VICTORIA JUNIOR COLLEGE
BIOLOGY DEPARTMENT
JC2 PRELIMINARY EXAMINATIONS 2016
Higher 2

CANDIDATE NAME

CLASS

BIOLOGY 9648/01

Paper 1 Multiple Choice **22 September 2016**

1 hour 15 minutes

Additional Materials: Multiple Choice Answer Booklet

READ THESE INSTRUCTIONS FIRST

Write in a soft pencil.
Do not use any staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided.

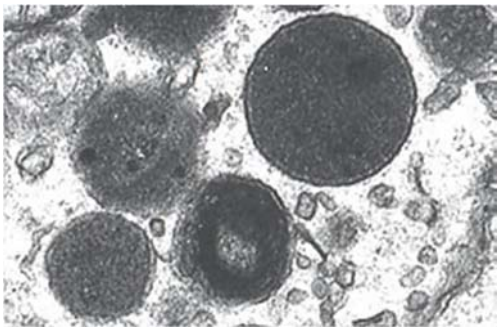
There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deduced for a wrong answer.
Any rough working should be done in this booklet

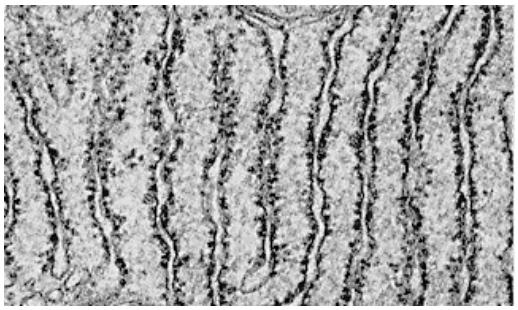
1. The electron micrographs of several structures of a liver cell are shown below.

1



2

3



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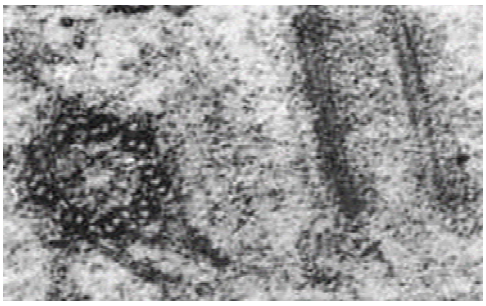
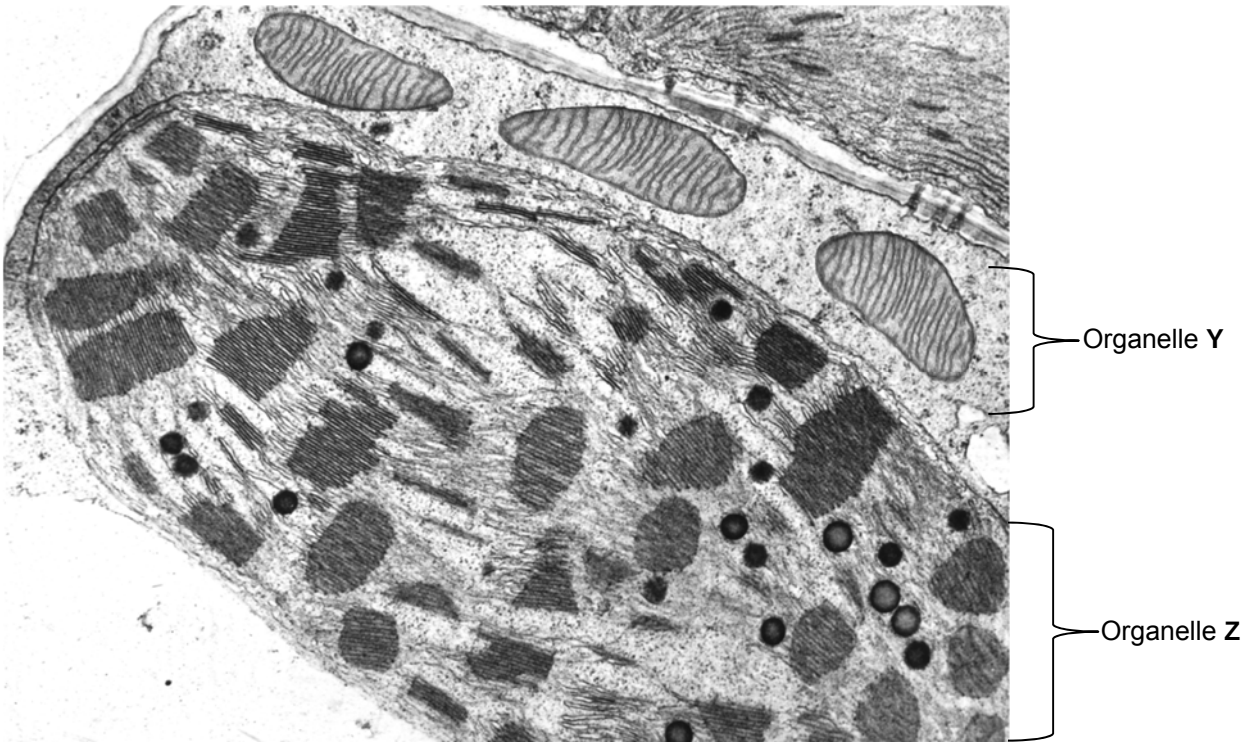


Radioactive amino acids were introduced into the cell to trace the path taken in the formation of hydrolytic enzymes.

Which of the following options correctly show the time taken, in minutes, for radioactivity to be detected in the structures **1 – 4**.

	Time taken, in minutes, for radioactivity to be detected in structure			
	1	**2**	**3**	**4**
A	3	10	20	30
B	30	20	3	-
C	10	20	30	3
D	20	10	3	30

2. The electron micrograph below shows two organelles **Y** and **Z** in a leaf mesophyll cell of a plant.



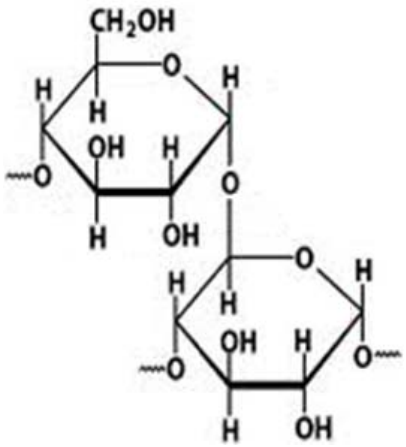
Which of the following statements are **not** true about organelles **Y** and **Z**?

1 Organelle **Z** utilises transporters to export ATP to organelle **Y** to drive cellular activities.
2 Oxygen released by organelle **Z** is used in organelle **Y** during glycolysis.
3 Transcription and translation occurs in both organelles.
4 Organelle **Y** has electron transport chain proteins but organelle **Z** does not.

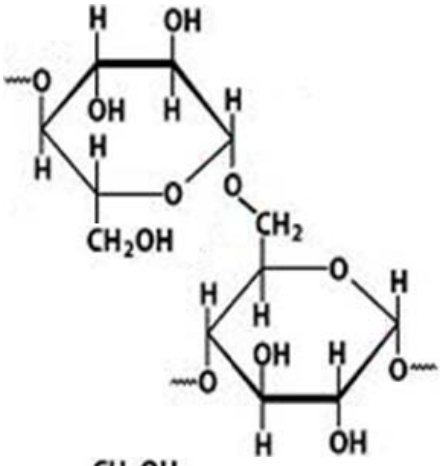
A 1 and 2 only
B 3 and 4 only
C 1, 2 and 4
D All of the above

3. Which of the following correctly shows an α 1,6 glycosidic bond found in amylopectin?

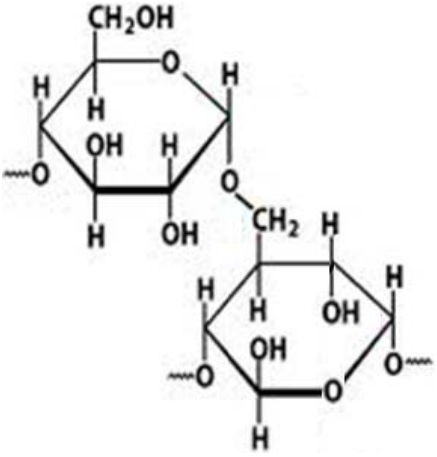
A



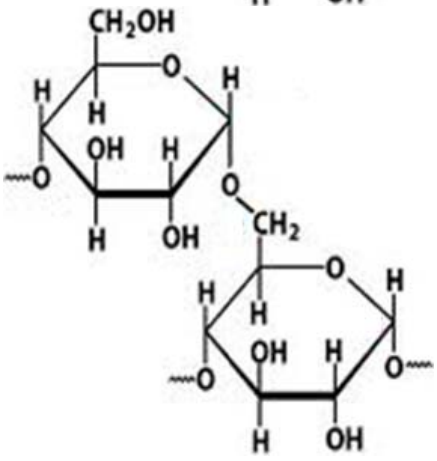
B



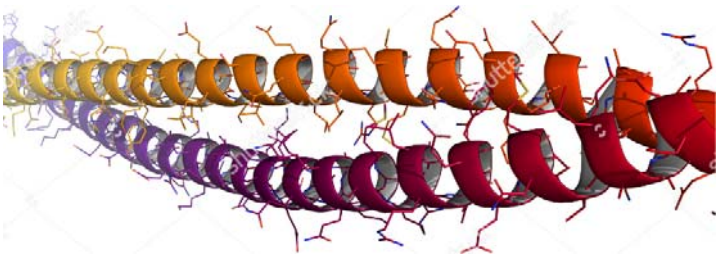
C



D



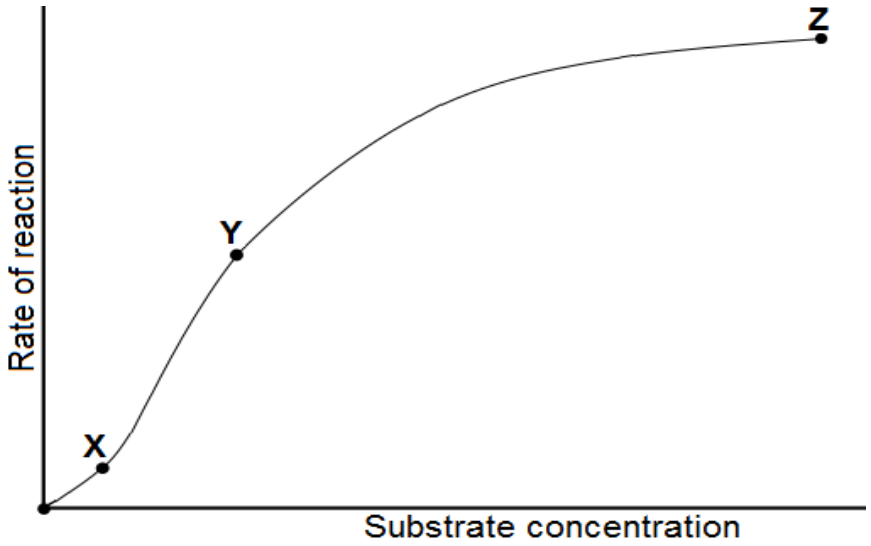
4. The diagram below shows the structure of a protein found in the hair, claws and horns of many animals.



Which of the following is true about the protein?

A The polypeptides are arranged in a staggered manner to increase in stability.
B The protein is insoluble in water due to hydrophobic R groups on the exterior.
C The secondary structure of the protein is maintained by hydrogen bonds between R groups.
D Every third amino acid is a proline.

5. The graph below shows the effect of increasing substrate concentrations on the activity of an allosteric enzyme under optimum conditions.



Which of the following statements is correct?

A There is low kinetic energy at **X** to overcome the activation energy, thus resulting in a low rate of reaction.
B Rate of reaction increases at a faster rate at **Y** as the allosteric activator outcompetes the allosteric inhibitor to bind to the allosteric site.
C At **Z**, enzyme molecules are in the active state and active sites are saturated.
D Substrate concentration is the limiting factor at **X** and **Y** but temperature is the limiting factor at **Z**.

6. Which of following statements regarding the fluid mosaic model are correct?

1 Fluidity of the membrane is a result of hydrophilic and hydrophobic interactions between components of the membrane.
2 Cholesterol maintains the fluidity of membrane by preventing the two layers of phospholipids from moving too far away from each other.
3 The attachment of different carbohydrates to the components of the membrane gives the look of a mosaic.
4 Fluidity of the membrane allows for the entry and release of influenza viruses.
5 Cholesterol increases membrane fluidity by binding to the phospholipid tails which causes the tails to bend.

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

7. An experiment was conducted to determine the mode of entry of a drug into animal cells. Cells which did not contain the drug were placed into separate containers with different concentrations of the drug. The concentrations of the drug inside the cells at the end of 10 minutes were obtained. The experiment was conducted in 2 different temperatures. The results are shown in the tables below.

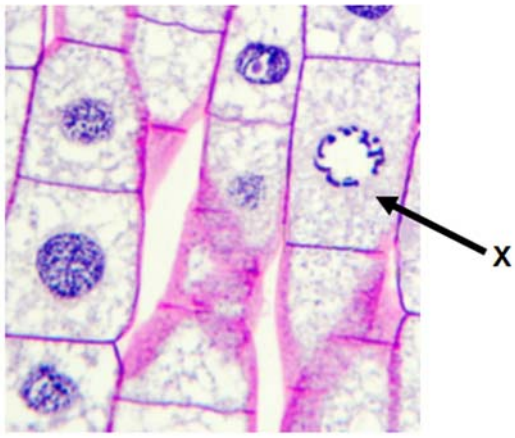
Experiment conducted in 20ºC	
Concentration of drug in the container / moldm^{-3}	**Concentration of drug inside the cells after 10 minutes / moldm^{-3}**
0	0
10	4
20	7
30	11
40	13
50	13
60	13

Experiment conducted in 30ºC	
Concentration of drug in the container / moldm^{-3}	**Concentration of drug inside the cells after 10 minutes / moldm^{-3}**
0	0
10	5
20	9
30	14
40	20
50	20
60	20

Which of the following statements is incorrect?

A The drug molecule is hydrophilic and water-soluble.
B A drastic change in extracellular pH will decrease rate of drug entry.
C No ATP is required for the entry of the drug.
D Increasing membrane fluidity results in faster drug entry.

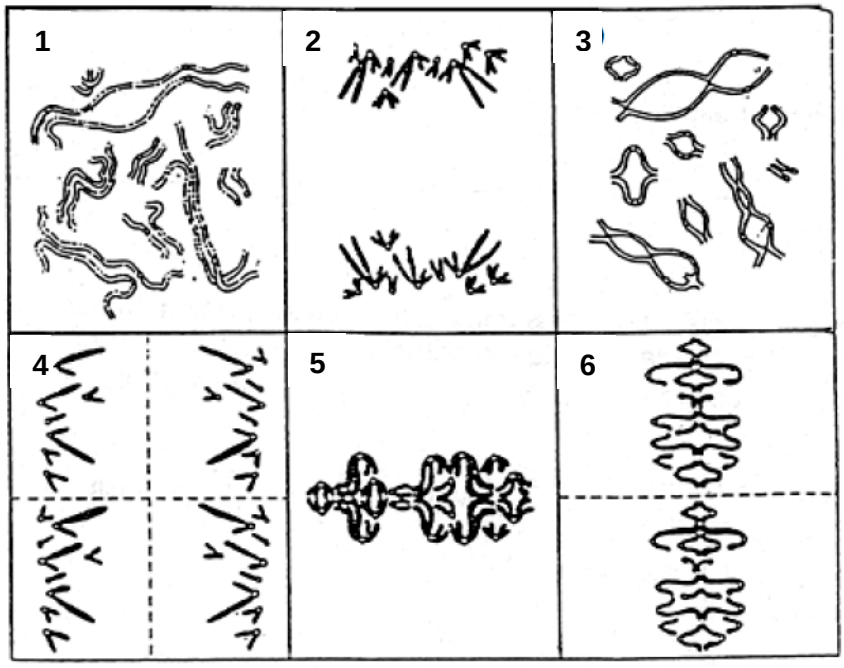
8. X shows a cell at a particular stage of cell division.



For the next stage in this nuclear division, what would be correct?

	Centrioles	Nuclear envelope	Paired chromatids
A	present	breaking down	absent
B	absent	reforming	present
C	present	absent	present
D	absent	absent	absent

9. The figure below shows 6 stages of the process of meiosis occurring in a plant cell. (2n = 18)



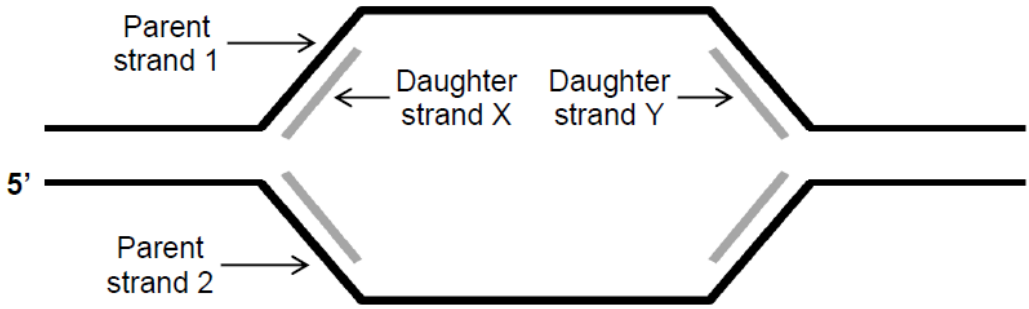
What is the correct order of these 6 stages?

A 3, 5, 2, 6, 4, 1
B 3, 1, 5, 2, 6, 4
C 2, 3, 1, 5, 6, 4
D 1, 3, 5, 2, 6, 4

10. The table below shows the events that occur at different stages of the cell cycle. Which row shows the correct event for the respective stages?

	Late interphase	**Prophase I**	**Metaphase I**	**Anaphase II**
A	DNA replication	condensation of chromosomes	alignment of chromosomes at the equator	separation of chromosomes
B	DNA replication	pairing of bivalents	alignment of bivalents at the equator	separation of sister chromatids
C	protein synthesis	crossing over	alignment of bivalents at the equator	separation of sister chromatids
D	replication of organelles	pairing of bivalents	alignment of chromosomes at the equator	separation of chromosomes

11. A simplified representation of a replication bubble is shown in the figure below. Parental strands 1 and 2 and the growing daughter strands X and Y are indicated.



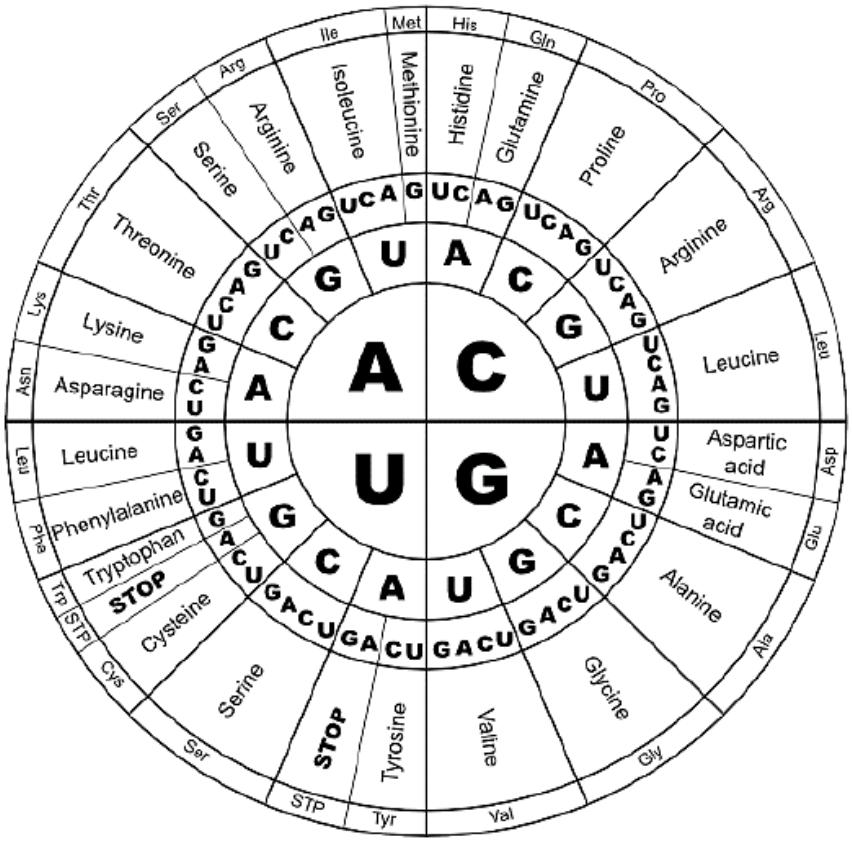
Which of the following statements about the syntheses of daughter strands X and Y is correct?

A Daughter strands X and Y are synthesised away from their respective replication forks.
B Daughter strand X is synthesised continuously while daughter strand Y is synthesised in the form of Okazaki fragments.
C Daughter strand X is synthesised in the 5' → 3' direction while daughter strand Y is synthesised in the 3' → 5' direction.
D DNA ligase will eventually catalyse the fusion of daughter strand X with daughter strand Y.

12. The first five DNA triplets that code for a particular protein is shown below:

3' CAC GGA AGC CCA GAA 5'

The genetic information in the sequence above is eventually converted into a specific amino acid sequence according to the figure below.

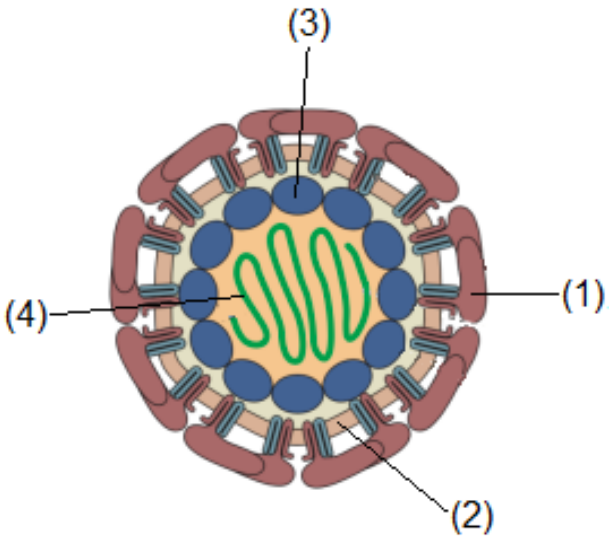


With the aid of figure, what is the sequence of the protein encoded by the DNA sequence above?

A His – Gly – Ser – Pro – Glu
B Val – Pro – Ser – Gly – Leu
C Lys – Thr – Arg – Arg – His
D Phe – Try – Ala – Ser – Val

13. Zika virus, formerly a neglected pathogen, has recently been associated with microcephaly in foetuses, and with Guillian–Barré syndrome in adults. Recent research into its structures and replication cycle has aided medical scientists in designing potential vaccines against the virus.

The diagram below shows the structure of Zika virus.



Which of the following shows correctly the components of each labelled structure in the diagram?

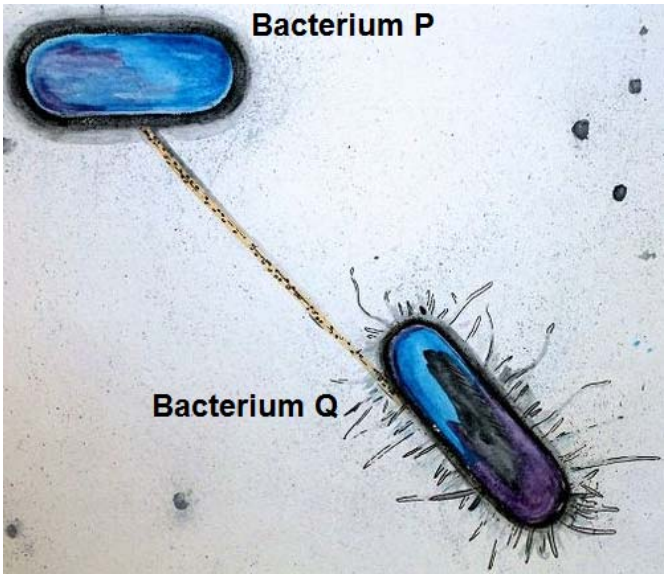
	(1)	(2)	(3)	(4)
A	Lipids	Phospholipids	Protein	DNA
B	Protein and carbohydrates	Phospholipids and cholesterol	Protein and carbohydrates	DNA
C	Protein and carbohydrates	Phospholipids and cholesterol	Protein	RNA
D	Carbohydrates	Phospholipids	Protein and carbohydrates	RNA

14. Which of the following are valid comparison between the replication cycles of a lambda phage and HIV?

1 Both replication cycles involve uncoating to release viral genome into the cytoplasm.
2 The protein involved in receptor binding for HIV is attached with short carbohydrate chains but not lambda phage.
3 The synthesis of viral proteins in both viruses involves transcription of viral DNA and translation.
4 Both involve the insertion of viral DNA into host genome and may cause insertional mutagenesis leading to uncontrolled cell division.
5 The replication cycle of HIV involves enzymes not coded by the host genome but not lambda phage.

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

15. The following shows a process taking place among prokaryotic cells.



Which of the following is false regarding the process?

A The ability of a bacterium to carry out the process is conferred by genes present on a plasmid.
B RNA primers are needed to provide free 3' OH ends for DNA replication in both bacteria.
C The DNA is linear as it is being transferred between the two bacteria via the cytoplasmic bridge.
D Genes transferred from bacterium P to bacterium Q are not essential for survival normally but are beneficial under stressful conditions.

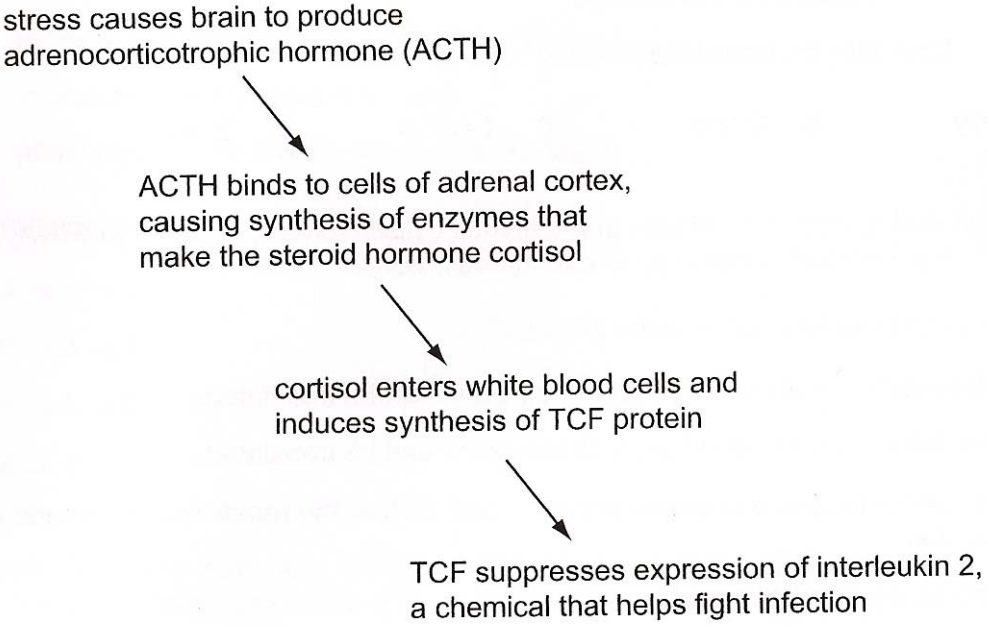
16 Some steps involved in bacterial binary fission are listed below.

1 Breaking of hydrogen bonds in DNA
2 Formation of cell membrane and cell wall between DNA
3 Attachment of DNA to mesosome
4 Bidirectional DNA replication
5 Separation of DNA due to cell elongation

Which of the following shows the correct sequence of events in binary fission?

A 3 → 1 → 4 → 5 → 2
B 3 → 4 → 5 → 1 → 2
C 1 → 4 → 3 → 5 → 2
D 1 → 3 → 5 → 4 → 2

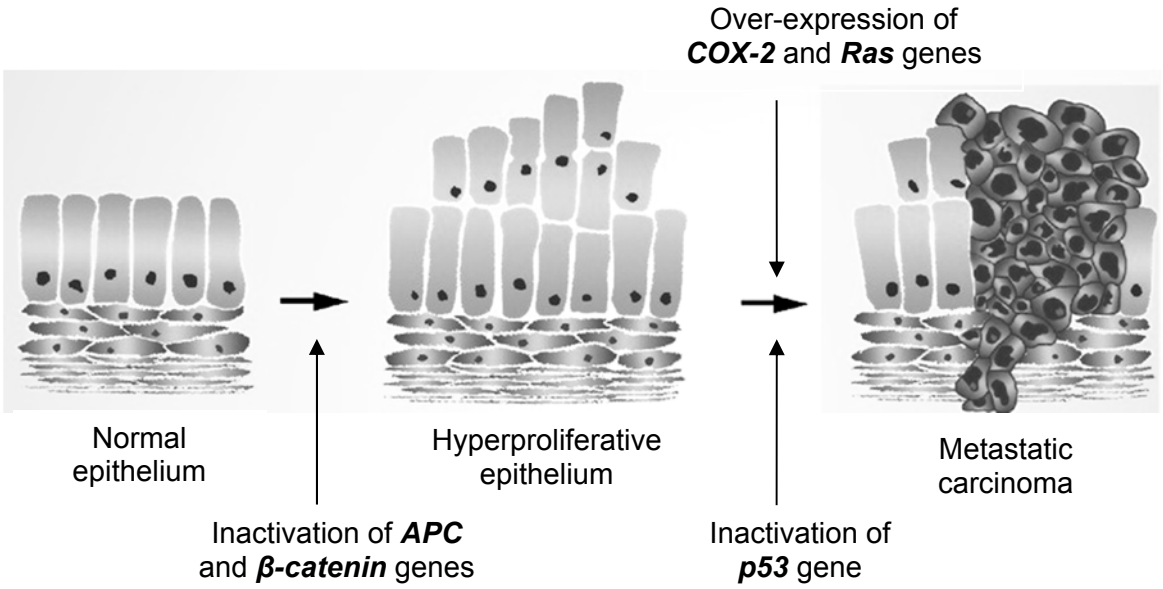
17. When a person undergoes a stressful experience, their immune system can be depressed and they become more susceptible to infection. Some of the elements involved in this chain of events are shown in the diagram below.



Which combination correctly shows the genes that are likely to have transcription-enhancing factors bound to their control elements during the above sequence of events?

	Gene for ACTH	Gene for TCF	Gene for interleukin 2
A	✓	X	X
B	X	✓	✓
C	✓	✓	X
D	X	X	✓

18. The diagram below illustrates the development of colorectal cancers.



Which of these statements can be inferred from this multistep model of carcinogenesis?

1 Cells whose *APC* and *β-catenin* genes are inactivated have lost contact inhibition and can form a tumour mass.
2 *APC* and *β-catenin* genes are tumour suppressor genes
3 High levels of *Ras* protein are produced only when both copies of *Ras* gene are mutated.
4 Two copies of normal *p53* alleles must be present to inhibit cell division
5 Gain-of-function mutation in *COX-2* gene is a pre-requisite for the formation of metastatic carcinoma.

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

19. Which of the following **do not** provide a possible mechanism for the production of a wide number of types of antibody proteins from a small number of genes?

1 gene amplification
2 alternative splicing
3 crossing over and random segregation
4 deletions and random translocation of DNA segments

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

20. The fur colour of hamsters is controlled by a gene with 3 alleles. The phenotypes are black, brown and white fur. 4 crosses were repeated many times. The crosses and the outcomes of these crosses are shown in the table below.

Cross	Parents	Offspring phenotype and ratio
1	black x black	3 black : 1 white
2	brown x white	1 brown : 1 white
3	black x black	3 black : 1 brown
4	white x white	all white

From the data, it is possible to conclude that

A brown fur is recessive to white fur.

B all of the white fur offspring are heterozygous.

C two thirds of the black fur offspring in cross **3** are heterozygous.

D the black fur parents in cross **1** have the same genotype as the black fur parents in cross **3**.

21. Fruit flies *Drosophila* homozygous for long wings, were crossed with flies homozygous for vestigial wings. The F_1 and F_2 generations were raised at three different temperatures.

At each temperature, the F_1 generation all had long wings.

The table below shows the results in the F_2 generation.

Temperature	***Result***
21°C	¾ long wings, ¼ vestigial wings
26°C	¾ long wings, ¼ intermediate wing length
31°C	all long wings

Which statement explains these results?

A Wing length is under polygenic control.

B Long wing and vestigial wing illustrate codominance at 26°C.

C Heterozygous flies have vestigial wings only at 21°C or below but have long wings at 31°C or above.

D Vestigial wing allele is recessive but causes a vestigial wing phenotype only at lower temperatures.

22. In cattle, the gene responsible for normal development of hair and teeth, ectodysplasin 1 (*ED1*) is located on the X chromosome. Mutations in the *ED1* gene result in a rare genetic disorder, anhidrotic ectodermal dysplasia. Another character, the presence of horns, is determined by a gene on an autosome. The allele for the absence of horns (**H**) is dominant and the allele for the presence of horns (**h**) is recessive.

A horned bull with anhidrotic ectodermal dysplasia was mated on several occasions to the same female. A large number of offspring consisting of males and females in equal numbers in all combinations of phenotypes are shown in the table.

Offspring phenotypes
No anhidrotic ectodermal dysplasia, horns present
No anhidrotic ectodermal dysplasia, horns absent
Anhidrotic ectodermal dysplasia, horns present
Anhidrotic ectodermal dysplasia, horns absent

If $\mathbf{X^E}$ represents an X chromosome carrying the normal *ED1* allele and $\mathbf{X^e}$ represents an X chromosome carrying the *ED1* allele for anhidrotic ectodermal dysplasia, what is the genotype of the female parent?

A $\mathbf{X^EX^EHH}$

B $\mathbf{X^EX^EHh}$

C $\mathbf{X^EX^eHH}$

D $\mathbf{X^EX^eHh}$

23. Which of the following statements are true?

1 Continuous variation is controlled by the additive effects of polygenes.

2 Continuous variation is always affected by the environment.

3 Discontinuous variation is sometimes affected by the environment.

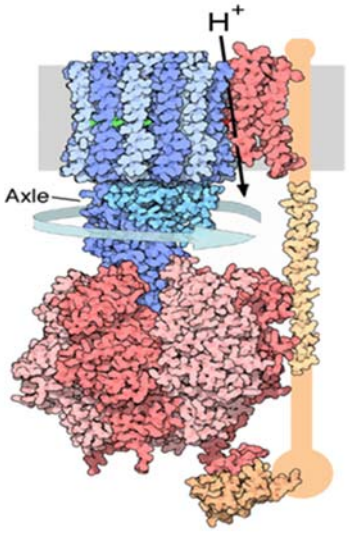
4 Discontinuous variation exhibits a normal distribution curve.

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

24. A man and a woman, both with normal colour vision, have a colour-blind boy together. The woman is pregnant for a second time, and the doctor tells her she is carrying twins of one boy and one girl. What is the chance that both twins will have normal colour vision?

A 0%
B 25%
C 50%
D 100%

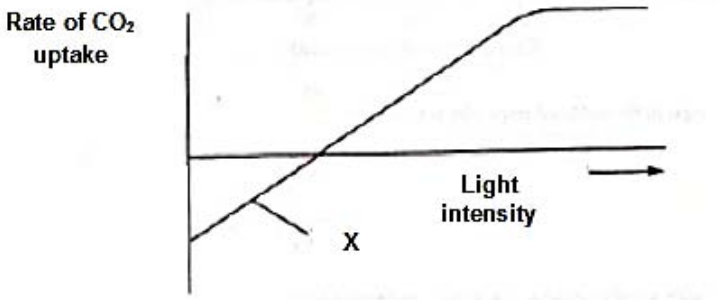
25. The diagram below shows a transmembrane protein that is involved in photophosphorylation



Which of the following statements are true

A It utilises the energy of ATP to do work.
B Its activation results directly in the production of water
C It carries out an oxidation reaction
D It transports ions through it via facilitated diffusion

26. In the graph below, the rate of CO_2 uptake by green algae cells is shown to vary with increasing light intensity.



Which of the following is true at point **X**?

A The algae cells are photosynthesising.
B Rate of carbon fixation by the calvin cycle equals rate of respiration.
C CO_2 is a limiting factor.
D There is not enough light for photosynthesis to have commenced.

27. A mitochondria suspension obtained from liver cells is prepared for investigations of the products of respiration. Acetyl-CoA is added to the suspension.

Which of the following correctly matched the products of Krebs cycle for every oxidation of one glucose molecule in this mitochondria suspension?

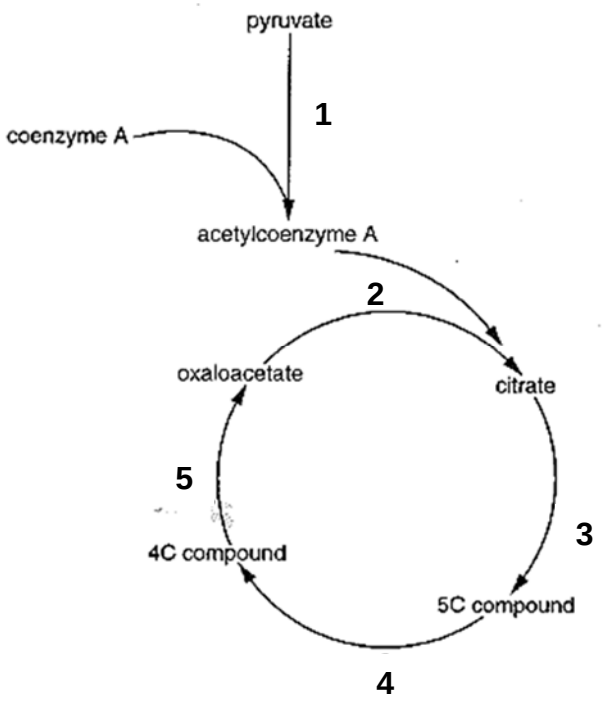
	Product	**Krebs cycle / glucose**
A	ATP	1
	Reduced NAD	3
	Reduced FAD	1
	CO_2	2

	Product	**Krebs cycle / glucose**
B	ATP	2
	Reduced NAD	6
	Reduced FAD	2
	CO_2	4

	Product	**Krebs cycle / glucose**
C	ATP	4
	Reduced NAD	4
	Reduced FAD	2
	CO_2	2

	Product	**Krebs cycle / glucose**
D	ATP	4
	Reduced NAD	6
	Reduced FAD	2
	CO_2	4

28. The diagram shows a process in a cell.



At which numbered stages does decarboxylation take place?

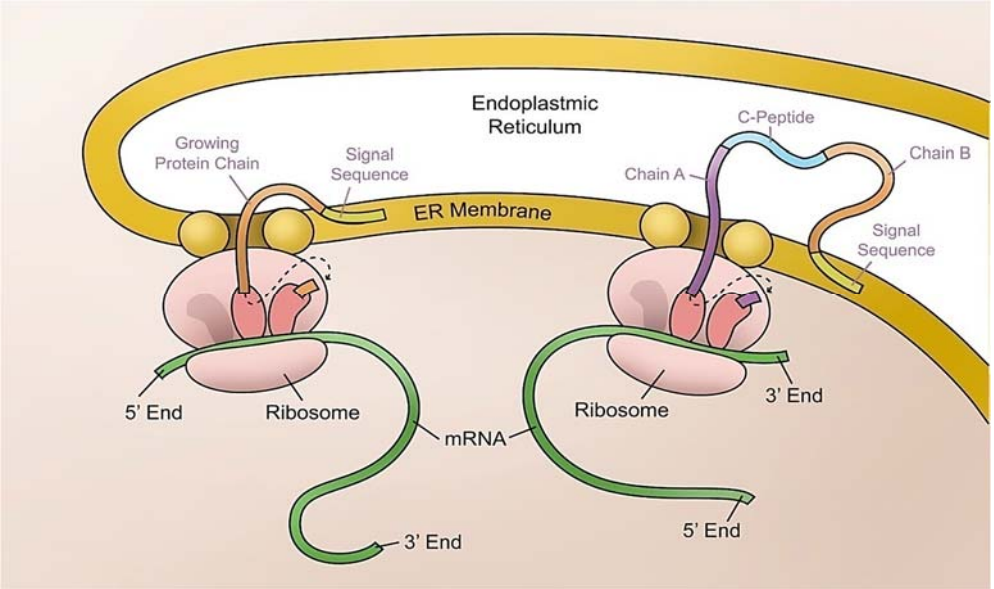
A 1 and 3
B 1, 3 and 4
C 2, 3 and 4
D 3, 4 and 5

29. Tetrodotoxin, a puffer fish toxin, blocks voltage-gated sodium channels. Black widow spider's venom causes the voltage-gated calcium channels to be constantly open. Crotoxin binds irreversibly to acetylcholine receptors.

What will happen to the nerve transmission if each toxin is applied?

	Tetrodotoxin	**Black widow spider's venom**	**Crotoxin**
A	block action potentials along axon	reduce transmission of impulse across synapse	increase transmission of impulse across synapse
B	increase transmission of impulse across synapse	reduce transmission of impulse across synapse	block action potentials along axon
C	block action potentials along axon	increase transmission of impulse across synapse	reduce transmission of impulse across synapse
D	reduce transmission of impulse across synapse	block action potentials along axon	increase transmission of impulse across synapse

30. The diagram below shows part of the insulin synthesis pathway in the pancreas.

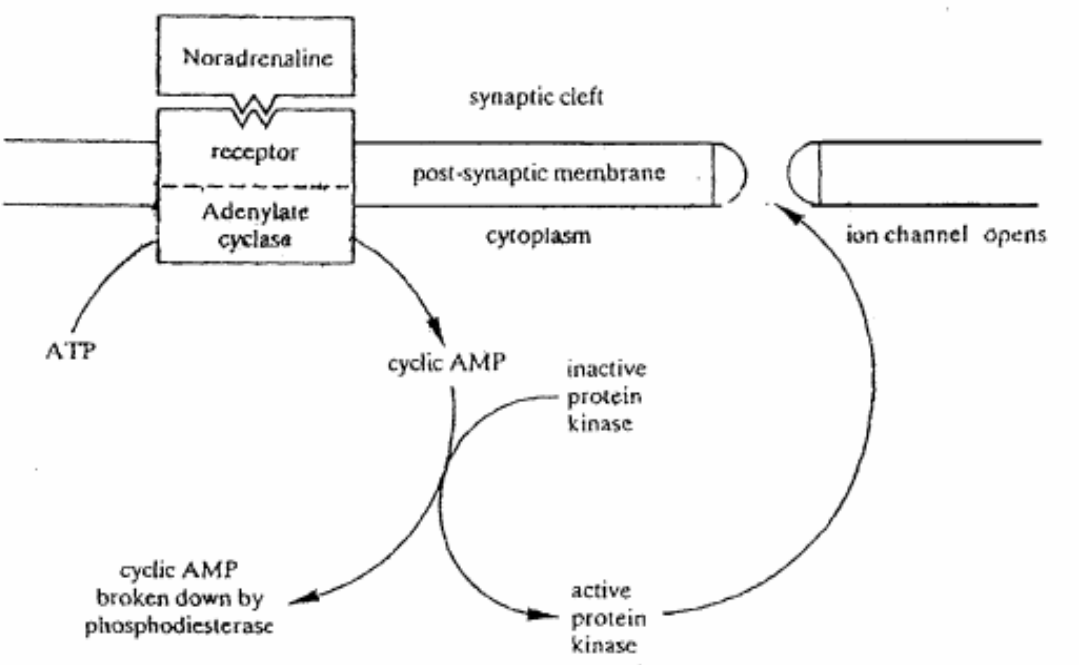


Which of the following statements is correct?

1 The islets of Langerhans are the effector cells in the regulation of blood glucose levels.
2 The signal peptide sequence (in the diagram above) that is synthesised in beta cells is made up of many amino acids with hydrophobic R groups.
3 The functional insulin hormone, made up of an A chain and a B chain held together by disulfide bonds, is formed in the rER lumen.
4 In the beta cells, pro-insulin will be converted to insulin after proteolytic cleavage of the C peptide from pro-insulin and the A and B chains are joined in the correct conformation.
5 Two separate ribosomes synthesise the A chain and the B chain in the above beta cell.
6 Negative feedback to prevent further synthesis of insulin occurs when blood glucose levels rise above norm.

A 1, 2 and 6
B 1, 3, and 4
C 2, 3 and 4
D 3, 5 and 6

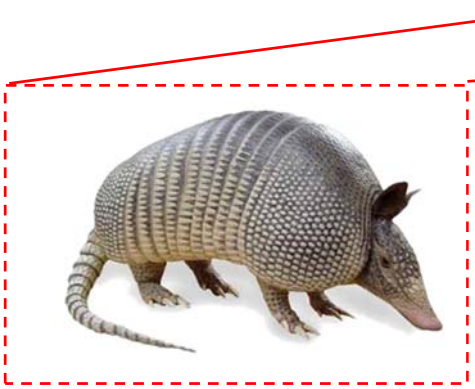
31. Noradrenaline stimulates the activity of an enzyme adenylate cyclase located on the post-synaptic membrane of a neurone. This initiates the sequence of reactions shown in the diagram, causing the opening of channels in the membrane through which ions can pass



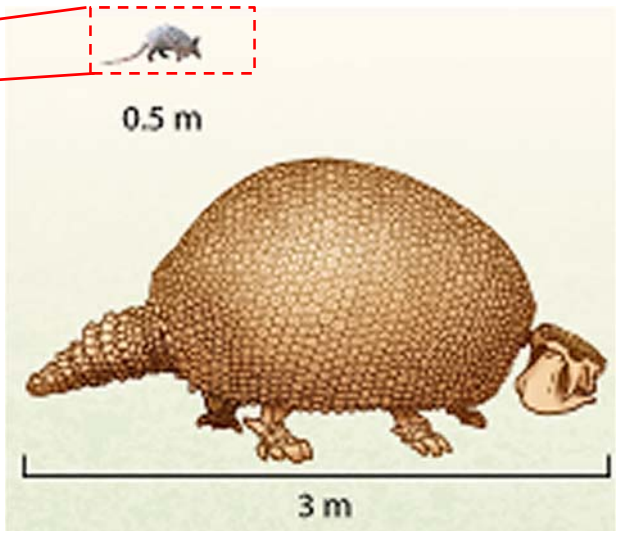
Caffeine causes the ion channels to remain open. A possible explanation is the inhibition of

A ATP production
B phosphodiesterase
C cyclic AMP production
D adenylate cyclase

32. Armadillos are medium-sized mammals with tough bony covering that protects the body. When harassed, armadillos will coil under their shield to minimise the amount of exposed flesh. They are insectivores, feeding on adult and larval forms of ants and termites. Once the prey is detected, armadillos use their claws to dig rapidly to tear into the ant and termite mounds. Their sticky tongues effectively lap up the scurrying insects. Fossils of a recent extinct species of giant armadillo were found to be similar to another smaller species of armadillo presently inhabiting the same region where it is discovered.



Living armadillo



Extinct armadillo

Which of the following statement supports the theory of natural selection?

A Some environmental conditions remained similar whereas other conditions changed between the past and the present.
B The similar characteristics of both species are due to the result of divergent evolution.
C The difference in size of both species is due to the result of constant rate of mutation of a particular gene affecting the growth rate.
D The extinction of the larger armadillo species was due to a chance event.

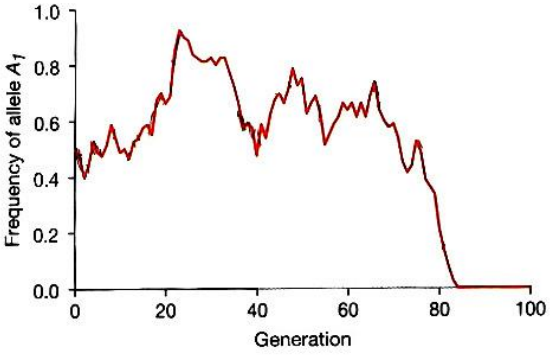
33. Cabbage, *Brassica oleracea* (2n = 20), and radish, *Raphanus sativus* (2n = 18), are different species of the Brassicaceae family. When these plants are crossed, a hybrid is produced. Two cells from the hybrid plant are fused to form a single cell which is propagated using tissue culture technique.

Which of the following is true?

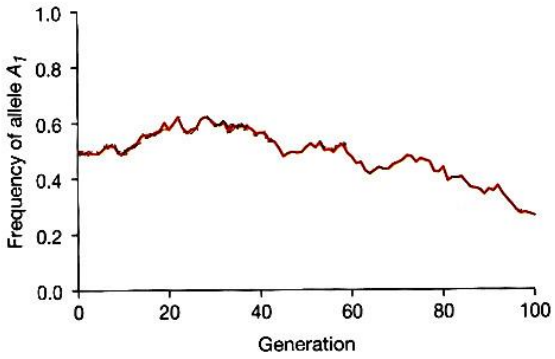
A The hybrid plant is a polyploid.
B The hybrid plant can produce gametes.
C The single fusion cell may eventually result in a new plant species.
D The plant that arises from the cultured cell may be crossed with either *Brassica oleracea* or *Raphanus sativus* to produce a viable and fertile offspring.

34. The graphs show the frequency of allele A1 of two fruit fly populations on an island and on a nearby mainland over time.

Island population size: 40



Mainland population size: 400,000



Based on the information, which of the statement(s) is/are true?

1 Selective pressures for gene A in the mainland changed over time.
2 Genetic drift and natural selection contributed to the change in frequency of allele A1 in the mainland population.
3 The loss of allele A1 from the island population could be due to a spontaneous mutation in the allele sequence.
4 Random chance could result in the fixation or loss of allele A1 in the island population.

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

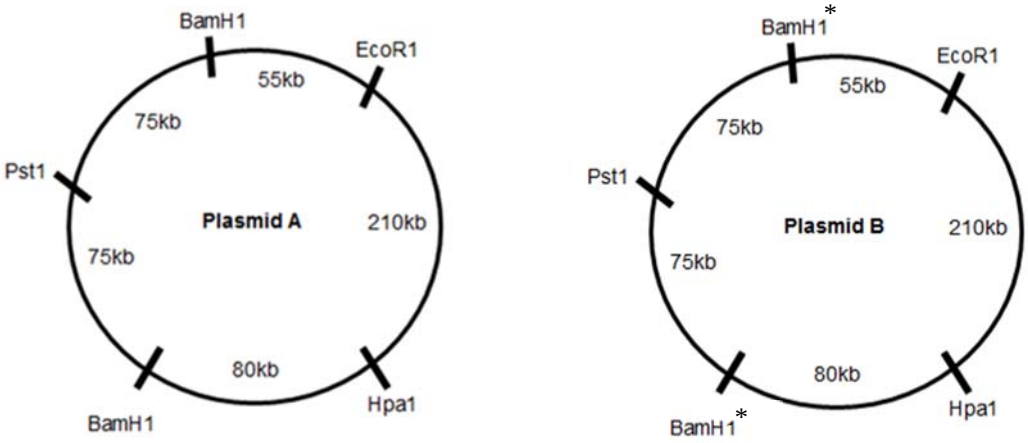
35. Which of the following statements are true for DNA libraries in cancer research?

1 The amino acid sequence of a mutated p53 protein can be determined from only a genomic DNA library.
2 Only a genomic DNA library can be used for the study of a strong enhancer sequence of a proto-oncogene.
3 The expression of specific proto-oncogenes and tumour suppressor genes in a type of cancer can only be determined from a cDNA library.
4 The identity of a specific regulatory protein affecting the expression of a tumour suppressor gene in a type of cancer can only be determined from a cDNA library.

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

36. The figure below shows 2 plasmids (A and B) and the respective restriction sites of various restriction enzymes.

In plasmid B, mutations were deliberately introduced and affected restriction sites are denoted by *****. The lengths of the plasmid DNA between consecutive restriction sites are also indicated.



A scientist carried out a series of 2 experiments by adding different restriction enzymes to the plasmids. Each tube was then left to incubate at 37ºC for about 60 minutes (sufficient time for complete digestion to take place). The results are shown in the table below.

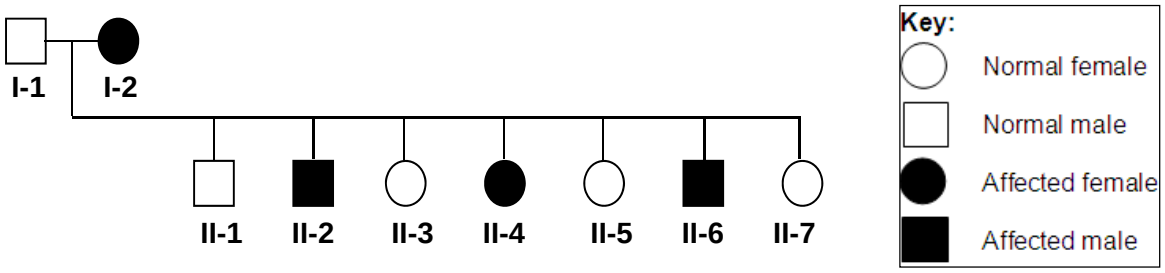
Tube number	Components	Fragment sizes/ kb
1	Plasmid A + 2 restriction enzymes	80, 150, 265
2	Plasmid B + 2 restriction enzymes	155, 340

Identify the enzymes that were added to tubes 1 and 2.

	Tube number	Restriction enzymes
A	1	HpaI , EcoRI
	2	EcoRI , HpaI
B	1	BamHI , PstI
	2	PstI , EcoRI
C	1	BamHI , HpaI
	2	HpaI , PstI
D	1	BamHI , EcoRI
	2	HpaI , BamHI

37. Use the information below for Questions 37 and 38.

Adult polycystic kidney disease (APKD) is inherited in an autosomal dominant manner. In an investigation to determine the chromosomal locus of APKD, linkage analysis of the APKD gene was carried out on members of one family. Three RFLP loci, **P**, **Q** and **R**, located on the non-coding regions of three different chromosomes, were used. The results of the linkage analysis are shown in the figure.



	RFLP alleles present at various individuals' RFLP loci								
	I-1	**I-2**	**II-1**	**II-2**	**II-3**	**II-4**	**II-5**	**II-6**	**II-7**
RFLP locus P	2 , 6	1 , 6	1 , 2	2 , 6	1 , 6	6 , 6	1 , 2	6 , 6	1 , 6
RFLP locus Q	1 , 5	2 , 7	5 , 7	2 , 5	1 , 7	1 , 2	5 , 7	1 , 2	1 , 7
RFLP locus R	4 , 8	5 , 8	5 , 8	8 , 8	5 , 8	4 , 8	5 , 8	4 , 8	5 , 8

Based on the information, which RFLP allele(s) will reveal if an individual has APKD?

	RFLP locus P	**RFLP locus Q**	**RFLP locus R**
A	-	2	-
B	6	2	8
C	-	1 , 2 , 5 , 7	-
D	1 , 2 , 6	1 , 2 , 5 , 7	4 , 5 , 8

38. Once the RFLP allele(s) associated with the disease allele is/are identified and sequence is determined, how could one check if a child may be suffering from APKD? Assume the sequence of APKD is not known.

1 Obtain genomic DNA → restriction digestion → gel electrophoresis → ethidium bromide staining
2 Obtain genomic DNA → restriction digest → gel electrophoresis → southern blot → autoradiography
3 Obtain genomic DNA → PCR → restriction digestion → gel electrophoresis → ethidium bromide staining
4 Obtain mRNA → cDNA → restriction digestion → gel electrophoresis → ethidium bromide staining

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

39. Which of the following correctly describes the role of stem cells in adult tissues and organs?

A Stem cells are undifferentiated cells found amongst differentiated cells and they take over the function of the tissue when the overlying cells become damaged or worn out.
B Stem cells are embryonic cells that persist in the adult, and can give rise to all of the cell types in the body.
C Stem cells are partially differentiated cells that have yet to express the genes and proteins characteristic of their differentiated state, and do so when needed for repair of tissues and organs.
D Stem cells are undifferentiated cells that can divide asymmetrically, giving rise to one daughter cell that remains a stem cell and one daughter cell that will differentiate to replace damaged and worn out cells in the adult tissue or organ.

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 gut bacteria 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