



H2 Biology

9744/01

Paper 1 Multiple Choice

22 September 2025

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use paper clips, glue or correction fluid/tape.

Write your name, civics group and registration number 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.

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.

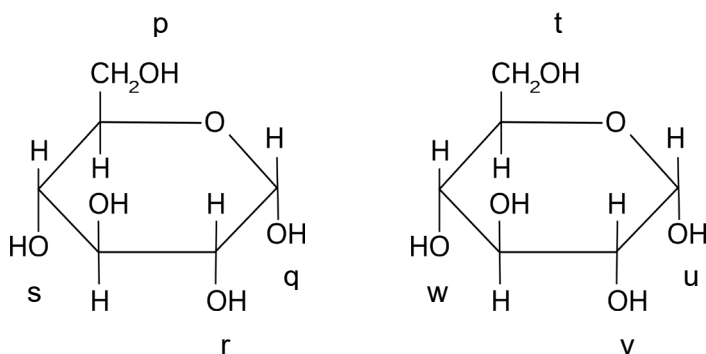
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **22** printed pages and **2** blank pages.

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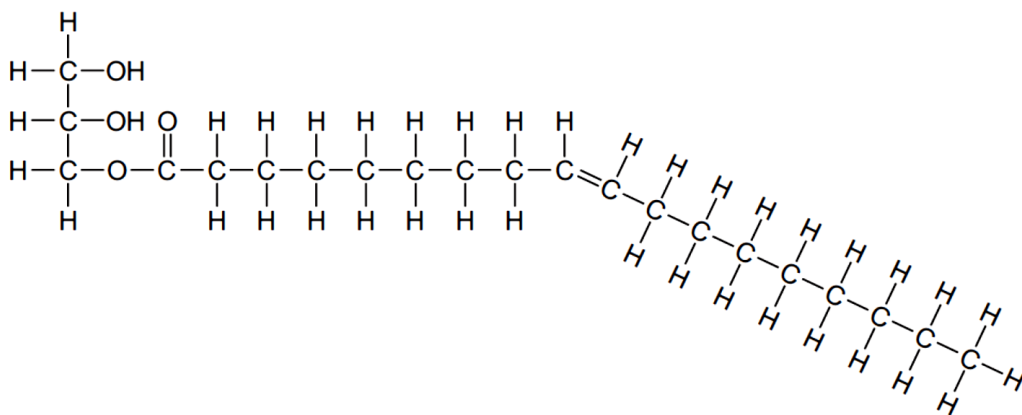
Answer **all** questions.

- 1 The diagram shows two identical molecules of glucose which are involved in the formation of glycogen. The possible bonding positions in the two molecules are labelled p, q, r, s, t, u, v and w.



When the two molecules condense during the formation of glycogen, where could bonds form?

- A** p – u or r – v
B s – t or q – u
C s – w or q – t
D q – w or p – u
- 2 The diagram shows a triglyceride molecule that has been partially hydrolysed.



What will be the products of the total hydrolysis of the molecule shown?

- A** a molecule of glycerol and a saturated fatty acid molecule only
B a molecule of glycerol and an unsaturated fatty acid molecule only
C a molecule of water, a molecule of glycerol and a saturated fatty acid molecule
D a molecule of water, a molecule of glycerol and an unsaturated fatty acid molecule

- 3 A peptide section of an insulin molecule was hydrolysed by two proteases, trypsin and chymotrypsin.

- Trypsin breaks the peptide bonds at the carboxyl terminals of lysine (lys) and arginine (arg).
- Chymotrypsin breaks the peptide bonds at the carboxyl terminals of phenylalanine (phe), tryptophan (trp) and tyrosine (tyr).

The hydrolysis was performed separately using:

- (i) both enzymes, **or**
- (ii) trypsin only, **or**
- (iii) chymotrypsin **only**.

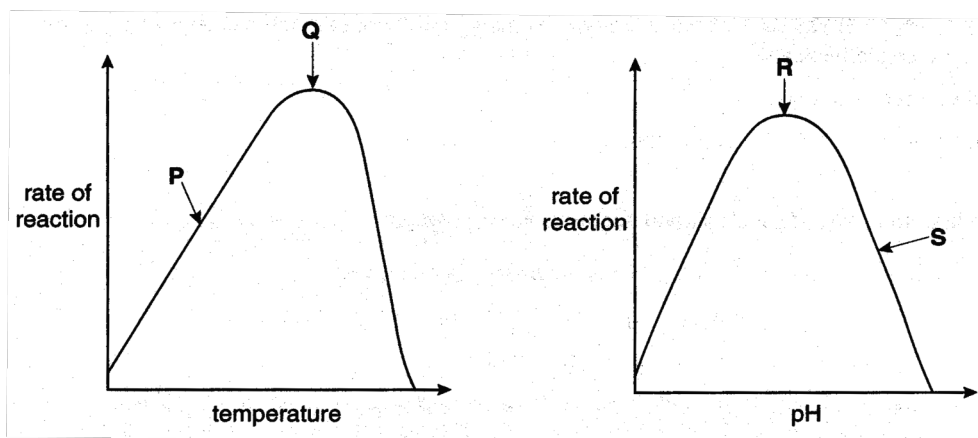
The sequence of amino acid residues in the peptide is shown below:

amino terminal	tyr-leu-val-cys-gly-glu-arg-gly-phe-phe-tyr-thr-pro-lys-ala	carboxyl terminal
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Which statement concerning the products of hydrolysis is correct?

- A** Fewer than half of the fragments from hydrolysis (i) are single amino acids.
- B** Hydrolysis (ii) yields one fewer fragment than hydrolysis (iii).
- C** Hydrolysis (ii) yields one more dipeptide than hydrolysis (iii).
- D** With hydrolysis (i), all fragments formed are seven or fewer amino acid residues long.

- 4 The graphs show the effects of temperature and pH on enzyme activity.



Which statement is a correct explanation of the rate of reaction at the point shown?

- A** At P, hydrogen bonds in the enzyme are broken.
- B** At Q, the kinetic energy of enzyme and substrate is highest.
- C** At R, covalent bonds are formed between enzyme and substrate.
- D** At S, ionic bonds in the enzyme are broken.

- 5** A researcher is studying the properties of a toxin produced by a plant. When cellular contents are exposed to the toxin, the cell will die.

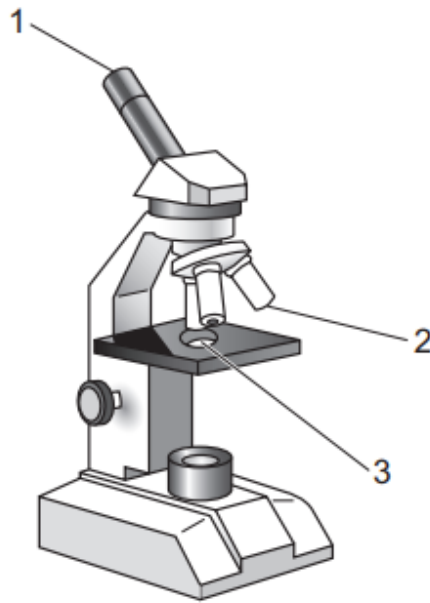
The table shows the relative proportion of various structures in cells that are not actively producing the toxin and cells that are actively producing the toxin.

cell structure	description	relative proportion of cell / %	
		non-toxin producing cell	toxin producing cell
W	double membrane-bound organelle with cristae	12	15
X	sheet-like, membrane-bound organelle with continuous lumen	15	20
Y	membrane-bound organelle arranged in tubules	14	3
Z	large, dense, and contains rRNA	3	10

Which conclusion is consistent with the data provided above?

- A** Toxin production is energy intensive, which requires more of structure W.
- B** Protein synthesis at structure X is upregulated, implying that the toxin is protein-based and embedded in the membrane of structure X.
- C** The decrease in structure Y is due to transport vesicles containing the toxin budding off.
- D** Increased ribosome production in structure Z suggests that the toxin is RNA-based.

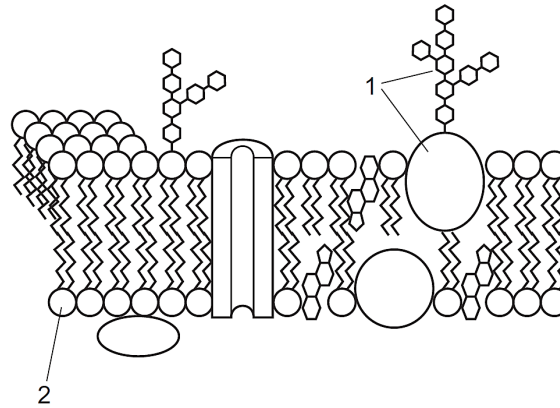
- 6 A graticule and a micrometer scale can be used to measure the size of biological structures that are viewed with a microscope.



Which row shows the correct locations for the placement of a graticule and a micrometer scale on the microscope shown?

	graticule	micrometer scale
A	1	3
B	2	1
C	2	3
D	3	1

7 The diagram shows part of a cell surface membrane.



Which row correctly matches the function of the molecules labelled 1 and 2?

	1	2
A	acts as a binding site for other cells	limits the permeability of the membrane
B	acts as a recognition site for other cells	transports water across the membrane
C	restricts membrane fluidity at high temperature	transports ions across the membrane
D	improves membrane fluidity at low temperature	limits the permeability of the membrane

8 A circular DNA molecule comprises 1700 base pairs and has equal numbers of A, T, C, and G.

What is the total number of hydrogen bonds and phosphodiester bonds present in this DNA molecule?

- | | |
|---------------|---------------|
| A 5949 | B 5950 |
| C 7648 | D 7650 |

9 Which statements correctly describe the process of translation?

- 1 A section of DNA is copied into an mRNA molecule by RNA polymerase.
- 2 A polypeptide is produced because ribosomal RNA joins adjacent amino acids.
- 3 The nucleotide sequence on an mRNA molecule is used to produce a specific amino acid chain.
- 4 A polypeptide is produced because anticodons on tRNA molecules attach to mRNA codons through peptide bonds.

- | | |
|---------------------|------------------------|
| A 1 and 3 | B 2 and 3 |
| C 1, 2 and 3 | D 1, 2, 3 and 4 |

- 10** Sickle cell anaemia is caused by a mutation in an allele of the gene that codes for the β -globin polypeptide of haemoglobin.

The diagram shows the sequence of bases in a small section of the template strand of DNA for both the Hb^A (normal) and Hb^S (sickle cell) β -globin alleles.

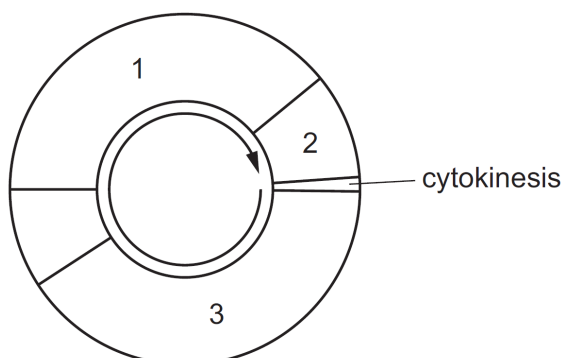
Hb^A	CTGACTCCTGAGGAGAAGTCT
Hb^S	CTGACTCCTGTGGAGAAGTCT

Both the polypeptides for Hb^A and Hb^S are the same length.

How will the mutation in the allele result in the production of an altered version of the β -globin polypeptide?

- A** A tRNA molecule with the anticodon GUG will form hydrogen bonds with the altered codon on mRNA.
- B** All the amino acids coded for after the mutation will differ from those in the Hb^A protein.
- C** mRNA transcribed from the Hb^S allele will contain the codon CAC instead of the codon CTC.
- D** The ribosome will be unable to continue translation of the Hb^S mRNA after the altered codon.

- 11** The diagram shows an outline of the mitotic cell cycle.



Which numbered stages of the cell cycle include a period of time when each chromosome consists of sister chromatids joined by a centromere?

- | | |
|------------------|------------------|
| A 2 only | B 1 and 2 |
| C 1 and 3 | D 2 and 3 |

- 12** Which row correctly shows a representation of one chromosome at the beginning of prophase I and at the end of anaphase II of meiosis and the number of DNA strands in the chromosome?

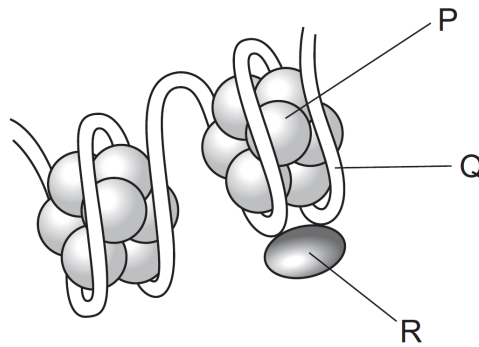
	at the beginning of prophase I		at the end of anaphase II	
	appearance of one chromosome	number of DNA strands	appearance of one chromosome	number of DNA strands
A		2		1
B		4		2
C		1		2
D		2		4

- 13** Melanoma is a form of skin cancer that begins in cells called melanocytes that control pigment production in the skin.

Which of the following rows correctly compares a normal and cancerous melanocyte?

	similarity	difference
A	both cells arise from pre-existing cells	the cell cycle of cancerous melanocytes is arrested at either the S phase or M phase
B	some genes are silenced in both cells	cancerous melanocytes continue to divide even when they are tightly packed
C	both cells contain well-defined nuclei	cancerous melanocytes are always in the M phase of the cell cycle
D	telomerase is active in both cells	more gene mutations are evident in cancerous melanocytes

- 14** The diagram shows part of the organisation of a section of a DNA molecule and the associated histones, P and R, in prophase of mitosis.

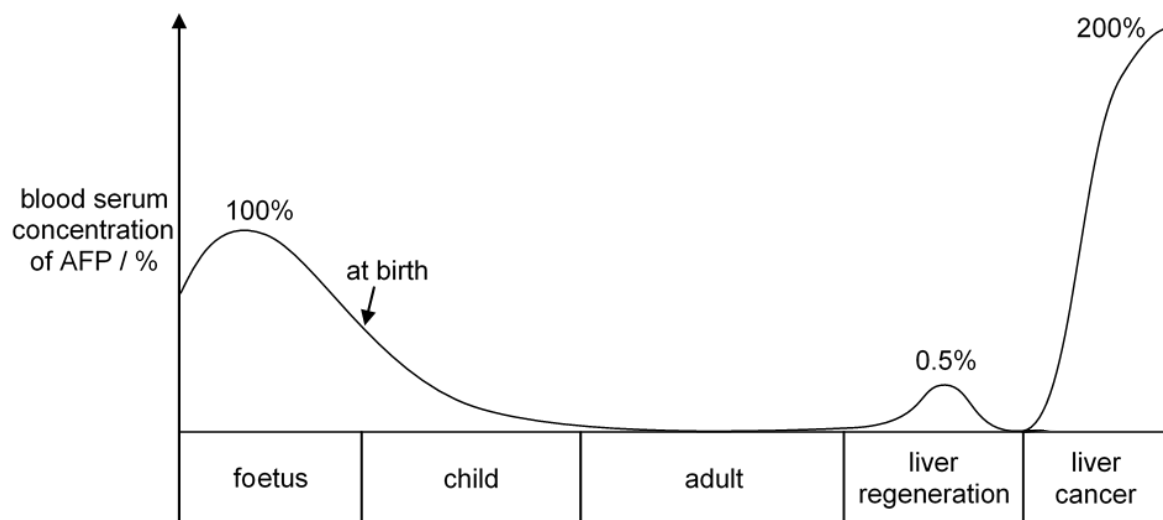


Which statement about the features labelled P, Q and R during prophase of mitosis is correct?

- A** The coiled DNA molecule forms Q and wraps around histone R to form small clusters held in place by histone P.
- B** The groups of histones, P, and its associated DNA, Q, move closer together as the chromosome condenses around R.
- C** The histones P and R are made of protein around which the DNA molecule, Q, is wrapped so that the DNA molecule can fit inside the nucleus.
- D** The linked groups of histones P and R and the associated DNA, Q, form fibres that fold and twist together to form a chromatid.

- 15** α -fetoprotein (AFP) in blood serum is commonly used as a biomarker for the detection of liver cancer. The *AFP* gene is expressed only in the human foetus but not in a healthy adult.

The graph (not drawn to scale) shows the blood serum levels of AFP at various stages of life.



Which of the following statements are correct?

- 1 The *AFP* gene is found in euchromatin regions of the nucleus of a foetal cell.
- 2 During early foetal development, deacetylation of lysine residues of histones could have occurred at the *AFP* gene promoter.
- 3 Upon birth, DNA methylation of the *AFP* gene may have occurred to silence gene expression.
- 4 It may be difficult to distinguish early-stage liver cancer from liver tissue regeneration.

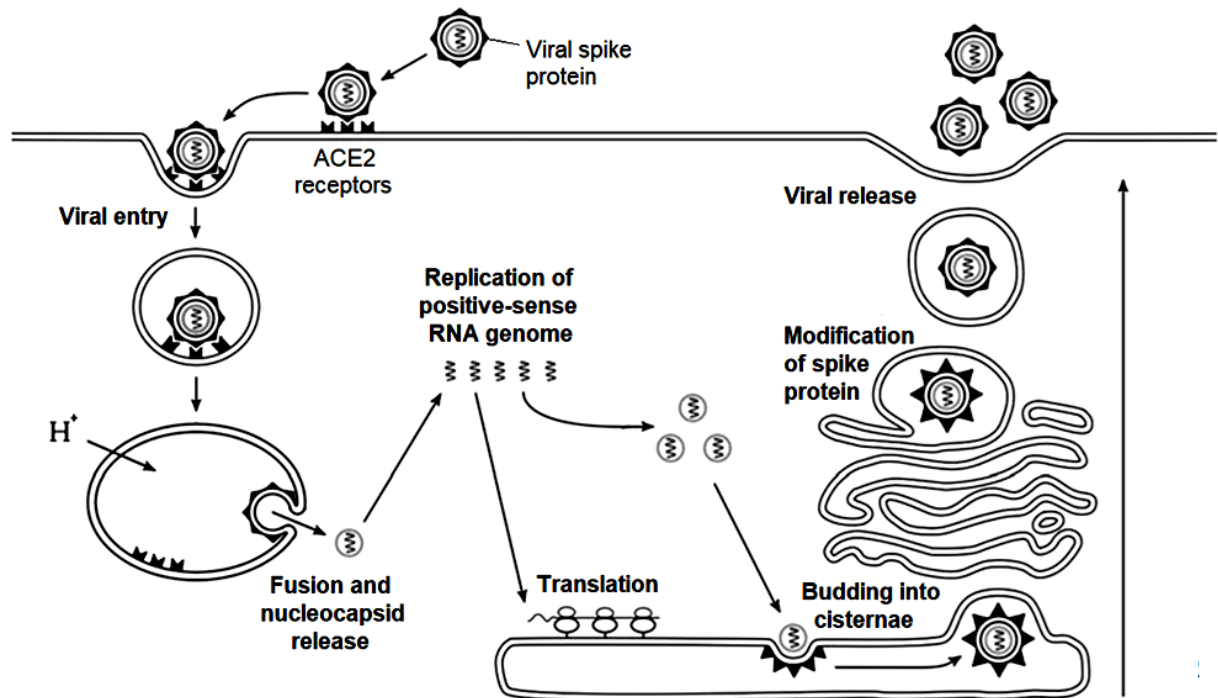
A 1 and 4

B 2 and 3

C 1, 2, and 3

D 1, 3, and 4

- 16** The diagram below shows the reproductive cycle of the SARS-CoV-2. It is a positive-sense single-stranded RNA enveloped virus.



Which of the following statements are correct?

- 1 The envelope of the virus is derived from the membrane of the Golgi apparatus.
- 2 The viral genome can be used directly for translation.
- 3 Replication of the virus is via RNA dependent RNA polymerase.
- 4 The viral glycoprotein is synthesised and modified only at the ribosomes of the RER.
- 5 The virus exits the host cell via budding.

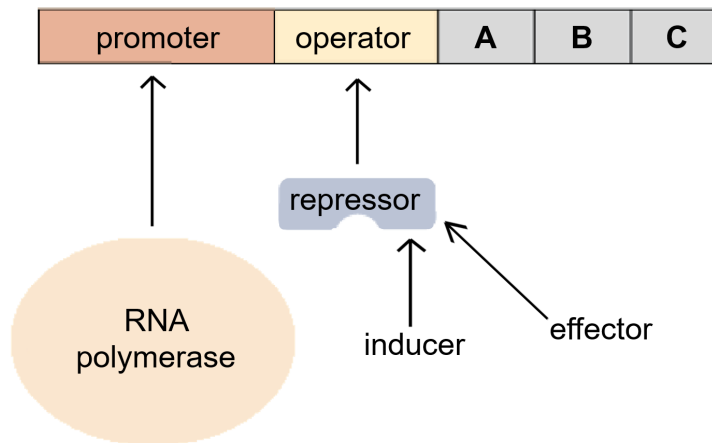
A 1 and 4

B 2 and 3

C 1, 3, and 4

D 2, 3, and 5

- 17 The diagram shows some of the molecules involved in controlling the expression of genes **A**, **B** and **C** in a strain of bacteria.



The following statements refer to the expression of genes **A**, **B** and **C** in the bacteria:

- 1 RNA polymerase must bind to the promoter to transcribe structural genes **A**, **B** and **C**.
- 2 The regulatory gene codes for a repressor.
- 3 The polypeptide coded by structural gene **A** acts as an effector.
- 4 The effector binds to the repressor to activate the repressor.
- 5 The binding of inducer to repressor inactivates the repressor.

Based on the information above, which mutation does **not** result in constitutive expression of the structural genes?

- A** Mutation in gene **A**
- B** Mutation in gene **B**
- C** Mutation in regulatory gene
- D** Mutation in operator

- 18 An experiment was conducted to investigate respiration of yeast cells.

Tube 1: Radioactive glucose solution + suspension of yeast cells + oxygen

Tube 2: Radioactive glucose solution + suspension of yeast cells + oxygen + antimycin

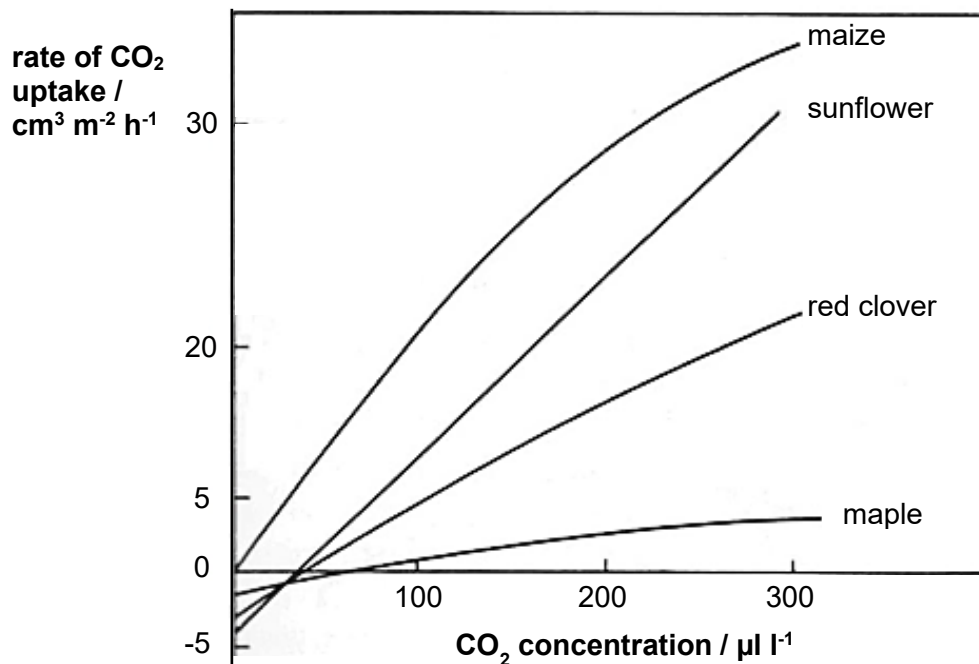
All the six carbon atoms of the radioactive glucose are ^{14}C . The initial radioactivity measured in each test tube is 60 arbitrary units.

Antimycin is an electron transport chain inhibitor.

After all the glucose has been metabolised, the amount of radioactivity in the gaseous product and the content of the tubes were measured. Which of the following shows the expected result?

	tube 1		tube 2	
	radioactivity of content / arbitrary units	radioactivity of gaseous product / arbitrary units	radioactivity of content / arbitrary units	radioactivity of gaseous product / arbitrary units
A	40	20	0	60
B	0	60	60	0
C	0	60	40	20
D	60	0	40	20

- 19 The graph below shows the rate of photosynthesis of four different plants at different concentrations of carbon dioxide.



Which of the following conclusions can be made?

- 1 At CO₂ concentrations below 150 $\mu\text{l l}^{-1}$, CO₂ concentration is the major limiting factor for all the plants.
 - 2 CO₂ compensation point is around 40 $\mu\text{l l}^{-1}$ for sunflower and red clover, and it measures the light intensity when the rate of CO₂ uptake equals to the rate of CO₂ given off.
 - 3 At CO₂ concentration of 300 $\mu\text{l l}^{-1}$, release of CO₂ by maize from respiration is more than the uptake of CO₂ for photosynthesis.
 - 4 Maple has the lowest amount of organic compound produced at CO₂ concentration of 200 $\mu\text{l l}^{-1}$.
- A** 1 and 4 only
B 2 and 3 only
C 1, 3 and 4 only
D 2, 3 and 4 only

- 20** A fisherman was surprised to catch a fish which had no scales (scaleless). To investigate the origin of this phenotype, the scaleless fish was mated several times with scaled fish and the result of each cross was recorded. In the crosses of scaleless with scaled, a third phenotype appeared, which was later called linear. The linear phenotype has only a single line of scales down one side of the body.

The outcomes of these crosses are shown in the table.

Cross	Parents	Offspring phenotype and ratio
1	scaled x scaleless	all offspring linear
2	linear x linear	1 scaled : 2 linear : 1 scaleless

Which of the following is conclusive from the above data?

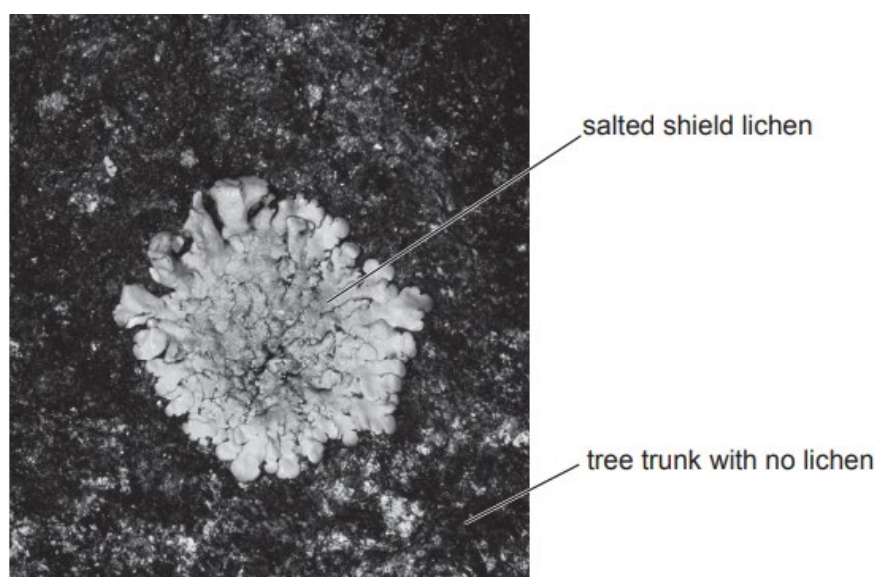
- A** There is incomplete dominance between the scaleless and scaled phenotype.
 - B** The environment is the reason for the loss of scales in the scaleless fish.
 - C** All of the linear fish are homozygous.
 - D** The scaleless fish are heterozygous.
- 21** In *Primula*, the dominant allele, **A**, of a gene for anthocyanin pigment production gives magenta-coloured flowers. The recessive allele, **a**, gives yellow-coloured flowers. The dominant allele, **B**, of another unlinked gene inhibits the effect of allele **A**, while the recessive allele, **b**, has no effect. Plants in which allele **A** is inhibited by allele **B** have yellow flowers.

A yellow-flowered plant is known to be homozygous recessive at the **A/a** locus. The genotype at the **B/b** locus is unknown.

The genotype of the yellow-flowered plant can be deduced by crossing it with a plant of one of the following genotypes below. Identify which of the following is the correct plant to use in such a cross.

- A** aabb
- B** AABB
- C** AAbb
- D** aaBB

- 22 Lichens are found in a large range of habitats, including on the trunks of trees. An example of a lichen, the salted shield lichen, *Parmelia saxatilis*, on the trunk of a tree, is shown below.



Scientists think that grazing of plants by red deer has affected the abundance of certain lichens found growing on the trunks of trees in mixed woodlands.

To investigate this, the scientists excluded red deer from certain mixed woodland areas (exclosures) in 1995, allowing the exclosures to remain ungrazed.

In 2013, the scientists conducted a t-test to compare the abundance of the salted shield lichen in the exclosures and in the grazed areas. The table below shows the mean results and values of t the scientists obtained.

position on tree trunk	mean percentage cover in exclosures	mean percentage cover in grazed areas	t	probability
base	1.7	3.2	0.730	$p > 0.05$
middle	3.4	9.8	2.117	$p < 0.05$
upper	8.5	22.0	2.071	$p < 0.05$

Based on the results shown in the table, which of the following conclusion is **wrong**?

- A The percentage cover of salted shield lichen is greater in grazed areas than exclosures.
- B The abundance of salted shield lichen is greater at a higher position on the tree trunk.
- C There is no significant difference in the abundance of salted shield lichen between exclosures and grazed areas for middle and upper parts of the tree.
- D There is no significant difference in the mean percentage cover of salted shield lichen between exclosures and grazed areas for the base of the tree.

23 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?

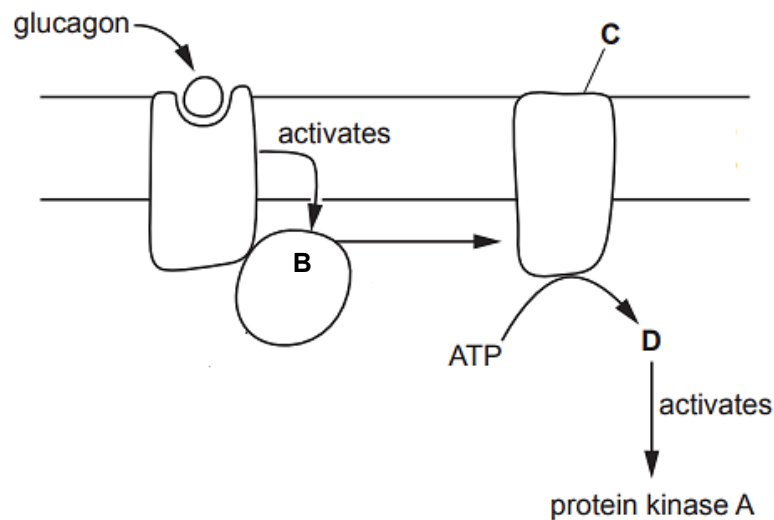
- A** Nucleotide substitutions between DNA of the new variants and the original DNA occur between the regions where primers bind.
- B** The changes to the variant sequences prevent separation of the DNA strands during heating.
- C** The primers for the original gene are not complementary to the DNA of the new variants.
- D** There are too few changes of nucleotides in the variant gene to stop primers annealing.

24 Anti-cancer therapy that targets dividing cells can reduce the number of the 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 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.
- D** 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.

- 25 The diagram below is an outline of the cell signalling pathway activated when glucagon binds to its receptor on liver cells.



Which of the following is true?

- A Molecule B is usually associated with a nucleotide.
 - B Activation of protein kinase A by molecule D illustrates signal amplification.
 - C Molecule C is a second messenger and can be activated by molecule B.
 - D Molecule C has enzymatic activity whereas molecule B does not.
- 26 Bacteria in the genus *Wolbachia* infect many butterfly species. They are passed from one generation to the next in eggs, but not in sperm, and they selectively kill developing male embryos.
- In Samoa in the 1960s, the proportion of male blue moon butterflies fell to less than 1% of the population. However, by 2006, the proportion of males was almost 50% of the population.
- Resistance to *Wolbachia* is the result of the dominant allele of a suppressor gene.
- Which statements correctly describe the evolution of resistance to *Wolbachia* in the blue moon butterfly population?
- 1 *Wolbachia* acts as a selection pressure.
 - 2 The selective killing of male embryos is an example of artificial selection.
 - 3 When infected with *Wolbachia*, male embryos that are homozygous for the recessive allele of the suppressor gene die.
 - 4 Male embryos that carry the dominant allele of the suppressor gene pass that allele to all of their offspring.
 - 5 The frequency of the dominant allele of the suppressor gene increases in the butterfly population.

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

27 *Oryza rufipogon* and *Oryza nivara* are two species of wild rice.

- *O. rufipogon* grows in places where water is always available.
- *O. nivara* grows within the same geographical range as *O. rufipogon*.
- The habitat of *O. nivara* can lack water for part of the year.
- The two species flower at different times of the year.

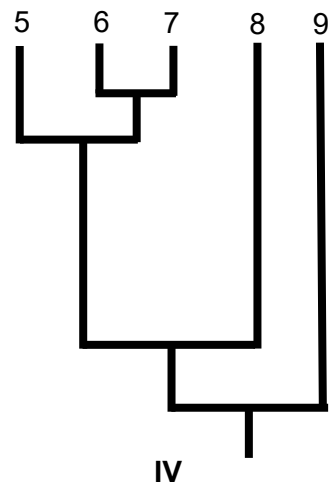
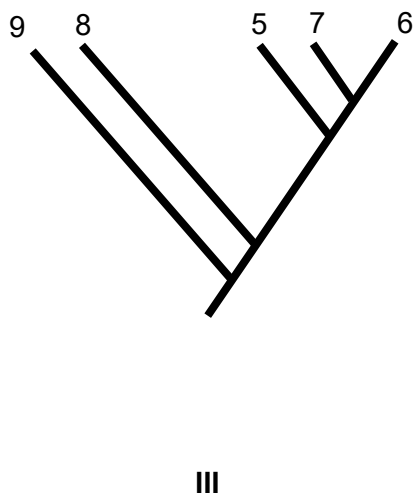
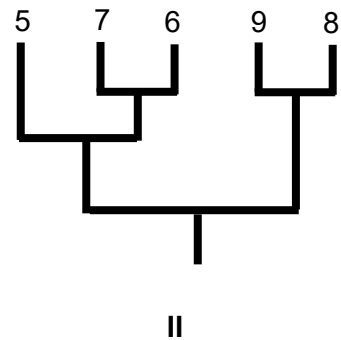
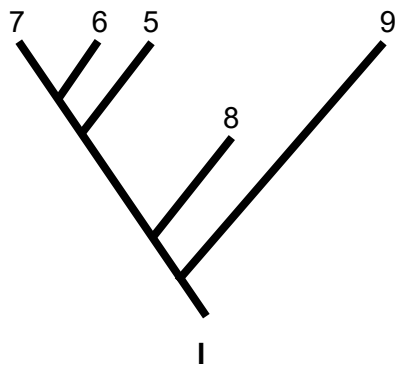
Based on the information given above, which of the following is **false**?

- A** *O. rufipogon* and *O. nivara* evolved through sympatric speciation.
- B** Behavioural differences such as flowering times resulted in disruption of gene flow.
- C** *O. rufipogon* and *O. nivara* are reproductively isolated.
- D** Both wild rice species occupy different niches.

- 28** To determine relatedness for 5 different living species, the amino acid differences for a particular homologous protein are shown below.

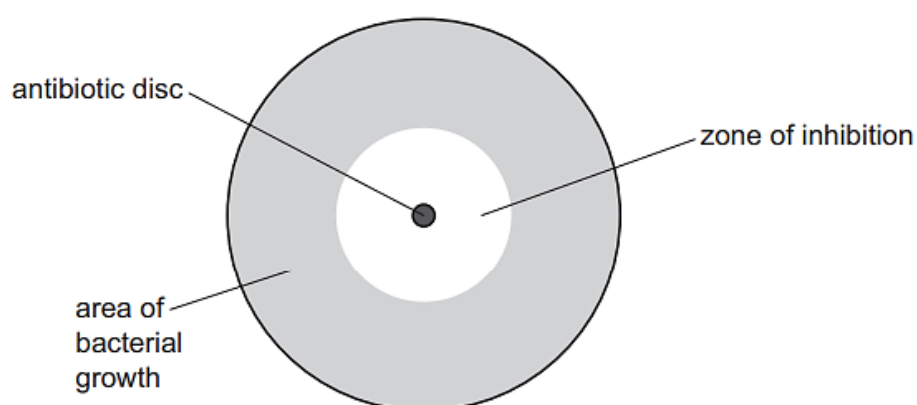
species	5	6	7	8	9
5	0	7	8	20	23
6	7	0	3	19	22
7	8	3	0	18	21
8	20	19	18	0	20
9	23	22	21	20	0

Using the table above, which one of the following represents the probable evolutionary relationships between the species?

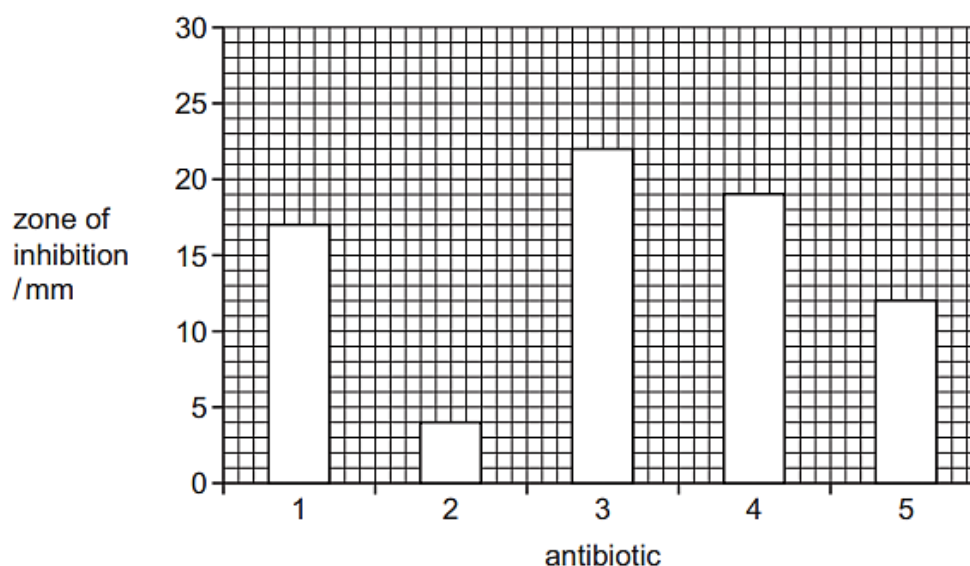


- A** I only
B II only
C III only
D III and IV

- 29 When bacteria are grown in a Petri dish containing discs with antibiotics, there will be zones of inhibition of bacterial growth.



The chart shows the size of the zones of inhibition when a species of bacteria was incubated on five different plates of agar, each containing a disc with a different antibiotic.



Which conclusions can be made about the most and least effective antibiotics on this species of bacteria?

	most effective antibiotic	least effective antibiotic
A	3	2
B	4	3
C	3	1
D	2	3

- 30** More cases of malaria are being reported in Europe. Other diseases, formerly confined to tropical countries and transmitted in the same way as malaria, have also spread to parts of Europe. Tropical countries have higher mean temperatures and humidity than Europe.

What could explain the increase in the number of cases of these diseases in Europe?

- 1 rising temperatures and humidity in Europe as a result of climate change
- 2 increased travel between Europe and tropical countries
- 3 creation of wetland areas such as marshes to increase biodiversity

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

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