IB Biology B2.3 Cell Specialization

Worksheet 3 - Stem Cell Niches and Self-Renewal

Name:	Class:	Date:
_____	_____	_____

Focus: B2.3.2-B2.3.3: properties of stem cells, niches in adult humans, bone marrow and hair follicles

Instructions: Answer all questions. Use named examples when asked. Full sentences are expected for short-answer and extended-response questions.

Section A - Multiple choice

1. Self-renewal means that stem cells

A. always form only differentiated cells
B. maintain a population of stem cells after division
C. cannot divide
D. lose all DNA

2. Which pair are suitable examples of human stem cell niches?

A. bone marrow and hair follicles
B. red blood cells and sperm tails
C. alveolar lumen and acrosome
D. haemoglobin and surfactant

3. Bone marrow stem cells are important because they produce

A. different blood cells
B. pulmonary surfactant
C. egg cells
D. cardiac intercalated discs

4. Hair follicle stem cells are described as

A. totipotent
B. multipotent
C. non-living
D. fully differentiated red blood cells

5. A stem cell niche can

A. maintain stem cells or promote proliferation and differentiation
B. prevent any signalling
C. remove all mitotic spindle activity
D. turn every cell into a zygote

6. In a typical stem cell division, one daughter cell may remain a stem cell while the other

A. must lose its plasma membrane
B. may differentiate
C. must become an embryo
D. must become a gamete

Section B - Short answer

1. Define a stem cell niche. [2 marks]

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2. Describe how stem cell division can maintain the stem cell population while producing differentiated cells. [3 marks]

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3. Explain why blood vessels are important in the bone marrow niche. [2 marks]

4. State two functions supported by stem cells in hair follicles. [2 marks]

Section C - Data response / case study

Data response: proportions of cells in a bone marrow culture

A culture of bone marrow cells was monitored for six days after a signal factor was added.

Day	Stem cells (%)	Early blood-cell precursors (%)	Differentiated blood cells (%)
0	70	25	5
2	55	32	13
4	44	36	20
6	38	34	28

1. Describe the change in the percentage of differentiated blood cells. [2 marks]

2. Suggest what effect the signal factor had on the culture. [2 marks]

3. Explain why the stem cell percentage did not fall to zero. [2 marks]

Section D - Extended response

Extended response: Explain the importance of adult stem cell niches in tissue maintenance and repair, using bone marrow and hair follicles as examples. [7 marks]

Answer key and marking guidance - Worksheet 3 - Stem Cell Niches and Self-Renewal

Use this section for teacher marking or student self-assessment. Award credit for equivalent wording if the biological idea is accurate and clearly expressed.

- MCQ: 1 B; 2 A; 3 A; 4 B; 5 A; 6 B.

- Niche: a specific microenvironment/location where stem cells are maintained (1) and receive signals that regulate self-renewal, proliferation and differentiation (1).

- Division: stem cell divides by mitosis (1); at least one daughter may remain a stem cell (self-renewal) (1); another daughter may differentiate into a specialized cell (1).

- Bone marrow vessels: transport differentiated blood cells away (1); supply nutrients/oxygen and support niche conditions (1).

- Hair follicle functions: hair growth (1); skin regeneration, hair follicle regeneration or sebaceous gland production (1).

- Data: differentiated blood cells increased from 5% to 28% (1); steady/rising increase over six days (1).

- Signal factor: promoted differentiation/proliferation of blood-cell lineages (1); reduced relative proportion of stem cells as more cells became precursors/differentiated cells (1).

- Stem cells remain: some divisions produce daughter cells that self-renew (1); niche conditions/signalling maintain stem cells (1).

- Extended response marking: defines adult stem cell niche (1); explains self-renewal (1); explains differentiation for tissue replacement (1); bone marrow example - blood-cell production/transport (1); hair follicle example - hair/skin/follicle/sebaceous regeneration (1); explains role of signalling factors/microenvironment (1); links to repair/maintenance and avoids claiming all adult stem cells are totipotent (1).

General IB-style marking notes

- Do not award marks for vague statements without a clear biological link.

- For structure-function questions, award credit only when the structure is linked to the correct function.

- For data questions, accept rounded numerical answers if the working is correct.

- For extended responses, prioritize accurate terminology, logical sequence and use of relevant examples.