

NAME: _____ CLASS: _____ INDEX: _____



CATHOLIC JUNIOR COLLEGE

JC2 PRELIMINARY EXAMINATIONS

Higher 1

SUGGETED ANSWERS

BIOLOGY

8876/01

18 September 2023

1 hour

Additional Materials: Answer Sheet (Multiple Choice Optical Mark Sheet)

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your **name (as per NRIC)**, **class**, and **index number** on this booklet.

Write and shade your **name (as per NRIC)**, **NRIC / FIN number** and **class** on the Answer Sheet (Multiple Choice Optical Mark Sheet) in the spaces provided.

There are **30 multiple choice questions** in 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 shade your choice in **soft pencil** on the Answer Sheet (Multiple Choice Optical Mark Sheet).

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

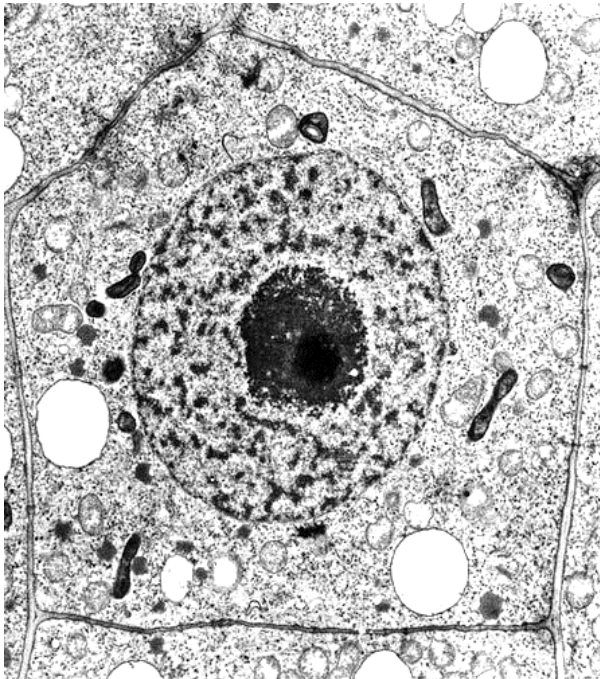
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **28** printed pages and **0** blank page.

[Turn over

Answer **all** questions.

- 1 The diagram shows two electron micrographs of cells.



F



G

Which organelles are visible in each of the cells **F** and **G**?

	cell	chloroplasts	nucleolus	nucleus
A	F	X	✓	X
	G	✓	✓	✓
B	F	X	✓	✓
	G	✓	X	✓
C	F	✓	✓	X
	G	✓	X	✓
D	F	X	X	✓
	G	✓	✓	✓

Key: ✓ = visible
 X = not visible

ANS: B

- 2 Different chemical processes occur in different organelles in a plant cell.

<i>chloroplast</i>	<i>mitochondrion</i>	<i>ribosome</i>
phosphorylation	oxidation	translation
polymerization	transcription	replication
transcription	reduction	polymerization
translation	phosphorylation	transcription

How many rows in the table correctly show processes that occur in these three organelles?

A 1

B 2

C 3

D 4

ANS: B

- 3 Three types of glycosidic bonds that occur between the carbon atoms of monosaccharides to form different polysaccharides are listed.

1, 2 (carbon 1 to carbon 2)

1, 4 (carbon 1 to carbon 4)

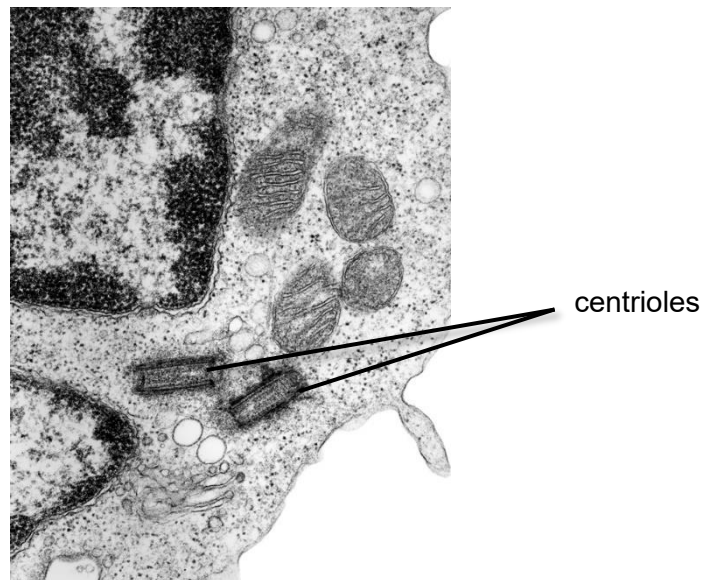
1, 6 (carbon 1 to carbon 6)

Which row identifies the glycosidic bonds found in each of the molecules shown?

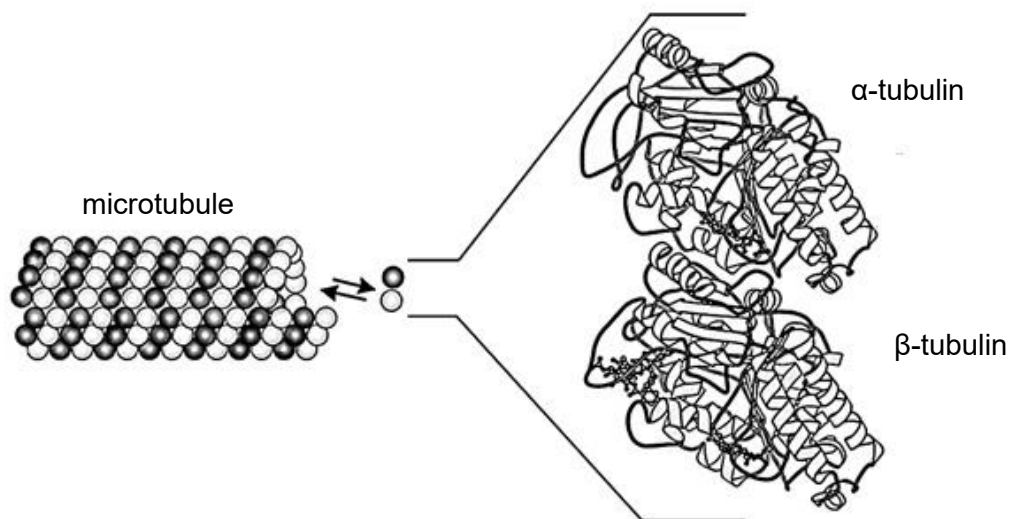
	amylose	amylopectin	cellulose	glycogen
A	1,4	1,2 and 1,6	1,6	1,4 and 1,6
B	1,4	1,4 and 1,6	1,4	1,4 and 1,6
C	1,4 and 1,6	1,4 and 1,6	1,4	1,2 and 1,6
D	1,6	1,4	1,6	1,2 and 1,6

ANS: B

- 4 The figure below is an electron micrograph of a pair of barrel-shaped centrioles that play an important role in organising microtubules that serve as the cell's skeletal system. They help determine the locations of the nucleus and other organelles within the cell.



Microtubules are assembled from a heterodimeric protein called tubulin, as shown in the diagram below.



Which of the following explains why tubulin is considered a polymer as well as a monomer?

	why tubulin is a polymer	why tubulin is a monomer
A	It is a macromolecule.	It is a quaternary protein.
B	It is the building block of microtubule.	It is made up of many amino acids.
C	It is made up of many amino acids.	It is the building block of microtubule.
D	It has many α -helices and β -pleated sheets.	It is made up of two different subunits.

ANS: C

5

- 5 One way of representing fatty acid chains is **C_x : y**, where **C_x** is the number of carbon atoms and **y** is the number of double bonds.

The table shows the percentage mass of eight different fatty acid chains in four cell membranes, **1**, **2**, **3** and **4**.

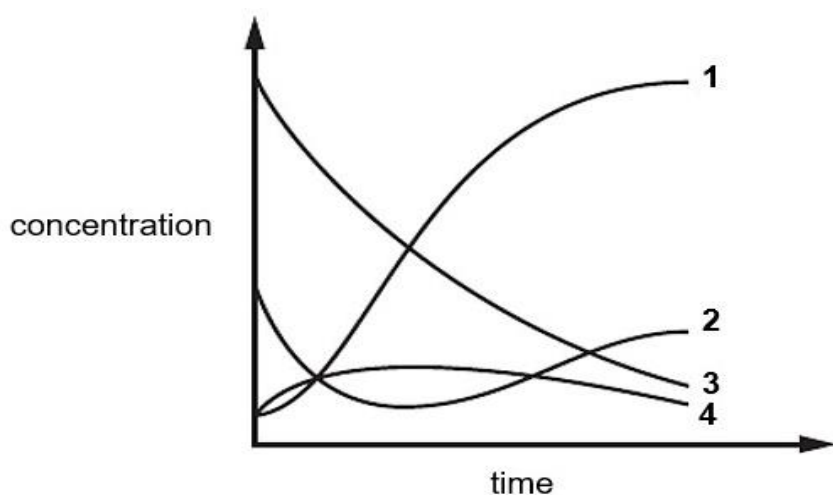
Cell Membrane	percentage mass of each fatty acid chain							
	C10 : 0	C12 : 0	C14 : 0	C16 : 0	C18 : 0	C18 : 1	C18 : 2	C18 : 3
1	1	2	2	21	35	29	2	1
2			2	23	19	45	3	1
3		2	3	23	21	43	4	
4	1	2	4	22	2	52	11	1

Which of the following about the four cell membranes (**1**, **2**, **3** and **4**) is correct?

	Most fluid	Least fluid
A	1	2
B	2	3
C	3	4
D	4	1

ANS: D

- 6 The graph shows how the concentration of components of an enzyme-catalysed reaction changes with time.



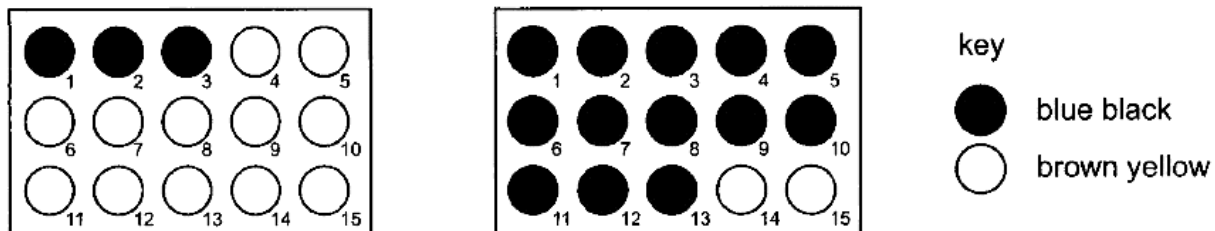
Which row is correct?

	enzymes with empty active sites	substrates	products	enzyme-substrate complexes
A	1	2	4	3
B	2	3	1	4
C	4	1	3	2
D	3	4	2	1

ANS: B

- 7 An experiment was carried out to investigate the digestion of starch using amylase at two different temperatures. A sample was removed from each mixture at 15 seconds intervals and placed onto a spotting tile well containing two drops of iodine in KI solution.

The results are shown in the diagram.

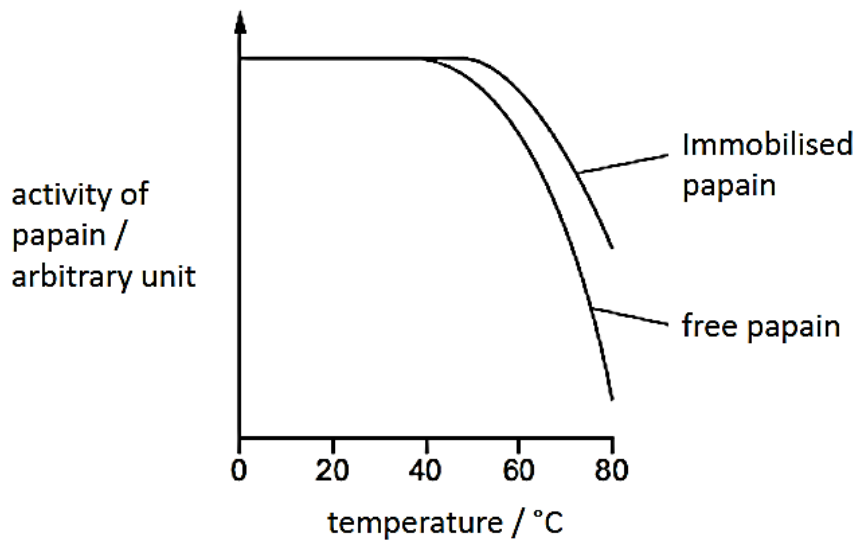


Which shows the correct temperatures and times for the complete digestion of starch?

	temperature / °C	Time / s
A	30 10	3.15 0.45
B	30 10	45 195
C	10 30	45 195
D	10 30	3.15 0.45

ANS: B

- 8 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.

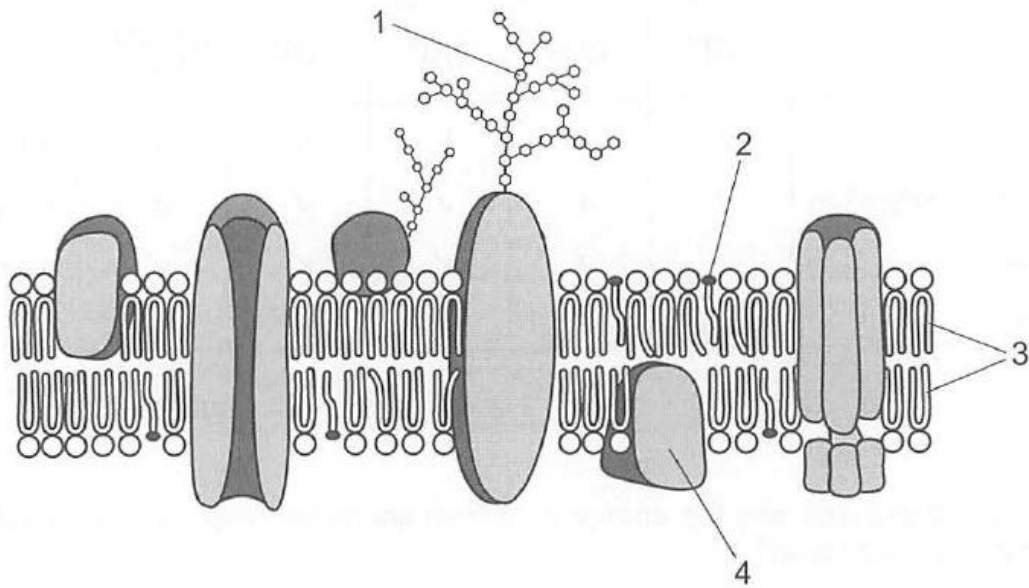


Which statement about the effect of immobilisation of papain is correct?

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

ANS: A

9 The diagram shows the fluid mosaic model of membrane structure.

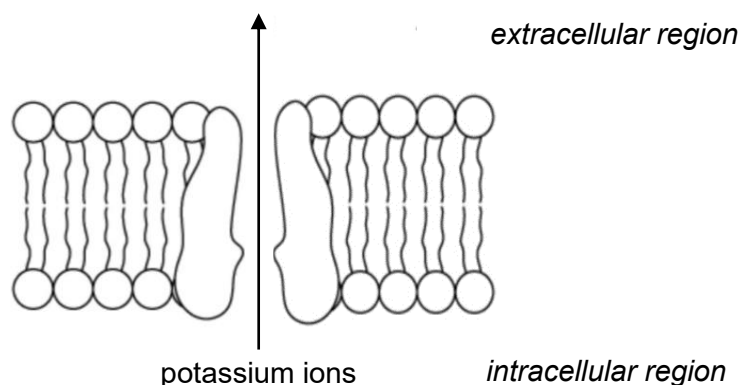


Which row gives possible functions for the numbered parts?

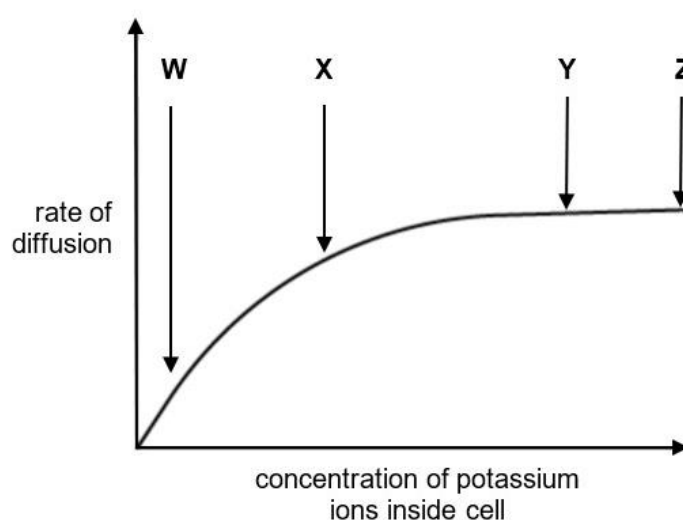
	1	2	3	4
A	barrier to polar molecules	enzyme	cell recognition	regulates fluidity
B	cell recognition	regulates fluidity	barrier to polar molecules	enzyme
C	enzyme	cell recognition	regulates fluidity	barrier to polar molecules
D	regulates fluidity	barrier to polar molecules	enzyme	cell recognition

ANS: B

- 10 The diagram shows part of a cell surface membrane. The arrow shows the path taken by potassium ions when they diffuse through the membrane out of a cell.



The graph shows how the rate of diffusion of potassium ions across the cell surface membrane is affected by the concentration of potassium ions within the cells.



Which row is correct?

	region W to X : limiting factor on the rate of diffusion	region Y to Z : limiting factor on the rate of diffusion
A	concentration of potassium ions inside the cell	number of potassium channels
B	number of potassium channels	concentration of potassium ions outside the cell
C	concentration of potassium ions inside the cells	slower rate of potassium ions passing through the channels
D	concentration of potassium ions outside the cell	minimum rate of potassium ions passing through the channels

ANS: A

- 11** Molecules and ions can cross membranes by a number of different mechanisms.

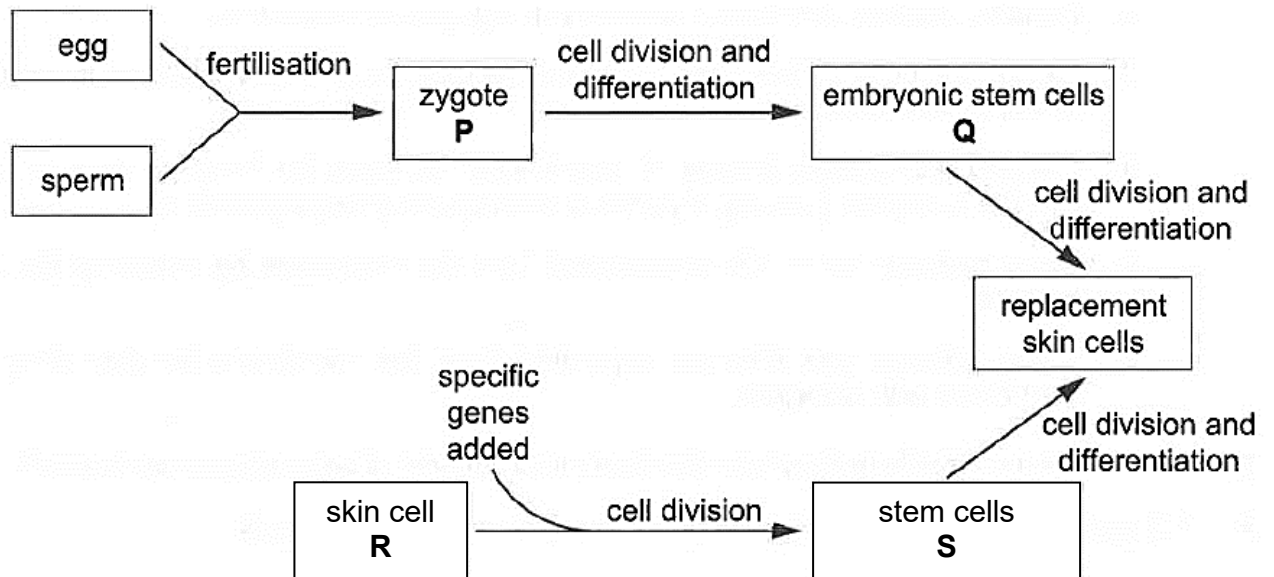
Which row shows possible mechanisms by which each molecule or ion can cross the cell surface membrane?

	glycosylated enzyme	glucose	hydrogen ions	carbon dioxide
A	diffusion and exocytosis	facilitated diffusion	active transport and facilitated diffusion	diffusion
B	endocytosis	diffusion and facilitated diffusion	active transport and diffusion	diffusion and facilitated diffusion
C	exocytosis	active transport and facilitated diffusion	active transport and facilitated diffusion	diffusion
D	facilitated diffusion and endocytosis	facilitated diffusion	diffusion and facilitated diffusion	facilitated diffusion

ANS: C

12 Stem cells can be used to replace cells in damaged tissues, such as skin.

The diagram shows two ways in which replacement skin cells can be produced.



Which row correctly describes the stem cells **P**, **Q**, **R** and **S**?

	P	Q	R	S
A	pluripotent	multipotent	Induced pluripotent	totipotent
B	pluripotent	induced pluripotent	multipotent	induced pluripotent
C	totipotent	pluripotent	multipotent	induced pluripotent
D	totipotent	totipotent	totipotent	totipotent

ANS: C

13 Which of the following statements explain the difference in the direction in which the two strands of a DNA molecule are synthesised?

- 1 The replication of DNA is semi-conservative.
- 2 DNA polymerase can only add deoxyribonucleotides to the 3' OH group.
- 3 Each DNA molecule consists of two anti-parallel polynucleotides.
- 4 The synthesis of the lagging strand requires many more RNA primers.

A 1 and 2 only

B 2 and 3 only

C 1, 2 and 4 only

D 2, 3 and 4 only

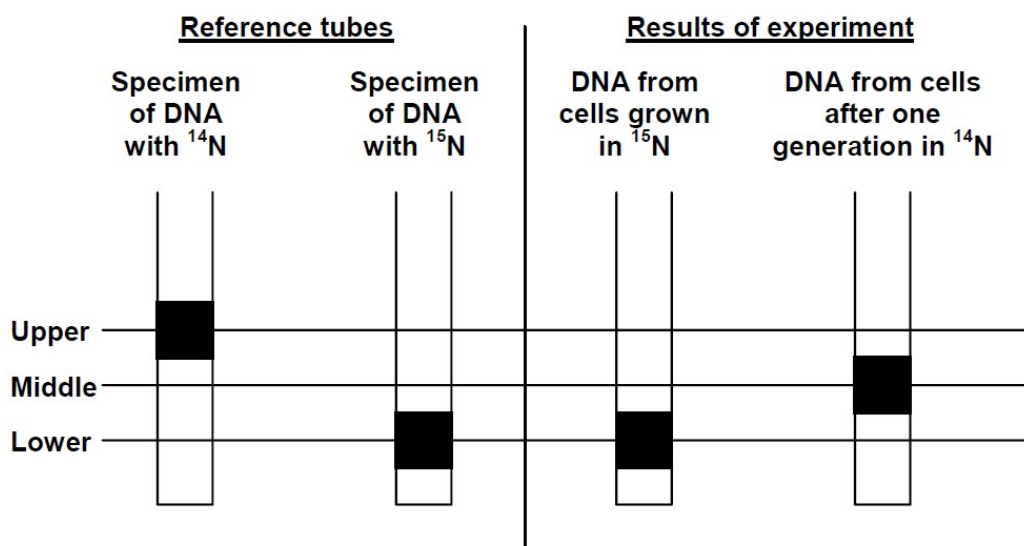
ANS: B

- 14 A research student wanted to replicate the Meselson and Stahl experiment.

He selected cells of the bacterium *E. coli* that have been grown for many generations on a medium containing only the heavy isotope of nitrogen (^{15}N) and transferred these cells to a medium containing only ^{14}N to grow.

Samples of the bacteria were removed from the culture after one generation and the DNA from the samples was extracted and centrifuged.

The results are illustrated in the diagram below:



The student then replated by transferring the remaining bacteria onto 2 new petri dishes of growth medium and allowed them to grow for 2 generations.

Samples were taken from each of the 2 petri dishes and DNA was extracted and centrifuged in 2 separate tubes, tube **X** and tube **Y** which showed different results.

The student suspected that there might have been a mixed up in the growth medium in the 2 petri dishes used for the replating. Instead of both containing ^{14}N only, the growth medium in one of the petri dish might contain ^{15}N only.

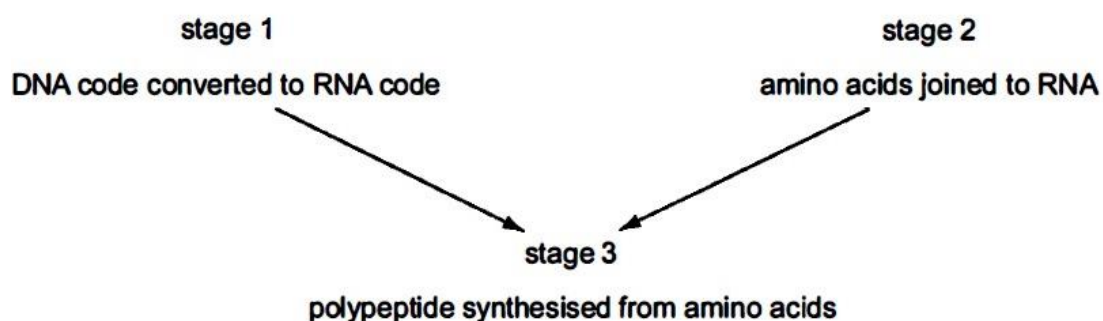
He analysed the results from tube **X** and tube **Y** and concluded that the DNA in tube **Y** came from bacteria cells that have been replated and grown on medium containing ^{15}N .

What are the positions and relative proportions of the bands in both tube **X** and tube **Y**?

	Tube X			Tube Y		
	Upper	Middle	Lower	Upper	Middle	Lower
A	0%	25%	75%	25%	75%	0%
B	50%	50%	0%	0%	50%	50%
C	50%	0%	50%	0%	75%	25%
D	75%	25%	0%	0%	25%	75%

ANS: D

- 15 The synthesis of a polypeptide from its DNA code involves three stages.



Which row correctly describes the roles of DNA and RNA in these three stages?

	stage 1	stage 2	stage 3
A	DNA code transcribed to code on tRNA	each amino acid attached to a specific rRNA molecule	tRNA code translated to polypeptide
B	DNA code translated to code on tRNA	each amino acid attached to identical rRNA molecules	tRNA code transcribed to polypeptide
C	DNA code transcribed to code on mRNA	each amino acid attached to a specific tRNA molecule	mRNA code translated to polypeptide
D	DNA code translated to code on mRNA	each amino acid attached to identical tRNA molecule	mRNA code transcribed to polypeptide

ANS: C

- 16 The information describes some events during protein synthesis.

- 1 Codons and anticodons form hydrogen bonds
- 2 Ribonucleotides form mRNA.
- 3 Amino acids are attached to tRNA molecules.
- 4 Peptide bonds form between amino acids.

Which row is correct

	events that involve enzymes	events that involve base pairing
A	1 and 2	2 and 4
B	1 and 4	1, 3 and 4
C	2, 3 and 4	1 and 2
D	3 and 4	1, 2 and 3

ANS: C

- 17 A point mutation (the replacement of a single nucleotide) can occur anywhere on a chromosome.

Which statements are true?

- 1 Point mutation in an exon can alter the codon resulting in a different amino acid sequence.
- 2 Point mutation in an exon can produce a shorter protein as a stop codon is produced.
- 3 Point mutation in an intron can alter the binding site of a splicing enzyme.

A 1 and 2

B 1 and 3

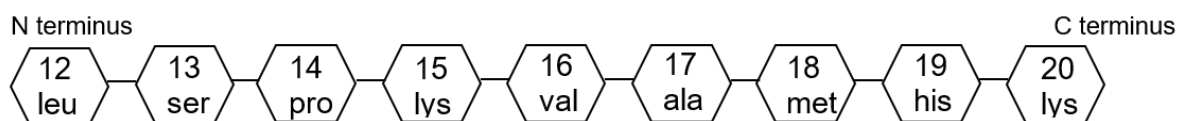
C 2 and 3

D 1, 2 and 3

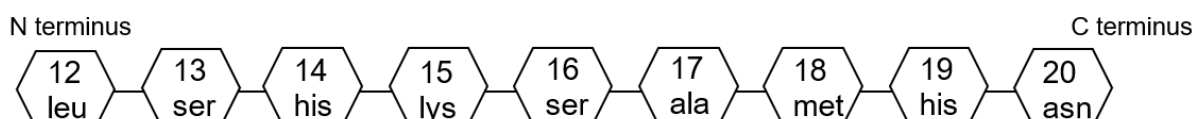
ANS: D

- 18 When a mutation occurs at the gene coding for protein A1, a structurally similar mutant protein, protein A2, is synthesised instead. The two proteins differ by only three amino acids, at positions 14, 16 and 20.

amino acid sequence of normal protein A1



amino acid sequence of mutant protein A2



The table shows the mRNA codons for the amino acids in these positions for proteins A1 and A2.

amino acid	mRNA codons
ala	GCU
ser	AGU
pro	CCA
leu	CUU
lys	AAA
ala	GCU
met	AUG
his	CAU
asn	AAU
val	GUC

Which combination of mutations occurred in order to account for the amino acid sequence of the mutant protein A2?

- 1 Frameshift mutation resulting from an addition of a single nucleotide in the codon that codes for amino acid at position 14.
- 2 Substitution of a single nucleotide in the codon that codes for amino acid at position 14.
- 3 Frameshift mutation resulting from a deletion of two nucleotides in the codon that codes for amino acid at position 16.
- 4 Deletion of a single nucleotide in the codon that codes for amino acid at position 16.

A 1 and 3

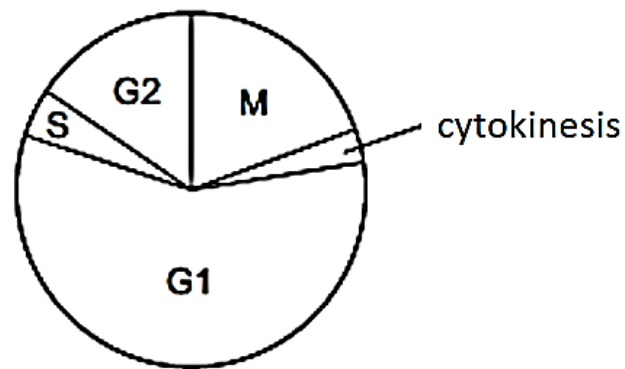
B 1 and 4

C 2 and 3

D 3 and 4

ANS: B

19 The diagram shows the cell cycle of a mammalian cell.



Checkpoints in the cell cycle of mammals prevent the cell cycle from continuing when mistakes are made or DNA is damaged.

Four of the checkpoints are described:

- 1 Mitosis is blocked if DNA replication is incomplete.
- 2 Anaphase is blocked if the assembly of chromatids on the spindle is unsuccessful.
- 3 DNA replication is blocked if DNA is damaged.
- 4 DNA replication stops if damage to DNA has not been repaired.

In which phases of the cell do these checkpoints occur?

	checkpoints			
	1	2	3	4
A	M	G1	S	G2
B	G2	M	G1	S
C	G2	S	G1	M
D	S	G2	M	G1

ANS: B

20 The list below shows mutations in genes that control cell division that can lead to cells becoming cancerous.

- 1 Gain of function mutation of a tumour suppressor gene
- 2 Gain of function mutation of a proto-oncogene
- 3 Loss of function mutation of an oncogene
- 4 Loss of function mutation of a tumour suppressor gene

Which of these gene mutations might lead to the initiation of a cancer?

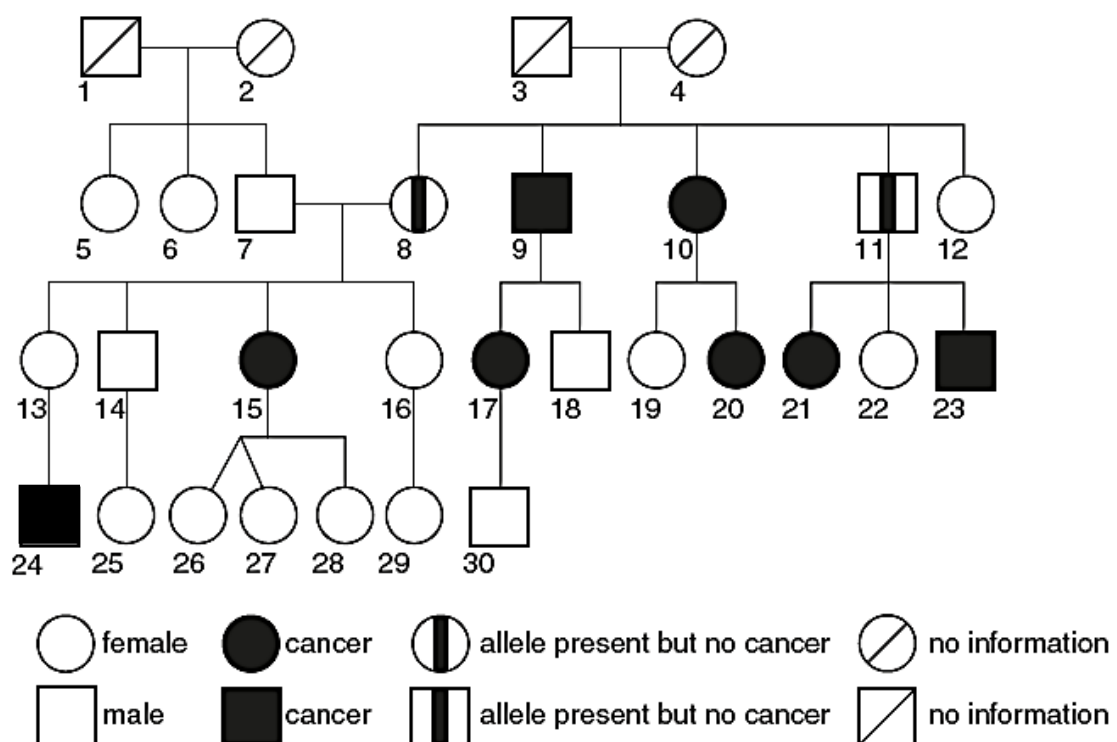
- A** 1 and 3 only
- B** 2 and 4 only
- C** 1, 2 and 3 only
- D** 2, 3 and 4 only

ANS: B

- 21 The BRCA2 protein is involved in suppressing the development of tumours. The gene that codes for this protein is on chromosome 13.

Several different dominant alleles of this gene, *BRCA2*, code for faulty versions of the protein. The presence of any one of these faulty alleles leads to an increased chance of developing several types of cancer, including breast cancer. Not everyone with one of these alleles develops cancer.

The pedigree (family tree) below shows the occurrence of cancers in four generations of a family. The presence of a faulty *BRCA2* allele was confirmed in person 15. The other individuals with cancer were not tested for the presence of the allele. For individuals 17 to 30, only one of their parents is shown in the pedigree. Individuals 24–30 are all under twelve years old.



Which one of the following statements is **not** correct?

- A Individuals 8 and 11 have *BRCA2* allele and may develop cancer later in life.
- B Individuals 8 to 11 may have inherited *BRCA2* allele from either of their parents.
- C Individual 15 may have inherited one copy of *BRCA2* allele from her mother.
- D Individual 24 may have inherited the *BRCA2* allele only from his mother and not his father.

ANS: D

- 22** Wilson's disease is a genetic disease caused by a recessive mutation of the gene coding for the copper-transporting ATPase 2 protein. Different mutations of this gene can result in proteins that are not fully functional or do not work at all. The functional protein is vital for exporting excess copper ions into the bile for excretion.

Individuals with Wilson's disease lack any alleles for the fully functional protein. As a result, copper ions gradually accumulate in their tissues and, when the concentration reaches a critical level, cause damage to tissues.

The symptoms of Wilson's disease typically appear in people between the ages of 6 and 20, or even later.

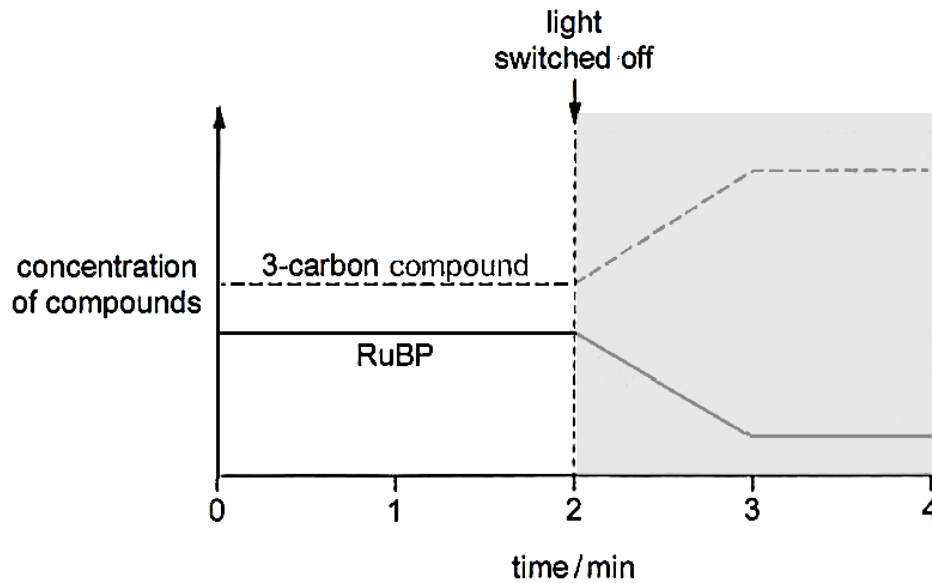
Which statements help to explain why there is such a wide variation in the age at which the symptoms first appear in people with Wilson's disease?

- 1 Different mutations of the gene coding for the copper-transporting ATPase 2 protein affect copper ion transport to different extents.
- 2 The age at which symptoms first appear is affected by both genetic and environmental factors.
- 3 Heterozygotes with fully functional copper-transporting ATPase 2 proteins do not develop symptoms of the disease.

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

ANS: B

- 23 The concentrations of a 3-carbon compound and RuBP formed in the leaf during photosynthesis were measured in different light conditions.



What could cause the decrease in RuBP concentration when the light is switched off?

- 1 Less carbon dioxide is absorbed
- 2 Insufficient ATP
- 3 Insufficient reduced NADP
- 4 Accumulation of the 3-carbon compound in the chloroplast

A 1, 2 and 3

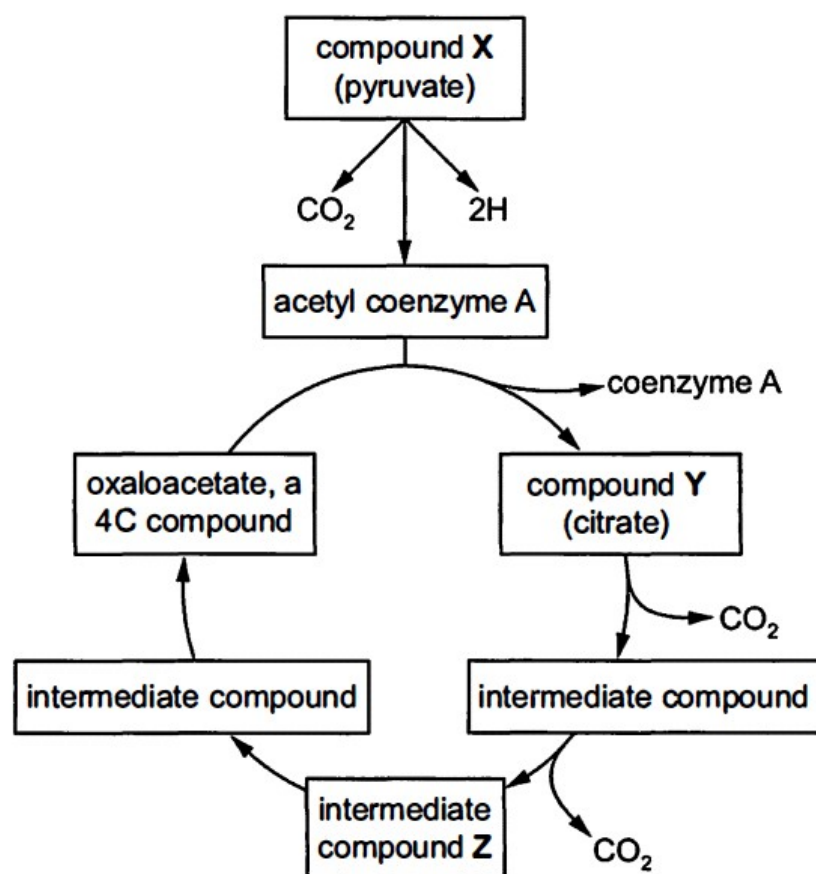
B 1 and 4

C 2 and 3 only

D 2 and 4

ANS: C

- 24 The diagram shows some of the reactions following glycolysis during aerobic respiration.



How many carbon atoms are in each molecule of compounds X, Y and Z?

	X	Y	Z
A	2	5	3
B	2	6	4
C	3	4	6
D	3	6	4

ANS: D

- 25** Approximately 1 in 20 Europeans are heterozygous for a recessive allele responsible for the genetic condition, cystic fibrosis (CF). People who are homozygous for CF have a reduced life expectancy. Heterozygotes are more resistant to some bacterial infections of the gut, such as typhoid fever, than homozygotes for the normal, dominant allele.

What could explain the high incidence of the recessive CF allele in the European population?

- A** Natural selection favouring heterozygotes
- B** Natural selection favouring homozygotes for the recessive CF allele
- C** Lack of genetic drift in the European population
- D** Mutation

ANS: A

- 26** A large population of equal numbers of dark and light mice was released into an area where owls are predators of mice. Because of predation, only 25 % of these mice survived and selective killing by owls changed the proportions of dark to light mice from 1 : 1 to 4: 1.

If mice produce an average of eight offspring per litter and the pattern of predation remains the same, what would happen to the population of light mice?

- A** They disappear after one further generation.
- B** They disappear after two further generations.
- C** They remain at the level of one fifth of the population.
- D** They will be reduced to a constant but very low frequency.

ANS: D

- 27 An investigation was carried out to assess the effect of diet on the milk yield and methane production of cows. The cows in group **A** were fed a traditional diet and those in group **B** were fed the same diet with a mixture of chopped hay and straw added.

The table below shows the results of this investigation.

Group	Diet	Mean milk yield per cow/ $\text{dm}^3 \text{ day}^{-1}$	Methane emission for each dm^3 milk produced / dm^3
A	Traditional with no added material	24.0	30.0
B	Traditional with added chopped hay and straw	27.6	24.0

Which of the following actions will help reduce the impact of global warming?

- 1 Decreasing consumption of beef and milk
- 2 Creating more foraging grounds to feed the cows
- 3 Adding chopped hay and straw to the cows' diet.

- A** 1 only
- B** 1 and 3 only
- C** 2 and 3 only
- D** All of the above

ANS: B

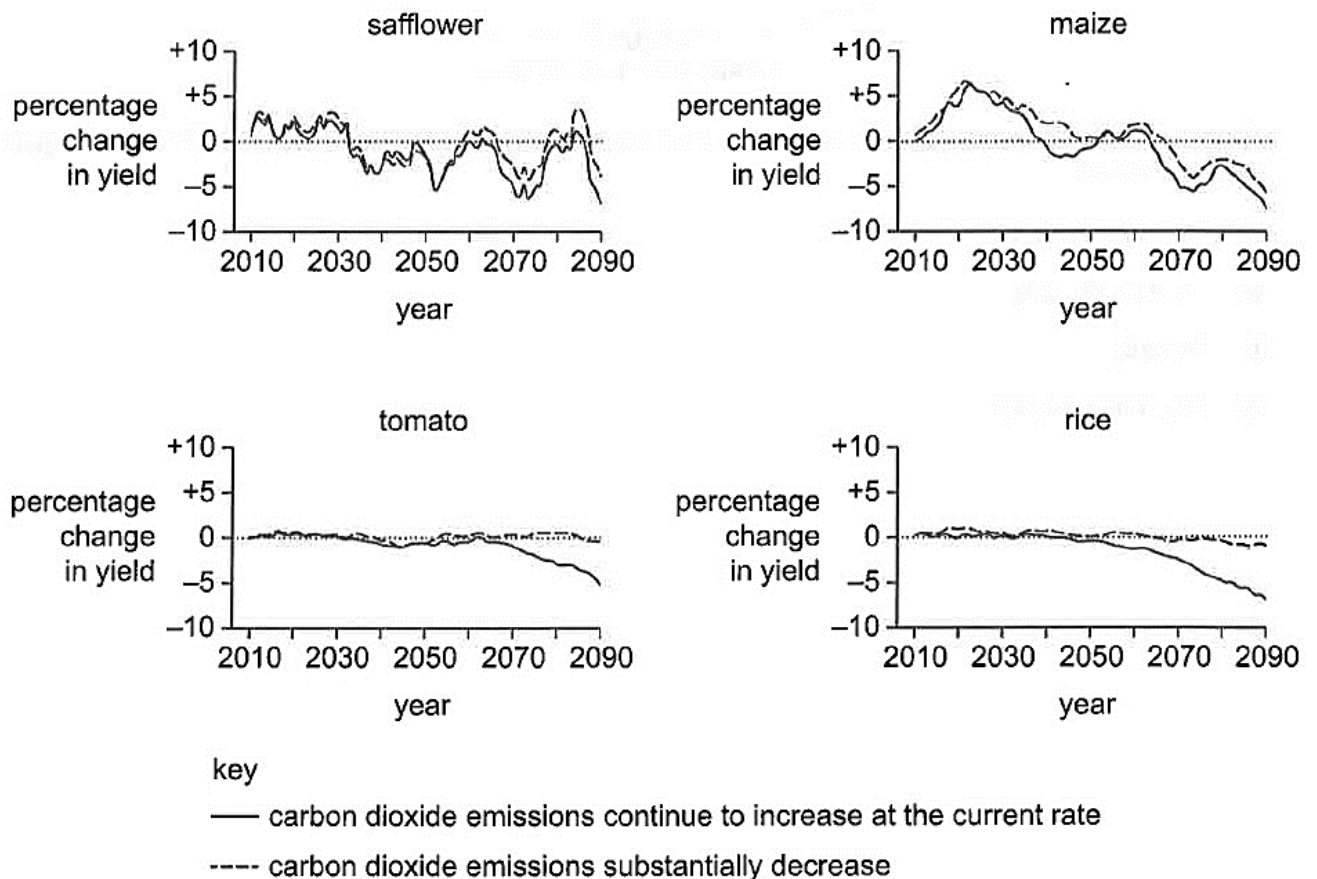
- 28 The graphs show the predicted impact of climate change on the yield of four different crops grown in the same region of California.

These predictions are based on two possible scenarios:

- carbon dioxide emissions continue to increase at the current rate
- carbon dioxide emissions substantially decrease

For each crop, the percentage change in yield compared to the yield in 2009 is shown.

It is assumed that water and nutrient supplies are adequate.

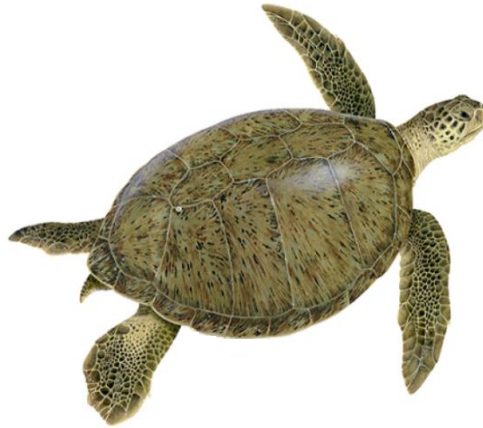


Which statement about crop yield in this region of California is consistent with the information in the graphs?

- A** If carbon dioxide emissions continue to increase at the current rate, yields will always be lower after 2070 than in 2009 for all four crops: safflower, maize, tomato and rice.
- B** Substantially decreasing the emission of carbon dioxide will have benefits for the yields of all four crops, but yields are still likely to be no higher in 2090 than in 2009.
- C** Introducing stricter controls on carbon dioxide emissions in California will ensure that by 2090 there will be benefits to the yield of all four crops, especially rice and tomato.
- D** Reducing carbon dioxide emissions will have little effect on the trend in yields for safflower and maize, but by 2090 yields of tomato and rice will increase by at least 5%.

ANS: B

- 29 The habitat of sea turtles is shallow coastal water in warm and temperate seas.



Sea turtles migrate to breeding areas to lay their eggs on sandy beaches. The nest temperature has a strong influence on the sex of the offspring. Colder temperatures result in a higher proportion of males and warmer temperatures result in a higher proportion of females.

Which effects of climate change could contribute to a decline in populations of sea turtles?

- 1 Increased melting of glaciers causing a rise in sea level.
- 2 Increased air temperature causing more heating of the Earth's surface.
- 3 Changes in ocean currents modifying migration pathways.
- 4 Heavy rainfall causing flooding of land and coastal erosion.

A 1, 2, 3 and 4

B 1, 2 and 3

C 1 and 2

D 2 and 4

ANS: A

- 30 Several factors can help to predict the risk of an outbreak of viral dengue disease in a human population. Four of these factors are listed.

	factor
<i>P</i>	Frequency of rainfall
<i>Q</i>	Incidence of viral dengue disease in the human population
<i>R</i>	Size of the mosquito population
<i>S</i>	Temperature

Ways in which these factors could affect this risk are also listed.

	what the factor could affect
1	Proportion of mosquitoes that are carriers of the dengue virus
2	Generation time of vector
3	Ability of vector to breed
4	Rate of new infections in the human population

Which row links each factor to one way it could affect the risk of an outbreak of dengue disease?

	<i>P</i>	<i>Q</i>	<i>R</i>	<i>S</i>
A	1	3	2	4
B	2	4	3	1
C	3	1	4	2
D	4	2	1	3

ANS: C

END-OF-PAPER