EUNOIA JUNIOR COLLEGE
JC2 Preliminary Examination 2023
General Certificate of Education Advanced Level
Higher 2

H2 Biology **9744/01**

Paper 1 Multiple Choice **22 September 2023**

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.

BLANK PAGE

Answer **all** questions.

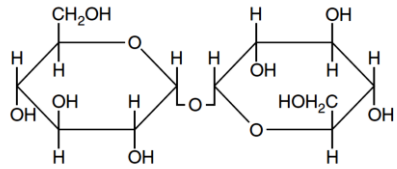
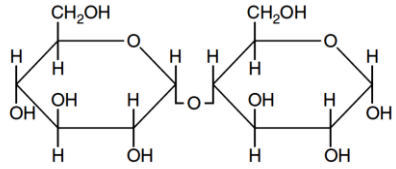
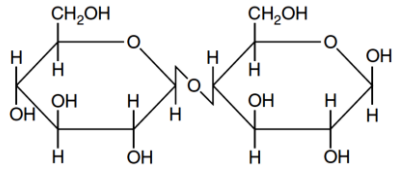
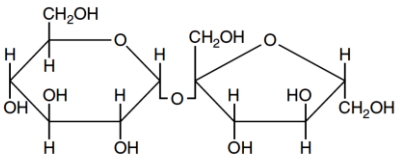
1 Disaccharides are formed following synthesis from monosaccharides or as a result of polysaccharide hydrolysis.

Cellobiose, maltose, sucrose and trehalose are four different disaccharides found in nature.

Some features of these disaccharides are listed.

- Cellobiose is formed from the hydrolysis of the polysaccharide cellulose.
- Sucrose is composed of glucose and fructose.
- Trehalose is a non-reducing disaccharide that is synthesised from two α-glucose molecules.
- Maltose is formed from the hydrolysis of amylose, a component of starch.

Which column correctly identifies each disaccharide?

	A	**B**	**C**	**D**
	cellobiose	maltose	sucrose	trehalose
	maltose	cellobiose	trehalose	maltose
	sucrose	trehalose	cellobiose	cellobiose
	trehalose	sucrose	maltose	sucrose

2 When hydrolysed, which molecules have products containing carboxyl groups?

1 phospholipids
2 polysaccharides
3 proteins

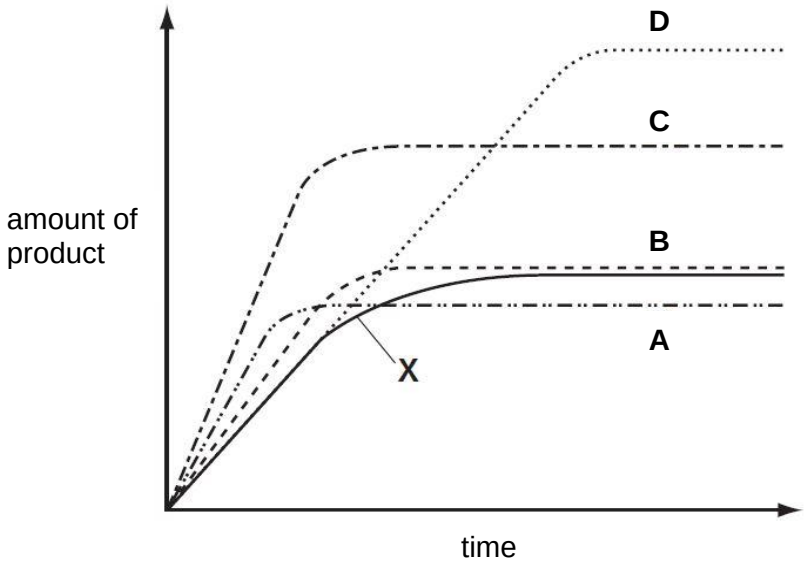
A 3 only
B 1 and 2
C 1 and 3
D 2 and 3

3 How many different polypeptides, each of 100 amino acids, can be made if the number of different amino acids available is 10?

A 100^{10} **B** 10^{100} **C** 1000 **D** 10

4 The curve **X** shows the activity of an enzyme at 20°C. Curves **A**, **B**, **C** and **D** show the effect of different conditions on the activity of the enzyme.

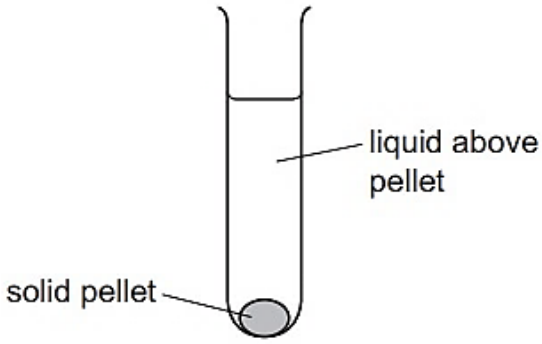
Which curve shows the effect of increasing the temperature by 10°C and adding extra substrate?



5 A scientist carried out an experiment to separate the organelles in an animal cell by density.

The scientist mixed the cells with a buffer solution which had the same water potential as the cells. The cells were lysed with a blender to release the organelles.

The mixture was filtered and then spun in a centrifuge at a high speed to separate the heaviest organelle. This sank to the bottom, forming a solid 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 organelle. This organelle sank to the bottom, forming a solid pellet, 2.

He repeated this procedure twice more to obtain pellet 3 and pellet 4, each containing a single type of organelle.

What is the most likely function of the organelle extracted in pellet 4?

A digestion of old organelles
B production of mRNA
C production of ATP
D catalyse bond formation in polypeptides

6 Studies have shown that the formation of stable flattened stacks of membranes are essential for the proper functioning of the Golgi body. This structure is maintained by a microtubule network and a group of peripheral and integral proteins found on the cytoplasmic surface of Golgi membranes.

In some diseases, such as certain types of cancer and some neurodegenerative diseases, the structure of the Golgi body is fragmented as shown in the diagram below. The fragments are unlinked and are dispersed in the cytoplasm of the cell.

normal Golgi body fragmented Golgi body

Which statements are possible inferences from the given information?

1 Fragmented Golgi bodies contain non-functional glycosyltransferases, which results in hyperactive glycoproteins linked to cancer.

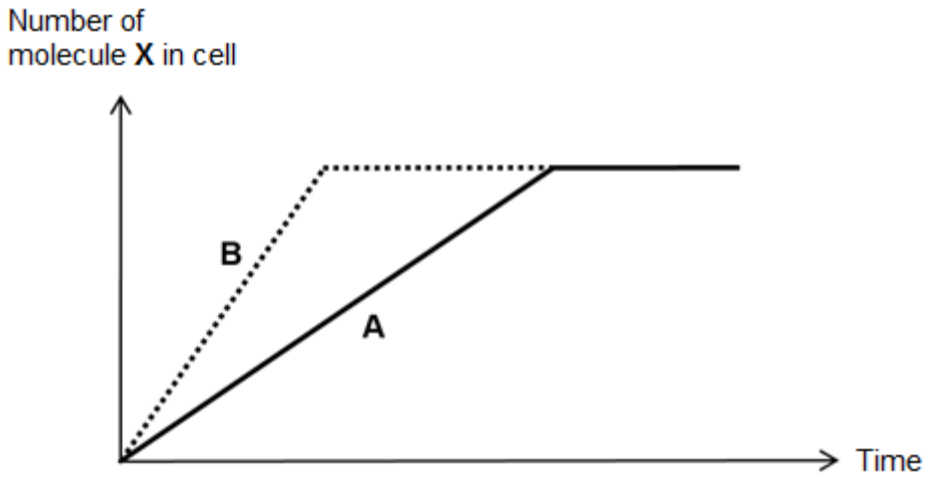
2 Fragmented Golgi bodies are a consequence of mutated Golgi membrane proteins, resulting in the loss of attachment sites for cisternae to stack.

3 Fragmented Golgi bodies may result in the loss of attachment sites for transport vesicles from the rough endoplasmic reticulum, leading to unmodified proteins which are non-functional.

4 Fragmented Golgi bodies may result in reduction of sorting and processing of proteins for the maintenance of nerve cells, leading to their degeneration.

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

7 Graph **A** shows the transport of molecule **X**, with the help of carrier proteins, over time.

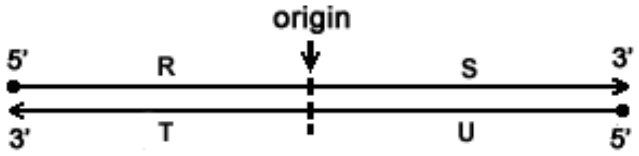


A student predicted that the alteration of one variable would result in graph **B**.

Which row shows the correct transport process and the correct alteration in variable that would result in graph **B**?

	Transport process	Alteration resulting in graph **B**
A	facilitated diffusion	increase in concentration of X outside cells
B	active transport	increase in concentration of X in cells
C	facilitated diffusion	increase in number of carrier proteins
D	active transport	increase in environmental temperature to 90°C

8 If DNA synthesis is initiated at the indicated origin of replication as shown in figure below**.**



Which segments of single-stranded DNA are templates for the synthesis of Okazaki fragments?

A **R** and **U**

B **S** and **T**

C **R** and **T**

D **S** and **U**

9 An antibiotic, edeine, was isolated. It inhibits protein synthesis but has no effect on either DNA synthesis or RNA synthesis. When added to a mixture containing fully intact organelles, edeine stops translation after 10s.

Analysis of the edeine-inhibited mixture showed that no polyribosomes remained by the time protein synthesis had stopped. Instead, all the mRNA accumulated together with small ribosomal subunit and initiator tRNA.

What step in protein synthesis does edeine inhibit?

A It interferes with chain termination and release of the peptide.

B It inhibits the binding of amino acyl-tRNAs to the A-site in the ribosome.

C It blocks the translocation of peptidyl-tRNA from the A-site to the P-site of the ribosome.

D It prevents the formation of the translation initiation complex, which contains the initiator tRNA and both ribosomal subunits.

10 The codons UGU and UGC code for the amino acid cysteine, which can form disulfide bonds in a polypeptide.

The codon UGG codes for the amino acid tryptophan, which does not contain a sulfur atom.

UGA is a stop codon.

On the template DNA strand, the DNA triplet code for the 10th amino acid in a particular polypeptide is ACA.

Which single base substitution(s) in this triplet code will result in **no** disulfide bond being formed with the 10th amino acid in the polypeptide?

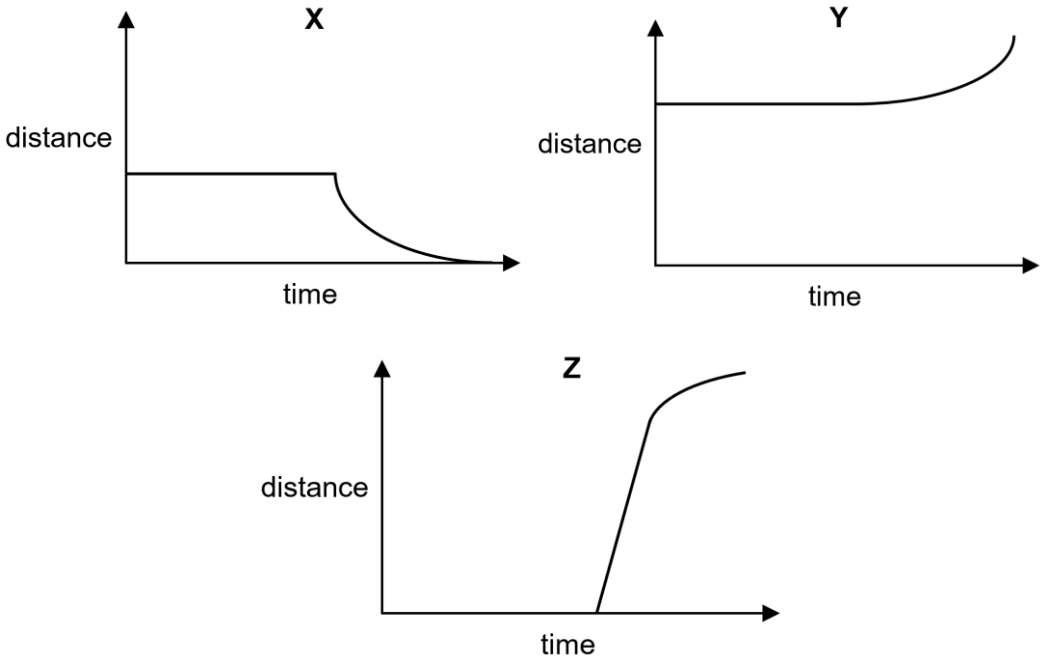
A ACC and ACG

B ACG and ACT

C ACT and ACC

D ACG only

11 The graphs show various measurements taken from mitotic stages of metaphase and beyond. The graphs are all to the same scale.



Which row correctly describes each graph?

	X	Y	Z
A	distance between centrioles	distance between sister chromatids	distance of centromere to pole of cell
B	distance between centrioles	distance of centromere to pole of cell	distance between sister chromatids
C	distance of centromere to pole of cell	distance between centrioles	distance between sister chromatids
D	distance of centromere to pole of cell	distance between centrioles	distance between centrioles

12 A diploid cell from a certain organism contains *x* amount of DNA and 38 chromosomes and can undergo either mitosis or meiosis.

During which stage(s) would 2*x* amount of DNA and 76 chromosomes be found in each cell?

A Anaphase of mitosis only.

B Anaphase of meiosis I only.

C Anaphase of mitosis and anaphase of meiosis I.

D Anaphase of mitosis and anaphase of meiosis II.

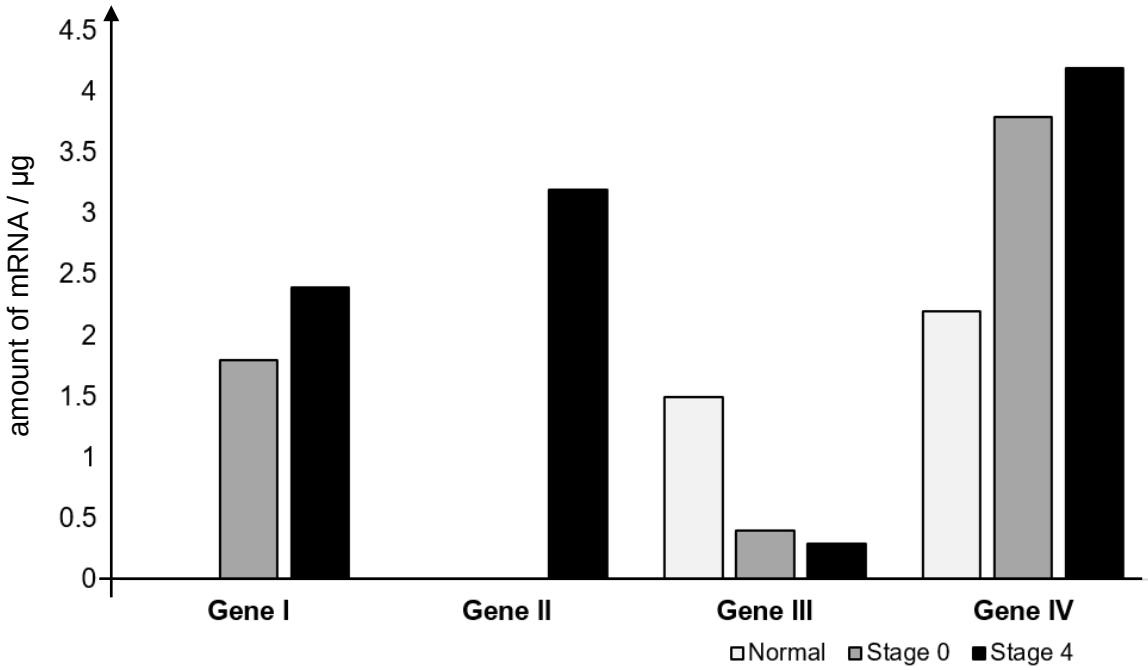
13 When a patient is diagnosed with cancer, the diagnosis will include the stage of the cancer. There are typically five stages, characterised as follows:

stage	description
0	Small localised tumour mass which has not spread to nearby tissues.
1	Small localised tumour mass that has not grown deeply into nearby tissues. It has not spread to the lymph nodes or other parts of the body.
2 and 3	Larger tumour mass which has grown more deeply into nearby tissues. It may have also spread to lymph nodes but not to other parts of the body.
4	Cancer has spread to other organs or parts of the body.

The expression of four genes, **I** to **IV**, was studied in three different individuals:

- Normal (not suffering from cancer)
- Stage 0 cancer
- Stage 4 cancer

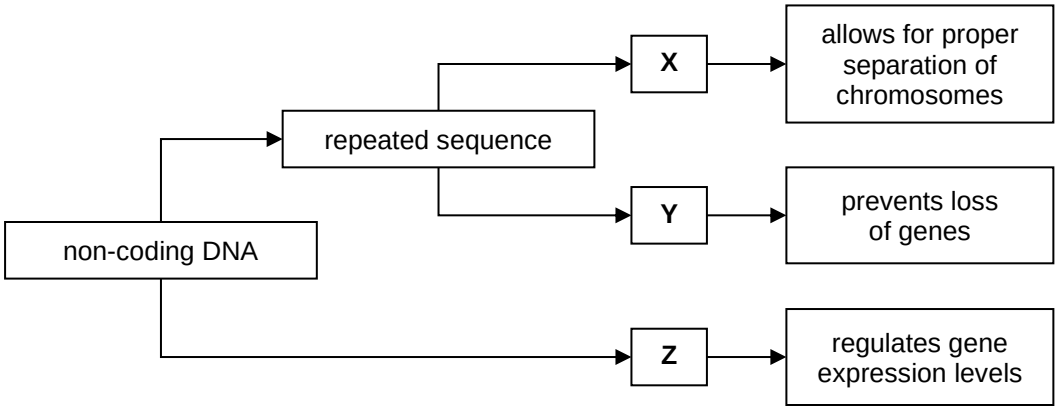
All four genes have been implicated in cancer development. The amount of mRNA transcribed from each gene in a somatic cell was quantified, and the results are shown below.



Which of the following correctly identifies genes **I** to **IV**?

	Gene **I**	Gene **II**	Gene **III**	Gene **IV**
A	telomerase gene	gene involved in metastasis	tumour suppressor gene	proto-oncogene
B	gene involved in metastasis	telomerase gene	tumour suppressor gene	proto-oncogene
C	gene involved in metastasis	telomerase gene	proto-oncogene	tumour suppressor gene
D	telomerase gene	gene involved in metastasis	proto-oncogene	tumour suppressor gene

14 The flowchart shows the classification of several regions of non-coding eukaryotic DNA, **X**, **Y**, and **Z**.



How many of the following statements correctly describe **X**, **Y**, and **Z**?

1 Regions **X** and **Y** are made up of transcriptionally active tandem repeat sequences.

2 Regions **X** and **Y** are always associated with proteins, but DNA at region **Z** is only associated with proteins during gene expression.

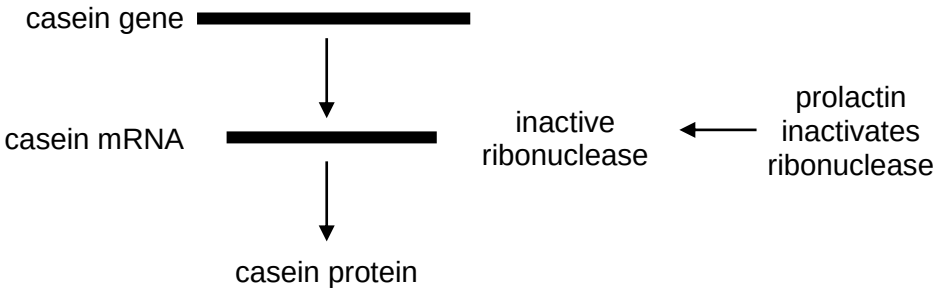
3 Region **Z** may involve DNA bending but region **Y** shortens during every round of DNA replication.

4 Regions **X**, **Y**, and **Z** are conserved throughout the life of the organism.

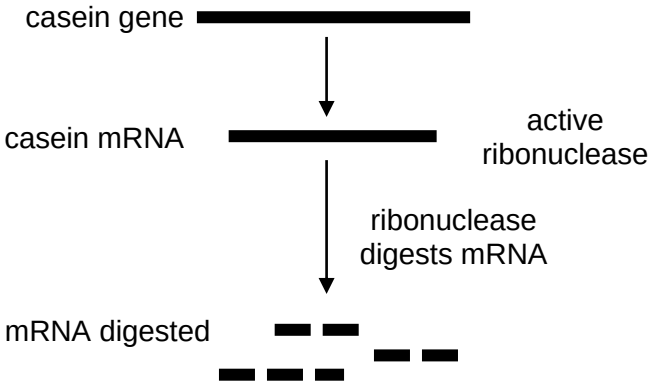
A one **B** two **C** three **D** four

15 Casein is a major protein found in mammalian milk.

When the mammal is producing milk, the biochemical pathway for the production of casein can be represented as shown in the diagram below.



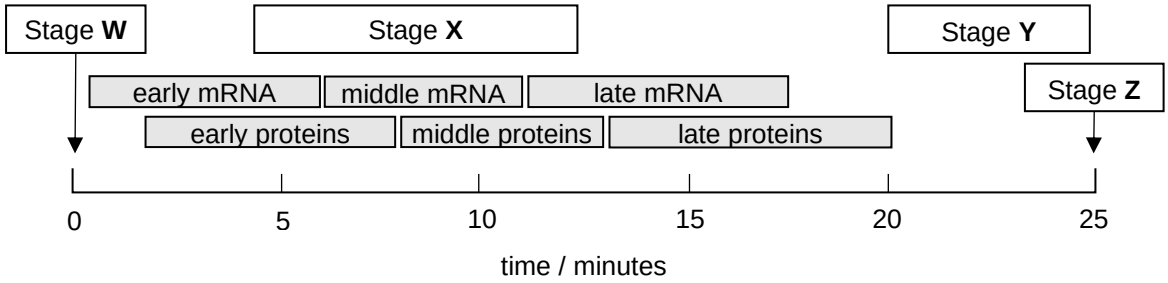
When the mammal is not producing milk, the biochemical pathway can be represented as shown in the diagram below.



Given the above information, which row shows the correct level of regulation and valid conclusion about casein gene expression?

	level of regulation	conclusion about casein production
A	post-transcriptional	Casein protein cannot be produced without the presence of prolactin.
B	post-transcriptional	Casein mRNA is hydrolysed by ribonuclease into its constituent ribonucleotides.
C	translational	The hormone prolactin allows the expression of the casein gene.
D	translational	Ribonuclease prevents casein gene expression by acting as a translational repressor.

16 The diagram below shows the various stages of the reproductive cycle of a T4 bacteriophage, as well as phage mRNA and protein production.



Which statements correctly describe the events that occur in stages **W** to **Z**?

1 During stage **W**, T4 phage tail fibres bind to specific molecules on the bacterial cell wall and the viral genome enters the cell via contraction of the tail sheath.

2 During stage **X**, T4 phage replicates its RNA genome using host cell RNA polymerase.

3 During stage **Y**, structural proteins, such as the capsid head, tail, base plate, and tail fibre proteins, assemble to form mature T4 phages.

4 From 11 to 20 minutes, mRNA coding for enzymes required to liberate the mature phage particles in stage **Z** are synthesised.

A 1 and 3

B 2 and 3

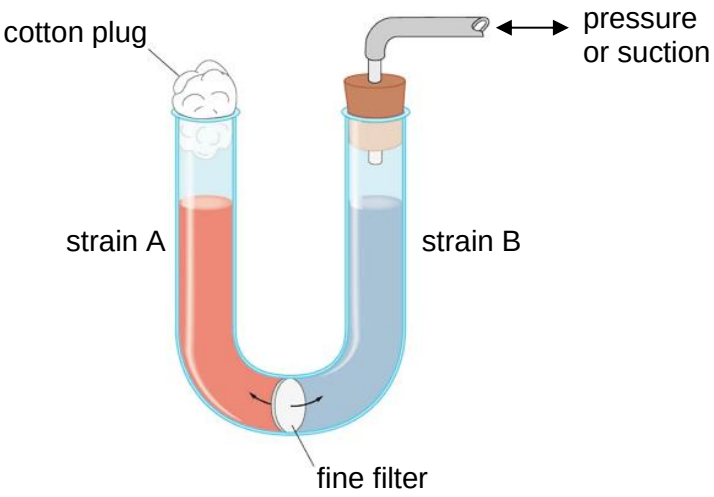
C 1, 2 and 4

D 2, 3 and 4

17 To investigate gene transfer between bacteria, two strains of the same species of nitrogen-fixing bacteria were each placed in one arm of a U-tube with a fine filter separating them. Nitrogen fixing bacteria are capable of converting atmospheric nitrogen, N_2, into ammonia, NH_3, which can then be used for metabolic processes.

The liquid medium may be transferred between the arms of the tube by applying pressure or suction. The fine filter has a pore size of 0.1 µm, and particles that are larger than the filter pore size would not be able to pass through the fine filter. It is known that the sizes of particles that are present in the liquid medium are as such:

type of particle	size / µm
bacteria	1 – 10
bacteriophages	0.025 – 0.2
DNA	0.002



(Question continued on next page)

Strain B has *nif*$^+$, which is a cluster of genes that codes for the ability to fix nitrogen. Strain A has *nif*$^-$, which indicates that the *nif*$^+$ cluster of genes has undergone a loss-of-function mutation.

After several hours of incubation, bacterial cells were taken from the left arm of the tube and plated on minimal medium that lacks a usable source of nitrogen. Growth of colonies was observed.

Which pair of rows correctly identifies and explains the processes responsible for gene transfer between strains A and B?

	processes	explanation
A	binary fission	Newly divided bacteria cells from strain B are small enough to pass through the fine filter and enter the left arm of the tube.
	transduction	A fragment of bacterial DNA containing the *nif*$^+$ gene cluster was packaged into the phage capsid head.
B	conjugation	The sex pili of the donor bacteria cell can pass through the fine filter to pass the *nif*$^+$ gene cluster to the recipient bacteria cell.
	transduction	A fragment of bacterial DNA containing the *nif*$^+$ gene cluster was packaged into the phage capsid head.
C	conjugation	The sex pili of the donor bacteria cell can pass through the fine filter to pass the *nif*$^+$ gene cluster to the recipient bacteria cell.
	transformation	DNA fragments containing the *nif*$^+$ gene cluster can freely pass through the fine filter to the left arm of the tube.
D	transduction	A fragment of bacterial DNA containing the *nif*$^+$ gene cluster was packaged into the phage capsid head.
	transformation	DNA fragments containing the *nif*$^+$ gene cluster can freely pass through the fine filter to the left arm of the tube.

18 Some steps of respiration in yeast cells are shown below.

1 pyruvate → ethanal
2 pyruvate → acetyl-CoA
3 oxaloacetate → citrate
4 citrate → oxaloacetate

Which of the above steps involve **both** decarboxylation and dehydrogenation?

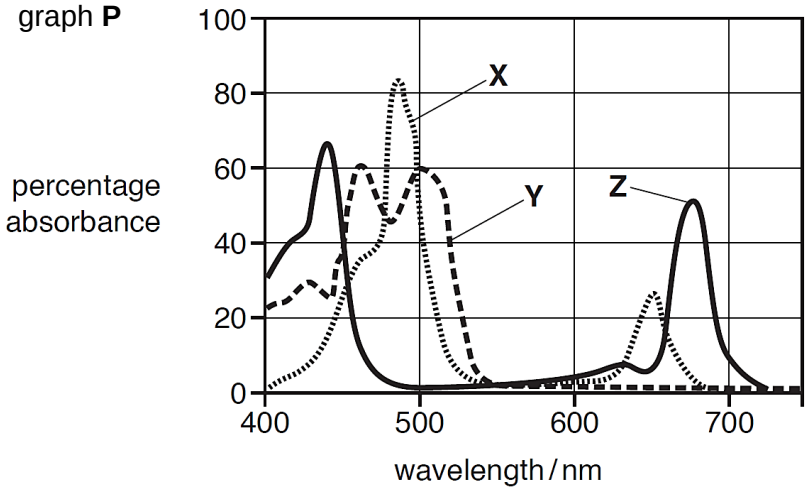
A 1 and 3
B 2 and 4
C 1, 2 and 4
D 2, 3 and 4

19 Visible light has wavelengths from approximately 380 nm (violet light) to 750 nm (red light).

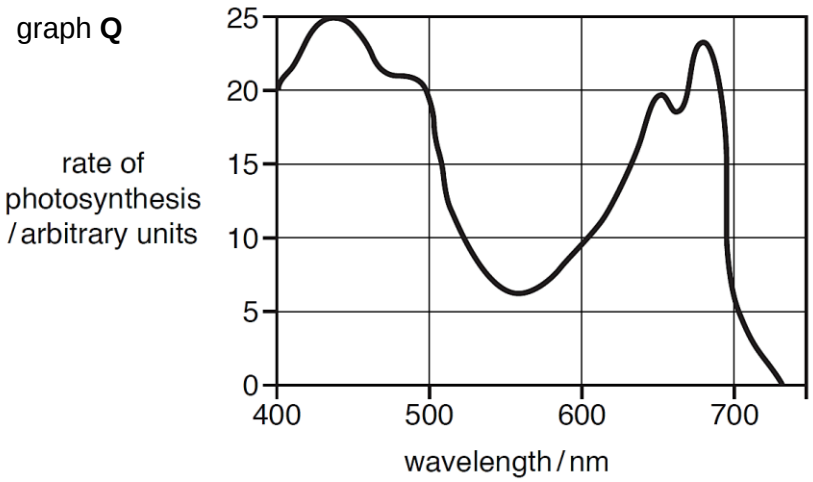
Graph **P** shows the absorption spectra of three types of photosynthetic pigment, **X**, **Y**, and **Z**, which were extracted from the leaves of a flowering plant. **X** is known to be chlorophyll b.

Graph **Q** shows the action spectrum for photosynthesis for the same plant.

graph **P**



graph **Q**



Four students were asked to relate the information shown in graphs **P** and **Q** to their knowledge and understanding of the light-dependent stage of photosynthesis.

Which student's comment is correct?

student	comment
A	The high absorption of blue light by chlorophyll b provides evidence that this is the primary electron donor of photosystem 1.
B	The poor absorption of green light by all three pigment types will provide only enough energy for cyclic photophosphorylation to occur.
C	The presence of pigment **Y** extends the ability of the plant to absorb light in the blue-green part of the spectrum but not the yellow-green part of the spectrum.
D	Cyclic photophosphorylation occurs at a wavelength of 680 nm, indicating that pigment **Z** is more likely to be chlorophyll a than pigment **Y**.

20 In organisms with the same genotype, which of the following would cause phenotypic variation?

1 polygenes
2 continuous variation
3 different environments
4 mutation

A 3 only

B 2 and 3 only

C 1, 2 and 3 only

D 1, 2, 3 and 4

21 Duroc Jersey pigs are typically red, but a sandy variation is also seen. Crossing two different varieties of true-breeding sandy pigs produced F_1 offspring that were red. When these F_1 offspring were crossed with each other, they produced red, sandy and white pigs in a 9:6:1 phenotypic ratio.

Which row correctly shows the possible genotypes for each phenotype?

	red	sandy	white
A	AABB	AAbb	aaBB
B	AaBb	AaBB	aabb
C	Aabb	aaBB	aabb
D	AaBB	Aabb	aabb

22 Eye colour and wing type in *Drosophila* flies are determined by the R/r and N/n gene loci respectively. It is not known if these two genes are on different chromosomes or on the same chromosomes.

Test crossing some F_1 *Drosophila* flies gave the following results:

red eye, normal wing	59
purple eye, vestigial wing	43
red eye, vestigial wing	37
purple eye, normal wing	62

A χ^2 test was performed to test the significance of the difference between the observed and the expected results.

$$\chi^2 = \Sigma\frac{(O-E)^2}{E} \qquad v = c - 1$$

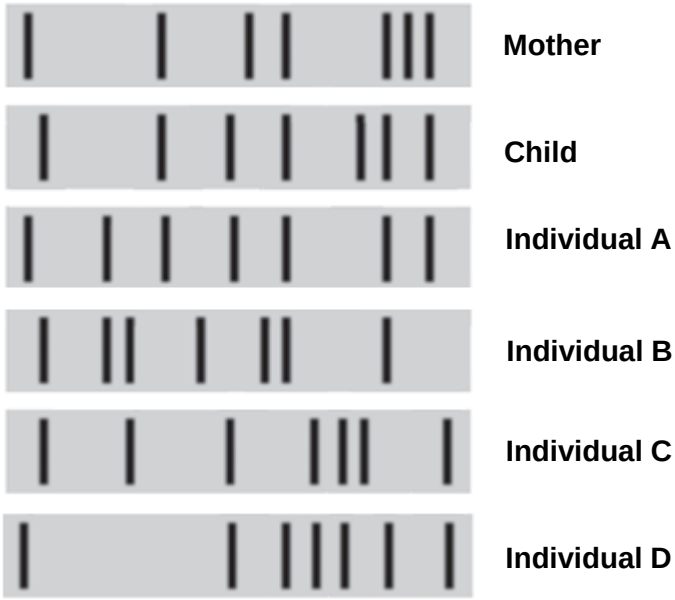
Where Σ = 'sum of…' O = observed 'value'
v = degrees of freedom E = expected 'value'
c = number of classes

degrees of freedom	*probability, p*						
	0.50	*0.20*	*0.10*	*0.05*	*0.02*	*0.01*	*0.001*
1	0.46	1.64	2.71	3.84	5.41	6.64	10.38
2	1.39	3.22	4.61	5.99	7.82	9.21	13.82
3	2.37	4.64	6.25	7.82	9.84	11.35	16.27
4	3.36	5.59	7.78	9.49	11.67	13.28	18.47

Which combination correctly describes the result of the χ^2 test?

	probability	difference between observed and expected results	loci of genes
A	< 0.05	not significant	different chromosomes
B	< 0.05	significant	same chromosomes
C	> 0.05	not significant	different chromosome
D	> 0.05	significant	same chromosome

23 The diagram below shows a DNA profile used to determine fatherhood in a paternity case.



Which individual is most likely to be the child's father?

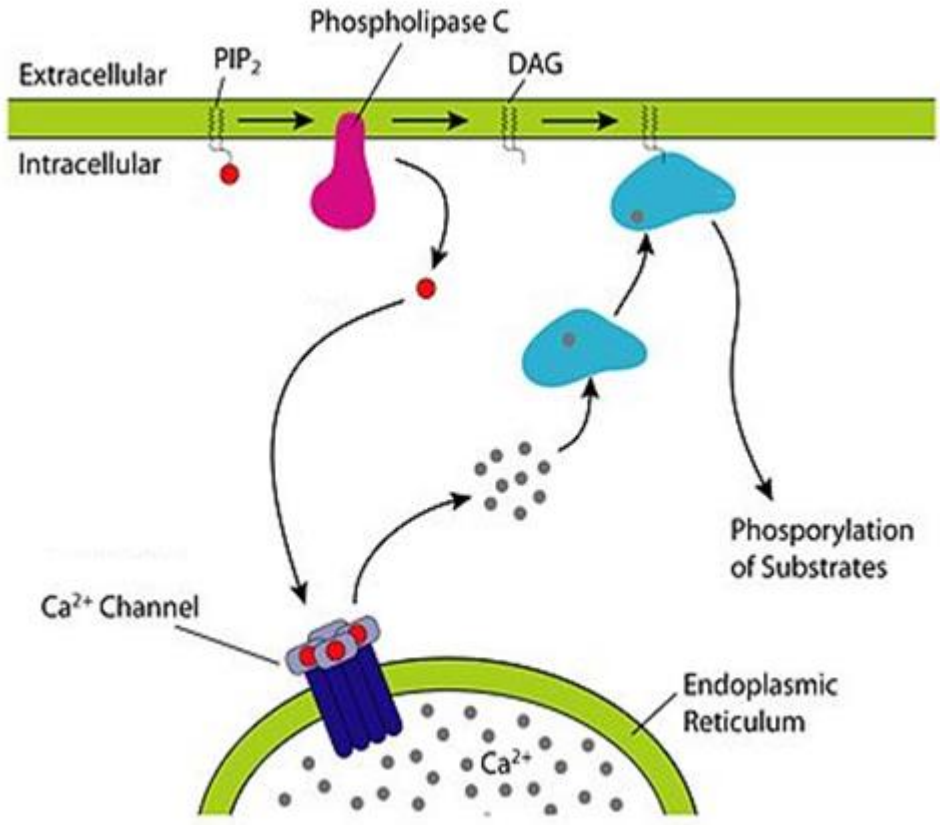
A Individual A
B Individual B
C Individual C
D Individual D

24 Which of the following is/are **not** true about blood stem cells?

1 They can be found in bone marrow.
2 They are unspecialised cells.
3 They are pluripotent.
4 They can be used as a source of undifferentiated cells.

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

25 The figure below shows part of a cell signalling pathway following ligand-receptor interaction.



How many of the following statement(s) is/are correct with regards to the above cell signalling pathway?

- This pathway is initiated after ligand binds to a receptor tyrosine kinase, thereby resulting in phosphorylation occurring during signal transduction.
- Calcium ions are second messengers.
- Phospholipase C, DAG and kinases serve as relay proteins in this pathway.
- The action of phospholipase C results in signal amplification.

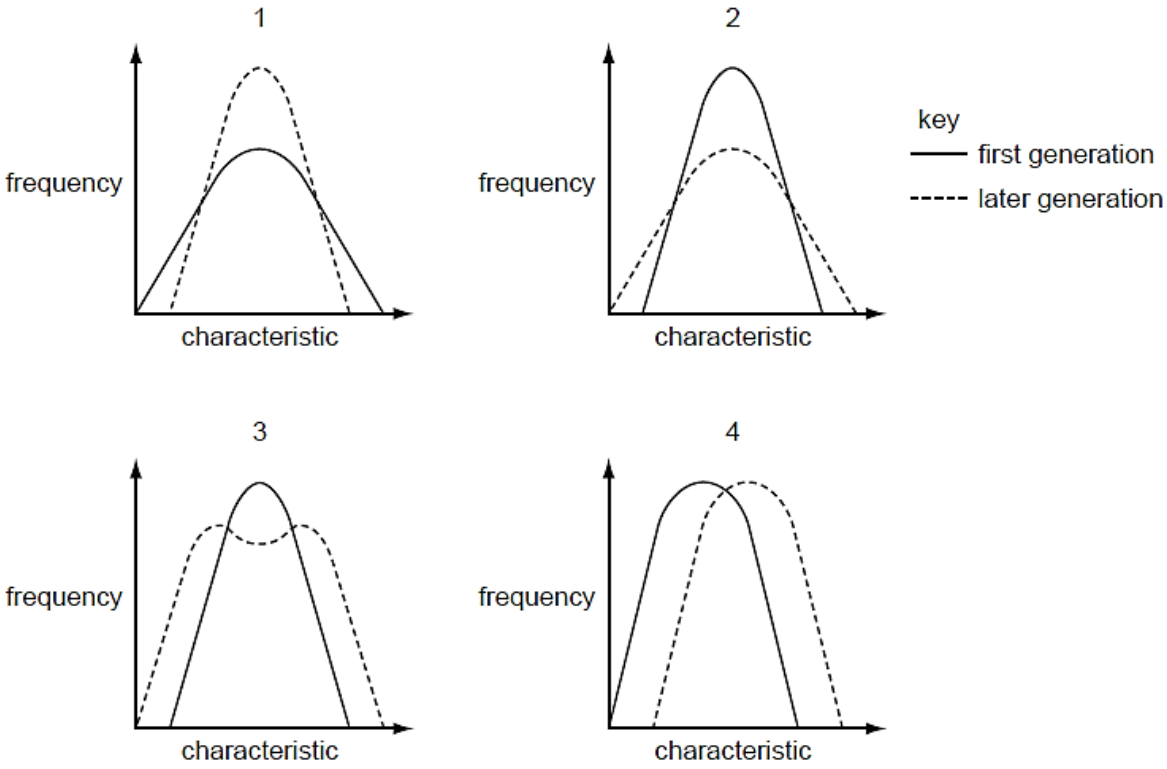
A one

B two

C three

D four

26 The graphs show frequency of individuals against a measured characteristic in the first and a later generation of a species.



Which graph represents the correct type of natural selection?.

	directional	disruptive	stabilising
A	4	3	2
B	2	3	4
C	3	1	2
D	4	3	1

27 Polar bears, *Ursus maritimus*, and giant pandas, *Ailuropoda melanoleuca*, both belong to the family Ursidae.

How many of the following statements is **not** true about the classification of polar bears and giant pandas?

- They each belong to a different class.
- They each belong to a different genus.
- They both belong to the same order, carnivora.
- They both belong to the same phylum, chordata.

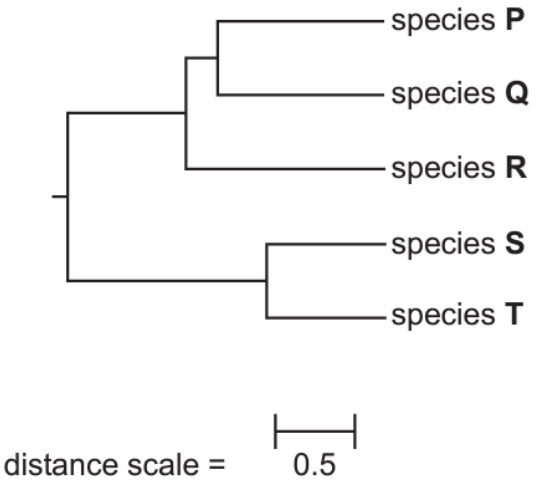
A one

B two

C three

D four

28 A phylogenetic tree for five species is shown below.



The evolutionary distance between two species is calculated as the sum of the lengths of all the horizonal branches between the two species.

What is the estimated evolutionary distance between species **R** and species **T**?

A 2.0

B 4.0

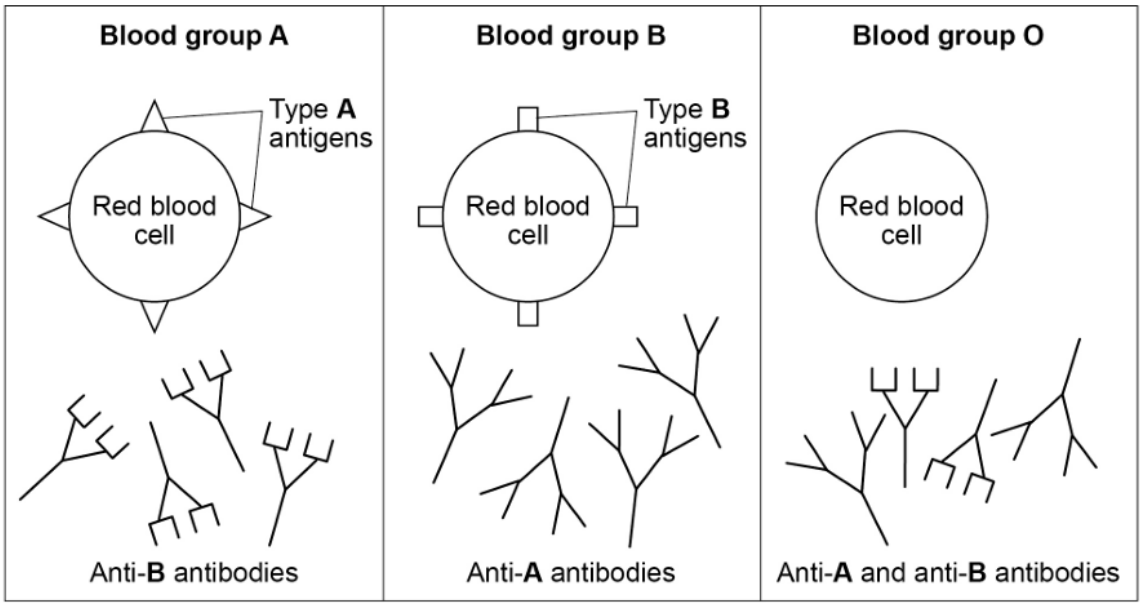
C 8.0

D 16.0

29 A person's blood group is determined by antigens present on the red blood cells. Antibodies in the plasma of the blood recipient can make some blood transfusions unsafe.

The following diagram shows:

- the red blood cells in people with different blood groups
- the antibodies produced by people of different blood groups.



Antibodies can bind to antigens that have complementary shapes. When antibodies bind to the antigens on the red blood cells, many red blood cells begin to clump together.

Based on the above information, which deduction is correct?

A Anti-A antibodies will cause the red blood cells from a person with blood group B to clump together.

B Anti-B antibodies from a person with blood type B will cause the red blood cells from a person with blood group O to clump together.

C Anti-A and anti-B antibodies will cause the red blood cells from a person with blood group AB to clump together.

D Person with blood group AB has anti-A and anti-B antibodies.

30 Which of the following sequence of events brought about by global warming is correct?

A growing of crops → burning of trees to clear land → increased methane production → global warming

B global warming → melting of permafrost → emergence of deadly diseases → possibility of increased mortality

C global warming → metabolism of insects in the tropics increases → size of insects increases → amount of pesticides required to kill insect pests increases

D global warming → calcium carbonate uptake by corals increases → coral bleaching → disruption of food web in ocean

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