



Organelles and compartmentalization: practice questions

8 questions • 25 marks • mark scheme at the back

For IB Diploma Biology, Standard Level and Higher Level (first assessment 2025). **HL only** is additional higher level content, for HL students only.

Name

Total / 25

1 PAPER 1A STYLE

[1 mark]

Which structure is considered an organelle?

- A. ☐ Cell wall
- B. ☐ Cytoskeleton
- C. ☐ Ribosome
- D. ☐ Cytoplasm

2

[6 marks]

Liver tissue was homogenised in an ice-cold, isotonic, buffered solution and separated by differential centrifugation. Each fraction was tested for DNA and for the activity of two enzymes: succinate dehydrogenase, a Krebs cycle enzyme, and acid phosphatase, a hydrolytic enzyme found in lysosomes. The data are for practice. (a) Identify, with a reason, the fraction that contains most nuclei. [1] (b) Deduce which fraction contains most mitochondria. [1] (c) Suggest why some acid phosphatase activity is found in pellet 2. [1] (d) Explain why the homogenate was kept ice-cold, isotonic and buffered. [3]

Percentage of the total DNA and enzyme activity found in each fraction				
Fraction	Centrifugation	DNA / %	Succinate dehydrogenase activity / %	Acid phosphatase activity / %
Pellet 1	1 000 × g for 10 min	95	4	3
Pellet 2	10 000 × g for 20 min	2	88	30
Pellet 3	20 000 × g for 30 min	1	6	55
Final supernatant	None	2	2	12

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[2 marks]

Outline the advantage of separating the nucleus and cytoplasm into separate compartments.

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4 PAPER 2A STYLE

[3 marks]

Explain, using lysosomes and phagocytic vacuoles as examples, the advantages of compartmentalization in the cytoplasm of cells.

5 PAPER 1A STYLE

[1 mark]

HL only

Which feature of the mitochondrion allows a high concentration of protons to build up quickly during aerobic respiration?

- A. ☐ The large surface area of the cristae
- B. ☐ The small volume of the intermembrane space
- C. ☐ The enzymes of the Krebs cycle in the matrix
- D. ☐ The double membrane surrounding the mitochondrion

6 PAPER 2A STYLE

[3 marks]

HL only

Explain how the structure of the chloroplast is adapted for photosynthesis.

7 PAPER 2A STYLE

[2 marks]

HL only

Outline why the nuclear membrane needs pores, and why it breaks into vesicles during mitosis.

HL only

Explain how a protein that is secreted from a cell is synthesized, processed and released.

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Mark scheme

One mark for each point unless a maximum is given. Words in brackets are not needed for the mark.

1. [1]

C C: ribosomes are organelles; the cell wall, cytoskeleton and cytoplasm are not [1]

2. [6]

- (a) pellet 1, because it contains most of the DNA / 95 % of the DNA [1]
- (b) pellet 2, because it has the highest succinate dehydrogenase activity / 88 % [1]
- (c) some lysosomes are similar in size / density to mitochondria, so they sediment with them OWTTE [1]
- (d) cold reduces enzyme activity / stops hydrolytic enzymes digesting the organelles [1]
- (d) isotonic solution prevents water moving into or out of organelles by osmosis / stops organelles bursting or shrinking [1]
- (d) buffer keeps pH constant so proteins / enzymes are not denatured [1]

3. [2]

- transcription (in the nucleus) is separated from translation (in the cytoplasm) [1]
- mRNA can be modified after transcription before it meets ribosomes [1]
- for example, introns removed [1]
- in prokaryotes mRNA may meet ribosomes immediately, so this is not possible [1]
- max 2

4. [3]

- enzymes and substrates / metabolites can be concentrated, so reactions are faster [1]
- incompatible processes are kept separate [1]
- lysosomes contain hydrolytic / digestive enzymes that would digest cell components if free in the cytoplasm [1]
- lysosome contents can be kept at acid pH, the optimum for these enzymes [1]
- phagocytic vacuole forms by endocytosis of a pathogen; lysosomes fuse with it so digestion happens inside a compartment [1]
- max 3

5. [1] **HL only**

B B: protons are pumped into a small volume, so their concentration rises quickly [1]

6. [3] **HL only**

- thylakoid membranes have a large surface area / are stacked in grana [1]
- for many photosystems / more light absorption [1]
- small volume of fluid inside the thylakoids [1]
- so a steep proton gradient builds quickly for ATP production [1]
- stroma compartmentalizes the enzymes and substrates of the Calvin cycle [1]
- max 3

7. [2] HL only

- pores allow mRNA to leave the nucleus [1]
- pores allow proteins (such as enzymes or histones) to enter from the cytoplasm [1]
- membrane breaks into vesicles so spindle microtubules can reach / attach to / move chromosomes [1]
- vesicles later fuse to re-form nuclear membranes around each set of chromosomes [1]
- Award [1] max for pores and [1] max for vesicles
- max 2

8. [7] HL only

- protein synthesized by ribosomes bound to the rough ER [1]
- free ribosomes make proteins retained in the cell, so secreted proteins are made on the rER [1]
- polypeptide enters the lumen of the rER [1]
- protein transported from the rER to the Golgi apparatus in vesicles [1]
- vesicles fuse with the cis face of the Golgi apparatus [1]
- protein processed / modified in the Golgi apparatus, for example carbohydrate added [1]
- secretory vesicles bud from the trans face of the Golgi apparatus [1]
- protein folds / is modified in the rER lumen, for example carbohydrate added [1]
- vesicles move to the plasma membrane [1]
- vesicle fuses with the plasma membrane and the protein is released by exocytosis [1]
- fusion and budding are possible because membranes are fluid [1]
- Do not credit clathrin as coating the vesicles that carry the protein from the rER to the Golgi apparatus
- max 7