RIVER VALLEY HIGH SCHOOL
YEAR 6
PRELIMINARY EXAMINATION II

H2 BIOLOGY 9648

PAPER 1
26 SEP 2016
1 HOUR 15 MIN

CANDIDATE NAME										
CENTRE NUMBER	S					INDEX NUMBER				

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, centre and index number on the Answer Sheet in the spaces provided.
DO **NOT** WRITE IN ANY BARCODES.

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 Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

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

This Question Paper consists of **25** printed pages.

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.

1 A sample of yeast cells were grown in a culture with radioactive amino acids. At various times, samples of the cells were taken and the amount of radioactivity in different organelles was measured. The results are shown in the table below.

Time after radioactive amino acids were added to the solution/ minute	Amount of radioactivity present/arbitrary units		
	P	**Q**	**R**
10	21	120	6
20	42	68	6
40	86	39	8
60	76	28	15
90	50	27	28
120	38	26	56

Which of the following best describes the identities of organelles **P**, **Q** and **R**?

	P	**Q**	**R**
A	Golgi apparatus	Rough endoplasmic reticulum	Secretory vesicles
B	Rough endoplasmic reticulum	Smooth endoplasmic reticulum	Golgi apparatus
C	Rough endoplasmic reticulum	Secretory vesicles	Golgi apparatus
D	Smooth endoplasmic reticulum	Golgi apparatus	Secretory vesicles

2 Three unknown specimens were tested to determine the identity of biomolecule(s) present. The results are shown in the table below.

	biuret solution	benedict's solution and heated	dilute hydrochloric acid, benedict's solution and heated	iodine in potassium iodide solution
Specimen 1	purple	blue	brick-red	brown
Specimen 2	purple	blue	blue	blue-black
Specimen 3	blue	brick-red	brick-red	brown

Using the results shown, which of the following can be concluded?

1 When treated with amylase, Specimen 2 will yield the same result as Specimen 1.
2 No lipids are present in Specimens 1, 2 and 3.
3 Sucrose is present in Specimen 3.

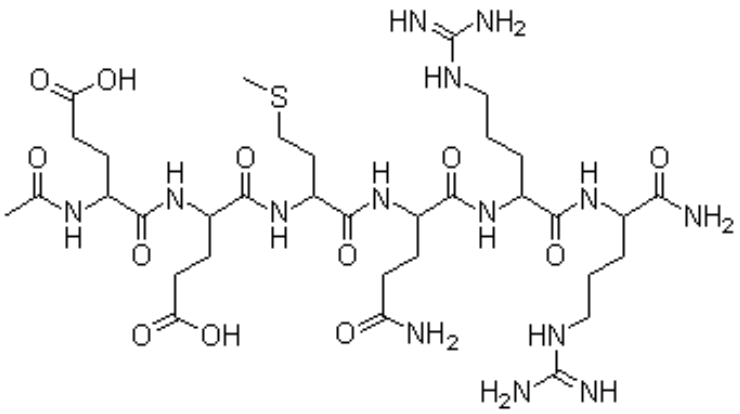
A 2 only

B 1 and 2

C All of the above

D None of the above

3 The diagram shows the chemical structure of a polypeptide chain. The polypeptide chain can be broken down by proteases to yield amino acids.



Which of the following combination is correct?

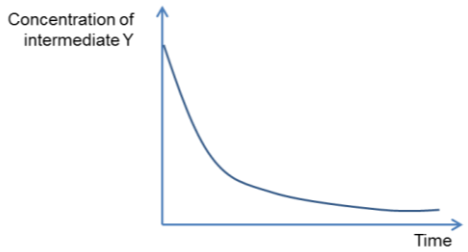
	type of reaction	number of bonds broken	number of amino acids
A	hydrolysis	5	6
B	hydrolysis	4	5
C	condensation	6	7
D	condensation	7	6

4 In the production of isoleucine from threonine, the end product acts as an inhibitor of the first enzyme of the pathway. The pathway is shown below.

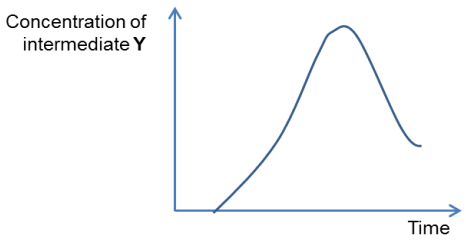
threonine $\xrightarrow[\text{enzyme 1}]{}$ intermediate **X** $\xrightarrow[\text{enzyme 2}]{}$ intermediate **Y** $\xrightarrow[\text{enzyme 3}]{}$ isoleucine

Which of the following graphs shows the concentration of intermediate **Y** when threonine is supplied in excess?

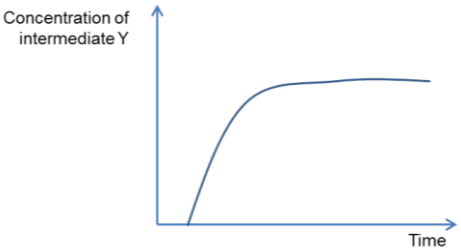
A



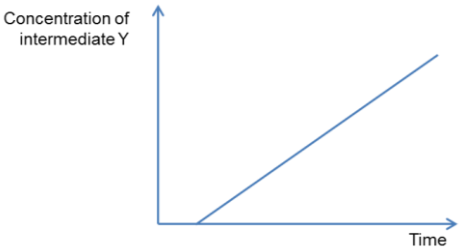
B



C



D



5 The diagram below 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 The table below shows the events that occur at different stages of meiosis.

Which row correctly shows the correct events for the respective stage?

	Interphase II	Prophase I	Metaphase I	Anaphase II
A	replication of DNA	condensation of chromosomes	alignment of chromosomes at the equator	separation of homologous chromosomes
B	replication of DNA	pairing of bivalents	alignment of bivalents at the equator	separation of sister chromatids
C	intense 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 homologous chromosomes

7 An unknown organism has a linear double-stranded DNA genome like that in a eukaryote. When its DNA replication was examined, it was revealed that although the process is semi-conservative, no Okazaki fragments were observed in the multiple replication forks. In addition, the end-replication problem of shortened daughter strands was not observed.

Which statement correctly explains this phenomenon?

A The organism's DNA is antiparallel.

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

C DNA polymerases synthesise DNA in both 5' to 3' and 3' to 5' direction.

D DNA ligases are not involved in the DNA replication process.

8 The electron micrograph shows protein synthesis in a yeast cell.

Which statements about processes occurring in this cell are correct?

1 Transcription occurs from left to right along template DNA.
2 **S** is used as template during translation.
3 Transcription and translation occur simultaneously in the cell.
4 Many RNA polymerases are transcribing **R**.

A 1 and 3 only

B 2 and 4 only

C 1, 2 and 4

D All of the above

9 Which statements about tRNA are correct?

1 There is a binding site for the attachment of a specific amino acid, as well as a different binding site for the attachment to the ribosome, in order to allow translation to occur.
2 There is a ribose-phosphate backbone with strong covalent phosphoester bonds and areas within the polynucleotide chain where base-pairing by hydrogen bonding occurs.
3 There is a section known as an anticodon that contains the same triplet of bases as the triplet of DNA bases that has been transcribed to produce the mRNA codon.
4 There is a specific enzyme to load each tRNA with its respective amino acid.

A 1 and 2 only

B 2 and 3 only

C 1, 2 and 3

D 1, 2 and 4

10 A segment of an mRNA sequence bearing a point mutation is shown. What is the sequence of the corresponding DNA coding strand prior to the mutation?

5'-ACCGUAGCAGCU-3'

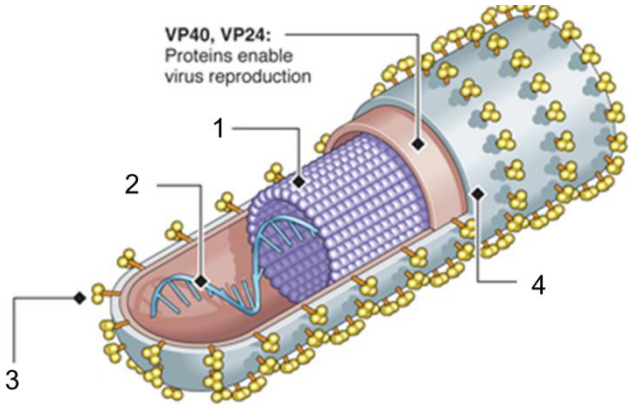
A 5'-AGCTGCTACGGT-3'

B 5'-ACCGTAGCAGCT-3'

C 5'-ACCGGAGCAGCT-3'

D 5'-AGCTGCTCCGGT-3'

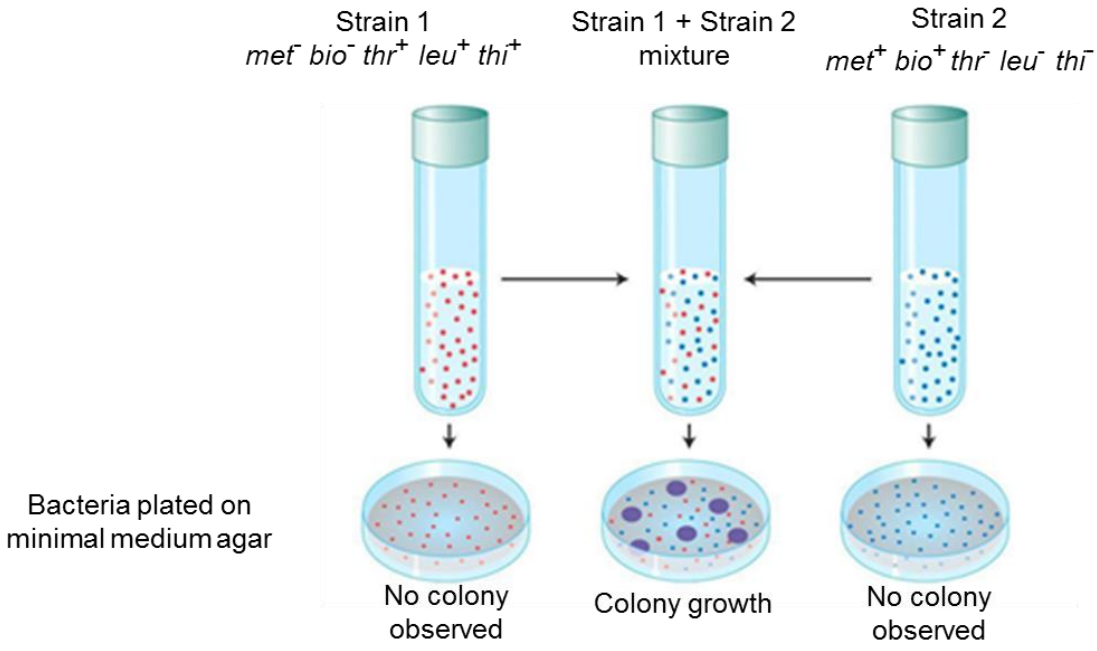
11 In 2015, Ebola Virus Disease outbreak in West Africa is the largest outbreak of the disease since the Ebola virus was first identified. Ebola virus is an animal virus and has structural components similar to that of influenza virus and human immunodeficiency virus. The structure of the Ebola virus is shown below.



Which of the following correctly identifies the function of the labelled structures?

	bind to specific receptor on human cell surface membrane	contain viral genes	fuse with host cell membrane	enclose viral genome
A	3	2	1	4
B	3	2	4	1
C	1	4	3	2
D	1	2	3	4

12 In 1947, Lederberg and Tatum conducted an experiment to study gene transfer between bacteria. Methionine, biotin, threonine, leucine and thienylalanine are essential for bacteria growth. Strain 1 has genes *thr*, *leu* and *thi* which can be used to synthesise threonine, leucine and thienylalanine. Strain 2 has genes *met* and *bio* which can be used to synthesise methionine and biotin. In the experiment, Strain 1 and Strain 2 are mixed and cultured on a minimal agar plate which does not contain any amino acids and biotin. The result of the experiment is shown below.



What conclusion can be made from the results shown?

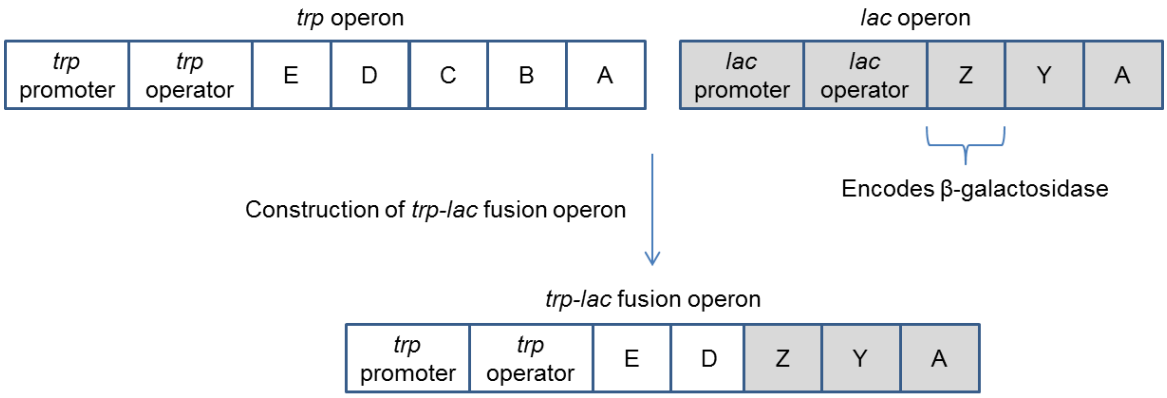
A Direct cell-cell contact is required for conjugation to take place.

B The resulting bacteria from the colony grown from the Strain 1 and Strain 2 mixture has has genes *met*, *bio*, *thr*, *leu* and *thi.*

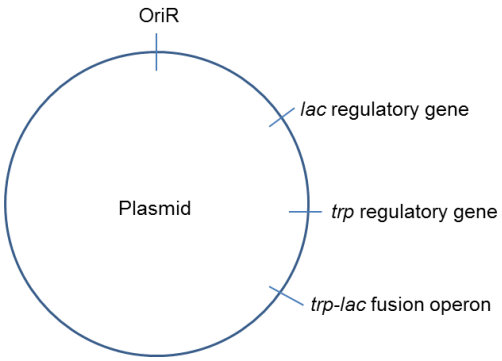
C Mutation has occurred in the genes of Strain 1 and Strain 2, hence no colony growth is observed.

D The resulting bacteria from the colony grown from the Strain 1 and Strain 2 mixture has taken up DNA through transformation.

13 A *trp-lac* fusion operon is constructed as shown in the figure below.



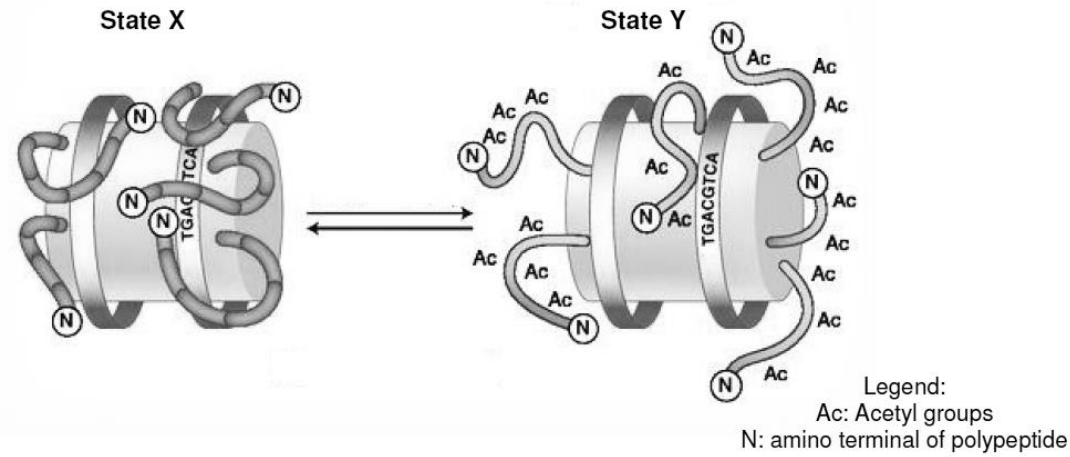
A plasmid containing the *trp-lac* fusion operon is introduced into bacterial cells by heat shock procedures.



β-galactosidase is encoded by *lac Z* gene. Which of the following combinations best shows the conditions required for the synthesis of β-galactosidase?

	tryptophan	lactose	glucose	amino acids	deoxyribonucleoside triphosphate
A	√	√	√	x	√
B	x	√	x	√	x
C	x	x	x	√	√
D	x	x	x	√	x

14 The diagram below shows two possible states of chromatin.



Which of the following statements are true?

1 State **X** may be a result of DNA methylation.
2 State **X** is only present during the beginning of mitosis or meiosis.
3 State **Y** is the result of acetylation which decreases the positive charges on the polypeptides.
4 Transition between State **X** and **Y** are carried out by DNA acetylases and deacetylases in all cells.

A 1 and 3

B 2 and 4

C 1, 2 and 3

D 1, 3 and 4

15 Which of the following statement(s) about eukaryotic gene expression is true?

1 By binding to the 5' UTR of an mRNA, a translational regulatory protein blocks the initiation of translation.
2 Having a relatively shorter mRNA half-life allows more rapid control of gene expression at the translational level.
3 Different transcription factors help the same RNA polymerase recognise different promoters.
4 By binding to the 3' UTR of the mRNA, a translational regulatory protein increases the stability of an mRNA.

A 1 only

B 1 and 3

C 2 and 4

D 1, 3 and 4

16 Which of the following statements about transcription in eukaryotes are **incorrect**.

1 Specific sequences found near the promoter may increase the affinity of RNA polymerase binding, thus increases the probability of forming transcription initiation complex.
2 RNA polymerase, general transcription factors and specific transcription factors make up the transcription initiation complex.
3 Specific transcription factors such as repressors bind to silencers to prevent assembly of the transcription initiation complex.
4 The binding of enhancer proteins to activators results in enhanced rate of transcription.

A 1 and 2 only

B 1 and 3 only

C 2 and 4 only

D None of the above

17 Which of the following shows the types of genetic changes **least** likely to be found in an proto-oncogene and a tumour suppressor gene of tumour cells?

	proto-oncogene	tumour suppressor gene
A	gene amplification	chromosomal deletion
B	chromosomal deletion	substitution mutation
C	substitution mutation	chromosomal translocation
D	nonsense mutation	gene amplification

18 The table shows the loci of certain genes in *Drosophila melanogaster.* These genes are found either on chromosome 1 or 3.

Character controlled by gene	Chromosome	Position on chromosome
cut wings	1	20
body stripe	3	62
vermillion eye	1	33
rough eye	3	91
pink eyes	3	48
forked bristles	1	57

Which pair of characteristics will produce the highest crossing over value when the F_1 generation is test-crossed?

A body stripe and rough eye

B cut wing and vermillion eye

C rough eye and cut wing

D rough eye and pink eye

19 Pure breeding plants of contrasting traits were cross fertilised and the seeds were planted in pots of soil containing equal proportion of fertiliser. The pots were then exposed to different light conditions for 60 days. Throughout the investigation, the plants were watered with equal amount of water twice daily.

At the end of the investigation, the plants' height, number of leaves, length of leaves and colour of leaves were measured and summarised in the table below.

	No light	Dim Light	Bright light
Height/cm	10.3 ± 0.3	8.1 ± 0.5	6.6 ± 0.4
Length of leaves/cm	1.7 ± 0.3	1.7 ± 0.2	1.6 ± 0.1
Colour of leaves	Yellow	Pale green	Dark green

Which of the following statement(s) cannot be explained by the data?

1 The height and length of leaves exhibit continuous variation as different plants have different genotypes.
2 The additive effect of genes is responsible for the continuous variation observed in the height and length of leaves.
3 The genes involved in chlorophyll pigment synthesis are activated by light.
4 The colour of leaves is due to a single gene whereby heterozygotes have pale green leaves.

A 3 only

B 1 and 4

C 1, 2 and 4

D All of the above

20 In a mammalian species, the inheritance of skin colour is controlled by three pairs of genes, **A**/**a**, **B**/**b** and **C**/**c**, which are inherited independently.

The genes for dark pigmentation **A**, **B** and **C** code for the production of about the same degree of pigmentation. If skin colour is proportional to the sum of the dominant alleles present, how many classes of skin colour would be expected from a mating between two individuals that are heterozygous at all three loci?

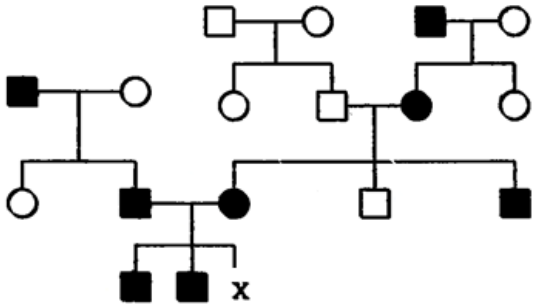
A 3

B 5

C 7

D 9

21 The family tree below was constructed by a genetic counsellor of a family with history of heart disease due to hypercholesterolaemia. Children who inherit the dominant mutant allele from both parents rarely survive beyond puberty.



What is the probability that X will be unaffected?

A 0.75

B 0.50

C 0.25

D 0.00

22 Colour of flower petals of a plant species is controlled by two independently assorting genes. Plants with genotypes **AABB** and **aabb** have flowers with white petals.

Pure breeding plants with genotypes **AABB** and **aabb** were crossed. The resulting F_1 plants had flowers with white petals. F_2 progenies from the self-fertilisation of F_1 generation is summarised in the table below.

Colour of petals	Number of plants
White	406
Blue	94

Which of the following statement(s) is true?

1 The two genes controlling colour of petals are found on the same chromosome.
2 The phenotypes observed in the F_2 generation are due to interaction with the environment.
3 The gene products of gene **A** and gene **B** are involved in the same metabolic pathway.
4 Gene **A** is an epistatic gene whereby the presence of two copies of recessive alleles at the epistatic gene locus masks the expression of Gene **B**.
5 Gene **A** encodes for an inhibitor that prevents the production of a white intermediate.

A 2 and 3 only

B 3 and 5 only

C 1, 3 and 5 only

D 2, 3 and 4 only

23 In a buffered suspension of freshly isolated thylakoids incubated in light, the rate of photolysis can be measured using DCPIP. DCPIP is reduced at Photosystem I and changes its colour from blue to colourless.

Which of the following modification(s) of the experiment will significantly reduce the rate of this reaction?

1 Raising the temperature of the solution from 15ºC to 30ºC.
2 Removing soluble gases from the buffer solution before adding the thylakoids.
3 Adding DCMU, a herbicide that binds to Photosystem II.
4 Adding 2,4-D, a herbicide that acts as a synthetic auxin.

A 3 only

B 1 and 3 only

C 2 and 3 only

D All of the above

24 Six tubes containing preparations from animal tissue were set up as shown below.

Tube	Contents
1	Glucose + homogenised cells
2	Glucose + mitochondria
3	Glucose + cytoplasm lacking organelles
4	Pyruvate + homogenised cells
5	Pyruvate + mitochondria
6	Pyruvate + cytoplasm lacking organelles

After incubation, in which three tubes would carbon dioxide be produced?

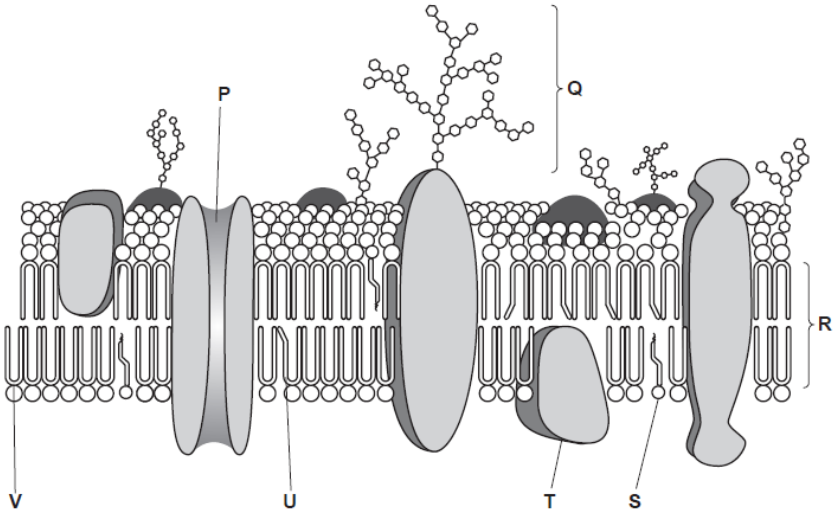
A 1, 2 and 3

B 1, 4 and 5

C 2, 4 and 6

D 4, 5 and 6

25 The diagram shows a section through a cell surface membrane from a typical animal cell.



When compared to the cell surface membrane of a phagocytic cell, a number of differences in the membrane components can be observed.

Which is the most likely set of differences that will be observed in the phagocytic cell?

A a complete absence of component **Q** and a higher proportion of component **P**

B a higher proportion of component **S** and a higher proportion of component **T**

C a lower proportion of component **V** and a higher proportion of component **U**

D an increased distance across **R** and a higher proportion of component **U**

26 Diagrams **1** and **2** show how the longitudinal section of a stem changes when moved from solution **W** to a different solution, **Y**.

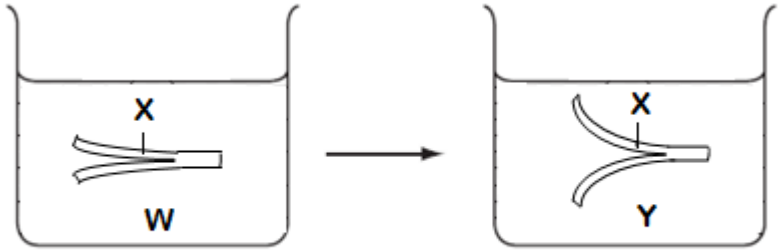


Diagram **1** Diagram **2**

How has the respective water potential changed in diagram 2?

	water potential of cells at **X** in solution **Y** compared to the same cells in solution **W**	water potential of solution **Y** compared to solution **W**
A	less negative	less negative
B	less negative	more negative
C	more negative	less negative
D	more negative	more negative

27 The Ca^{2+} in blood is maintained at the normal level of 10mg/100ml. When blood Ca^{2+} levels rise above the normal level, the thyroid gland releases calcitonin, which stimulates Ca^{2+} deposition in bones and reduces the uptake of Ca^{2+} by the kidneys.

When blood Ca^{2+} levels fall below the normal level, the parathyroid glands release the parathyroid hormone, which stimulates the release of Ca^{2+} from bones and increases Ca^{2+} uptake by the kidneys.

Which of the following shows the correct receptor, control centre, and effector in the regulation of blood Ca^{2+} levels?

	Receptor	Control centre	Effector
A	Bones	Parathyroid glands	Bones
B	Parathyroid glands	Parathyroid glands	Parathyroid hormone
C	Calcitonin	Thyroid gland	Bones
D	Thyroid gland	Thyroid gland	Kidneys

28 Which of the following process(es) leads to signal amplification in the cell?

1 Binding of multiple signal molecules to the membrane bound receptor.
2 Phosphorylation of the first kinase of a cascade.
3 Branching of different signalling pathways that produces multiple cellular responses.
4 Activation of numerous intracellular receptors that acts as transcription factors in gene expression.

A 3 only

B 2 and 3 only

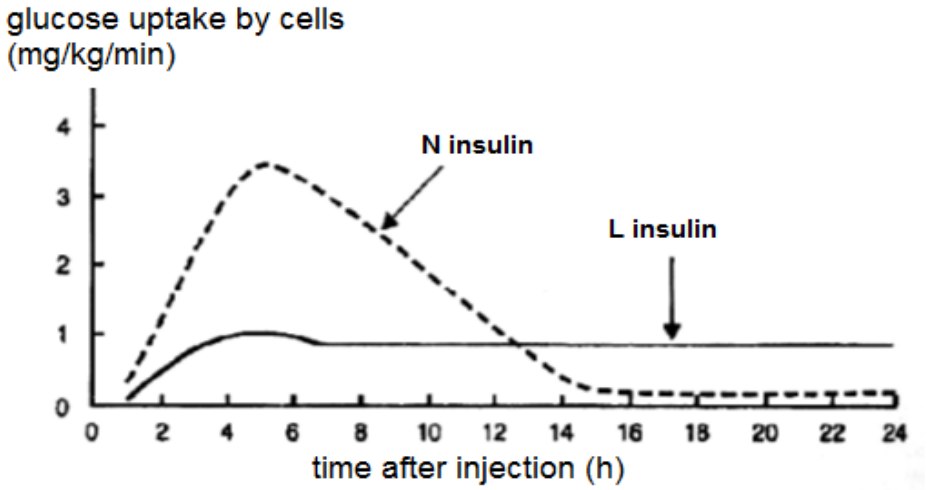
C 1 and 4 only

D All of the above

29 Insulin is a hormone involved in the regulation of blood glucose levels. Failure to produce insulin results in insulin-dependence (type I diabetes), and people with this condition must have regular injections of insulin.

The effectiveness of two types of insulin was tested. Participants in this test were divided into two groups. One group received **N** insulin. The second group received **L** insulin. All participants received the same amount and concentration of the respective insulin.

The following graph shows the average results for participants in each of the two groups.



Which of the following statement(s) is true about the effectiveness of the two types of insulin?

1 **N** insulin needs to be given more frequently than **L** insulin in a day.
2 A dose of **N** insulin is more effective than **L** insulin in reducing blood glucose level in one day.
3 Using **L** insulin may be more advantageous for a person with type I diabetes.

A 2 only

B 1 and 2

C 1 and 3

D 1, 2 and 3

30 Certain drugs act at synapses and affect ATP production.

Which of the following correctly matches the protein affected to its effect on synaptic transmission, when ATP production is inhibited?

	protein affected	effect
A	Na^+ / K^+ ATPase	no restoration of Na^+ and K^+ gradient across membrane
B	acetylcholinesterase	acetylcholine cannot be broken down and hence remains in synaptic cleft
C	Ca^{2+} pump	no restoration of Ca^{2+} gradient across membrane
D	voltage-gated Ca^{2+} channel	no influx of Ca^{2+} and fusion of synaptic vesicles with membrane

31 *Staphylococcus aureus* is a common bacteria found on human skin. There are many strains of *S. aureus*. The antibiotic methicillin was used to treat infection by *S. aureus*. Now, there are at least 15 different strains of methicillin resistant *S. aureus* (MRSA).

Which of the following are valid reasons for the emergence of 15 different strains of MRSA?

A Different mutations occur to the bacteria's DNA when the bacteria are exposed to methicillin, thus becoming resistant.

B Some bacteria in the population of *S. aureus* had genes for enzymes which break down methicillin, before exposure to methicillin.

C Different strains of MRSA emerged as a result of neutral selection.

D Bacteria cells undergo asexual reproduction, giving rise to a population of genetically identical cells.

32 The classification of the domestic horse, *Equus ferus caballus* and the Przewalski horse, *Equus ferus przewalskii*, is not fully established.

They were considered to be members of the same species, but some evidence suggests that they should be classified as separate species.

Extinct in the wild, Przewalski's horse survived in zoos and has now been successfully reintroduced into the steppe area of Mongolia.

Which statements would suggest that these two types of horse are members of the same species?

1 Domestic horses in the Mongolian steppe area are capable of interbreeding with the re-introduced Przewalski horse to produce fertile offspring.
2 DNA testing suggests that the two types of horse diverge from wild horse ancestor at similar time.
3 The diploid number of domestic horse is 64 and that of the Przewalski's horse is 66.
4 DNA testing has found few differences between the two types of horse.

A 1 and 2

B 1 and 4

C 2 and 4

D 3 and 4

33 The DNA for β-globin subunit of haemoglobin in organism **X** was compared with that in five other organisms of different species.

A segment of DNA bases of the β-globin gene in organism **X** and the 5 organisms are shown below.

organism	DNA bases
X	TTACCACGCCACTTT
1	TAACCACCCCACTAT
2	TTACCACCCTACATT
3	TTTCCACCCCACTTT
4	TTACCACGCCACATT
5	TTTCAACGCCACCTT

Which organisms are most closely related to organism **X**?

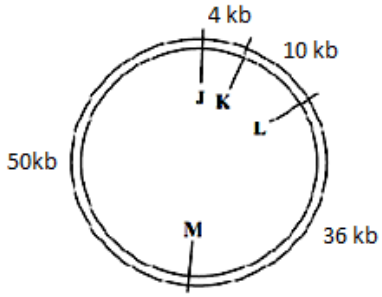
A 1 and 2

B 2 and 3

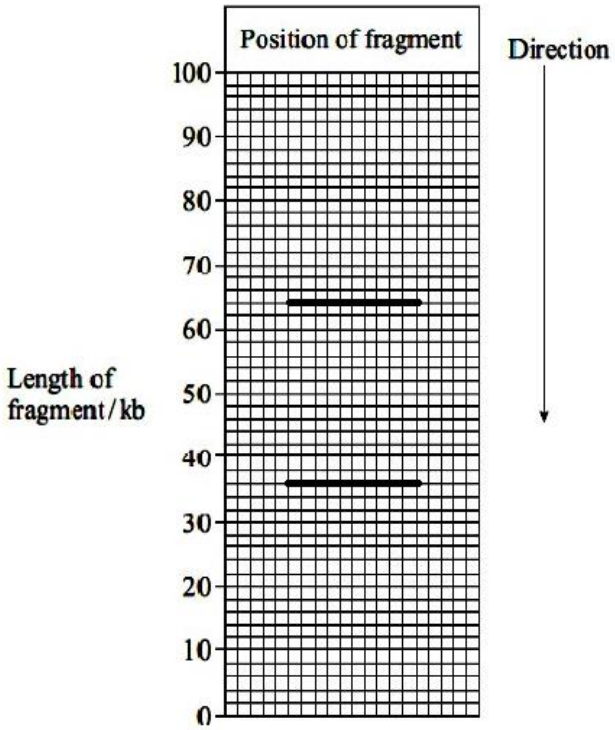
C 3 and 4

D 4 and 5

34 The diagram below shows the positions of four restriction sites **J**, **K**, **L** and **M** for four different restriction enzymes in a plasmid. The distances between these sites are measured in kilobases of DNA.



The plasmid was cut using only two restriction enzymes. The resulting fragments were separated by gel electrophoresis. The positions of the fragments are shown in the chart below.



Which restriction sites were cut?

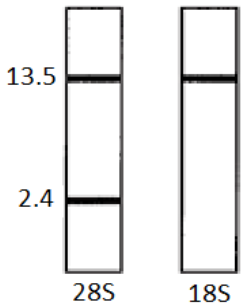
A **J** and **K**

B **L** and **M**

C **J** and **M**

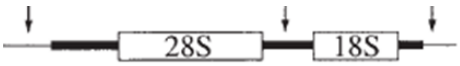
D **L** and **K**

35 Human DNA is digested with a specific restriction enzyme and subjected to gel electrophoresis. Following which, Southern blotting is carried out using a nitrocellulose membrane. Probes complementary to 28S region and 18S region respectively are then added to the nitrocellulose membrane. Lastly, autoradiography is carried out to give the autoradiogram shown below.



With arrows indicating the restriction sites, which of the following restriction maps best explains the results shown?

A

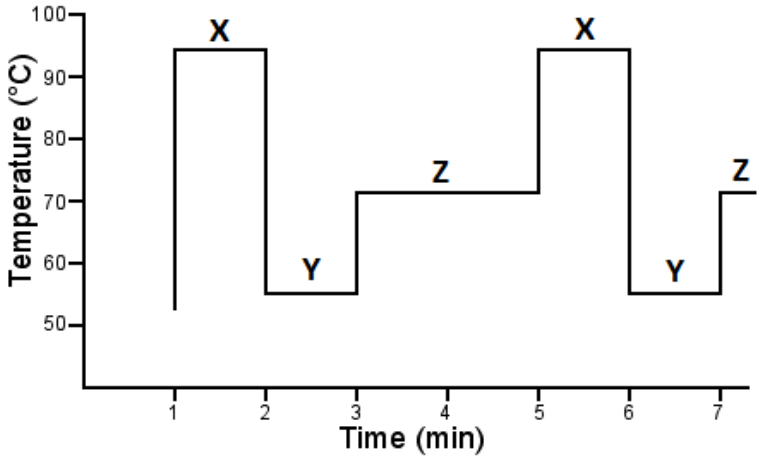


B

C

D

36 The diagram below shows the changes in temperature in a thermal cycler over time during polymerase chain reaction.



How many of the following statements are true?

1 Elongation of new strands occurs during **Y**.
2 Taq polymerase functions optimally at **Z**.
3 DNA primers are annealed to the DNA template during **X**.
4 Double stranded DNA template denatures into single strands during **X**.

A One

B Two

C Three

D Four

37 The human genome project (HGP) was successfully completed on 14 April 2003. Several ethical concerns were raised during the HGP. Which of the following is **not** an ethical concern of the HGP?

A Anxiety and frustration may arise in patients when genetic testing is conducted for diseases with no medical treatment currently available.

B If genetic sequences are patented, it will increase the cost of genetic research and treatment.

C Mankind is tampering with nature when the human genome is modified.

D The use of genetic test results may lead to discrimination of individuals by insurance companies and employers.

38 What is the role of stem cells with regard to the function of adult tissues and organs?

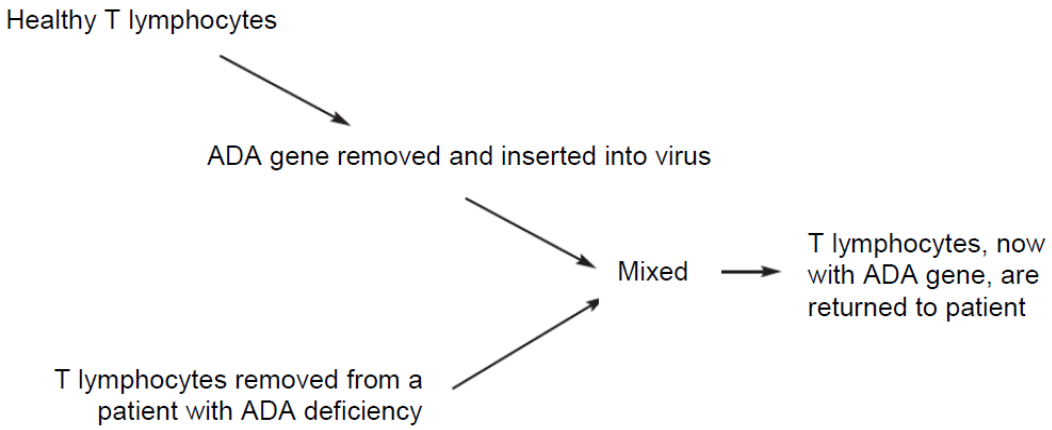
A Stem cells are undifferentiated cells that divide asymmetrically, giving rise to one daughter cell that remains a stem cell and one daughter that will differentiate to replace damaged and worn out cells in the adult tissue or organ.

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 undifferentiated cells that have expressed the genes and produced proteins characteristic of their differentiated state for repair of tissues and organs.

D Stem cells are fully differentiated cells that reside under the surface of epithelial tissue, in position to take over the function of the tissue when the overlying cells become damaged or worn out.

39 Gene therapy is used to treat a genetic disorder which results from a deficiency of the enzyme, adenosine deaminase (ADA). Without this enzyme, T lymphocytes have impaired function and the immune system of the affected individual is compromised.



If the therapy failed in the first round, which of the following is **not** a possible explanation for the failure?

A Insertion of the ADA gene into the enhancer region of the viral genome.

B ADA was expressed in very low amounts.

C Expressed ADA failed to fold in the correct conformation.

D The viral vector in the modified T lymphocytes stimulated the patient's immune system to mount an attack on the T lymphocyte.

40 The development of genetically modified organisms (GMO) has conferred many benefits and advantages to mankind. However, there are many who are still sceptical of GMOs.

Which of the following is **not** a reason for opposing the use of GMOs?

A Genetically modified herbicide-resistant crops may result in the excessive use of herbicides by farmers, hence polluting the agricultural land and surrounding waterways.

B Genetically modified Bt corn will only kill the European corn borers that feed on them.

C Genetically modified salmon, if accidentally released into the wild, may outcompete local resident salmon fish populations, and lead to decreased biodiversity.

D The antibiotic-resistant marker gene used in genetically modified tomatoes Flavr Savr may be taken up by bacteria through transformation process, hence leading to an increase in antibiotic-resistant bacteria harmful to mankind.

- End of Paper 1 -