VICTORIA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
2024
HIGHER 2

NAME: .....

CT CLASS: .....

BIOLOGY
Paper 1 Multiple Choice

9744 / 01

20/09/2024

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 and class on the Answer Sheet in the spaces provided.

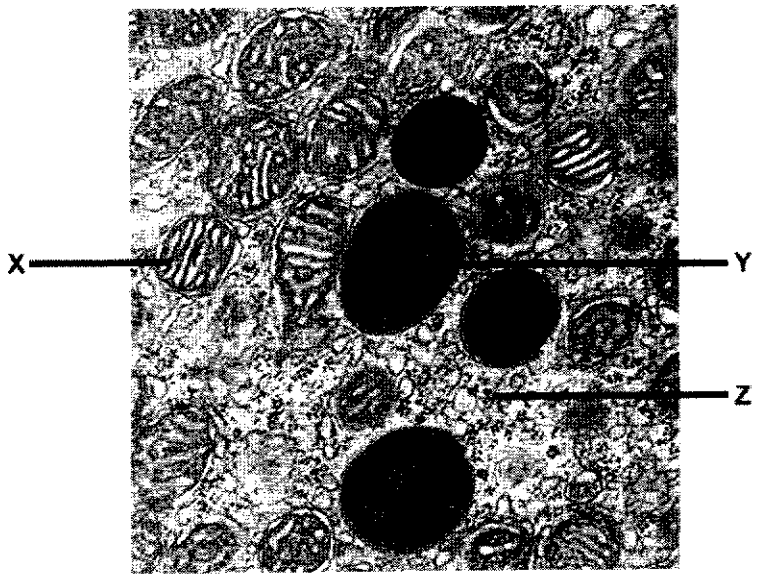
There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

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 an approved scientific calculator is expected, where appropriate.

This document consists of **20** printed pages.

[Turn over]

1 The diagram below shows an electron micrograph of a eukaryotic cell.



Which of the following options shows the correct functions of the labelled structures?

	X	Y	Z
A	site of photophosphorylation	involved in autolysis	site of protein synthesis
B	site of oxidative phosphorylation	involve in secretion of proteins	site of glycolysis
C	site of photophosphorylation	involve in rRNA synthesis	site of glycolysis
D	site of oxidative phosphorylation	involved in autophagy	site of protein synthesis

2 The table shows the diameter of some atoms when they form bonds.

atom	single bond / nm	double bond / nm
H	0.060	-
O	0.132	0.110
N	0.140	0.120
C	0.154	0.134

Using the table, the approximate length of an amino acid is estimated to be 0.7 nm.

What would be the approximate length of a dipeptide formed using this amino acid?

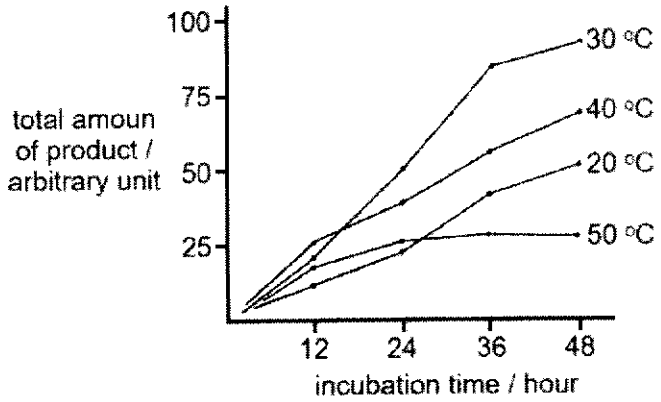
A 0.9 nm **B** 1.2 nm **C** 1.4 nm **D** 1.7 nm

3 Which row shows the chemical groups present in the biological molecules listed?

	biological molecule	presence of carboxyl (COOH) groups	presence of two or more hydroxyl (OH) groups
1	amino acid	yes	no
2	β glucose	no	yes
3	glycerol	no	no
4	fatty acid	yes	no

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

4 The graph shows the activity of an enzyme at four different temperatures, with all other conditions being constant.



What conclusion can be drawn from the graph?

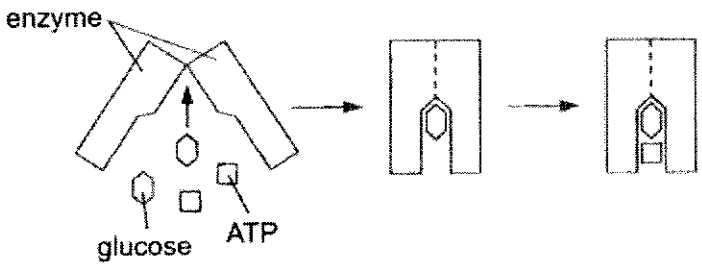
A No enzyme denaturation occurs at temperatures below 40 °C.

B The optimum temperature for the enzyme is 30 °C in all incubation times.

C The V_{max} of enzyme activity is reached after 36 hours at 50 °C.

D There are more functional enzyme molecules after 48 hours at 20 °C than 40 °C.

5 The action of the enzyme hexokinase, which catalyses the phosphorylation of glucose, is shown below.



Which statements describe the behaviour of this enzyme?

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

2 The active site for ATP is formed only in the presence of glucose.

3 The enzyme catalyses both hydrolysis and condensation reactions.

4 The activation energy is lowered as substrates are placed in the correct orientation.

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

6 When investigating enzyme-substrate interactions, which one of the following would be expected to show a linear relationship under constant conditions?

A amount of product against time, with the amount of substrate limited

B rate of reaction against substrate concentration, with the amount of enzyme limited

C rate of reaction against enzyme concentration, in the presence of excess substrate

D rate of reaction against enzyme concentration, with the amount of substrate limited

7 For most stem cells, once they are differentiated, they lose the ability to turn into other types of cell. However, some fully differentiated cells can be stimulated to change back into stem cells in tissue culture. Such cells are called induced pluripotent stem cells (iPS cells).

In experiments with mice, it was discovered that the introduction of four genes would cause certain fully differentiated cells to change to iPS cells. Genes were introduced into host mouse cells using artificially synthesised plasmids.

There is evidence to suggest that the introduction of the four genes caused an increase in the production of telomerase reverse transcriptase (TERT) in the fully differentiated cells.

Which statements are correct?

1 The iPS cells are useful for research because they have the ability to differentiate into cells of the extra-embryonic membranes.

2 Only a few genes were required to be added because these genes were likely able to influence the activity of many other genes by coding for transcription factors.

3 TERT, which plays a part in maintaining the length of the telomere at the end of a chromosome, is not normally switched on in differentiated cells.

4 This method of creating iPS cells has less ethical concerns than harvesting embryonic stem cells.

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

8 Which statements correctly describe the role of rRNA in protein synthesis?

1 It helps to align mRNA and tRNA molecules during translation.

2 It links specific amino acids to different tRNA molecules.

3 It catalyses the addition of amino acids to the C-terminus of the polypeptide.

4 Together with ribosomal proteins, it binds mRNA to the ribosome.

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

9 During the process of protein synthesis, individual amino acids are combined with individual nucleic acid molecules in the cytoplasm of a cell.

Which four nitrogenous bases, represented by their initial letters, make up the variable regions of these nucleic acid molecules?

A A C G T

B A C G U

C A C T U

D C G T U

10 In an experiment modelled after that of Meselson and Stahl, bacteria having DNA fully labelled with the light isotope of nitrogen (^{14}N) were transferred to a medium containing only the heavy isotope of nitrogen (^{15}N).

The bacteria were allowed to reproduce for two generations in this medium.

Which statement would be true of the DNA of the second generation?

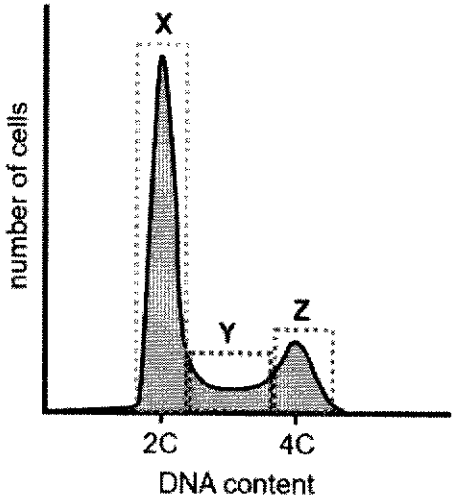
A All DNA molecules will have ^{15}N nucleotides.

B 50% of DNA molecules will have ^{14}N nucleotides only and 50% will have half ^{15}N and half ^{14}N nucleotides.

C 50% of DNA molecules will have ^{14}N nucleotides only and 50% will have ^{15}N nucleotides only.

D 25% of DNA molecules will have ^{14}N nucleotides and 75% will have ^{15}N nucleotides.

11 The diagram below shows the distribution of cells of varying DNA content during interphase.



Which of the following statements can be concluded from the diagram above?

1 Most of the cells are in G1 phase.

2 All cells in area **Z** will eventually complete the nuclear division.

3 Area **Y** represents the number of cells undergoing anaphase.

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

12 When there is low availability of nutrients, yeast cells can exit the mitotic cell cycle and enter the meiotic cell cycle.

Researchers grew a culture of yeast cells in nutrient-rich medium and then transferred them to nutrient-poor medium to induce meiosis. The data below shows the changes in DNA content after the induction.

time after induction (hours)	average amount of DNA per cell (µg)
0.0	24.0
1.0	24.0
2.0	40.0
3.0	47.0
4.0	47.5
5.0	48.0
6.0	48.0
7.0	47.5
8.0	25.0
9.0	24.0
10.0	23.5
11.0	14.0
12.0	13.0
13.0	12.5
14.0	12.0

Which of the following statements is true?

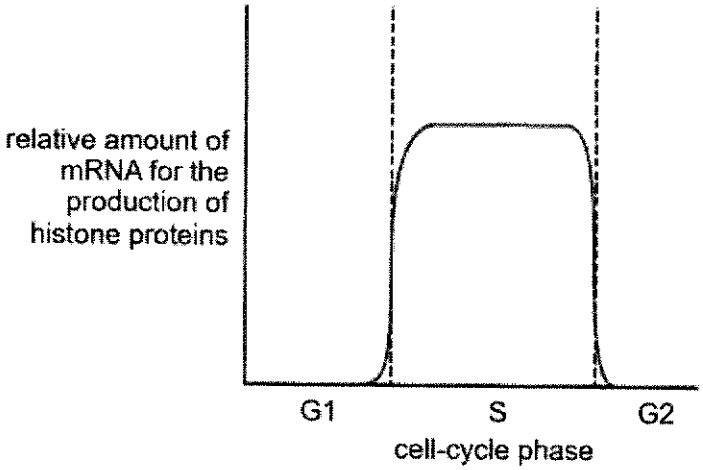
A Meiosis is only induced 9 hours after transferring to the nutrient-poor medium.

B After 9 hours, the chromosome number in each yeast cell is halved.

C 5 hours after the induction, there is a doubling of the chromosome number.

D The duration of meiosis in yeast cells is shorter than that of mitosis.

13 The graph below shows the relative amount of mRNA for the production of histone proteins at different times throughout a cell cycle.



Using your knowledge of the cell cycle and the information in the graph, it is correct to deduce that

A DNA replication occurs most actively in the G1 phase.

B histone genes are actively expressed throughout the cell cycle.

C histone protein synthesis occurs simultaneously with DNA synthesis.

D histone proteins are not present in the cell during the G1 and G2 phases.

14 The following are descriptions of chromosomes.

1 Non-coding sequences are only located within the genes.

2 The ends of the chromosomes can be lengthened using an RNA template.

3 Sequences found in the middle of chromosomes are always integral to the positioning of spindle fibres.

4 Each chromosome comprises DNA coiled around histone and scaffold proteins.

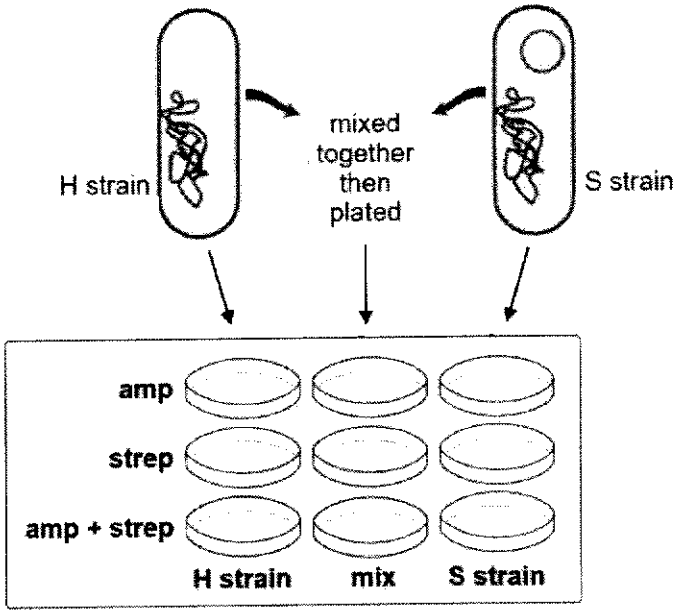
How many of the statements above apply only to a eukaryotic chromosome?

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

15 In an experiment to study conjugation between bacteria, scientists used 2 strains of *E. coli*.

- The H strain has no plasmid. The bacterial chromosome contains a gene that codes for resistance to streptomycin (strep).
- The S strain contains the F plasmid *pARO* with a resistance gene to ampicillin (amp).

The H and S strains were mixed together. The different strains were then plated on various culture media as shown in the figure below.



What would the results of the experiment look like for each of these plates if conjugation was successful?

	medium with amp	medium with strep	medium with amp + strep
A	only H strain grew	only S strain grew	H, S and mix grew
B	S strain and mix grew	H strain and mix grew	only mix grew
C	S strain and mix grew	H strain and mix grew	H, S and mix grew
D	only S strain grew	only H strain grew	only mix grew

16 All of the following statements about viruses are true **except**:

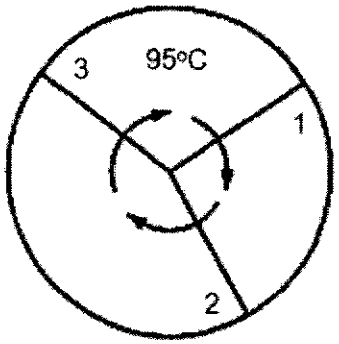
A The genomes of RNA viruses are more likely to mutate than those of DNA viruses.

B All RNA viruses produce DNA as an intermediate molecule during the production of new viruses.

C All RNA viruses produce RNA as an intermediate molecule during the production of new viruses.

D Before entering a host cell, specific proteins of viruses bind to receptors on specific host cells.

17 The diagram represents the stages of a polymerase chain reaction.

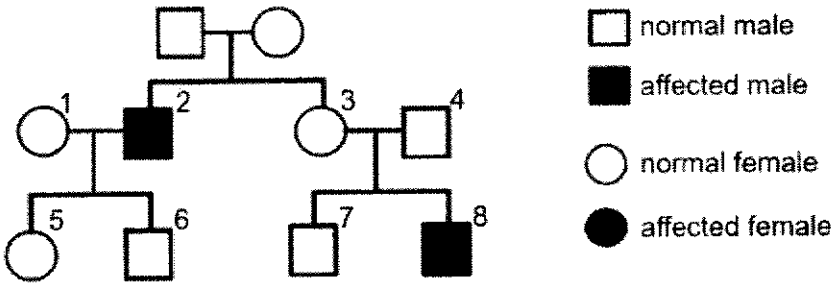


Which row correctly shows the processes occurring in each stage?

	1	2	3
A	denaturation	annealing	elongation
B	DNA synthesis	separation of templates	binding of primers
C	hybridisation	polymerisation	hydrogen bonds break
D	primase activity	polymerase activity	helicase action

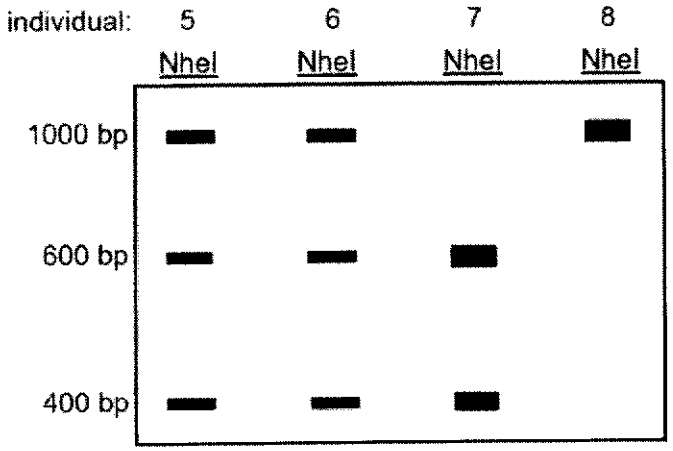
18 In a common genetic condition afflicting children, the mutant allele differs from the wild-type allele by a single nucleotide substitution. This substitution eliminates a *NheI* restriction site so that the mutant allele is not cut by the restriction enzyme, *NheI*.

A pedigree of a family exhibiting this condition is shown below:



DNA from four individuals in the pedigree were isolated and subjected to polymerase chain reaction (PCR). This technique amplifies a 1000 bp portion of their DNA that includes the *NheI* site affected by the mutation.

The PCR products are then digested with *NheI* and analysed. The DNA fragments from the digest are run on an agarose gel and the results are shown below:



Based on the information above, identify the correct mode of inheritance for the condition.

A autosomal dominant

B autosomal recessive

C sex-linked dominant

D sex-linked recessive

19 Western honey bees, *Apis mellifera*, live in colonies. Colonies consist of three types of bees:

- a single fertile female called a queen bee,
- infertile females called worker bees,
- fertile males called drones.

Queen bees and worker bees develop from fertilised eggs. After hatching into larvae, the type of bee each larva develops into is determined by the diet each larva is fed with.

Drones develop from unfertilised eggs.

Which of the following indicates the condition for development of a queen bee?

	ploidy level of the egg	diet of the larva
A	haploid	pollen, nectar and royal jelly
B	haploid	royal jelly only
C	diploid	pollen, nectar and royal jelly
D	diploid	royal jelly only

20 Flower colour in sweet pea, *Lathyrus odoratus*, may be purple or white. When two plants with white flowers were crossed, all the plants produced had purple flowers. Random crossing among the plants with purple flowers produced 96 progeny plants, 53 exhibiting purple flowers and 43 with white flowers.

Which statements correctly explain the type of inheritance involved?

1 Inheritance of flower colour is due to two genes that assort independently.

2 The two alleles of each gene display a dominant-recessive relationship to each other.

3 A homozygous recessive genotype at either or both gene loci results in the same phenotype.

4 When both dominant alleles of one gene locus are present together, they complement each other and produce a different phenotype.

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

21 Fur colour in a type of guinea pig is controlled by a single gene carried on an autosome. It has two alleles, one coding for an enzyme that synthesises brown pigments, the other coding for an enzyme that synthesises yellow pigments.

The recessive allele of another gene, found on a separate chromosome, codes for an inhibitor that inhibits the enzymes synthesising colour pigments, resulting in white fur. The dominant allele does not code for any inhibitor.

A male guinea pig with brown fur was mated with a female guinea pig with yellow fur. All the female offspring had beige fur. However, only half of the male offspring had beige fur, and the other half had white fur.

Which of the following modes of inheritance are exhibited in the fur colour of guinea pigs?

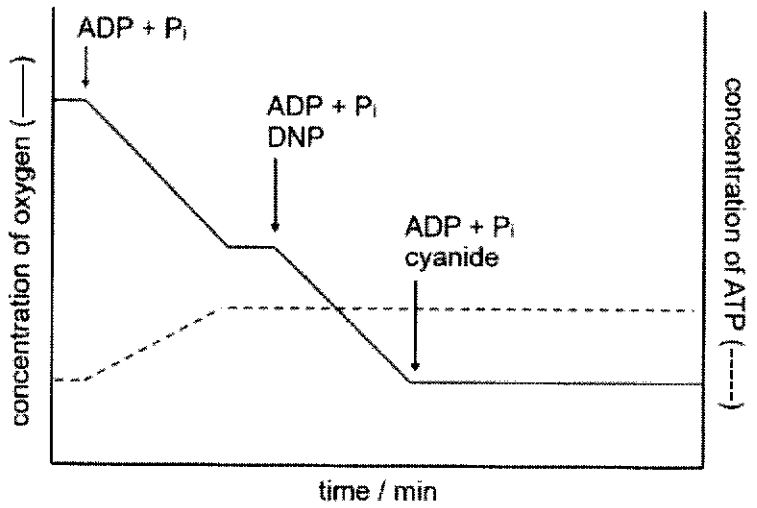
√ = *exhibited, X = not exhibited*

	sex linkage	autosomal linkage	incomplete dominance	multiple alleles	epistasis
A	√	X	X	√	√
B	X	√	√	√	X
C	√	√	X	X	√
D	√	X	√	X	√

22 Both 2,4 dinitrophenol (DNP) and cyanide are considered respiratory poisons, as they disrupt normal cellular respiratory processes.

In an experiment, a suspension of isolated mitochondria was incubated with excess succinate (an intermediate of the Krebs cycle) and oxygen.

The graphs below show how oxygen consumption and ATP production can be affected by the addition of DNP and cyanide.



Which of the following is a possible mode of mechanism of cyanide and DNP?

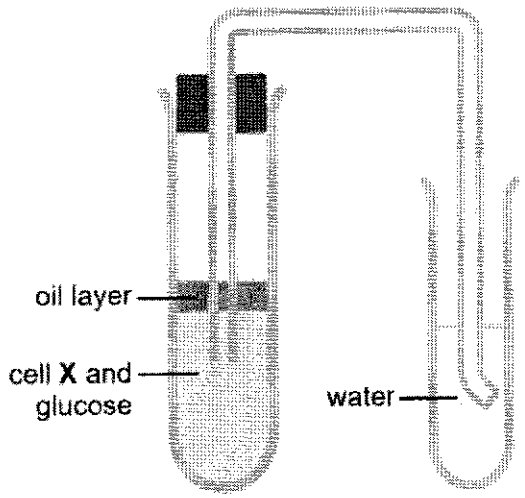
A DNP inhibits the flow of electrons.

B Cyanide can act as an uncoupler of electron transfer and ATP synthesis.

C DNP binds to reduced NAD and FAD irreversibly.

D Cyanide can act as an electron carrier inhibitor.

23 The diagram below shows an experimental set up to investigate respiration of cell **X**.



Gas bubbles were observed in the test tube of water.

Which of the following can be concluded from the experiment?

A The gas bubbles formed are likely to be oxygen.

B Cell **X** is likely to be yeast cells.

C Gas bubbles are formed because of oxidative decarboxylation processes in link reaction and Krebs cycle.

D The pH of water in the test tube is going to be increased.

24 Which of the following is a similarity between insulin and glucagon receptors?

A Both have hydrophilic stretches of amino acids spanning across the plasma membrane several times that serve to anchor these receptors.

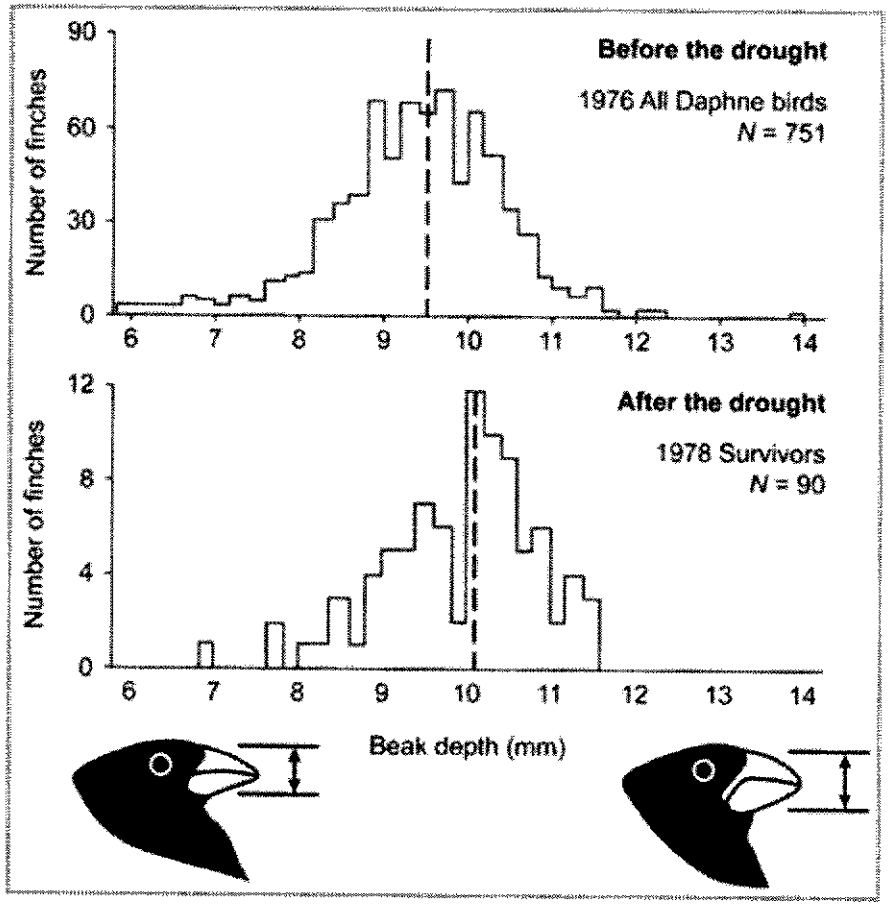
B Both are directly involved in carrying out enzymatic reactions to initiate signal transduction processes.

C Both undergo conformational changes through dimerisation when bound by extracellular ligands.

D When activated, both lead to amplification of the signal via individual signal transduction pathway.

25 Daphne Major finches are one of the species of Darwin's finches that reside in the Daphne Major Island. In 1977, there was a major drought that affected the island.

The figure below showed the change in beak depth of the Daphne Major finches before and after the drought. The mean beak depth of the finches is indicated with the dotted line.



Which of the following statement is the primary cause for the change in the beak depth of the Daphne Major finches?

A There was a lack of water available in the island.

B After the drought, temperature was increased.

C There was an influx of new predators after the drought.

D After the drought, only larger and tougher seeds were available.

26 A student gave some examples on "morphological homology".

1 The wings of bats and the arms of humans have the same forelimb plan.

2 Humans and macaques contain genes that code for similar haemoglobin protein.

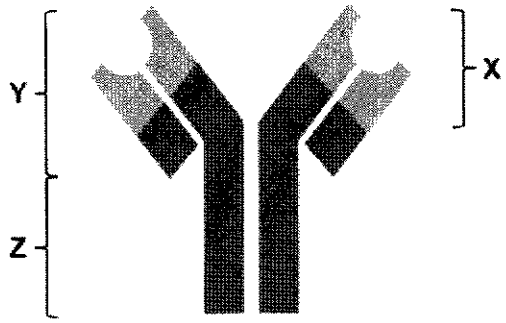
3 The wings of bats and mosquitoes are both used for flight.

4 The appendix, which had vital roles in digestion for herbivorous ancestors, are now drastically reduced in humans.

How many of the above statements are correct examples of "morphological homology"?

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

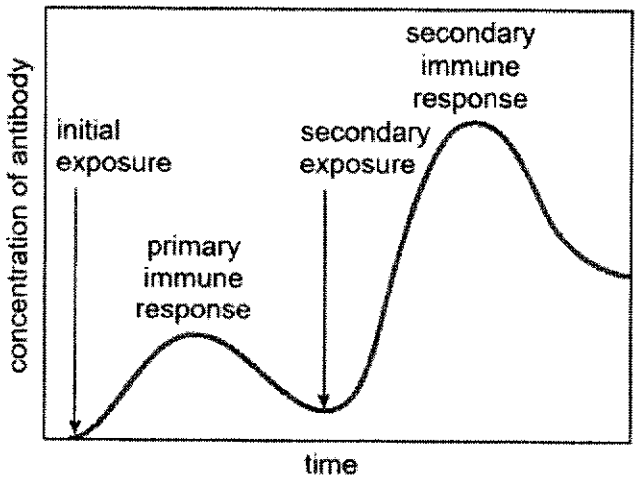
27 The diagram below shows the structure of an antibody.



Which of the following correctly matches the events with the regions in which diversity is generated?

	somatic recombination	somatic hypermutation	class switching
A	**X**	**X**	**Z**
B	**Y**	**X**	**Z**
C	**Y**	**Y**	**Z**
D	**Z**	**X**	**Y**

28 The diagram below shows the antibody production during primary and a secondary immune response.



Which of the following statements is / are correct?

1 Class switching only occurs during the secondary immune response.

2 Secondary immune response is faster and stronger compared to the primary immune response.

3 Class switching results in production of antibodies with higher binding affinity during secondary immune response.

4 Vaccination 'primes' the immune system such that a secondary immune response can be mounted when the body encounters the actual pathogen.

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

29 Which of the following phenomena can be described as a positive feedback regarding climate change?

A Increased burning of fossil fuels increases atmospheric CO_2 concentration, enhancing the greenhouse effect.

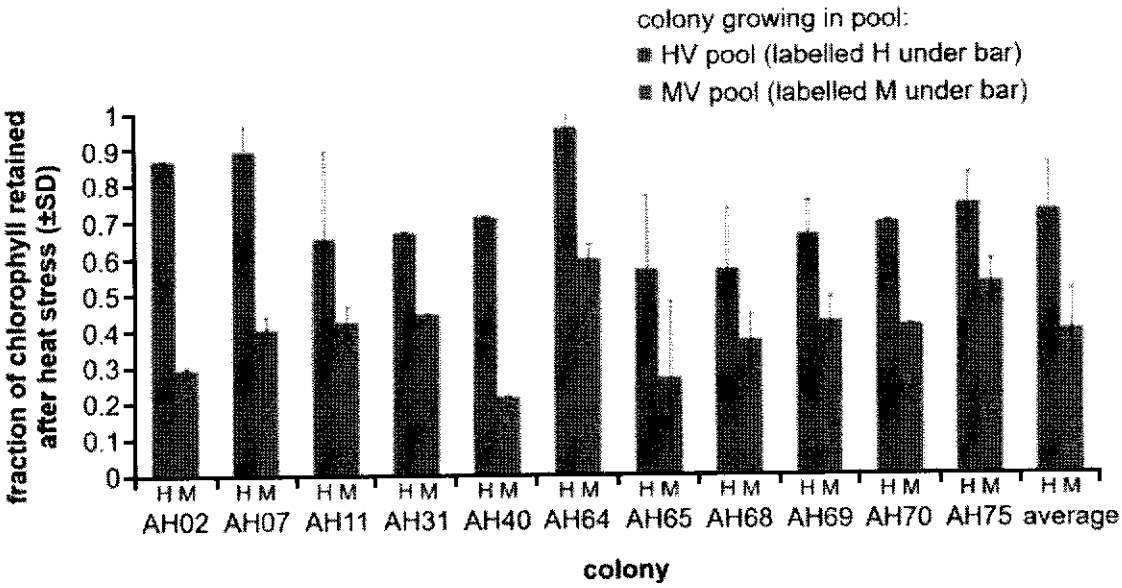
B Increase in atmospheric temperature causes many species to migrate to higher altitudes to stay within their optimum temperature range.

C Melting of glaciers results in an increase in sea levels which leads to further shrinking of land ice masses.

D Increased atmospheric temperature results in the melting of sea ice which decreases the amount of sunlight reflected back into space.

30 In a study on climate impacts on coral, coral colonies of the species *Acropora hyacinthus* were moved from their original environments to either a moderately variable heat pool (MV) or a highly variable heat pool (HV). After a period of time in the new environments, the corals were exposed to heat stress.

The figure shows the degree of resistance to bleaching in each coral colony, measured as a fraction of the chlorophyll that remained in the corals after heat stress, compared to non-heat stressed controls.



What conclusion can one draw about the how corals would adapt to climate change?

A Corals are able to adapt and cope with climate change, which makes global warming the least of our worries when we consider their risks of extinction.

B Corals subjected to short-term fluctuations in temperature are better adapted to climate change.

C Colony AH11 suffered more chlorophyll losses at high heat variations compared to AH02.

D On average, with more heat, greater algae growth can occur and hence corals can withstand bleaching at higher variable temperatures.

2024 H2 Biology Prelim MCQ Answer

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