

BIOLOGY · CHAPTER 3

THE CELL

Complete Exercise Solutions & Explanations



Every MCQ answer highlighted & ticked with reasoning · Full short & detailed answers · Diagram labelling guide · Curated for focused revision

Chapter 3 — The Cell

Exercise Solutions Booklet

SECTION A — Multiple Choice Questions (Solved)

1 The process of cellular respiration occurs in:

a) Nucleus

b) Mitochondria ✓

c) Ribosomes

d) Golgi apparatus

Why: Mitochondria are the "powerhouses of the cell." They contain the enzymes needed for the Krebs cycle and the electron transport chain, where glucose and oxygen are used to make ATP energy.

2 The smooth endoplasmic reticulum (SER) is primarily involved in the synthesis of:

a) Proteins

b) Lipids ✓

c) Carbohydrates

d) Nucleic acids

Why: The SER lacks ribosomes on its surface, which is why it specializes in lipid and steroid synthesis, along with detoxifying drugs and harmful chemicals — unlike the rough ER, which makes proteins.

3 Which specialized region of the nucleus is responsible for ribosome assembly?

- a) Nucleoplasm
- b) Nucleolus ✓**
- c) Chromatin
- d) Chromatin

Why: The nucleolus is a dense region inside the nucleus where ribosomal RNA (rRNA) is synthesized and combined with proteins to assemble ribosomal subunits, which are later exported to the cytoplasm.

4 What is the primary function of ribosomes?

- a) Energy production
- b) Protein synthesis ✓**
- c) Lipid synthesis
- d) DNA synthesis

Why: Ribosomes are the site of translation, where the genetic code carried by mRNA is read and used to link amino acids together into polypeptide chains (proteins).

5 What is the main function of the nuclear pores?

- a) Regulation of cell division
- b) Protein synthesis
- c) Control of pH of the cell
- d) Control of transport of molecules ✓**

Why: Nuclear pores are channels in the nuclear envelope that regulate the movement of molecules – such as mRNA, proteins, and ions – between the nucleus and the cytoplasm.

6 Which cell organelle is responsible for breaking down waste materials?

a) Golgi apparatus

b) Nucleus

c) Mitochondria

d) Lysosome ✓

Why: Lysosomes are membrane-bound sacs filled with digestive (hydrolytic) enzymes. They break down worn-out organelles, cell debris, and foreign material – earning them the nickname "suicide bags."

7 Which of the following cellular structures is found in animal cells and helps in cell division?

a) Cell membrane

b) Centriole ✓

c) Plasmodesma

d) Vacuole

Why: Centrioles occur in pairs near the nucleus of animal cells. During cell division, they help organize the spindle fibres that pull chromosomes apart into the two daughter cells.

8 Which sub-cellular organelle plays a crucial role in energy production within the cell?

a) Endoplasmic reticulum

b) Golgi apparatus

c) Mitochondria ✓

d) Lysosomes

Why: Mitochondria convert the chemical energy stored in food into ATP through aerobic respiration, supplying the cell with usable energy for its activities.

9 In a multicellular plant, which cell type is responsible for the production of glucose?

a) Xylem

b) Phloem

c) Epidermal

d) Mesophyll ✓

Why: Mesophyll cells, found inside the leaf, are packed with chloroplasts. They carry out photosynthesis, converting carbon dioxide and water into glucose using light energy.

10 Which organelle can double its number by itself?

a) Ribosomes

b) Lysosomes

c) Mitochondria ✓

d) Golgi apparatus

Why: Mitochondria are semi-autonomous organelles — they contain their own small circular DNA and ribosomes, which allow them to grow and divide (by fission) independently of the cell cycle.

SECTION B — Short Answers (Solved)

1 What are the main functions of the cell membrane?

The cell membrane **encloses and protects** the cell's contents, gives the cell its shape, and acts as a **selectively permeable barrier** — controlling which substances (nutrients, gases, ions, waste) enter or leave the cell. It also helps in cell-to-cell recognition and communication through surface receptors.

2 What key role does the Golgi apparatus play in eukaryotic cells?

The Golgi apparatus **modifies, sorts, and packages** proteins and lipids received from the endoplasmic reticulum. It adds finishing touches (like carbohydrate groups), packs the products into vesicles, and directs them to their correct destination inside or outside the cell — acting like the cell's "post office."

3 How do lysosomes contribute to the cell's functioning?

Lysosomes contain powerful digestive enzymes that **break down food particles, worn-out organelles, and invading microbes**. This recycles cellular material and protects the cell, which is why lysosomes are important for both nutrition and defence.

4 Which organelle detoxifies harmful substances and breaks down lipids?

The **smooth endoplasmic reticulum (SER)** detoxifies drugs and harmful chemicals (especially in liver cells) and is also involved in breaking down and synthesizing lipids.

5 What is the smooth endoplasmic reticulum responsible for?

The SER is responsible for **lipid and steroid hormone synthesis**, carbohydrate metabolism, storage of calcium ions, and detoxification of harmful substances. Unlike the rough ER, it has no ribosomes on its surface.

6 How do vacuoles in plant cells differ from vacuoles in animal cells?

Plant cells usually have **one large, permanent central vacuole** that stores water, ions, and nutrients, and maintains turgor pressure to keep the cell rigid. Animal cells, in contrast, have **several small, temporary vacuoles** mainly used for storage and transport of materials.

7 What could happen if lysosomal enzymes stop working properly?

If lysosomal enzymes fail, the cell cannot break down waste, damaged organelles, or debris. This causes **harmful material to build up inside the cell**, which can damage the cell and lead to diseases known as lysosomal storage disorders.

8 Why are cristae important for cellular respiration?

Cristae are the folds of the inner mitochondrial membrane. These folds **greatly increase the surface area** available for the enzymes and electron carriers of the electron transport chain, allowing the mitochondria to produce more ATP efficiently.

9 How are chromatin and chromosomes related?

Chromatin is the **loosely coiled form of DNA and proteins (histones)** found in a non-dividing cell's nucleus. When a cell prepares to divide, chromatin condenses and coils tightly to form visible, distinct structures called **chromosomes**. So chromosomes are simply the tightly packed form of chromatin.

10 Label the parts of the cell diagrams.

Animal Cell (typical numbering)

Label	Structure
①	Cell membrane
②	Golgi apparatus
③	Nucleus (with nucleolus)
④	Mitochondrion
⑤	Lysosome
⑥	Rough endoplasmic reticulum
⑦	Ribosomes
⑧	Cytoplasm

Plant Cell (typical numbering)

Label	Structure
①	Cell wall
②	Nucleus
③	Chloroplast
④	Vacuole (large, central)
⑤	Cell membrane
⑥	Mitochondrion
⑦	Endoplasmic reticulum / Golgi apparatus

⚠ Note: Exact numbering can vary slightly between textbook editions. Match each label using its arrow position in your own diagram — animal cells always lack a cell wall, chloroplasts, and a large central vacuole, which are present only in the plant cell.

SECTION C — Detailed Answers (Solved)

1 Explain the fluid mosaic model of the cell membrane.

The **fluid mosaic model**, proposed by Singer and Nicolson, describes the structure of the cell membrane as a dynamic, flexible sheet.

- **"Fluid"** refers to the phospholipid bilayer, whose molecules can move sideways freely, giving the membrane flexibility rather than a rigid, fixed structure.
- **"Mosaic"** refers to the way proteins are scattered throughout the lipid bilayer like tiles in a mosaic pattern, some sitting on the surface (peripheral proteins) and others spanning the whole membrane (integral proteins).
- Cholesterol molecules are embedded within the bilayer to help regulate its fluidity, keeping it stable at different temperatures.
- Carbohydrate chains attach to proteins and lipids on the outer surface, forming glycoproteins and glycolipids used in cell recognition.

This flexible arrangement allows the membrane to carry out selective permeability, cell signalling, and transport of materials.

Structure: The cell wall is a rigid, non-living layer found outside the cell membrane in plant cells, fungi, and bacteria. In plants, it is mainly composed of **cellulose** fibres arranged in a network, along with hemicellulose, pectin, and sometimes lignin for extra strength. It usually has a primary wall (thin, flexible, formed first) and, in some cells, a secondary wall (thicker, formed later).

Functions:

- Provides mechanical strength, shape, and rigidity to the cell.
- Protects the cell from mechanical damage and infection.
- Prevents the cell from bursting when water enters by osmosis (resists turgor pressure).
- Allows movement of water and small molecules through tiny pores.
- Provides support to the whole plant, helping it stand upright.

The nucleus is the "control centre" of the cell and is made up of the following components:

- **Nuclear envelope:** A double membrane that separates the nucleus from the cytoplasm, studded with nuclear pores that regulate the movement of molecules in and out.
- **Nucleoplasm:** The jelly-like matrix inside the nucleus in which other components are suspended.
- **Chromatin:** Long, thread-like strands of DNA wound around histone proteins; condenses into chromosomes during cell division.
- **Nucleolus:** A dense, round body inside the nucleus responsible for producing ribosomal RNA (rRNA) and assembling ribosomal subunits.

Together, these components store genetic information, control the cell's activities, and manage protein synthesis by producing ribosomes and mRNA.

4 Describe the structure and function of the lysosome and endoplasmic reticulum.

Lysosome: A small, membrane-bound, spherical sac produced by the Golgi apparatus and filled with hydrolytic (digestive) enzymes. Its function is to digest worn-out organelles, break down large food molecules, and destroy foreign invaders such as bacteria — helping in intracellular digestion and cell defence.

Endoplasmic Reticulum (ER): A network of interconnected membranous tubules and flattened sacs extending from the nuclear envelope through the cytoplasm. It occurs in two forms:

- **Rough ER (RER):** Studded with ribosomes on its surface; synthesizes and processes proteins.
- **Smooth ER (SER):** Lacks ribosomes; synthesizes lipids and steroids, and detoxifies harmful substances.

The ER also acts as a transport pathway, moving proteins and lipids to other parts of the cell, including the Golgi apparatus.

5 Describe the formation and function of the Golgi complex.

Formation: The Golgi complex (Golgi apparatus) is formed of a stack of flattened, membrane-bound sacs called cisternae, along with associated small vesicles. It receives transport vesicles budding off from the rough endoplasmic reticulum, which carry newly made proteins and lipids.

Function:

- Modifies proteins and lipids received from the ER (e.g., adding sugar chains to form glycoproteins).
- Sorts and packages these molecules into vesicles.
- Directs and ships the finished products to their correct destinations — the cell membrane, lysosomes, or outside the cell via secretion.
- Also plays a role in forming lysosomes.

Structure: The chloroplast is a double-membrane-bound organelle found in plant cells and algae. Inside, it contains a fluid-filled matrix called the **stroma**, and a system of membranous sacs called **thylakoids**, which are stacked into structures called **grana**. The thylakoid membranes contain the green pigment **chlorophyll**, which absorbs light energy. Chloroplasts also contain their own DNA and ribosomes.

Functions:

- Carry out **photosynthesis** — converting light energy, water, and carbon dioxide into glucose and oxygen.
- The light-dependent reactions occur on the thylakoid membranes (grana), producing ATP and NADPH.
- The light-independent reactions (Calvin cycle) occur in the stroma, using ATP and NADPH to build glucose.
- Store starch, the product of photosynthesis, temporarily.

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