

14.1 Specialized cells: structure linked to function

Name: _____ Class: _____ Date: _____

Total: 10 marks

KEY WORDS differentiation • gene expression

Objective

Specialized cells: structure linked to function. Supported HL concept preparation; original classroom practice, not an official IB paper or assessed learner work.

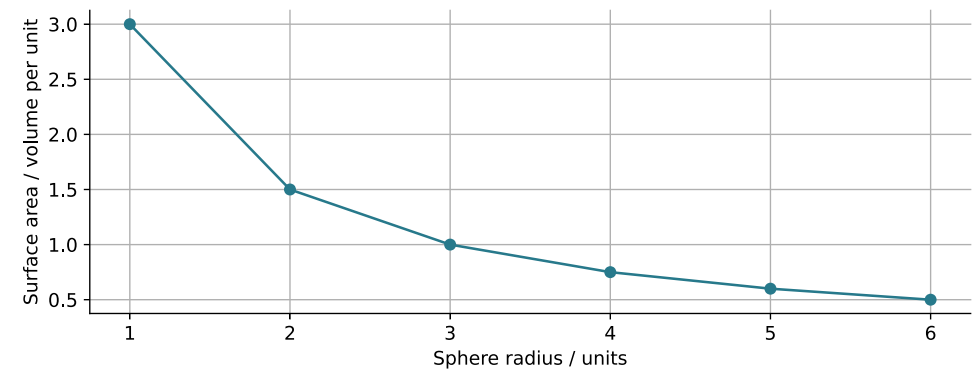
1 Key knowledge and worked examples

■ What would explain this observation?

- A root-hair cell and a red blood cell have different shapes because their functions impose different demands.
- Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.

■ Build the model

- **Differentiation** produces specialized cells through different patterns of **gene expression**. A root-hair extension increases exchange area. A mammalian red blood cell lacks a nucleus at maturity and contains haemoglobin; this is a specific adaptation, not a rule for all animal cells.
- differentiation: Development of specialized cell structure and function; gene expression: Use of genetic information to produce a functional product.



■ Choose evidence that can test it

- Link a named feature to a mechanism and then to the function. Increased area can support exchange, but membrane proteins, gradients and metabolic demand also matter. Stem cells retain different degrees of developmental potential.
- Compare scaled drawings of named cells. Label the structure, state the function and explain the causal link. Use tissue-specific examples rather than saying every specialized cell has every adaptation.

■ Work from known quantities

- State the known values and their units. Choose the relation because its assumptions fit this case, then rearrange before substitution.
- Known: a spherical model cell has radius 2 units. Surface area/volume = $3/r = 1.5$ per unit. A radius of 4 gives 0.75 per unit. Doubling radius halves this ratio, even though total area increases.

Example:

For a sphere, surface area/volume = $3/r$. Find this ratio when $r = 6$ units. Use the same sequence: known quantities → model → relation → substitution → unit and interpretation.

■ Check the conclusion and its limits

- Specialization does not usually require a cell to lose most of its genes. The spherical calculation models geometry; it does not describe every actual cell shape.
- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

All mature animal cells lack a nucleus. This claim is false: Specialization does not usually require a cell to lose most of its genes. The spherical calculation models geometry; it does not describe every actual cell shape.

Key:

Specialized cells: structure linked to function: Link a named feature to a mechanism and then to the function. Increased area can support exchange, but membrane proteins, gradients and metabolic demand also matter. Stem cells retain different degrees of developmental potential.

2 Practice

2.1 What best explains many differences between specialized cells? Choose one answer.

- **A** They express different sets of genes
- **B** Every cell has a different genetic code
- **C** They have no shared ancestry

[1]

2.2 For a sphere, surface area/volume = $3/r$. Find this ratio when $r = 6$ units. Show the relation, substitution and units.

[2]

2.3 Decide whether this claim is true and justify: All mature animal cells lack a nucleus.

[2]

2.4 Development of specialized cell structure and function: write the technical term.

[1]

3 Exam-style questions

3.1 A spherical cell doubles radius. Compare area, volume and SA/V factors; explain why total area increasing does not remove exchange constraints.

[4]

Solutions

2.1 A Link a named feature to a mechanism and then to the function. Increased area can support exchange, but membrane proteins, gradients and metabolic demand also matter. Stem cells retain different degrees of developmental potential.

2.2 $SA/V = 3/r = 3/6 = 0.5$ per unit length.

2.3 False. Specialization does not usually require a cell to lose most of its genes. The spherical calculation models geometry; it does not describe every actual cell shape.

2.4 differentiation. differentiation means Development of specialized cell structure and function.

3.1 $\text{Area} \times 4$, $\text{volume} \times 8$, $SA/V \times 1/2$. Exchange capacity per volume falls in the geometric model; actual cell specialization also involves shape, transport and demand.