HWA CHONG INSTITUTION
JC2 Preliminary Examination
Higher 1

CANDIDATE NAME		**CT GROUP**	**15S____**

CENTRE NUMBER		**INDEX NUMBER**	

BIOLOGY

8875/01

Paper 1 Multiple Choice

22 September 2016

Additional Materials: Optical Mark Sheet

1 hour

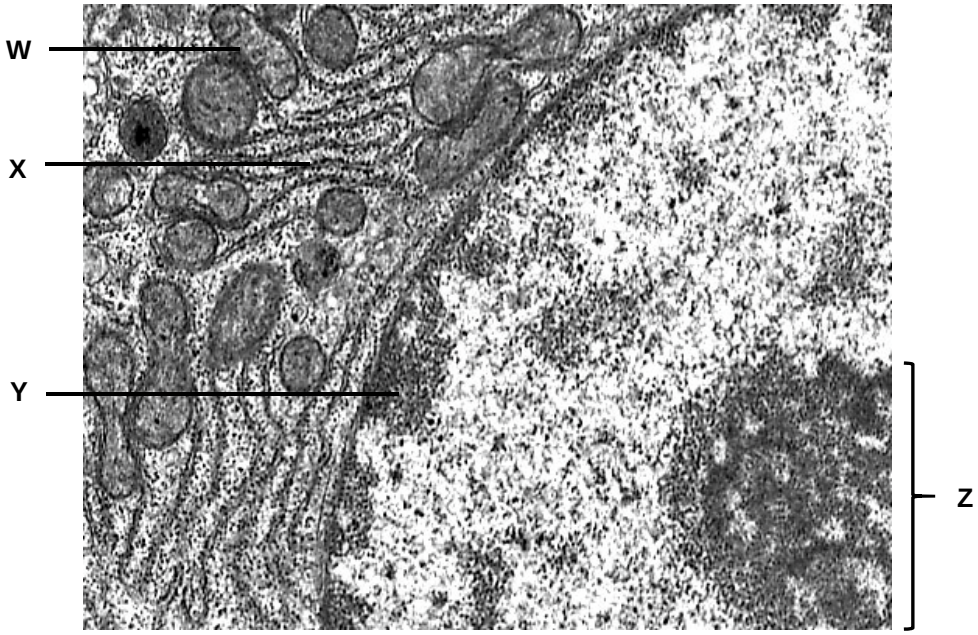
INSTRUCTIONS TO CANDIDATES

1. Write your **name**, **CT group**, **Centre number** and **index number** in the spaces provided at the top of this cover page.
2. Fill in your particulars on the Optical Mark Sheet. Write your **NRIC number** and shade accordingly.
3. There are **thirty** 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 record your choice in **soft pencil** on the separate Optical Mark Sheet.
4. At the end of the paper, you are to submit **only** the Optical Mark Sheet.

INFORMATION FOR CANDIDATES

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

1 The electronmicrograph shows part of an animal cell with structures W to Z labelled.



Which statements correctly describe the activities of structures W to Z?

1 Structure X is involved in the synthesis and processing of membrane proteins.
2 Translation occurs in structures W and X.
3 DNA replication occurs only in structure Y.
4 Condensation of chromosomes occur in structure Z.

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

2 Which row shows the correct match between the descriptions of different types of biological molecules and where they are found?

1 a linear polymer of 1,4 linked β-glucose molecules

2 an amphipathic, phosphate containing molecule

3 a highly branched polymer of 1,4 and 1,6 linked α-glucose molecules

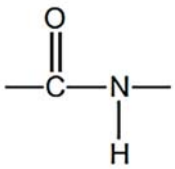
	1	2	3
A	eukaryote and prokaryote cell walls	cell surface membranes of both eukaryotes and prokaryotes	forming storage granules in the cells of prokaryotes
B	eukaryote cell walls	cell surface membranes of both eukaryotes and prokaryotes	forming storage granules in the cells of some eukaryotes
C	eukaryote cell walls	cell surface membranes of both eukaryotes and prokaryotes	forming starch grains in the cells of all eukaryotes
D	forming storage granules in the cells of eukaryotes	prokaryote cell walls	eukaryote cell walls

3 The diagrams show different types of bond found in biological molecules.

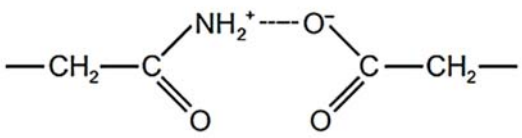
1

2

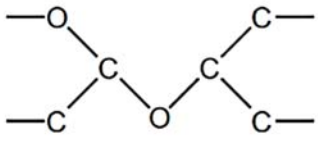
3



4



5



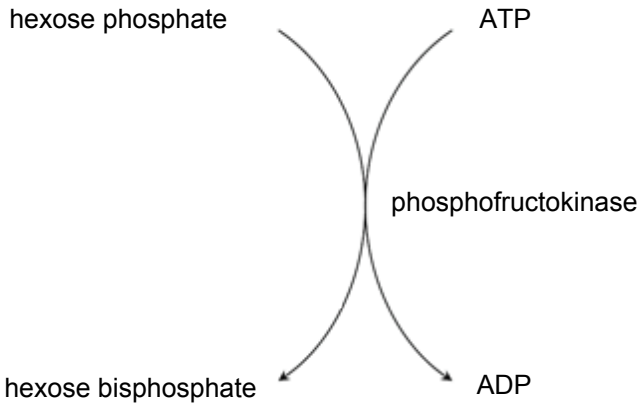
Which combination of bonds could **not** be found in a protein with a tertiary structure?

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

4 Which levels of protein structure are always involved when competitive and non-competitive inhibitors bind to enzymes?

	competitive	non-competitive
A	primary, secondary and tertiary	secondary
B	quaternary and tertiary	quaternary and tertiary
C	secondary	primary and tertiary
D	tertiary	tertiary

5 The enzyme phosphofructokinase (PFK) is involved in phosphorylation of hexose phosphate during glycolysis as shown in the diagram. It is involved in controlling the rate of glycolysis and thus respiration, by end-product inhibition.

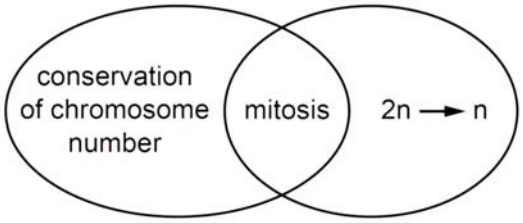


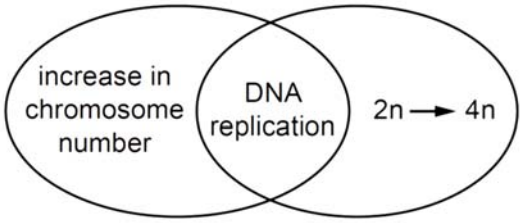
Which statement correctly describes the binding site(s) of PFK?

A	active site allosteric site	: :	complementary to ATP and hexose phosphate absent
B	active site allosteric site	: :	complementary to hexose phosphate complementary to glucose
C	active site allosteric site	: :	complementary to ATP and hexose phosphate complementary to ATP
D	active site allosteric site	: :	complementary to hexose bisphosphate absent

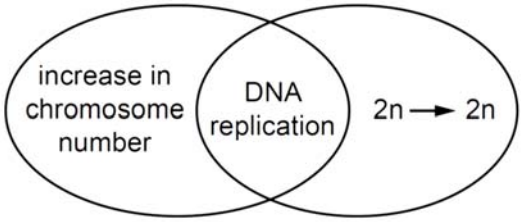
6 Which diagrams show the correct relationships?

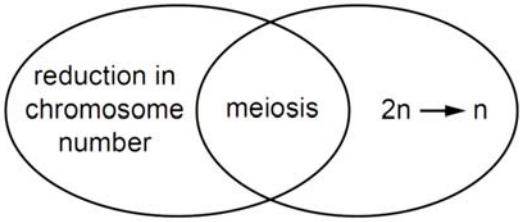
A



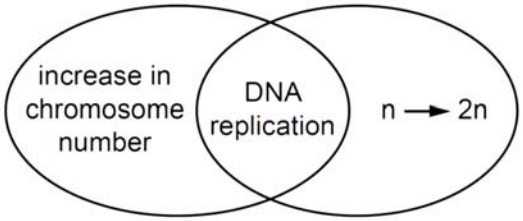


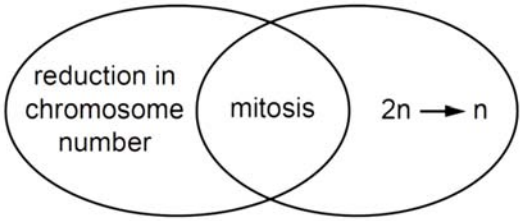
B



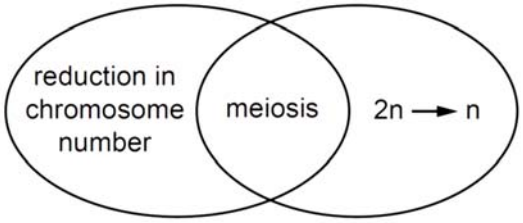


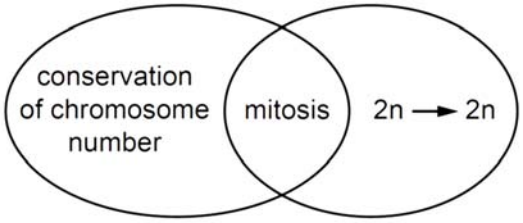
C





D





7 What is the correct description of centrioles, nuclear envelope and spindle during mitosis in animal cells?

	phase	centrioles	nuclear envelope	spindle
A	anaphase	replicate	absent	present
B	metaphase	present	reforms	present
C	prophase	move apart	breaks up	forms
D	telophase	replicate	breaks up	breaks up

8 A space probe brought back some living material from a distant planet. Proteins very similar to those found on Earth were present.

DNA of this living material, which exists as double helices, contains six different nucleic acid bases, identified as H, I, J, K, L and M. Among these, J, L and M were found to be pyrimidine bases.

Studies of the DNA from this living material gave the following results:

ratio of bases in double-stranded DNA	numerical value
H / J	1.00
(H + I) / (J + M)	1.02
(H + K) / (J + M)	1.14
(H + K) / (J + L)	1.01

Assuming that the base-pairing follows Chargaff's rule, what can be concluded from these data?

1 H base pairs with J.

2 H, I, K are likely to be purine bases.

3 It is probable that I base pairs with M, and K base pairs with L.

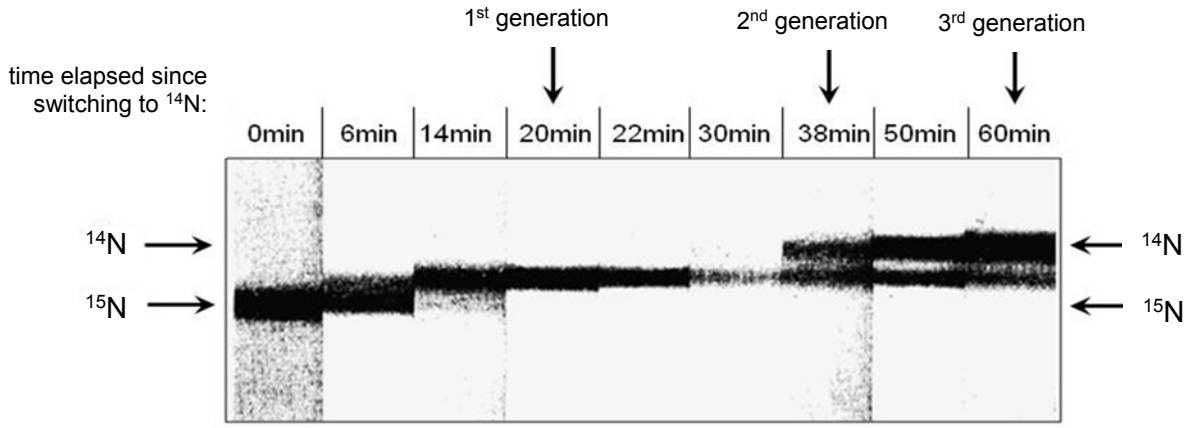
A 1 and 2 only **B** 1 and 3 only **C** 2 and 3 only **D** 1, 2 and 3

9 In an investigation to study the mode of DNA replication, *Escherichia coli* (*E. coli*) cells were grown in a nutrient medium containing heavy isotope of nitrogen (^{15}N) for an extended period of time until all the DNA was labelled.

These *E. coli* cells were then transferred to a nutrient medium containing only light isotope of nitrogen (^{14}N) and were allowed to multiply over three generations. The DNA of the *E. coli* cells was then harvested at nine different time intervals.

Subsequently, density gradient centrifugation of these *E. coli* DNA using caesium chloride was performed.

The diagram shows the results obtained.



Which statements are consistent with the results observed?

1 There was no evidence of semi-conservative DNA replication.
2 In the 1st generation, only hybrid $^{14}N/^{15}N$ DNA was produced.
3 In the 3rd generation, 75% hybrid $^{14}N/^{15}N$ DNA and 25% light $^{14}N/^{14}N$ DNA were produced.
4 In the subsequent 4th generation, only light $^{14}N/^{14}N$ DNA would be produced.

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

10 A polypeptide has the amino acid sequence glycine-arginine-lysine-serine.

The table gives possible tRNA anticodons for each amino acid.

amino acid	tRNA anticodons
arginine	UCC GCG
glycine	CCA CCU
lysine	UUC UUU
serine	AGG UCG

Which DNA sequences would code for this polypeptide?

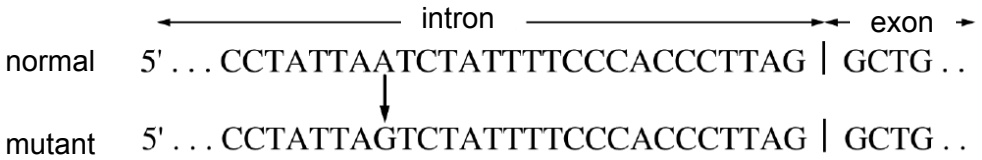
A CCACGCAAGAGC

B CCTTCCTTCTCG

C GGAAGGAAAAGC

D GGTTGGTTGTGC

11 A segment of the DNA sequences of normal and mutant β-globin genes are shown. A base substitution from A to G results in the disease β-thalassemia.



What is the most plausible explanation as to why the indicated mutation results in β-thalassemia?

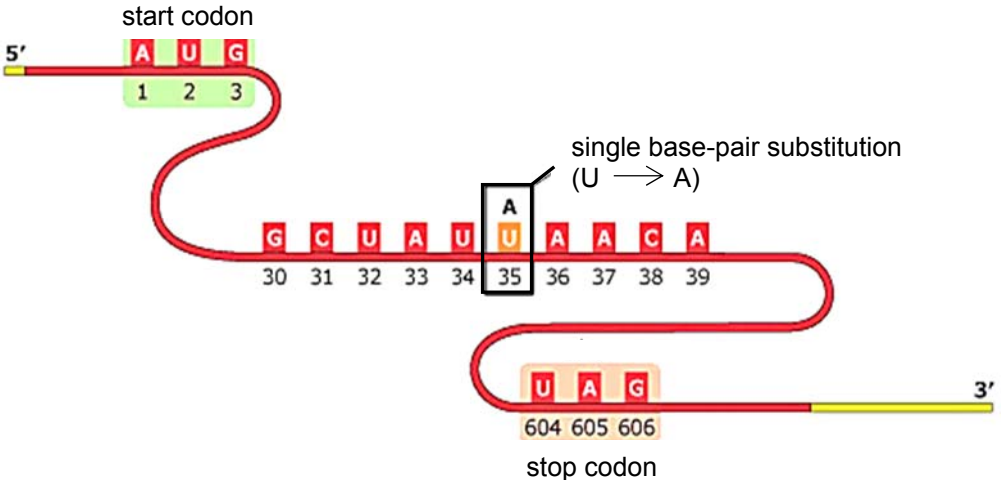
A A restriction site is generated, so that the gene is cut into two.

B A new splice site is created, so that a portion of the intron is not removed.

C An increase in the rate of transcription of the β-globin gene.

D A translation stop codon is created at the site of the mutation.

12 The diagram shows part of the sequence of an mRNA. A single base-pair substitution in the DNA resulted in a change from uracil (U) to adenine (A) at position 35 of the mRNA.



Second letter

First letter	U	C	A	G	Third letter
U	UUU Phe UUC Phe UUA Leu UUG Leu	UCU Ser UCC Ser UCA Ser UCG Ser	UAU Tyr UAC Tyr UAA Stop UAG Stop	UGU Cys UGC Cys UGA Stop UGG Trp	U C A G
C	CUU Leu CUC Leu CUA Leu CUG Leu	CCU Pro CCC Pro CCA Pro CCG Pro	CAU His CAC His CAA Gln CAG Gln	CGU Arg CGC Arg CGA Arg CGG Arg	U C A G
A	AUU Ile AUC Ile AUA Ile AUG Met	ACU Thr ACC Thr ACA Thr ACG Thr	AAU Asn AAC Asn AAA Lys AAG Lys	AGU Ser AGC Ser AGA Arg AGG Arg	U C A G
G	GUU Val GUC Val GUA Val GUG Val	GCU Ala GCC Ala GCA Ala GCG Ala	GAU Asp GAC Asp GAA Glu GAG Glu	GGU Gly GGC Gly GGA Gly GGG Gly	U C A G

Based on the genetic code, which statement would be the result of this single base-pair substitution?

A Nonsense mutation resulting in early termination of translation.

B Missense mutation causing a single amino acid change in the protein.

C Silent mutation resulting in no change in the amino acid sequence.

D Neutral mutation resulting in delayed termination of translation.

13 Grey seed colour (G) in garden peas is dominant to white seed colour (g). In the following crosses, the indicated parents with known phenotypes, but unknown genotypes, produced the progeny as shown in the table.

female parent	parents female x male	progeny	
		grey	white
P	grey x white	81	82
Q	grey x grey	118	39
R	grey x white	74	0
S	grey x grey	90	0

Based on Mendel's first law of segregation, which row identifies the genotypes of the female parents, P to S?

	genotype of the female parent			
	P	Q	R	S
A	X^GX^g	X^GX^G	X^GX^g	X^GX^g
B	Gg	GG	Gg	Gg
C	X^GX^g	X^GX^g	X^GX^G	X^GX^g
D	Gg	Gg	GG	GG

14 In pea plants, there are two alleles for the seed colour, yellow and green, and two alleles for seed texture, smooth and wrinkled. Two pure-breeding pea plants were mated and all the F1 offspring had yellow and smooth seeds.

When the F1 offspring were mated, the following results were obtained for the F2 generation:

Yellow and smooth seeds	92
Yellow and wrinkled seeds	33
Green and smooth seeds	34
Green and wrinkled seeds	12

Which statements are correct?

1 The probability of producing pure-bred offspring is 1 in 16.

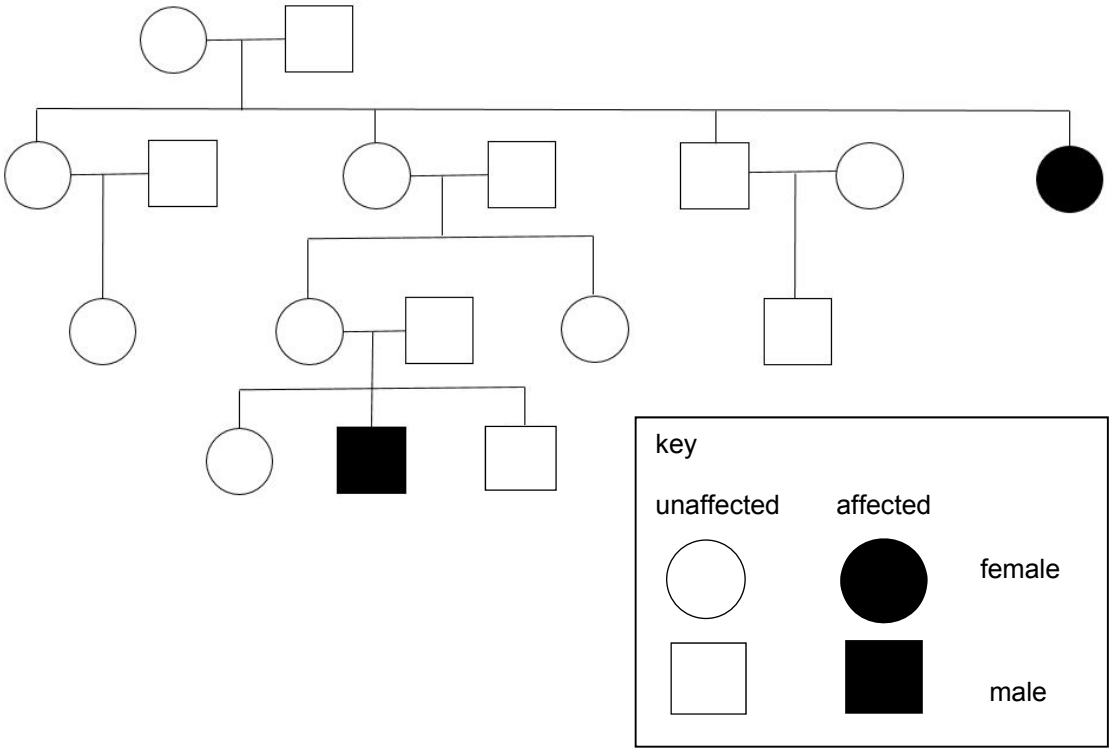
2 The phenotypes of the pure-breeding parents could only have been yellow and wrinkled seeds and green and smooth seeds respectively.

3 The genes for seed colour and seed texture assort independently.

4 Two out of four phenotypes in the F2 generation are formed as a result of a crossover event.

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

15 Xeroderma pigmentosum, a condition that occurs in some families, predisposes people to cancer of the skin. They do not have an increased risk of cancers of other tissues and organs. The condition is caused by a defective allele of a single gene. The pedigree diagram shows part of the family tree of a family in which the condition occurs.



Predict what is the likely combination of triggers needed for skin cells to become cancerous in people predisposed to develop the condition.

A A combination of ultraviolet light and a recessive allele for the condition.

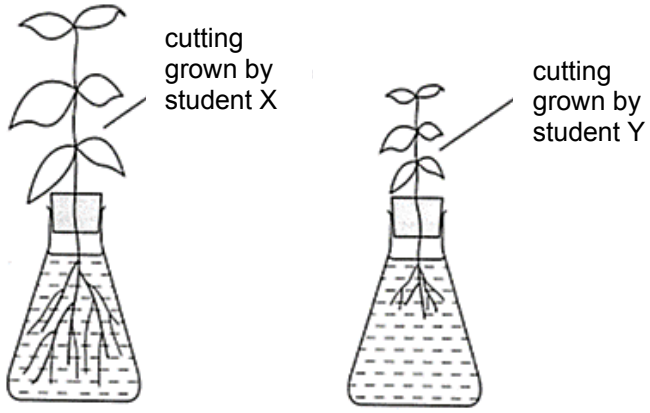
B A combination of X-rays and a recessive allele for the condition.

C A combination of ultraviolet light and a dominant allele for the condition.

D A combination of X-rays and a dominant allele for the condition.

16 A student, X, looked after a plant. Another student, Y, looked after another plant of the same species. Each student followed the same instructions to set up apparatus to take cuttings from their plant and grow the cuttings next to the plant from which the cutting had been taken.

The diagrams show the result after one week.

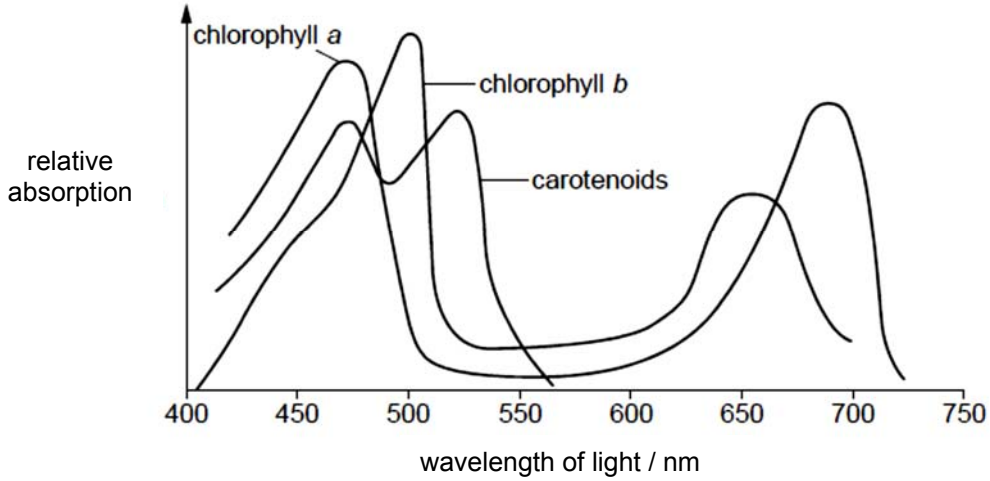


Which factors could have caused the different appearance of the two cuttings?

1 phenotypic variation due to environment
2 genetically different cuttings
3 mutation due to environment
4 genotypic variation due to environment

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

17 The graph shows the absorption spectra for three different photosynthetic pigments.



Which statements are correct?

1 Having several photosynthetic pigments, rather than one, increases the efficiency of photosynthesis.

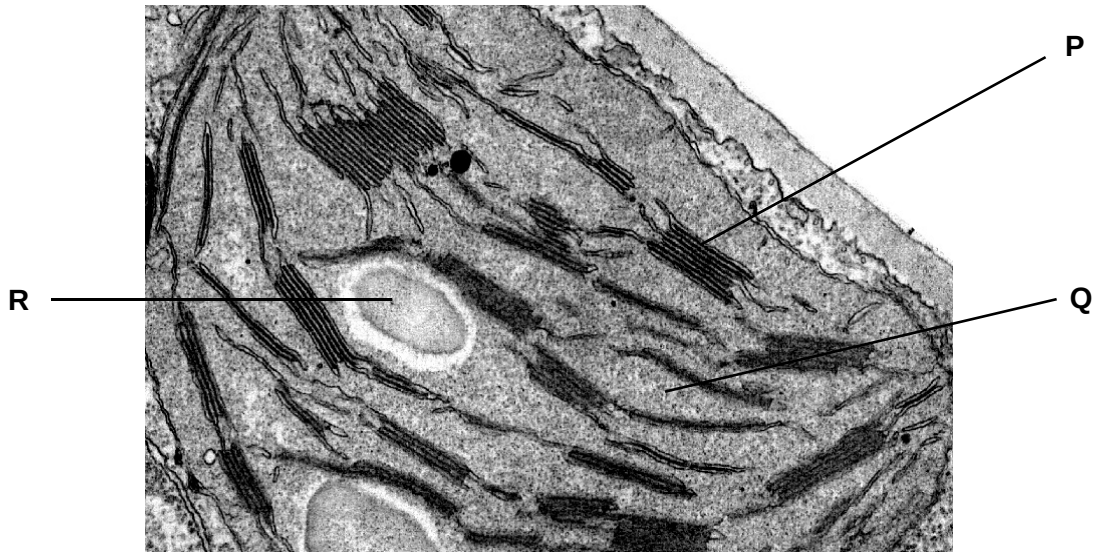
2 Most leaves are green as chlorophyll *a* and *b* absorbs light in the blue and red regions of the spectrum.

3 Photosynthesis will be fastest in light at the red end of the spectrum, as red light has higher energy than blue light.

4 Carotenoids absorb the intermediate wavelengths of light, thus broadening the spectrum of colours that can be used for photosynthesis.

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

18 The electronmicrograph shows an organelle found in a plant cell. Three structures in the organelle are labelled P, Q and R.



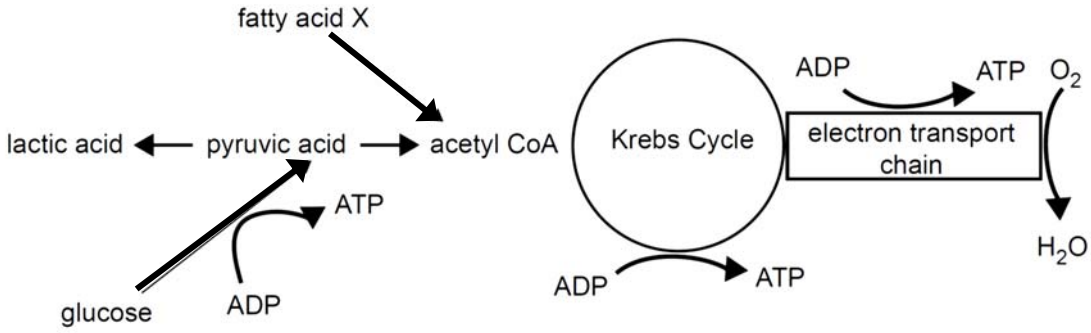
Which row identifies the functions of structures P, Q and R?

	P	Q	R
A	site of photolysis of water	site of storage of carbohydrate	site where ATP and NADPH are utilised
B	site where ATP and NADPH are utilised	site of photolysis of water	site of storage of carbohydrate
C	site of photolysis of water	site where ATP and NADPH are utilised	site of storage of carbohydrate
D	site where ATP and NADPH are utilised	site of storage of carbohydrate	site of photolysis of water

19 If there is insufficient glucose for cellular respiration, fatty acids can be converted to acetyl CoA. Each molecule of fatty acid X produces eight molecules of acetyl CoA.

The diagram summarises the pathways for the breakdown of fatty acid X and glucose molecules.

The number of molecules produced in each step is not shown.

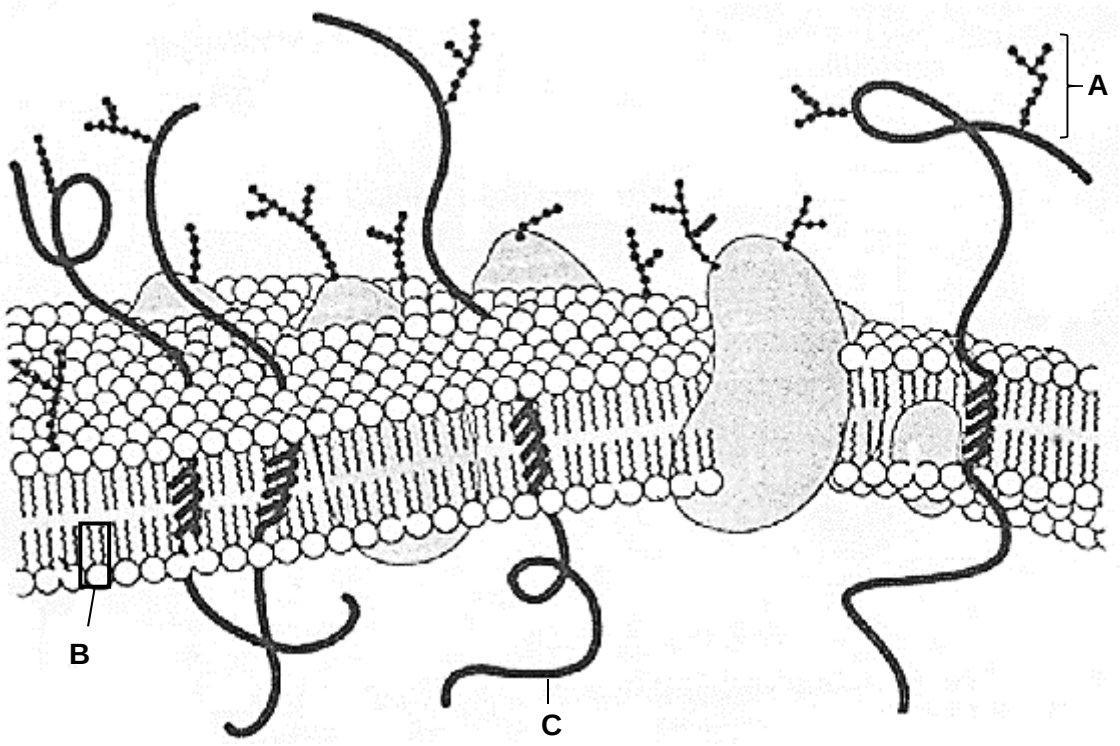


Which statements are correct?

1 More ATP is made in the Krebs cycle than in glycolysis per glucose molecule oxidised.
2 Under aerobic conditions, one molecule of fatty acid X produces more ATP than one glucose molecule.
3 Under anaerobic conditions, fatty acids are preferred over glucose as respiratory substrates.
4 Oxygen acts as the final electron acceptor regardless of whether fatty acids or glucose molecules are oxidised.

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

20 The diagram represents the fluid mosaic model of a cell surface membrane with molecules A, B and C labelled.



Which statements correctly describe the roles of molecules A, B and C?

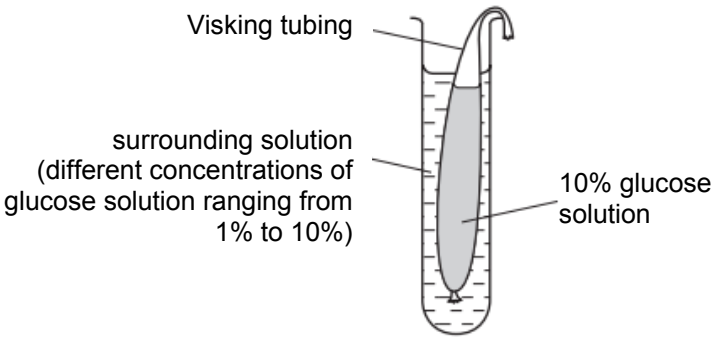
1 Molecule A contains many peptide bonds and can play a role in cell-to-cell recognition.

2 Weak hydrophobic interactions between Molecule B and its adjacent molecules allow them to move laterally and transversely.

3 Molecule C contains both hydrophilic and hydrophobic regions, and it can transmit signals from the exterior to the interior of the cell.

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

21 The diagram shows an investigation into the effect of changing the concentration of glucose in the surrounding solution on the movement of glucose and water molecules through a partially permeable membrane (Visking tubing) in 15 minutes.



As the concentration of glucose solution in the surrounding solution increases, which statements are correct?

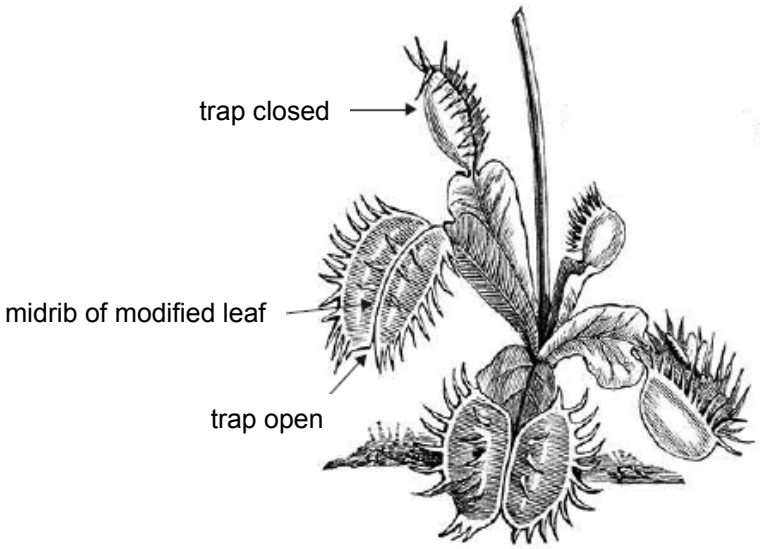
1 Net diffusion of water increases.
2 Net diffusion of glucose increases.
3 Glucose molecules reach an equilibrium quicker.
4 There is less change in the volume of surrounding solution.

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

22 In some plants, a modified leaf forms an insect trap. Motor cells are located along the midrib of the modified leaf.

When there is no trigger, the trap remains open. The motor cells are turgid and contain potassium ions at a concentration higher than the surrounding fluid.

When the trap is triggered, potassium ions stream out of the motor cells through ion channels. The cells lose their turgidity. The pressure in the surrounding cells then causes the modified leaf to bend and so the trap closes.



Taking into consideration the opening and closing of the trap, which statement is true?

A When the trap is opening, potassium ions accumulate in the motor cells by diffusion.

B When the trap is opening, water accumulates in the motor cells by active transport.

C When the trap is closing, potassium ions leave the motor cells because of the pressure in the surrounding cells.

D When the trap is closing, water leaves the motor cells by osmosis.

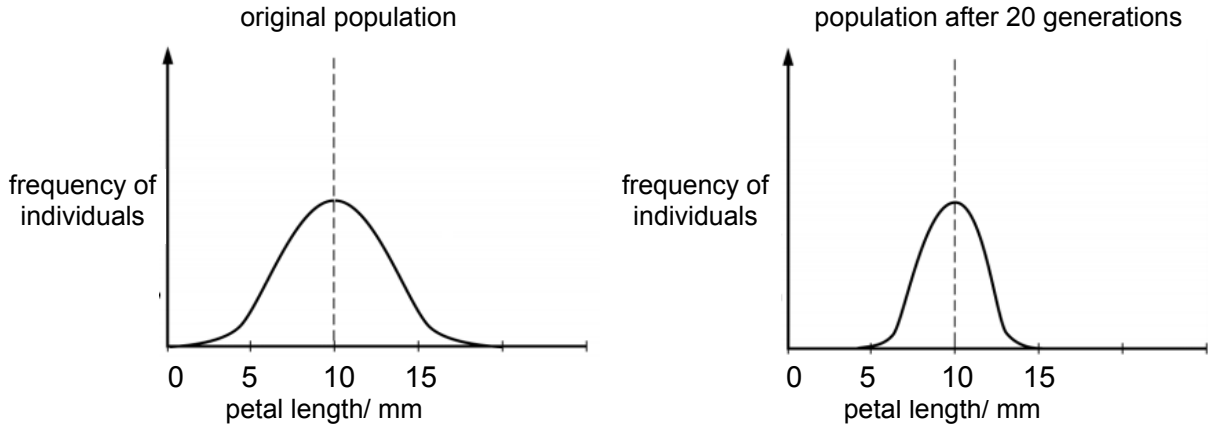
23 Which statements are acceptable parts of Darwinian evolutionary theory?

1 Advantageous behaviour acquired during the lifetime of an individual is likely to be inherited.
2 In competition for survival, the more aggressive animals are more likely to survive.
3 Species perfectly adapted to a stable environment will continue to evolve.
4 Variation between individuals of a species is essential for evolutionary change.

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

24 A plant species arrives at an island for the first time, where it is exposed to the island pollinators. These island pollinators include bees and hummingbirds that carry pollens from one plant to another plant of the same species hence, fertilising the plant to produce fruits. Without the island pollinators, the plants cannot reproduce. Over the course of 20 generations, the petal length of its flowers changes.

The diagram shows the frequency distribution of petal length in the original colonising population and the population after 20 generations.

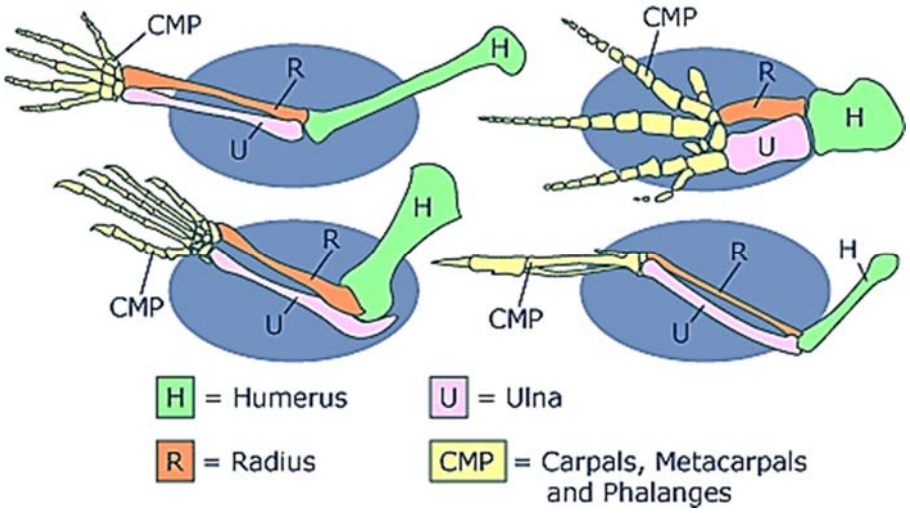


Which statements about the frequency distribution of petal length are correct?

1 Island pollinators act as the selection pressure.
2 The most common phenotype of the population has changed.
3 Island pollinators selected for flowers with extremely long or extremely short petals.
4 This type of selection is typical of a changing environment where competition is not severe.

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

25 The diagram shows the arrangement of bones in tetrapods, animals with four pentadactyl limbs.

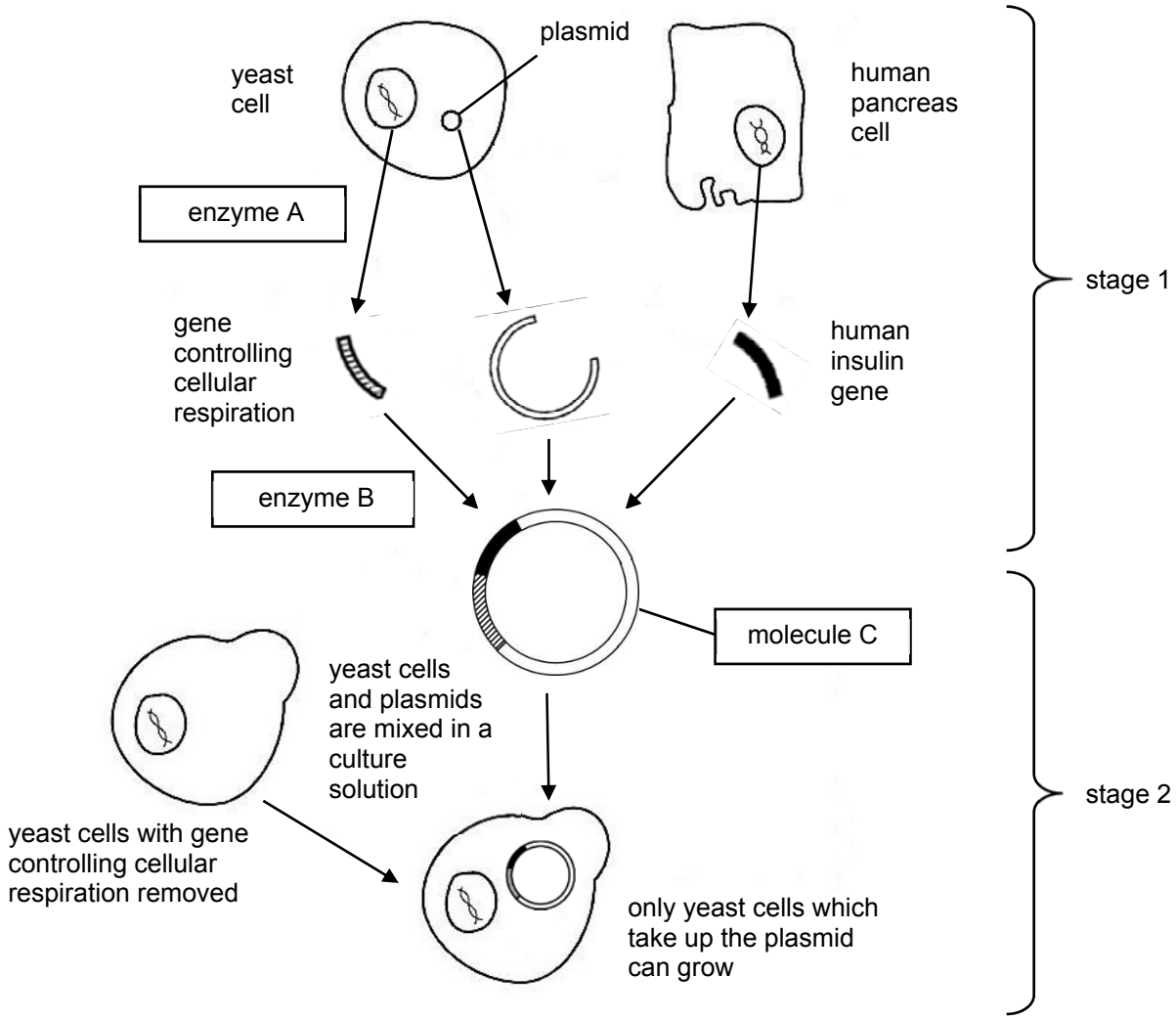


Based on the limb structures of tetrapods, which statements are true?

1 All four animals possess homologous structures.
2 The arrangement of bones in the limbs of these animals reflects divergent evolution.
3 The arrangement of bones in the limbs is due to shared ancestry.
4 All four animals share similar arrangement of bones in their limbs due to adaptation to similar environments.

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

26 The diagram shows the main stages in the production of human insulin using genetic engineering.



Which statements about the process are correct?

1 Enzyme A and enzyme B catalysed hydrolytic and condensation reactions respectively.

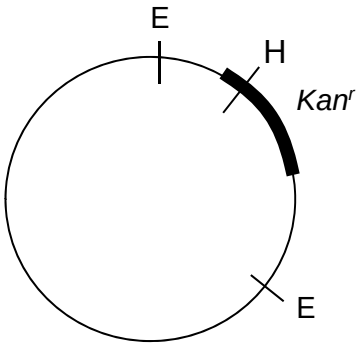
2 In stage 1, only enzyme A was used to cut the plasmid and anneal the gene controlling cellular respiration from yeast DNA to generate complementary sticky ends.

3 Molecule C is known as a recombinant cloning vector.

4 In stage 2, the gene controlling cellular respiration must be present in yeast cells before it can grow and make insulin.

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

27 Locations where restriction enzymes *Eco*RI and *Hpa*II cut a plasmid are shown in the diagram. After both enzymes are used in combination to cut the plasmid, a Southern blot analysis was performed with a probe which hybridises to the kanamycin resistance (*Kan*^{r}) gene sequence.

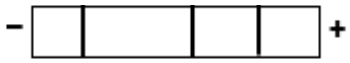


E = *Eco*RI restriction site

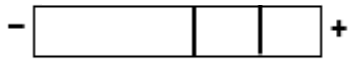
H = *Hpa*II restriction site

Which banding pattern would be expected?

A

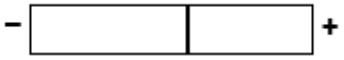


B



C

D



28 In which ways is the polymerase chain reaction (PCR) similar to the replication of DNA?

1 DNA is heated to break hydrogen bonds
2 only a section of DNA is replicated
3 free nucleotides are used
4 DNA polymerase enzymes are required

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

29 Which row correctly matches the unique features of embryonic stem cells (ESCs) to its functions?

	produce the body's specialised tissues	particularly useful in medical research
A	ESCs can be stimulated by chemical signals to express particular genes	ESCs can divide and are pluripotent
B	ESCs lose genetic information as they differentiate	ESCs can divide and are pluripotent
C	ESCs can be stimulated by chemical signals to express particular genes	ESCs will continue to divide indefinitely
D	ESCs lose genetic information as they differentiate	ESCs will continue to divide indefinitely

30 Marker genes are often inserted into genetically engineered crop plant cells, along with desired genes. Bacterial antibiotic resistance genes are sometimes used as marker genes. These may include short DNA repeats to make them unstable so that they are quite quickly eliminated by the genetically engineered crop plant cells.

Which is **not** a reason why elimination by such marker genes is favoured?

A It is theoretically possible for the antibiotic resistance marker gene in human food to pass to bacteria in the human gut.
B It is difficult to carry out repeated transformations using the same antibiotic.
C The antibiotics may affect the growth and differentiation of the fields of crop plants.
D There are a few such antibiotic resistance marker genes available.

--- END OF PAPER –

[BLANK PAGE]

Copyright acknowledgements:

Acknowledgement is herein given to third-party sources for the use of third-party owned material protected by copyright in this document which is administered internally for assessment purposes only.