TAMPINES MERIDIAN JUNIOR COLLEGE

JC2 PRELIMINARY EXAMINATION

CANDIDATE NAME	( )
CIVICS GROUP	

H2 BIOLOGY 9744/01

Paper 1 Multiple Choice Questions **22 September 2023**

1 hour

Additional material: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

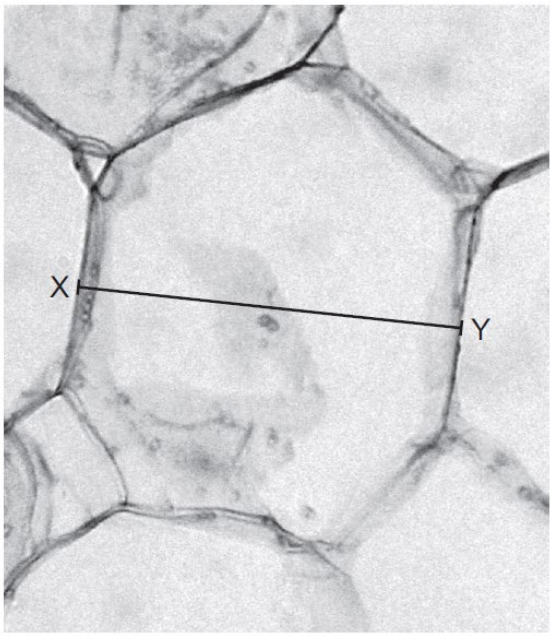
Do not open this booklet until you are told to do so.
Write your name, civics group and index number on the Multiple Choice Answer Sheet.
Do not use staples, paper clips, glue or correction fluid/tape.

There are **30** questions in this paper. Answer **all** questions. For each question, there are four possible answers labelled **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Multiple Choice Answer Sheet.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

You may keep this booklet after the exam.

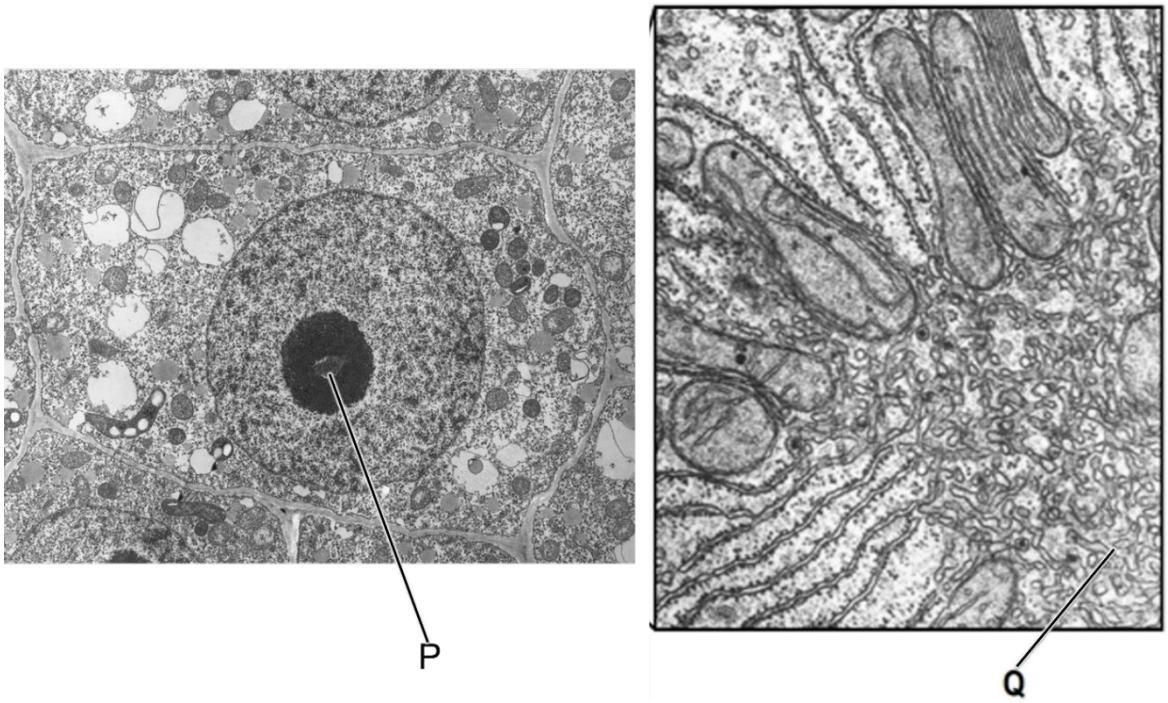
1 The photomicrograph is of a plant cell. The cell is 25 μm in width from **X** to **Y**.



What is the magnification of the photomicrograph?

A 2×10^1 **B** 2×10^2 **C** 2×10^3 **D** 2×10^4

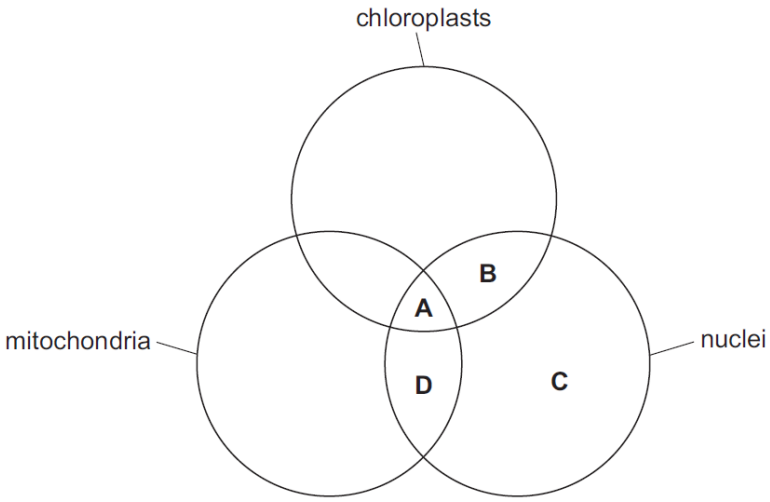
2 The diagrams below show the electron micrographs of two organelles **P** and **Q**.



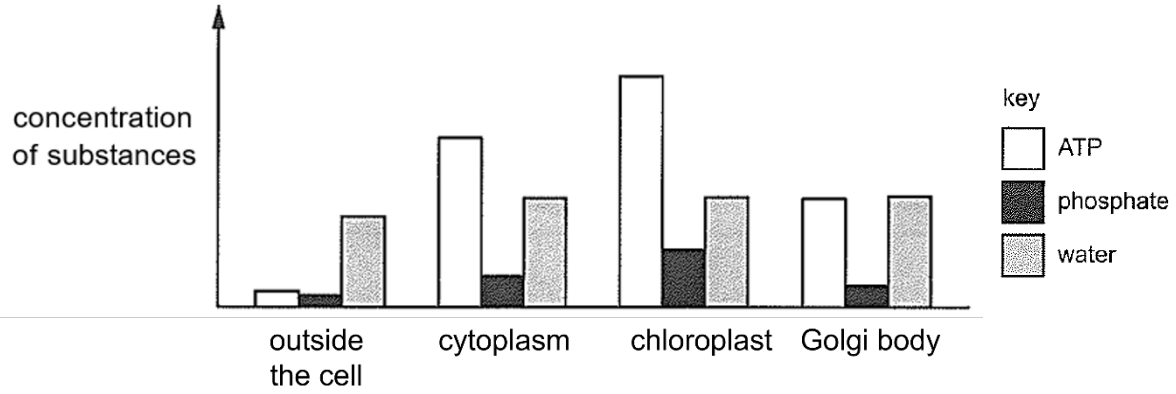
Which of the following shows the correct identities and functions of **P** and **Q**?

	Identity of **P**	Function of **P**	Identity of **Q**	Function of **Q**
A	Nucleosome	Transcription of rRNA gene	Smooth ER	Transport of proteins
B	Nucleosome	Assembly of ribosomal subunits	Secretory vesicles	Synthesis of lipids
C	Nucleolus	Assembly of ribosomal subunits	Smooth ER	Synthesis of lipids
D	Nucleolus	Transcription of rRNA gene	Secretory vesicles	Transport of proteins

3 Which letter identifies the cell structures where semi-conservative replication of DNA occurs?



4 The chart shows the concentration of some substances outside the cell, in the cytoplasm, in the chloroplast and in the Golgi body of a plant cell.



Which statement about the direction of movement of these substances and the process by which they are moving is correct?

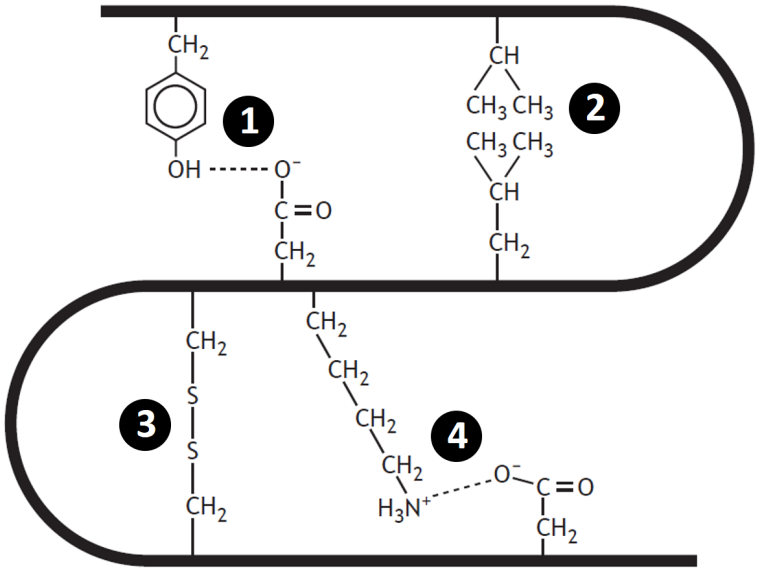
A ATP is leaving the chloroplast by facilitated diffusion, water is leaving the plant cell by osmosis.

B Phosphate and ATP are entering the chloroplast and Golgi body by active transport.

C Phosphate and ATP are leaving the Golgi body by facilitated diffusion, water is leaving the plant cell by osmosis.

D Phosphate is entering the chloroplast by facilitated diffusion, water is entering the chloroplast by osmosis.

5 The diagram shows some interactions between amino acid R-groups in a polypeptide chain.



Which row correctly describes the nature of the interactions?

	can be disrupted by extreme pH	can be disrupted by high temperatures	located within the core of a globular protein	located within the transmembrane domain of a receptor protein
A	1, 3, 4	1, 2, 3, 4	2	1, 2, 4
B	2, 4	3	1, 4	2, 3
C	3	1, 4	2, 3	1, 2, 3, 4
D	1, 4	1, 4	2, 3	2

6 How many of the following statements correctly describe red blood cells?

- At high altitude, humans have increased number of red blood cells to compensate for low percentage saturation of oxygen.
- At high altitude, humans have increased number of red blood cells to increase the number of mitochondria in the blood for ATP production.
- The shape of haemoglobin in red blood cells changes when oxygen is released from it.
- Haemoglobin in red blood cells is insoluble in water because hydrophobic R groups are arranged around the outside of the molecule.

A 1 **B** 2 **C** 3 **D** 4

7 Collagen is a fibrous protein found in mammalian tendons.

Which feature contributes to the great tensile strength of collagen?

A A secondary structure with many hydrogen bonds firmly holding the α-helices.

B A regularly folded tertiary structure held together with hydrogen bonds and ionic bonds.

C A primary sequence with covalent bonds linking a variable sequence of amino acids.

D A quaternary structure of triple helix held together by hydrogen bonds between the three polypeptides.

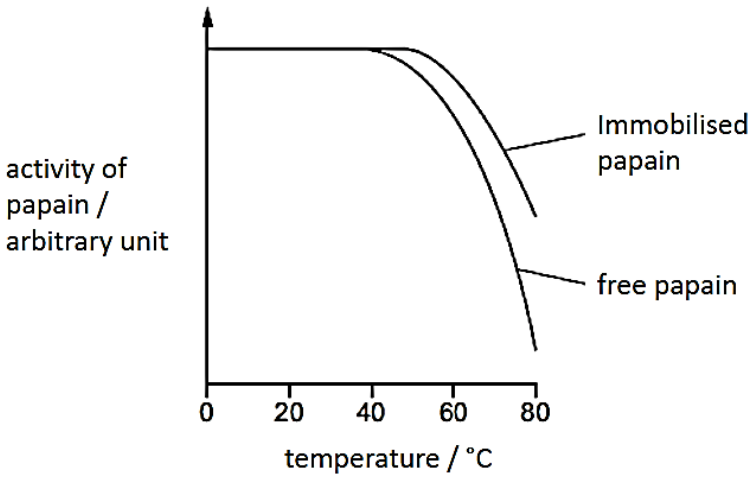
8 The lock-and-key hypothesis and induced-fit hypothesis explain how an enzyme interacts with a substrate.

Which of the following statements are true of both hypotheses?

1 An increase in substrate concentration will not increase the rate of formation of enzyme-substrate complexes.
2 Covalent bonds hold the substrate at the active site of the enzyme.
3 An enzyme undergoes a conformational change as it forms enzyme-substrate complexes.
4 An increase in enzyme concentration may increase the number of enzyme-substrate complexes.

A 4 only **B** 1 and 4 only **C** 1, 2 and 4 only **D** 1, 2, 3 and 4

9 The graph compares the effect of temperature on the activity of the protease enzyme, papain, when free in solution and when immobilised in alginate beads.



Which statement about the effect of immobilisation of papain is correct?

A It increases the stability of papain at higher temperatures.

B It alters the shape of papain's active site at 40°C.

C It decreases the activity of papain at 45°C.

D It reduces the number of collisions of papain with the substrate.

10 Rotenone and antimycin are two metabolic poisons which affect cellular respiration. The effects of rotenone and antimycin on aerobic respiration are summarised in the table.

	Ability to use glucose	Ability to use oxygen	ATP yield
Rotenone	Yes	No	Decreases
Antimycin	Yes	Yes	Decreases

Which of the following correctly identifies the specific functions of these two metabolic poisons?

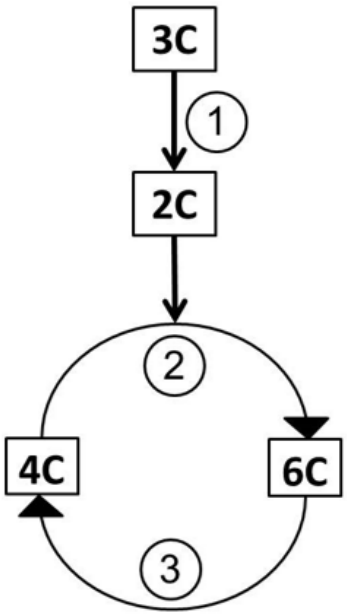
	Rotenone	Antimycin
A	Electron transport inhibitor	Inhibits ATP synthase
B	Inhibits ATP synthase	Electron transport inhibitor
C	Dissipate proton gradient	Inhibits ATP synthase
D	Inhibits ATP synthase	Dissipate proton gradient

11 In an experiment, chloroplast extracts were first treated with a chemical that binds with the electron that was accepted by the electron acceptor in Photosystem **I**. The extracts were then treated with two hours of light and were provided with ample carbon dioxide and water.

Which of the following correctly shows the products that were formed after the experiment?

	O_2	ATP	Reduced NADP	Glucose
A	+	+	-	-
B	-	+	+	+
C	+	-	-	-
D	-	-	+	-

12 The diagram shows a few stages of respiration and number of carbon atoms in the compounds involved.



Which reactions occur at Stages 1-3?

	Stage 1	Stage 2	Stage 3
A	CO_2 production and oxidation of coenzyme	ATP hydrolysis	Oxidative decarboxylation and oxidative phosphorylation
B	Oxidative decarboxylation and oxidation of coenzyme	Substrate-level phosphorylation	CO_2 production and oxidative phosphorylation
C	CO_2 production and reduction of coenzyme	ATP hydrolysis	Oxidative decarboxylation and dehydrogenation
D	Oxidative decarboxylation and reduction of coenzyme	Substrate-level phosphorylation	CO_2 production and dehydrogenation

13 A child with Down syndrome has the genotype P^1 P^2 P^3 for a gene on chromosome 21 that has four different alleles — allele P^1, allele P^2, allele P^3, allele P^4. The child's mother has the genotype P^1 P^2 and the father has the genotype P^3 P^4.

In which parent did chromosomes fail to separate, and did this event occur in the first or second meiotic division?

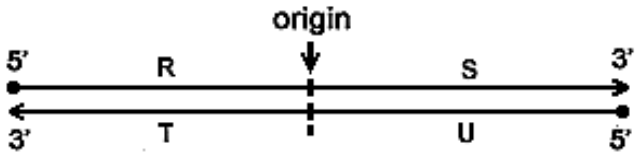
A Mother; Meiosis I

B Mother; Meiosis II

C Father; Meiosis I

D Father; Meiosis II

14 DNA synthesis is initiated at the indicated origin of replication as shown in figure below**.**



Which segments of single-stranded DNA are templates for the synthesis of Okazaki fragments?

A R and U

B S and U

C R and T

D S and T

15 Which statement about the transcription and translation of a gene is correct?

A The non-transcribed strand of DNA has a base sequence that is identical to the mRNA produced in transcription.

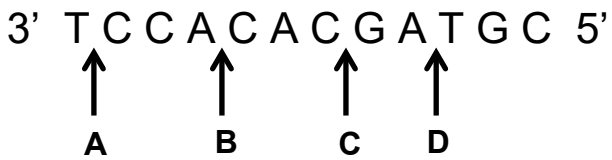
B The template strand of DNA has a base sequence that is identical to the mRNA produced in transcription.

C The non-transcribed strand of DNA has a base sequence that is complementary to the tRNA molecules required in translation.

D The template strand of DNA has a base sequence that is complementary to the tRNA molecules required in translation.

16 The diagram shows a template strand of DNA which codes for four amino acids.

Where would a mutation, introducing a thymine nucleotide, result in the premature termination of translation?



17 Sickle cell anaemia is caused by a mutation in an allele of the gene that codes for the β-globin polypeptide of haemoglobin.

The diagram shows the sequence of bases in a small section of the non-template strand of DNA for both the Hb^A (normal) and Hb^S (sickle cell) β-globin alleles.

Hb^A CTGACTCCTGAGGAGAAGTCT

Hb^S CTGACTCCTGTGGAGAAGTCT

How will the mutation in the allele result in the production of an altered version of the β-globin polypeptide?

A All the amino acids coded for after the mutation will differ from those in the Hb^A protein.

B mRNA transcribed from the Hb^S allele will contain the codon GAG instead of the codon GTG.

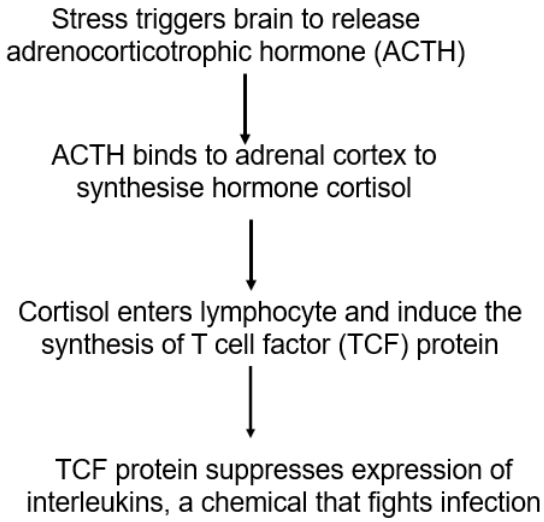
C A tRNA molecule with the anticodon CAC will hydrogen bond to the altered codon on mRNA.

D The ribosome will be unable to continue translation of the Hb^S mRNA after the altered codon.

18 Which of the following correctly describes an advantage and limitation of the Polymerase Chain Reaction (PCR)?

	Advantage	Limitation
A	Highly accurate due to proof-reading function of *Taq* DNA polymerase	The extent of amplification is limited by the denaturation of polymerase
B	Able to produce 20^2 copies of the target DNA after 20 cycles	Cannot amplify unknown sequences as primers cannot be made
C	Works on DNA from various species and sources	More time consuming than traditional methods of using bacteria to amplify DNA sequences
D	Only requires a minute amount of template for amplification	Only able to amplify a small fragment of DNA

19 When a person undergoes a stressful experience, their immune system can be suppressed and they become more susceptible to infection. Some of the elements involved in this chain of events are shown in the diagram below.



Which combination correctly shows the genes that have transcription-enhancing factors bound to their control elements during the above sequence of events?

	Gene for ACTH	Gene for TCF	Gene for interleukin
A	✓	×	×
B	×	✓	✓
C	✓	✓	×
D	×	×	✓

20 What are some similarities between all cancer cells and all stem cells?

A They replicate indefinitely, lack cell-cell adhesion and are able to move from one location in the body to another.

B They lack contact inhibition, are non-differentiated and are regulated by molecular signals.

C They are able to move from one location to another, are regulated by molecular signals and can be found in various parts of the body.

D They replicate indefinitely and are non-differentiated.

21 Which of the following is **not** found in all viruses?

A Nucleic acid

B Capsid

C Viral membrane

D Proteins complementary to host cell receptor

22 In *E. coli* bacteria, regulation of gene expression involving the catabolite activator protein (CAP) is a type of positive regulation because

A cAMP-CAP helps RNA polymerase to initiate transcription.

B CAP increases the production of cAMP.

C glucose binds to CAP and activates it.

D glucose stimulates the production of cAMP.

23 A gene is found in the plasmid of a bacterial cell.

A student made the following statements regarding the transfer of this gene to a recipient bacterial cell.

1 Transformation occurs when gene is taken up by proteins present on the cell surface membrane of the recipient cell of a closely related species.

2 Transfer by conjugation occurs only if the plasmid is the F factor.

3 Generalised transduction occurs when gene is accidentally packaged into newly assembled temperate phages which then infect the recipient cell.

Which statements are **not** correct?

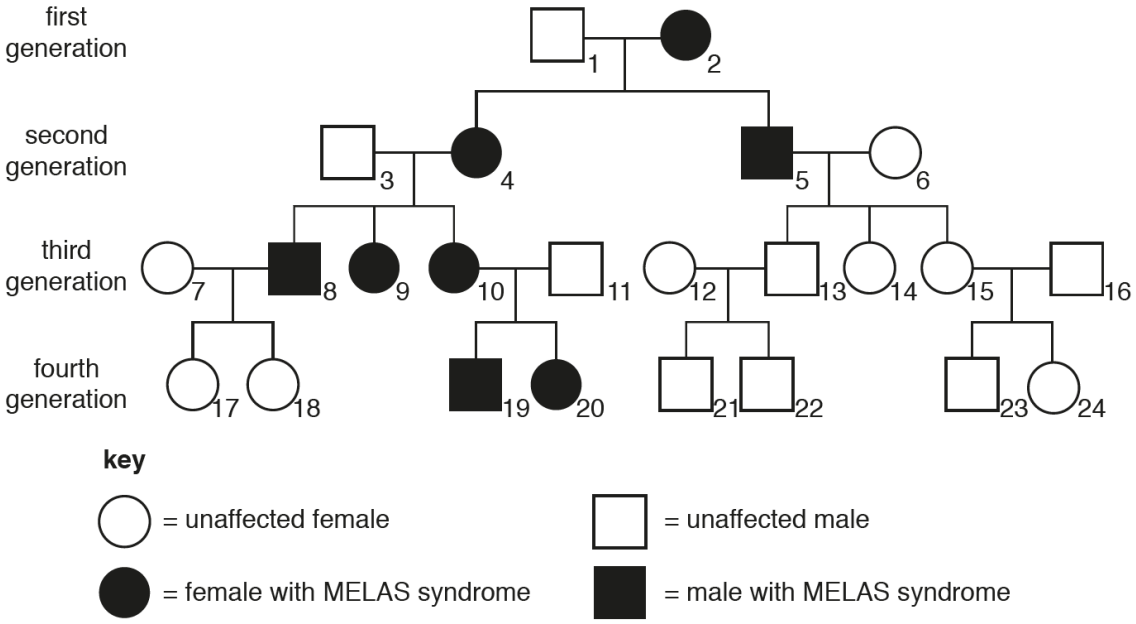
A 1 and 2 only

B 1 and 3 only

C 2 and 3 only

D 1, 2 and 3

24 The pedigree shows four generations of a family where several individuals are affected by MELAS syndrome, a progressive neurodegenerative disorder.



Which statement describes how the mutant allele is inherited?

A The mutant allele is carried on the mitochondrial DNA, which is inherited only through the maternal line since sperms do not contribute mitochondria to the zygote.

B The mutant allele is carried on the Y-chromosome.

C The mutant allele is dominant and is carried on the X-chromosome.

D The mutant allele is recessive and is carried on the X-chromosome.

25 A pure-breeding black fowl is crossed with a pure-breeding white fowl. All the progeny are blue. Sibling cross is carried out and there are black, white as well as blue progeny.

Which statement most likely explains the above crosses?

A It is a monohybrid cross involving three different alleles.

B It is a monohybrid cross involving two alleles that exhibit incomplete dominance.

C It is a dihybrid cross involving two alleles that exhibit incomplete dominance at each gene locus.

D It is a dihybrid cross involving three different alleles at each gene locus.

26 Granitic Island and Coralline Island of Seychelles are home to seven and three endemic species of lizards respectively.

The lizards could be differentiated by their different body colouration. It was found that lizards with similar body colouration mate with one another more frequently than would be expected under a random mating pattern.

Which of these statements could apply to these lizards?

1 Different species between Granitic Island and Coralline arose by allopatric speciation due to the presence of a geographical barrier between them.

2 The seven species of lizards within Granitic Island arose by sympatric speciation due to reproductive isolation.

3 Adaptive radiation has taken place due to the many available ecological niches found on the islands.

A 1 only **B** 1 and 3 only **C** 2 and 3 only **D** 1, 2 and 3

27 Harmful alleles can lead to various disorders, diseases, or reduced overall fitness of an organism. They are usually recessive and remain in populations globally despite natural selection.

Which statements are true?

1 Harmful traits may be maintained by the same mutation that keeps arising in the population.

2 The harmful effects may only be expressed later in the life of the organism, after reproduction has occurred.

3 Harmful alleles continue to exist due to diploidy.

4 Genetic drift can select for harmful alleles.

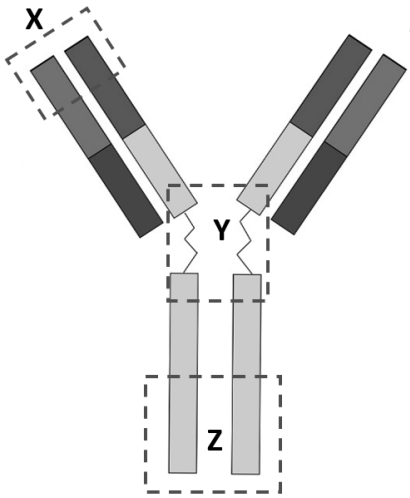
A 1 and 2 **B** 2 and 3 **C** 2 and 4 **D** 3 and 4

28 The innate immune system involves phagocytes while the adaptive immune system involves……1…… . Humoral immunity is mediated by antibodies from ……2…… and is involved in the elimination of……3…… . Cell-mediated immunity is mediated by ……4…… and is involved in the elimination of ……5…….

Which words correctly complete gaps 1–5?

	1	2	3	4	5
A	lymphocytes	naïve B lymphocytes	intracellular pathogens	mature cytotoxic T cell	extracellular pathogens
B	specific circulating glycoproteins	plasma cells	intracellular pathogens	macrophages	extracellular pathogens
C	intact skin and mucosal layers	activated B lymphocytes	extracellular pathogens	antibodies	intracellular pathogens
D	lymphocytes	plasma cells	extracellular pathogens	mature cytotoxic T cell	intracellular pathogens

29 The diagram shows an antibody molecule.



Which statements on formation of antibody diversity are true?

1 The presence of multiple variable gene segments allows variation in region **X**.

2 Random arrangement of VDJ segments at the light chain locus by recombinase.

3 Region **Y** is the disulfide bridges that gives the flexibility for the antibody molecule to bind around different antigens.

4 Affinity maturation through the process of somatic hypermutation in the production of mature naïve B and T cells.

5 Class switching to other classes in region **Z** occurs to further diversify antibodies of the same specificity.

A 2 and 4 only **B** 2, 3 and 4 **C** 1 and 5 only **D** 1, 2, 3 and 5

30 Which of the following describes a positive feedback loop concerning climate change?

A Rising sea temperatures will cause increased growth of photosynthetic algae.

B Increased atmospheric temperature result in melting of sea ice which decreases the amount of sunlight reflected into space.

C Earlier migration of birds from southern winter habitats to northern breeding habitats.

D Increase in atmospheric temperature causes many species to move towards increased altitudes to stay within their optimum temperature range.

☺ End of Paper 1 ☺