

TEMASEK JUNIOR COLLEGE
2025 JC2 PRELIMINARY EXAMINATION
Higher 2



BIOLOGY

9744/01

Paper 1 Multiple Choice

18 September 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, civics group and index number on the Answer Sheet in the spaces provided.

Do not open this booklet until you are told to do so.

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.

- 1 A scientist carried out an experiment to separate cell structures in animal cells.

The cells were broken open to release the cell structures.

This extract was filtered into a centrifuge tube and then spun in a centrifuge. The heaviest cell structure sank to the bottom forming pellet 1.

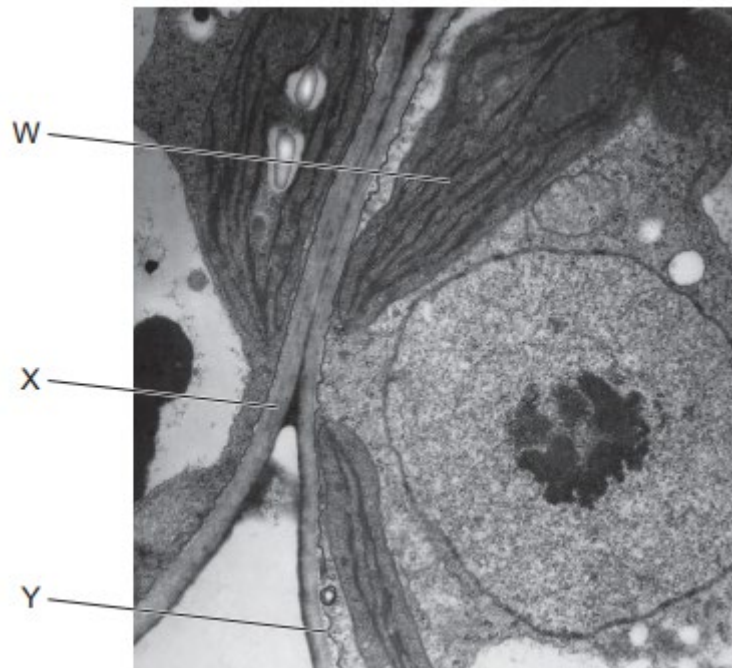
The liquid above pellet 1 was poured into a clean centrifuge tube and spun in the centrifuge at a higher speed to separate the next heaviest cell structure. This cell structure sank to the bottom, forming pellet 2.

This procedure was repeated twice more to obtain pellet 3 and pellet 4, each containing a single type of cell structure.

Which row shows the order in which the cell structures were collected?

	pellet 1	pellet 2	pellet 3	pellet 4
A	nucleus	lysosomes	mitochondria	ribosome
B	nucleus	mitochondria	lysosomes	ribosomes
C	ribosomes	lysosomes	mitochondria	nucleus
D	ribosomes	mitochondria	lysosomes	nucleus

- 2 The electron micrograph shows part of two cells.



Which labelled features identify these cells as eukaryotic?

- A** W, X and Y **B** W and X only **C** W only **D** X only

- 3 Batrachotoxin is a poison found in frogs in the Columbian jungle. The poison is used by Native Indians to produce poison darts.

The poison works by increasing the permeability of some cell surface membranes to sodium ions, which move out of the cells.

Which statements are correct for cells affected by batrachotoxin?

- 1 The intracellular fluid has a higher water potential than the extracellular fluid.
- 2 The extracellular fluid has a higher water potential than the intracellular fluid.
- 3 Water leaves the cells by osmosis, causing the cells to shrink.
- 4 Water enters the cells by osmosis, causing the cells to swell.

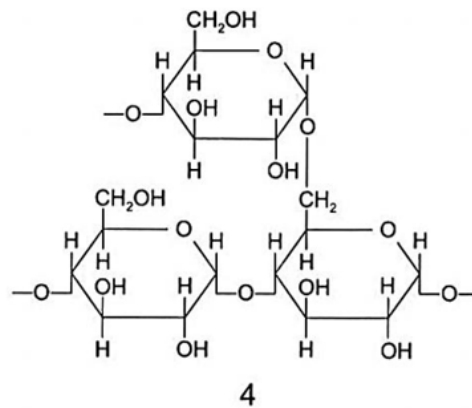
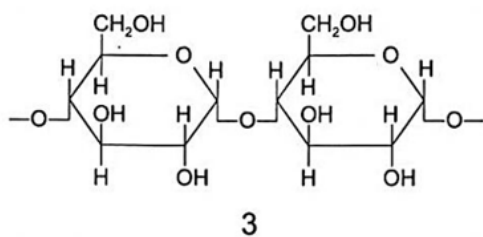
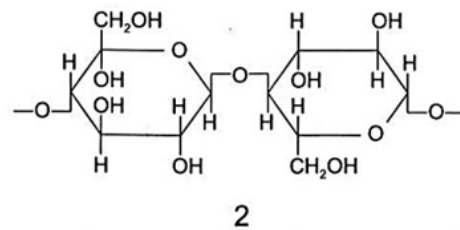
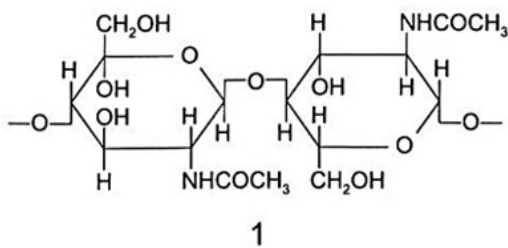
A 1 and 3

B 1 and 4

C 2 and 3

D 2 and 4

- 4 The diagrams show short sections of some common and modified polysaccharides.

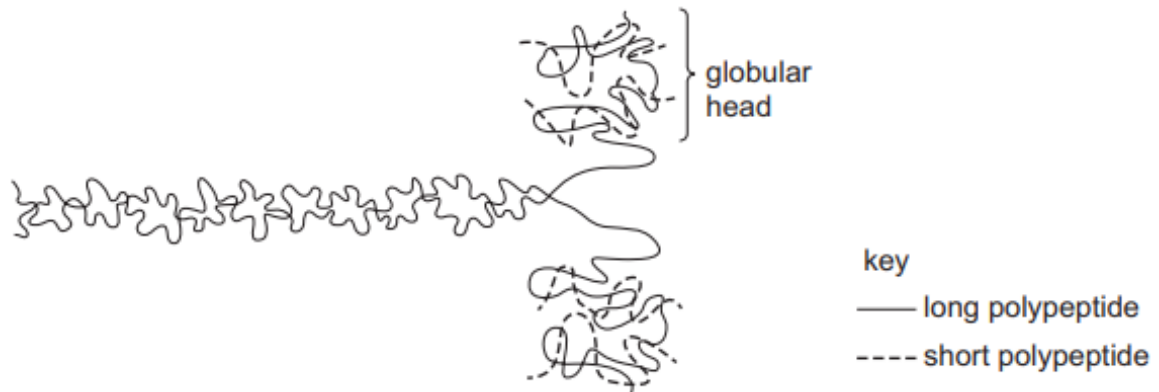


Which statement is correct?

- A 1 is found in cellulose as β -1,4-glycosidic bond is present.
- B 2 is found in amylopectin, which is a helical molecule, allowing for extensive coiling and entangling.
- C 3 is found in cellulose, which is an unbranched and straight chain of β -glucose monomers.
- D 4 is found in glycogen, which is made of chains of α -glucose linked by α -1,4-glycosidic bonds and α -1,6-glycosidic bonds at the branches.

[Turn over

- 5 The diagram shows a protein molecule.



Two long polypeptides each form α -helices for much of their length and these twist together into a fibre.

At one end, each of these polypeptides coils into a globular head.

Two short polypeptides bind to each head.

What describes the protein structure of this molecule?

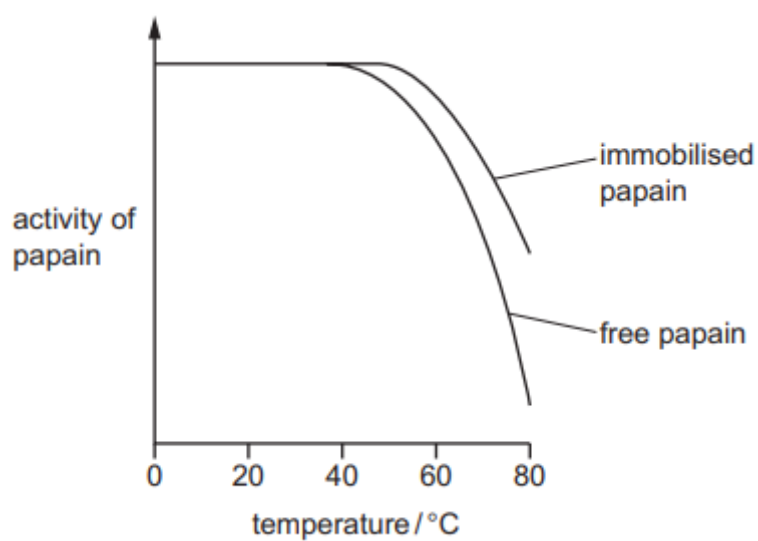
- A quaternary structure because each molecule consists of six polypeptides
 - B secondary structure because the long polypeptides form α -helices
 - C tertiary structure because the α -helices form a fibre
 - D tertiary structure because the heads form globular proteins
- 6 A species of bacterium, *Streptococcus salivarius*, produces an enzyme, FruA, which digests complex sugars.

The fungus *Aspergillus niger* secretes a different FruA with a different molecular weight, which is encoded by a different gene.

How can these different FruA enzymes digest the same complex sugars in the same way?

- A Both FruA enzymes have the same primary structure.
- B The enzyme-substrate complexes formed by both enzymes are identical.
- C The FruA enzymes both have the same tertiary structure.
- D The parts of the primary structure forming the active site are the same in both enzymes.

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

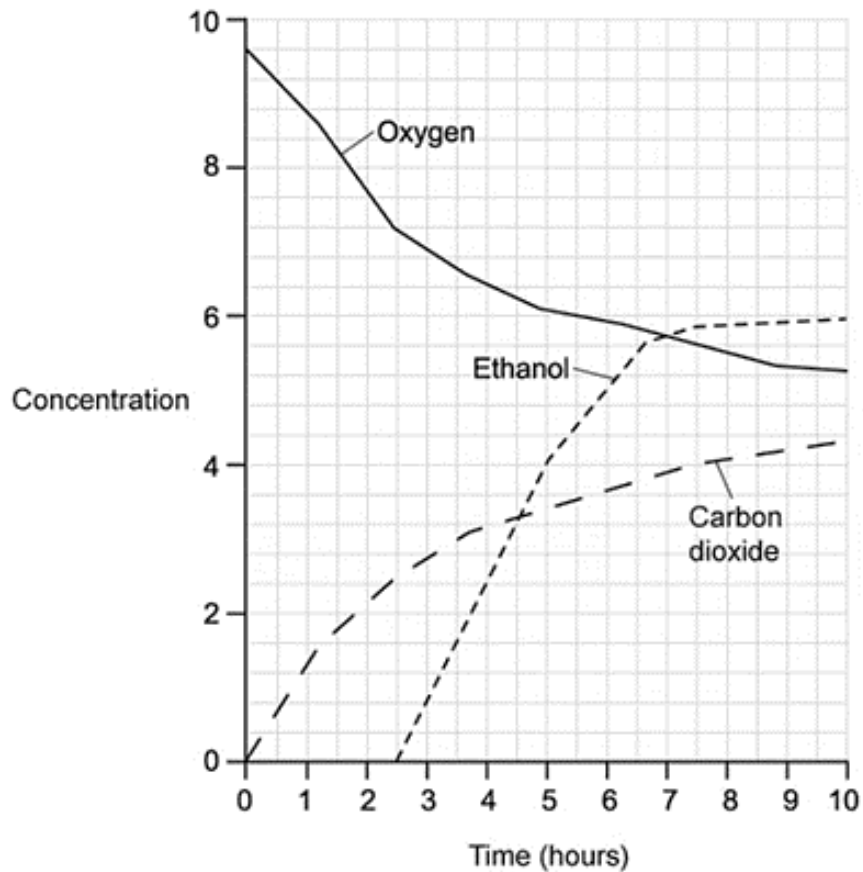


Which statement about the effect of immobilisation of papain is correct?

- A** It alters the shape of papain's active site at higher temperatures.
- B** It decreases the activity of papain at higher temperatures.
- C** It increases the stability of papain at higher temperatures.
- D** It reduces the number of collisions of papain with the substrate.

- 8 An experiment was conducted to investigate the use of a new carbohydrate source (substance L) for the production of ethanol as biofuel. The aim was to find the optimum length of time to leave a mixture of yeast and substance L to produce ethanol. An airtight container containing yeast and substance L was set up and the concentrations of oxygen, carbon dioxide and ethanol were measured over 10 hours.

The results of the experiment are shown in the graph.



Which statement is consistent with the results?

- A** Amount of ethanol increased because there was insufficient supply of the hydrogen carrier NAD^+ as the reaction proceeded.
- B** Anaerobic respiration occurred two and a half hours into the experiment and the mixture should be left for seven hours.
- C** High rate of glycolysis resulted in higher rate of anaerobic respiration as seen by an increase in carbon dioxide concentration.
- D** Substance L is a good carbohydrate source as the amount of ethanol produced remains relatively high even after several hours into the experiment.

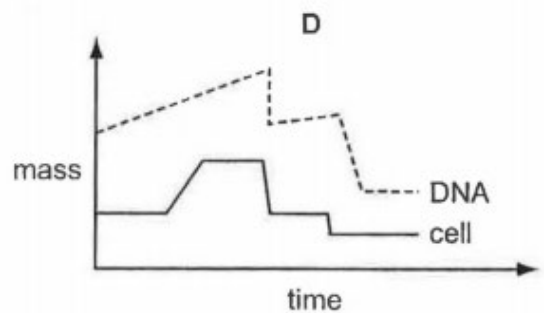
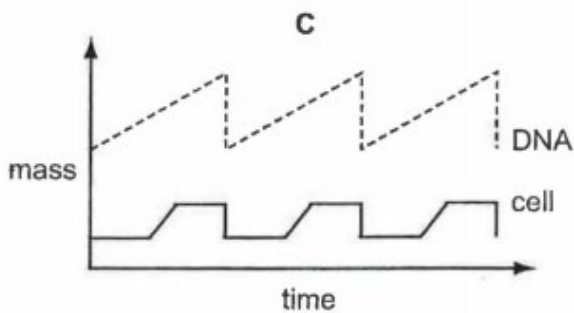
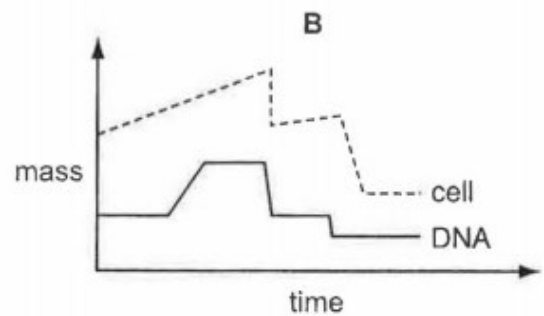
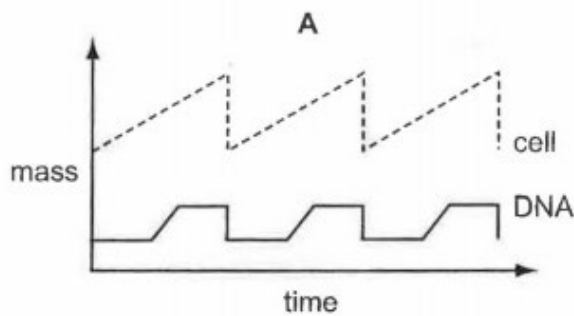
- 9 Different types of reactions occur in the Calvin cycle.

Which statement correctly describes Calvin cycle?

- A Carboxylation occurs in the conversion of triose phosphate to ribulose biphosphate.
- B Decarboxylation occurs in the conversion of ribulose biphosphate to 3-phosphoglycerate.
- C High rate of glycolysis resulted in higher rate of anaerobic respiration as seen by an increase in carbon dioxide concentration.
- D Reduction occurs in the conversion of 3-phosphoglycerate to glyceraldehyde-3-phosphate.

- 10 Cell division is the means of almost all growth and reproduction.

Which graph correctly represents a form of cell division that maintains genetic stability at the expense of variation?



- 11 Which property of embryonic stem cells makes them particularly useful in medical research?

- A They can be fused together to form a zygote.
- B They can divide and are pluripotent.
- C They can divide and are totipotent.
- D They can continue to divide indefinitely.

12 Which statement is correct?

- A** During transcription, mRNA is synthesised from DNA nucleotides to have the same sequence of nucleotides as the DNA strand on which it was made.
- B** During transcription, tRNA is synthesised from RNA nucleotides and carries codons that are complementary to the sequence of nucleotides on the DNA strand on which it was made.
- C** During translation, mRNA is synthesised from RNA nucleotides to have the complementary sequence of nucleotides to that of the DNA strand on which it was made.
- D** During translation, ribosomes join amino acids in a sequence determined by mRNA with the complementary sequence of nucleotides to that of the DNA strand on which it was made.

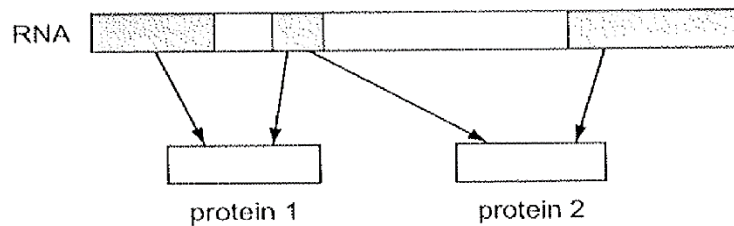
13 Scientists have made a nucleic acid (HNA) that has a sugar with the same number of carbon atoms as glucose instead of deoxyribose. Although genetic information can be stored by HNA, naturally occurring DNA polymerase cannot replicate HNA.

Which statements could explain why naturally occurring DNA polymerase cannot replicate HNA?

- 1 DNA polymerase cannot form bonds between the sugars of two HNA nucleotides.
- 2 DNA polymerase cannot form hydrogen bonds between two HNA nucleotides.
- 3 HNA nucleotides do not fit into the active site of DNA polymerase.
- 4 The shape of an HNA nucleotide is slightly larger than that of a DNA nucleotide.

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

- 14** RNA transcribed from a length of DNA of a chromosome was found to code for two different proteins, as shown in the diagram.



Which is correct?

- A** The DNA from which this RNA was transcribed was part of a eukaryotic chromosome because this is a way of saving space in a small genome.
 - B** The DNA from which this RNA was transcribed was part of a eukaryotic chromosome because introns have been edited out of the RNA.
 - C** The DNA from which this RNA was transcribed was part of a prokaryotic chromosome because introns have been edited out the RNA.
 - D** The DNA from which this RNA was transcribed was part of a prokaryotic chromosome because this is a way of saving space in a small chromosome.
- 15** The statements are about the types of gene expression identified by Jacob and Monod in the 1950s.
- 1 In repressible systems, the unmodified regulator protein molecule always binds to DNA. In inducible systems, the unmodified regulator protein never binds to DNA.
 - 2 In repressible systems, the operon is active unless it is inhibited. In inducible systems, the operon is suppressed until it is activated.
 - 3 Repressible systems are always regulated by negative control. Inducible systems are always regulated by positive control.
 - 4 Repressible systems are usually regulated by the amount of end product. Inducible systems are usually regulated by the amount of substrate.

Which statements are true for both of these types of gene expression?

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

- 16** Tay Sachs's disease is a genetic condition that can be caused by mutations in the hexoseaminidase gene resulting in an abnormal enzyme.

The table below shows details for part of a normal and abnormal peptide sequence for hexoseaminidase.

	codon position			
	4	5	6	7
normal hexoseaminidase	thr ACU	ser UCU	val GUU	gln CAG
abnormal hexoseaminidase	thr ACU	tys UAC	ser UCU	val GUU

Using this information it is reasonable to say that the abnormal hexoseaminidase enzyme could have resulted from a change in the mRNA due to

- A** a substitution of C for U at 6.
- B** a substitution of C for A at codon 5.
- C** an addition mutation at the beginning of codon 5.
- D** a deletion mutation at the beginning of codon 6.

- 17** Which of the following combinations increases the chances of tumour growth in an individual?

	tumour suppressor gene	oncogene	telomerase gene	genes responsible for apoptosis
A	non-functional	functional	non-functional	non-functional
B	non-functional	functional	non-functional	functional
C	functional	non-functional	functional	functional
D	non-functional	functional	functional	non-functional

- 18** The mimivirus has a much more complex structure than most other viruses. For example, it has more genes, including some associated with translation and some associated with protein folding.

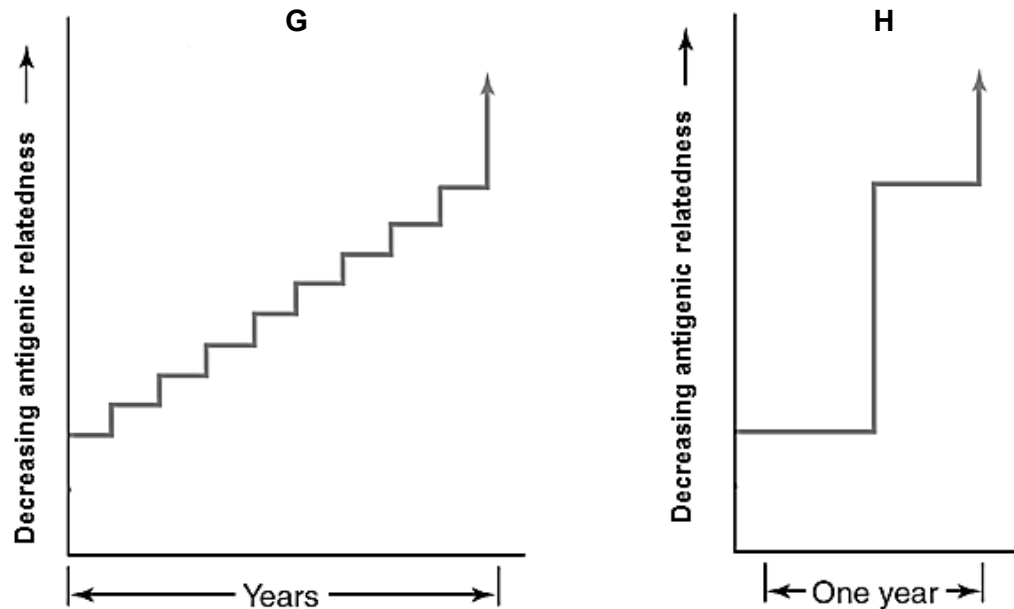
Three features of the mimivirus shared with some other virus are listed:

- 1 reproduces via a lytic cycle
- 2 double-stranded DNA
- 3 capsid of proteins

Which of these features would also be expected in a T4 phage?

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

- 19 Influenza infections are difficult to eliminate because of the antigenic changes that occur in haemagglutinin (HA), a surface glycoprotein of influenza virus. These changes are responsible for the formation of influenza viral strains with different levels of virulence. The figures below depict two processes (G and H) that contribute to the decreasing antigenic relatedness of HA between different viral strains over time.



Which conclusions about processes G and H are valid?

- 1 G occurs due to a single point mutation in the gene coding for HA protein.
- 2 H may occur due to the genetic re-assortment of RNA genomes of human and avian influenza viruses.
- 3 G and H could only occur in an individual host who is simultaneously infected with at least two different strains of influenza virus.
- 4 The immune system of a host functions as a selective force for new antigenic variants of HA formed via process G.

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

- 20** Pollen from a tomato plant with yellow flowers and red fruit was transferred to a pure-bred plant with white flowers and yellow fruit. Seeds were collected and grown, giving 200 plants with the following phenotypes.

yellow flowers and red fruit	87
yellow flowers and yellow fruit	13
white flowers and red fruit	17
white flowers and yellow fruit	83

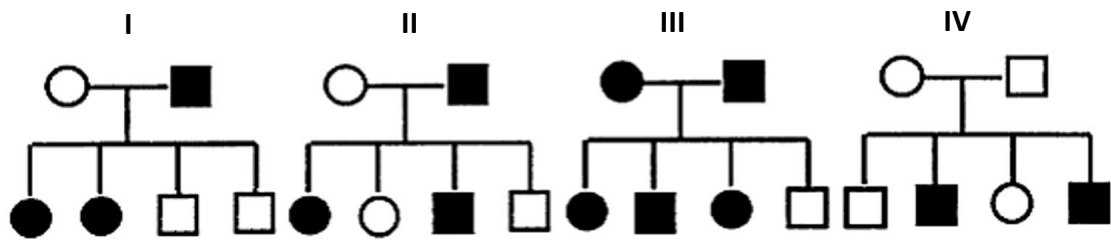
What explains these results?

- A** epistasis between loci
 - B** co-dominance of alleles
 - C** multiple alleles
 - D** crossing over between linked genes
- 21** In a monohybrid cross involving different alleles, different phenotypes are observed.

Which statement correctly explains these different phenotypes?

- A** The nucleotide sequence of the different alleles each produces a different mRNA molecule, of which not all can be translated into functional proteins.
- B** Expression of the recessive allele only occurs in homozygous recessive individuals, because the expression of the recessive allele is prevented in heterozygous individuals.
- C** The recessive allele present in heterozygotes is unlikely to be transcribed and translated.
- D** Transcription of alleles at different loci leads to translation of active and inactive enzymes.

- 22 The figure below shows four pedigrees. A shaded circle represents an affected female while a shaded square represents an affected male.



Which pedigree(s) show(s) a sex-linked dominant trait in humans?

- A I only B I and III C II and III D III and IV
- 23 The following are stages in one cycle of the polymerase chain reaction (PCR).

- 1 Heat tolerant polymerase replicates DNA
- 2 DNA heated to separate strands
- 3 Primers bind to DNA

Which of the following is the correct order of the occurrence of these stages in PCR?

- A $2 \rightarrow 3 \rightarrow 1$
 B $3 \rightarrow 2 \rightarrow 1$
 C $2 \rightarrow 1 \rightarrow 3$
 D $3 \rightarrow 1 \rightarrow 2$

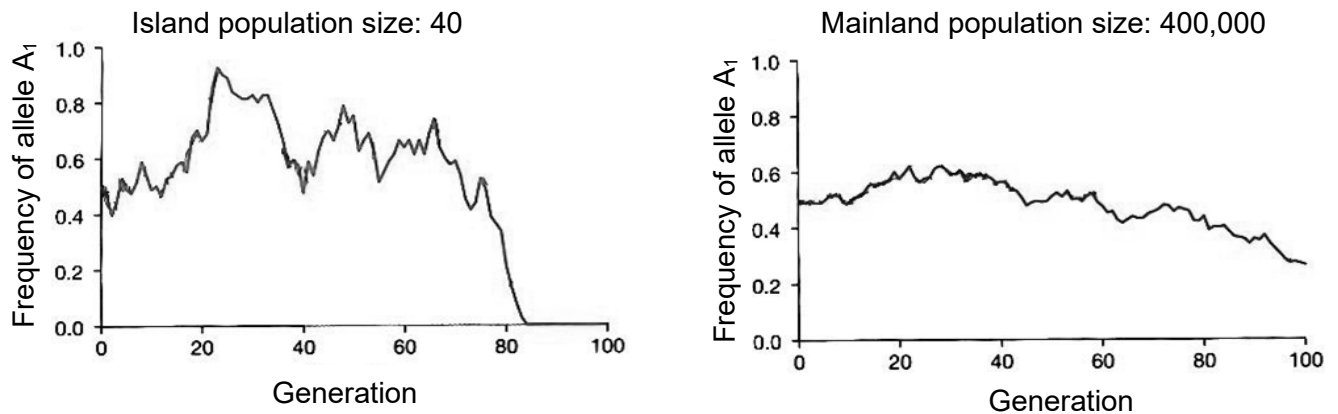
- 24** The table shows equivalent amino acid sequences of part of a protein from four animal species.

animal species	amino acid sequence							
1	trp	met	val	glu	cys	asp	arg	leu
2	trp	val	met	glu	cys	asp	asp	ala
3	trp	val	val	glu	cys	asp	arg	leu
4	phe	trp	val	gly	cys	arg	asp	leu

Using the technique of molecular homology, which of the following is correct?

	least closely related pair	conclusion
A	1 and 4	Species 1 and 4 share the most recent common ancestor amongst the four species.
B	2 and 4	Species 2 and 4 diverged the earliest amongst the four species.
C	2 and 3	Species 2 and 3 share the most recent common ancestor amongst the four species.
D	3 and 4	Species 3 and 4 diverged the earliest amongst the four species.

- 25 The graphs show the frequency of allele A1 of two fruit fly populations on an island and on a nearby mainland over time.



Based on the information provided, which of the statement(s) most likely explain the change in the frequency of allele A1 in both locations?

- 1 Selection pressure in the mainland remained the same over time.
- 2 Random events could have resulted in the loss of allele A1 in the island population.
- 3 Natural selection contributed to the change in frequency of allele A1 in the mainland population.
- 4 The size of the island population contributed to the loss of allele A1.

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

- 26** A study was conducted to study the signalling pathway of a newly discovered hormone. A liver cell extract was treated with the hormone. At regular time intervals, samples of cells were lysed and the levels of specific cellular components were measured.

Results of the measurement are shown in the table below.

time / s	levels of cellular component / arbitrary units			
	PIP ₂	PKC	IP ₃	Ca ²⁺
15	8.9	0.0	4.8	1.2
30	6.5	0.0	6.9	1.2
45	4.3	0.0	8.0	1.2
60	1.5	0.0	9.5	8.7
75	0.3	6.9	11.4	12.4

Based on the results, which of the following is the correct sequence of cellular components in the signalling pathway?

- A** PKC → IP₃ → Ca²⁺ → PIP₂
- B** IP₃ → PKC → Ca²⁺ → PIP₂
- C** PIP₂ → IP₃ → Ca²⁺ → PKC
- D** Ca²⁺ → PIP₂ → IP₃ → PKC
- 27** Which of the following statements does not describe the advantages of the signal transduction stage in G-protein coupled receptor (GPCR) signaling?
- A** The activated adenylyl cyclase converts intracellular ATP into cAMP and this increased cAMP level serves to amplify glucagon signal to produce stronger response.
- B** The G-protein system and phosphorylation cascade in the liver cells with GPCR serves as many potential checkpoints for regulation of the GPCR signaling.
- C** One single glucagon ligand molecule can result in many cellular responses through different pathways.
- D** Glucagon can diffuse across the cell surface membrane and bind to intracellular GPCR to result in the activation of genes in the nucleus.

28 The statements refer to the disease tuberculosis (TB).

- 1 the pathogen lives inside human cells so is not accessible to the immune system.
- 2 the bacterial pathogen reproduces slowly.
- 3 the pathogen is not very sensitive to antibiotics.

Which explains why antibiotic treatment for TB takes a long time?

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

29 Some of the risk factors that increase the probability that a person will develop a more severe form of dengue disease are listed.

- 1 Having previously been infected with a different variant of the virus
- 2 Having a genetic susceptibility to the virus
- 3 Living in a region where mosquitoes carry a more virulent form of the virus
- 4 Living near open sewers
- 5 Being immunocompromised

Some of these risk factors increase the probability of being infected with the virus while others increase the risk of developing severe dengue disease following infection.

Which of these risk factors increase the probability of developing severe dengue disease following infection?

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

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

- A** Increased atmospheric temperature resulting in melting of sea ice, which decreases the amount of sunlight reflected back into space.
- B** Increased burning of fossil fuels, increasing atmospheric CO₂ concentration, enhancing the greenhouse effect.
- C** Increase in atmospheric temperature causes many species to move towards higher altitudes to stay within their optimum temperature range.
- D** Melting of glaciers, causing an increase in sea levels.

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