IB Biology B2.2 - Organelles and Compartmentalization

Worksheet 4: Cytoplasmic compartmentalization, lysosomes and phagocytosis

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 organelle contains enzymes for digesting worn-out organelles and material brought in by endocytosis? **[1 mark]**

A. Lysosome
B. Chloroplast
C. Ribosome
D. Cell wall

A2. A phagocytic vacuole forms when a cell... **[1 mark]**

A. copies DNA in the nucleus
B. engulfs a food particle or pathogen
C. exports a hormone
D. absorbs light in thylakoids

A3. Why are lysosomal enzymes kept inside a membrane-bound organelle? **[1 mark]**

A. They must absorb sunlight
B. They could damage healthy cell structures
C. They are made only of DNA
D. They prevent mRNA leaving the nucleus

A4. Which sequence best describes phagocytosis and digestion? **[1 mark]**

A. Fusion with lysosome -> entrapment -> digestion
B. Entrapment -> vacuole formation -> lysosome fusion -> digestion
C. Translation -> transcription -> secretion
D. Photosystem activation -> Calvin cycle -> exocytosis

A5. The concentration of enzymes and metabolites in one compartment helps pathways because it... **[1 mark]**

A. slows all reactions
B. makes reactions easier to control and more efficient
C. removes the need for substrates
D. prevents all membrane transport

A6. A pathogen is best described as... **[1 mark]**

A. a protein-synthesis organelle
B. a disease-causing organism
C. a chloroplast membrane
D. a DNA fluorescent dye

Section B: Short answer

B1. Outline two advantages of compartmentalization in the cytoplasm. **[4 marks]**

B2. Explain how lysosomes and phagocytic vacuoles work together during defence against pathogens. **[4 marks]**

B3. Suggest why a cell with high rates of intracellular digestion would contain many lysosomes. **[4 marks]**

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

C1. Data response: lysosomal enzyme activity

A class investigated a digestive enzyme extracted from lysosomes. Activity was measured at different pH values.

pH	Relative enzyme activity
2	35
4	100
6	45
7	18
8	5

C1a. Identify the optimum pH for this lysosomal enzyme. **[1 mark]**

C1b. Explain how compartmentalization can maintain suitable conditions for lysosomal enzymes. **[2 marks]**

C1c. Predict the effect of lysosome rupture in the cytoplasm. **[2 marks]**

C1d. Use the data to explain why lysosomal enzymes may be less active in neutral cytoplasm. **[3 marks]**

Section D: Extended response (8 marks)

D1. Explain how cytoplasmic compartmentalization supports both metabolism and cellular protection. **[8 marks]**

Answer key and marking guidance

Worksheet 4: Cytoplasmic compartmentalization, lysosomes and phagocytosis - 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	A	Lysosomes contain digestive enzymes.
A2	B	Phagocytosis forms a vacuole around engulfed material.
A3	B	Digestive enzymes need isolation from the cytoplasm.
A4	B	Engulfment produces a vacuole, which fuses with lysosomes for digestion.
A5	B	Concentration supports efficient controlled pathways.
A6	B	A pathogen causes disease.

Section B: Short answer

B1. [4 marks] Concentrates enzymes/metabolites; separates incompatible biochemical processes; protects the cell from destructive enzymes; permits division of labour; allows control of reaction conditions such as pH.

B2. [4 marks] Pathogen is engulfed by endocytosis/phagocytosis; phagocytic vacuole forms; vacuole fuses with lysosome; lysosomal enzymes digest/inactivate pathogen.

B3. [4 marks] More lysosomes provide more digestive enzymes; can fuse with more vacuoles; allow rapid breakdown of waste/pathogens/damaged organelles; enzymes remain compartmentalized and controlled.

Section C: Data response / case study

C1. C1a: pH 4. C1b: The lysosome membrane separates the enzyme from cytoplasm and can maintain an acidic internal environment. C1c: Digestive enzymes may damage cellular components, although activity may be reduced if cytoplasmic pH is less optimal. C1d: Activity falls from 100 at pH 4 to 18 at pH 7; neutral cytoplasm is far from optimum, so enzyme shape/activity is reduced.

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: organelles as division of labour, concentrated enzymes/substrates, control of pH/conditions, separation of incompatible reactions, lysosomes as example of protection, phagocytic vacuoles as protection during pathogen uptake, need for membrane transport/coordination.

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.