NATIONAL JUNIOR COLLEGE, SINGAPORE
Senior High 2
Preliminary Examination
Higher 2

CANDIDATE NAME			
BIOLOGY CLASS	2bi2_____	REGISTRATION NUMBER	

Biology 9744/01

Paper 1: Multiple Choice Questions **15 September 2023**

Additional Materials: Multiple Choice Answer Sheet **1 hour**

READ THESE INSTRUCTIONS FIRST

Write your name, Biology class and registration number on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

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.

Your five-digit OAS index number is made up of the **second** and **last four digits** of your registration number.

For example:

Registration no.	OAS Index no.
2**2**05**123**	**25123**

This document consists of **23** printed pages and **1** blank page.

1 Which statement is true?

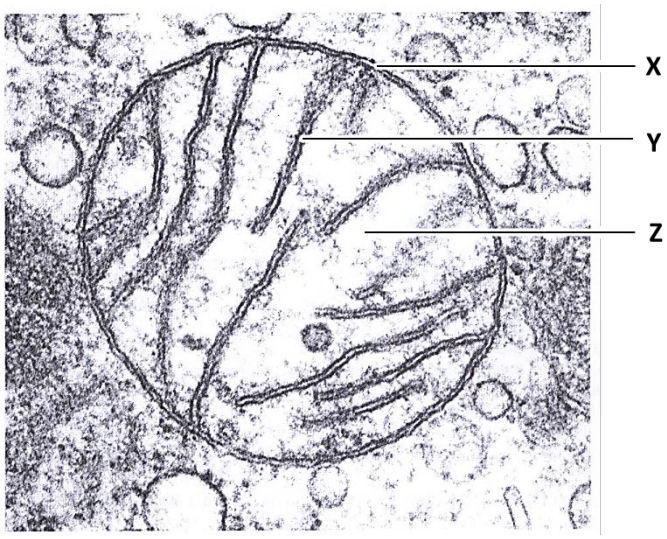
A Centrioles and vesicles can be seen under a light microscope.

B Hydrolytic enzymes are mainly found in lysosomes for both animal and plant cells.

C Mitochondria share the same 80S ribosome as the prokaryotic cell.

D Vesicles from the smooth endoplasmic reticulum carry lipids to the Golgi apparatus for modification.

2 The electron micrograph below shows an organelle.



Which of the following statements are true?

1 X is made up of a phospholipid bilayer and it is selectively permeable to substances.
2 X serves to compartmentalise the organelle from the extracellular environment.
3 Y has embedded ATP synthase that synthesises ATP.
4 Y has embedded photosystems that are involved in the absorption of light.
5 Z contains DNA that has histones that help to package DNA present in the organelle.
6 Z contains enzymes that oxidises glucose to pyruvate.

A 1, 2 and 3

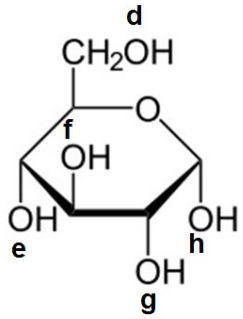
B 1 and 3

C 2, 4 and 6

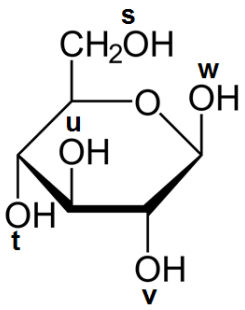
D 5 and 6

3 The diagram shows two isomers of a hexose labelled I and II.

Four possible bonding positions are labelled d, e, f, g and h on one isomer, and s, t, u, v and w on another isomer.



isomer I



isomer II

Which isomer and bonding positions are involved in the formation of glycogen?

	isomer	bonding positions
A	isomer I	d-g and d-h
B	isomer I	e-h and d-h
C	isomer II	s-v and s-w
D	isomer II	t-w and s-w

4 Which of the following statement(s) is / are true?

1 Formation of a peptide bond involves a reaction between an amino group and a carboxyl group.

2 In a neutral solution, most amino acids exists as positively charged compounds.

3 The secondary structure of a polypeptide chain is formed as a result of hydrogen bonds formed between the R-groups.

4 The primary structure of a protein will most likely be preserved when a protein is denatured.

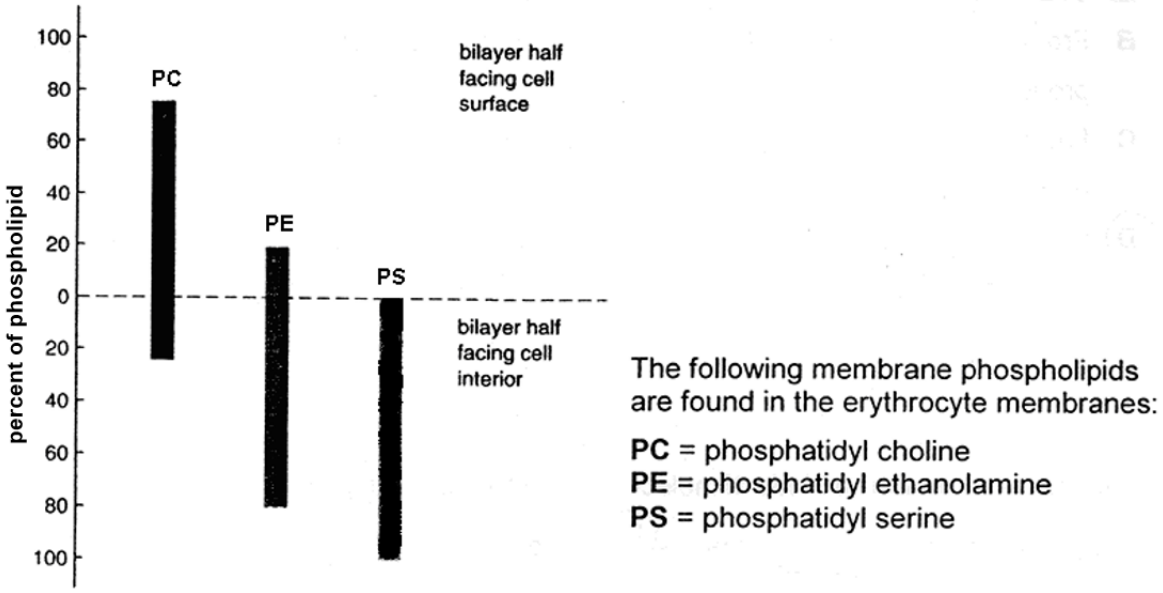
A 1 and 4 only

B 1 only

C 2 only

D 3 and 4 only

5 The diagram illustrates the types of membrane phospholipids found in the intact erythrocytes (red blood cells).



Which of the following statements can be concluded from the graph?

1 76% of the total membrane phospholipids contain choline and 20% contain ethanolamine.

2 24% of PC and 80% of PE are confined to the inner surface of the erythrocytes.

3 Most PC is confined to the outer surface of the erythrocytes while most of the PE are confined to the inner surface of the erythrocytes.

4 Membranes in most cell types can be concluded to be asymmetric.

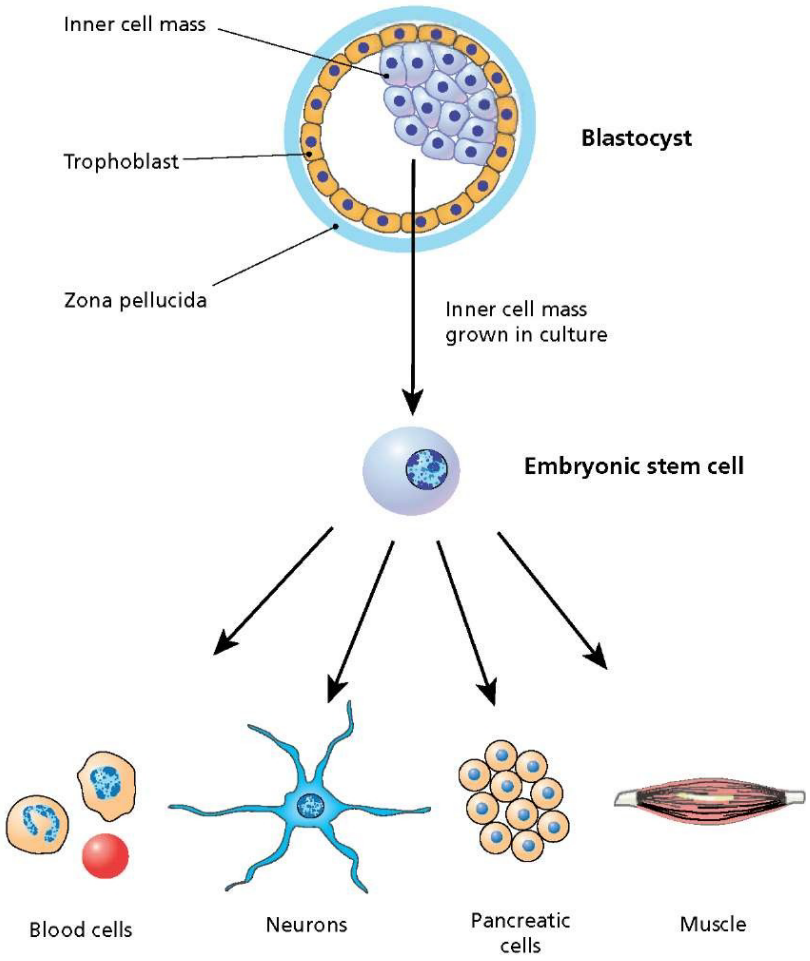
A 1 and 2 only

B 1 and 3 only

C 2 and 3 only

D 2 and 4 only

6 The diagram illustrates various features of embryonic stem cells and specialised cells.



Which row correctly describes the features of embryonic stem cells and specialised cells?

	embryonic stem cells	specialised cells
A	Embryonic stem cells are multipotent and are capable of differentiating into limited range of cell types.	The blood cells are genetically different from the embryonic stem cells because different genes are expressed.
B	Embryonic stem cells are pluripotent and are capable of differentiating into many different cell types.	The pancreatic cells are genetically identical to the embryonic stem cells but have shorter telomeres.
C	Embryonic stem cells are totipotent and are capable of differentiating into many different cell types.	The pancreatic cells are genetically identical to the embryonic stem cells but with a different set of genes expressed.
D	Embryonic stem cells display greater potential to differentiate when grown in culture than when in blastocyst.	The muscle cells are genetically different from the embryonic stem cells but have shorter telomeres.

7 How many different polypeptides, each consisting of r amino acids, can be made if there are n different amino acids?

A n

B n^r

C nr

D r^n

8 CFTR is a transmembrane regulator protein. It is made up of 1480 amino acids.

People with cystic fibrosis produce a defective CFTR protein which is missing one amino acid from its structure. A normal CFTR protein molecule has sugar molecules attached to it which make it functional.

Which of the following statements are true?

1 4440 is the number of bases on the template DNA which code for the amino acid sequence of a normal CFTR protein.

2 Cystic fibrosis is due to a chromosomal mutation known as a deletion.

3 The defective CFTR is not functional as the mutation in the DNA resulted in changes in its tertiary structure.

4 The functional CFTR is a protein that undergone glycosylation.

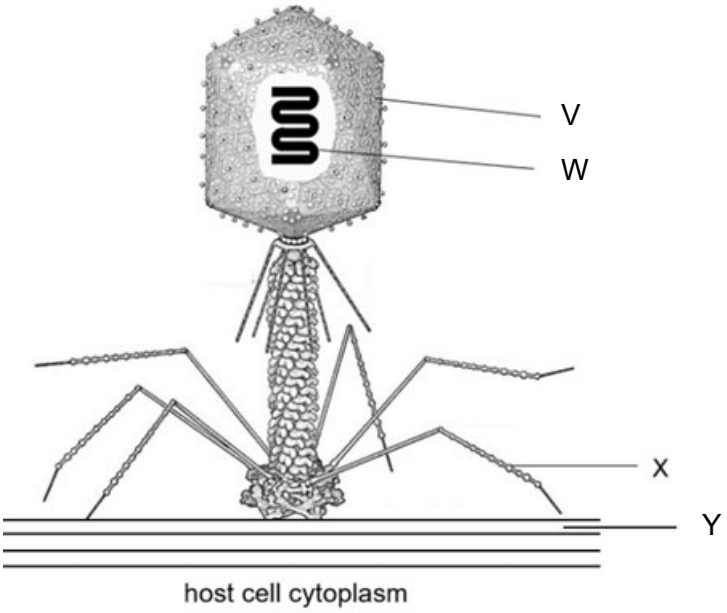
A 1, 3 and 4 only

B 1 and 3 only

C 1 and 4 only

D 2, 3 and 4 only

9 The diagram shows a T4 bacteriophage attaching to its host cell.



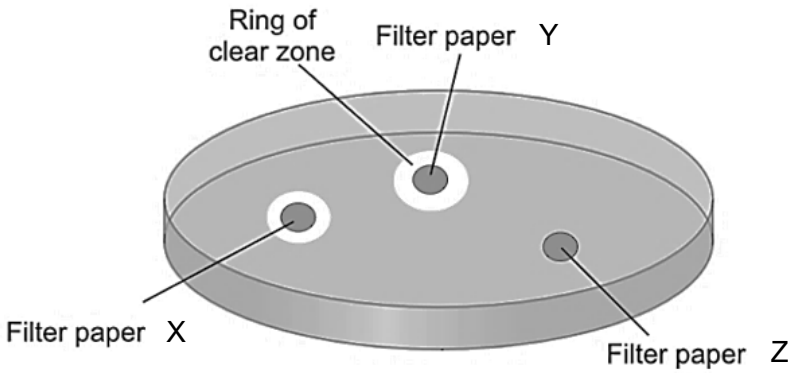
Which combination correctly identifies the constituents of the lettered components?

	V	W	X	Y
A	amino acids	DNA nucleotides	amino acids	peptidoglycan
B	amino acids	RNA nucleotides	lipids	lipids
C	lipids	DNA nucleotides	amino acids	lipids
D	lipids	RNA nucleotides	lipids	peptidoglycan

10 An experiment was carried out to investigate the effect of bacteriophages and antibiotics on *Escherichia coli.*

Two strains of *E. coli* were used where one of the strains was resistant to antibiotics. Three discs of filter papers were soaked with either temperate phages, virulent phages or antibiotics and placed on an agar plate spread with one strain of *E. coli*.

The plate was then incubated at 37°C for 10 hours and rings of clear zones were observed. The diagram below shows the results.



The same experiment was repeated on a second agar plate containing the other strain of *E. coli* and there was only one ring of clear zone around filter paper Y.

Which explanation could be deduced from the experiment?

A Filter paper X was soaked in antibiotics but the strain of *E. coli* used in the second plate was resistant to antibiotics, resulting in no clear zone around filter paper X.

B Filter paper X was soaked with phages that did not initiate an immediate lysis of *E. coli* cells, resulting in a smaller clear zone around filter paper X than filter paper Y.

C Filter paper Y was soaked with phages that could integrate its genome into dividing *E. coli* cells, resulting in a larger clear zone around filter paper Y than filter paper X.

D Filter paper Z was soaked in antibiotics, resulting in the absence of a clear zone.

11 Which statement correctly describes conjugation?

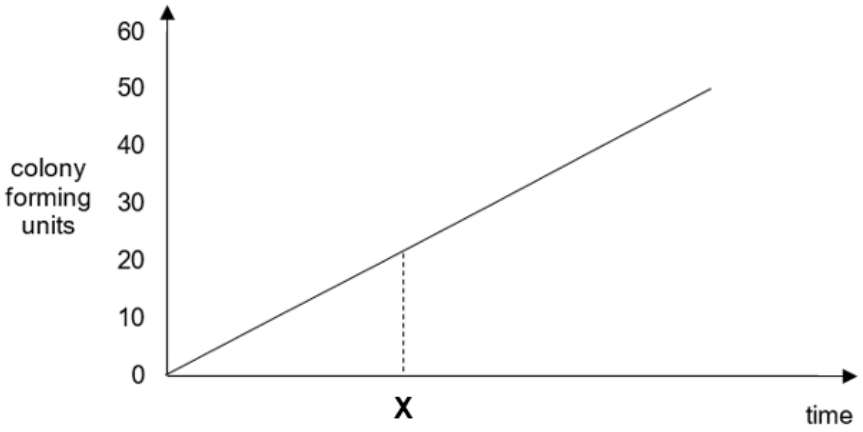
A Both donor and recipient bacteria will be genetically identical at the end of conjugation.

B Both strands of F plasmid are transferred from one bacterium to another.

C Conjugation combines DNA from two bacterial cells into the genome of one.

D Lysis of bacteria cells does not occur.

12 The graph shows the total number of colony forming units in a mutant strain of bacteria. It was initially grown in the presence of glucose and when glucose was depleted, it was then supplied with lactose at X.



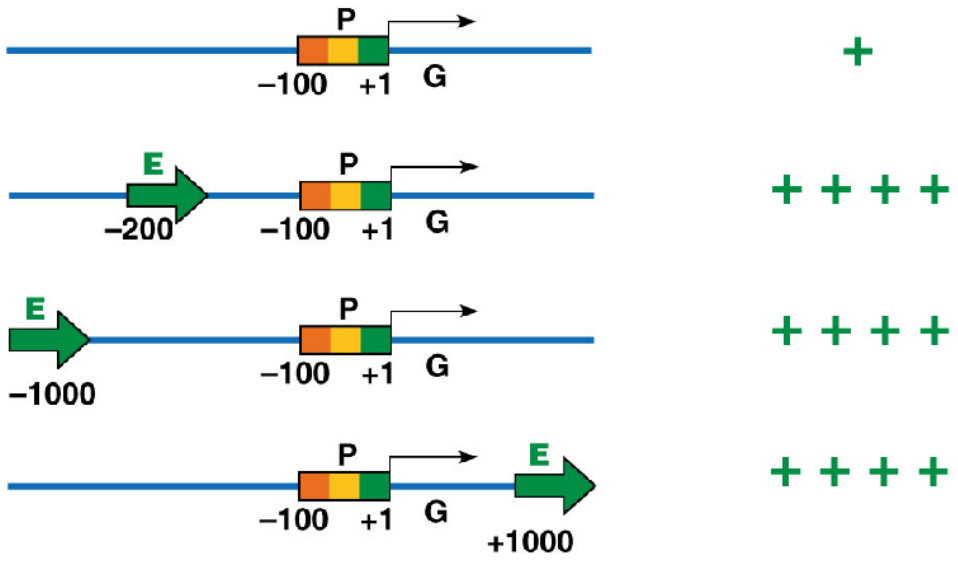
Which row correctly describes this mutant strain of bacteria?

key:
+ normal
– mutant

	lacI	*lac* promoter	*lac* operator	*lacZ*	*lacY*	*lacA*
A	**–**	**+**	**+**	**+**	**+**	**+**
B	**+**	**–**	**+**	**+**	**–**	**–**
C	**–**	**+**	**+**	**–**	**+**	**+**
D	**+**	**–**	**–**	**–**	**+**	**+**

13 A transcription unit is a sequence of DNA that codes for single RNA molecule along with the regulatory sequences necessary for its transcription.

The diagram shows various transcription units and corresponding relative levels of transcription. The promoter, enhancer and coding sequences are represented by letters P, E and G respectively. The number of symbol '+' indicates the relative level of transcription.



With reference to the diagram, which statement is a valid conclusion?

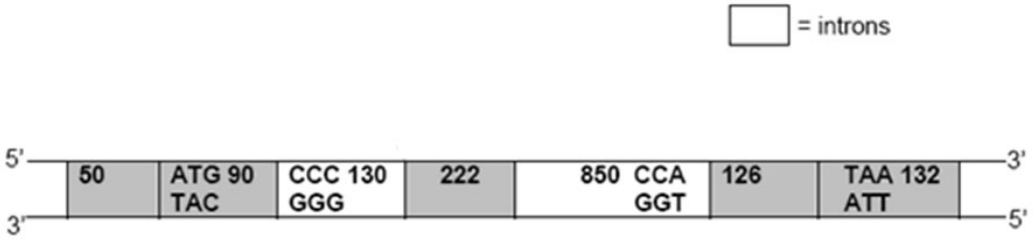
A An enhancer is required for transcription.

B The frequency of transcription is increased when the enhancer is located upstream of the promoter.

C The orientation of the enhancer does not affect the frequency of transcription.

D The relative distance between promoter and enhancer has no effect on the frequency of transcription.

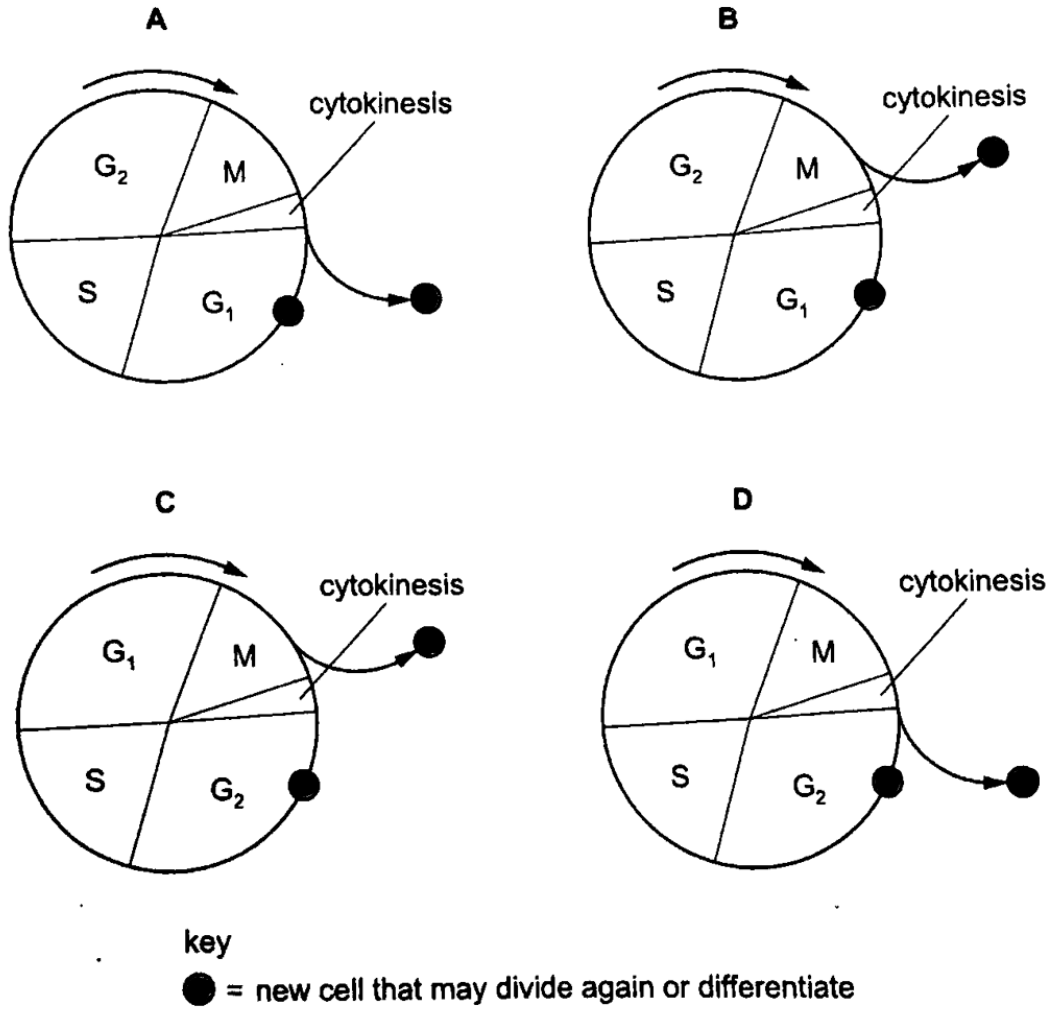
14 The diagram shows the sequence of a human gene. The numbers within the boxes indicate the length of nucleotide base pairs of each region, inclusive of the bases stated in the diagram. The DNA sequences corresponding to the start codon and the stop codon are also indicated.



What is the length (in nucleotide base pairs) of the pre-mRNA and how many amino acids are present in the encoded protein?

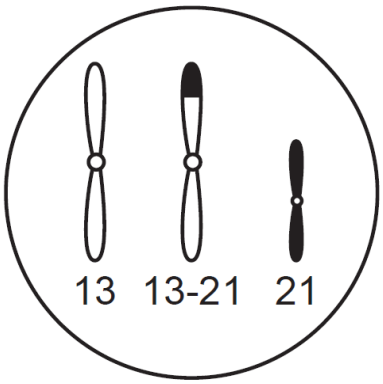
	length of pre-mRNA	number of amino acids in protein
A	620	146
B	620	206
C	1600	146
D	1600	206

15 Which diagram correctly represents the mitotic cell cycle?



16 Down syndrome can be caused by a trisomy of chromosome 21, but can also result from translocation of chromosome 21 onto chromosome 13, forming a single chromosome 13-21.

The diagram shows chromosomes 13 and 21 in the nucleus of a diploid (2n) testis cell from a phenotypically normal male carrier of a 13-21 translocation. This cell has a chromosome number of 45.



Which is not a likely outcome of fertilisation of normal oocytes by sperm from this male?

	chromosomes in sperm	embryo
A	13-21	2n = 45 normal phenotype
B	13 and 21	2n = 46 normal phenotype
C	13-21 and 21	2n = 46 Down syndrome
D	13-21 and 21	2n = 47 Down syndrome

17 A bacterium produces a normal protein with the following amino acid sequence:

Met – Val – His – Lys – Arg – Thr – Leu - Val

After irradiation, a mutant strain is produced that synthesises a mutant protein from the same coding region on DNA with the following sequence:

Met – Val – His – Lys – Glu – Pro

The mRNA codons for some amino acids are shown as follows:

Arg	Glu	Leu	Pro	Thr	Val
AGA	GAA GAG	UUA	CCU CCC	ACC ACG ACA	GUU GUA GUG

Which of the following mutations have occurred in the template DNA strand encoding the protein?

A Deletion of T at the 13th nucleotide position.

B Insertion of C at the 13th nucleotide position.

C Substitution of A by T with the 20th nucleotide position.

D Substitution of T with A at the 13th nucleotide position.

18 Which of the following statements about cancer is / are true?

1 Cancer is a result of increased cell division which promotes the mutation of a proto-oncogene.

2 Individuals who inherit one inactive copy of tumour suppressor gene are more likely to develop cancer than individuals with two non-mutant copies.

3 Mutagenic activation of a single oncogene is sufficient to convert a normal cell into a cancer cell.

A 1, 2 and 3

B 1 and 3 only

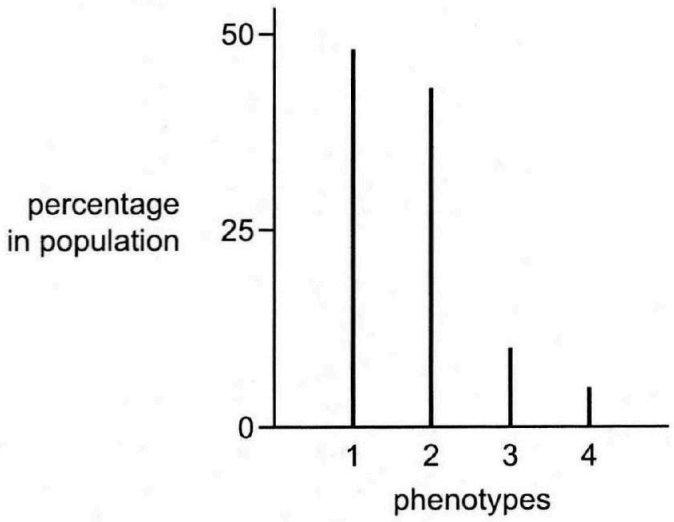
C 2 and 3 only

D 2 only

19 Which row correctly identifies a similarity and difference between primers used in PCR and probes used in Southern blotting?

	similarity	difference
A	Both are complementary to a DNA sequence of interest.	Primers used in PCR are RNA while probes used in Southern blotting are DNA.
B	Both are composed of a short sequence of single stranded DNA.	Probes used in Southern blotting are radioactively labelled while primers used in PCR are not.
C	Both are radioactively labelled to identify a DNA sequence of interest.	Two different primer sequences are required for PCR while only one probe sequence is needed for Southern blotting.
D	Both bind to a DNA sequence of interest by phosphodiester bonds.	Probes used in Southern blotting are longer than primers for PCR.

20 The graph shows the frequencies with which different phenotypes of a particular characteristic occur within a population.



Which description about the type of variation is correct?

A continuous, with many genes each with small effect

B continuous, with one or few genes each with large effect

C discontinuous, with many genes each with small effect

D discontinuous, with one or few genes each with large effect

21 Pure-breeding red-eyed flies, CCBB were crossed with pure-breeding cinnabar-eyed flies, ccbb. The test cross of F_1 generation gave 32 red-eyed, 18 brown-eyed and 50 cinnabar-eyed flies. 36 of the cinnabar-eyed offspring in the test cross generation were pure-breeding.

A chi-squared test was used to compare the observed results of the test cross with the expected numbers based on Mendelian principles.

The formula for chi-square is:

$$\chi^2 = \sum \frac{(O-E)^2}{E}$$

A chi-squared table is provided.

degrees of freedom	probability (p)
	0.05
1	3.84
2	5.99
3	7.81

number of degrees of freedom = number of classes – 1

Which conclusion correctly explains the chi-squared test results?

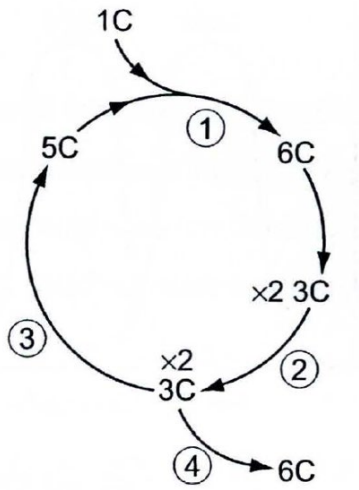
A The calculated χ^2 is 3.92 and the deviation from the expected ratio is not significant at 0.05 probability. Any difference is due to chance.

B The calculated χ^2 is 3.92 and the deviation from the expected ratio is significant at 0.05 probability. The difference is not due to chance.

C The calculated χ^2 is 13.6 and the deviation from the expected ratio is not significant at 0.05 probability. Any difference is due to chance.

D The calculated χ^2 is 13.6 and the deviation from the expected ratio is significant at 0.05 probability. The difference is not due to chance.

22 The diagram shows some phases of the Calvin cycle and the numbers of carbon atoms in the compounds involved.



Which reactions occur at phases 1 to 4?

A

phase 1	RuBP + CO_2
phase 2	ATP → ADP + P_i NADP → reduced NADP
phase 3	ATP → ADP + RuBP
phase 4	triose → hexose

B

phase 1	triose → hexose
phase 2	ADP + P_i → ATP NADP → reduced NADP
phase 3	ADP + RuBP → ATP
phase 4	glycerate 3-phosphate → triose

C

phase 1	triose → hexose
phase 2	ADP + P_i → ATP reduced NADP → NADP
phase 3	ADP + RuBP → ATP
phase 4	glycerate 3-phosphate → triose

D

phase 1	RuBP + CO_2
phase 2	ATP → ADP + P_i reduced NADP → NADP
phase 3	ATP → ADP + RuBP
phase 4	triose → hexose

23 Rotene and oligomycin are two metabolic poisons which affect cellular respiration. The effects of rotene and oligomycin on aerobic respiration are summarised in the table.

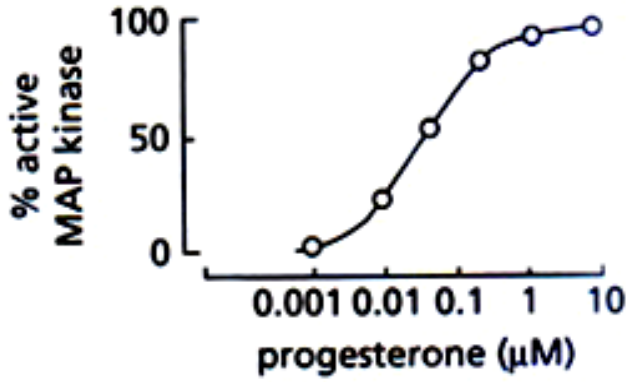
	ability to use glucose	ability to use oxygen	ATP yield
rotene	yes	no	decreases
oligomycin	yes	yes	decreases

Which row correctly identifies the specific functions of the two metabolic poisons?

	rotene	oligomycin
A	dissipates proton gradient	inhibits ATP synthase
B	electron transport inhibitor	inhibits ATP synthase
C	inhibits ATP synthase	dissipates proton gradient
D	inhibits ATP synthase	electron transport inhibitor

24 Maturation of frog oocytes (fertilised eggs) results from a series of cell signalling events triggered by the hormone progesterone. Progesterone is able to enter the oocytes and directly stimulates the translation of the mRNA encoding MOS protein which sets off a downstream signalling cascade leading to the activation of an enzyme called MAP kinase. MAP kinase stimulates oocyte maturation.

In an investigation, frog oocytes were placed in petri dishes and treated with different concentrations of progesterone. The percentage active MAP kinase was measured by the proportion of oocytes that have matured. The results are shown in the graph.



Which conclusions could be deduced from the information provided?

1 Progesterone is a lipid-soluble hormone.

2 The maturation of frog oocytes involves phosphorylation.

3 The rate of oocyte maturation is highest at 0.1 μM progesterone.

4 MOS is a second messenger.

5 Signal transduction is multistep.

A 1, 2 and 5 only

B 1 and 4 only

C 2 and 5 only

D 3 and 4 only

25 The huia, *Heteralocha acutirostris*, was found only in New Zealand until 1907, when it became extinct. This bird had a ground-feeding habit and was particularly noted for large, attractive tail feathers. Males and females had very different beak forms, with the males having a short strong beak, whilst the females had a long-curved beak to reach into otherwise inaccessible places.

What is the most likely reason for the extinction of the huia?

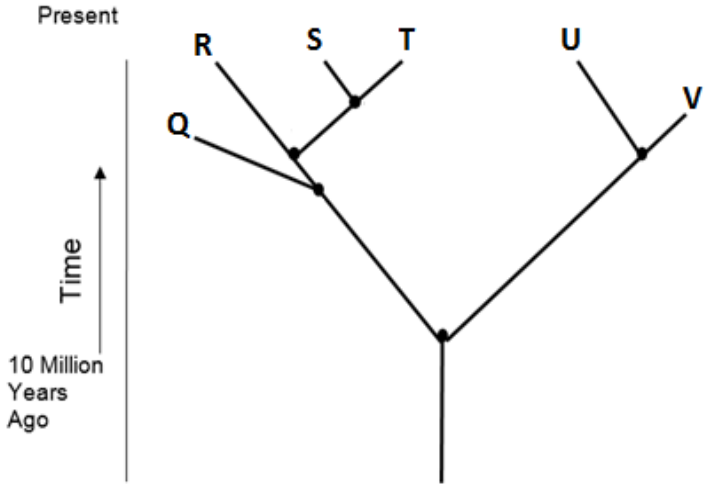
A Male and female huia have different beak forms.

B Males are unable to obtain sufficient food due to their short beak forms.

C New competitors in New Zealand occupied part of the huia's niche.

D The huia evolved into a tree-living species.

26 The diagram below shows a phylogenetic tree.



Which of the following statements can be concluded from this phylogenetic tree?

1 V and Q are extinct.

2 R and Q are more closely related than U and V.

3 R share more homologous structures with S than Q.

4 Q share unique characteristics with R that are absent in S and T.

A 1, 2, 3 and 4

B 1, 2 and 3 only

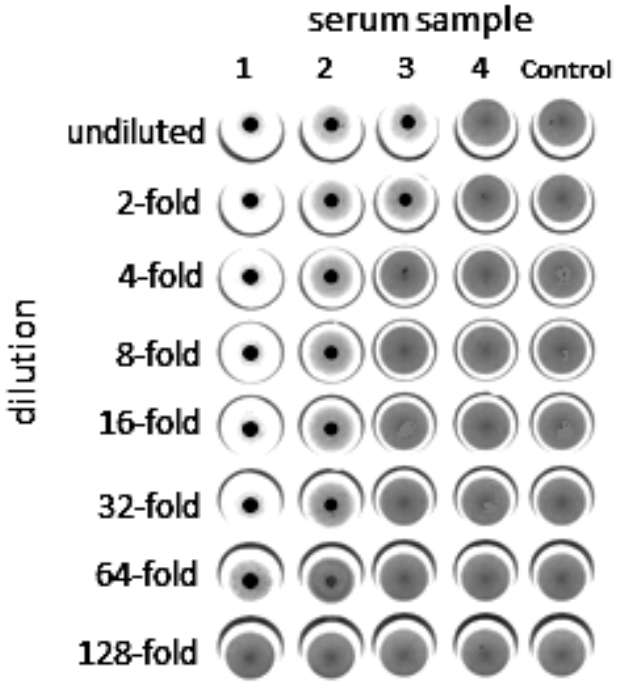
C 1 and 3 only

D 2 and 4 only

27 The effectiveness of a vaccine is measured by the concentration of antibodies produced that can bind to specific antigens in the vaccine.

Blood from an individual is taken at different times after vaccination and the blood serum containing antibodies is extracted. The serum is then subjected to a serial dilution where the concentration is halved with each step of the dilution. Each diluted blood serum is added to a well containing a fixed concentration of antigens. At a sufficiently high antibody concentration, a visible dark spot is formed due to a high level of antigen-antibody agglutination.

The diagram shows the results of an investigation on the effectiveness of the first dose of the vaccine and the second dose given after six months. Four serum samples were taken at different time points.



Which serum samples correspond to the different time points after the first dose and the second dose were given?

	two days after first dose is given	immediately before second dose is given	two days after second dose is given	six months after second dose is given
A	1	2	4	3
B	1	4	2	3
C	4	2	3	1
D	4	3	1	2

28 Which of the following statement(s) describe(s) both B lymphocytes and T lymphocytes?

1 They contain specific protein receptors in their cell surface membranes.

2 They differentiate into antibody-secreting cells.

3 They divide by mitosis.

4 They secrete cytokines.

A 1, 3 and 4 only

B 1 only

C 2 and 3 only

D 3 and 4 only

29 Which statement about dengue disease is true?

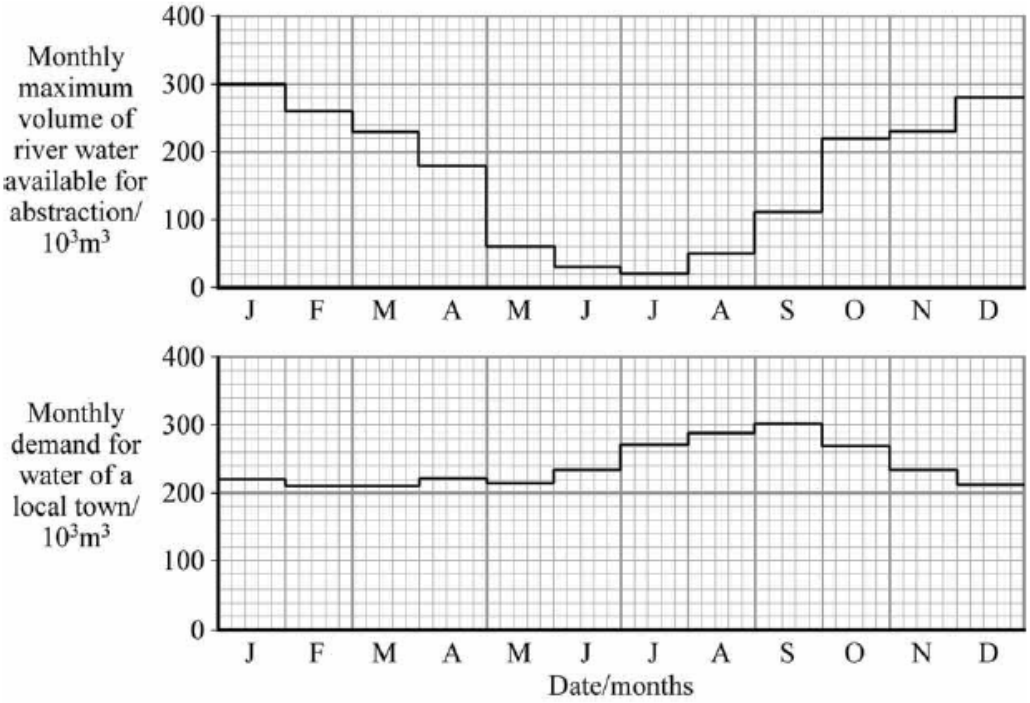
A Due to global warming, there is an increase in vector types beyond mosquitoes that can contribute to the spread of dengue.

B Increase in temperatures can increase metabolism of the vector, thus leading to longer incubation periods.

C People who are exposed to a different dengue serotype a second time will not have an increased risk of dengue shock syndrome compared with those who were not previously exposed.

D The dengue virus develops resistance to drug rapidly due to the lack of RNA polymerase proof reading activity.

30 A small town depends on a river for water supply. The graph shows the projected water availability from the river and the demand for water in the town. The winter months are from July to September and the summer months are from January to April.



Which statement is not true?

A Climate change can increase the water stress on the town by causing the mountain ice caps to melt more rapidly during December and January.

B The decrease in the volume of river water leads to a corresponding increase in the demand for water within the same month.

C The demand for water will be higher in winter than in summer.

D The increase in temperature can result in rainfall to replace snowfall during winter, thus the town will suffer from low water supplies by summer's end.

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