KRISHNAGAR ACADEMY

Basic Cell Theory & Structure

class -9

Biology

Cytoplasm

Cytoplasm is the **semi-fluid** content of the cell present between the plasma membrane and the nuclear membrane.

- It is viscous, gelatinous and **jelly-like**, consisting of water, various inorganic substances and organic molecules.
- Many chemical reactions take place in the cytoplasm.
- It also contains many specialised cell organelles, each of which carries out a particular function.

The cell organelles are discussed here in brief:

Endoplasmic Reticulum (ER)

The endoplasmic reticulum, first observed by **Porter** in 1945, is a network of double membranes found scattered in the cytoplasm.

- The membranes of ER are continuous with the nuclear membrane on the inner side.
- These are connected with the plasma membrane on the other side.
- The endoplasmic reticulum is of two types:
  - (*i*) **Rough ER (RER)**, which has ribosomes attached to its surface.
  - (*ii*) **Smooth ER (SER)**, which is devoid of ribosomes on its surface.

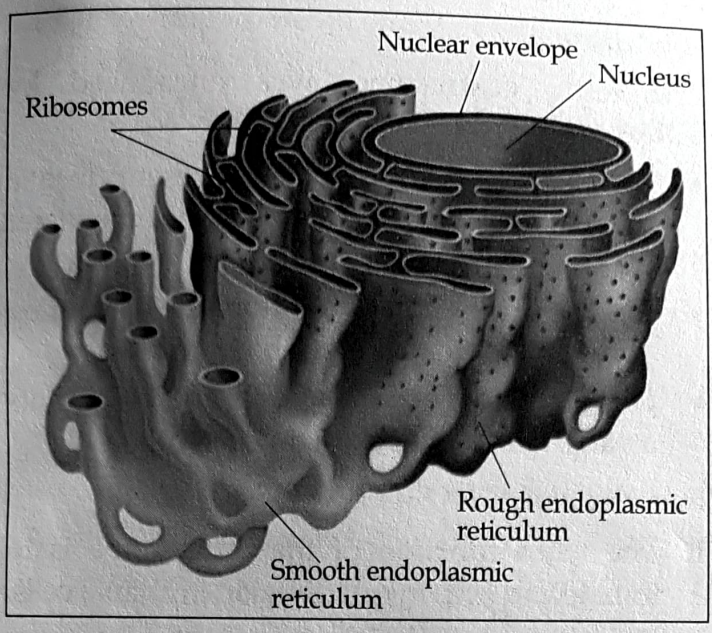


Fig. 1.9: Structure of endoplasmic reticulum

Functions of ER

1. Endoplasmic reticulum provides **mechanical support** to the cytoplasm.
2. It serves as a **channel for the transport** of material from one part of the cell to the other.
3. The RER facilitates **protein synthesis**, while the SER helps in **lipid synthesis** and various biochemical reactions.

Golgi Apparatus

Golgi apparatus was first observed by **Camillo Golgi** in 1898, while studying nerve cells of barn owl.

- Golgi apparatus occurs in the form of granules, rods or filaments and arises from the membranes of endoplasmic reticulum.

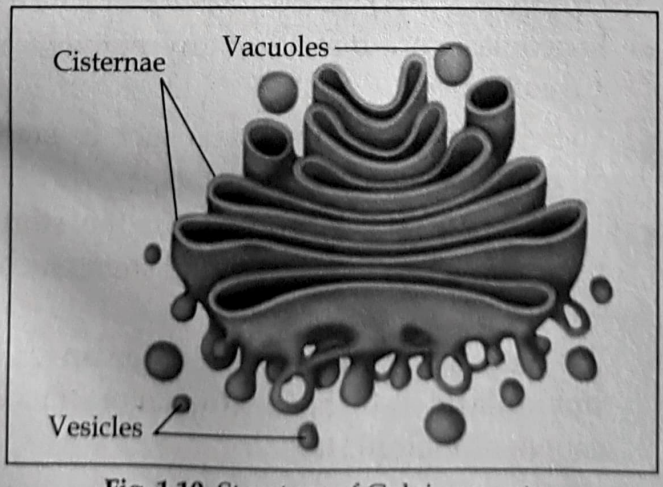


Fig. 1.10: Structure of Golgi apparatus

- It consists of a set of smooth, flattened **cisternae** or sac-like structures, which are stacked one above the other in parallel rows.
- The Golgi apparatus is associated with some minute **vesicles** and **vacuoles** which bud off from cisternae.

- In plant cells, the Golgi apparatus is known as **dictyosome**.

Functions of Golgi Apparatus

1. It is associated with the **secretions of cell**, such as enzymes and hormones.
2. It modifies, concentrates and packs the substances synthesised near the ER and directs them to the required destination.
3. It is also known as the **traffic police** of the cell.

Lysosomes

(**Gr.** *lysis* = digestive; *soma* = body)

Lysosomes were first discovered in 1955 by **Christian de Duve** in the liver cells.

- These are **bag-like cell organelles** bound by a single membrane.
- These are present in abundance in each cell and contain digestive or tissue-dissolving **enzymes**.

Functions of Lysosomes

1. Lysosomes destroy and digest any foreign material, such as bacteria, present inside the cell. They keep the cells clean and are also known as **demolition squads** or **housekeepers**.
2. They also break down worn out and poorly working organelles and digest them. Therefore, they form the **waste** or **garbage disposal system** of the cell.
3. Lysosomes are also referred to as **digestive bags** because their enzymes help in the digestion of stored food.
4. Lysosomes also digest their own cells when the cells are diseased or damaged with poor oxygen supply or improper metabolism. Thus, these are also called as **suicide bags**.

Mitochondria

(**Gr.** *mito* = thread; *chondrion* = granule)

The term 'mitochondria' was coined by **K. Benda** in 1897.

- The mitochondria are **rod-shaped organelles** present in the cytoplasm of a cell.
- Each mitochondrion is bordered by a **double membrane**.
- The outer membrane is porous and smooth, while the inner one is folded into **finger-like** projections known as **cristae**.

Functions of Mitochondria

1. The mitochondria are commonly known as the **powerhouse** of the cell, as they provide energy required for various cellular activities.

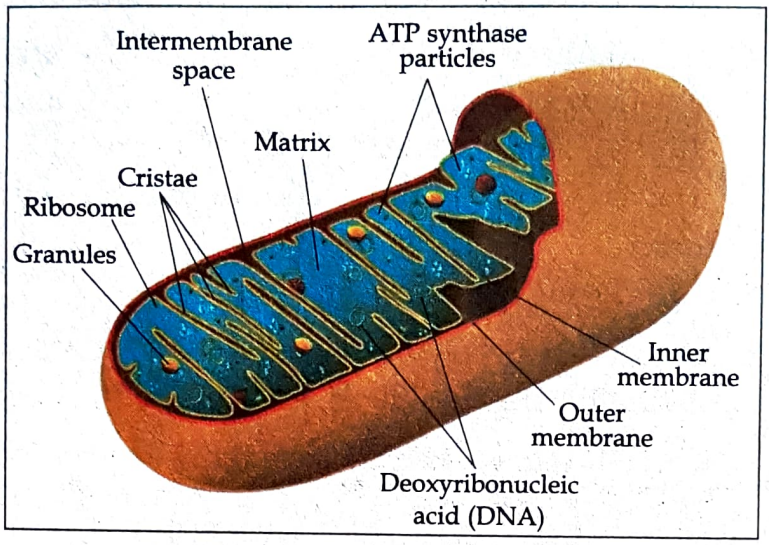


Fig. 1.11: Structure of a mitochondrion

2. It contains enzymes for cellular respiration which convert the stored energy of food into usable energy. The energy is stored as ATP (Adenosine triphosphate) molecule(s), which is known as **energy currency** of the cell.
3. The mitochondria are also regarded as **biochemical machines** of the cell as they help in various metabolic activities of the cell.

Ribosomes

Ribosomes are the smallest organelles of the cell first observed by Romanian cell biologist **George Palade** in mid-1950s and the term was proposed by **Richard B. Roberts** in 1958.

- Ribosomes are either **attached** to the outer membrane of the endoplasmic reticulum or present in the cytoplasm as independent or **free ribosomes**.
- These contain high **RNA** content and many **proteins**. Because of their high RNA content, they have been named ribosomes.
- Ribosomes are of two types—**70S** found in prokaryotes and **80S** found in eukaryotes.

Functions of Ribosomes

1. Ribosomes are the centres of protein synthesis, hence called **protein factories** of the cell.
2. It provides sites for the attachment of RNA molecules involved in **protein synthesis**.

Centrosome

The term 'centrosome' was introduced by **T. Boveri** in 1888.

- Centrosome is a minute body present close to the nucleus of animal cells and in some lower plants.
- It is a specialised zone of cytoplasm containing two central granules called **centrioles**.
- Centrioles are short bundles of microfilaments arranged at right angles to each other.

Functions of Centrioles

1. The main function of the centrosome is to initiate and help in **cell division** in animal cells.
2. During nuclear division, the centrioles move to two opposite ends of the cell and **spindle fibres** develop from them.

Plastids

The term 'plastid' was introduced by **Ernst Haeckel**.

- Plastids are small disc-shaped or spherical bodies found scattered in all plant cells and in some protista.
- These are absent in animal cells, fungi, bacteria and blue-green algae.
- Like mitochondria, plastids are double-walled and have their **own DNA and ribosomes**. Depending on the colour, plastids are of three types:

(a) Leucoplasts

(**Gr.** *leucos* = white; *plastos* = formed)

- Leucoplasts are devoid of any pigment and are **colourless**.
- These store certain materials such as **starch, oil** and **protein granules**.
- These are commonly found in the storage cells of roots and underground stems such as potato.
- The leucoplasts which store starch are called **amyloplasts** and those which store fats are known as **elaioplasts**.

(b) Chromoplasts

(**Gr.** *chroma* = colour; *plastos* = formed)

- These are the **coloured plastids**, the colour varying from yellow to orange-red.
- These contain certain pigments, *i.e.*, **xanthophyll** (yellow) and **carotene** (orange-red) which are responsible for their colour.

- They impart colour to the petals of flowers to attract insects for pollination.
- They also provide different colours to fruits which are formed as a result of combination of yellow, red and orange.

(c) Chloroplasts

(**Gr.** *chloros* = green; *plastos* = formed)

- These plastids are **green-coloured**, which is due to the presence of a green pigment, **chlorophyll**.
- They also have xanthophylls and carotenoids, but in minor amounts. These pigments are masked by the large quantities of chlorophyll.
- Chloroplasts are found abundantly in green leaves and also in green parts of the shoot.
- Chloroplasts are necessary for carrying out **photosynthesis** in plants.
- They also contain their **own DNA** and can divide.

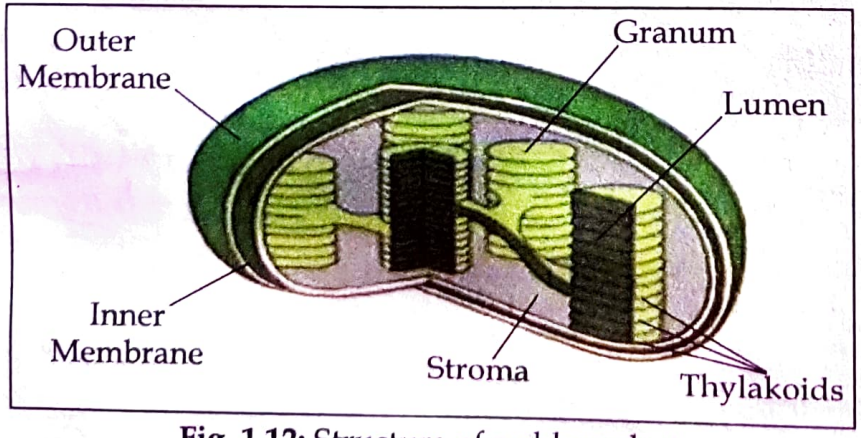


Fig. 1.12: Structure of a chloroplast

At A Glance

There are many flowers which are coloured due to the presence of pigments called **anthocyanins**. These pigments provide blue, violet and purple colours to the flowers, roots (beetroot) and stems (balsam). The pigments remain dissolved in the cell sap and probably protect chloroplasts from strong sunlight.

Vacuoles

- The vacuole is a **single membrane-bound** space found in the cytoplasm.
- It is a kind of **storage sac** which is filled with water and semi-solid or liquid substance.
- In an animal cell, the vacuoles are small-sized and few in number.
- In plant cells, a single prominent vacuole occupies about 90% of the cell volume. It is filled with a liquid called **cell sap**. Because of its large size and central position, the nucleus and other cell organelles are pushed towards the periphery of the plant cell.

Functions

1. They provide **turgidity** and **rigidity** to the plant cell.
2. They provide space for the storage of water-soluble compounds like sugar, minerals, etc.

Table 1.2: Summary of Cell Components, their Features and Functions

S. No.	Cell Component	Characteristic Features	Functions
1.	Plasma membrane	• Surrounds all cells. • Thin, living covering. • Composed of lipids and proteins. • Has fine pores. • Selectively permeable.	• Separates cell contents from external medium. • Helps in maintaining internal environment of the cell. • Regulates entry of molecules.
2.	Cell Wall	• Thick, non-living covering in plant cells. • Composed of **cellulose**. • Freely permeable. • Absent in animal cells.	• Provides rigidity and shape to the cell. • Allows free movement of molecules.
3.	Nucleus	• Prominent and the most important part. • Small and spherical structure.	• Controlling centre. • Regulates the enzyme synthesis.

		• Located in the centre of an animal cell and at the periphery in a plant cell. • Covered by a double-layered **nuclear membrane**. • Filled with a transparent, granular, liquid **nucleoplasm**. • Contains **nucleolus** and **chromatin** material.	• Controls all the metabolic activities. • Controls inheritance of characters from parents to the offspring. • Responsible for the development of different characters. • Plays an important role in cell division.
4.	Nucleolus	• Small spherical bodies in the nucleus. • Not bound by any membrane. • Rich in **proteins** and **RNA**.	• Sites for the synthesis of ribosomes. • Helps in protein synthesis.
5.	Chromatin Material	• Thin, thread-like, intertwined mass of filaments in nucleus. • Composed of genetic material **DNA** and **proteins**. • During cell division, it condenses into distinct chromosomes.	• Contains information for growth and development, metabolism, reproduction and hereditary character of an organism.
6.	Cytoplasm	• Semi-fluid, viscous, gelatinous and jelly-like content of the cell. • Present between plasma membrane and the nuclear membrane. • Consists of water, various inorganic substances and organic molecules.	• Contains cell organelles which perform specific functions. • Metabolic reactions take place here.
7.	Endoplasmic Reticulum	• Network of double membranes found scattered in the cytoplasm. • Membranes continuous with nuclear membrane on one and plasma membrane on the other side. • May be **Rough ER** with attached ribosomes or **Smooth ER** devoid of ribosomes.	• Provides mechanical support to the cell. • Serves as a channel for the transport of material from one part of the cell to the other. • RER facilitates protein synthesis. • SER helps in lipid synthesis and various biochemical reactions.
8.	Golgi Apparatus	• In the form of granules, rods or filaments. • Consists of stack of smooth, flattened cisternae. • Known as **dictyosomes** in plant cells.	• Secretions of cell-enzymes and hormones. • Modifies, concentrates and transports the synthesised substances.
9.	Lysosomes	• Bag-like cell organelles. • Bound by a single membrane. • Contain digestive or tissue-dissolving enzymes.	• Destroy and digest any foreign material. • Digest worn out and poorly working organelles.

			• Help in the digestion of stored food. • Digest their own cells when diseased or damaged.
10.	Mitochondria	• Rod-shaped organelles. • Bordered by a double membrane. • Outer membrane porous and smooth. • Inner membrane folded into finger-like **cristae**.	• Provide energy required for various cellular activities. • Contain enzymes for cellular respiration. • Store energy as ATP. • Help in metabolic activities.
11.	Ribosomes	• Smallest organelles. • Either attached to endoplasmic reticulum or present in the cytoplasm as free ribosomes. • Contain high RNA content and many proteins.	• Centres of protein synthesis. • Provide sites for the attachment of RNA.
12.	Centrosomes	• Minute bodies present close to the nucleus of animal cells. • Contain two **centrioles**—short bundles of microfilaments.	• Initiate and help in cell division. • Form spindle fibres during cell division.
13.	Plastids	• May be colourless or variously coloured. • Most common are green-coloured **chloroplasts** containing chlorophyll. • Found abundantly in green parts of plant. • Covered by double membrane. • Contain their own DNA.	• Impart colours to flowers and fruits. • Chloroplasts necessary for photosynthesis. • Leucoplasts store starch, oil and protein granules.
14.	Vacuoles	• Single membrane-bound space. • Filled with water and semi-solid or liquid substance. • Animal cell has small-sized and few vacuoles. • Plant cell has a single prominent vacuole filled with cell sap.	• Provide turgidity and rigidity to the plant cell. • Provide space for the storage of water-soluble compounds like sugar, minerals, etc.

PROTOPLASM

Protoplasm is a living, transparent, granular, semi-fluid substance and mainly consists of water. It also contains:

1. Common **elements**—carbon, hydrogen, oxygen, nitrogen, sulphur, iron, etc.,
2. A variety of **organic compounds**—carbohydrates, proteins and lipids,
3. Nucleoproteins, and
4. Mineral salts.

The organisms which contain protoplasm are considered living. If the protoplasm dies, the cell stops performing any function and results in death of the organism.

The protoplasm of a cell includes **cytoplasm** and **nucleoplasm**. The living cellular structures present in cytoplasm are called **cell organelles** while the non-living components are termed as **cell inclusions**.

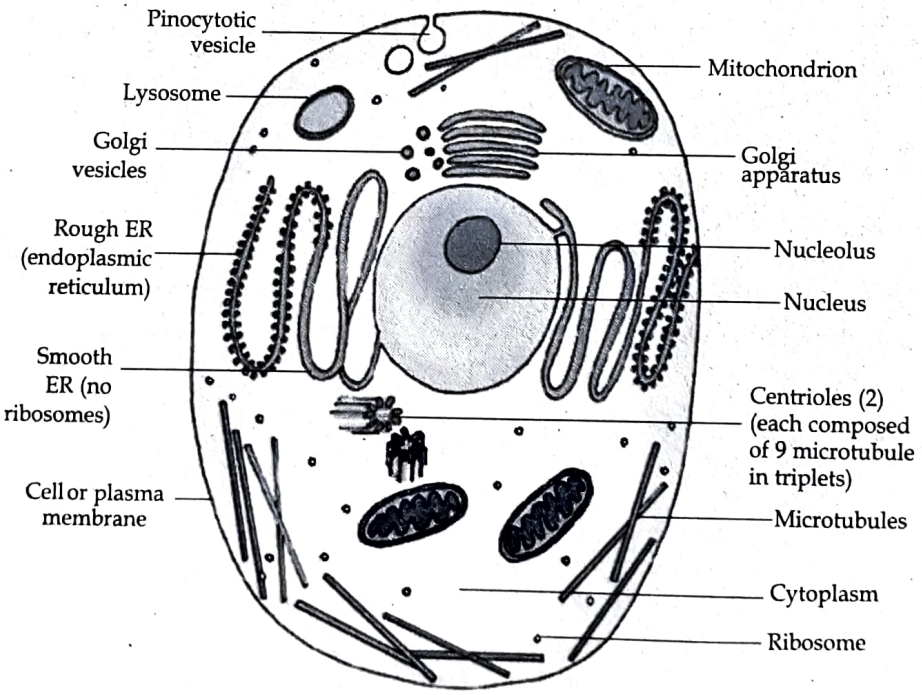
PLANT AND ANIMAL CELLS

The plant and animal cells are similar in basic structure. Both have three important structural parts, *i.e.*, the plasma membrane, cytoplasm and nucleus.

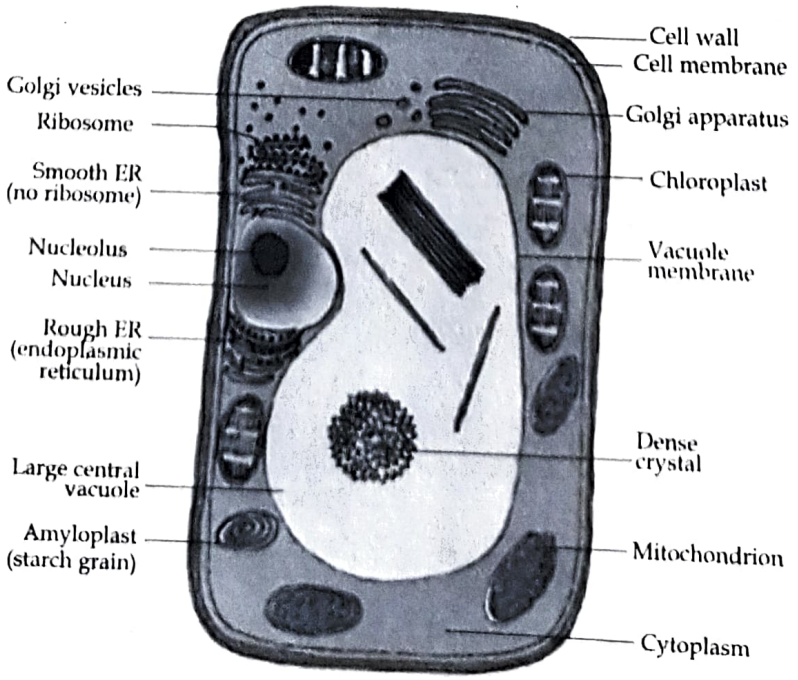
The cytoplasm of both plant and animal cells contains similar cell organelles which carry out more or less similar functions.

Table 1.3: Differences between Plant and Animal Cells

S.No.	*Plant Cells*	*Animal Cells*
1.	These are comparatively larger in size.	These are comparatively smaller in size.
2.	A thick cell wall, made up of cellulose, is present around the thin plasma membrane.	The cell wall around thin plasma membrane is absent.
3.	Plastids are present.	Plastids are absent.
4.	Cytoplasm is less dense and less granular.	Cytoplasm is denser and more granular.
5.	A single large vacuole is present.	Vacuoles are small and more than one.
6.	Cytoplasm is pushed to the periphery by vacuole.	Cytoplasm is present throughout the cell.
7.	Centrosome is usually absent.	Centrosome is present.
8.	These contain small units of dictyosomes as scattered Golgi apparatus.	These have prominent and highly complex Golgi apparatus near the nucleus.



(*a*)



(*b*)

Fig. 1.13: (*a*) Animal Cell (*b*) Plant Cell

List the organelles present in the cytoplasm of a cell.

Differentiate between the following:

(*a*) Leucoplast and Choloroplast

(*b*) Lysosomes and Ribosomes

(*c*) Cell sap and Cytoplasm.

Name the organelle which

(*a*) has ribosomes attached to its surface.

(*b*) was discovered by Christian de Duve.

(*c*) is known as dictyosome in plant cells.

(*d*) contains enzymes for cellular respiration.

(*e*) stores starch in plants.

What is the relation between endoplasmic reticulum and Golgi apparatus?

Classify plastids on the basis of their colour.

Name the following organelles:

(*a*) Biochemical machine of the cell.

(*b*) Provides colour to the flowers.

(*c*) Helps in cell division by spindle formation.

(*d*) Contains high RNA content.

Differentiate between the following:

(*a*) Plasma membrane and cell wall.

(*b*) Animal cell and plant cell.

(*c*) Rough ER and smooth ER.

(*d*) Prokaryotes and eukaryotes.

(*e*) Leucoplasts and chromoplasts.

(*f*) Centrosome and chromosome.

Draw a well-labelled diagram of the nucleus. Write the functions of each part.

List the cytoplasmic organelles of a cell. Write the functions of each organelle.

What are the different names given to lysosomes? Justify each name with reference to the functions.

State **one** characteristic feature and **major** functions of the following organelles:

(*a*) Centrosome

(*b*) Vacuole

(*c*) Dictyosomes

(*d*) Smooth endoplasmic reticulum

(*e*) Elaioplasts.

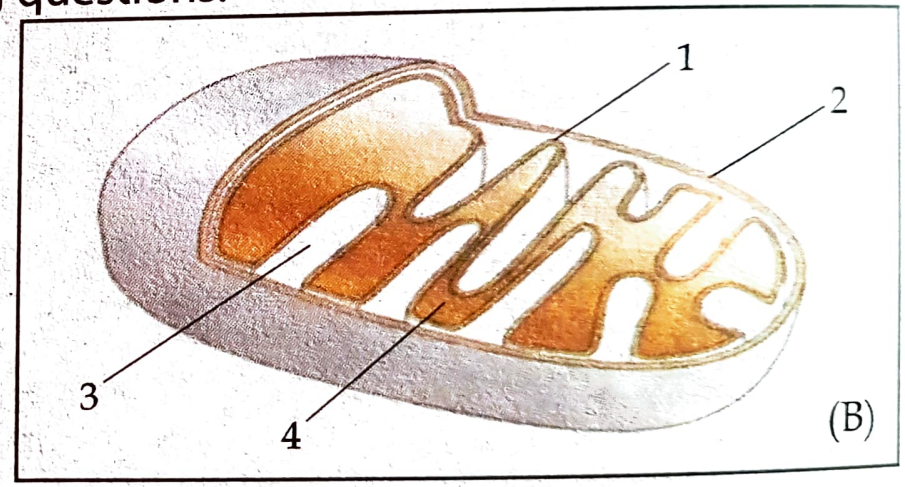
Observe the cell organelle in figure B and answer the following questions:

(*a*) Name the cell organelle and label the parts numbered 1–4.

(*b*) Write **two** similarities between above organelle and plastids of the plant cell.

(*c*) Is the above organelle present in a plant cell?

(*d*) Give at least **two** important functions of the above organelle.



(B)

. Observe the cell in figure C and answer the following questions:

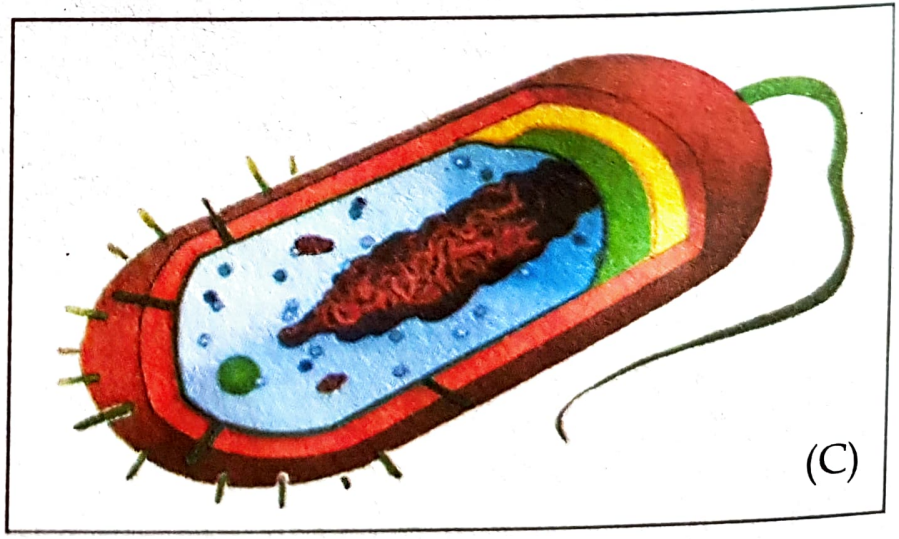
(*a*) Identify the cell.

(*b*) Name at least **two** organisms which are composed of this kind of cell.

(*c*) Write **two** characteristic features of the nuclear region of the cell.

(*d*) How is the cell structurally different from an animal cell? Mention **two** differences.

(*e*) Name a eukaryotic organelle found in the cell.


(C)