

# IB Biology B2.2 - Organelles and Compartmentalization

## Worksheet 2: Tools for cell research and Nature of Science

Name:	_____	Class:	_____	Date:	_____
Time suggested:	55-65 minutes	Total marks:	34	Level:	SL/HL mixed

Instructions: Answer all questions. Show biological reasoning clearly. HL questions are included where the topic requires HL understanding. The answer key and marking guidance are provided at the end for teacher/student review.

### Section A: Multiple choice (6 marks)

**A1.** Which technique separates cell components by spinning samples at high speed? [1 mark]

- A. Chromatography
- B. Gel electrophoresis
- C. Centrifugation
- D. Fluorescence microscopy

**A2.** Which organelles would generally pellet before smaller ribosomes during centrifugation? [1 mark]

- A. Nuclei and mitochondria
- B. Ribosomes only
- C. mRNA molecules
- D. Amino acids

**A3.** Gel electrophoresis separates molecules mainly by... [1 mark]

- A. density only
- B. size and charge in an electric field
- C. colour only
- D. ability to photosynthesize

**A4.** Ethidium bromide is used because it... [1 mark]

- A. digests proteins
- B. fluoresces when associated with DNA fragments
- C. breaks organelles into vesicles
- D. forms mitochondria

**A5.** Which molecules are commonly separated using chromatography? [1 mark]

- A. Whole nuclei only
- B. Amino acids, proteins, carbohydrates and pigments
- C. Only intact cells
- D. Only ribosomes

**A6.** The Nature of Science idea shown by ultracentrifugation is that scientific progress often follows... [1 mark]

- A. development of new techniques
- B. removal of all evidence
- C. avoidance of instruments
- D. replacement of experiments by opinion

### Section B: Short answer

**B1.** Outline the main steps used in cell fractionation to isolate organelles. [4 marks]

**B2.** Compare chromatography and gel electrophoresis as separation techniques. [4 marks]

**B3.** Explain why fluorescent dyes improve investigations of cell molecules. [4 marks]

### Section C: Data response / case study (8 marks)

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**C1. Data response: differential centrifugation**

A homogenized liver cell sample was centrifuged in stages. The table shows the main pellet observed at each stage.

Stage	Relative speed	Main pellet	Supernatant still contains
1	Low	Nuclei and unbroken cells	Mitochondria, lysosomes, ribosomes, soluble molecules
2	Medium	Mitochondria and lysosomes	Ribosomes, soluble molecules
3	High	Ribosomes/small vesicles	Soluble proteins and metabolites

**C1a.** Identify the stage most suitable for collecting mitochondria. **[1 mark]**

**C1b.** Explain why nuclei pellet at a lower speed than ribosomes. **[2 marks]**

**C1c.** Suggest why a scientist might test the mitochondrial pellet for ATP production. **[2 marks]**

**C1d.** State two precautions needed when interpreting fractionation data. **[3 marks]**

**Section D: Extended response (8 marks)**

**D1.** Discuss how developments in scientific techniques have improved understanding of organelles. **[8 marks]**

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# Answer key and marking guidance

Worksheet 2: Tools for cell research and Nature of Science - Total: 34 marks

Use the guidance below flexibly. Award credit for scientifically correct equivalent wording. Do not award marks for vague statements unless they are supported by a correct biological explanation.

## Section A: Multiple choice

Question	Answer	Guidance
A1	C	Centrifugation separates by density/size/shape in a spinning tube.
A2	A	Larger/heavier structures pellet at lower speeds.
A3	B	Molecules migrate through a gel due to charge and size.
A4	B	It makes DNA fragments visible under UV light.
A5	B	Chromatography can separate pure substances such as amino acids and pigments.
A6	A	New techniques allow scientists to study cell parts in more detail.

## Section B: Short answer

**B1.** [4 marks] Break cells/open membranes; place sample in tube; spin at high speeds; separate components according to density/size/shape; heavier/larger components collect at bottom/pellet.

**B2.** [4 marks] Both separate mixtures. Chromatography separates molecules by movement through a medium, often depending on size/affinity; gel electrophoresis uses an electric field and separates by size and charge; electrophoresis is commonly used for nucleic acids.

**B3.** [4 marks] Dyes bind specific molecules; absorb light at one wavelength and emit longer wavelength; increase visibility/contrast; allow DNA/proteins/fragments to be detected after separation.

## Section C: Data response / case study

**C1.** C1a: Stage 2. C1b: Nuclei are larger/heavier/denser so they sediment at lower speed; ribosomes are much smaller and require higher speed. C1c: Mitochondria are adapted for aerobic respiration and ATP production; testing confirms the pellet contains functional mitochondria. C1d: Fractions may be contaminated with other organelles; organelles can be damaged during homogenization; relative speed/time affects results; results should be checked with marker enzymes or microscopy.

*Marking guidance: Award marks according to the mark allocations shown in the question. For data questions, credit both correct interpretation of the data and correct biological explanation.*

## Section D: Extended response

**D1.** [8 marks] Award marks for references to improved light/electron microscopy, ultracentrifuges, cell fractionation, chromatography, gel electrophoresis, fluorescent dyes, and specific examples of what each technique reveals. Award synthesis marks for linking new tools to reductionism and understanding organelle function.

*Suggested extended-response marking bands: 0-2 limited statements with major omissions; 3-4 some relevant ideas but weak links; 5-6 mostly accurate with examples and links to function; 7-8/10 detailed, well-organized, balanced and fully linked to the question. For 10-mark questions, use 9-10 for exceptionally thorough synthesis and evaluation.*