BC01 — Cell Biology (Cytology)

📖 BC01 · CDS General Knowledge — Biology ★ High Priority

The cell is the fundamental unit of all life. Every biological process — from muscle contraction to memory — happens inside cells. CDS consistently asks about organelle functions, prokaryote vs eukaryote, and cell division. This chapter builds the vocabulary you need for every other biology chapter.

📌 **CDS Focus:** Mitochondria = powerhouse (ATP); ribosome = protein synthesis; lysosome = suicidal bag; Golgi = packaging; nucleus controls heredity. Mitosis = equational (growth); meiosis = reductional (gametes). Prokaryotes have no membrane-bound nucleus. These exact facts repeat across CDS papers.

PART 1 — CELL THEORY & TYPES

1. Cell Theory & Two Fundamental Cell Types

Cell theory, proposed by Schleiden (1838) and Schwann (1839) and later completed by Virchow (1855), states three things: all living organisms are made of cells; the cell is the basic structural and functional unit of life; and all cells arise from pre-existing cells. The one major exception is **viruses** — they are non-cellular and show life only inside a host.

FIG. 1 — PROKARYOTIC VS EUKARYOTIC CELL: KEY STRUCTURAL DIFFERENCES

PROKARYOTIC vs EUKARYOTIC CELLS		
Feature	**PROKARYOTE**	**EUKARYOTE**
Nucleus (control centre)	**NO membrane-bound** nucleus; naked DNA	**TRUE nucleus** with nuclear membrane
Organelles	**ABSENT** (no membrane-bound)	**PRESENT** (mitochondria, Golgi etc.)
Cell wall	**PRESENT** (peptidoglycan in bacteria)	Plant: cellulose wall Animal: no cell wall
Size & Examples	Smaller (1–10 µm) **Bacteria, Blue-green algae**	Larger (10–100 µm) **Plant, Animal, Fungal cells**
Ribosomes are present in BOTH types (70S in prokaryotes; 80S in eukaryotes)		

PART 2 — CELL ORGANELLES

2. Cell Organelles — Structure and Function

Each organelle is like a specialist department in a factory. The key for CDS is knowing the specific job of each organelle and the memorable nickname associated with it.

FIG. 2 — CELL ORGANELLES: FUNCTION, MEMBRANE TYPE AND KEY FACT

CELL ORGANELLES — Function, Type and Memorable Fact		
Organelle	**Main Function**	**Key Fact / Nickname**
Nucleus Double membrane	Contains DNA (hereditary material). Controls all cell activities.	**"Control Centre"** Nucleolus makes rRNA
Mitochondria Double membrane	Cellular respiration; produces ATP (energy currency).	**"Powerhouse of cell"** Has own DNA (semi-autonomous)
Ribosome No membrane (naked)	Site of protein synthesis (translation of mRNA).	**"Protein factory"** 70S (prokaryote); 80S (eukaryote)
Golgi Body Single membrane	Packaging and secretion of proteins and lipids.	**"Post office of cell"** Forms lysosomes
Lysosome Single membrane	Digests worn-out organelles and foreign material (autolysis).	**"Suicidal bag"** Contains digestive enzymes
Chloroplast Double membrane	Photosynthesis — converts light energy to chemical energy.	**Plants only!** Contains chlorophyll pigment
Vacuole Single membrane	Storage of water, nutrients, and waste products.	**Plant: one large central** Animal: many small vacuoles
ER (Rough): has ribosomes; makes proteins | ER (Smooth): no ribosomes; makes lipids & detoxification		

PART 3 — CELL DIVISION

3. Cell Division — Mitosis and Meiosis

Cells divide for two purposes: to grow and repair (mitosis) and to form sex cells for reproduction (meiosis). Understanding which is which — and why — is critical for CDS.

FIG. 3 — MITOSIS VS MEIOSIS: PURPOSE, CHROMOSOME COUNT AND STAGES

MITOSIS vs MEIOSIS — The Two Types of Cell Division

MITOSIS — Equational Division	MEIOSIS — Reductional Division
Purpose: Growth, repair, and replacement of somatic (body) cells.	**Purpose:** Formation of gametes (sperm and egg cells).
Result: **2 daughter cells** Same chromosome number as parent cell (2n → 2n). Cells are genetically identical.	**Result:** **4 daughter cells** HALF the chromosome number of parent cell (2n → n). Cells are genetically varied.
Stages: Prophase → Metaphase → Anaphase → Telophase	**Stages:** Meiosis I (reductional) + Meiosis II (equational)

💡 **Human = 46 Chromosomes (23 pairs):** After meiosis, gametes (sperm and egg) each carry **23 chromosomes** (haploid, n). When sperm and egg fuse at fertilisation, the resulting zygote restores the full complement of **46 chromosomes** (diploid, 2n). This halving and doubling keeps the chromosome number stable across generations. It is one of the most directly tested CDS biology facts.

PART 4 — TISSUES

4. Animal Tissues

Tissue TypeStructure & LocationFunction **Epithelial**Cells tightly packed; line body surfaces — skin, gut lining, lung surfaceProtection, absorption, secretion, filtration **Connective**Cells scattered in matrix — bone, cartilage, blood, adipose, tendonsSupport, binding, transport (blood), insulation (fat) **Muscular**Skeletal (voluntary, striated); Smooth (involuntary, unstriated); Cardiac (heart muscle, involuntary striated)Movement and locomotion **Nervous**Neurons (nerve cells) with axon and dendrites; found in brain, spinal cord, nervesTransmission of electrical signals; coordination

📝 CDS PYQs — Cell Biology

Q1. Which organelle is called the "powerhouse of the cell"? CDS PYQ

(a) Nucleus (b) Ribosome (c) Mitochondria (d) Golgi apparatus

✓ Answer: (c) Mitochondria

The **mitochondria** produces ATP (adenosine triphosphate) through cellular respiration — the energy currency that powers every cellular activity. It has its own DNA and ribosomes, making it semi-autonomous. This is why it is called the powerhouse. The number of mitochondria is highest in metabolically active cells like liver cells, muscle cells, and sperm (flagellum movement). This is the single most repeated CDS cell biology question.

Q2. Lysosomes are known as "suicidal bags" because: CDS PYQ

(a) They produce energy

(b) They contain digestive enzymes that can destroy the cell itself

(c) They carry genetic information (d) They synthesise proteins

✓ Answer: (b) Contain digestive enzymes

Lysosomes contain around 40 different hydrolytic (digestive) enzymes. When a cell is damaged or during programmed cell death (apoptosis), the lysosome membrane ruptures and releases these enzymes into the cell cytoplasm, digesting the entire cell from within — hence "suicidal bags." They also digest foreign particles and worn-out organelles (autophagy). This CDS question appears in multiple years.

Q3. Cell division that produces gametes (sperm/egg) is called: CDS PYQ

(a) Mitosis (b) Meiosis (c) Binary fission (d) Budding

✓ Answer: (b) Meiosis

Meiosis is called reductional division because it halves the chromosome number from 2n (diploid) to n (haploid). It produces 4 genetically varied gametes. Mitosis produces 2 genetically identical cells with the same chromosome number (equational division) — used for growth and repair. Germ cells (in testes and ovaries) undergo meiosis; all other body cells undergo mitosis.

Q4. Which of the following is NOT found in a plant cell? Tricky

(a) Cell wall (b) Chloroplast (c) Centriole (d) Vacuole

✓ Answer: (c) Centriole

Centrioles are absent in plant cells. They are present in animal cells and play a key role in forming the spindle fibres during cell division. Plants manage cell division without centrioles. Cell wall (cellulose), chloroplasts, and large central vacuole are all found in

plant cells but not in animal cells — the reverse of this question also appears in CDS. This four-way plant-animal comparison is extremely important.

🧠 Quick Memory Chart — BC01

💡 Organelle Nicknames

- Mitochondria: **Powerhouse**
- Ribosome: **Protein factory**
- Lysosome: **Suicidal bag**
- Golgi: **Post office / packaging**
- Nucleus: **Control centre**

♿ Division Key Facts

- Mitosis: 2 cells, same 2n; growth & repair
- Meiosis: 4 cells, half n; gametes
- Human: 46 chromosomes (2n)
- Gametes: 23 chromosomes (n)
- Stages: P-M-A-T (Pro-Meta-Ana-Telo)

📈 Plant vs Animal Cell

- Plant only: cell wall, chloroplast, large vacuole
- Animal only: centriole, cholesterol membrane
- Prokaryote: no membrane-bound nucleus
- Ribosome: both pro & eukaryote
- Viruses: non-cellular (exception to cell theory)

📝 Practice Exercise

E1. Which organelle is the site of protein synthesis?

(a) Golgi body (b) Lysosome (c) Ribosome (d) Mitochondria

E2. Ribosomes of prokaryotic cells are:

(a) 80S (b) 70S (c) 60S (d) 90S

E3. The process of a cell digesting its own components using lysosomal enzymes is called:

(a) Phagocytosis (b) Autophagy (c) Exocytosis (d) Pinocytosis

E4. Mitosis results in:

(a) 4 haploid cells (b) 2 diploid cells genetically identical to parent

(c) 2 haploid cells (d) 4 diploid cells

Answers:

E1 → (c) Ribosome [both free and ER-attached ribosomes translate mRNA into proteins] | E2 → (b) 70S [Eukaryotic ribosomes = 80S; the 'S' stands for Svedberg sedimentation units; antibiotics target 70S] | E3 → (b) Autophagy [auto = self; phagocytosis = engulfing external particles] | E4 → (b) 2 diploid cells genetically identical [mitosis preserves both chromosome number and genetic content]