HWA CHONG INSTITUTION
JC2 Preliminary Examinations
Higher 2

CANDIDATE NAME		**CT GROUP**	**12S7____**
CENTRE NUMBER		**INDEX NUMBER**	

BIOLOGY

9648/01

Paper 1 Multiple Choice

27 September 2013

Additional Materials: Optical Mark Sheet

1 hour 15 minutes

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 **forty** 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.

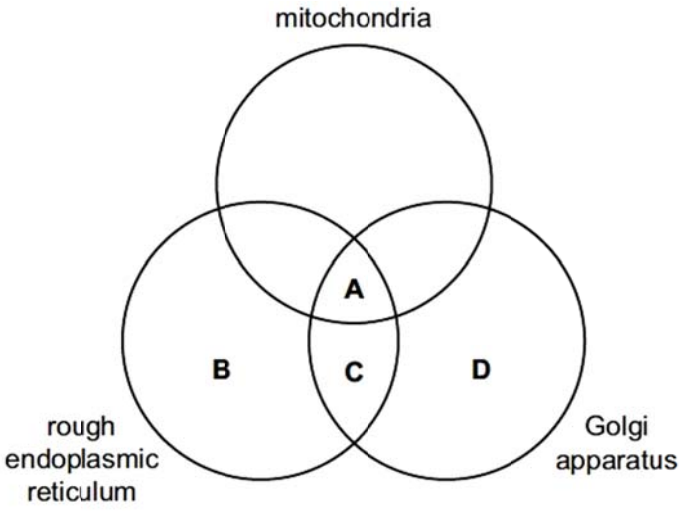
INFORMATION FOR CANDIDATES

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

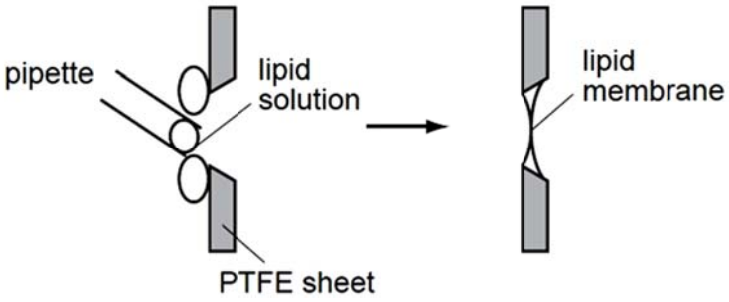
Any rough working should be done in this booklet.

Calculators may be used.

1 Which organelle(s) is / are required for the formation of the hydrolytic enzymes found in lysosomes?



2 Lipid membranes can be formed in the laboratory by painting phospholipids over a support (PTFE sheet) with a hole in it.



Such a lipid membrane is impermeable to water-soluble materials including charged ions such as Na^+ or K^+. In one experiment with Na^+ ions, no current flowed across the membrane until a substance called gramicidin was added.

Which statement is consistent with this information and your knowledge of membrane structure?

Gramicidin becomes incorporated into the membrane and is

A a carbohydrate molecule found only on the outside of the membrane.

B a non-polar lipid which passes all the way through the membrane.

C a protein molecule with both hydrophilic and hydrophobic regions.

D a protein molecule which has only hydrophobic regions.

3 The table shows the results of food tests carried out to identify two types of biomolecules.

test-tube	reagent added to test-tube		
	sodium hydroxide + copper sulphate	Benedict's solution	iodine in potassium iodide
X	purple	brick red	brown
Y	blue	blue	blue-black
Z	purple	blue	blue-black

Which conclusion is consistent with the results?

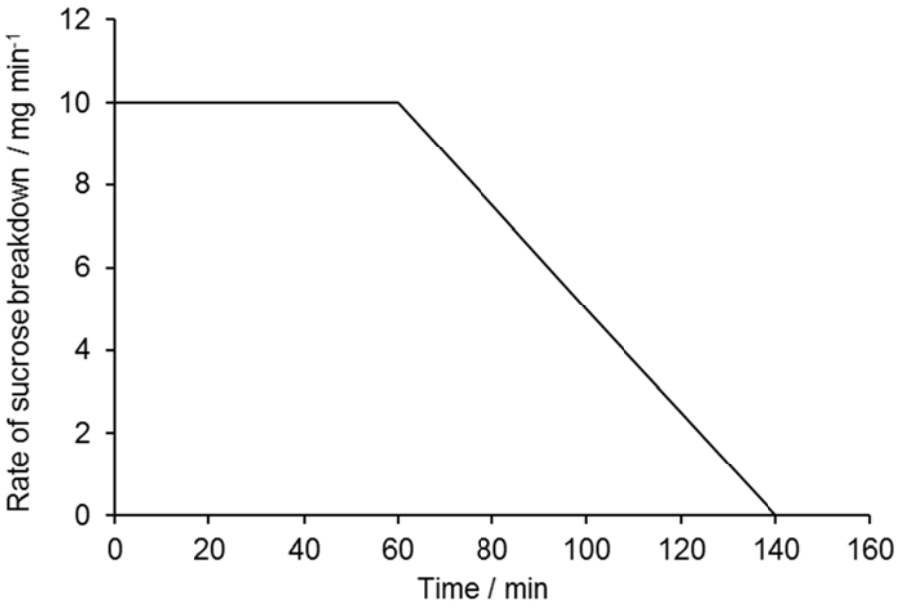
A Only albumen and sucrose had been placed in tube X.

B Only maltose and starch had been placed in tube Z.

C Only starch and sucrose had been placed in tube Y.

D Only starch and sucrose had been placed in tube Z.

4 The graph shows the results of an investigation using the enzyme invertase that breaks down sucrose into glucose and fructose. 1 g of sucrose was dissolved in 100 cm^3 water and 2 cm^3 of a 1 % invertase solution was added.



Which conclusion can be drawn from this information?

A Between 0 and 60 min, the concentration of the substrate remains constant.

B After 60 min, the concentration of enzymes becomes the limiting factor.

C At 140 min, some of the enzyme molecules are denatured.

D Between 60 and 140 min, the concentration of the substrate is the limiting factor.

5 The diagram shows a stage of mitosis in a cell. The amount of DNA present is 12 picograms (pg).

Which row correctly identifies the number of DNA molecules and amount of DNA in each nucleus at different stages of nuclear division?

	telophase of mitosis		telophase II of meiosis	
	number of DNA molecules	amount of DNA / pg	number of DNA molecules	amount of DNA / pg
A	12	6	6	3
B	24	12	12	6
C	12	12	6	3
D	24	6	12	6

6 Nocodazole is a chemical used in the study of mitosis. It causes all mitotic cells to be arrested at metaphase.

Which statement(s) correctly identify how nocodazole might work?

1 Inhibits chromatin condensing in the nucleus

2 Prevents replication of the centrioles

3 Stops sister chromatids migrating to opposite poles

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

7 A double-stranded DNA molecule is 10 kb long.

Which row correctly describes the structure of this DNA molecule?

	number of nucleotides	number of complete turns	length of DNA molecule / μm
A	10000	1000	3.4
B	20000	1000	0.34
C	20000	1000	3.4
D	20000	10000	3.4

8 An alien organism was found and investigated. Like eukaryotes, it has a linear double-stranded DNA genome. When DNA replication was examined, it revealed that although the process is semi-conservative, no Okazaki fragments were observed in all the multiple replication forks. In addition, the end-replication problem was not observed.

Which statement correctly explains this phenomenon?

A Alien DNA is antiparallel.

B Alien DNA replication only starts at the 3' end of each template strand.

C Alien DNA polymerase synthesises DNA in both 5' to 3' and 3' to 5' directions.

D Alien DNA ligase is not involved in the DNA replication process.

9 You have three different double-stranded DNA molecules, each of which you incubate (separately) in solution that is heated from 25 °C to 100 °C to denature the double-stranded molecules.

Molecule 1 is 1000 bp long and has a G-C content of 70 %.

Molecule 2 is 1000 bp long and has a G-C content of 50 %.

Molecule 3 is 2000 bp long and has a G-C content of 40 %.

Which statement is likely to be the correct prediction of the denaturation of these molecules?

A Molecule 2 will denature at the highest temperature.

B Molecule 3 will denature at the highest temperature.

C Molecules 1 and 2 will denature at a higher temperature than Molecule 3.

D All three molecules will denature at the same temperature.

10 Which statements correctly describe the structure and function of prokaryote ribosomes?

1 Prokaryote ribosomes are smaller than eukaryote ribosomes and sediment at 70S.

2 A prokaryote ribosome consists of two subunits, one of 50S and one of 30S.

3 In prokaryotes, ribosomes translate mRNA in the same cellular compartment in which it is transcribed.

4 In prokaryotes, ribosomes can begin translating mRNA before its synthesis has been completed.

5 A prokaryote ribosome can accommodate only one tRNA at a time.

A 1, 3 and 5 only

B 2, 4 and 5 only

C 1, 2, 3 and 4 only

D All of the above

11 Which statements about the genetic code are correct?

1 The genetic code has redundancy and is degenerate.

2 There is only one codon for the amino acid methionine.

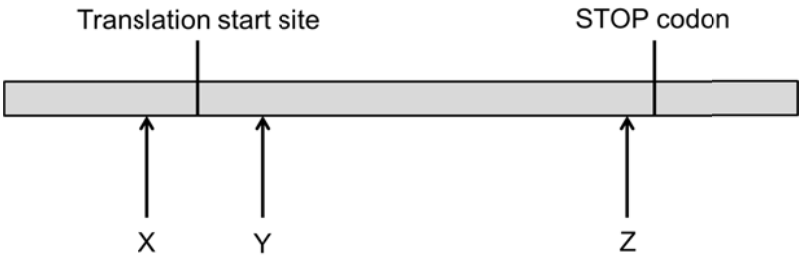
3 Codons act as 'stop' and 'start' signals during transcription and translation.

4 Prokaryotes generally use the same genetic code as eukaryotes.

5 mRNA codons have the same nucleotide sequence as DNA triplet codes.

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

12 During the process of transcription, errors sometimes occur such that certain nucleotides are repeated. These errors are often referred to as duplications. Duplications of nucleotide bases within genes vary in severity. Some result in non-functional proteins and others may have little or no effect on function. The diagram shows a strand of mRNA produced from a particular gene.



Which duplication event is most likely to lead to the synthesis of a non-functional protein?

A One base pair is duplicated at Z.

B Three base pairs are duplicated at X.

C One base pair is duplicated at Y.

D Three base pairs are duplicated at Y.

.

13 Which statement(s) about bacterial genetic transfer is / are **not** correct?

1 In transformation, only bacterial cells which possess competence factors in their chromosomes can take up naked DNA from the surroundings.

2 In generalised transduction, bacterial genes near the prophage insertion site on the donor chromosome can be transferred to the recipient cell via a T4 phage.

3 In conjugation, DNA replication of the F plasmid occurs in both donor and recipient cells.

4 Binary fission does not lead to variation in bacterial cells.

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

14 Which statements about viruses are correct?

1 They can only be seen under the electron microscope.

2 They possess DNA but not RNA.

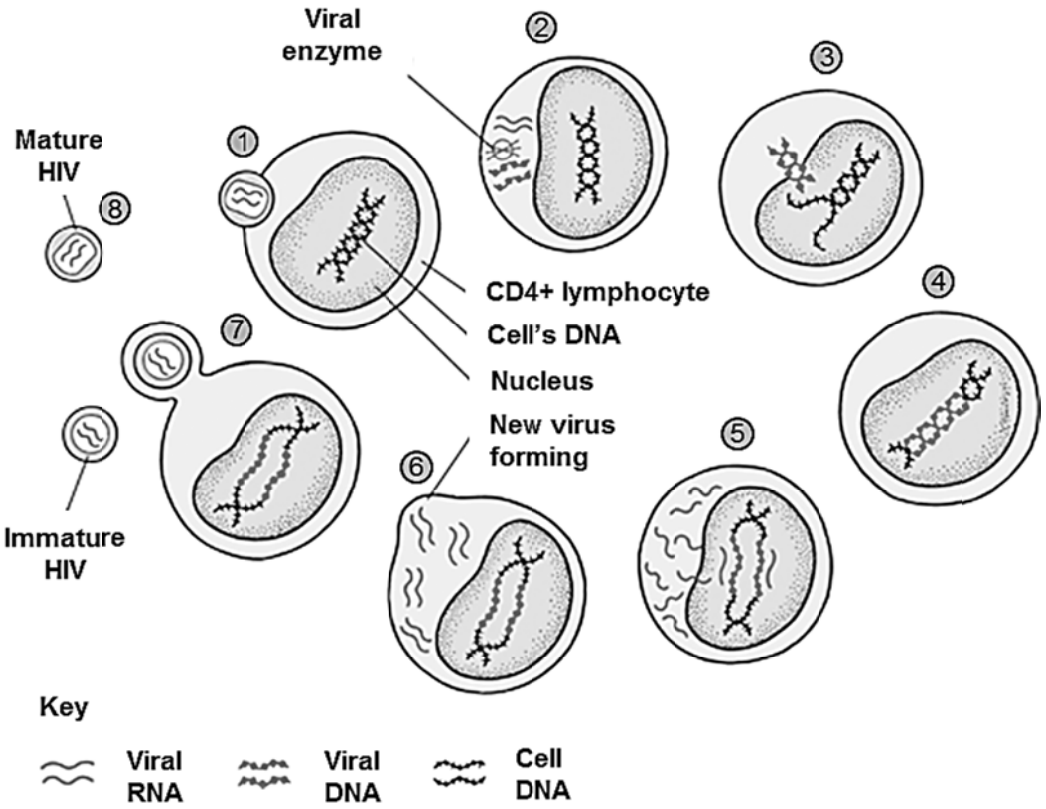
3 They have a simple structure based on nucleic acids, proteins and polysaccharides.

4 They are obligate parasites.

5 All possess a capsid made of capsomeres.

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

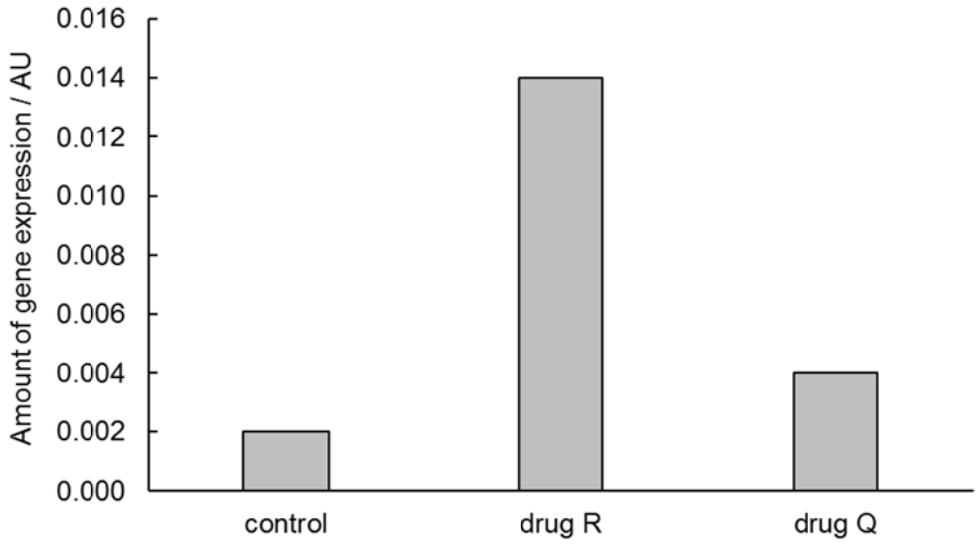
15 The diagram shows stages (1 to 8) of the reproductive cycle of a human immunodeficiency virus (HIV) in infecting a human CD4+ lymphocyte.



Which row correctly explains how the reproductive cycle of HIV can be arrested at the various stages?

	stage 1	stage 2	stage 4	stage 7
A	drugs that bind to gp120	inhibition of viral replicase	mutation in the HIV genome	inhibition of exocytosis
B	restriction endonucleases to cut the viral genome	inhibition of viral replicase	inhibition of integrase	inhibition of budding
C	drugs that bind to gp120	inhibition of reverse transcriptase	inhibition of integrase	inhibition of budding
D	restriction endonucleases to cut the viral genome	inhibition of reverse transcriptase	mutation in the HIV genome	inhibition of exocytosis

16 Drug R is a DNA methyltransferase inhibitor and drug Q is a histone deacetylase inhibitor. An experiment was carried out to investigate the effects of drug R and Q on expression of a gene. The graph shows the experimental results.



Which are possible explanations to the results shown?

1 Drug Q controls modification of histones, resulting in weaker binding of histones to DNA.

2 Drug Q increases gene expression by increasing accessibility of RNA polymerase to the promoter.

3 Drug R increases gene expression by preventing methylation at CpG islands at the promoter.

4 Inhibiting DNA methylation is more effective in increasing gene expression than inhibiting histone deacetylation.

A 1 and 2 only **B** 2 and 4 only **C** 1, 2 and 3 only **D** All of the above

17 The table compares the genomes of various organisms.

organism	classification	number of chromosomes	size of genome / Mb	approximate number of protein-coding genes
Haemophilus influenzae	bacteria	1	1.8	1700
Saccharomyces cerevisiae (yeast)	eukarya	16	12.1	5900
Drosophila melanogaster (fruit fly)	eukarya	4	180	13000
Oryza sativa (rice)	eukarya	12	440	50000
Canis familiaris (dog)	eukarya	39	2400	19000
Homo sapiens (human)	eukarya	23	3000	20000

Which statement can be concluded from the table?

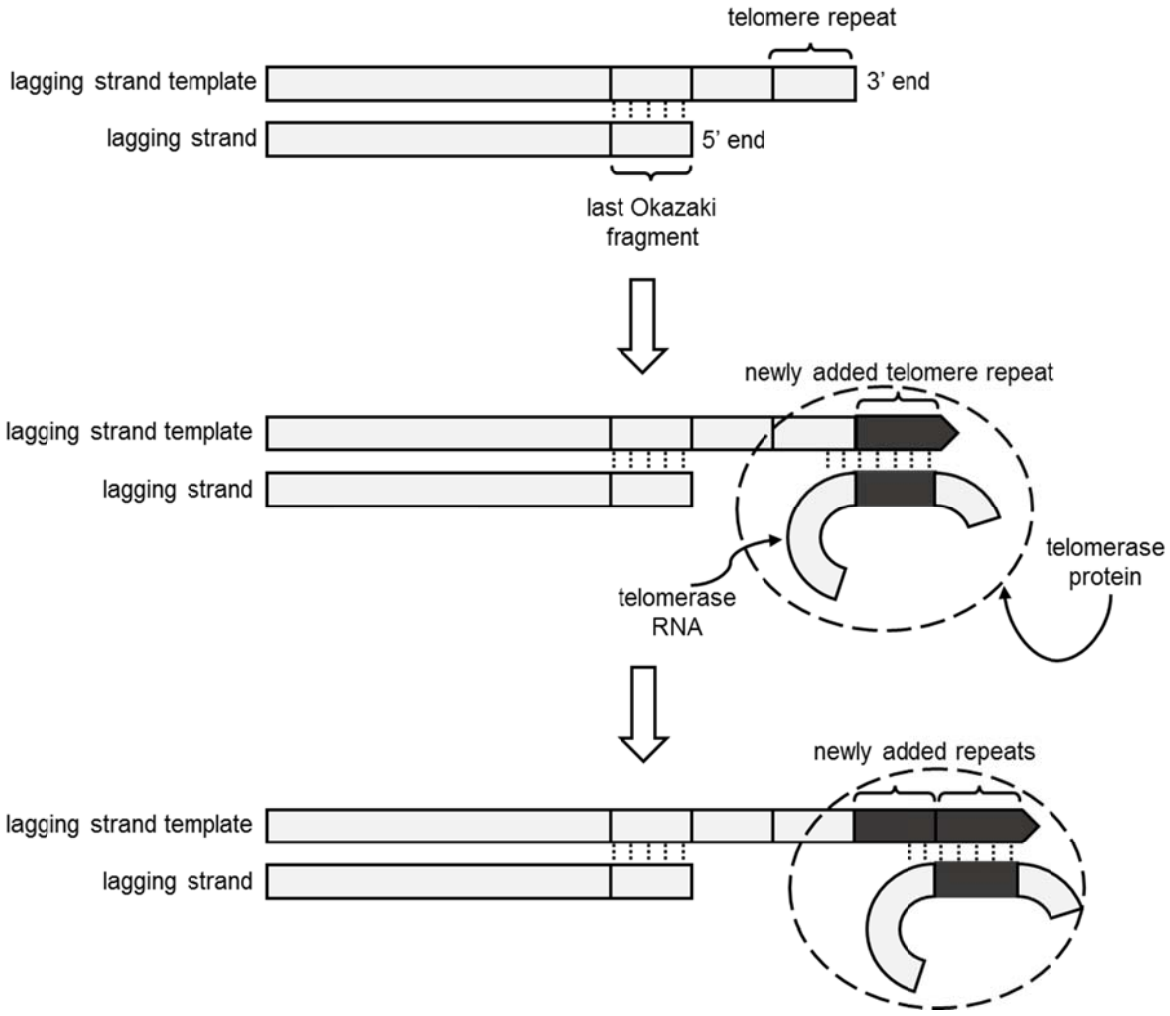
A There is no correlation between chromosome number and genome size.

B Presence of introns in the eukaryotes resulted in larger genomes and more chromosomes.

C The more genes there are, the larger the genome.

D The genes are smaller in *O. sativa*, hence it has a smaller genome.

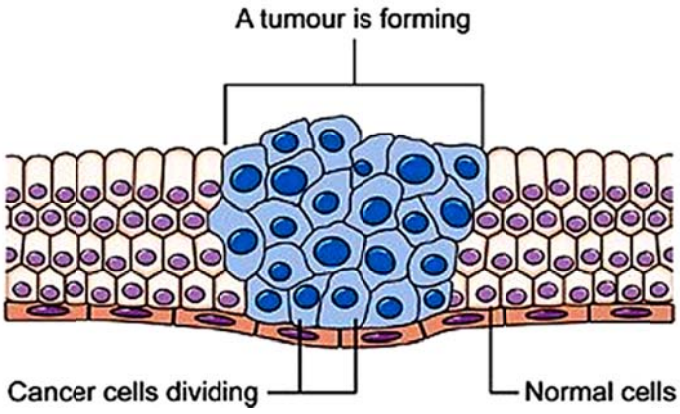
18 The flowchart shows the mechanism of telomerase action.



Which row correctly describes the roles of the respective molecules in telomerase action?

	telomerase RNA	lagging strand template	telomerase protein
A	acts as a ribozyme	acts as a template	acts as a DNA polymerase
B	acts as a primer	acts as a template	acts as a reverse transcriptase
C	acts as a template	acts as a primer	acts as a reverse transcriptase
D	acts as a ribozyme and a template	acts as a primer	acts as a terminal transferase

19 The diagram shows cancerous cells dividing in between normal cells.



Which statements can be concluded from the diagram?

1 Cancerous cells can undergo self-renewal due to the presence of telomerase.

2 Cancerous cells invade normal cells by undergoing excessive mitosis.

3 A tumour is a localised mass of cells.

4 A tumour is formed after undergoing through metastasis and angiogenesis.

A 1 and 2 only **B** 2 and 3 only **C** 1, 2 and 4 only **D** All of the above

20 A population of cats contains individuals with shortened tails known as Manx cats and individuals with normal tails known as non-Manx cats. Mating of two non-Manx cats always produced non-Manx cats. Mating of two Manx cats always produced a mixture of Manx cats and non-Manx cats, where the number of Manx cats is usually twice that of non-Manx cats.

Which hypothesis is consistent with these observations?

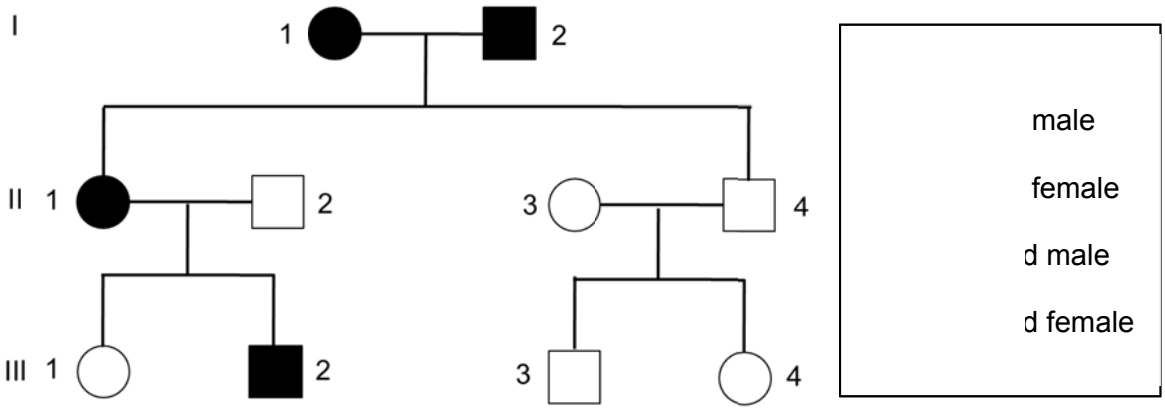
A The genes for shortened tails and normal tails are linked on the same chromosome.

B The genes for shortened tails and normal tails are sex-linked.

C The allele for shortened tails is dominant over the allele for normal tails, but the homozygous dominant genotype is lethal.

D The allele for shortened tails is dominant over the allele for normal tails, but the homozygous recessive genotype is lethal.

21 The pedigree shows inheritance of a dominant trait.



Which identifies the correct probabilities of the trait appearing in the offspring for the two marriages?

	probability of trait inheritance	
	marriage 1: III - 1 x III - 3	marriage 2: III - 2 x III - 4
A	0 %	50 % offspring
B	50 % offspring	0 %
C	0 %	50 % female offspring
D	50 % male offspring	50 % female offspring

22 In the fruit fly, recessive mutations in either of two independently assorting genes, brown and purple, prevents the synthesis of red pigments in the eyes. Thus, homozygotes of either of these mutations have brownish-purple eyes. However, heterozygotes for both of these mutations have dark red, that is, wild-type eyes.

If two flies which are both homozygous for a different mutation and heterozygous for the other corresponding mutation are crossed, what proportion of the progeny will be mutants?

A $\frac{7}{16}$ **B** $\frac{1}{2}$ **C** $\frac{2}{3}$ **D** $\frac{3}{4}$

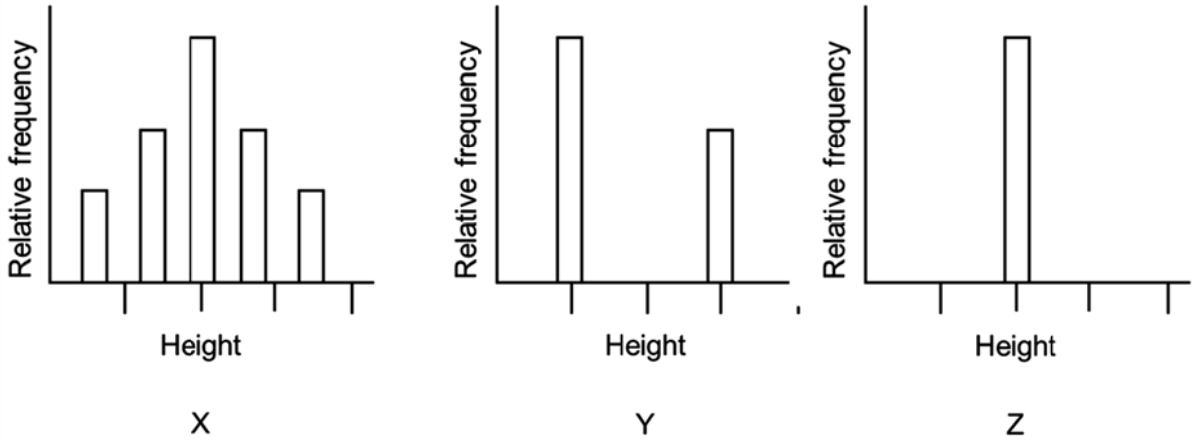
23 In a breed of rabbits, multiple alleles with the following dominance relationships control coat colouration: C (agouti) > c^{ch} (chinchilla) > c^{h} (Himalayan) > c (albino)

An experimental cross between agouti and Himalayan produced 50 % agouti and 50 % Himalayan progeny.

Which cross would have the lowest probability of producing this result?

A Cc^{h} x $c^{h}c^{h}$ **B** Cc x $c^{h}c$ **C** Cc^{h} x $c^{h}c$ **D** Cc x $c^{h}c^{h}$

24 The phenotypes of three experimental populations of plants X, Y and Z are shown in the graphs.



The three populations X, Y and Z represent, respectively, the

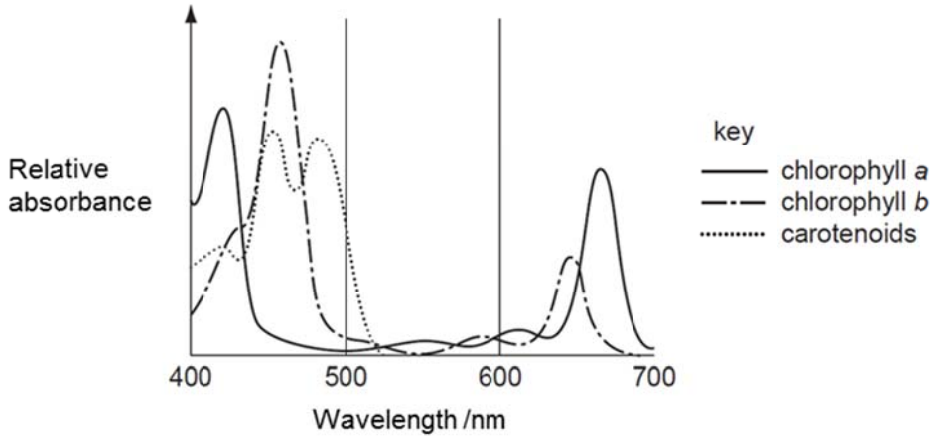
A F_1, F_2 and F_3 generations.

B P, F_1 and F_2 generations.

C F_2, P and F_1 generations.

D F_3, F_1 and F_2 generations.

25 The graph shows the absorption spectra of some pigments found in chloroplasts.



Which statement is **not** correct?

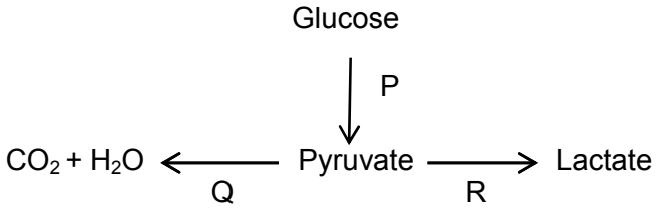
A Having several pigments, rather than one, increases the efficiency of photosynthesis.

B Most leaves are green as chlorophyll absorbs light in the blue and red regions of the spectrum.

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

D Prior to leaf fall, chlorophyll is broken down, leaving carotenoids which makes leaves look yellow or red.

26 The diagram shows the relationship between various metabolic processes.



Which statements are correct?

1 Acetyl coenzyme A is required for step Q.

2 Substrate level phosphorylation occurs in both steps P and Q.

3 There is a net increase in ATP during steps P, Q and R.

4 Oxidised form of NAD is used in steps P and R.

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

27 Mammalian liver cells were homogenised and the resulting homogenate centrifuged. Portions containing only mitochondria and cytosol (residual cytoplasm) were each isolated. Samples of each portion, and of the complete homogenate, were incubated in four ways:

1 with glucose;

2 with pyruvate;

3 with glucose plus cyanide; and

4 with pyruvate plus cyanide.

Cyanide inhibits carriers in the electron transport chain. After incubation, the presence or absence of carbon dioxide and lactate in each sample was determined. The results are summarised in the table below.

	samples of homogenate					
	complete		mitochondria only		cytosol	
	carbon dioxide	lactate	carbon dioxide	lactate	carbon dioxide	lactate
1 glucose	✓	✓	×	×	×	✓
2 pyruvate	✓	✓	✓	×	×	✓
3 glucose + cyanide	×	✓	×	×	×	✓
4 pyruvate + cyanide	×	✓	×	×	×	✓

× = absent, ✓ = present

Which statement can be concluded from the table?

A Carbon dioxide was not formed when mitochondria was incubated with glucose as there was no oxygen present.

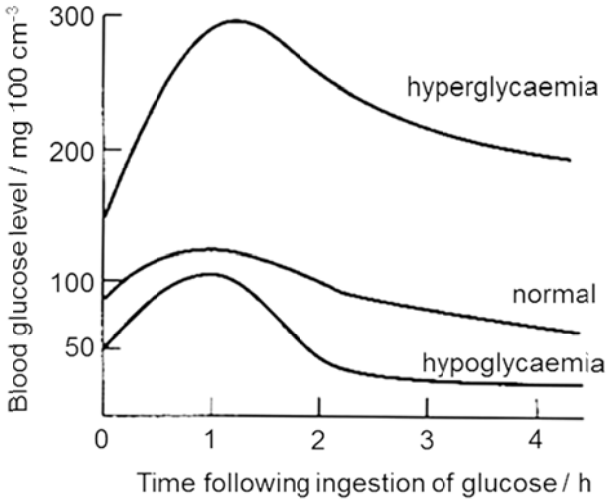
B Both aerobic and anaerobic respiration were occurring in 3.

C Lactate formation in mitochondria was inhibited by the presence of cyanide.

D The mode of action of cyanide would be similar to that of a cell experiencing anaerobic respiration.

28 A test was administered to evaluate blood glucose levels. Subjects were asked to fast for 12 hours before the start of the test. They were administered glucose at time 0 and then had blood samples drawn every 30 min for a total of 4 h 30 min.

A graph of blood glucose levels for normal, hyperglycaemic and hypoglycaemic individuals is shown. The values represent averaged data from ten subjects for each condition.



Why would a physician prescribe a diet consisting of several small meals to hypoglycaemic individuals?

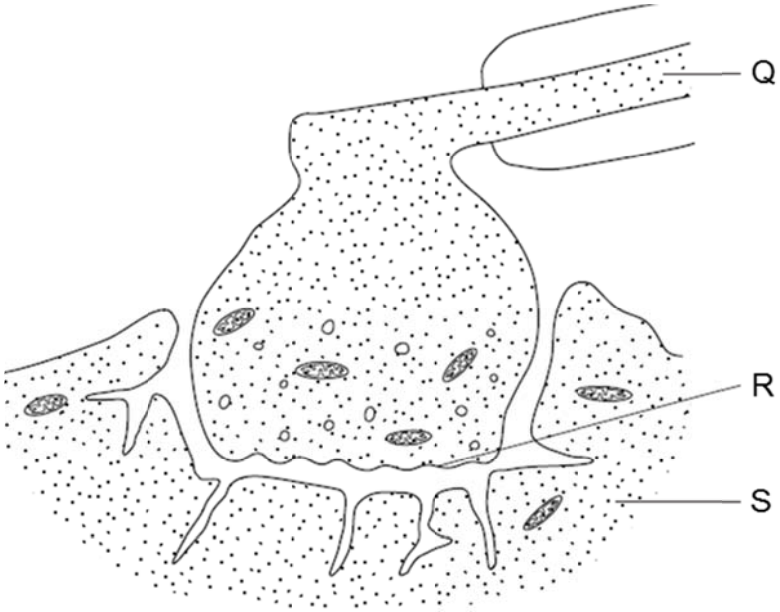
A to cause the pancreas to release more glucagon

B to cause the liver to convert more glucose to glycogen

C to rapidly decrease the blood glucose concentration

D to maintain a steady blood glucose concentration

29 The diagram shows a neuromuscular junction.



Which row shows the correct structure to function relationship?

	Q	R	S
A	axon allows for transmission of electrical impulse	post-synaptic membrane allows for exocytosis of neurotransmitters	muscle cell will undergo contraction upon receiving chemical signals
B	axon allows for movement of neurotransmitters from cell body to the post-synaptic membrane	pre-synaptic membrane allows for exocytosis of neurotransmitters	signal transduction will occur in cytoplasm of muscle cell upon activation of chemically-gated receptors
C	axon allows for transmission of electrical impulse	pre-synaptic membrane allows for exocytosis of neurotransmitters	signal transduction will occur in cytoplasm of muscle cell upon activation of chemically-gated receptors
D	axon allows for movement of neurotransmitters from cell body to the pre-synaptic membrane	post-synaptic membrane allows for exocytosis of neurotransmitters	muscle cell will undergo contraction upon receiving chemical signals

30 Gamma-aminobutyric acid (GABA) is a neurotransmitter that functions as a signalling molecule in the central nervous system. GABA binds to a receptor protein located in the plasma membrane of target cells as shown in Fig.1. Binding of a GABA molecule opens a channel that allows chloride ions (Cl^-) to enter the cell.

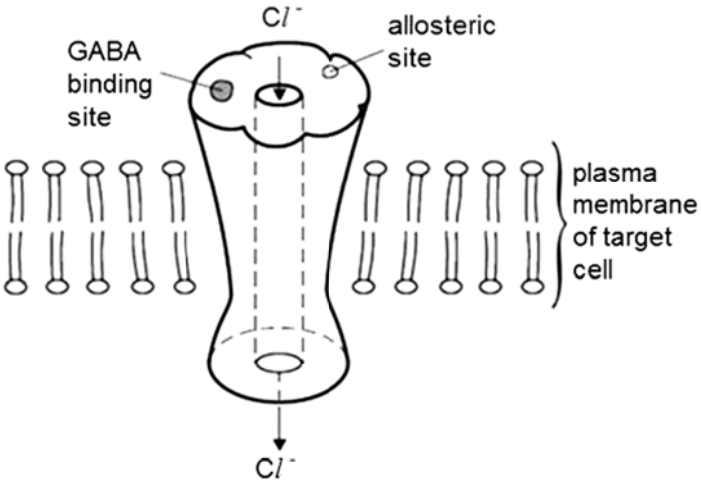


Fig. 1

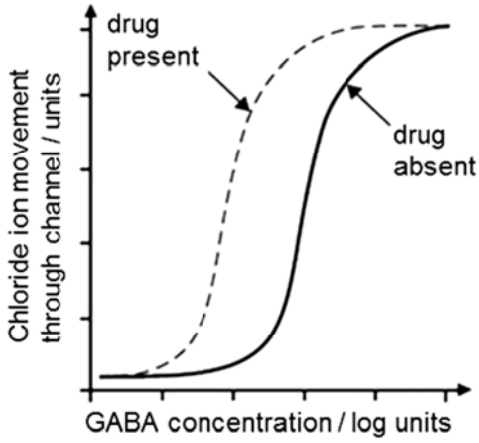


Fig. 2

In a treatment for seizures, Valium, a drug, acts as allosteric regulator by binding at a site that is away from the GABA-binding site. Fig. 2 shows the movement of chloride ions through the channel as GABA is increased with and without the drug being present.

Which statements are correct?

1 The GABA receptor is a multimeric protein.

2 Binding of Valium enhances the opening of the channel.

3 A depolarization occurs in the target cell.

4 Binding of Valium helps to open the channel even if GABA is not present.

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

31 Before the settlement of California in the 1800s, the elk population was very large. By about 1900 there were only a few dozen elk left. Owing to protection, there are now about 3000 elk living in a small number of isolated herds. Unfortunately, some of the elk in all the herds have difficulty grazing due to a shortened lower jaw.

Which statements best explain this?

1 The early settlers only hunted elk that could graze.

2 There was a mutation affecting jaw size.

3 There is random mating within each herd.

4 The current elk population demonstrates genetic drift.

5 There was directional selection favouring short jaws.

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

32 The following statements relate to molecular phylogenetics.

1 Lines of descent from a common ancestor to present-day organisms have undergone similar, fixed rates of DNA mutation.

2 Organisms with similar base sequences in their DNA are closely related to each other.

3 The number of differences in the base sequences of DNA of different organisms can be used to construct evolutionary trees.

4 The proportional rate of fixation of mutations in one gene relative to the rate of fixation of mutations in other genes stays the same in any given line of descent.

Which statements, when taken together, suggest the existence of a 'molecular clock' that enables scientists to estimate the time at which one species might have diverged from another?

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

33 Two organisms, P and Q are from the same order but from different families. Therefore organisms P and Q belong to

A different kingdoms.

B different phyla.

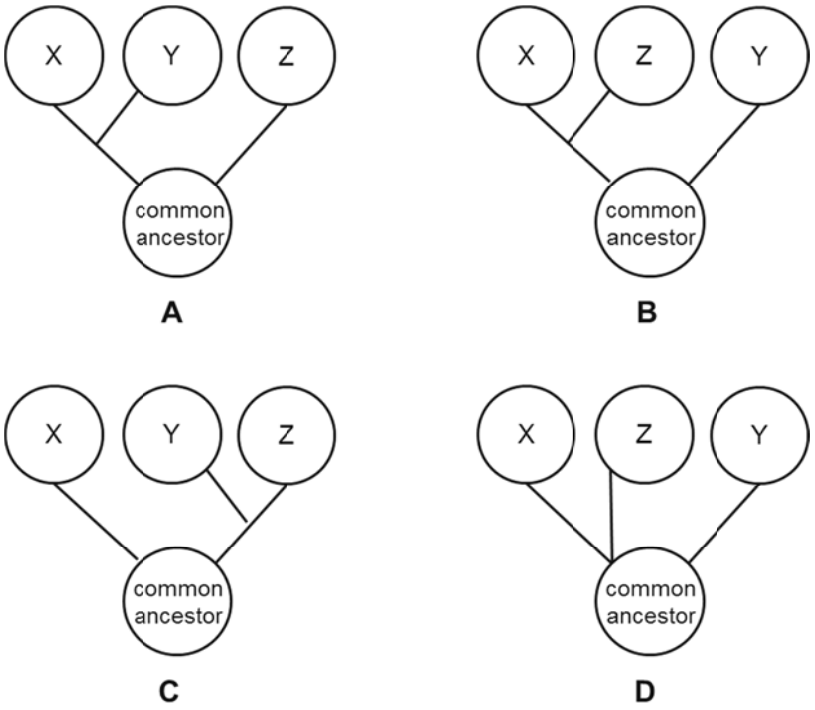
C the same genus.

D the same class.

34 Cytochrome c is a protein found in most organisms. The amino acid sequence of this protein varies between different species and can be used to determine evolutionary relationships. The table shows the numbers of differences in the amino acid sequences of cytochrome c between three species (X, Y, and Z).

	species Y	species Z
Species X	8	2
Species Y	0	9

Which diagram best represents the evolutionary relationships between species X, Y and Z?



35 *Hind* III is a restriction endonuclease commonly used to cut human DNA into pieces before inserting it into a plasmid.

Which is most likely to be the recognition sequence for this enzyme?

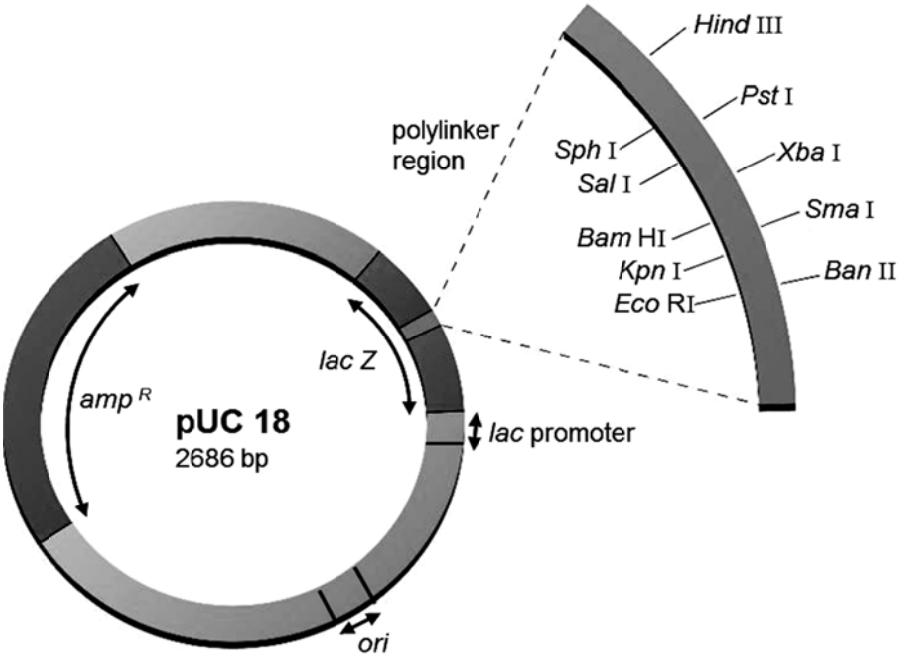
A AAGGAA

B AAGAAG

C AAGTTC

D AAGCTT

36 The diagram shows a vector, pUC18, used in genetic engineering.



Which statements are true for the use of pUC18 in genetic engineering?

1 Gene of interest is inserted into the *lac* promoter.

2 Gene of interest is inserted into the polylinker.

3 Bacteria colony with successfully inserted gene of interest will appear white in colour.

4 Bacteria colony with this vector will grow in agar plate with ampicillin.

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

37 Which statement is correct?

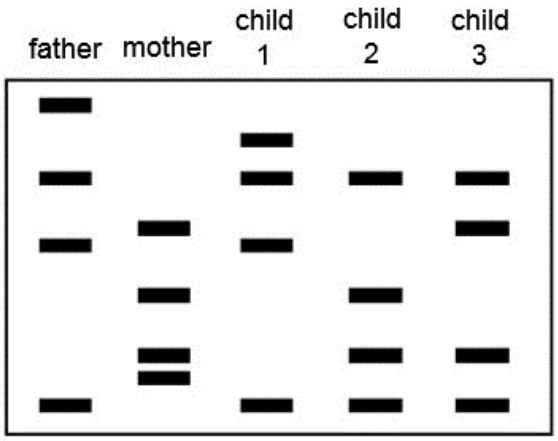
A Clones isolated from cDNA libraries contain promoter sequences.

B Restriction endonucleases cut DNA at specific sites that are always located between genes.

C To make a cDNA library, either a reverse transcriptase or a restriction endonuclease, but not both, can be used.

D It is possible for a coding region of a gene to be present in a genomic library prepared from a particular tissue but absent from cDNA library prepared from the same tissue.

38 DNA fingerprinting is often used to confirm the identity of an individual. The diagram shows a small section of the gel electrophoresis results from a DNA fingerprinting analysis of a family.



Which of the children is least likely to be the offspring of both parents?

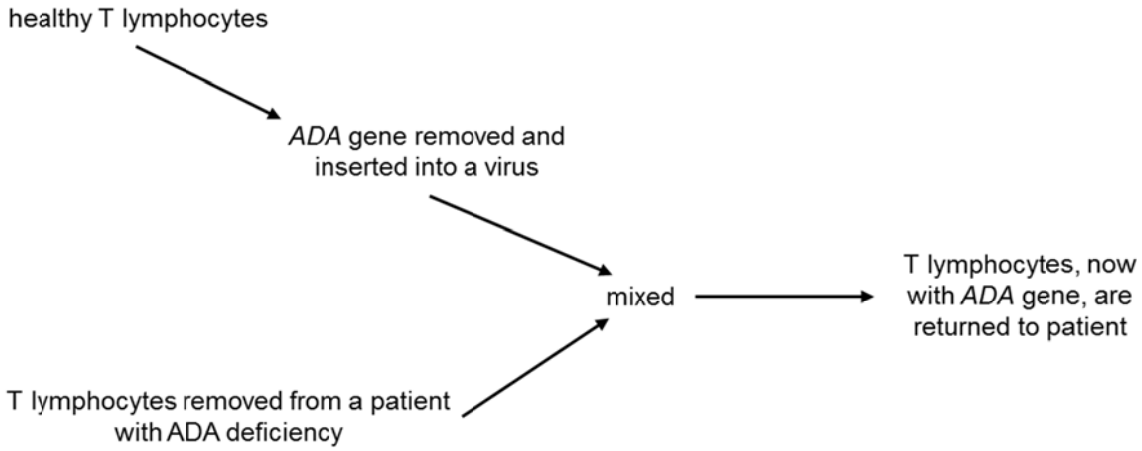
A child 1

B child 2

C child 3

D all of the children are definitely offspring of both parents

39 The diagram shows a gene therapy approach for SCID.



Which factors prevent this gene therapy approach from becoming an effective treatment for the patient?

1 The patient may develop leukaemia.

2 The virus may lyse the target T lymphocyte.

3 The normal ADA allele may be passed to the next generation.

4 This approach may not be permanent, thus continual gene therapy is necessary.

A 1 and 4 only

B 2 and 3 only

C 1, 2 and 4 only

D 1, 3 and 4 only

40 What are the arguments against the use of genetically modified organisms (GMOs)?

1 Insufficient testing of genetically modified crop for their side effects

2 Unforeseen long-term effects of genetic manipulation

3 Accidental genetic recombination in humans as a result of consuming food derived from GMOs

4 Control of food supply by a small number of companies that have access to genetic engineering technology

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

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