13.1 Organelles and compartmentalization

Name: _____ Class: _____ Date: _____ **Total: 24 marks**

KEY WORDS organelle • compartmentalization • cell fractionation • lysosome • centrifuge • nuclear pore

Objective

Build the skills to answer exam questions on **organelles and compartmentalization** : why cells have compartments, the nucleus, and how cell fractionation separates organelles.

You must be able to:

- explain the advantages of separating the nucleus from the cytoplasm
- explain how compartments such as lysosomes and vacuoles help cells work
- describe how organelles are separated by cell fractionation
- distinguish organelles from other cell structures
- relate the structures of mitochondria, chloroplasts, nuclear pores and the Golgi apparatus to their functions

1 Key knowledge and worked examples

■ Organelles and compartmentalization

Organelles are separate structures inside a cell with a specific job. The cell wall, cytoskeleton and cytoplasm are **not** organelles.

The nucleus: keeps DNA apart from the cytoplasm. **Transcription** (making mRNA) happens in the nucleus, and the mRNA can be **modified** before it reaches the ribosomes. Prokaryotes have no nucleus, so their mRNA is translated straight away.

Compartments keep conditions and enzymes in one place: **lysosomes** hold digestive enzymes that would damage the cytoplasm; **phagocytic vacuoles** digest bacteria; enzymes and substrates are more concentrated, so reactions are faster.

Cell fractionation: cells are broken up in a cold, **isotonic**, **buffered** solution, then spun in a centrifuge at **increasing speeds**. The densest organelles (nuclei) sink first, then mitochondria and chloroplasts, then ribosomes.

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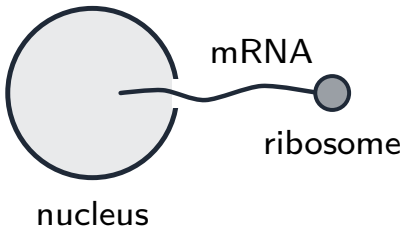
HL: mitochondria: a folded inner membrane (**cristae**) gives a large area for the electron transport chain; the matrix holds Krebs-cycle enzymes. **Chloroplasts**: stacks of **thylakoids** (grana) give a large area for light absorption; the stroma holds Calvin-cycle enzymes. **Nuclear pores** let mRNA out and proteins in. **Free ribosomes** make proteins for the cytoplasm; ribosomes on the **rough ER** make proteins for secretion, which the **Golgi apparatus** modifies and packs into vesicles.

Worked example. Why cold? Low temperature slows enzymes released from lysosomes, so they do not digest the organelles.

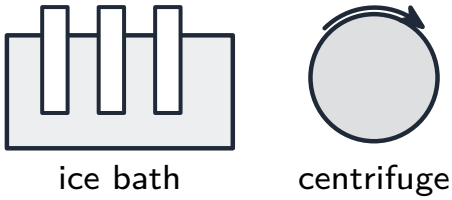
Answer shapes: organelle → structure → function, with "so".

2 Practice

2.1 State two advantages of separating the nucleus from the cytoplasm. [2]



2.2 Explain why the solution used in cell fractionation must be cold, isotonic and buffered. [3]

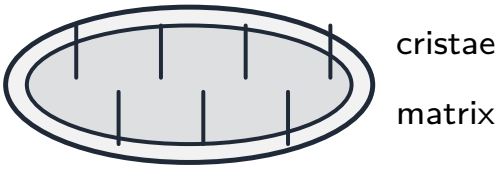


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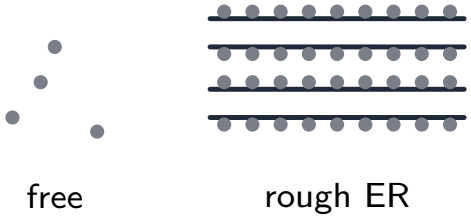
2.3 Explain how lysosomes show the advantage of compartmentalization. [3]



2.4 Explain how the structure of a mitochondrion suits its function. [2]



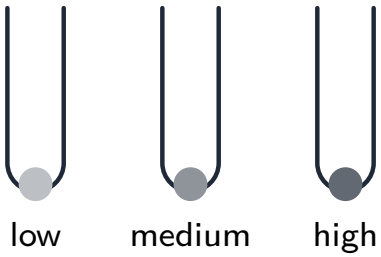
2.5 State the difference in function between free ribosomes and ribosomes attached to the rough ER. [2]



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3 Exam-style questions

3.1 Liver cells were broken up and spun in a centrifuge at increasing speeds.



speed / g	time / min	pellet contains
1000	10	P
10 000	20	mitochondria
100 000	60	Q

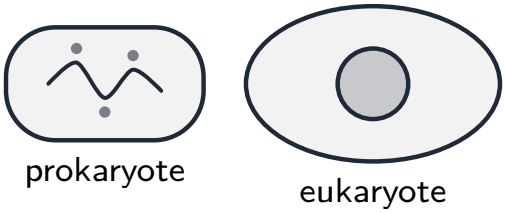
(a) Identify P and Q. [2]

(b) Explain why P forms a pellet at the lowest speed. [2]

(c) Suggest why the cell wall is not listed as an organelle. [2]

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3.2 Prokaryotes have no nucleus.



(a) State where transcription and translation happen in a eukaryotic cell. [2]

(b) Explain one advantage for a prokaryote of having no nuclear membrane. [2]

(c) Explain why phagocytic vacuoles help a white blood cell kill bacteria safely. [2]

Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

any two: protects DNA; mRNA can be modified before translation; transcription and translation kept apart / controlled

2.2

cold: slows enzymes that would digest organelles; isotonic: no water moves in or out by osmosis, so organelles do not burst or shrink; buffered: keeps the pH constant so proteins are not denatured

2.3

lysosomes hold digestive enzymes inside a membrane; this keeps them from digesting the cell's own contents; enzymes are concentrated with their substrate / kept at their best pH, so digestion is efficient

2.4

cristae give a large area for the electron transport chain / ATP synthase; the matrix holds the enzymes of the link reaction and Krebs cycle

2.5

free ribosomes make proteins used inside the cell (in the cytoplasm); ribosomes on the rough ER make proteins for secretion / membranes / lysosomes

3.1

(a) P: nuclei; Q: ribosomes

(b) nuclei are the largest / densest organelles; so they sink first, at the lowest speed

(c) an organelle is a separate structure inside the cell; the cell wall is outside the plasma membrane

3.2

(a) transcription: in the nucleus; translation: at ribosomes in the cytoplasm / on the rough ER

(b) translation can start while the mRNA is still being made; so proteins are made quickly in response to change

(c) the bacterium is kept inside a membrane, separate from the cytoplasm; enzymes / toxic chemicals can be added to the vacuole without harming the cell