



VICTORIA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
2025
HIGHER 2

NAME :

CT CLASS:

BIOLOGY

Paper 1 Multiple Choice

9744 / 01

22/09/2025

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.

1 What is correct about the synthesis and release of the glycoprotein mucin in epithelial cells lining the intestines?

- 1 The protein is produced on free ribosomes and a carbohydrate chain is added in the Golgi body.
- 2 The glycoproteins are packed into vesicles in the Golgi body forming lysosomes.
- 3 Secretory vesicles containing the glycoprotein move from the Golgi body and fuse with the cell surface membrane.

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

2 Hydroxyproline is synthesised by addition of an –OH group to the R-group of the amino acid proline. Hydroxyproline is a major component of collagen and has an important role in increasing the stability of its structure.

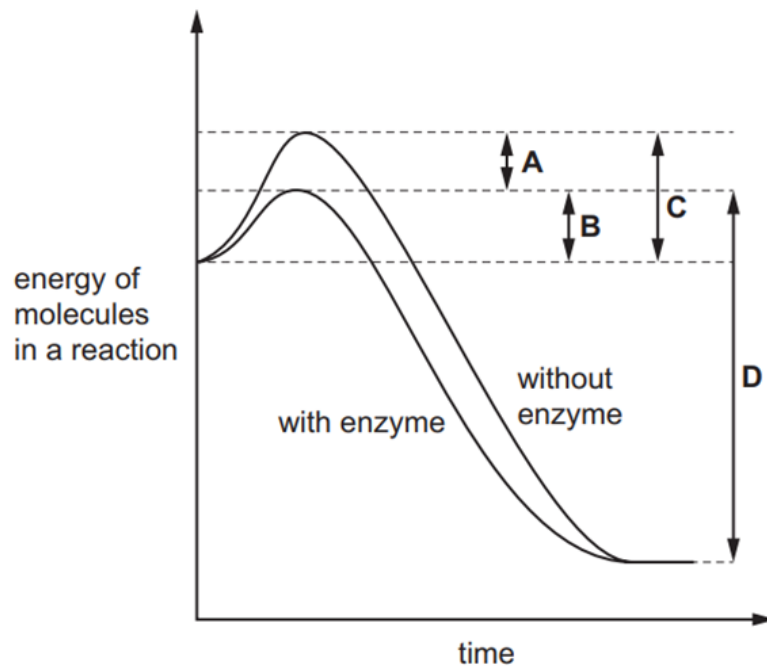
Which statement explains why the addition of an –OH group to proline could increase the stability of collagen?

- A** It strengthens hydrogen bonding between R-groups of adjacent polypeptide chains, resulting in a tertiary structure that is more resistant to heat denaturation.
- B** It increases the number of sites available for the formation of hydrogen bonds within the secondary structure of collagen, resulting in more stable alpha helices.
- C** The –OH group changes proline's ring shape, locking collagen into a stable triple helix conformation.
- D** It strengthens the quaternary structure of collagen by increasing the number of sites for hydrogen bonding between R-groups of distantly separated amino acids within the same polypeptide chain.

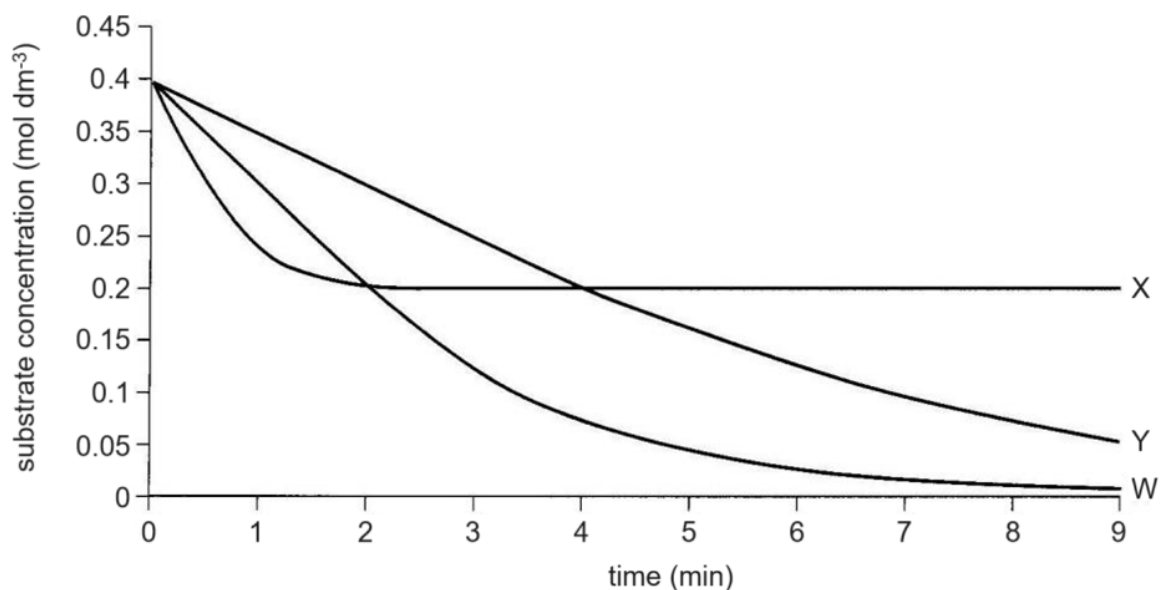
3 Which statement about fatty acids is correct?

- A** Fatty acids are amphoteric molecules because they have a polar –COOH group at one end and a long non-polar hydrocarbon chain.
- B** All unsaturated fatty acids are polyunsaturated, meaning they have two or more C=C double bonds in their hydrocarbon chains.
- C** The complete oxidation of fatty acids releases more energy per gram than the complete oxidation of polysaccharides because fatty acids are less reduced.
- D** Fatty acids stored as components of fats in adipose tissue have no direct effect on the osmotic potential of the cytoplasm.

- 4 Which statement correctly describes how an enzyme acts on its substrate?
- A Binding and catalytic amino acids at the active site form covalent interactions with complementary chemical groups on the substrate molecule.
 - B Conformational change of both enzyme and substrate molecules occurs upon the binding of substrate.
 - C Most enzymes catalyse irreversible reactions as they can only bind to their substrate molecules and not their product molecules.
 - D Activation energy of an enzyme-catalysed reaction may be lowered by the use of metal ion cofactors at the enzyme's active site.
- 5 Which region on the graph shows the activation energy of an enzyme-catalysed reaction?



- 6 An enzyme experiment was conducted, with the graph showing the concentration of substrate remaining each minute after the enzyme was added to the substrate. Graph W shows the results obtained at a temperature of 40°C. Some modifications were made in subsequent experiments and results recorded in two separate graphs X and Y.



Which statement best explains the graphs above?

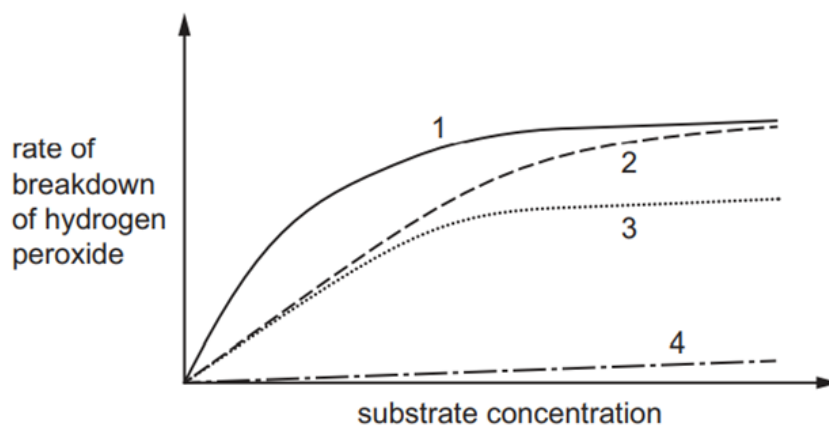
- A The temperature used for experiment X was higher than W.
- B A less concentrated reaction mixture was used for X than W.
- C Experiment Y used a lower initial substrate concentration than W.
- D The pH used for experiment Y was closer to the enzyme's optimum than in W.

7 A scientist investigated the rate of breakdown of hydrogen peroxide.

Four experiments were carried out using different reaction mixtures. In each experiment, the concentration of the enzyme (if present) and all physical conditions such as volumes, temperature and pH were kept the same.

- substrate only
- substrate + enzyme
- substrate + enzyme + competitive inhibitor
- substrate + enzyme + non-competitive inhibitor

The results are sketched in the graph.



- 1 In experiment 1, the graph plateaus off at high substrate concentration due to high activation energy.
- 2 In experiment 2, the maximum rate of breakdown of hydrogen peroxide is similar to experiment 1 because competitive inhibition can be overcome by the substrate.
- 3 In experiment 3, the maximum rate of breakdown of hydrogen peroxide can be increased by adding more substrate.
- 4 In experiment 4, the lower rate of breakdown of hydrogen peroxide is due to a permanent reduction in active enzyme molecules.

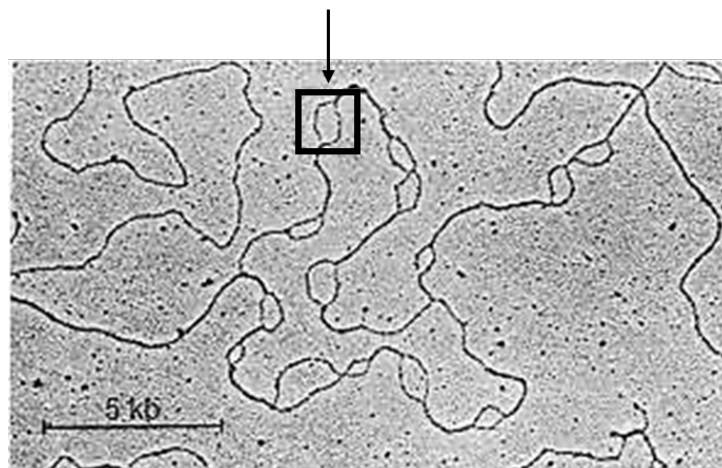
Which statement(s) correctly explain the patterns observed?

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

- 8 Anti-cancer therapy that targets dividing cells can reduce the numbers of different blood cell types in a person's body.

Which statement about blood stem cells is correct?

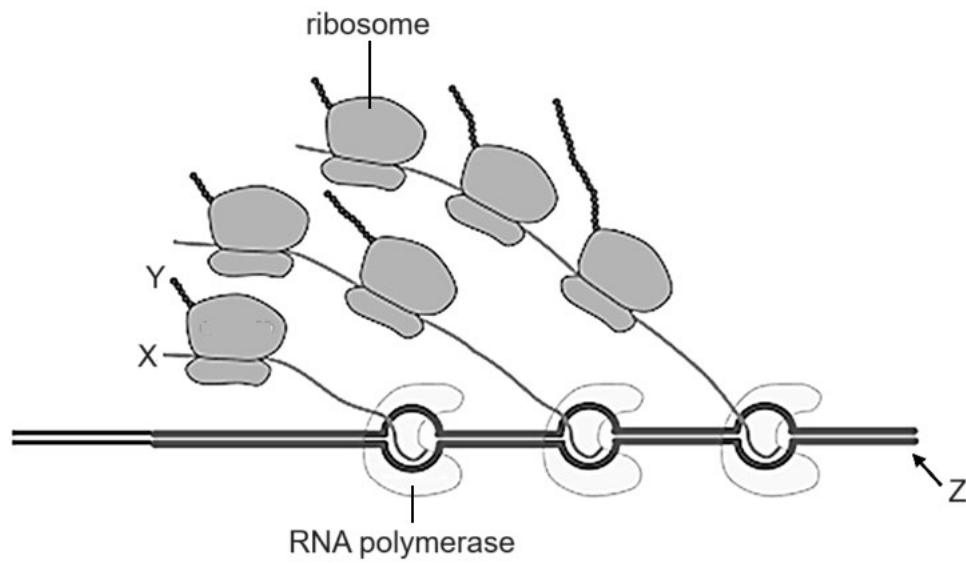
- A As blood stem cells are totipotent, all the blood cell types can be produced to restore circulating differentiated blood cells to their normal numbers.
 - B As blood stem cells are undifferentiated, they are unaffected by anti-cancer therapy and will continue to renew themselves to gradually bring numbers of blood cells back to normal.
 - C Blood stem cells removed from the bone marrow, if transplanted to the site where the cancer is located, will differentiate into the cell types of the new location.
 - D Blood stem cells that are collected from a person before anti-cancer therapy and are then put back into the same person after therapy are able to produce new blood cells.
- 9 The figure shows an electronmicrograph of DNA undergoing replication.



Which of the following correctly describes the region indicated by the arrow?

- 1 A mixture of DNA and RNA can be found.
 - 2 Non-enzymatic proteins can be found.
 - 3 DNA can be double-stranded or single-stranded.
- A 1, 2 and 3 B 1 and 2 only C 1 and 3 only D 2 and 3 only

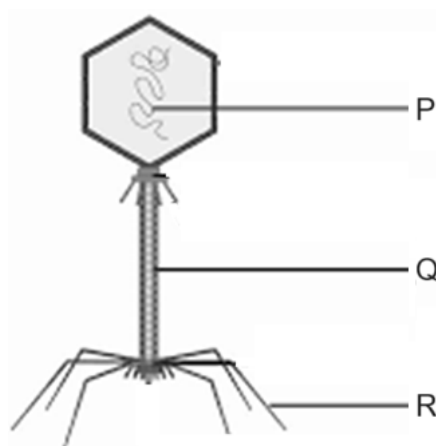
10 The figure shows protein synthesis.



Which row correctly identifies the labels of X, Y and Z, as well as the direction of RNA pol movement?

	X	Y	Z	direction of RNA pol movement
A	5'	N-terminal	5'	→
B	3'	N-terminal	3'	→
C	5'	C-terminal	3'	←
D	3'	C-terminal	5'	←

11 The figure shows the structure of a bacteriophage.



Which row correctly matches the function of the labelled structures P, Q and R?

	P	Q	R
A	carries genetic information for passing down to daughter cells	for the transfer of genetic material to the host cell	for adsorption to the host cell surface
B	double stranded DNA	contractile sheath	tail fibres
C	for integration into the host cell chromosome	for the injection of genetic material into the host cell	for conformational changes enabling entry of the viral core
D	carries genetic information for lysozymes	contracts to drive a hollow tube through the host cell wall	attach to receptors on the host cell surface

12 The cell cycle includes mitosis.

What are features of this type of nuclear division?

- 1 formation of two nuclei each with the same chromosome number as the parent nucleus
- 2 formation of daughter cells of equal size to each other and to the parent cell
- 3 semi-conservative replication of DNA to maintain genetic stability
- 4 movement of identical DNA molecules to opposite poles of the cell

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

- 13 During gametogenesis in a diploid organism, crossing over is observed between non-sister chromatids. At which point in the meiotic cell cycle does this process take place?
- A before synapsis begins, during the initial pairing of homologous chromosomes
 - B after synapsis completes and during the stage when chiasmata are first visible
 - C after chiasmata resolution, when homologues are preparing for segregation
 - D following nuclear envelope breakdown but before homologous chromosomes align at the metaphase plate
- 14 In the prokaryote *Streptococcus suis*, a set of genes is responsible for the uptake of an antioxidant ergothioneine, ET. This set of genes is controlled by a single promoter in the ET transport operon. It is known that another gene, gene *U*, is always expressed to give an active product, U, that regulates the ET transport operon. ET is known to bind directly to U.

Which statement correctly describes the ET transport operon and how U regulates the operon?

- A It is an inducible operon, which is negatively regulated by U, a repressor protein.
 - B It is an inducible operon, which is positively regulated by U, an inducer.
 - C It is a repressible operon, which is negatively regulated by U, a repressor protein.
 - D It is a repressible operon, which is positively regulated by U, an activator protein.
- 15 In a recent study on a highly aggressive form of neuroblastoma tumour, it was discovered that histone deacetylase (HDAC) inhibitors improved the success rate of chemotherapy treatment. Chemotherapy treatment interferes with cell growth and promotes apoptosis in fast growing cells.

It was observed that the use of HDAC inhibitors resulted in changes in tumour cell behaviour, which enabled the chemotherapeutic drugs to better carry out their functions.

Which of the following does **not** explain how HDAC inhibitors function in the treatment of neuroblastoma?

- A Lysine residues on the histone tails are acetylated, reducing the positive charges on the histone tails, increasing gene expression for a large number of genes.
- B The chromatin is now more loosely coiled, increasing the chance of random mutations that promotes apoptosis.
- C The genes promoting uptake of chemotherapeutic drugs are no longer inhibited.
- D There is increased expression of tumour suppressor genes.

16 The standard polymerase chain reaction (PCR) repeats three stages:

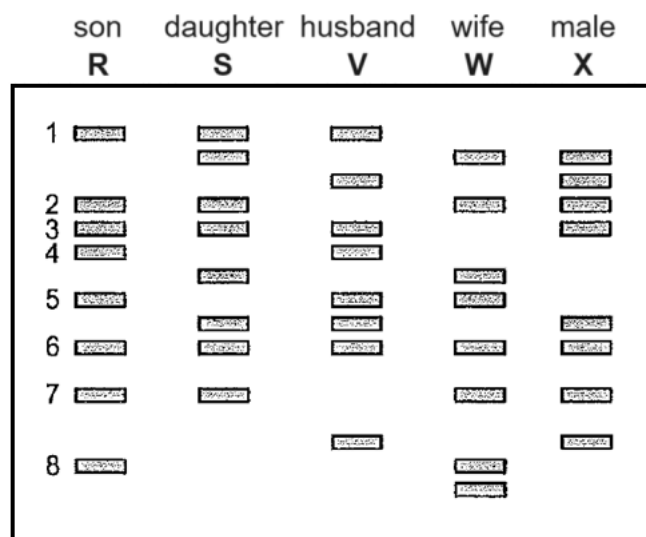
- separation of the DNA strands by heating
- binding (annealing) of selected primers to each strand by cooling
- complementary binding of new nucleotides to form a new strand.

By choosing specific primers complementary to a particular gene, that gene can be amplified and detected in samples from individual organisms.

Why may new variants of this gene, arising by mutation, **not** always be amplified using the PCR process?

- A** Nucleotide substitutions between DNA of the new variants and the original DNA occur between the regions where primers bond.
- B** The changes to the variant sequences prevent separation of the DNA strands during heating.
- C** DNA nucleotides are unable to form complementary base pairing to the separated DNA strands of the variant sequences.
- D** Primers for the original gene are not complementary to the DNA of the new variants.

17 The diagram shows the results of electrophoresis of DNA fragments from four members of a family R, S, V, W and another male X, who claims that he is actually the father of person R.



Which bands on the electrophoretogram indicate that person V is the father of person R?

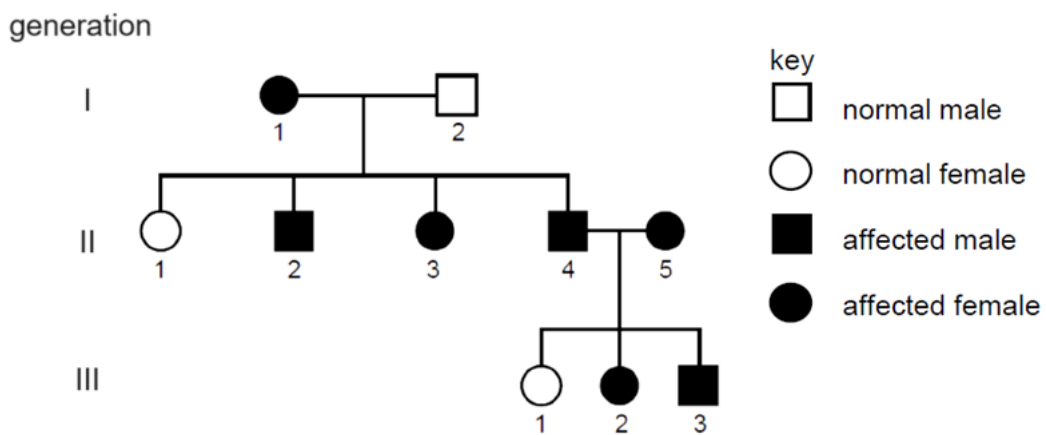
- A** 1 and 2 **B** 1 and 4 **C** 2 and 6 **D** 5 and 8

18 Which statement does **not** explain how mutations lead to cancer?

- A Mutations result in the over-expression of activator proteins that regulate proto-oncogenes.
- B There is a deletion within the promoter sequence for tumour suppressor genes.
- C Chromosomal mutation causes the translocation of a proto-oncogene downstream of an active promoter.
- D Mutation leads to the duplication of a locus containing a tumour suppressor gene.

19 Marfan syndrome is a genetic disorder of the connective tissue, particularly affecting the heart, blood vessels, skeleton and eyes.

Shaded individuals in the pedigree have this condition.



How many statements are correct?

- 1 Individual I-1 must be homozygous since both her sons II-2 and II-4 have the condition.
- 2 Individual II-3 must be heterozygous as she would have inherited a normal recessive allele from her father I-2.
- 3 Individual III-1 must be homozygous as she would have received a dominant allele from each of her parents II-4 and II-5.

- A 0 B 1 C 2 D 3

- 20** Possession of white or coloured feather in poultry is controlled by two genes, P/p and Q/q. The phenotypes of offspring that are expected from mating two birds, each of which is heterozygous at both loci, are shown in the Punnett square.

gametes	PQ	Pq	pQ	pq
PQ	white feather	white feather	white feather	white feather
Pq	white feather	white feather	white feather	white feather
pQ	white feather	white feather	coloured feather	coloured feather
pq	white feather	white feather	coloured feather	white feather

What best explains the proportion of white to coloured feather in the Punnett square?

- A** The ratio arises because the two genes are linked on the same chromosome and thus do not assort independently.
- B** Gene Q shows incomplete dominance so heterozygotes (Qq) produce an intermediate (coloured) phenotype that combines with P to give the ratio.
- C** The dominant allele at P locus masks expression at the Q locus so any genotype with at least one P allele is white.
- D** A chi-squared test comparing the observed counts to a simple 3 : 1 expectation would show no significant difference, confirming a 3 white : 1 coloured ratio.
- 21** Which row correctly describes the genetic basis of continuous and discontinuous variation of the phenotype?

	continuous variation	discontinuous variation
A	many genes involved with different gene loci having quite different effects on the character	few genes and the effects of each gene are discernible
B	many genes involved, with different alleles at a single gene locus have large effects	few genes involved, with different gene loci having quite different effects on the character
C	many genes involved, with each gene having a small, additive effect	few genes involved, with each gene having a large effect
D	few genes involved, with each gene having a small, additive effect	many genes involved, with each gene having a large effect

22 Glycolysis is a stage of respiration that occurs in both aerobic and anaerobic conditions.

Which other statements also apply both to respiration under aerobic conditions and to respiration under anaerobic conditions in the muscle cells of a mammal?

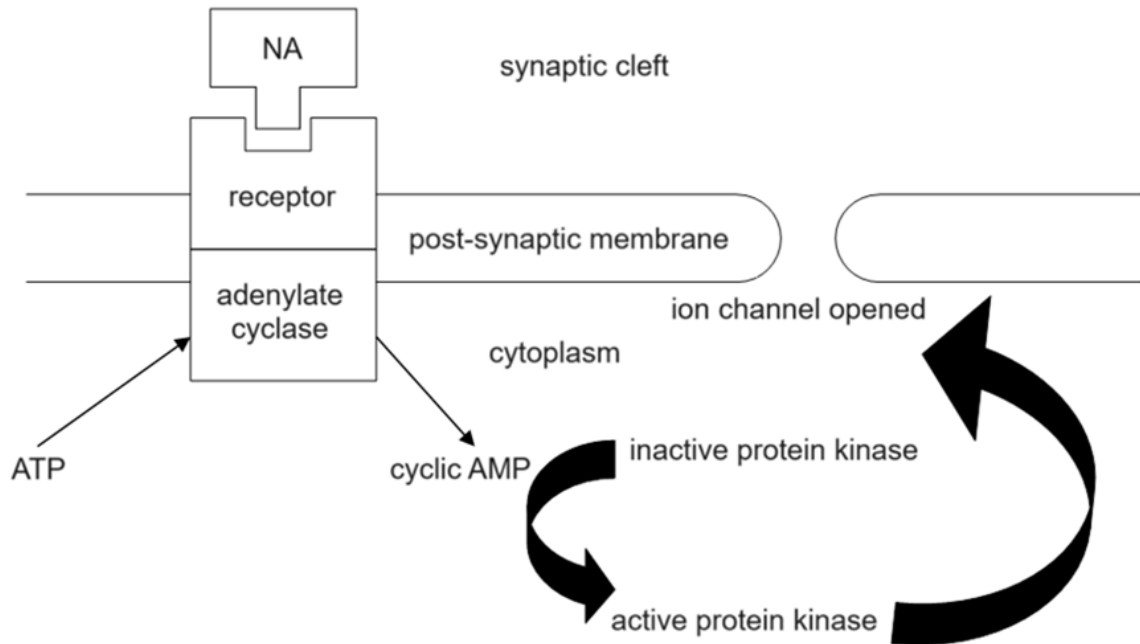
- 1 Both pathways involve the oxidative decarboxylation of pyruvate before entry into further metabolic steps.
- 2 Both pathways generate ATP through substrate-level phosphorylation.
- 3 Both pathways regenerate NAD^+ .
- 4 Both pathways begin with phosphorylation of glucose using ATP.

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

23 Which description of aspect of the arrangement of mitochondrial membranes or molecules is correctly linked with the function of these membranes and molecules in respiration?

	aspect of the arrangement of mitochondrial membranes or molecules	function of these membranes or molecules in respiration
A	inner membrane folded into cristae	allows transfer of electrons
B	inner membrane forming tightly folded tubes stacked on each other	allows the release of oxygen after photolysis
C	enzymes embedded in membranes	transfer energy for ATP synthesis and reduction of NAD
D	space enclosed by the outer and inner membrane	receives hydrogen ions transferred using energy from electron movement

- 24 Noradrenaline (NA) stimulates the activity of adenylate cyclase, which is found on the post-synaptic membrane of a neurone. This initiates the sequence of reactions shown in the diagram, causing the opening of channels in the membrane through which ions can pass.



Caffeine causes the ion channels to remain open. How many of the following are possible actions of caffeine?

- 1 Caffeine reduces the efficiency of aerobic respiration.
- 2 Caffeine inhibits the activity of phosphodiesterase.
- 3 Caffeine causes a conformation change to noradrenaline.
- 4 Caffeine prevents the action of GTPase in G protein.
- 5 Caffeine decreases the activity of phosphatase.
- 6 Caffeine aids in the cross-phosphorylation of the receptor.

A 2 **B** 3 **C** 4 **D** 5

- 25 Which statement about natural selection is **not** correct?

- A** One consideration in natural selection is the ability for a population, relative to other populations, to survive to reproductive age and produces offspring.
- B** Natural selection will have a greater effect in causing change if the variation that is shown for a trait is largely caused by genetic, rather than environmental, variation.
- C** One important factor is that natural selection acts on the phenotype, but for evolution to occur a modification of the genotype must occur.
- D** When directional selection is not occurring, the allele frequencies of a large, isolated population remain constant from one generation to the next, unless mutation occurs.

- 26** Whales and snakes do not have any hind limbs, but their skeletons still have the small bones that, in other vertebrates, are part of the pelvic girdle. The pelvic girdle is important in the functioning of hind limbs. Whales and snakes do not move in the same way as each other.

What does this suggest about the evolution of whales and snakes?

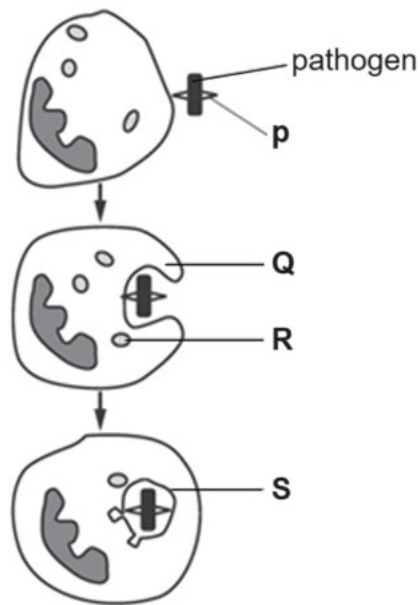
- 1 Their movement involves the same adaptations of the skeleton.
- 2 As their ancestors evolved and adapted to different habitats, the pelvic girdle lost its function.
- 3 They are descendants of different groups of animals that used their hind limbs for movement.
- 4 They share a common ancestor that used hind limbs for movement.

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

- 27** Which statement regarding a B cell expressing both IgM and IgD on its membrane is **not** correct?

- A** The L chains of the IgM and IgD have identical amino acid sequences.
- B** The constant parts of the H chains of the IgM and IgD have different amino acid sequences.
- C** The IgM and IgD have different antigen specificities.
- D** If it is triggered by antigen and T-cell signals to proliferate and differentiate, it may differentiate into a plasma cell that may secrete IgG, IgE, or IgA antibodies.

28 The diagram shows the process of phagocytosis of a pathogen by a neutrophil.



Which row shows the correct identification of the structures and function?

	P	Q	R	S	body's line of defence
A	antibiotic	fimbriae	lysozyme	lysosome	innate immunity
B	antibiotic	pseudopodia	Golgi vesicles	phagosome	cell-mediated immunity
C	antigen	fimbriae	Golgi vesicles	lysozyme	cell-mediated immunity
D	antigen	pseudopodia	lysosome	phagosome	innate immunity

29 A coastal city has experienced a series of environmental changes over the past two decades:

- The average annual temperature has risen by 2°C.
- Sea levels have increased, causing more frequent flooding during storms.
- Freshwater wells have shown increasing salt contamination.
- Local fishermen report that some traditional fish species have migrated further north, while some tropical insects have appeared in the area.
- Nearby coral reefs have experienced widespread bleaching events.

Which is the most likely underlying cause of the environmental changes described in the coastal city?

- A** Increased solar radiation from cyclical solar maxima has raised local temperatures, causing thermal expansion of seawater and ecosystem shifts, with coral bleaching driven primarily by UV radiation stress.
- B** Urban heat island effects and local deforestation have increased temperatures and altered freshwater availability, indirectly causing sea level rise through increased evaporation and driving biological migration, with coral bleaching due to sediment runoff.
- C** Anthropogenic greenhouse gas emissions have accelerated polar ice melt and ocean warming, causing sea level rise, saltwater intrusion, shifts in marine and insect populations, and coral bleaching due to increased ocean acidity.
- D** Decreased volcanic activity in the region has reduced atmospheric particles, resulting in higher temperatures and disruptions in marine and terrestrial ecosystems.

30 Several factors that can influence the likelihood that a person infected with dengue virus will develop severe dengue disease are listed.

- 1 being infected with a dengue virus strain different from the strain that caused a previous infection
- 2 inheriting a genetic variant that increases the ability of the virus to bind to host cell receptors
- 3 being infected by a dengue virus strain with a mutation that increases its replication rate in human cells
- 4 living in an area with a high density of *Aedes* mosquitoes due to stagnant water containers
- 5 having pre-existing health conditions such as cardiovascular disease

Which of these risk factors are linked to an increased probability of developing severe dengue disease after infection has occurred?

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