NAME: _____ CLASS: _____

JURONG PIONEER JUNIOR COLLEGE
JC2 Preliminary Examination 2023

BIOLOGY
Higher 2

9744/01
19 September 2023

Paper 1 Multiple Choice **1 hour**

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, class and index number on the Answer Sheet in the spaces provided unless this has been done for you.

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.

Read the instructions on the Answer Sheet very carefully.

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.

This document consists of **17** printed pages and **3** blank pages.

1 A molecule of carbon dioxide is in the centre of a mitochondrion.

Assuming there are no other cell structures in its path, how many phospholipid layers will the carbon dioxide molecule have to pass through to leave the cell?

A 2

B 3

C 4

D 6

2 Which nitrogenous bases are present in all viruses?

1 thymine

2 adenine

3 cytosine

A 1, 2 and 3

B 1 and 2 only

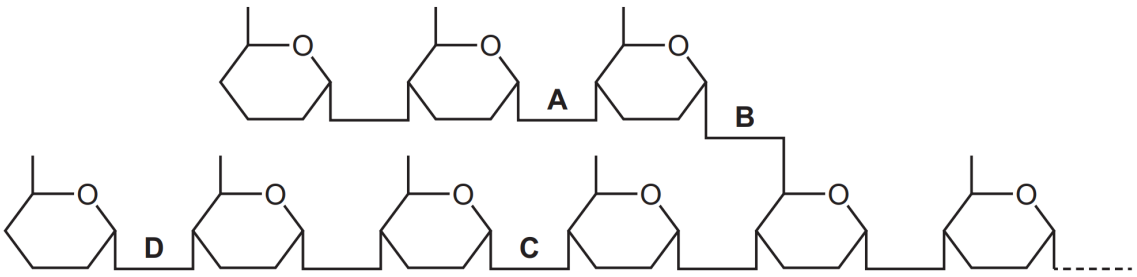
C 1 and 3 only

D 2 and 3 only

3 The enzyme α-amylase hydrolyses amylopectin but it is not able to hydrolyse some of its glycosidic bonds.

- It only hydrolyses 1,4 glycosidic bonds.
- It is not able to hydrolyse the last bond of a chain.
- It is not able to hydrolyse the bonds in a chain of three units attached by a 1,6 glycosidic bond to another chain.

Which glycosidic bond can be hydrolysed by α-amylase?



4 When investigating the rate of reaction of the enzyme lipase on the hydrolysis of triglycerides, the pH must be maintained at an optimum to prevent the lipase denaturing.

What is the reason for this?

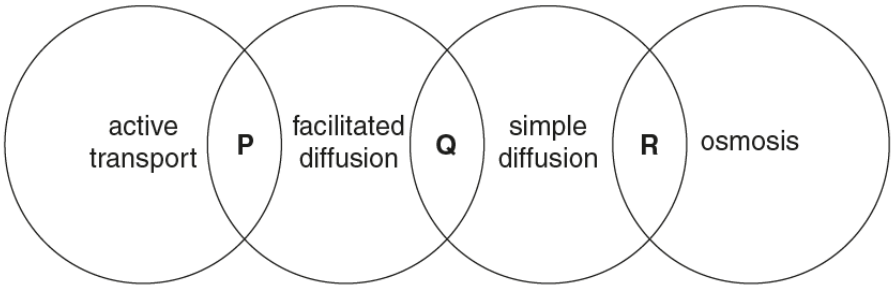
A The addition of water molecules produced by hydrolysis increases pH.

B The products of hydrolysis decrease the pH.

C The products of hydrolysis increase the pH.

D The removal of water molecules used in hydrolysis decreases pH.

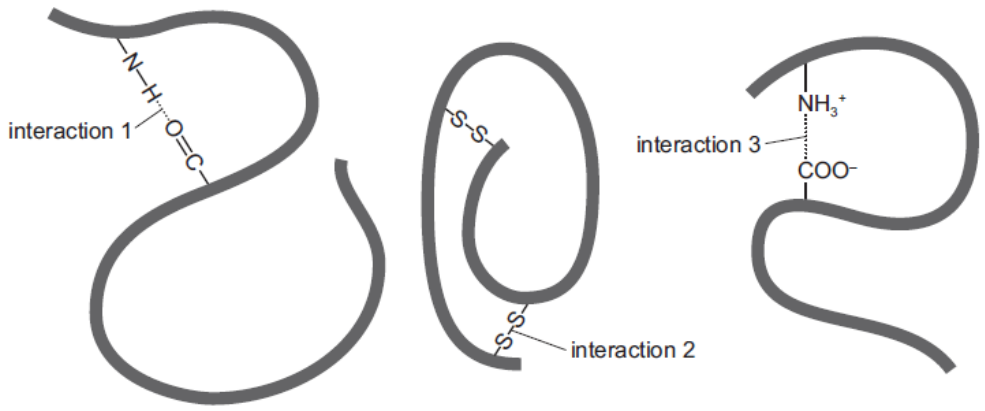
5 Four mechanisms involved in the movement of substances across membranes are shown below.



Which features of these transport mechanisms are represented by **P**, **Q** and **R**?

	P	Q	R
A	involves membrane carrier proteins	passive movement	movement against a concentration gradient
B	involves membrane transport proteins	movement down a concentration gradient	passive movement
C	movement against a concentration gradient	involves membrane channel proteins	movement through the hydrophobic core of the phospholipid bilayer
D	requires energy supplied by ATP	movement through the hydrophobic core of the phospholipid bilayer	involves membrane channel proteins

6 The diagram shows three interactions that hold protein molecules in shape.



Which row identifies these interactions?

	interaction 1	interaction 2	interaction 3
A	hydrogen bond	disulfide bond	hydrophobic interaction
B	hydrogen bond	covalent bond	ionic bond
C	hydrophobic interaction	ionic bond	hydrogen bond
D	ionic bond	disulfide bond	peptide bond

7 Some animals produce antimicrobial proteins which protect them from pathogens. These proteins could be used to kill human pathogens, however when used as a medicine they are broken down by protein-digesting enzymes.

Replacing one of the amino acids found in the protein with an amino acid that had been synthesised in the laboratory resulted in a modified protein that was **not** broken down.

What could explain why this modified protein was not broken down by the protein-digesting enzymes?

1 The modified protein has a different tertiary structure to the original protein.

2 The modified protein is not complementary in shape to the enzyme's active site.

3 The modified protein is unable to induce a fit with the protein-digesting enzyme.

A 1, 2 and 3

B 1 and 2 only

C 1 and 3 only

D 2 and 3 only

8 Which row describes some properties of stem cells?

	able to divide by mitosis to produce more stem cells	able to differentiate into specialised cells	able to repair damaged cells
A	✓	✓	✓
B	✓	✓	×
C	✓	×	×
D	×	×	✓

key
✓= is a property
× = is not a property

9 How many statements about semi-conservative replication of DNA in a eukaryotic cell are correct?

1 The process takes place in the cytoplasm.

2 An adenine nucleotide will line up against uracil on the template strand.

3 Each daughter molecule will contain half of the original DNA molecule.

4 If the DNA molecule contained 40% guanine nucleotides, each daughter molecule will contain 20% guanine nucleotides.

A 1

B 2

C 3

D 4

10 Some viruses are able to bind to the cell surface membrane before entering the host cell.

Which sequence of events will lead to a virus invading a cell?

A binding to a cholesterol molecule, followed by endocytosis

B binding to a glycoprotein receptor, followed by exocytosis

C binding to a protein receptor, followed by endocytosis

D binding to the hydrophilic portion of a phospholipid, followed by exocytosis

11 Two mutant strains of *Escherichia coli,* one having the F-plasmid and the other without the F-plasmid were mixed in suspension. One was unable to synthesise biotin and the amino acid threonine, the other was unable to manufacture the two amino acids leucine and lysine. The genes coding for the synthesis of these essential metabolites are widely separated on the F-plasmid.

After sixty minutes the bacteria were plated onto a growth medium deficient in all four metabolites. Four hundred colonies grew.

Which process would result in bacteria that are able to grow on a growth medium deficient in these essential metabolites?

A conjugation

B translocation

C transduction

D transformation

12 Gibberellin is a plant hormone which stimulates seed germination by the following mechanism:

1 PIF is required to stimulate the synthesis of amylase.

2 DELLA is a protein attached to PIF.

3 When gibberellin is present it binds to a receptor and an enzyme.

4 This complex breaks down the DELLA protein.

5 PIF is released.

6 PIF binds to the promoter region on the amylase gene.

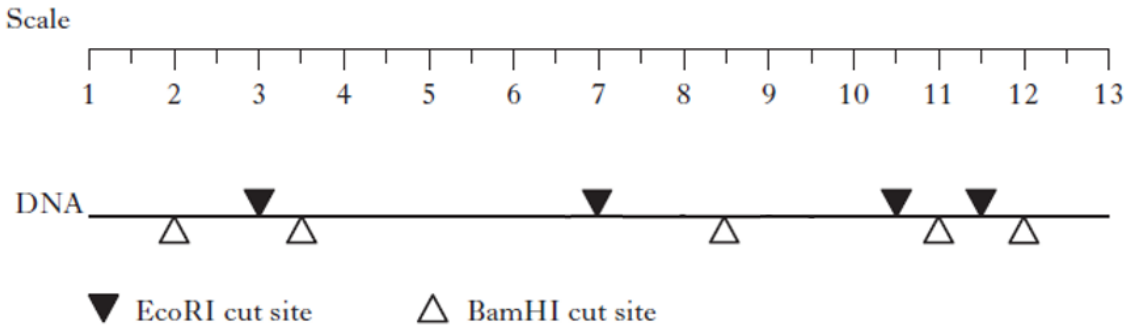
7 Transcription of amylase begins.

8 Amylase enzyme is responsible for the initiation of seed germination.

What role do the regulatory components DELLA and PIF play in the described mechanism?

	DELLA	PIF
A	promoter of amylase	activator protein
B	repressor protein	promoter of amylase
C	repressor protein	transcription factor
D	transcription factor	transcription factor

13 A piece of DNA is cut into fragments using the restriction enzymes *Bam*HI and *Eco*RI at the sites indicated in the diagram below.



How many bands would be observed following separation of the fragments by electrophoresis?

A 3

B 5

C 6

D 10

14 The DNA triplets of genes are translated as amino acids or stop signals during protein synthesis.

The table shows some of these triplets.

DNA triplet	name of amino acid
ATA	tyrosine
ATG	tyrosine
ACA	cysteine
ACG	cysteine
ATC	*stop signal*
ACC	tryptophan

What could be the effects of **one** substitution mutation in a triplet coding for tyrosine?

1 The triplet is translated as cysteine.

2 The triplet is translated as tryptophan.

3 The triplet is translated as tyrosine.

4 Translation stops at this triplet.

A 1, 2 and 3

B 1, 2 and 4

C 1, 3 and 4

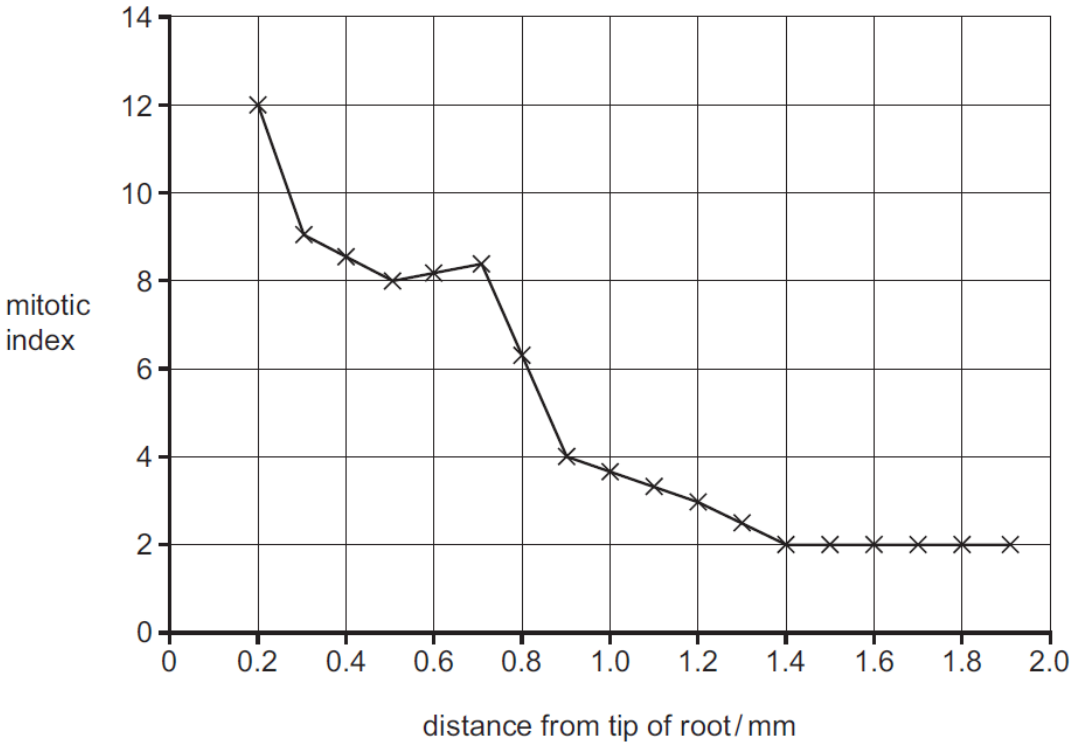
D 2, 3 and 4

15 The mitotic index is a measure of the proportion of cells that are undergoing mitosis in an area of tissue. It is calculated using the formula shown.

mitotic index = (number of cells undergoing mitosis ÷ total number of cells) × 100

A scientist calculated the mitotic index of areas of onion root at different distances from the tip of the root.

The results are shown.



Which statement is correct?

A No cell division occurs further than 1.4 mm from the tip of the root.

B The rate of cell division decreases as the distance from the root tip decreases.

C Most of the cells undergoing cell division are closer to the tip of the root.

D For a sample of 200 cells 0.2 mm from the tip of the root, 6 would be undergoing mitosis.

16 Chemical carcinogens and ionising radiation can result in an accumulation of mutations in genes that regulate the cell cycle.

What is the correct sequence of events that leads to metastasis of cancer in the body?

1 Cells start to divide continuously.

2 The tumour develops a blood supply.

3 A mass of undifferentiated cells forms.

4 Cells stop responding to some signals.

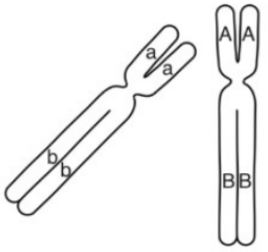
A 1 → 3 → 2 → 4

B 1 → 4 → 2 → 3

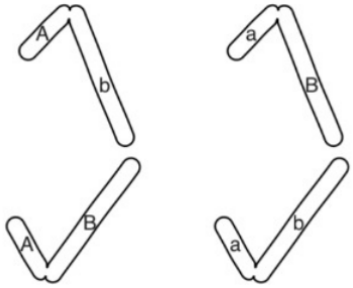
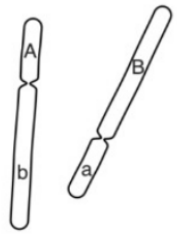
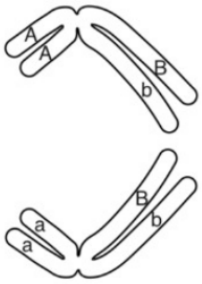
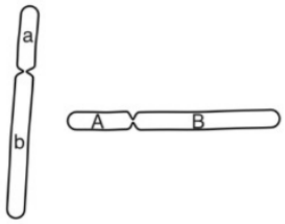
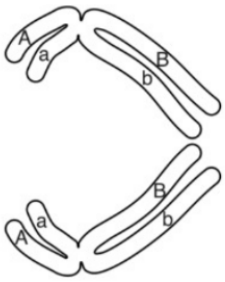
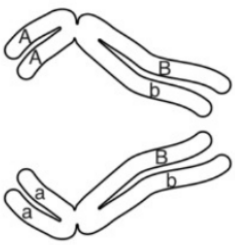
C 4 → 1 → 2 → 3

D 4 → 1 → 3 → 2

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 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 William Bateson and Reginald Punnett used the sweet pea (*Lathyrus odoratus*) in genetics studies in the early 20th century. Pure-breeding plants that produced purple flowers and long pollen grains were crossed with pure-breeding plants that produced red flowers and round pollen grains. The resulting offspring all produced purple flowers and long pollen grains. Two of the F1 generation plants were crossed. The table shows the ratio of phenotypes in the F2 generation.

Flower colour	Pollen grain shape	Number of plants
purple	long	4831
purple	round	390
red	long	393
red	round	1138

What is an explanation for these experimental results?

A Purple flowers and long pollen grains are dominant and the alleles have assorted independently.

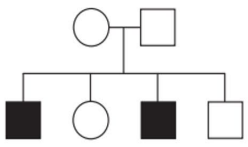
B The genes for flower colour and pollen shape are linked and all plants producing long pollen grains are recombinants.

C The genes for flower colour and pollen shape are linked and all plants producing red flowers are recombinants.

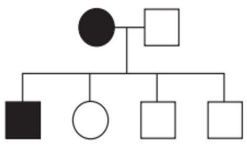
D Plants producing purple flowers and round pollen grains arose through crossing over.

19 Which pedigree chart is consistent with the inheritance of red-green colour blindness?

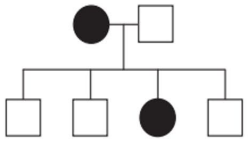
A



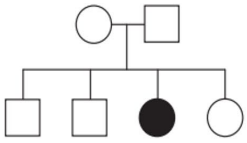
B



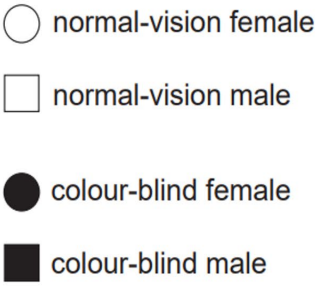
C



D



Key:



20 A genetic cross involving two genes for eye color and wing length was carried out using the fruit flies, *Drosophila melanogaster*.

- The gene involved in eye colour has two alleles, a dominant red allele and a recessive purple allele.
- The gene involved in wing length has two alleles, a dominant normal length allele and a recessive vestigial allele.

A double homozygous dominant parent was crossed with a double homozygous recessive parent to obtain F1 offspring. The F1 offspring were then crossed with a double homozygous recessive insect (a test cross).

The phenotypes of 200 test cross offspring were recorded.

phenotype	purple eye normal length wing	purple eye vestigial wing	red eye normal length wing	red eye vestigial wing
observed numbers	38	61	63	38
expected numbers	50	50	50	50

Which deductions can be made using the information provided?

1 A fruit fly that has purple eye is more likely to have normal length wing than a fruit fly with red eye.

2 Four different genotypes were represented in the gametes produced by the F1 individual used in the test cross.

3 The genotype of the F1 offspring used in the test cross was known before the test cross was carried out.

4 The genotypes of the test cross offspring can be worked out.

A 1 and 3

B 1 and 4

C 2, 3 and 4

D 2 only

21 The following steps describe non-cyclic photophosphorylation involving the electron transport chain.

1 Electrons from the photolysis of water replace lost electrons from photosystem II.

2 Light passes to primary pigments in photosystem I and II.

3 Electrons are passed from photosystem II to photosystem I via electron transport chain.

4 Energy is released to synthesise ATP.

5 Electrons are excited to a higher energy level.

Which option represents the correct sequence of the steps?

A 2 → 5 → 1 → 4 → 3

B 2 → 5 → 3 → 4 → 1

C 5 → 3 → 4 → 2 → 1

D 5 → 4 → 3 → 2 → 1

22 Which statements are **not** correct regarding chemiosmosis in photosynthesis?

1 Protons move down their concentration gradient through ATP synthase located in the chloroplast membrane.

2 The photolysis of water provides protons needed for chemiosmosis to occur.

3 ADP is phosphorylated to ATP due to the energy released by the movement of electrons down the electron transport chain.

4 A high concentration of protons build up outside the intermembrane space, creating a concentration gradient.

A 1, 3 and 4

B 1 and 4 only

C 2, 3 and 4

D 2 and 3 only

23 Which row correctly describes respiration under anaerobic conditions in yeast and plant cells?

	glucose is **not** completely broken down	NAD is a final product	carbon dioxide is produced	pyruvate is produced in mitochondria
A	×	✓	✓	✓
B	✓	×	×	✓
C	✓	×	×	×
D	✓	✓	✓	×

key
✓= correct
× = incorrect

24 What is the role of G protein in cell signalling?

A to act as a membrane-bound enzyme

B to act as a switch releasing a second messenger

C to amplify the original signal

D to change the shape of the protein receptor

25 Which statement correctly describes an environmental factor acting as a force of natural selection?

A External colour markings of some reptiles fade as a result of exposure to sunlight. This change improves the animals' camouflage in habitats with little cover and there they are less likely to be eaten by predators. Predation is acting as a force of natural selection.

B Human diseases that are caused by bacteria are often treated with antibiotics. When exposed to antibiotics, bacteria that already have some genetic resistance to the antibiotic are more likely to survive and reproduce. The genes causing resistance are acting as a force of natural selection.

C Some mammals develop thicker coats as day length decreases. In the cold temperatures of winter, a thick coat provides better insulation. Mammals with thicker coats are more likely to survive and breed in the spring. Day length is acting as a force of natural selection.

D Stomata open in sunlight increasing the availability of carbon dioxide to leaves. As a result, the rate of photosynthesis increases. This change improves the reproductive success of plants. Intensity of light is acting as a force of natural selection.

26 *Anolis sagrei*, a lizard native to Bahamas Island, spends most of its time on the ground. A predatory lizard, *Leiocephalus carinatus*, a ground dwelling predator of *Anolis sagrei* was introduced to the island.

Six months later, most of the *Anolis sagrei* lizards found in the island have longer legs. 12 months later, most of the *Anolis sagrei* lizards found in the island have shorter legs but becoming increasingly arboreal, spending time in treetop.

Which statements are true?

1 *Anolis sagrei* with longer legs can run faster and hence were at an advantage initially.

2 *Anolis sagrei* being arboreal can better evade *Leiocephalus carinatus.*

3 Presence of the predatory lizard results in mutation *of* a gene in *Anolis sagrei* that codes for the length of legs.

4 The selection pressure acting on the population of *Anolis sagrei* changed after 6 months.

A 1 and 2

B 1 only

C 2 and 3

D 3 and 4

27 In 1981, a male finch (a type of seed-eating bird) of the species *Geospiza conirostris* arrived on Daphne Major, one of the Galapagos Islands. This species had not previously occurred on this island. The male finch bred with a female of the species *G. fortis* that already occurred on Daphne Major.

Over several generations, the descendants of this pair gradually increased in number and formed a small breeding population. The size and beak shape of the finches in this population were distinct from those of other finches living on the island. No mutations had occurred.

What may be concluded from these observations?

A This is an example of evolution because new genes have been produced.

B This cannot be an example of evolution because the time scale is too short.

C This cannot be an example of evolution because the population is too small.

D This is an example of evolution because inherited changes have occurred.

28 Which statement correctly explains why viruses are unaffected by penicillin?

A Penicillin only affects host cell metabolism.

B Penicillin only binds with 70S ribosomes.

C Penicillin only blocks mRNA synthesis in prokaryotes.

D Penicillin only blocks peptidoglycan synthesis.

29 Human activity is believed to have contributed to climate change. It has been suggested that climate change has resulted in a worldwide loss of biodiversity.

Which statements explain why there may have been a loss of biodiversity?

1 habitat loss

2 invasion from immigrating species that replace native species

3 climatic conditions change faster than species can adapt by evolution

4 colonisation of previously uninhabited areas

A 1, 2 and 3

B 1, 2 and 4

C 1 and 3 only

D 2 and 4 only

30 The mosquito *Aedes aegypti* transmits the virus that causes dengue disease. Global warming is predicted to increase the incidence of viral dengue disease.

Which statement correctly explains why global warming could increase the incidence of viral dengue disease?

A As some regions where the mosquito live become too hot, mosquitoes will move out resulting in an increase in the number of infected mosquitoes in the remaining regions.

B Mosquitoes will be active for longer each day, improving their reproductive success and resulting in an increase in the number of mosquitoes hatching that are infected with the virus.

C The time for mosquitoes to complete their life-cycle will be reduced since increases in the rate of enzyme-catalysed reactions will result in faster metabolic rates.

D The viruses within a human host will replicate more rapidly, increasing the probability that a mosquito vector will be infected.

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