H2

ANDERSON SERANGOON JUNIOR COLLEGE
HIGHER 2

2023 JC2 PRELIMINARY EXAMINATION

BIOLOGY 9744/01

PAPER 1
MULTIPLE CHOICE

20 SEPTEMBER 2023
WEDNESDAY

1 HOUR

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and identification number on the MCQ Answer Sheet.

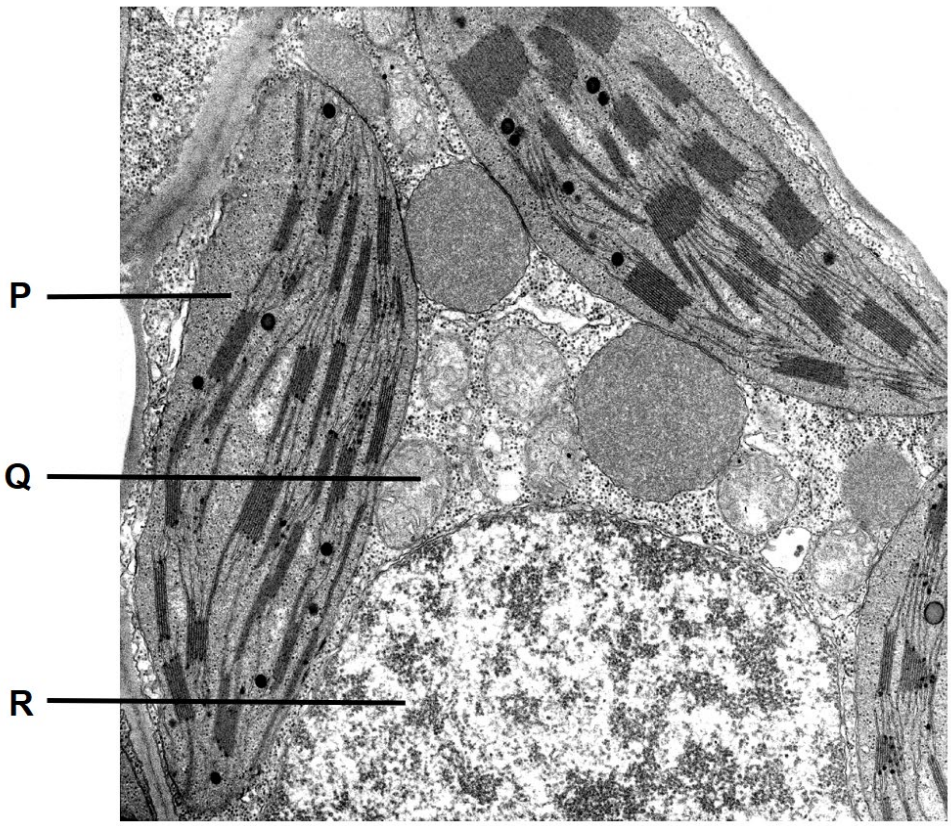
There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

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 scientific calculators is expected, where appropriate.

This document consists of **19** printed pages and **1** blank page.

1 The electron micrograph shows a section of a cell in which several different organelles are found.



Which statements correctly describe the labelled regions of the cell?

1 Organelles P, Q and R are present in all cells in a single plant.

2 DNA replication occurs in organelles P, Q and R.

3 Transcription and translation occur in organelles P and Q but not R.

4 Organelles P, Q and R use ATP in reactions that occur within them.

A 1 and 2 only

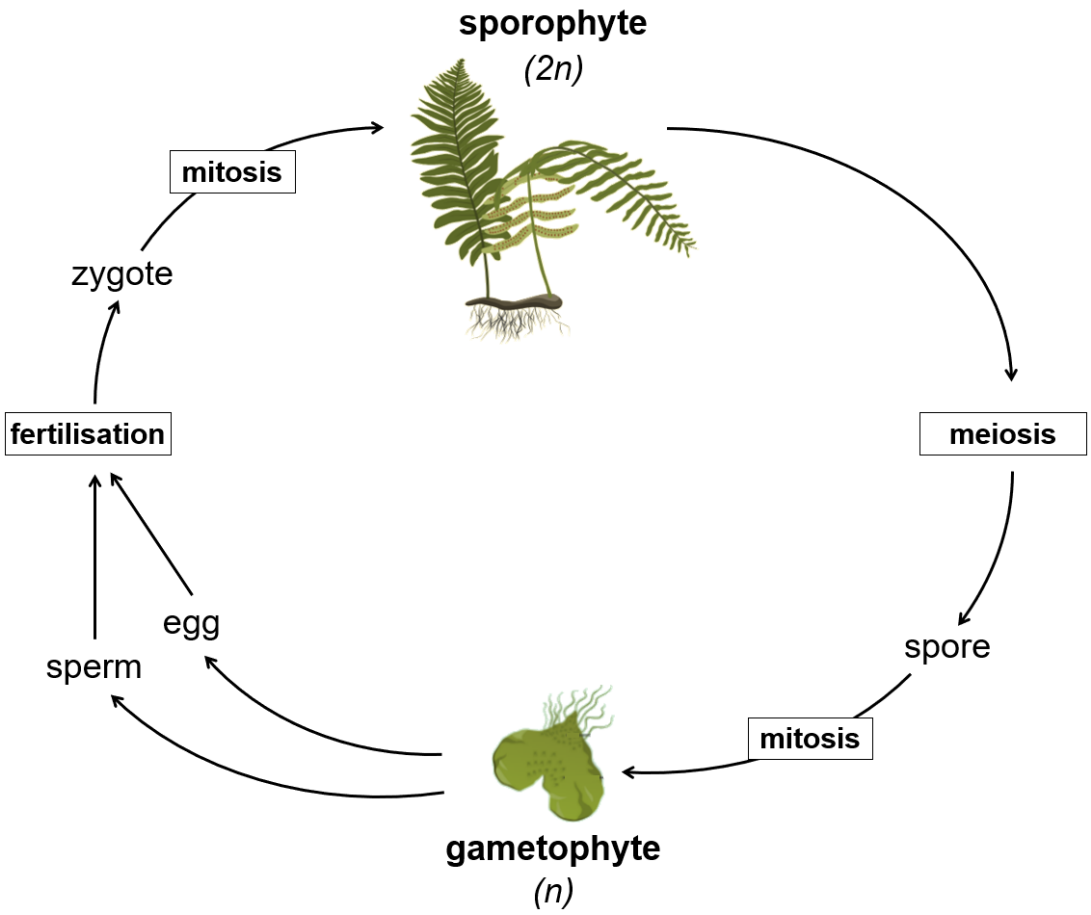
B 1 and 3 only

C 2, 3 and 4 only

D 1, 2, 3 and 4

2 In the life cycle of a fern, there is an alternation between haploid and diploid stages:

- sporophyte stage where the plant is diploid and releases spores
- gametophyte stage where the plant is haploid and releases gametes



How many principles of the cell theory does the life cycle above show?

A 0

B 1

C 2

D 3

3 The energy for bond formation in polysaccharides is provided by uridine triphosphate (UTP) instead of ATP. The stages involved in the formation of a glycosidic bond during cellulose synthesis include:

1 binding of an activated monosaccharide to the active site of a glycosyltransferase enzyme

2 release of UDP (uridine diphosphate) and water

3 the formation of a UDP-glucose complex releasing inorganic phosphate

4 reaction between a hydroxyl group of β-glucose and a UDP-glucose complex

5 reaction between a hydroxyl group of β-glucose and UTP

What is the sequence of these stages?

A 3 → 1 → 5 → 2 → 4

B 5 → 3 → 1 → 4 → 2

C 5 → 1 → 3 → 2 → 4

D 3 → 5 → 4 → 1 → 2

4 Three artificial cells of equal sizes, each surrounded by a partially permeable membrane, contain equal masses of different food reserves. One cell contains only fats, one cell contains only glycogen and one cell contains only glucose.

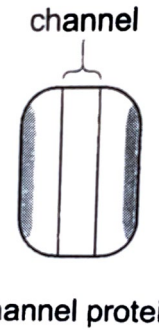
Which of the following shows the rate of expansion of these cells when immersed in distilled water, and their energy content?

(The sign ≈ means approximately equal and the sign > means greater than.)

	rate of expansion of cells	respiratory energy content
A	glucose ≈ glycogen > fats	fats > glycogen ≈ glucose
B	glucose ≈ glycogen > fats	fats ≈ glycogen > glucose
C	glucose > glycogen > fats	fats > glycogen ≈ glucose
D	glucose > glycogen > fats	fats ≈ glycogen > glucose

5 Detergent molecules have a similar structure to phospholipids, consisting of a phosphate-containing group and a hydrophobic tail.

When channel proteins extracted from cell membranes are mixed with a detergent solution, the detergent molecules cluster around the surfaces of the channel proteins that are shaded grey in the figure below.



channel protein

Which statement explains the orientation of detergent molecules when they cluster around the surfaces of the channel protein that are shaded grey in the figure?

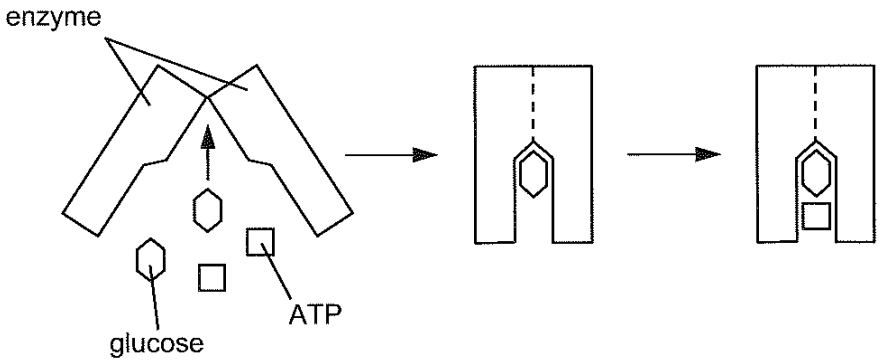
A The phosphate-containing groups of the detergent molecules are attracted to the shaded surfaces of the channel protein.

B The tails of the detergent molecules cannot form hydrogen bonds with water or other polar molecules.

C The shaded surfaces of the channel protein repel the hydrophobic tails of the detergent molecules.

D The shaded surfaces of the channel protein and the phosphate-containing groups of the detergent molecules are polar.

6 The enzyme hexokinase which catalyses the transfer of a phosphate group from ATP to glucose, changes shape during the reaction, as shown in the diagram.



Which statements are correct?

1 The reaction illustrates the 'lock and key' hypothesis of enzyme action.

2 ATP is a competitive inhibitor of hexokinase.

3 The active site for ATP is formed only in the presence of glucose, therefore binding of glucose to enzyme also allows ATP to bind.

4 In absence of glucose, ATP is not hydrolysed to release a phosphate group.

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

7 Which of the following statement(s) is/are true regarding blood stem cells and cancer cells?

1 Both are able to move from one location in the body to another.

2 Both are found in cancer patients.

3 Both are unspecialised cells which can differentiate further.

4 Both are capable of indefinite replication.

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

8 Which statements about complementary base pairing are correct?

1 Purines contain more atoms than pyrimidines.

2 The base pairs are of the same length.

3 Cytosine forms a triple bond with its complementary base.

4 It allows amino acid activation to occur.

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

9 Polypeptide synthesis is based on sequences of three nucleotides, each specific for an amino acid.

Which row shows the correct nucleotide sequences for an amino acid?

	nucleotide sequence of		
	non-transcribed DNA strand	mRNA codon	tRNA anticodon
A	GGT	CCA	GGU
B	GGG	CCC	CCC
C	CCG	CCG	GGC
D	CCT	CCU	CCU

10 The diagram shows the first six codons of an mRNA molecule and amino acids for which they encode.

AUG	—	AAG	—	UGU	—	UAU	—	CUC	—	AUG
methionine		lysine		cysteine		tyrosine		leucine		methionine

As a result of a mutation, a dipeptide was produced instead of the normal polypeptide.

The triplets on the DNA strand that is complementary to mRNA that code for ‘stop' are ATT, ATC and ACT.

Which statement explains the production of a dipeptide?

A The DNA triplet coding for cysteine is changed from ACA to ATA.

B The DNA triplet coding for lysine is changed from TTC to ATC.

C The DNA triplet coding for methionine is changed from TAC to ATC.

D The DNA triplet coding for tyrosine is changed from ATA to ATC.

11 Morbillivirus, which causes measles, and the human immunodeficiency virus (HIV) share these common features:

- outer envelope surrounding the protein coat
- RNA as the genetic material
- infect cells of the immune system.

Some **possible** characteristics are listed below:

1 does not contain adenine

2 uses CD4 receptors to enter its host cell

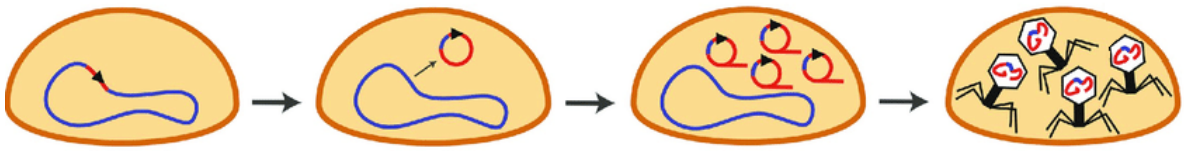
3 genome is directly used in translation

4 leaves its host cell by budding

How many of the above characteristics can be concluded about Morbillivirus, from the information provided?

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

12 The figure below shows a process which occurs in some bacterial cells.



Which of the following statements is incorrect?

A The genome of the bacterial cell above carries information for the synthesis of ribosomes and capsid proteins.

B Faulty prophage excision leads to the same segment of bacterial DNA being integrated into all phage particles.

C Host cell nucleic acid polymerases and ribosomes are used in the process above.

D Phage particles leave the bacterial cell subsequently via transient pores on the cell surface.

13 Gene transfer refers to the movement of genetic material between cells. There are two types of gene transfer in prokaryotes:

- vertical gene transfer where the transfer of genes is from parent to offspring
- horizontal gene transfer where the transfer of genes is between two prokaryotic cells

Which of the following statements correctly describe(s) the two types of gene transfer?

1 Vertical gene transfer consists of conjugation and horizontal gene transfer consists of transduction and transformation.

2 Horizontal gene transfer but not vertical gene transfer results in variation.

3 Both forms of gene transfer can transfer antibiotic resistance.

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

14 Which statement about Southern blotting is correct?

A The different lengths of DNA must undergo the polymerase chain reaction before Southern blotting.

B The nucleotide sequence on the DNA template strand can be used to synthesise a probe to identify a target DNA.

C DNA must be heated to 96 °C to allow the strands to separate, so that the DNA probe can hybridise to the target DNA.

D A DNA stain must be added to visualise the DNA fragments on the agarose gel, to allow for a dark image to develop on the X-ray film.

15 Which of the following is **least** likely to form an oncogene?

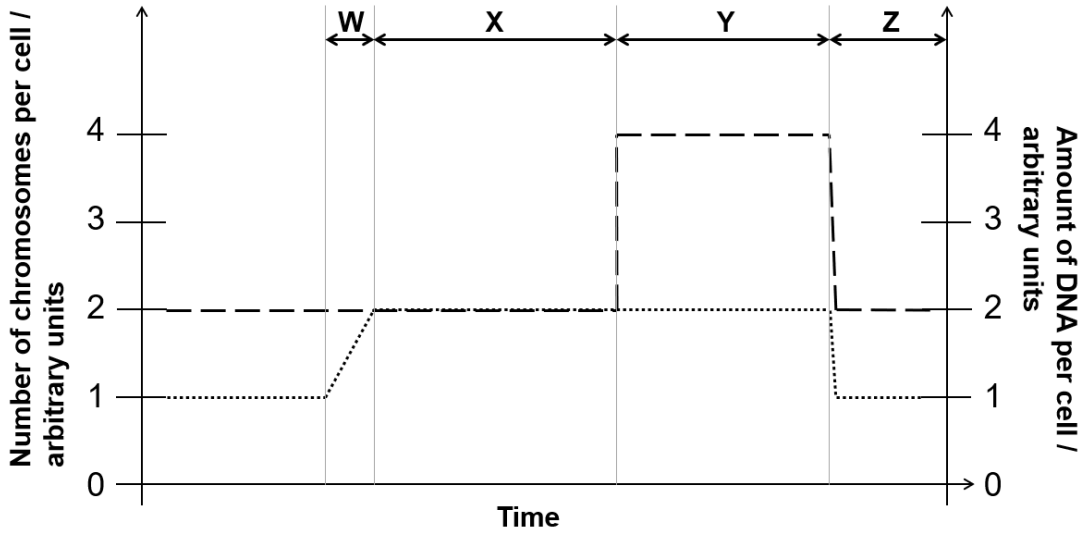
A a proto-oncogene is incorporated into a retroviral genome

B a proto-oncogene is moved downstream of an active promoter

C a proto-oncogene is moved into centromeric heterochromatin

D a proto-oncogene has one or more nucleotides substituted

16 The figure below shows changes that occur during the cell cycle.



Which of the following statements is correct?

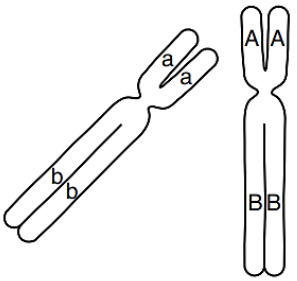
A During period W, S phase is occurring.

B During period X, the cell is in G_1 phase.

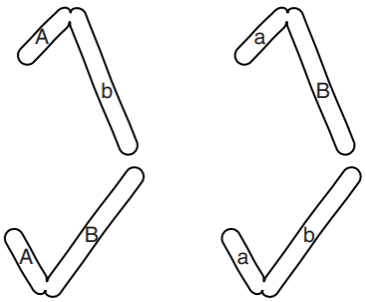
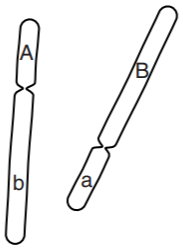
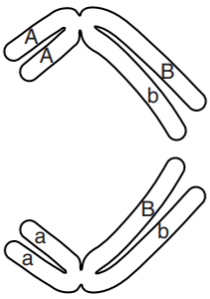
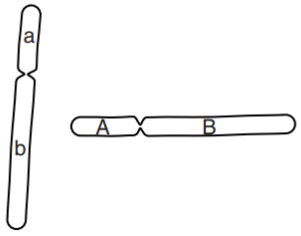
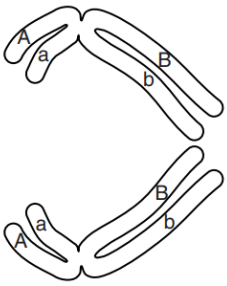
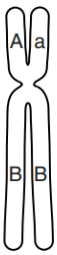
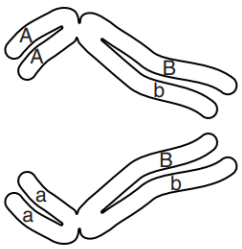
C During period Y, only prophase, metaphase and anaphase are occurring.

D During period Z, the cell has not completed telophase.

17 The diagram shows two homologous chromosomes in early prophase I of meiosis in an animal cell. Two genes, **A/a** and **B/b**, whose loci occur on the homologous chromosomes are also shown.



Which row of diagrams is a possible representation of these chromosomes as they progress from anaphase I to prophase II?

	anaphase I	prophase II
A		
B		
C		
D		

18 Incontinentia pigmenti is a condition that can affect the skin and is characterised by blistering rash at birth. The phenotypes of offspring from different couples were observed and recorded in the table below. Each couple in the table has three daughters and two sons.

couple	couple's phenotypes	offspring's phenotypes
I	unaffected father x unaffected mother	no affected offspring
II	affected father x unaffected mother	all daughters are affected the sons are not affected
III	unaffected father x affected mother	1 out of the 2 sons are affected 1 out of the 3 daughters are affected

Which of the following conclusions can be derived from the information given?

A Incontinentia pigmenti is a sex-linked recessive condition.

B The unaffected mother in couple II is heterozygous for the condition.

C Couple I are both homozygous dominant for the condition.

D The affected mother in couple III is heterozygous for the condition.

19 Which of the following is **not** an example of the effects of the environment on an organism's phenotype?

A Dog breeders crossed dogs of different phenotypes to produce the different breeds of dogs that exist today.

B Effects of the balding allele are more pronounced in males than in females due to higher levels of testosterone in males.

C In some butterflies, caterpillar exposure to red light results in intensely-coloured wings, while exposure to blue light causes pale-coloured wings.

D Cyclops fish eggs develop into embryos with two eyes when placed in sea water but develop into one-eyed embryos when placed in magnesium chloride solution.

20 Singapore tea comes in three distinct flavours – tangy, bitter-tangy, and bitter. The price of the bitter-tangy tea is cheaper because it is found more commonly than either the tangy or the bitter tea. Within each flavour there are different grades depending on the aroma which is controlled by both the level of inhibitor and enzyme. The aroma is richer if there is less inhibitor compared to enzyme.

Which of the following describes the mode of inheritance?

A dihybrid, autosomal linkage, multiple alleles

B multiple alleles, autosomal linkage, epistasis

C polygenes, co-dominance, epistasis

D polygenes, dihybrid, multiple alleles

21 A student was asked to describe some of the stages of aerobic respiration.

stage T	carbon compound is broken down, ATP is produced
stage U	carbon compound is regenerated, NADH is produced
stage V	electrochemical gradient is generated, water is produced

Which is the correct identification of the stages of aerobic respiration?

	stage T	stage U	stage V
A	glycolysis	Krebs cycle	oxidative phosphorylation
B	link reaction	Krebs cycle	chemiosmosis
C	glycolysis	Calvin cycle	chemiosmosis
D	link reaction	Calvin cycle	oxidative phosphorylation

22 Six tubes were set up as shown in the table.

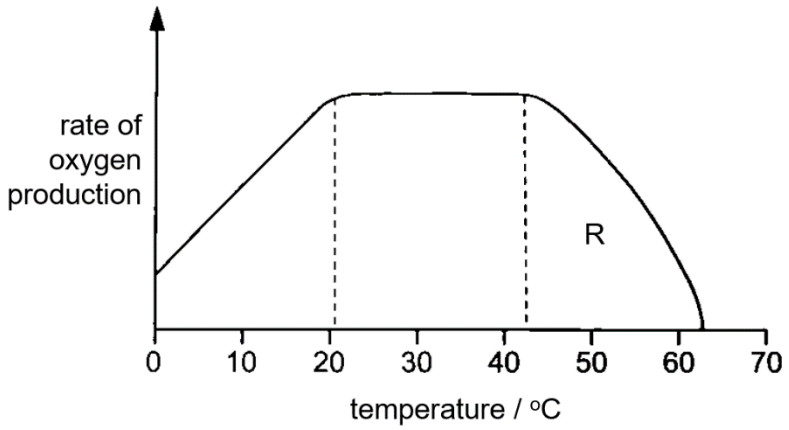
tube	contents
1	glucose and homogenised yeast cells
2	glucose and yeast mitochondria
3	glucose and yeast cytoplasm lacking organelles
4	pyruvate and homogenised animal cells
5	pyruvate and animal mitochondria
6	pyruvate and animal cytoplasm lacking organelles

After incubation under aerobic conditions, each sample was analysed to determine the presence of lactate.

In how many tubes is lactate likely to be present?

A 0 **B** 1 **C** 2 **D** 3

23 The graph shows how the rate of oxygen production by the photosynthetic alga *Chlamydomonas* varies with temperature, when all other factors are kept constant.



The following are factors that can limit the rate of reaction.

1 carbon dioxide concentration

2 light intensity

3 temperature

Which of these factors must be limiting the rate of reaction at R?

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

24 Which statements correctly describe the second messengers that are involved in cell signalling?

1 They are small, water-soluble proteins.

2 They are produced by enzymes.

3 They induce cellular response through change in concentration.

4 They cause a long-term cellular response.

A 1 and 3

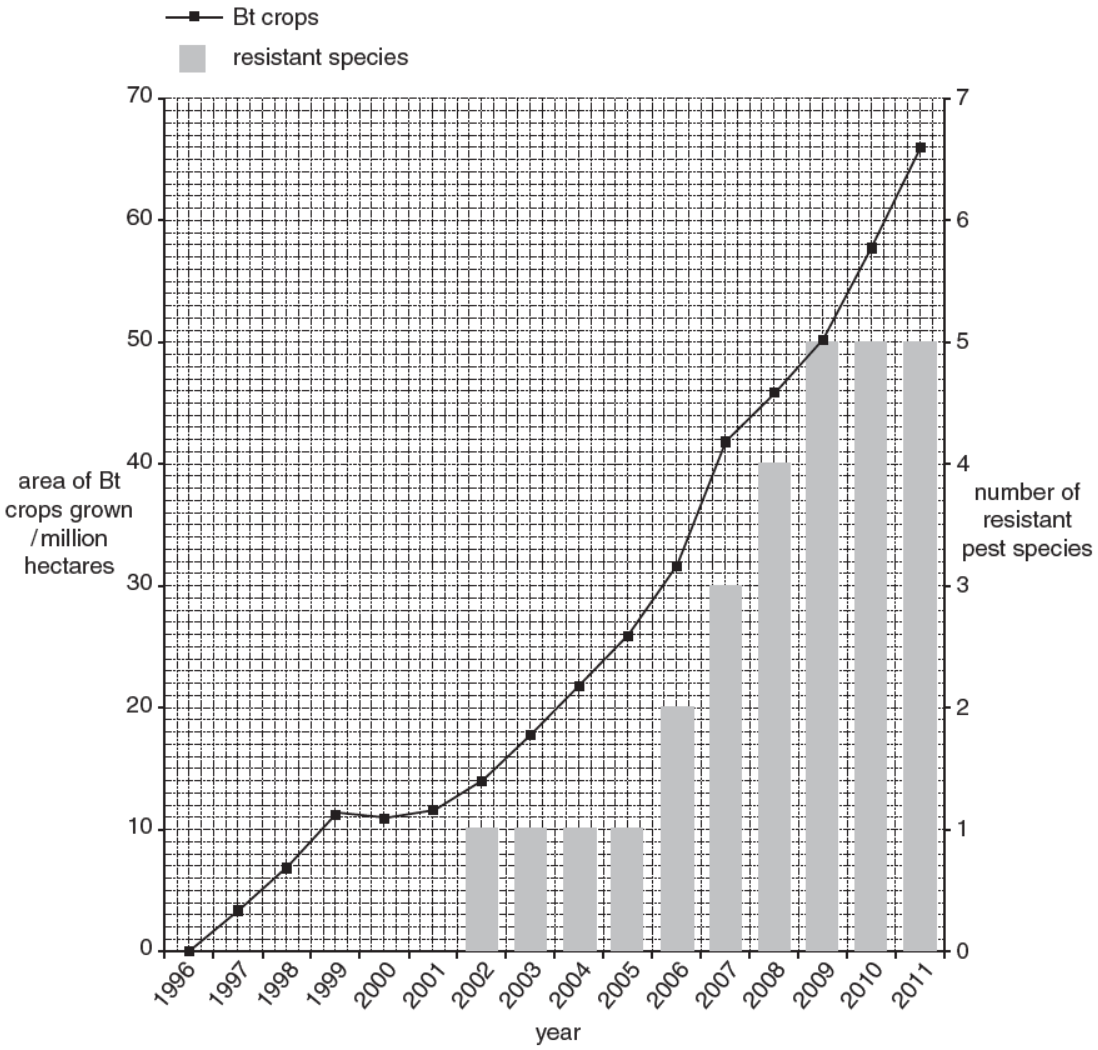
B 1 and 4

C 2 and 3

D 2 and 4

25 Maize and other crops have been genetically modified since 1996 to produce the Bt toxin to kill insect pests.

The figure below shows the area of Bt crops grown (plotted points) and the number of insect pest species in which resistance to Bt has been reported (bars).



Based on your biological knowledge and inferences from the information above, which of the following statements is valid?

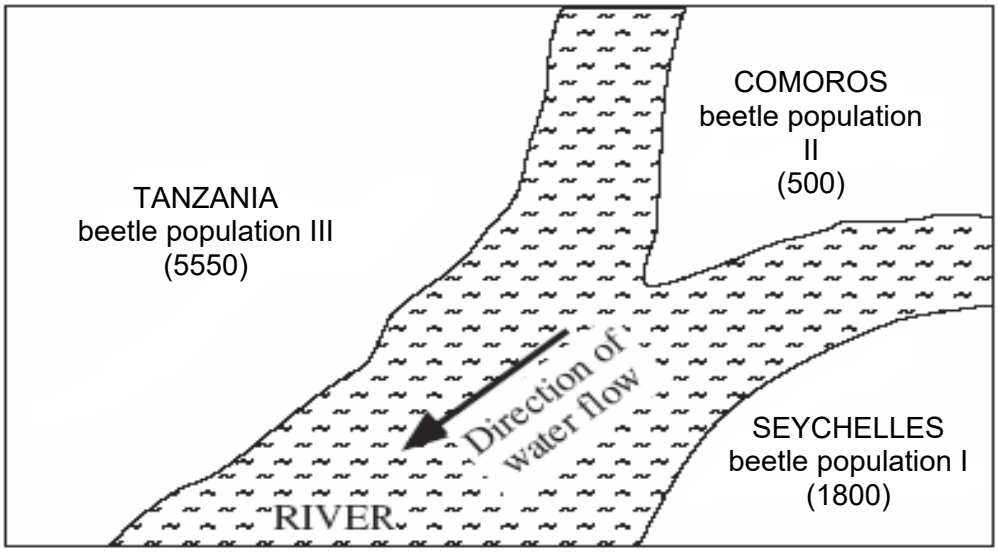
A The more the area of Bt crops grown, the more the number of resistant pest species.

B Resistance to Bt toxin among insect pests could arise from a spontaneous chromosomal aberration event.

C The farming of Bt crops exerted a selection pressure that caused mutations resulting in resistance to Bt toxin among insect pests.

D The allele for resistance to Bt toxin is likely to have spread from one pest species to another.

26 The diagram shows the distribution of three beetle populations on three different islands.



Population size is indicated within the bracket ( ).

The current distribution of these beetle populations is investigated and shown in the table.

beetle population	phenotype	observed to produce viable offspring with
I	light brown, smooth scales	II and III
II	light brown, keeled scales	I and III
III	dark brown, smooth scales	I and II

Which of the following inferences can be drawn from the investigation?

A Beetle population I has the most genetic variability.

B Tanzania has darker coloured soil than Seychelles or Comoros.

C The beetles underwent allopatric speciation to give three physically distinct species.

D Beetle population II is the source population from which populations I and III originated from.

27 Which of the following statements correctly describes the relationship between macrophages and CD4 T cells?

A Macrophages secrete cytokines to cause CD4 T cells to divide and differentiate into T helper cells. These effector T cells in turn secrete cytokines to stimulate an increase in toxic chemical production to kill ingested bacteria.

B Macrophages secrete chemokines to recruit circulating T helper cells to the infection site and these effector T cells secrete granzymes and perforin to induce apoptosis in macrophages which ingested bacteria, causing destruction of pathogens.

C Macrophages act as antigen-presenting cells to activate naïve CD4 T cells to divide and differentiate into T helper cells. These effector T cells in turn secrete chemokines to recruit more macrophages to accumulate at the site of infection to destroy pathogens via phagocytosis and toxic chemical production.

D Macrophages act as antigen-presenting cells to activate naïve CD4 T cells to divide and differentiate into cytotoxic T cells. These effector T cells in turn secrete granzymes and perforin to induce apoptosis in macrophages which ingested bacteria, causing destruction of pathogens.

28 Which process occurs in the human immune system?

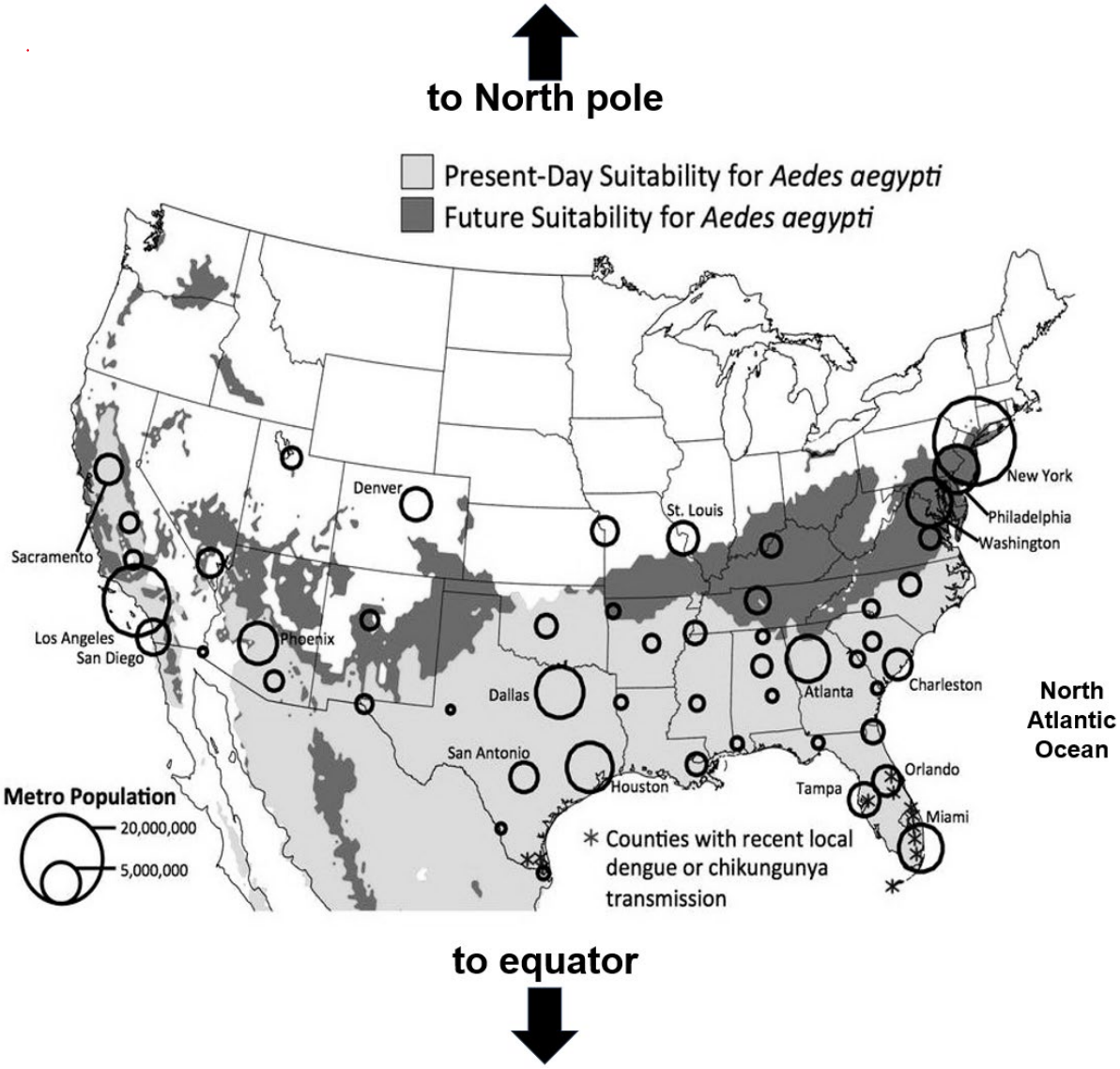
A binding of antigen molecules to the heavy chain and light chain of antibodies

B class switching as a result of changes to the variable region of an antibody

C hyper-mutation of T lymphocytes leading to the formation of new cytokines

D somatic recombination during the maturation of B lymphocytes in the thymus

29 The figure below shows the current and potential spread of dengue and chikungunya across the United States. Both diseases are spread by the *Aedes aegypti* mosquito.



Which of the following best explains the current or potential trends in the spread of these diseases as shown in the figure?

A Most of the regions with recent local dengue or chikungunya transmission are coastal regions possibly because these regions receive more rainfall and provide more suitable breeding grounds for *Aedes aegypti*.

B The larger the size of the metro population, the higher the chances of mosquitoes transmitting the diseases from person to person.

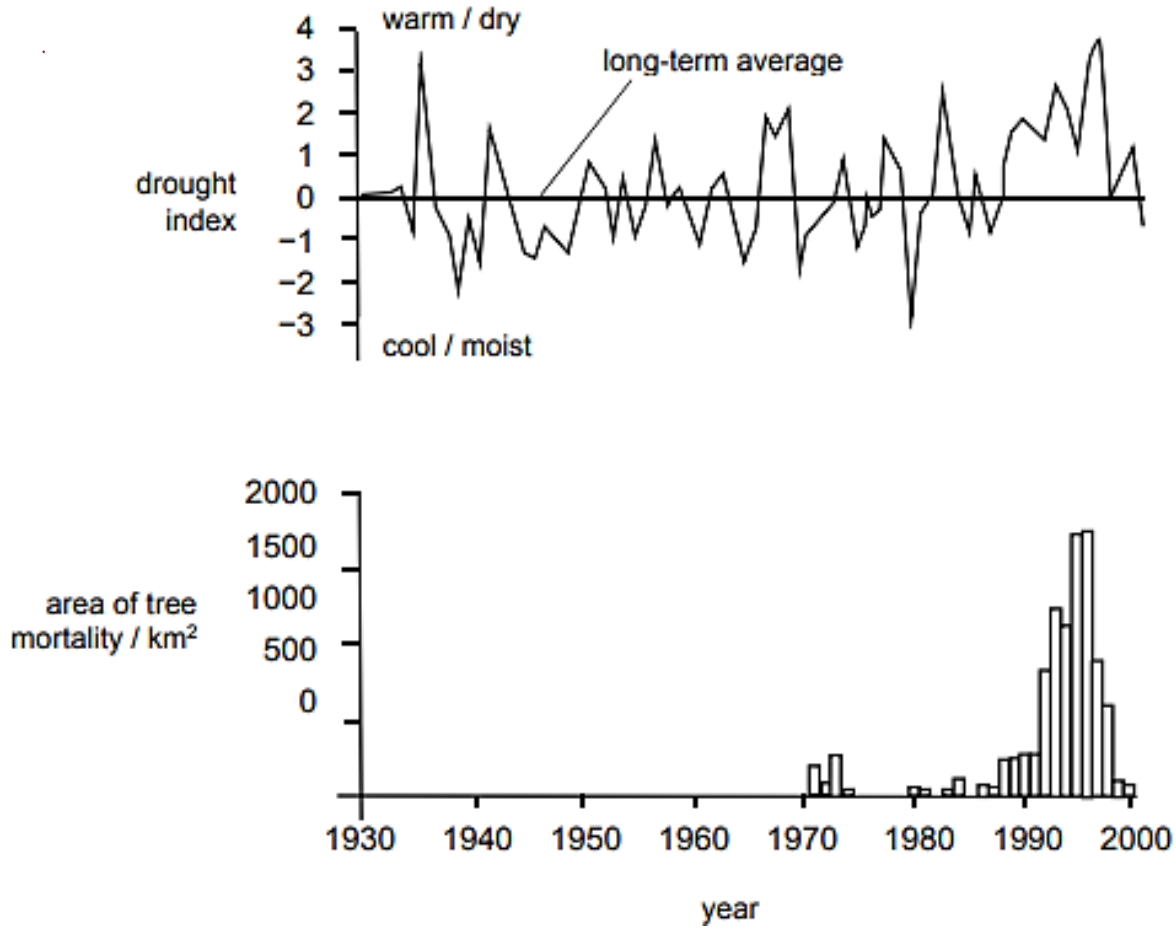
C These diseases would spread higher in altitude in the future with increased global warming.

D The diseases are unlikely to spread to the northern regions (in white) in the future because they are too warm for *Aedes aegypti* to survive.

30 With climate change, some regions on Earth are experiencing warmer temperatures. Warmer temperatures favour some species of pest, for example the spruce beetle, *Dendroctonus rufipennis.*

Since the first major pest outbreak, the spruce beetles have severely destroyed approximately four hundred thousand hectares of trees in Alaska and the Canadian Yukon.

The graphs show the drought index, a combination of temperatures and precipitation and the area of spruce trees destroyed annually.



Which statement best explains the trends observed in the graphs?

A From the late 1980s, a prolonged period of drought and warm weather resulted in an increased number of generations of the spruce beetles, which caused tree mortality.

B Between 1930 and 1970, there was no tree mortality because the spruce beetles had other food sources.

C The environmental conditions in the early 1970s favoured the population growth of spruce beetles, hence leading to some tree mortality.

D The spike in tree mortality was likely not related to climate, but due to a random catastrophic event that wiped out an entire patch of forest.

1	C	11	A	21	A
2	D	12	D	22	B
3	B	13	B	23	B
4	C	14	B	24	C
5	B	15	C	25	A
6	D	16	A	26	B
7	C	17	D	27	C
8	A	18	D	28	A
9	C	19	A	29	A
10	D	20	C	30	A