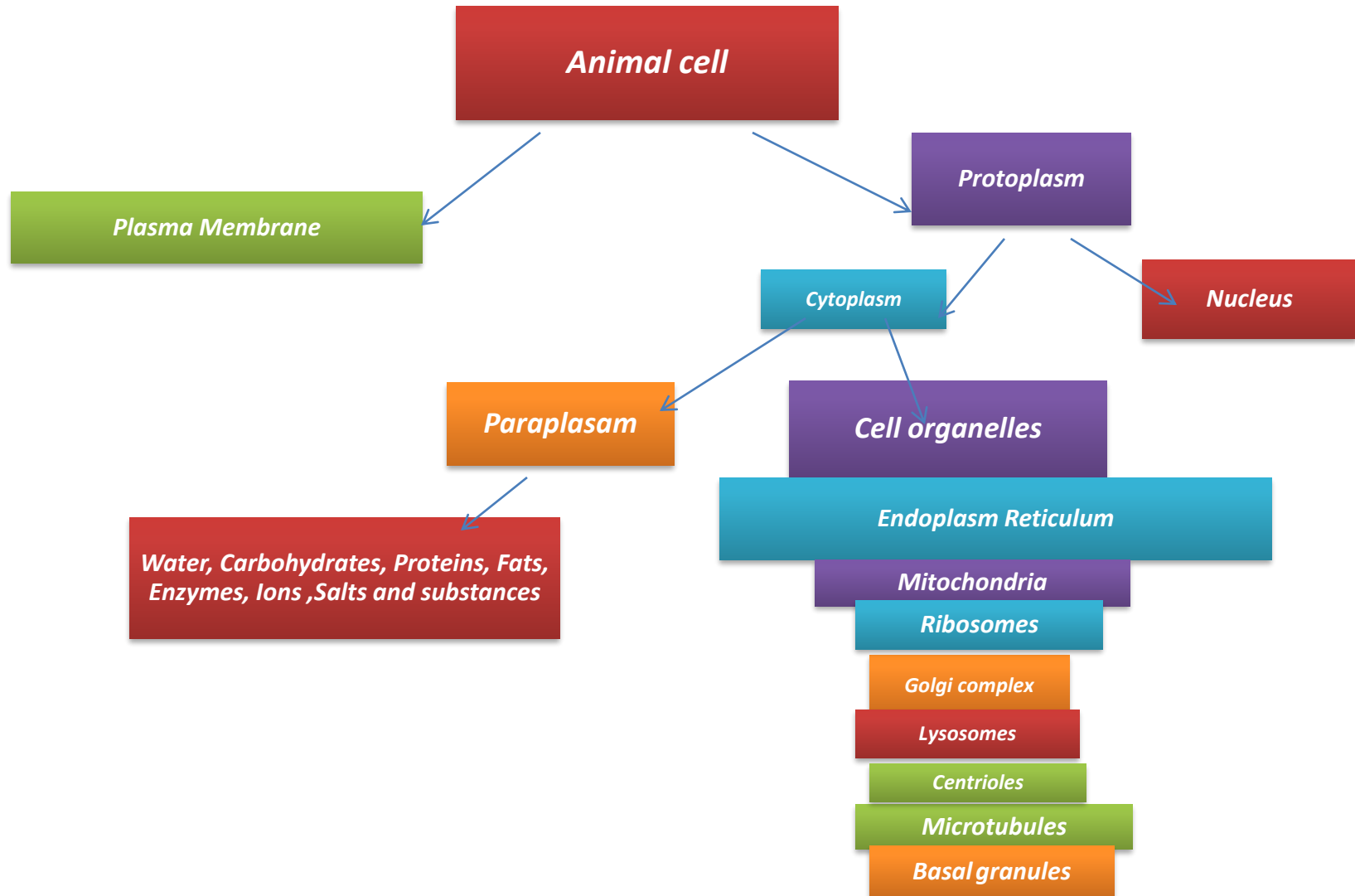
Simple compound microscope



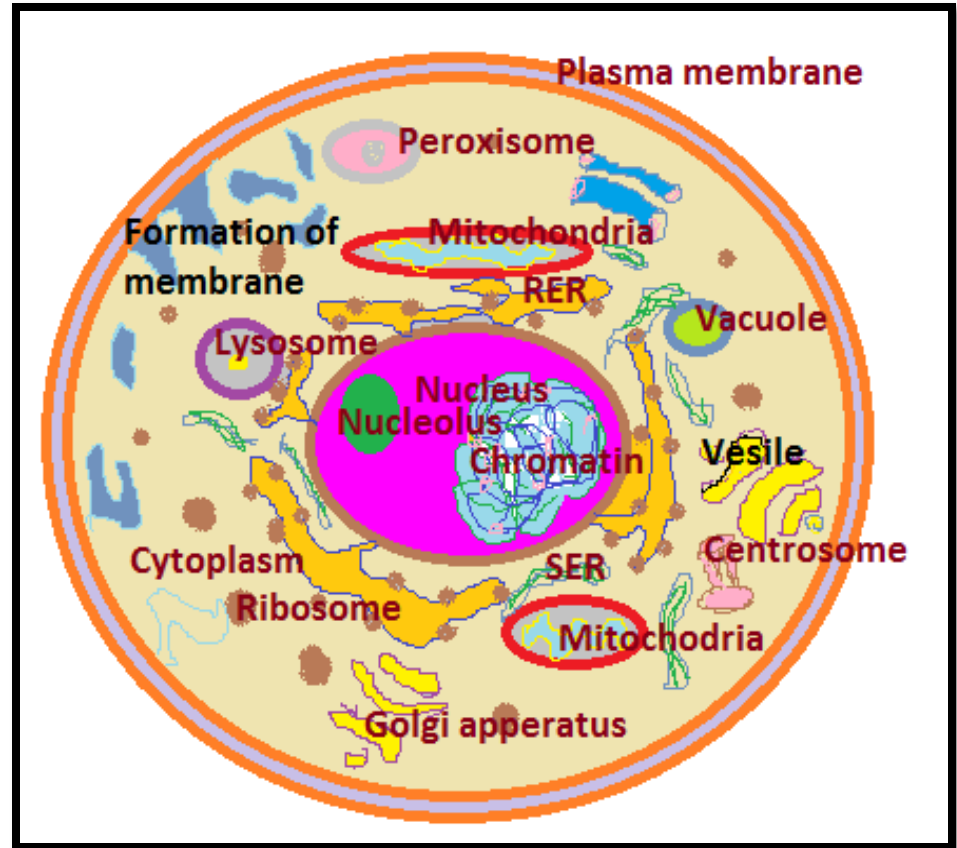
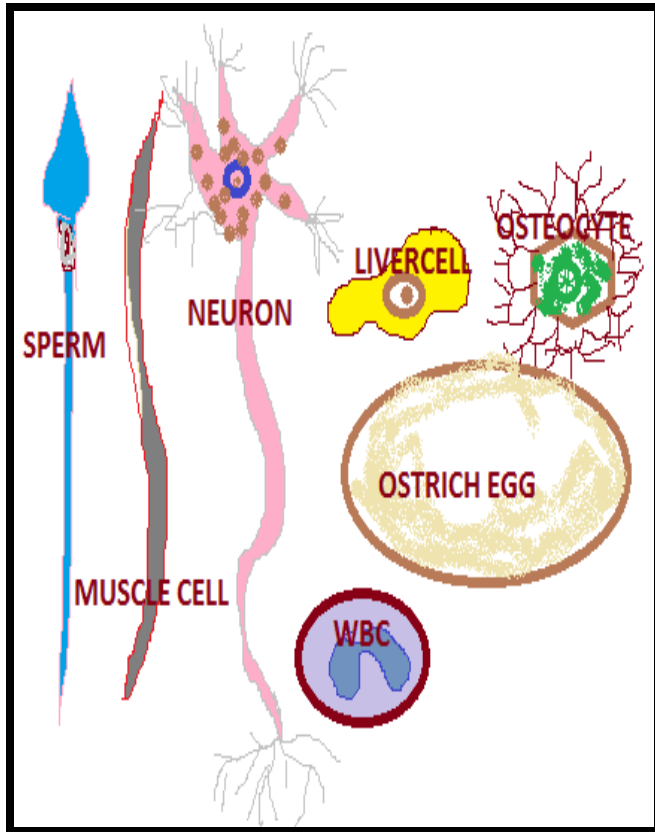
Dissection Microscope



Flow chart of Ultra Structure Animal cell



Ultra structure of Animal Cell



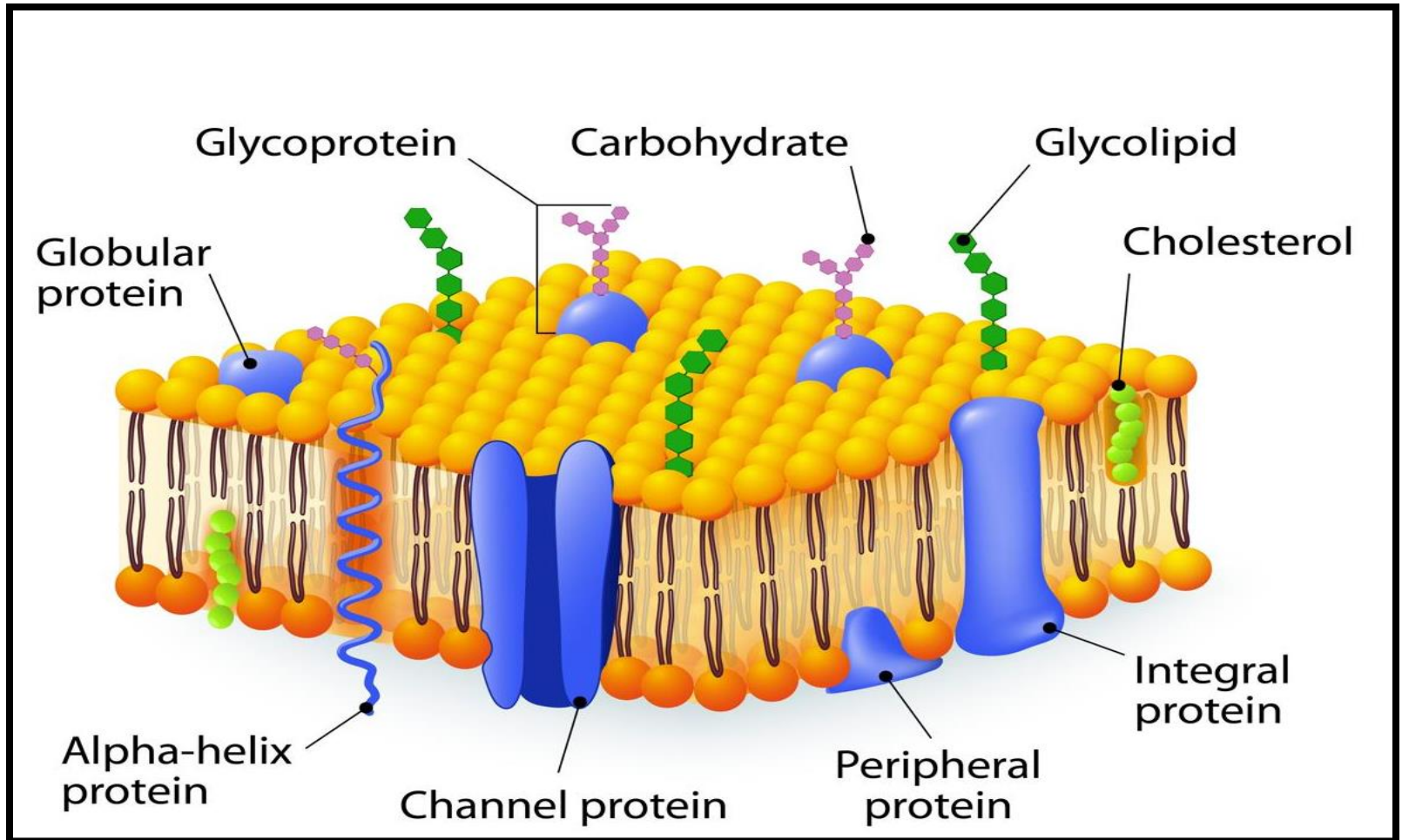
*different shapes and sizes
of Various cells*

Ultra Structure of Animal cell

1. Plasma Membrane :-

- It is a **thin, elastic, permeable** and definite shape to the cell.
- It is **bounded /surrounded** of the cell and **double unit membrane** with **thickness** is about **75 Å** which is made **of lipoproteins**.
- **Each unit membrane** is made of a **bilayer of phospholipids** between an outer membrane and inner membrane protein layers.
- **The term of plasma membrane** coined by **Negeli in 1855**.
- Plasma membrane **breaks and rejoin to form the whole structure is called Fluidity**, Fluidity helps **Endocytosis and Exocytosis**.
- **Functions:-**It provides **stability to the cell and maintain its shape**.
- It **regulates flow of ions, molecules of various substances into and out** of the cells. Different **methods of transport** by the plasma membrane such as
 - ❖ **Osmosis** means passes of **water and other solvents** from **lower concentration to higher concentration**.
 - ❖ **Diffusion** means transport **of ions and molecules of various substances** from **high concentration to lower concentration regions**.
 - ❖ **Endocytosis** (the objective of foreign bodies enter to cell then form plasma membrane surrounded it and ingestion of food) are two types namely **pinocytosis, phagocytosis and exocytosis also**.

Diagram of Plasma membrane



Ultra structure of Animal cell

2. Cytoplasm:-

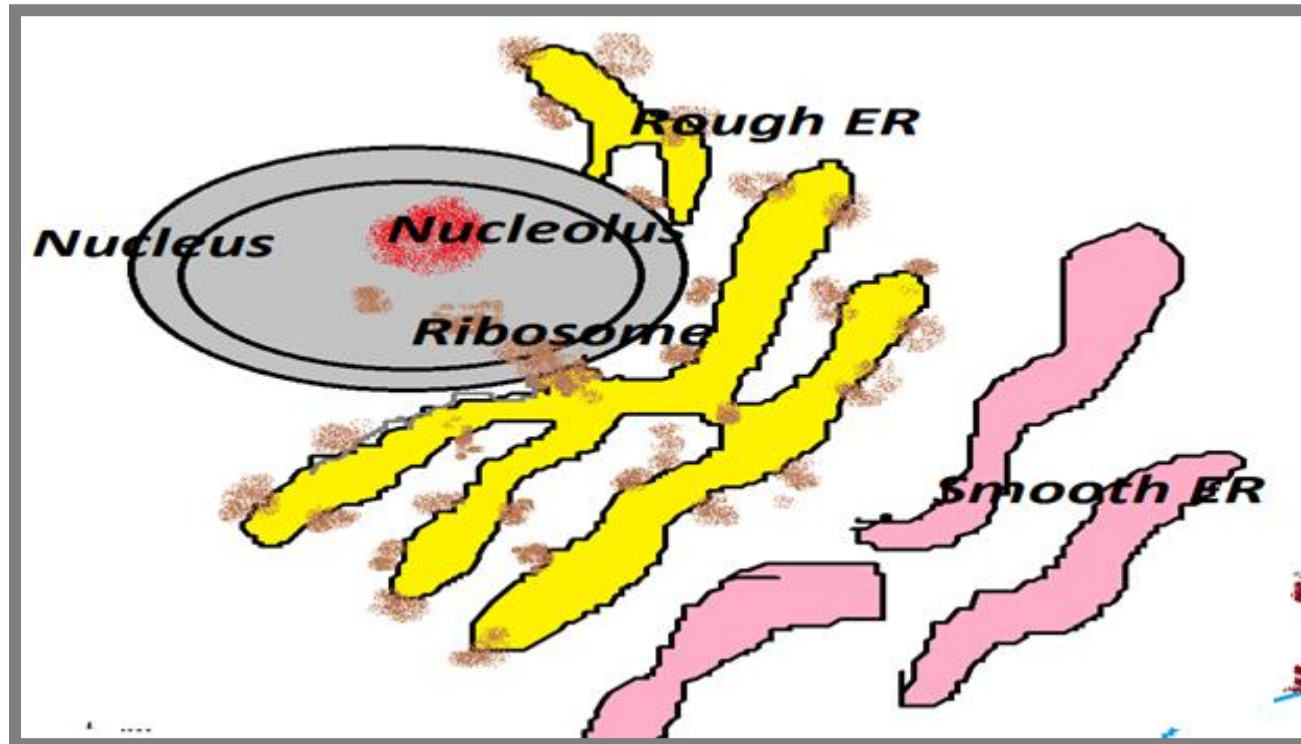
- It is namely called **cytoplasmic matrix or kinoplasm or hyloplasm or Cytosol**
- It is **colloidal, transparent colourless, homogenous fluid** present **between the cell/plasma membrane and nucleus.**
- The **cytoplasm** consists of **two parts-organelles or living structure and paraplasms or inclusions or non-living structure.**
- **Cell Organelles or organoids** are **Mitochondria, Endoplasmic reticulum, Ribosomes ,Golgi apparatus, Lysosomes, Peroxisomes, Phagosomes ,Filaments , fibrills , Centrioles , microtubules and Nucleus.**
- These are participated in **different activities** such as secretion, transport, cellular respiration, protein synthesis, made the acrosome of sperm, digestion of food materials and storage etc.,
- Paraplasms are **glycogen, fat globules , proteins , enzymes, Inorganic substances, and pigments.**

Ultra structure of Animal cell

A. Endoplasm Reticulum:-

- It is also called **bench work of the cell or cytoskeleton**.
- It was first reported by **Porter in 1953**.
- It is forming **a sort of networking**.
- It has a **membrane bounded** organelle.
- It has **two types** observed in the cytoplasm namely **Smooth and Rough ER** and the smooth and rough regions of the ER are **interconnected**.
- **Smooth ER** means **without or lacks ribosomes**. It is a **network of pipe-like interconnected tubes**.
- ❖ **Functions:-** synthesis and storage of lipids and glycogen, and **detoxification** of drugs and poisons.
- **Rough ER** has bound **ribosomes** attached to the **outside**. The **RER** is in fact an **extension of the outer nuclear membrane**.
- ❖ **Functions :-**It participate in **protein synthesis**.

Diagram of Endoplasm Reticulum

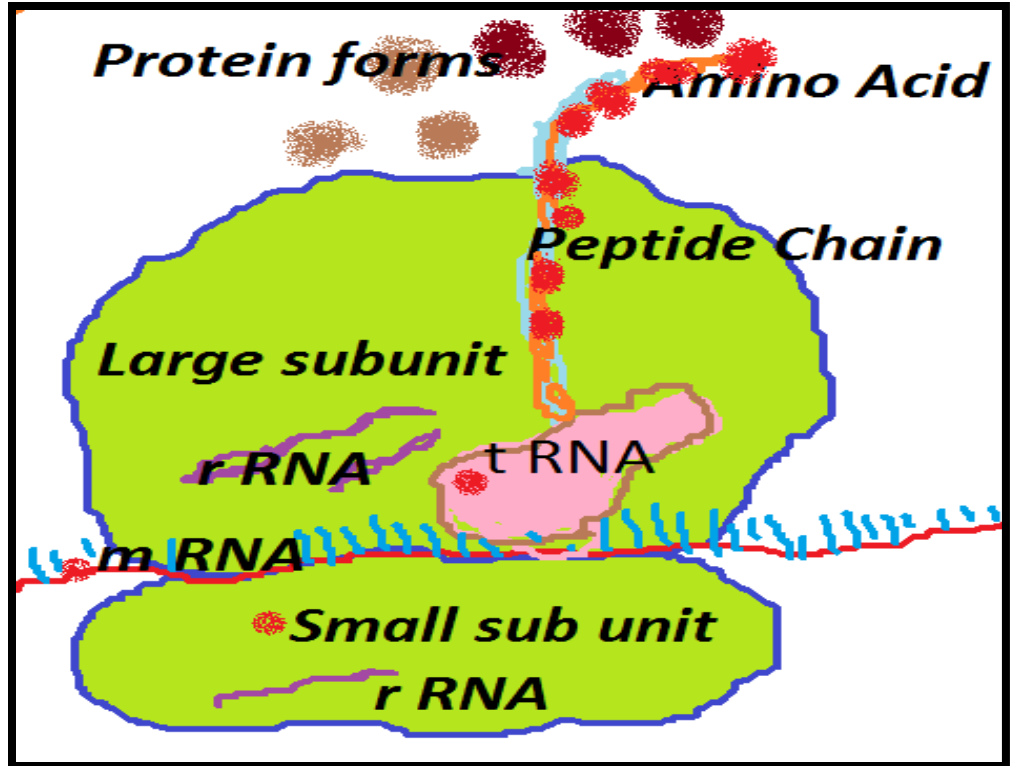
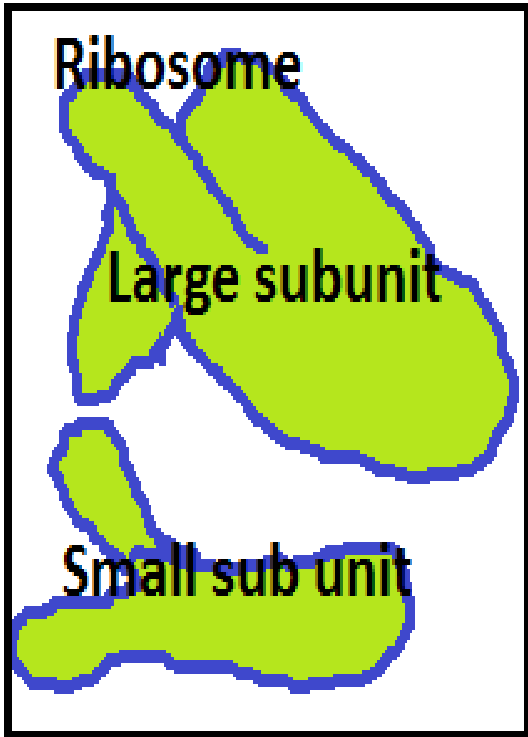


Ultra structure of Animal cell

B. Ribosomes:-

- It was **coined** by **Palade in 1995**.
- It is described as the **Engines of the cell** or **RNA granules** and also **Protein factories**.
- Shape of ribosome is **Spherical** with out membrane and each cell contains thousand of ribosomes **scattered freely** in the **cytoplasm** as well as attached to the **surface of the Endoplasm Reticulum**.
- It contains **60% RNA** and **40% proteins** Core and split proteins)
- Ribosomal proteins are mostly **act as enzymes** and **catalyse** the **protein synthesis**.
- **Each ribosome** is composed of **two subunits** i.e **large subunit bound t RNA molecule** and **small subunit bound mRNA molecule**.
- **The large subunit of ribosome has a value of 60S** and **small subunit of ribosome has a value of 40S**.
- It helps in **Protein synthesis**.

Diagram of Ribosome



Ultra structure of Animal cell

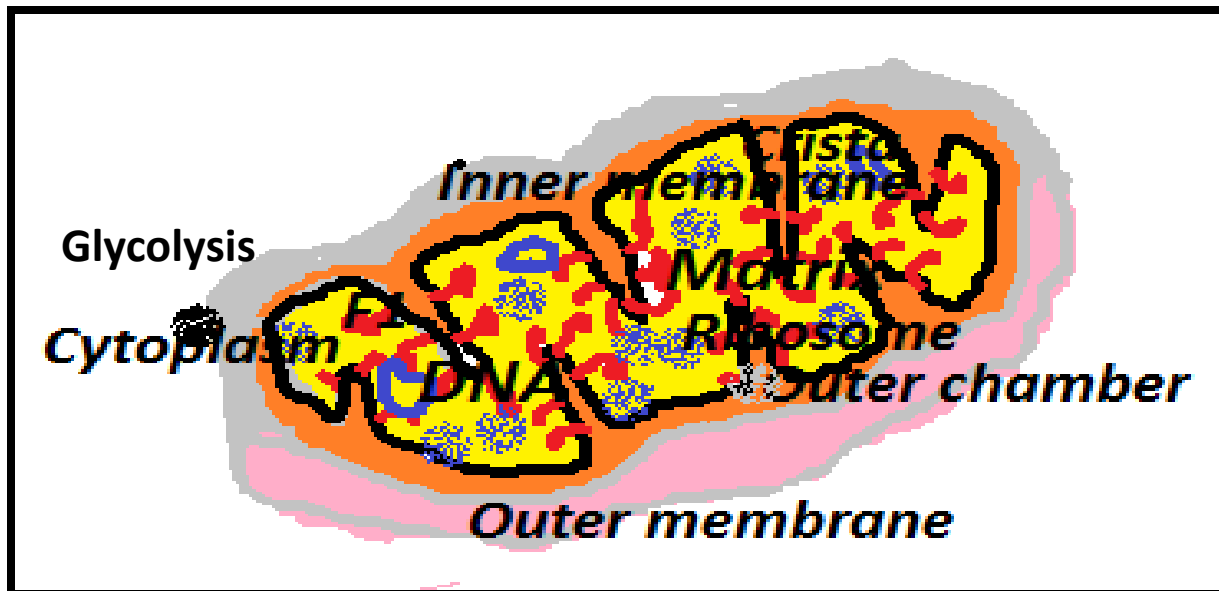
C. Mitochondria :-

- The name of Mitochondria was **coined** by **Benda**. These are **described** as the **Power houses of cell or store houses of cellular energy**.
- It is located in the **cytoplasm** with **rod-shaped** or **oval** or **spherically** shaped.
- Its a size of **0.5 to 10** μm and for example **Yeast** has **small mitochondria** and **oocyte of Amphibia** has **large size of mitochondria**.
- The number of mitochondria found in each cell varies widely depending on the function of the cell it perform, for example, mature **erythrocytes do not have mitochondria** while the **liver and muscle cells** have **thousands of mitochondria**.
- It has **double unit membranes** such as **outer and inner membrane** and contains **Matrix, Cristae, F1 and F0 Particles, Various enzymes, Ions, circular DNA and ribosomes**.
- **Inner Membranes** of mitochondria bend/fold into **matrix and appearance like to finger** known as **cristae**, and **gel-matrix** in the central mass of the mitochondria, to their presence of **Circular DNA, Ribosomes** as well as **enzymes**.
- **Outer and inner membrane** of mitochondria has **electron transport particles**.

Ultra structure of Animal cell

Functions:-

1. It participate in **cellular respiration** and **produces** / generate energy for the cell in form of **ATP** and through oxidative phosphorylation and
2. Mitochondria stores **calcium** which assists in **cell signaling activity**, generating cellular and mechanical **heat** and mediating cellular **growth** and **death**.

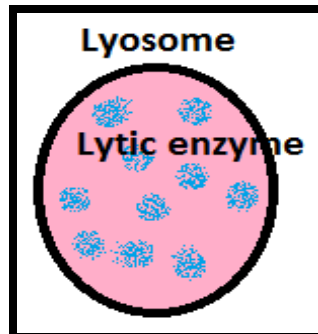


Ultra Structure of Animal Cell

D. Lysosome:-

- **1. It is called *Suicidal bags*.**
- **2. It was *first* described by *Christiande Duve* in *1955*.**
- **3. *Lysosome* is bounded *single layered membrane* and is *spherical or rounded* in shape.**
- **4. It exhibits *Polymorphism* in their morphology. They are *Primary, Secondary, Residual bodies* and *Autophagic vacuoles*.**
- **5. It contains *hydrolytic enzymes***

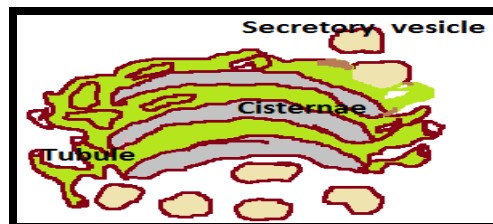
Functions:-1. It helps in extra intra cellular digestion and Autolysis.



Ultra Structure of Animal Cell

E. Golgi apparatus or Golgi complex:-

- *It was first discovered **Camillo Golgi** in **1898**.*
- *It is called **lipocodriosome / Ideosome**.(In plants called **dictiosomes**)*
- *It shapes various from **one cell to another cell**.*
- *It is an unit membrane and has three layers *ie* an inner lipid layer and two protein layers*
- *Golgi appears **three major components** such as **flattened cisternae** , **large vacuoles** and **vesicles**.*
- ***Functions**:-Several functions are attributed to Golgi *ie* **storage, secretion, formation of zymogen granules (Secretary vesicles),Lysosomes , pigmentation and acrosomes**.*



Ultra Structure of Animal Cell

F. *Centrioles*:-

- It is also called as the *cell centre*.
- It was discovered by *Von Benden* in *1887*
- It has located *near nucleus* and *hollow cylindrical* without limiting membrane.
- It has two proteins such as *Tubulin* and *Dyenin*.
- **Functions:-**
 1. It has formed *asters and spindles of microtubules* during late prophase or early metaphase of cell division
 2. The spindle tubules or fibres are *separation of chromosomes* and brings to polar regions in the *later stage of cell division*.

Ultra Structure of Animal cell

G. Microtubules:-

- It consists of **several hollow cylindrical tubules** with a **length of 200-300Å** and **thickness 50-70Å**.
- It is made of a **Tubulin protein** and consists **13 subunits** of microtubules is called **Protofilament**.
- 3. Each Protofilament is **globular in shape** has a **diameter of 50-70Å**.

Functions:-

- It act as the basic units for the **origin of Centrioles, Kinetosomes, Cilia, and Flagella**.
- **The microtubules** are also concerned **with the formation of Asters and spindles fibres** during **cell division**.
- **And also shape to cells and act as channels for intra cellular transport of water and ions**.

H. Kinetosomes:-

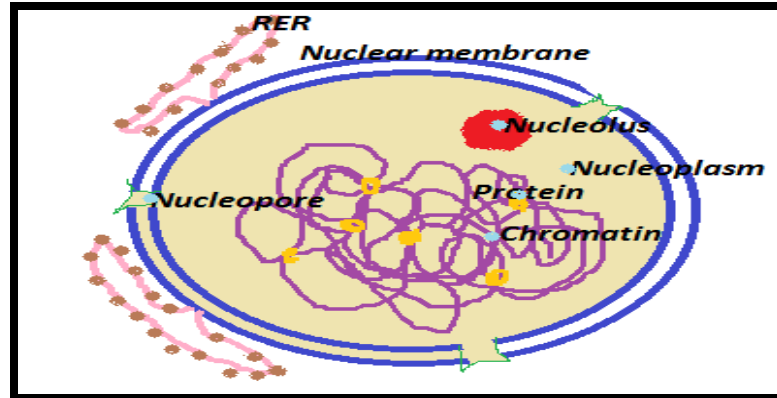
- It is called **basal granules**, are described as **modified Centrioles**.
- Each kinetosome has **nine triplets of hollow microtubules** each of which consists of **3 subunits or sub fibres**.
- The Kinetosomes are described as the **roots of cilia and flagella**.

Ultra structure of Animal Cell

3. Nucleus :-

- **Nucleus** observed by **Robert Brown** in **1831**
- It is described as **the dynamic centre of the cell** and present at the **center of the cell**.
- **Nucleus** comprises of **Nuclear membrane, Nuclear Pore, Nucleoplasm, Chromatin with genetical material as well as proteins and Nucleolus**.
- It occurs **10-15%** of the cell volume, **a spherical** shape, **double-layered made of lipoprotein** surrounded by a **nuclear membrane** separating it from the **cytoplasm**.
- In **between** two layer of nuclear membrane is called **peri nuclear space** of **20–40 nm**
- The **nuclear membrane** of the **nucleus** has about **3000- 4000 nuclear pore** and **size of the pore** about **80 nm in diameter** and **Nuclear pore** is **funnel shaped**
- **Nucleoplasm of nucleus** is a **heterogenous mixture**, to their presence of **histones, non-histones, and ions of calcium, sodium, potassium, many enzymes, Chromatin and Nucleolus**.
- **Chromatin** is appeared network and like to elongated thread (is called **chromosomes**) at the time of cell division.
- **Chromosomes** contain hereditary material (**DNA**) and many **nucleoprotein**

Diagram of Nucleus

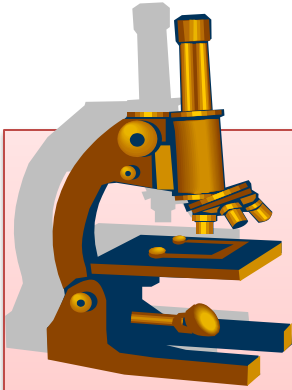


- **Nucleolus** was first discovered **Robert Fontana**.
- **Nucleolus** (Nucleoli) is **tiny or small bodies**, is a prominent structure within the **non-dividing nucleus of the cell**.
- It has **very rich RNA and Protein and origin of ribosomes also**.
- The main **function of nucleolus** is to **produce** and **assemble** subunits which **form the ribosome**.
- **Functions of Nucleus :-**
 - 1. It controls the **hereditary characteristics of an organisms**.
 - 2. Production of ribosomes, stores hereditary material and proteins, responsible for the protein synthesis.

Summary

<i>Name of the cell organelle</i>	<i>Role</i>
<i>Plasma membrane</i>	<i>Stability to the cell and maintain its shape. Diffusion, Osmosis, Endocytosis and exocytosis(Cell vomiting)</i>
<i>Cytoplasm</i>	<i>All organelles present</i>
<i>ER</i>	<i>Detoxification, cytoskeleton, Synthesis and storage of glycogen as well as lipids.</i>
<i>Mitochondria</i>	<i>Cellular Respiration, Produces ATP and do the oxidative phosphorylation.</i>
<i>Ribosome</i>	<i>Protein synthesis</i>
<i>Lysosome</i>	<i>digestion of extra and intra cellular helps lytic enzymes , Autolysis.</i>
<i>Golgi Apparatus</i>	<i>Acrosome of Sperm, formation of primary Lysosomes and secretion.</i>
<i>Nucleus</i>	<i>The master plan for Protein Synthesis, and hereditary characteristics of an organisms.</i>
<i>Nucleolus</i>	<i>produce and assemble of ribosome and Origin of RNA</i>

***References: Telugu Academy English Medium Books,
Vivek and from Google.***



Thank you very much

