Reproduction and Development

A Level

Part A Fertilisation

During fertilisation, two [ ] [ ] combine to form a [ ] [ ]. This process requires a liquid medium for the sperm cells to swim through.

In some animals (including all mammals), fertilisation occurs inside the mother's body. This is called [ ] fertilisation. In other animals, fertilisation occurs in the environment. This is called [ ] fertilisation.

Items:

external **zygote** **diploid** **haploid** **internal** **gametes**

Part B Sex determination

In mammals, sex is determined by the presence/absence of the Y chromosome. Other animals have different mechanisms of sex determination.

The sex of one species of fruit fly is determined by the number of X chromosomes relative to the number of non-sex chromosomes (A) in a cell. This is called the X : A ratio. A fruit fly will be male if X : A $= 0.5 : 1$, and female if X : A $= 1 : 1$. The Y chromosome contains genes necessary for making sperm. Match the sex to the fruit fly genotype in the table below.

Fruit fly genotype	Fruit fly sex
XAA	
XYAA	
XXAA	
XXYAA	
XXYYAA	

Items:

female **male**

Part C Embryonic development

After fertilisation, the [ ] undergoes many rounds of [ ] to form a multicellular embryo. Initially, all of the cells are [ ] but, throughout development, cells [ ] into the different cell types of the organism.

Items:

differentiate **gamete** **dedifferentiate** **differentiated** **zygote** **mitosis** **undifferentiated** **meiosis**

Question elements adapted with permission from NSAA 2022 Specimen Paper Section 1 Q73

Stem cells

A Level

Part A Characteristics

A stem cell is [ ] cell that has the ability to [ ] into multiple cell types and has the ability to divide indefinitely to produce more stem cells.

The number of cell types that the stem call can [ ] into is described as the [ ] of the stem cell.

When a stem cell divides to produce more stem cells, this is called [ ].

Items:

dedifferentiate **differentiate** **self-renewal** **a differentiated** **redundancy** **potency** **an undifferentiated**

Part B Potency

Match the level of potency and example to the definition.

Potency	Definition	Example
	Able to differentiate into all cell types, including extra-embryonic cells (e.g. placenta cells).	
	Able to differentiate into any cell type except extra-embryonic cells (e.g. placenta cells)	
	Able to differentiate into several cell types, but not all cell types	

Items:

zygote **Totipotent** **embryonic stem cells (ESCs)** **haematopoetic stem cells in bone marrow** **Pluripotent** **Multipotent**

Part C Differentiation

Which of the following may occur as part of the differentiation process? Select all that apply.

- [ ] activation of some genes to produce proteins
- [ ] deactivation of some genes to stop producing proteins
- [ ] changes in cell shape/structure
- [ ] an increase in the potency of the cell
- [ ] a decrease in the potency of the cell
- [ ] mutations of genes to alter the proteins they produce

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Multicellular Organisation

A Level

Part A Tissues

What is the definition of a tissue?

- the smallest unit of multicellular organisation
- a group of identical cells
- a group of similar cells and their extracellular matrix
- one structural unit, composed of one type of tissue, that performs a specific function
- one structural unit, composed of different tissue types, that performs a specific function
- a group of organs and/or tissues that work together to perform one or more functions
- all of the organs in the body

Part B Organs

What is the definition of an organ?

- the smallest unit of multicellular organisation
- a group of identical cells
- a group of similar cells and their extracellular matrix
- one structural unit, composed of one type of tissue, that performs a specific function
- one structural unit, composed of different tissue types, that performs a specific function
- a group of organs and/or tissues that work together to perform one or more functions
- all of the organs in the body

Part C Systems

What is the definition of a system?

- the smallest unit of multicellular organisation
- a group of identical cells
- a group of similar cells and their extracellular matrix
- one structural unit, composed of one type of tissue, that performs a specific function
- one structural unit, composed of different tissue types, that performs a specific function
- a group of organs and/or tissues that work together to perform one or more functions
- all of the organs in the body

Part D Extracellular matrix

A tissue is composed of a group of similar cells which are connected by extracellular matrix (ECM). Match the ECM component(s) to the tissue.

Tissue	ECM component(s)
blood	
bone	
artery smooth muscle	

Items:

erythrocytes **plasma** **osteoblasts and osteocytes** **collagen and calcium phosphate**

squamous epithelium **elastin and collagen**

Part E Plant growth

Plants contain tissues of totipotent stem cells, which produce new roots, shoots, and flowers. What is the name of this type of tissue in plants?

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Animal Tissue Types

A Level

Tissues in animals can be loosely categorized into four main types: epithelial, connective, muscle, and nervous.

Part A Tissue functions

Match the tissue type to its function.

Tissue type	Function
	transmits electrical signals between tissues
	holds tissues together or acts as a transport system between tissues
	covers the internal and external surfaces of organs
	contracts to cause movement of other tissues/fluids/objects

Items:

epithelial **connective** **nervous** **muscle**

Part B Epithelial tissue

Which of the following are examples of epithelial tissue? Select all that apply.

- [ ] external lining of alveoli
- [ ] tendons
- [ ] cartilage
- [ ] spinal cord
- [ ] cardiac muscle
- [ ] blood
- [ ] internal lining of the small intestine
- [ ] epidermis (external lining of the skin)

Part C Connective tissue

Which of the following are examples of connective tissue? Select all that apply.

- [ ] tendons
- [ ] cartilage
- [ ] spinal cord
- [ ] ligaments
- [ ] blood
- [ ] epidermis
- [ ] bone
- [ ] cardiac muscle

Part D Nervous tissue

Which of the following are examples of nervous tissue? Select all that apply.

- [ ] spinal cord
- [ ] tendons
- [ ] blood
- [ ] cardiac muscle
- [ ] cerebrum
- [ ] ligaments
- [ ] epidermis
- [ ] skeletal muscle

Part E Muscle tissue

Which of the following **contain** muscle tissue? Select all that apply.

- [ ] heart
- [ ] intestines
- [ ] epidermis
- [ ] bones
- [ ] uterus
- [ ] spinal cord
- [ ] stomach
- [ ] bladder

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Plant Tissue Types

A Level

Tissues in plants can be loosely categorized into four main types: epidermis, ground tissue, vascular tissue, and meristematic tissue.

Part A Tissue descriptions

Match the tissue type to its description.

Tissue type	Description
	transports water and nutrients throughout the plant
	contains stem cells that differentiate to form the other three tissue types
	the outer layer of cells
	the tissues between the vascular tissues and the epidermis

Items:

meristematic tissue **vascular tissue** **epidermis** **ground tissue**

Part B Vascular tissue

Which of the following are examples of vascular tissue?

- [ ] roots
- [ ] flowers
- [ ] spongy mesophyll
- [ ] xylem
- [ ] leaves
- [ ] palisade mesophyll
- [ ] phloem

Part C Ground tissue

Which of the following are examples of ground tissue?

- [ ] roots
- [ ] flowers
- [ ] spongy mesophyll
- [ ] xylem
- [ ] leaves
- [ ] palisade mesophyll
- [ ] phloem

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Blood Cell Production

A Level

C C C

Erythrocytes (mature red blood cells) are produced by stem cells in the bone marrow. A $1\,\mathrm{mm}^3$ sample of blood from a healthy person was found to contain 4×10^6 erythrocytes. The person has a consistent average total blood volume of $0.006\,\mathrm{m}^3$. Their total erythrocyte count does not change and, on average, erythrocytes have a lifespan of 100 days.

Part A Rate of production

What is the average rate of production of erythrocytes per hour?

Part B Cell statements

Which of the following statements are true? Select all that apply.

- [ ] Stem cells produce erythrocytes by meiosis.
- [ ] Stem cells produce erythrocytes by differentiation.
- [ ] The stem cells in the blood marrow that produce erythrocytes are pluripotent.
- [ ] The stem cells that produce erythrocytes do not have nuclei.
- [ ] Erythrocytes cannot produce other erythrocytes by mitosis because they do not have nuclei.
- [ ] Erythrocytes do not have nuclei.

Adapted with permission from NSAA 2021 Section 1 Q77