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# IB Biology B2.2 - Organelles and Compartmentalization

## Worksheet 3: Nucleus, cytoplasm and mRNA processing

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.*

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

**A1.** In eukaryotic cells, transcription mainly occurs in the... [1 mark]

- A. cytoplasm
- B. nucleus
- C. Golgi apparatus
- D. lysosome

**A2.** In eukaryotic cells, translation occurs mainly at... [1 mark]

- A. ribosomes in the cytoplasm or on rough ER
- B. nuclear pores
- C. chromatin only
- D. cell walls

**A3.** Which process can occur before eukaryotic mRNA meets ribosomes? [1 mark]

- A. Post-transcriptional modification
- B. Photosynthesis
- C. Phagocytosis
- D. Centrifugation

**A4.** Why is immediate translation of newly made mRNA possible in prokaryotes? [1 mark]

- A. They have many chloroplasts
- B. They lack a nucleus separating DNA from ribosomes
- C. Their mRNA cannot bind ribosomes
- D. They have no cytoplasm

**A5.** The separation of transcription and translation can reduce errors by allowing... [1 mark]

- A. mRNA processing before protein synthesis
- B. mitochondria to digest DNA
- C. chloroplasts to make proteins for secretion
- D. cell walls to become organelles

**A6.** Which organelle provides genetic control? [1 mark]

- A. Nucleus
- B. Lysosome
- C. Golgi apparatus
- D. Plasma membrane only

### Section B: Short answer

**B1.** Distinguish between transcription and translation. [4 marks]

**B2.** Explain why the nucleus is a compartment rather than just a storage area. [4 marks]

**B3.** Suggest why prokaryotic cells cannot carry out the same level of pre-translation mRNA processing as eukaryotic cells. [4 marks]

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

### C1. Case study: timing of mRNA use

Researchers compared the average time between mRNA synthesis and first ribosome binding in two cell types.

Cell type	Nucleus present?	Average delay before ribosome binding	mRNA processing observed
Eukaryotic cell	Yes	Several minutes	High
Prokaryotic cell	No	Almost immediate	Low/limited

**C1a.** State the relationship between the presence of a nucleus and delay before ribosome binding. **[2 marks]**

**C1b.** Explain why the eukaryotic delay can be beneficial. **[2 marks]**

**C1c.** Predict what would happen if nuclear pores were blocked. **[2 marks]**

**C1d.** Suggest one reason why prokaryotes may still successfully produce proteins without a nucleus. **[2 marks]**

## Section D: Extended response (8 marks)

**D1.** Explain the advantage of separating the nucleus and cytoplasm in eukaryotic cells. **[8 marks]**

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# Answer key and marking guidance

Worksheet 3: Nucleus, cytoplasm and mRNA processing - 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	B	Transcription occurs in the nucleus.
A2	A	Ribosomes translate mRNA.
A3	A	Nuclear separation allows mRNA processing before translation.
A4	B	No nuclear envelope separates transcription and translation.
A5	A	mRNA can be modified/checked before translation.
A6	A	The nucleus houses DNA and controls gene expression.

## Section B: Short answer

**B1.** [4 marks] Transcription uses DNA as a template to make mRNA; translation uses mRNA code at ribosomes to build a polypeptide/protein. Include locations for eukaryotes: nucleus vs cytoplasm/ribosomes.

**B2.** [4 marks] It is enclosed by a double membrane; controls exchange through pores; protects DNA from cytoplasmic reactions; allows mRNA processing; contains nucleolus/chromatin/nucleoplasm.

**B3.** [4 marks] No nucleus/nuclear envelope; transcription and translation occur in same cytoplasmic region; ribosomes can bind mRNA immediately; less separation/time for modification before translation.

## Section C: Data response / case study

**C1.** C1a: The cell with a nucleus has a longer delay before ribosomes bind mRNA. C1b: The delay allows post-transcriptional processing/modification and reduces errors before translation. C1c: mRNA could not leave the nucleus efficiently, so translation/protein synthesis in the cytoplasm would decrease. C1d: Prokaryotic genes are organized for rapid expression; ribosomes can translate directly; they have simpler organization and different control mechanisms.

*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 for: DNA protected/controlled environment, transcription in nucleus, translation in cytoplasm, mRNA processing before translation, nuclear pores regulate movement, ribosomal subunits made in nucleolus and exported, reduced protein-production errors, comparison with prokaryotes.

*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.*