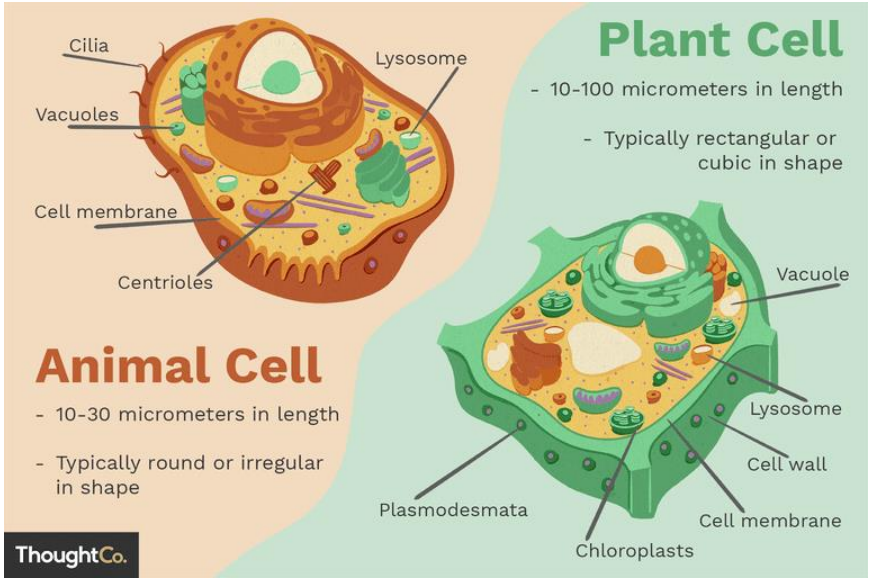


Lecture: Cell Structure and Function

Ref book: Biology for Engineers - Arthur T. Johnson [2nd edition]
Biology for Engineers – G. K. Suraishkumar

Prepared by **Nipa Roy and Hasin Anupama Azhari**
Institute of Natural Sciences
United International **University**

Web ref provided on slides
Images: From google image
Follow: https://byjus.com/biology/cells/

Cell: Overview

- Plant and animal cells
- Cell Structure and Function
- Fluid mosaic model
- Protein factories of the cell
- Nucleated and enucleated cells

Cell in a nutshell is shown here and also here.

Ref: wikipedia

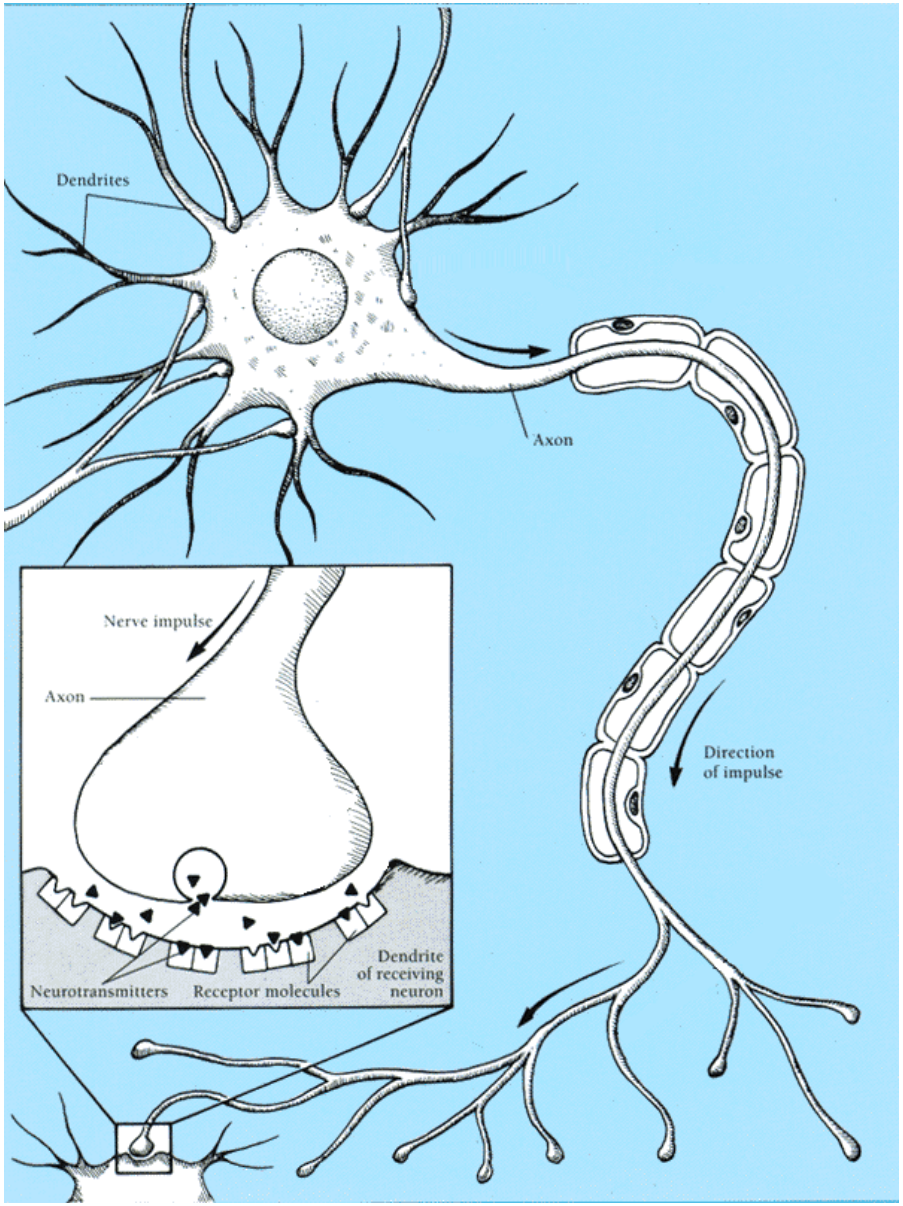
Life is Cellular

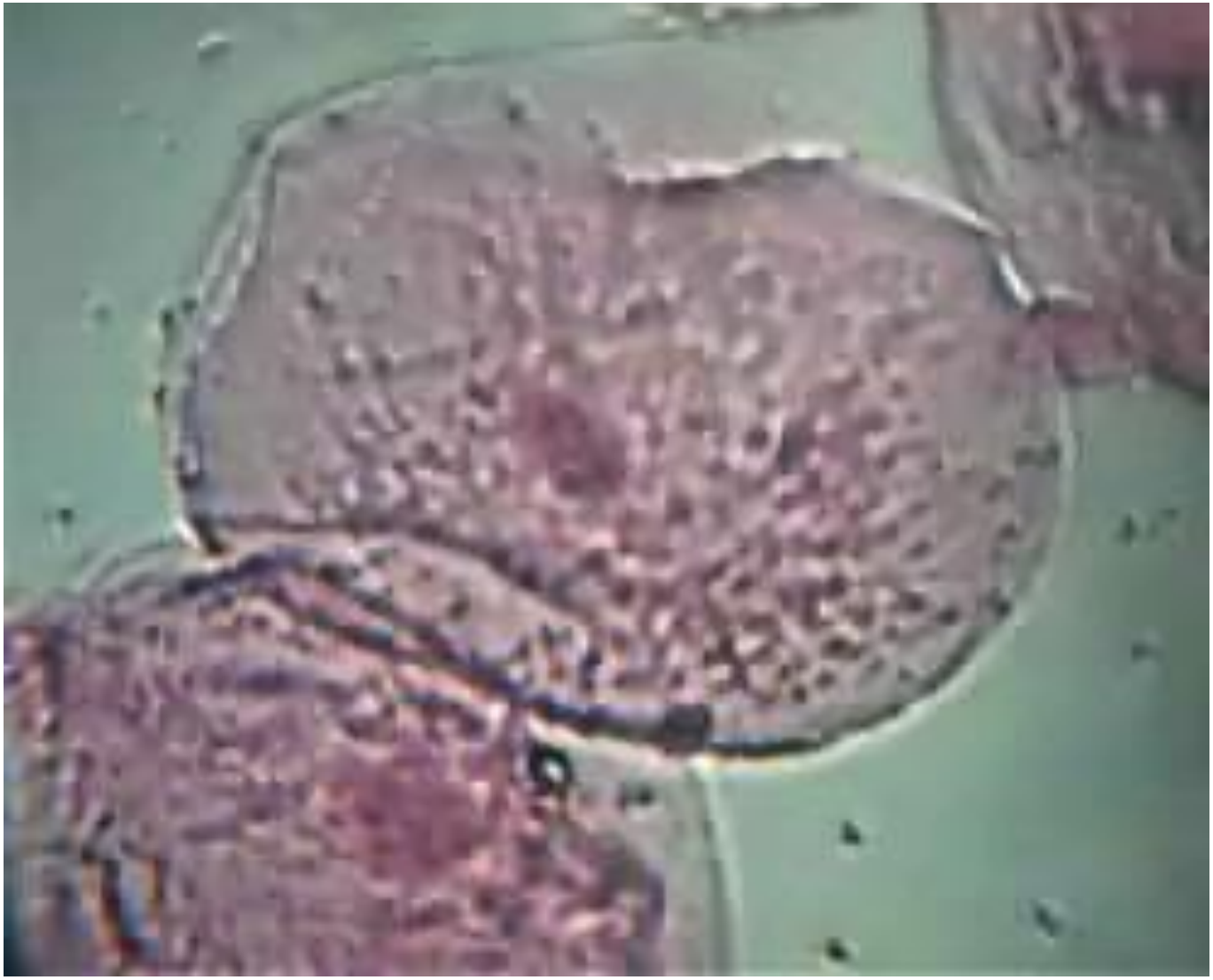
- How did the Cell Theory develop?
  - Cell Theory Guided Reading activity
  - Know the contributions of the following scientists:
    - Robert Hooke (1665)
    - Anton van Leeuwenhoek (1674)
    - Matthias Schleiden (1838)
    - Theodor Schwann (1839)
    - Rudolph Virchow (1855)
    - Janet Plowe (1931)
    - Lynn Margulis (1970)

Cells performing the same function often are similar in shape

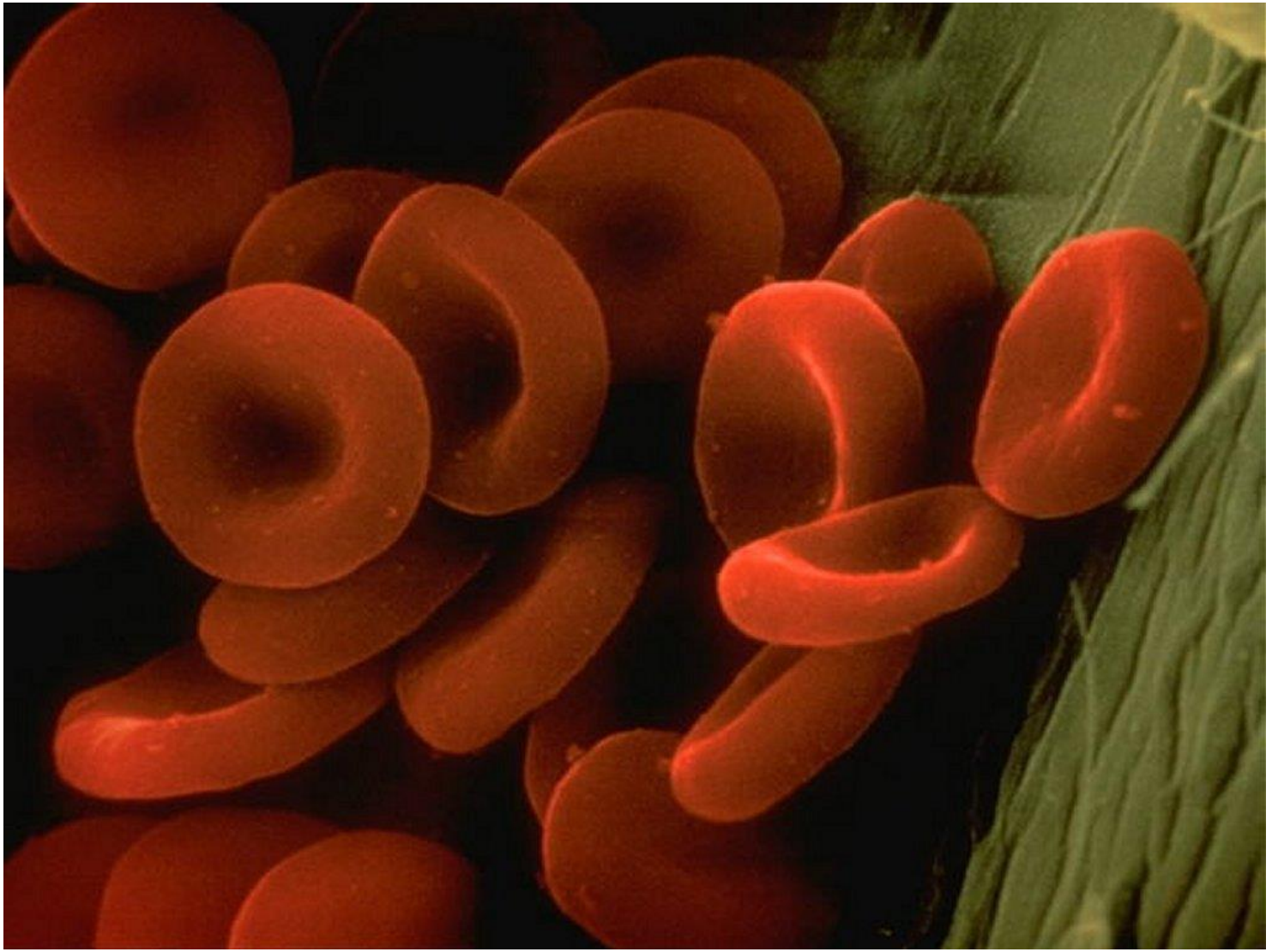
- Question: “How does the cell shape affect it’s function/allow it to function?”
- Choose from one of these cell types:
  - Neuron
  - Red Blood Cell
  - Cheek Epithelial Cell
- Product Ideas:
  - PowerPoint, Poster, graphic organizer, song, interpretive dance, model, acrostic poem, concept map

Neuron


Dendrites
Axon
Nerve impulse
Axon
Direction of impulse
Dendrite of receiving neuron
Neurotransmitters
Receptor molecules

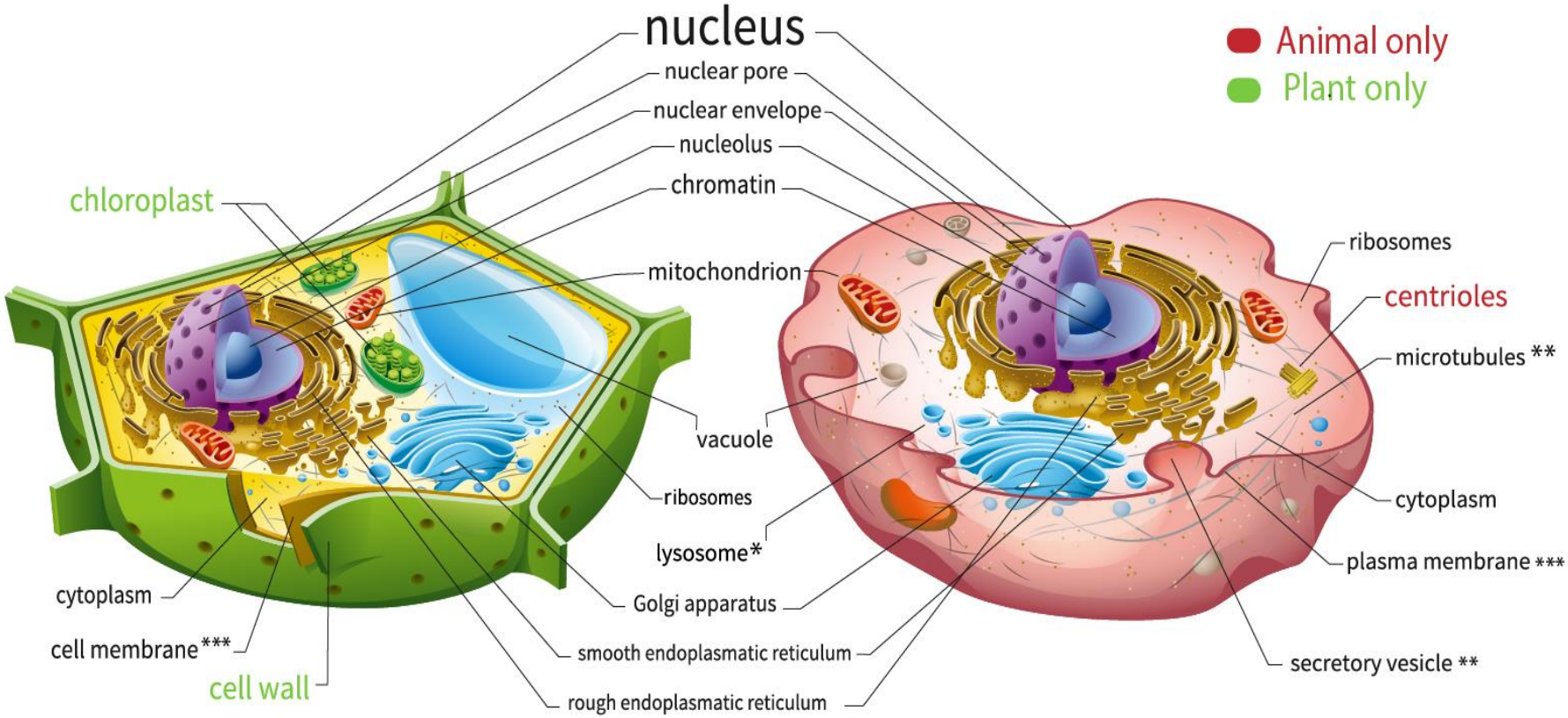


Cheek Epithelial Cell



Red Blood Cell

Cell: Overview



* Plants may have lytic vacuoles, which act like lysosomes in animal cells.

** Although they're not labelled here, plant cells have microtubules and secretory vesicles, too.

*** Cell membrane and plasma membrane are just different names for the same structure.

Ref: google image

Cellular Structure: Importance

- Every living organism falls into one of two groups: eukaryotes or prokaryotes.

- Cellular structure determines which group an organism belongs to.

Cell: Overview

Prokaryotic Cells

- Prokaryotic cells have no nucleus. Instead, some prokaryotes such as bacteria have a region within the cell where the genetic material is freely suspended. This region is called the nucleoid.
- They all are single-celled microorganisms. Examples include archaea, bacteria, and cyanobacteria.
- The cell size ranges from 0.1 to 0.5 µm in diameter.
- The hereditary material can either be DNA or RNA.
- Prokaryotes generally reproduce by binary fission, a form of asexual reproduction. They are also known to use conjugation – which is often seen as the prokaryotic equivalent to sexual reproduction (however, it is NOT sexual reproduction).

Ref: https://byjus.com/biology/cells/

Prokaryotic

*

•**Nucleoid:** A central region of the cell that contains its DNA.
•**Ribosome:** Ribosomes are responsible for protein synthesis.
•**Cell wall:** The cell wall provides structure and protection
•from the outside environment.
Most bacteria have a rigid cell wall made from carbohydrates and
proteins called peptidoglycans.
•**Cell membrane:** Every prokaryote has a cell membrane, also known as the plasma membrane, that separates the cell from the outside environment.
•**Capsule:** Some bacteria have a layer of carbohydrates that surrounds
•the cell wall called the capsule. The capsule helps the bacterium attach to surfaces.
•**Fimbriae:** Fimbriae are thin, hair-like structures that help with cellular attachment.
•**Pili:** Pili are rod-shaped structures involved in multiple roles,
including attachment and DNA transfer.
•**Flagella:** Flagella are thin, tail-like structures that assist in movement.

Examples of prokaryotes

Bacteria and archaea are the two types of prokaryotes.

Do prokaryotes have mitochondria?

No, prokaryotes

Differences: Prokaryotic and Eukaryotic

Prokaryotic Cell	Eukaryotic cell
Unicellular	Multicellular
Lysosomes and Peroxisomes absent	Lysosomes and Peroxisomes present
Microtubules absent	Microtubules present
Endoplasmic reticulum absent	Endoplasmic reticulum present

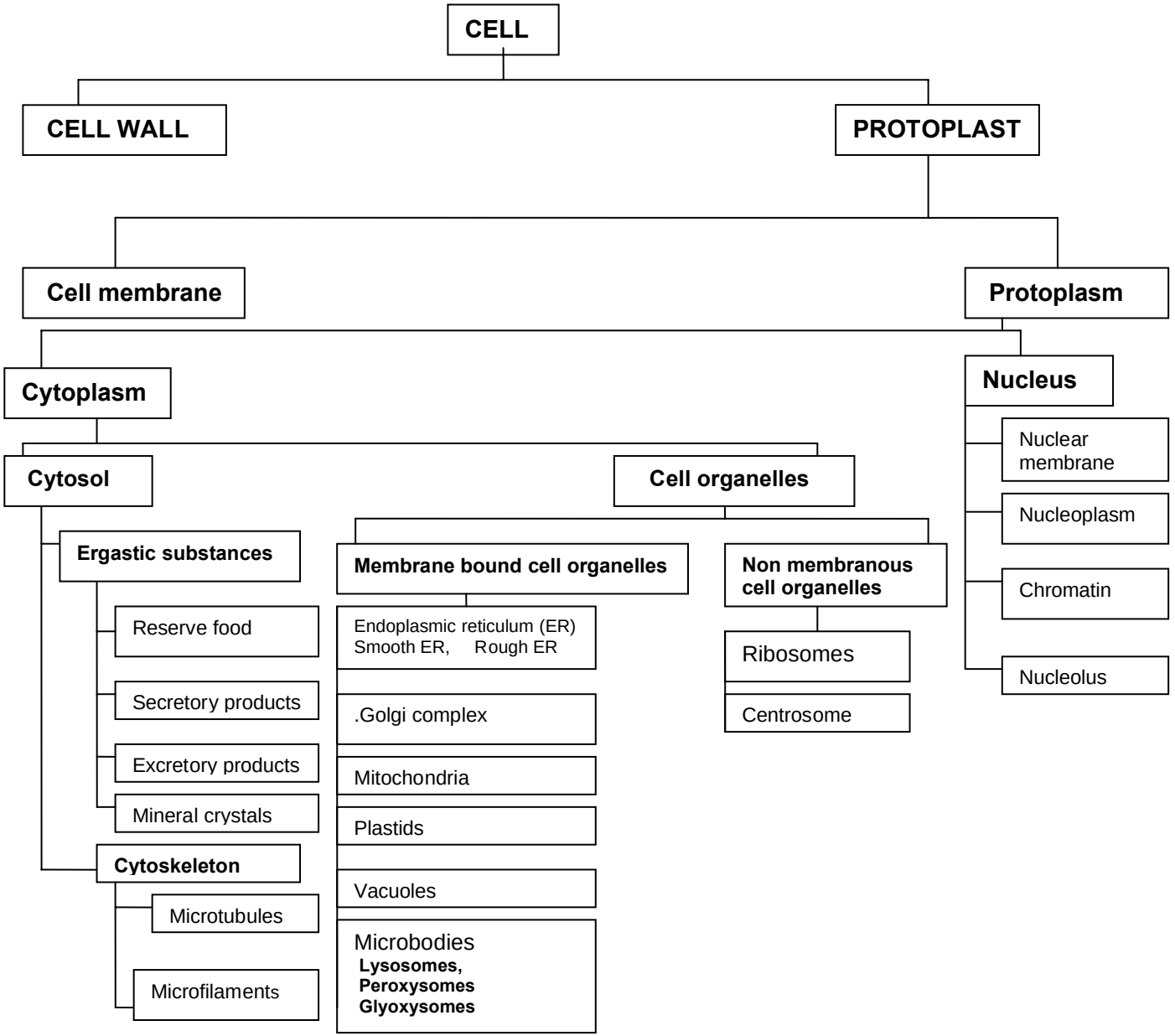
Cell: Overview

Eukaryotic Cells

- Eukaryotic cells are characterised by a true nucleus.
- The size of the cells ranges between 10–100 µm in diameter.
- This broad category involves plants, fungi, protozoans, and animals.
- The plasma membrane is responsible for monitoring the transport of nutrients and electrolytes in and out of the cells. It is also responsible for cell to cell communication.
- They reproduce sexually as well as asexually.
- There are some contrasting features between plant and animal cells. For e.g., the plant cell contains chloroplast, central vacuoles, and other plastids, whereas the animal cells do not.

Ref: https://byjus.com/biology/cells/

Cell: Overview

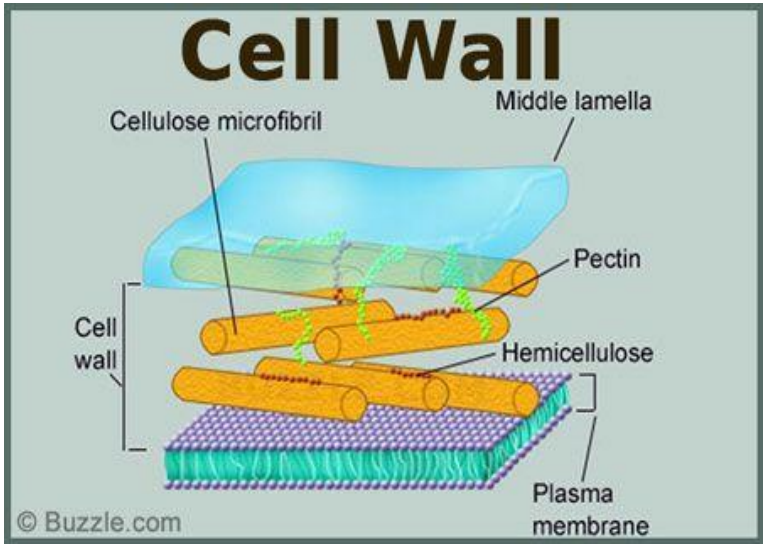


Ref: wikipedia

Cell: Cell Wall and Membrane

1. CELL WALL: It is an outer non living, rigid layer of cell. It is present in bacterial cells, fungal cells and plant cells. It is a permeable membrane chiefly composed of cellulose. It gives rigidity, mechanical support and protection to the cell.

2. PROTOPLAST: It includes cell membrane and protoplasm.

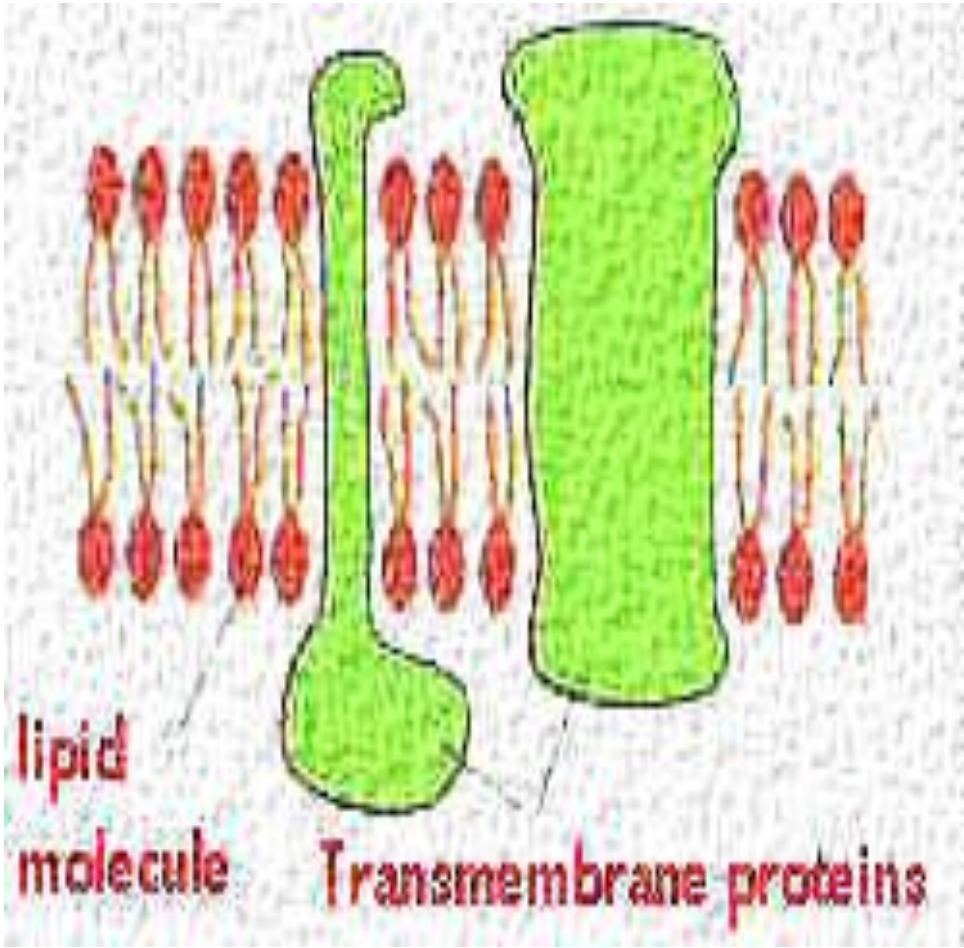


Question: *Do all cells have a cell wall?*
Answer: *Not all cells have cell walls.*
Question: *Which cells, therefore, have a cell wall?*
Answer: *Prokaryotes -except mycoplasma and L-form bacteria- and some eukaryotes have a cell wall.*
Question: *Do animal cells have a cell wall?*
Answer: *Cell walls are not present in animal cells. That's why animal cells are not as rigid as other cells surrounded by cell walls. Animal cells are, therefore, have more flexibility than plant cells.*

Ref: wikipedia

Structure

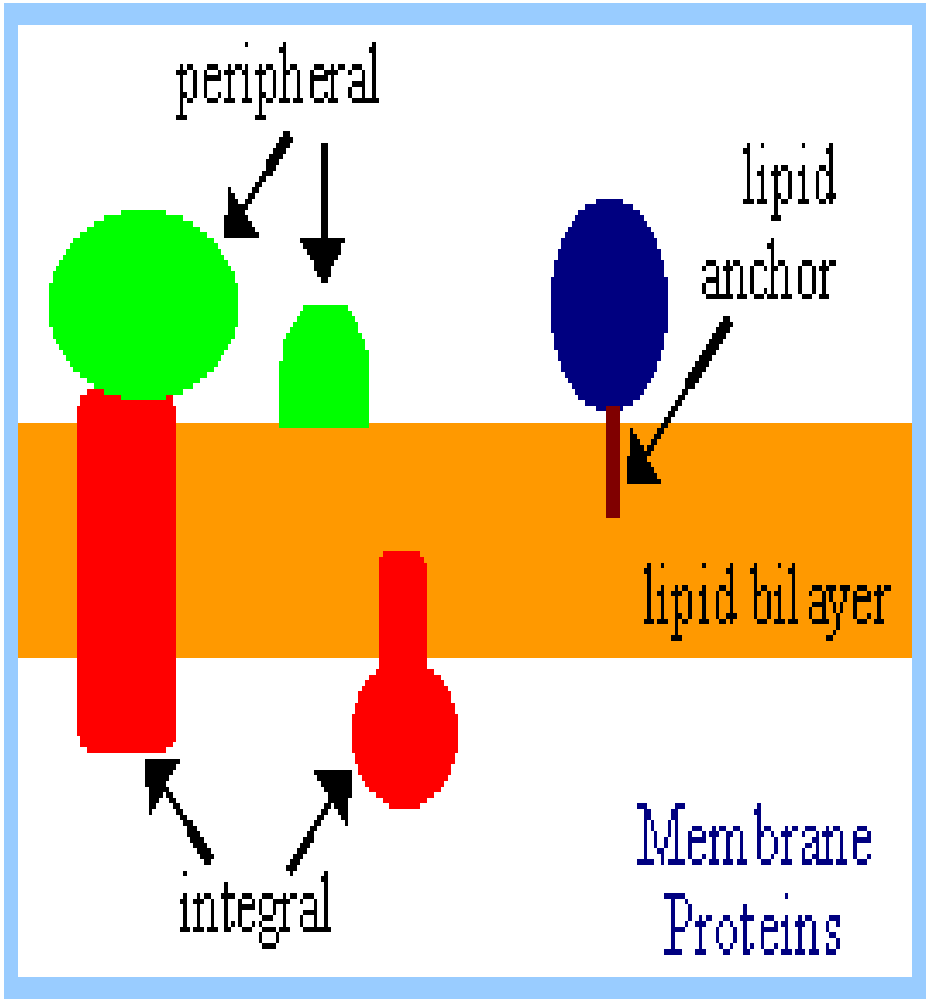
- Lipid bilayer is made of the following:
  - 2 types of proteins:
    - Integral proteins
    - Peripheral proteins
  - 3 types of lipids:
    - Membrane Phospholipids
    - Membrane glycolipids
    - Cholesterol



https://www.sparknotes.com/biology/cellstructure/cellmembranes/problems/

Integral proteins

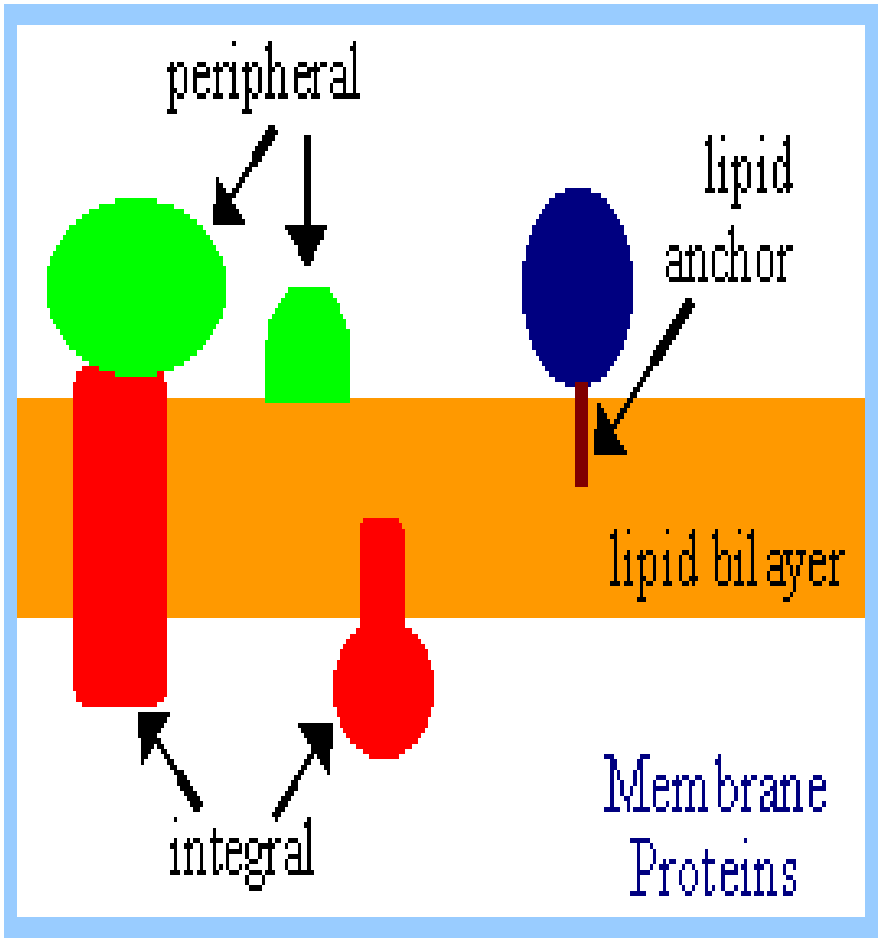
- Transmembrane proteins (or integral proteins)
  - Amphipathic = hydrophobic and hydrophilic regions



There are peripheral and integral proteins present in the cell membrane. They are **involved in the cell signaling pathway, defence mechanisms, facilitated diffusion and active transport**. They also act as receptors, enzymes, cytoskeletal proteins, e

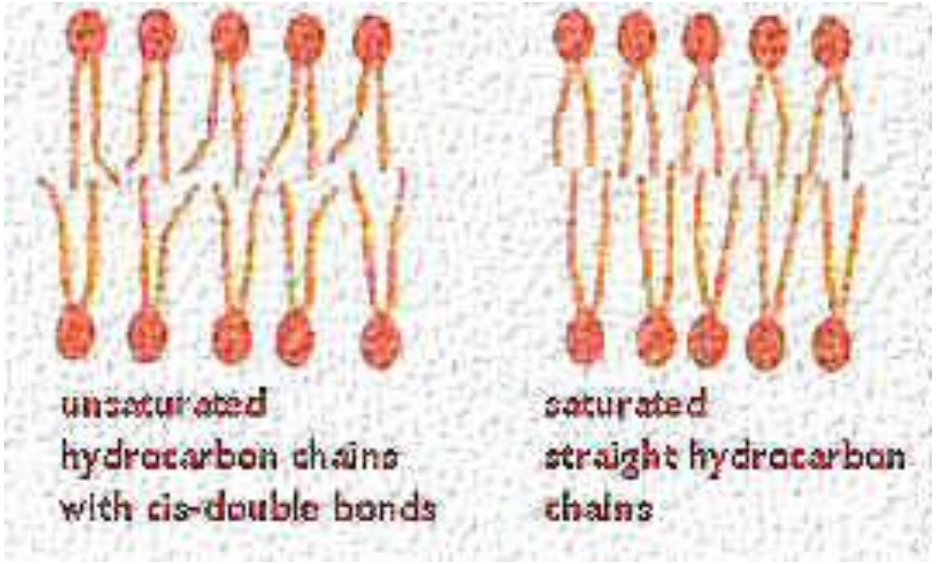
Peripheral proteins

- Peripheral proteins
  - linked at the cytoplasmic surface (by attachment to a fatty acid chain)
  - linked at the external cell surface (attached by an oligosaccharide)
  - may be bound to other membrane proteins

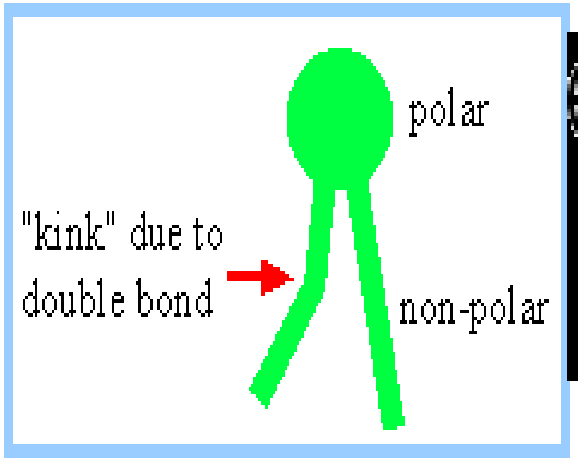


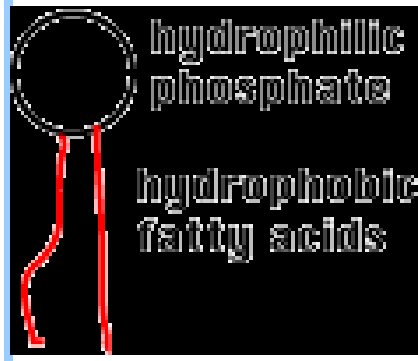
Membrane Phospholipids

- These have a polar head group and two hydrocarbon tails
- It is connected by glycerol to two fatty acid tails
- One of the tails is a straight chain fatty acid (saturated). The other has a kink in the tail (unsaturated).

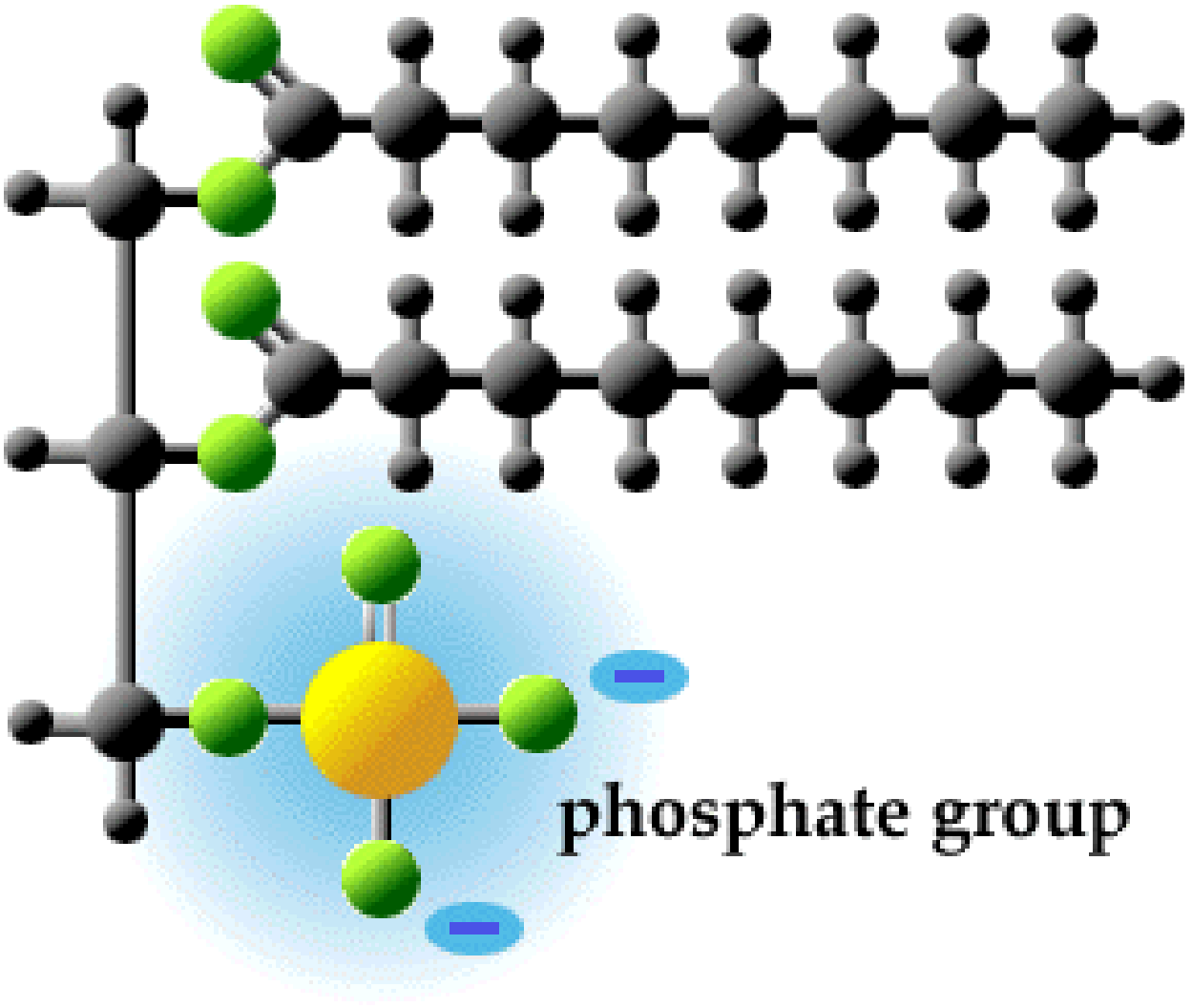


The heads (the phospho part) are polar while the tails (the lipid part) are non-polar. The heads, which form the outer and inner linings, are "hydrophilic" (water loving) while the tails that face the interior of the cell membrane are "hydrophobic" (water fearing).



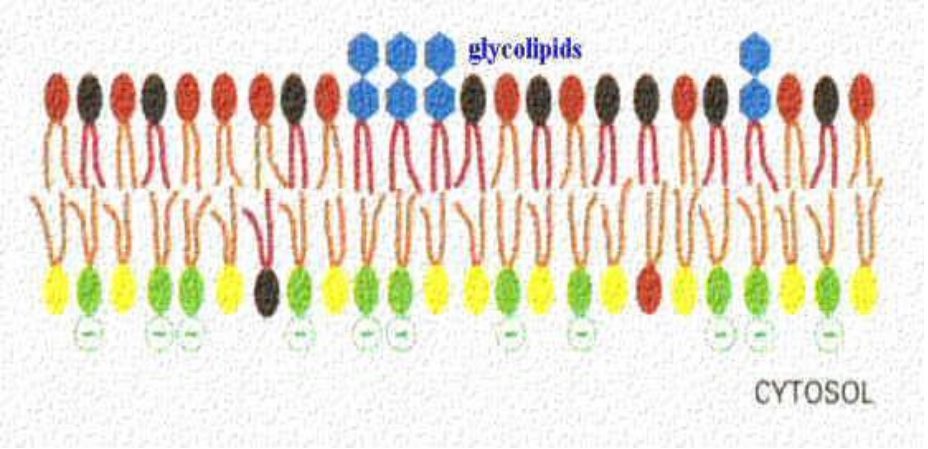


Phospholipid



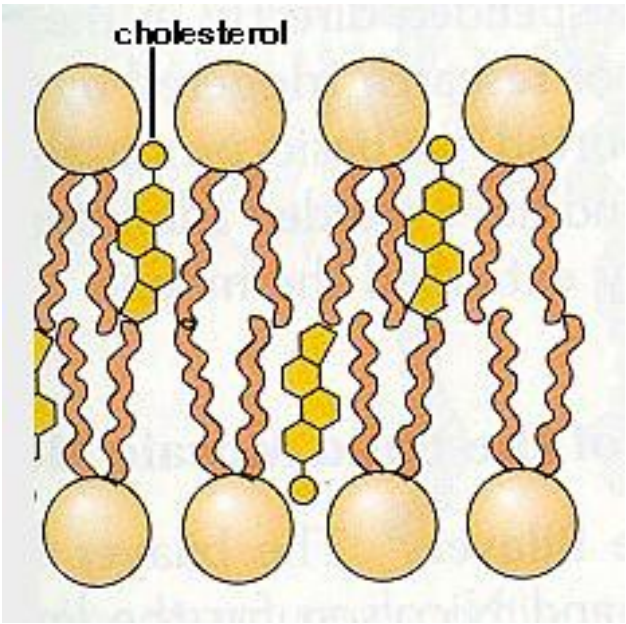
Membrane glycolipids

- Glycolipids are also a constituent of membranes.
- These components of the membrane may be protective, insulators, and sites of receptor binding.



Cholesterol

- The amount of cholesterol may vary with the type of membrane.
- Plasma membranes have nearly one cholesterol per phospholipid molecule.
- Other membranes (like those around bacteria) have no cholesterol

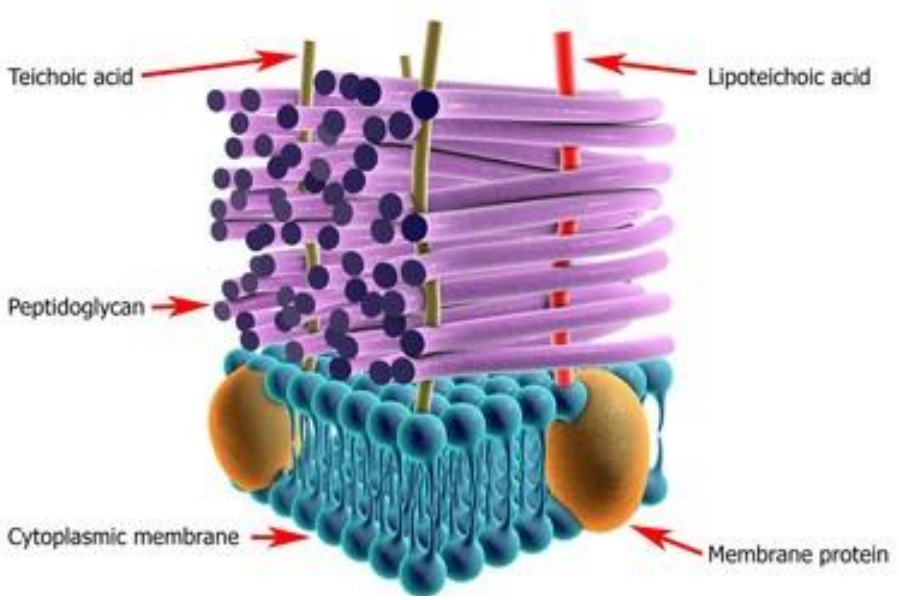


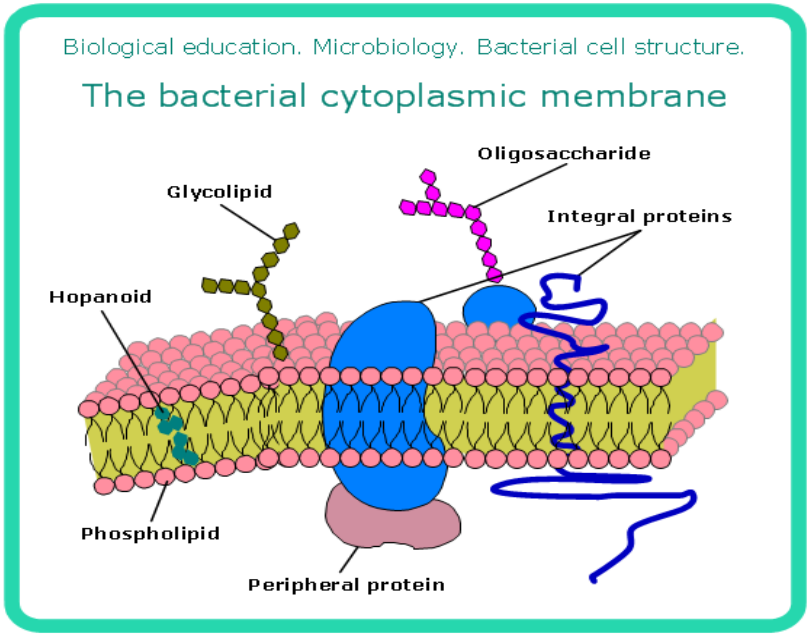
Cholesterol (continued)

- Function:
  - This makes the lipid bilayer less deformable
  - Without cholesterol (such as in a bacterium) a cell would need a cell wall.
  - Also keeps the cell membrane from becoming too stiff.

Cell: Cell Wall and Membrane

- **i) CELL MEMBRANE OR PLASMA MEMBRANE:** It is a semi permeable membrane present in all cells. It is present below the cell wall in plant cell and outermost membrane in animal cell. It is composed of phospholipids, proteins, carbohydrates and cholesterol.
- **Functions:** It allows the outward and inward movement of molecules across it. The movement of molecules across the plasma membrane takes place by diffusion, osmosis, active transport, phagocytosis (cell eating) and pinocytosis (cell drinking).

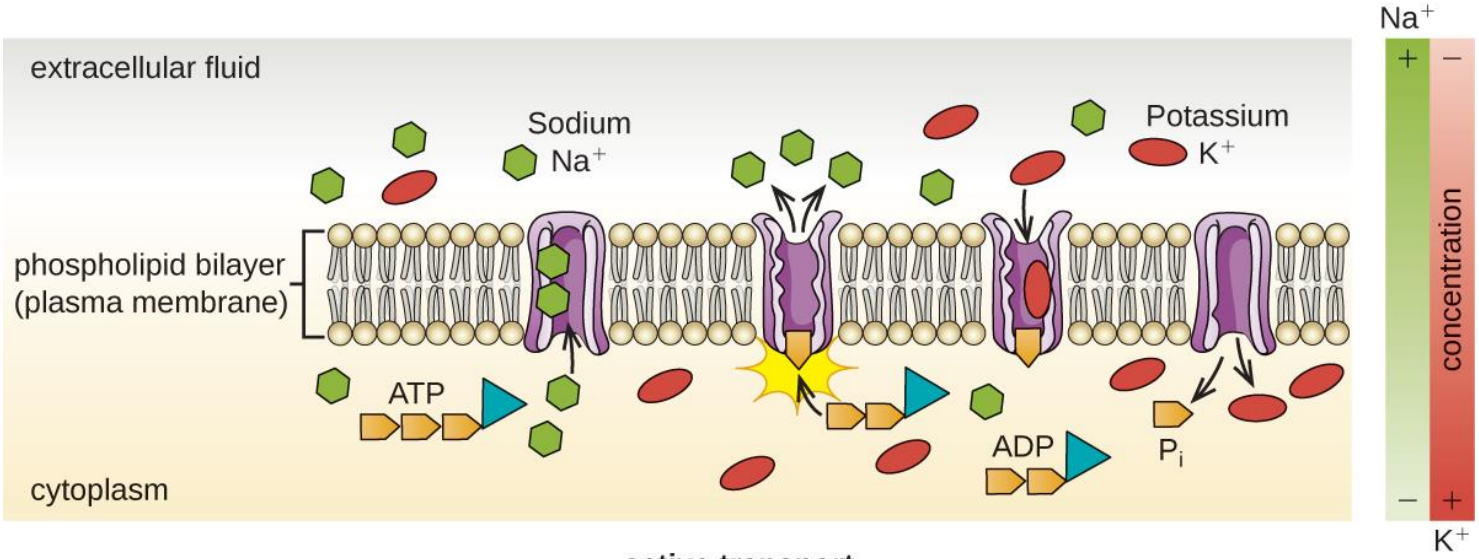




Ref: wikipedia

Cell: Cell Wall and Membrane

- **FLUID MOSAIC MODEL OF PLASMA MEMBRANE**
- **S.J.Singer and G. Nicolson (1974)**
- proposed Fluid Mosaic model to describe the structure of plasma membrane.



active transport

Ref: wikipedia

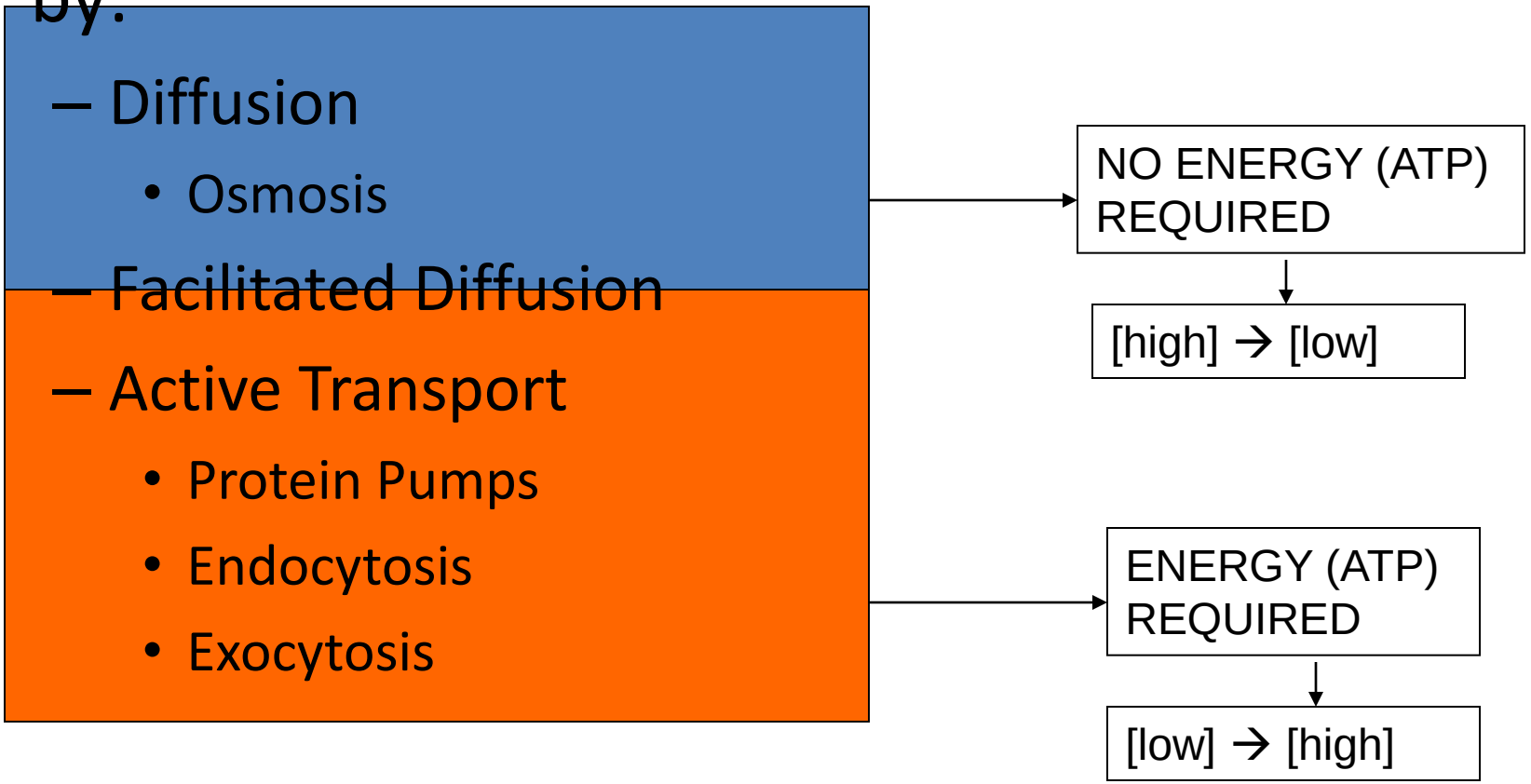
Cell: Cell Wall and Membrane

Cell wall	Cell membrane
The outermost layer, next to the cell membrane	A bilipid layer surrounding the cell contents, such as cytosoland organelles
Typically, 0.1 µm to several µm in thickness; but varies depending on the composition, i.e. if a new (secondary) cell wall is deposited by the old (primary) cell wall	Typically, 7.5–10 nm in thickness
Components vary depending on the species	Made up of lipid bilayer, with carbohydrates and lipoproteins
Confers rigidity, giving the cell a more definite shape	With only a cell membrane (lacking in cell wall), the cell is more flexible and can change shape as needed
Confers protection, e.g. against the impact of osmotic pressure; more permeable to small molecules	Confers protection, e.g. by being selective, regulating the passage of substances, and so, not all can readily enter the cell even if they are small, due to its semi-permeability; protection against osmotic pressure only up to a certain point
Lacks cell surface receptors	Have cell surface receptors
Present in plants, fungi, protists (e.g. algae and molds), and bacteria	Present in all cells

Ref: https://www.biologyonline.com/dictionary/cell-wall

Movement Through the Membrane

- Materials can move through the membrane by:
  - Diffusion
    - Osmosis
  - Facilitated Diffusion
  - Active Transport
    - Protein Pumps
    - Endocytosis
    - Exocytosis



Diffusion

- Requires no energy (ATP)
- Moves from an area of High concentration → low concentration until dynamic equilibrium is reached.
- Dynamic equilibrium activity
- http://www.stolaf.edu/people/giannini/flashanimat/transport/diffusion.swf

Osmosis

- A type of diffusion (no energy needed)
- Allows water molecules to pass easily through the selectively permeable membrane.
- Solution = solute + solvent
  - Solute = sugar (or another dissolved substance)…CANNOT go through the membrane
  - Solvent = water…CAN go through the membrane

Osmosis

- ONLY water moves
- The solute stays put on one side or the other
- Water moves back and forth according to the concentration of water on each side of the membrane
- http://www.stolaf.edu/people/giannini/flashanimat/transport/osmosis.swf

Osmotic Pressure

- Isotonic solutions
  - The 2 solutions have equal concentrations of solute and solvent.
- Hypotonic solutions
  - One solution has less solute and more water compared to the other solution.
- Hypertonic solutions
  - One solution has more solute and less water compared to the other solution.

What would happen?

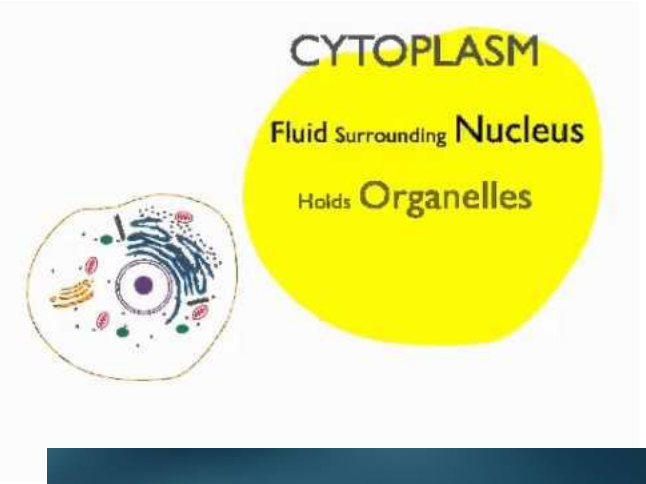
- What would happen if…
  - You placed a selectively permeable membrane "bag" with a hypotonic solution into a beaker with a hypertonic solution?
    - Which way would the water flow?
    - What would happen to the bag?
    - What would happen to the beaker?
    - How do you know?
    - How could you test this?

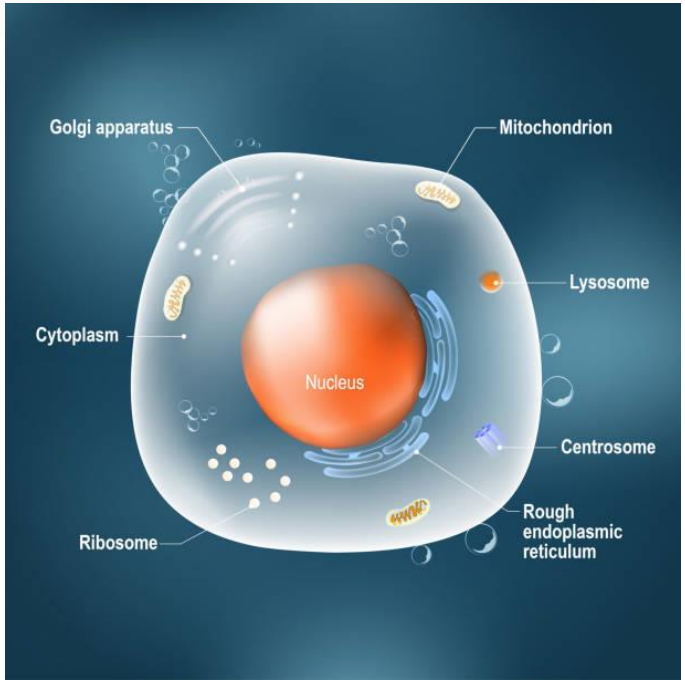
Facilitated Diffusion

- Diffusion with the help of **transport** proteins
- No energy required
- http://www.stolaf.edu/people/giannini/flashanimat/transport/channel.swf

Cell: Protoplasm

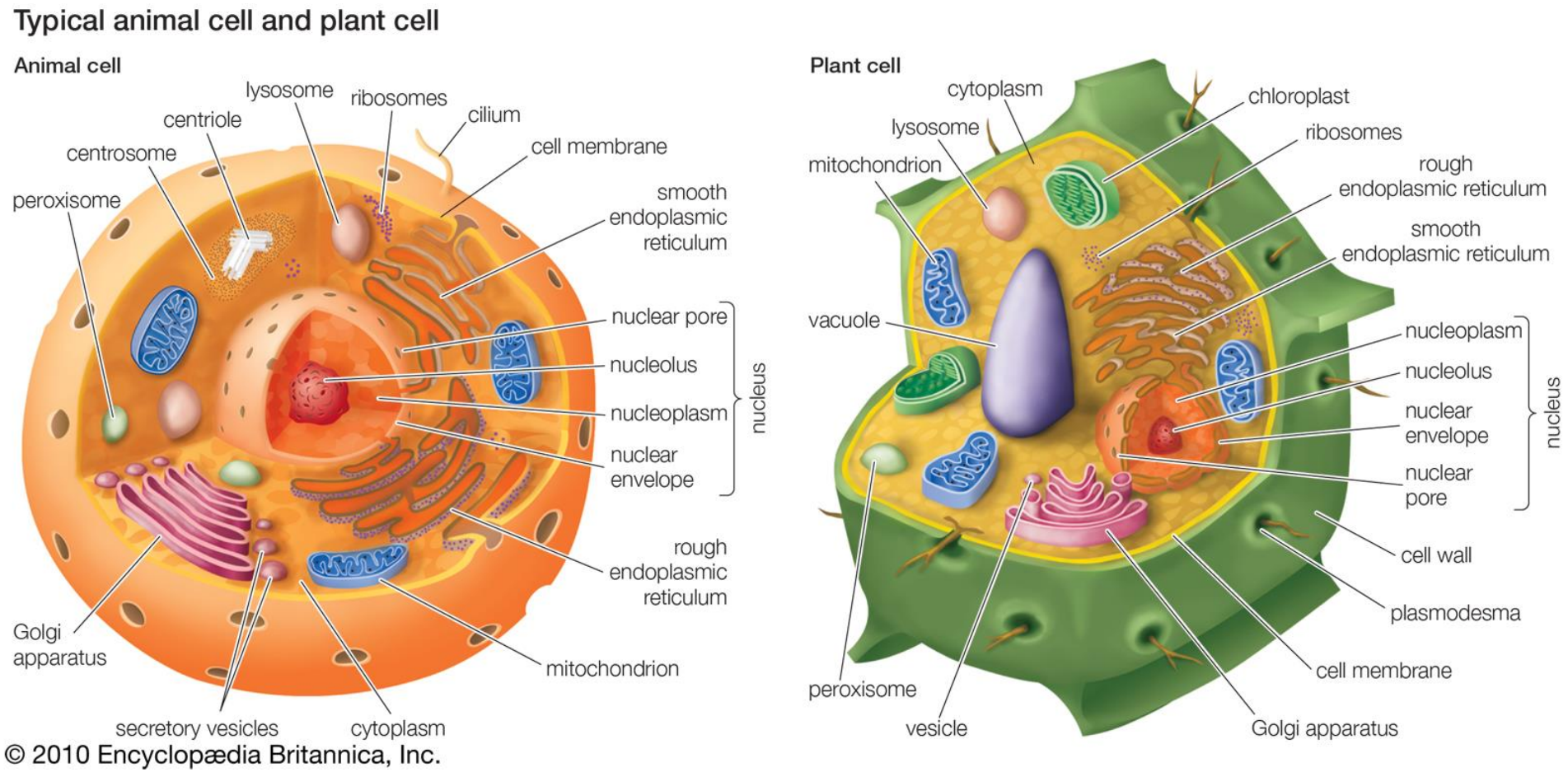
- **ii) PROTOPLASM:** It is a living substance of the cell that possesses all vital products made up of inorganic and organic molecules. It includes cytoplasm and nucleus. **Purkinje** (1837) coined the term protoplasm. **Huxley** called protoplasm as **"physical basis of life"**
- **CYTOPLASM:** It is the jellylike, semi fluid matrix present between the cell membrane and nuclear membrane. It has various living cell inclusions called **cell organelles** and non living cell inclusions called **ergastic substances and cytoskeletal elements**. The cytoplasm without cell organelles is called **cytosol**.





Ref: wikipedia

Cell: Protoplasm



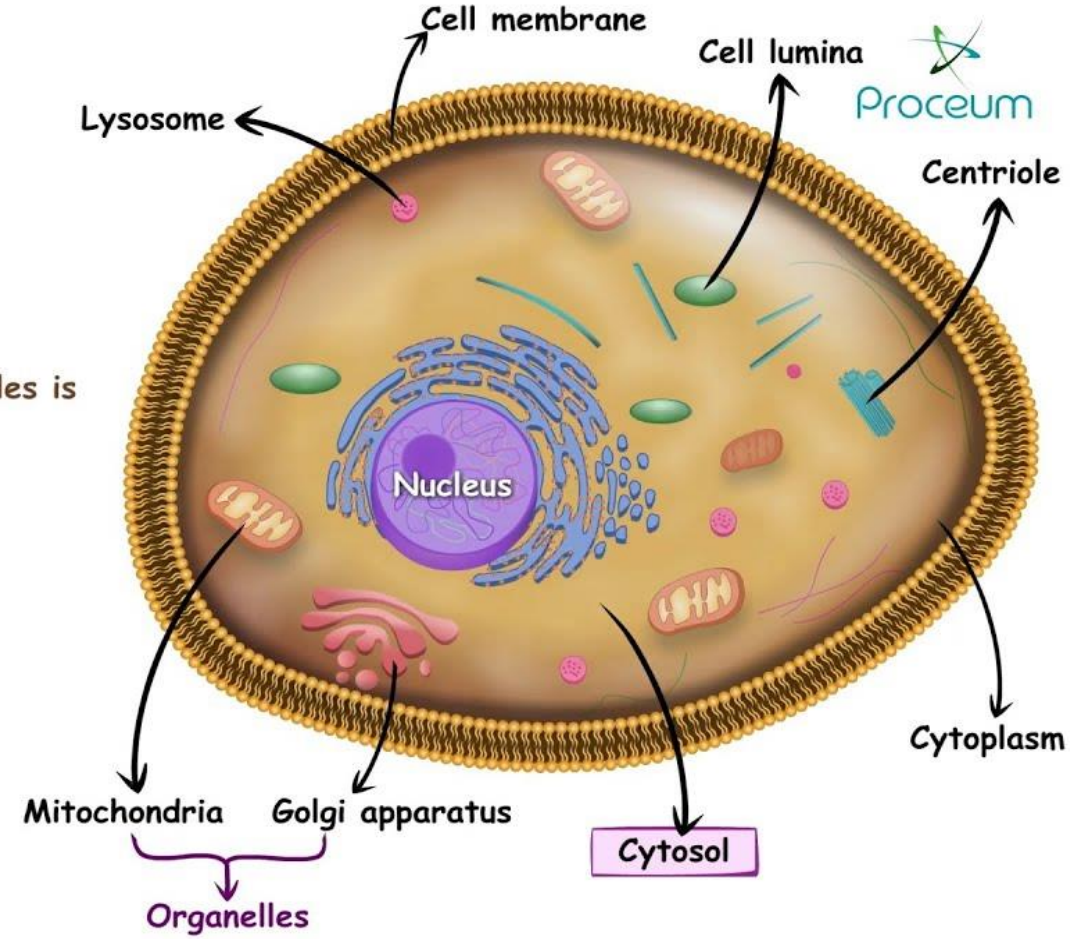
Ref: wikipedia

Cell: Cytoplasm

Cytoplasm

- Intracellular material
- Present inside cell
- Enclosed by cell membrane
- Except nucleus Q
  - Fluid present in between the organelles is called cytosol Q

Cytoplasm = Intracellular material
(Organelles + Cytosol) – Nucleus



Ref: wikipedia

Cell: ER

A. MEMBRANE BOUND CELL ORGANELLES PRESENT IN CYTOPLASM

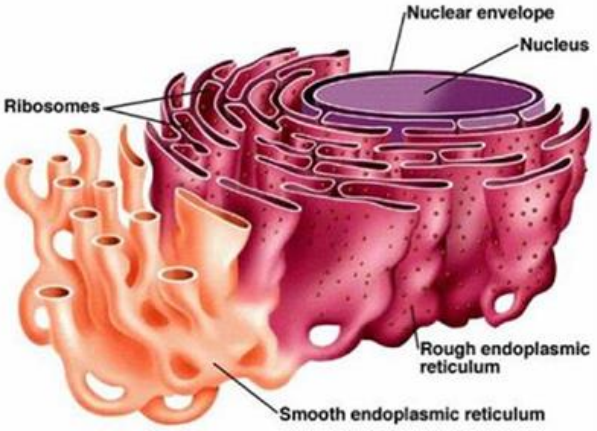
1. ENDOPLASMIC RETICULUM (ER):

Discovery: Porter (1945)

Endoplasmic Reticulum - Structure and Function

Structure

1. It is an irregular network of double membranes tube-like structure distributed over the entire cytoplasm in a cell.
2. It is continuous with the cell or plasma membrane on the outside and nuclear membrane of the inside.
3. At its outer end, endoplasmic reticulum (ER) connects itself with the cell membrane.
4. At the inner end, it is connected with the nuclear membrane.
5. It is of two types – rough and smooth endoplasmic reticulum. It appears rough when the particles-like ribosomes are attached to it and appear smooth without them.



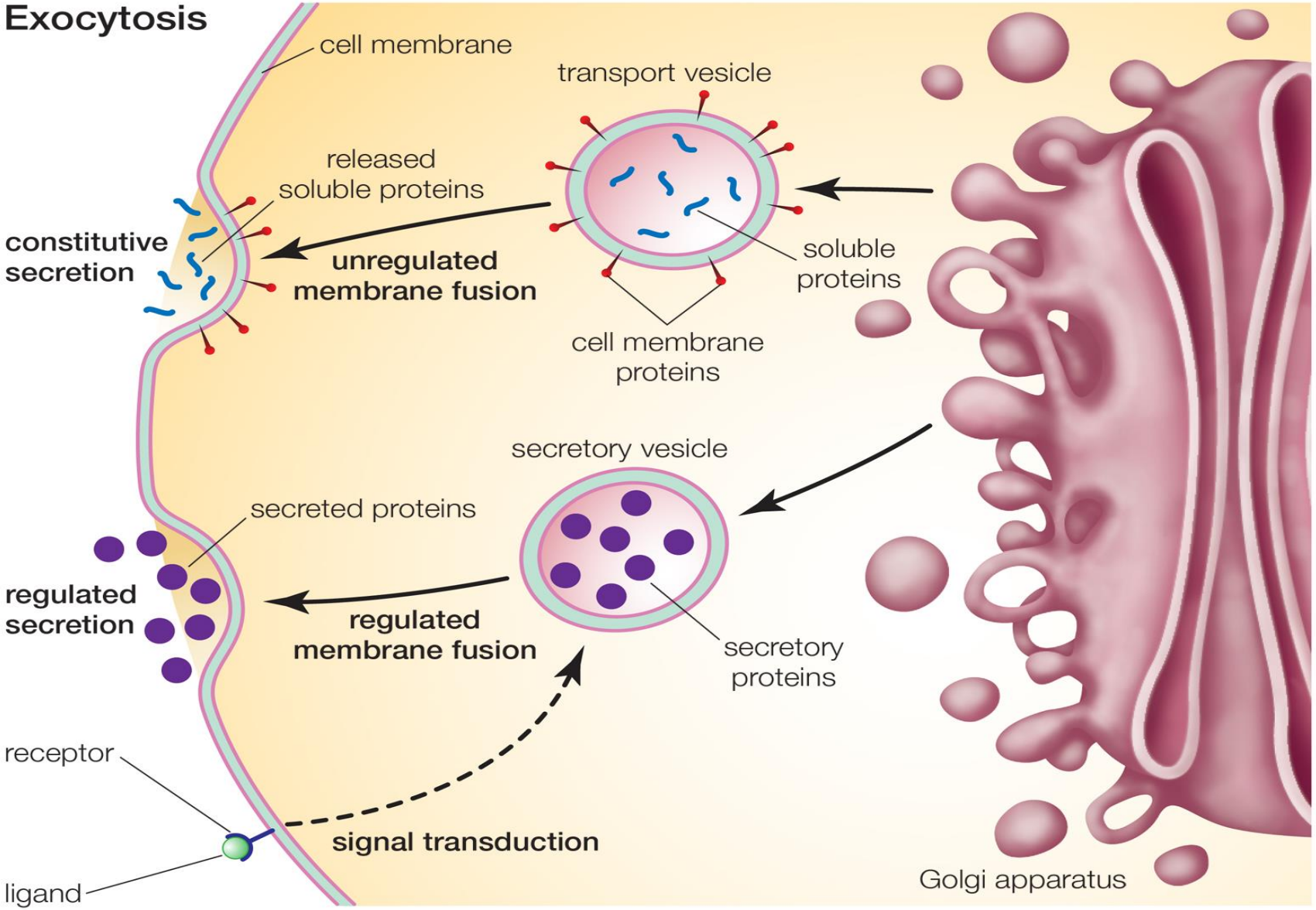
Function

1. Its main function is to form the supporting framework of the cell.
2. It also serves as a pathway for the distribution of the material (protein and fats) from one part of the cell to the other.
3. Due to the presence of ribosome - proteins and lipids are synthesized on the rough endoplasmic reticulum, which helps in regenerating cell membranes. This process is known as membrane biogenesis. ('Biogenesis' mean 'generation of a substance by living matter').

Ref: wikipedia

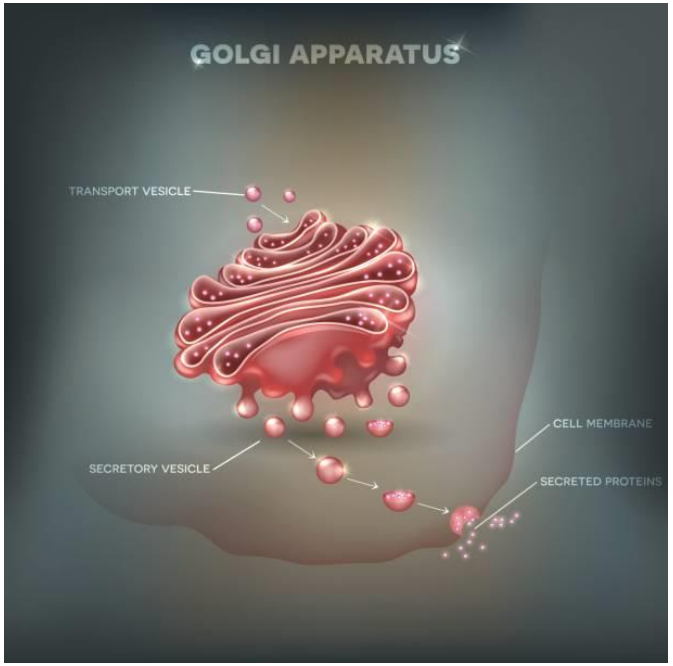
Cell: Golgi Bodies

- **2. GOLGI BODIES / GOLGI COMPLEX / GOLGI APPARATUS / DICTYOSOMES**



Cell: Golgi Bodies

2. GOLGI BODIES / GOLGI COMPLEX / GOLGI APPARATUS / DICTYOSOMES



Discovery: Camillo Golgi (1898)
Golgi complex has a group of curved, flattened plate like compartments called **cisternae**. They stacked one above the other like pancakes. The cisternae produce a network of **tubules** from the periphery. These tubules end in spherical enzyme filled **vesicles.**

Common name: "Packaging centres" of the cell

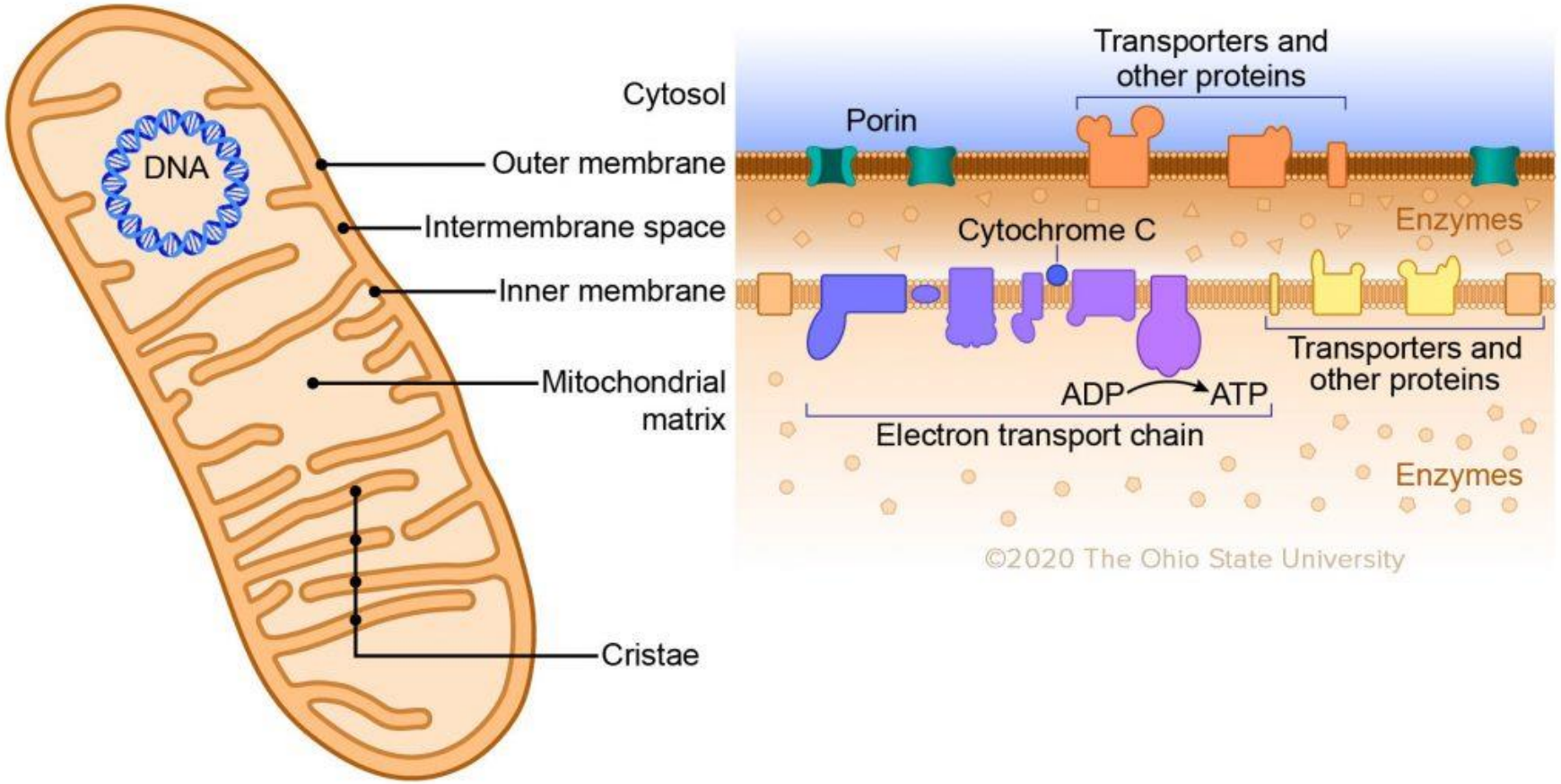
Functions:

- They pack enzymes, proteins, carbohydrates etc. in their vesicles, hence called packaging centres
- They produce Lysosomes
- They secrete various enzymes, hormones and cell wall material

Ref: wikipedia

Cell: Mitochondria

- **3. MITOCHONDRIA / CHONDRIOSOME**
- **Discovery – Kolliker** (1880)- discovered in the muscle cells of insects, **Altman** called them as **Bioplasts, Benda** (1897) coined the term **Mitochondria**

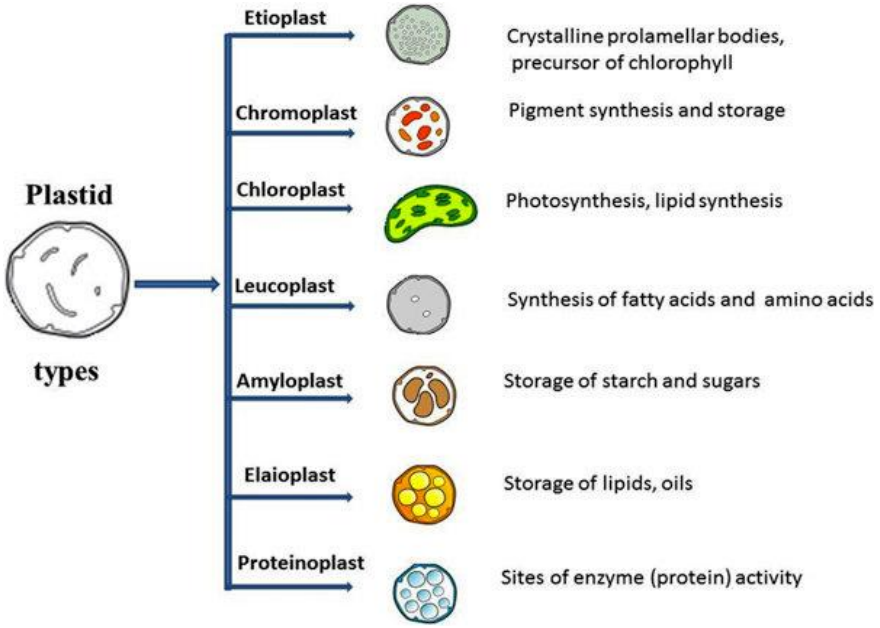


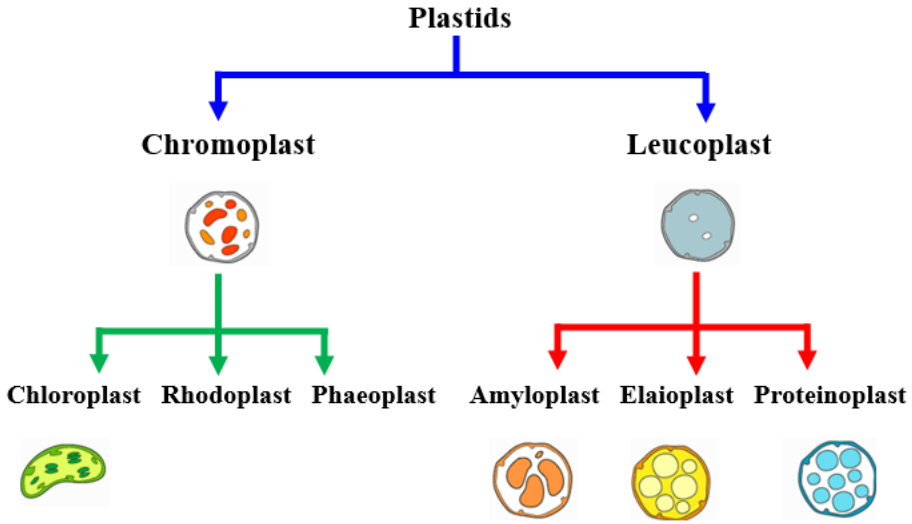
Common name: Power houses of the cell / Storage batteries of the cell

Functions:

- Mitochondria synthesise and store the energy rich molecules ATP (Adenosine triphosphate) during aerobic respiration. So, they are called "**Power houses of the cell**".

Cell: Plastids





- Structure:
  - Inner/Outer Membrane
  - Stroma
  - Grana
  - Thylakoids
- Functions:
  - Concentration gradient
  - Pigments for Photosynthesis embedded in the membranes
  - Make sugars!

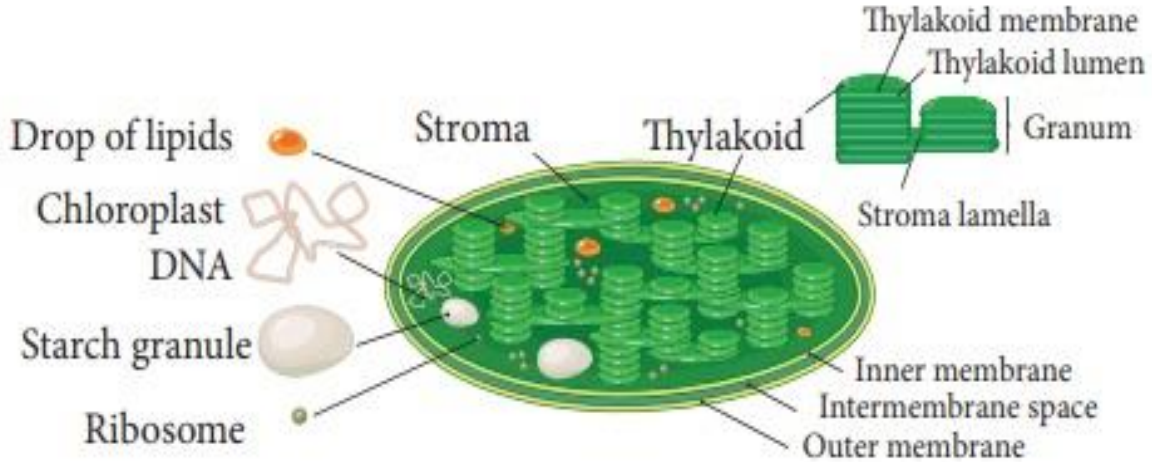


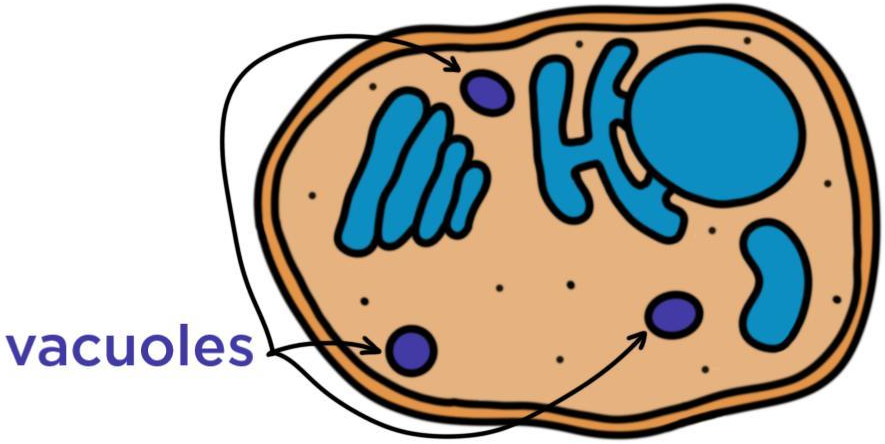
Figure 12.8 Ultrastructure of Chloroplast

Ref: google image

Cell: Vacuoles

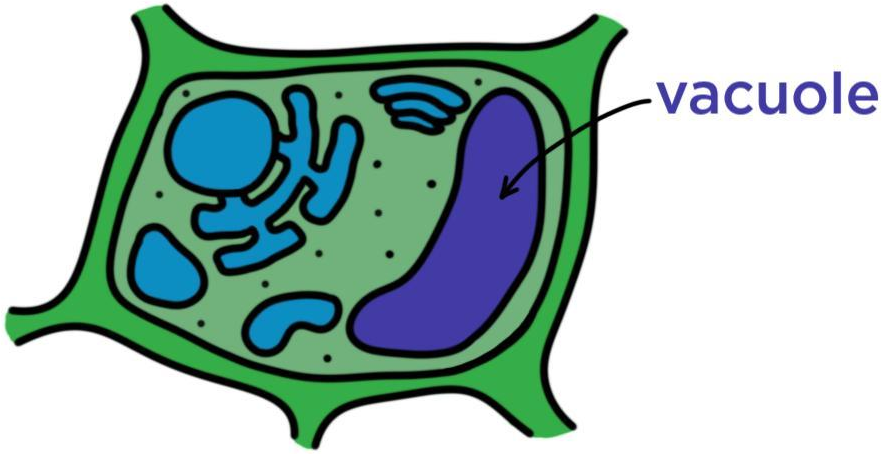
ORGANELLES: VACUOLE

ANIMAL CELL



- several small vacuoles
- used for storage
- can contain nutrients, water, or waste

PLANT CELL



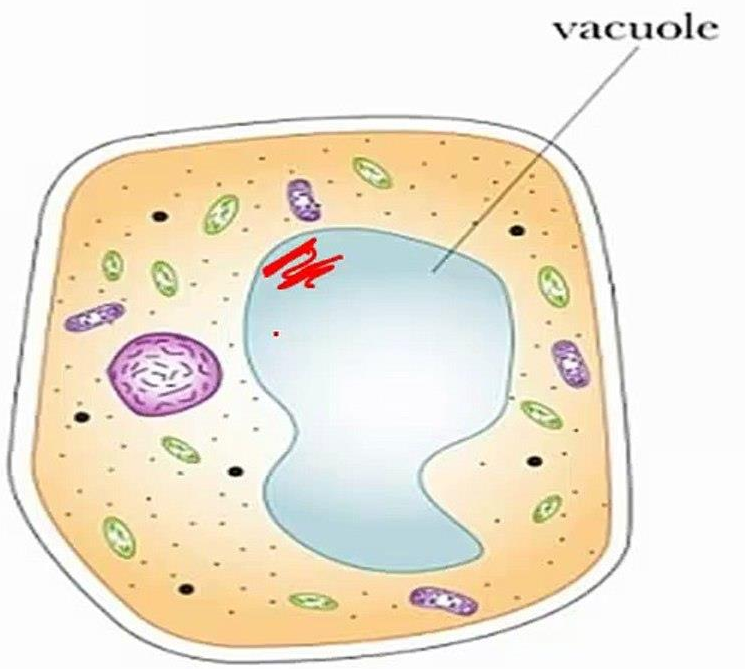
- one large vacuole
- used to store water and push against the cell wall
- keeps the plant rigid

Ref: google image

Cell: Vacuoles

Function of Vacuoles

- The vacuole is the storage structure in a cell.
- It can hold food for later use or waste for removal.



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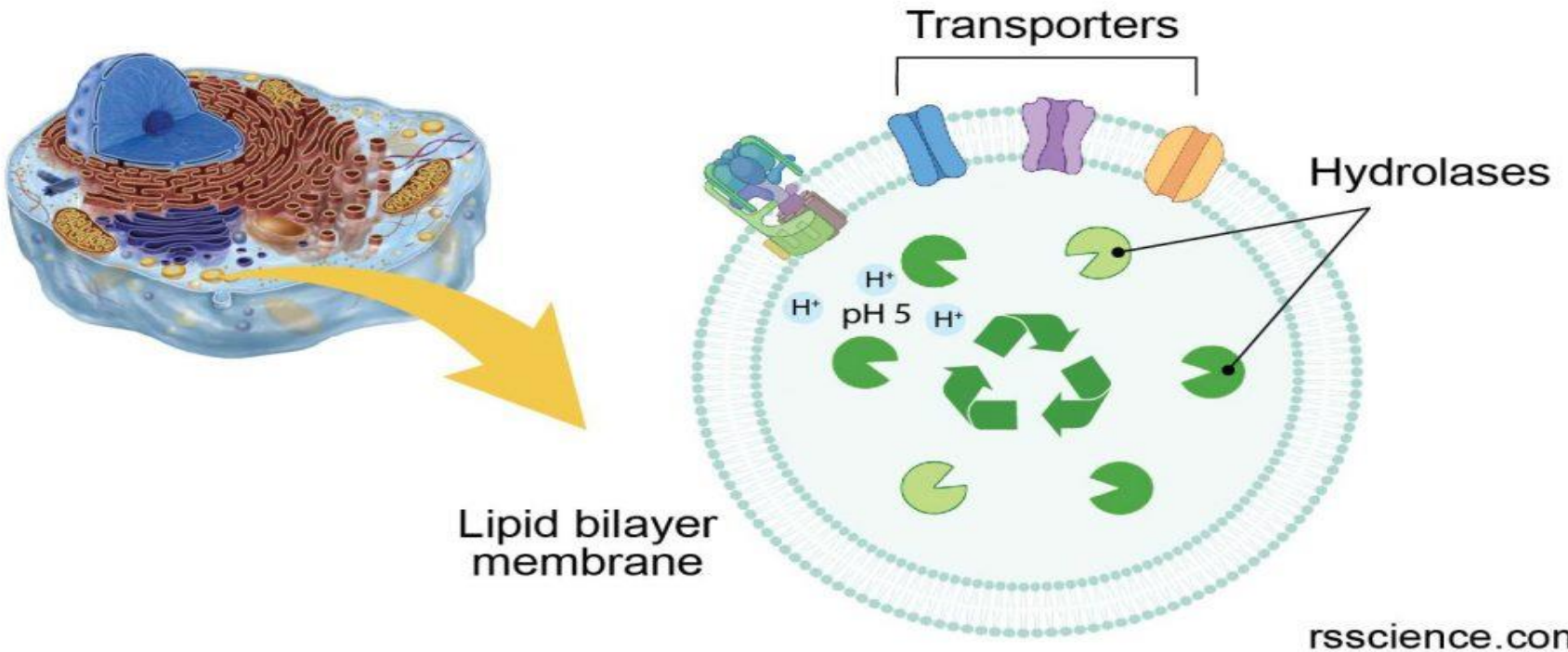
Cell: MICROBODIES

Positioning



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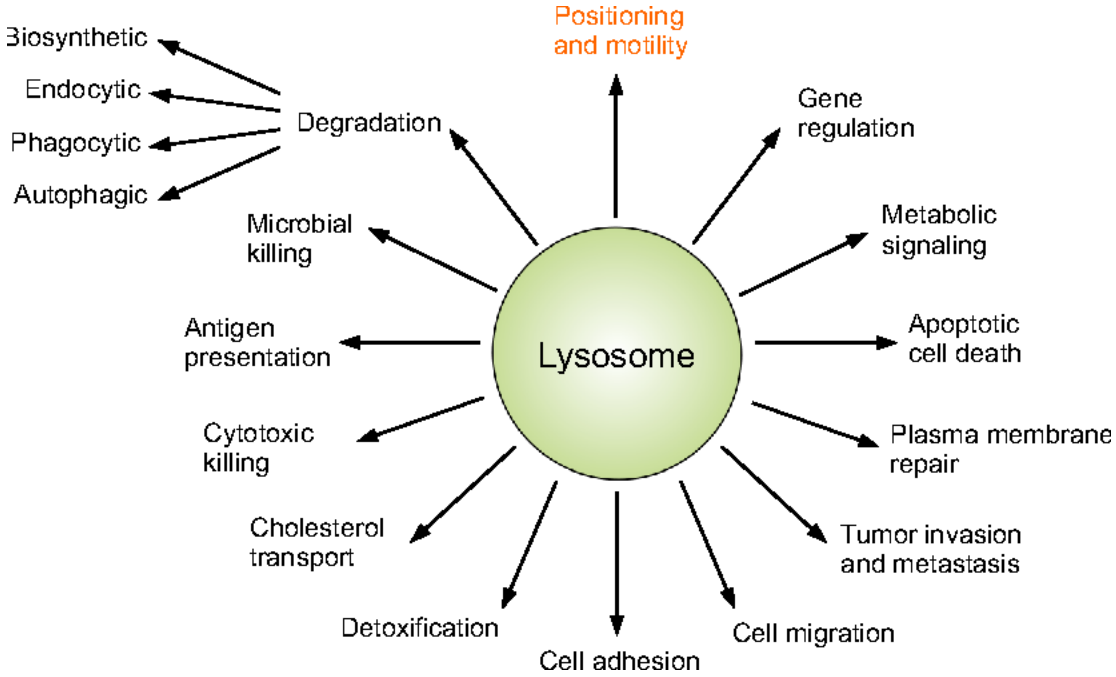
Cell: MICROBODIES



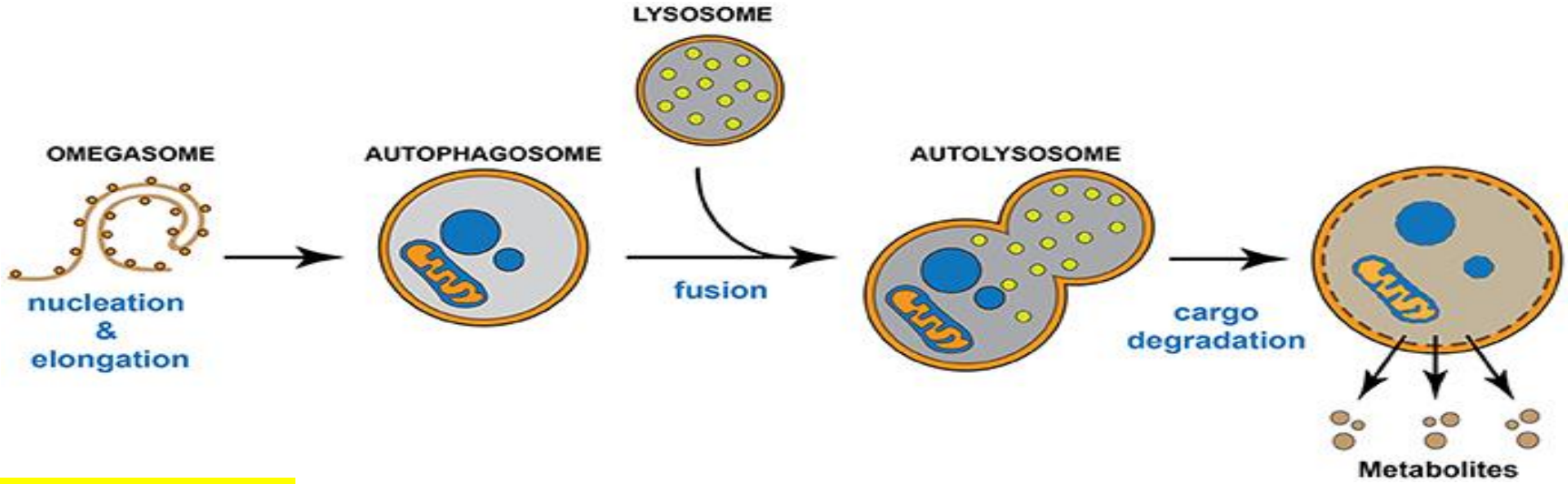
6. MICROBODIES: These are small, spherical, single membrane bound structures present in cytoplasm. The different types of microbodies are

a) Lysosomes: The types of Lysosomes are

- **Primary Lysosomes**: Newly produced Lysosomes from Golgi bodies
- **Secondary Lysosomes (Phagolysosome)**: These are formed by the union of phagosome and primary lysosome. It is also called **digestive vacuole**
- **Residual Lysosomes:** These are secondary Lysosomes left with undigested material which is thrown out by exocytosis

Ref: wikipedia

Cell: MICROBODIES



• **Autolysosomes (Autophagic lysosome)**: These are formed by the union of primary lysosome and worn out cell organelles

Common name: Suicidal bags of cell / Time bombs of the cell / Recycling centres

Functions:

- They are concerned with intracellular digestion
- They contribute to ageing process
- They destroy old and non functional cells, which bear them (Autolysis). So they are called **suicidal bags**
- They break worn-out cells, damaged cells and cell organelles to component molecules for building new cell organelles. So they are called " **Recycling centers"**

b) Peroxysomes: These oxidize substrates producing hydrogen peroxide and involved in photorespiration

c) Glyoxysomes: These store fat and convert it into carbohydrates

Cell: Ribosome

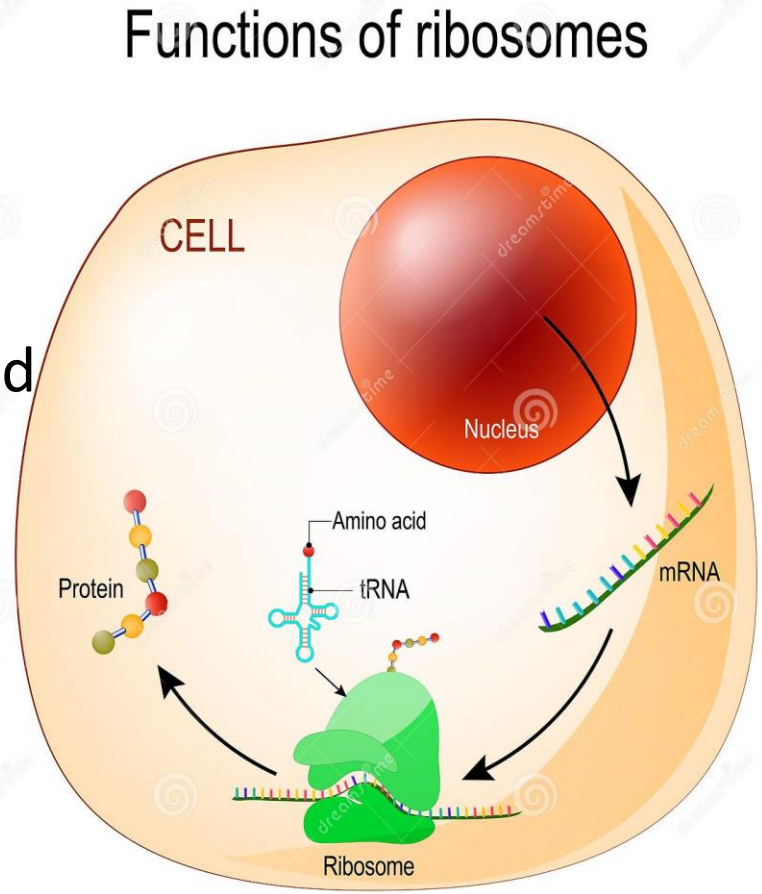
B. NON MEMBRANOUS CELL ORGANELLES PRESENT IN THE CYTOPLASM These organelles do not have any membranous covering. They are **Ribosomes** and **Centrosome.**

1. RIBOSOMES:

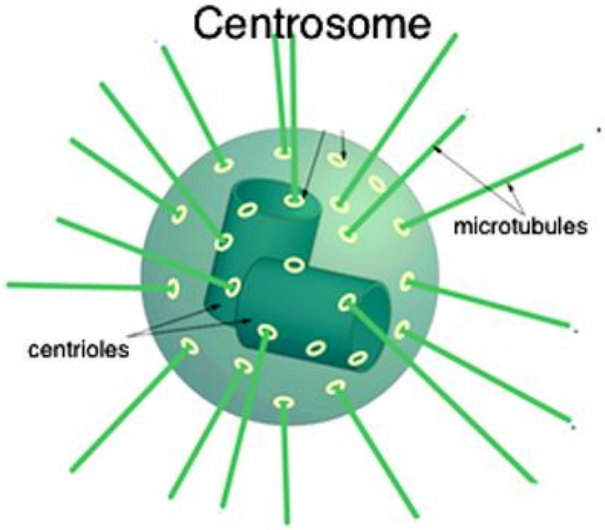
Discovery: K R Porter (1945) - observed in animal cells, **Robinson and Brown (1953**) observed in plant cells, **George Plate (1953**)

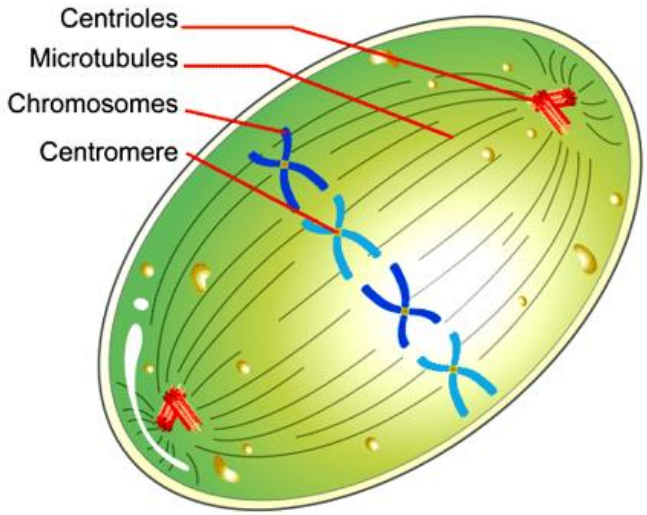
These are granular, non-membranous sub spherical structures present in the cytoplasm, mitochondria and chloroplast. They are also found attached to Rough ER and nuclear membrane.

Function: These are the sites of polypeptide or protein synthesis Ref: wikipedia



Cell: Centrosome





2. CENTROSOME: **Discovery: Van Benden (1880) 70S/80S**

Centrosome is found in animal cells and in some motile algae. It is absent in plant cells. It is present near the nucleus. Centrosome has two cylindrical structures called **centrioles** surrounded by a less denser cytosol called **centrosphere**. The centrioles are arranged at right angles to one another. Each centriole is made up of a whorl of nine triplets of microtubules. These microtubules run parallel to one another. The adjacent microtubules are connected by proteinaceous strands.

Functions:

- They form asters and organize the formation of spindle fibres during cell division.
- They are involved in the formation of cilia, flagella and axial filament in sperms.

Ref: wikipedia

Cell: Non-living Inclusions

NON-LIVING CELL INCLUSIONS
The non living cell inclusions includes **ergastic substances** and **cytoskeleton elements**

1. Ergastic substances: These are non living cell inclusions of cytoplasm like reserve food materials (starch, protein, oils), secretory products (nectar, pigments, enzymes), excretory products (alkaloids, resins, latex, tannins) and mineral crystals (cystoliths, raphides, druses).

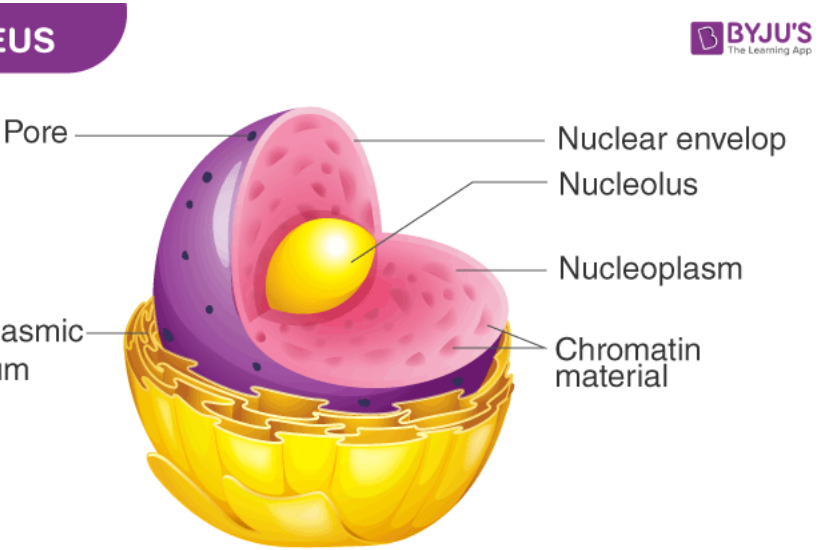
2. Cytoskeleton: It is a complex network of interconnected **microfilaments** and **microtubules** of protein fibres present in cytoplasm. The microfilaments are composed of **actin** and microtubules are composed of **tubulins**.

- It helps in mechanical support, cell motility, cell division and maintenance of the shape of the cell.

Ref: wikipedia

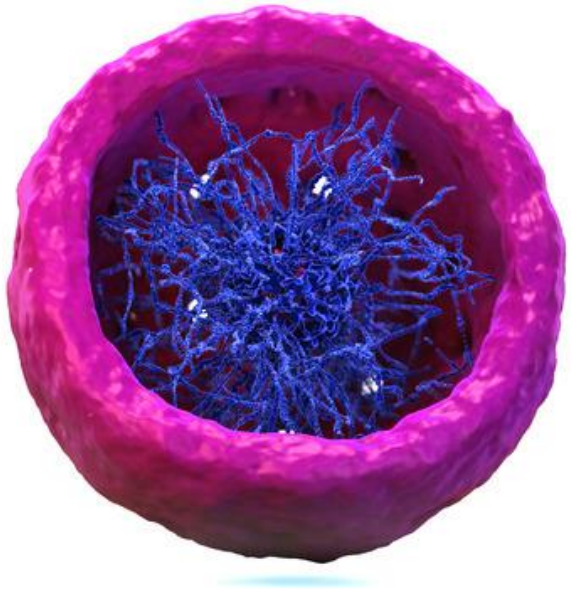
Cell: Nucleus

B.NUCLEUS (KARYON) (plural – Nuclei)



Discovery: Robert Brown (1831) – discovered in the cells of orchids Nucleus is a darkly stainable, largest cell organelle present in eukaryotic cells. It is usually spherical. It may be lobed in WBC, kidney shaped in paramecium.

- Nucleus has an outer double layered **nuclear membrane** with **nuclear pores**, a transparent granular matrix called **nucleoplasm or karyolymph**, **chromatin network** composed of DNA and histones and a darkly stainable spherical body called **Nucleolus.**



Ref: wikipedia

Cell: Nucleated or Eunucleated cells

- The cells having nucleus are called **Nucleated cells**
- The cells which loose nucleus at maturity are called **Enucleated cells**. Ex: Mammalian RBC, Sieve tube members of angiosperms
- The cells having incipient nucleus are called **prokaryotic cells.** Ex: Bacteria, Nostoc
- The cells having well defined nucleus are called **Eukaryotic cells.** Ex: Higher plant & animal cell

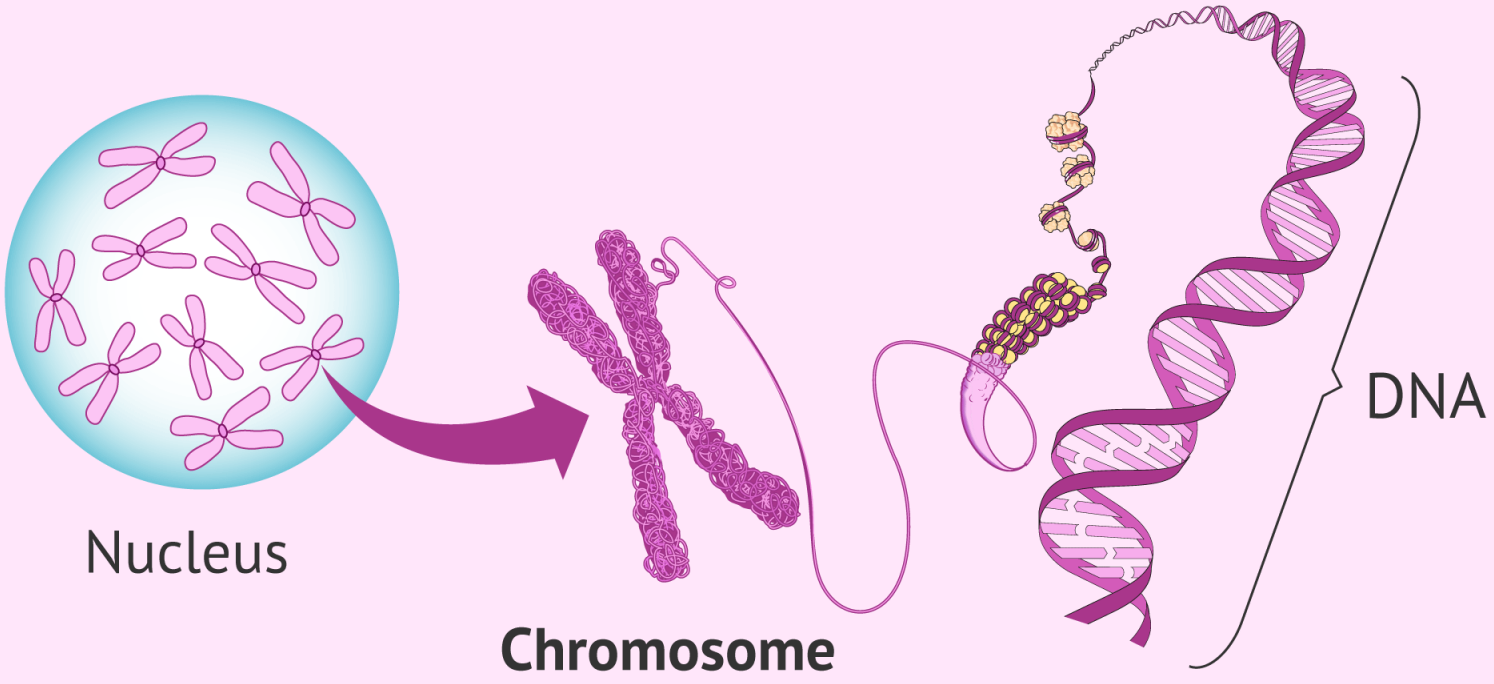
Ref: wikipedia

Cell: Nucleus

- **Prokaryotic cell:** The cell having incipient or primitive nucleus is called prokaryotic cell. The nucleus does not contain nuclear membrane. It is genetic DNA or Genophore or Nucleoid or prochromosome. It has only DNA but not histones unlike eukaryotic cell. Eg: Bacteria, Blue green algae.
- **Eukaryotic cell:** The cell having the nucleus with double layered nuclear membrane. Nucleus has chromatin composed of DNA and Histones Eg: cells of higher plants & animals
- **Function:**
- Nucleus is the controlling centre of the cell
- It contains the genetic material DNA which regulates various metabolic activities of the body by directing the synthesis of structural and functional proteins

Ref: wikipedia

Cell: Chromosome



Ref: wikipedia

Cell: Chromosome

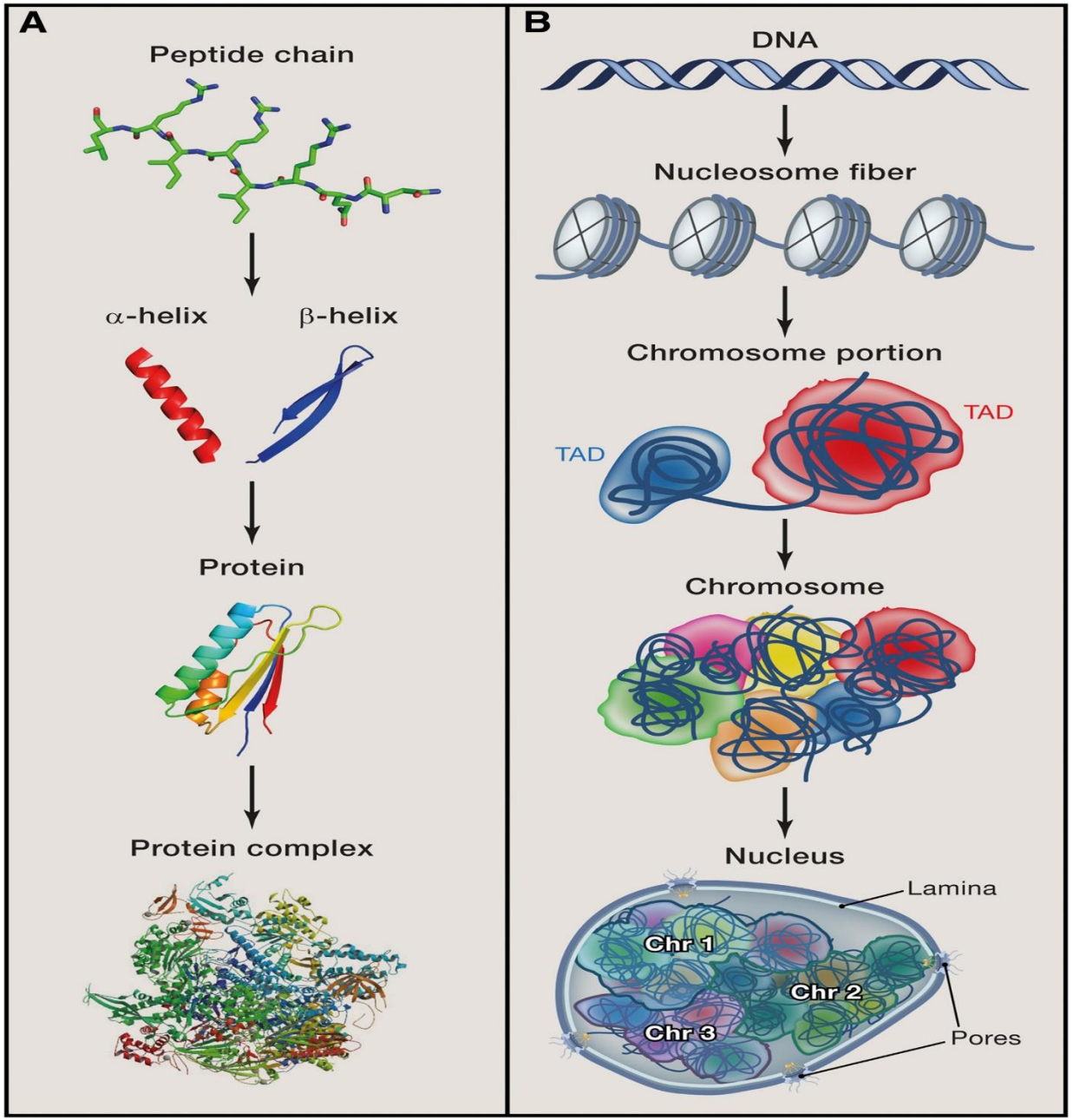
CHROMOSOME: The nucleus of a normal or non dividing cell has a loosened indistinct network of nucleoprotein fibers called **chromatin** (coined by **Flemming**). During cell division the chromatin condenses to form distinctly visible chromosomes.
Discovery: The term chromosome (chroma – colour, soma – body) was coined by **Waldeyer (1888),** Discovered by **Holf Meister (1848)** observed in pollen mother cells of *Tradescantia*.

- **T H Morgan** discovered the role of chromosome during transmission of characters and called them as **'vehicles of heredity'**.
- A metaphase chromosome has two similar darkly stainable parallel strands called **chromatids** held at a point called **centromere.** Centromere is a less stained primary constricted region having **kinetochores & microtubules**. Each chromatid is made up of a highly coiled thread like structure called **chromonema** or chromatin fibre made up of **DNA and Histones**. The coiling of chromonema results in bead like structures called **chromomeres**. At certain regions of chromosome is a tightly coiled, more stainable less active chromonema called **heterochromatin** and the loosely coiled, less stainable more active region called **euchromatin.** Chromosomes are classified into different types based on the position of centromere. They are Telocentric, acrocentric, submetacentric, metacentric chromosomes.

Functions: Chromosomes are the vehicles of heredity.

Ref: wikipedia

Cell: Chromosome



Cell: Overview

Cell Organelle and its Functions
Nucleolus
The nucleolus is the site of ribosome synthesis. Also, it is involved in controlling cellular activities and cellular reproduction
Nuclear membrane
The nuclear membrane protects the nucleus by forming a boundary between the nucleus and other cell organelles.

Ref: https://byjus.com/biology/cells/

Cell: Overview

Chromosomes
Chromosomes play a crucial role in determining the sex of an individual. Each human cells contain 23 pairs of chromosomes
Endoplasmic reticulum
The endoplasmic reticulum is involved in the transportation of substances throughout the cell. It plays a primary role in the metabolism of carbohydrates, synthesis of lipids, steroids and proteins.
Golgi Bodies
Golgi bodies are called the cell's post office as it is involved in the transportation of materials within the cell

Ref: https://byjus.com/biology/cells/

Cell: Overview

Ribosome
Ribosomes are the protein synthesisers of the cell
Mitochondria
The mitochondrion is called “the powerhouse of the cell.” It is called so because it produces ATP – the cell’s energy currency
Lysosomes
Lysosomes protect the cell by engulfing the foreign bodies entering the cell and helps in cell renewal. Therefore, it is known as the cell’s suicide bags

Ref: https://byjus.com/biology/cells/

Cell: Overview

Chloroplast
Chloroplasts are the primary organelles for photosynthesis. It contains the pigment chlorophyll
Vacuoles
Vacuoles stores food, water, and other waste materials in the cell

Ref: https://byjus.com/biology/cells/

Cell: Cell Theory

Cell Theory

- Cell Theory was proposed by the German scientists, Theodor Schwann, Matthias Schleiden, and Rudolf Virchow. The cell theory states that:
- All living species on Earth are composed of cells.
- A cell is the basic unit of life.
- All cells arise from pre-existing cells.
- A **modern version of the cell theory** was eventually formulated, and it contains the following postulates:
- Energy flows within the cells.
- Genetic information is passed on from one cell to the other.
- The chemical composition of all the cells is the same.

Ref: https://byjus.com/biology/cells/

Cell: Functions

Provides Support and Structure

- All the organisms are made up of cells. They form the structural basis of all the organisms. The cell wall and the cell membrane are the main components that function to provide support and structure to the organism. For eg., the skin is made up of a large number of cells. Xylem present in the vascular plants is made of cells that provide structural support to the plants.

Facilitate Growth Mitosis

- In the process of mitosis, the parent cell divides into the daughter cells. Thus, the cells multiply and facilitate the growth in an organism.

Ref: https://byjus.com/biology/cells/

Cell: Functions

Allows Transport of Substances

- Various nutrients are imported by the cells to carry out various chemical processes going on inside the cells. The waste produced by the chemical processes is eliminated from the cells by active and passive transport. Small molecules such as oxygen, carbon dioxide, and ethanol diffuse across the cell membrane along the concentration gradient. This is known as passive transport. The larger molecules diffuse across the cell membrane through active transport where the cells require a lot of energy to transport the substances.

Ref: https://byjus.com/biology/cells/

Cell: Functions

Energy Production

- Cells require energy to carry out various chemical processes. This energy is produced by the cells through a process called photosynthesis in plants and respiration in animals.

Aids in Reproduction

- A cell aids in reproduction through the processes called mitosis and meiosis. Mitosis is termed as the asexual reproduction where the parent cell divides to form daughter cells. Meiosis causes the daughter cells to be genetically different from the parent cells. Thus, we can understand why cells are known as the structural and functional unit of life. This is because they are responsible for providing structure to the organisms and performs several functions necessary for carrying out life's processes.

Ref: https://byjus.com/biology/cells/

Cell: Characteristics of cells

- Cells provide the necessary structural support for an organism.
- The genetic information necessary for reproduction is present within the nucleus.
- Structurally, the cell has cell organelles which are suspended in the cytoplasm.
- Mitochondria is the organelle responsible for fulfilling the cell's energy requirements.
- Lysosomes digest metabolic wastes and foreign particles in the cell.
- Endoplasmic reticulum synthesises selective molecules and processes them, eventually directing them to their appropriate locations.

Ref: https://byjus.com/biology/cells/

Cell Cycle Regulators

- Cyclin
  - Protein that regulates the cell cycle in eukaryotic cells
  - When injected into a non-dividing cell it causes a mitotic spindle to form
- Internal Regulators
  - Responds to events inside the cell
  - Makes sure that a cell does not enter mitosis until all chromosomes are replicated

Cell Cycle Regulators (cont.)

- External Regulators
  - Respond to events outside the cell
  - “Growth factors” that speed up or slow down growth and division

Uncontrolled Cell Growth

- CANCER –
  - Cells that lose the ability to control cell growth
  - Most cancers have damage to the p53 gene
    - Normally halts the cell cycle until all chromosomes are replicated
    - Chromosome damage builds up and the cancer cell loses the information that controls normal cell growth
  - Tumors → masses of cells that can damage the surrounding tissue
  - CAUSES: smoking tobacco, radiation exposure (UV, XRAY, etc.), viral infection

Life Spans of Various Human Cells

Cell Type	Life Span	Cell Division
Lining of esophagus	**2-3 days**	**Can divide**
Lining of small intestine	**1-2 days**	**Can divide**
Lining of large intestine	**6 days**	**Can divide**
Red blood cell	**Less than 120 days**	**Cannot divide**
White blood cell	**10 hours to decades**	**Cannot divide**
Smooth muscle	**Long-lived**	**Can divide**
Cardiac (heart) muscle	**Long-lived**	**Cannot divide**
Skeletal muscle	**Long-lived**	**Cannot divide**
Neuron (nerve cell)	**Long-lived**	**Most do not divide**

Life Spans of Human Cell Questions

- White blood cells help protect the body from infection and disease-producing organisms. How might their function relate to their life span?
- If cancer cells were added to the table, predict what would be written under the “Life Span” and “Cell Division” columns. Explain you’re the reasoning behind your predictions.