bio letters

Biology
Standard and Higher level
B2.3 Cell specialization Paper 1A

12 May 2025

Zone A afternoon | **Zone B** morning | **Zone C** afternoon

1 hour [Paper 1A]

Instructions to candidates

- Answer all questions.
- For each question, choose the answer you consider to be the best.
- A calculator is required for this paper.
- This paper generally presents questions in the same order the concepts are presented in the syllabus guide. The earlier questions are usually but not always easier than the later questions. Although most questions focus on this topic only, some are linked to other topics.
- This paper contains challenging IB-style problems. It is meant to enrich your learning and improve your mastery of the concepts presented in this topic after you have studied it.
- All of the questions here are original and written by me.
- The maximum mark for paper 1A is **[40 marks]**.

1. What is the main role of stem cells in the human body?

A. To perform specialized functions

B. To replace previous specialized cells

C. To slow the process of aging

D. To aid in immune function and tissue repair

2. What is the difference between stem cells and specialized cells?

A. Only specialized cells undergo cell division

B. Only stem cells express all genes to allow for future differentiation

C. Only specialized cells can divide into identical cells

D. Only stem cells can divide and maintain their potency

3. What is the role of embryonic stem cells?

A. To complete body tissues and organs

B. To divide into tissue that forms organs

C. To form extraembryonic tissue

D. To repair damages during embryonic development

4. What type of stem cells are found in bone marrow?

A. Totipotent

B. Pluripotent

C. Multipotent

D. Unipotent

5. Which process increases the number of stem cells?

A. Endless division

B. Self-renewal

C. Totipotency

D. Differentiation

6. Which of the following is **not** a unique property of stem cells?

A. Self-differentiation

B. Self-renewal

C. Unlimited division

D. Ability to differentiate

7. Which of the following correctly describes the property of self-renewal in stem cells?

A. Stem cells can divide into 2 daughter cells

B. Stem cells with less potency have partial self-renewal

C. Stem cells can divide and renew endlessly

D. Stem cell daughter cells can retain the parent cell's properties

8. What determines stem cell fate during early embryonic development?

A. Morphogen type

B. Morphogen diffusion rate

C. Morphogen concentration

D. Morphogen source cell

9. What would happen if multipotent stem cells are transplanted in tissue outside of their niche?

A. The stem cells would produce many cell lineages

B. The stem cells would become unipotent

C. The stem cells would die

D. The stem cells would differentiate

10. What happens if a stem cell loses its property of self-renewal?

A. It becomes partially undifferentiated

B. It also loses its potency

C. It is no longer considered a stem cell

D. It dies because it exits its niche

11. Why are large animals not made of a few large cells?

A. Large cells are only found in plants

B. Animal cells cannot carry out all functions of life

C. Surface area-to-volume ratio limits cell size

D. Eukaryotes are composed of many large cells

12. Can two identical cells respond differently to the same type of morphogen?

A. It depends on the type of the identical cells

B. Yes, if each cell is exposed to different morphogen concentrations

C. No, the cells will be identical in response

D. It depends on the type of morphogen

13. What type of stem cells are found in hair follicles?

A. Totipotent

B. Pluripotent

C. Multipotent

D. Unipotent

14. What is a stem cell niche?

A. An environment that maintains stem cells

B. An environment that keeps stem cells alive

C. An environment that promotes cell differentiation

D. An environment that secretes morphogens

15. Scientists modified a morphogen and increased its molecular weight. What result would this have on cell specialization of an early embryo?

A. Only cells far away from the source cell will be affected

B. Only cells close to the source cell will be affected

C. Both cells close to and far away from the source cell will be affected

D. It depends on the type of morphogen

16. What stem cell comes after totipotent cells during embryonic development?

A. Pluripotent

B. Multipotent

C. Oligopotent

D. Unipotent

17. What is the difference between 6 individual cubes of side length 1 cm and a rectangle that is created by fusing all 6 cubes?

A. The fused rectangle has greater volume

B. The 6 separate cubes have greater volume combined

C. The fused rectangle has a higher total surface area-to-volume ratio

D. The 6 separate cubes have a higher total surface area-to-volume ratio

18. After a patient experiences blood loss, what is the most likely outcome?

A. Stem cells differentiate only

B. Stem cells self-renew only

C. Stem cells differentiate and self-renew

D. Stem cells divide endlessly

19. What changes during stem cell differentiation?

A. DNA

B. mRNA

C. tRNA

D. rRNA

20. How does a morphogen affect the genes that maintain a stem cell?

A. The genes will be within euchromatin

B. The genes will be within heterochromatin

C. The genes will be deleted

D. The genes will be partially deleted

21. **[AHL]** What is the effect of losing the flattened (biconcave) structure of erythrocytes?

A. The plasma membrane becomes more round, increasing surface area-to-volume ratio

B. The plasma membrane becomes more round, decreasing surface area-to-volume ratio

C. Cell volume increases, allowing for more hemoglobin molecules to carry oxygen and improving oxygen transport

D. Cell volume decreases, allowing for less hemoglobin molecules to carry oxygen and worsening oxygen transport

22. **[AHL]** What feature of type II pneumocytes increases the surface area for surfactant release?

A. Cuboid shape

B. Lamellar bodies

C. Microvilli

D. Invaginations

23. **[AHL]** A student makes the following list of properties for a cell whose main function is to transport molecules. Which of the properties did the student correctly list?

I. Cuboid shape

II. Inner folding of the plasma membrane

III. Brush border

A. I only

B. I and II only

C. II and III only

D. I, II, and III

24. **[AHL]** What is the effect of a genetic mutation that decreases the number of microvilli on proximal convoluted tubules in the nephron?

A. The body compensates by increasing microvilli expression

B. More solutes are reabsorbed

C. Only some solutes are fully reabsorbed

D. Less solutes are reabsorbed

25. **[AHL]** Which of the following types of muscle cells are striated?

I. Skeletal

II. Smooth

III. Cardiac

A. I only

B. I and II only

C. I and III only

D. I, II, and III

26. **[AHL]** Cigarette smoking has been found to reduce the secretion of pulmonary surfactant from type II pneumocytes. What effect does this have on respiration?

A. Alveolar collapse as a result of increased tension

B. Surface tension will decrease, increasing the chance of alveolar collapse

C. Type I pneumocytes will thicken due to reduced surfactant secretion

D. Oxygen and carbon dioxide will begin diffusing between cells

27. **[AHL]** Why is the classification of striated skeletal muscle fibers as cells contested?

A. Most cells are not capable of contraction

B. Most cells do not contain actin and myosin in sarcomeres

C. Most cells perform all life functions unlike muscle fibers due to specialization

D. Most cells are relatively smaller than skeletal muscle fibers

28. **[AHL]** Why are cardiac muscles branched?

A. To spread over a larger area

B. To share resources with each other

C. To connect cardiac cells and ensure simultaneous contraction

D. To increase surface area-to-volume ratio for higher nutrient uptake

29. **[AHL]** Why are type II pneumocytes cuboid-shaped?

A. Provide structural support to alveoli

B. Ensures tight seal between alveolar lining

C. Creates a large surface area for gas exchange

D. Increases cellular volume for surfactant production

30. **[AHL]** What is a cytoplasmic feature that is only found in type II pneumocytes?

A. Microvilli invaginate into cytoplasm

B. Cuboid-shaped cytoplasm

C. Large number of secretory vesicles

D. Cytoskeletal proteins

31. **[AHL]** What is the most likely effect of shorter than normal flagella in sperm?

A. Faster speed since the sperm weighs less

B. Faster speed since the ovum reaches the sperm earlier

C. Slower speed since the sperm loses mitochondria

D. Slower speed since the sperm loses efficient motility

32. **[AHL]** What is the most likely effect of a reduction in the number of alveoli in the lungs?

A. Increased surface tension

B. Less surface area for gas exchange

C. More carbon dioxide leaves the body

D. Decreased alveolar elasticity

33. **[AHL]** Scientists discover a toxin that interferes with clathrin coat formation. Which of the following correctly predicts the effects of exposing a type I pneumocyte to this toxin on gas exchange?

A. Reduction in exchange of both oxygen and carbon dioxide

B. Reduced oxygen but not carbon dioxide exchange

C. Reduced carbon dioxide but not oxygen exchange

D. No reduction in exchange of both oxygen and carbon dioxide

34. **[AHL]** An individual acquires a mutation that interferes with cortical granule formation. What is the most likely effect?

A. Inability of sperm to penetrate zona pellucida

B. Inability of sperm and ovum nuclei to fuse

C. Insufficient nutrients in cortical granules for the zygote

D. Multiple nuclei may enter the ovum

35. **[AHL]** What is the most likely effect of a mutation in the gap junctions of cardiac muscle cells?

A. Faster conduction

B. Slower conduction

C. Faster heart rate

D. Slower material exchange

36. **[AHL]** Which cells have microvilli?

A. Type II pneumocytes and proximal tubule cells

B. Type I pneumocytes and cardiac muscle

C. Skeletal muscle and bone marrow

D. Erythrocytes and type II pneumocytes

37. **[AHL]** The SFTPA1 gene encodes for a protein within pulmonary surfactant. What effect would increasing DNA methylation of this gene have on respiratory function?

A. Increased surface tension leading to alveolar collapse

B. Decreased surface tension leading to alveolar collapse

C. Improper formation of lamellar bodies

D. Improper type II pneumocyte function

38. **[AHL]** Type II pneumocytes can only replace type I pneumocytes. What class of cells do type II pneumocytes belong to?

A. Multipotent stem cells

B. Unipotent stem cells

C. Regenerative stem cells

D. Repair stem cells

39. **[AHL]** Why are acrosomal vesicles an adaptation for sperm cells?

A. They allow sperm to penetrate the zona pellucida and insert its nucleus

B. They prevent polyspermy during fertilization

C. They enable sperm to travel through the female reproductive system

D. They improve sperm motility during fertilization

40. **[AHL]** A student performs differential centrifugation on cell cultures of cardiac and skeletal muscle separately. Which of the following is **not** a correct prediction of the results?

A. The first pellet of cardiac cells will be larger than that of skeletal cells

B. Before homogenization, both cells would appear striated under a light microscope

C. All pellets will not contain structures typical of neural cells for both types of muscle

D. The proteinic pellet of cardiac cells will have more gap junctions than skeletal cells

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References:

SFTPA1 surfactant protein A1 [Homo sapiens (human)] - Gene - NCBI. https://www.ncbi.nlm.nih.gov/gene/653509

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