

NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATIONS
Higher 1

CANDIDATE
NAME

CLASS

BIOLOGY

Paper 1 Multiple Choice

8875/01

26 September 2017

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

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

Write your name and CT on the Answer Sheet in the spaces provided unless this has been done for you.

There are **thirty** 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 deducted for a wrong answer.

Any rough working should be done in this booklet.

Calculators may be used.

This document consists of **17** printed pages.

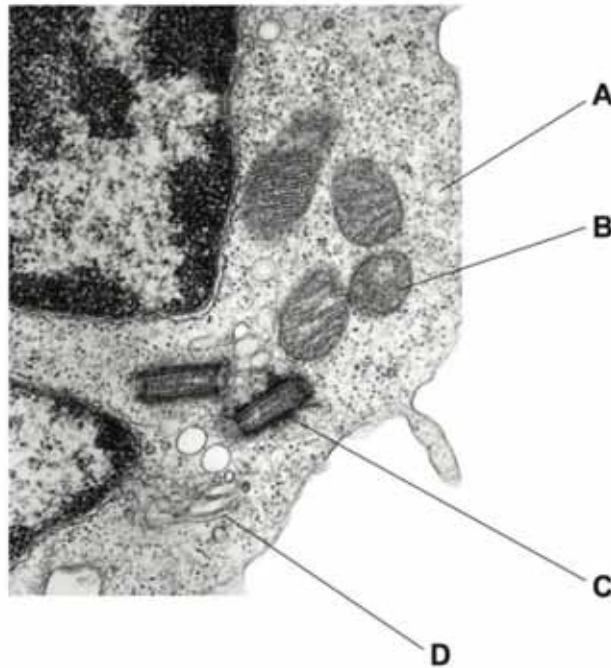
[Turn over

- 1 A student has drawn a cell structure as seen using a light microscope.
The magnification of the drawing is $\times 600$.
The length of the structure on the drawing is 6mm.

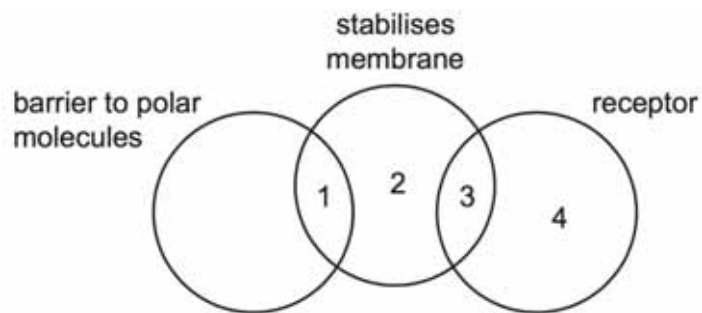
What is the actual length of the cell structure?

- A $1 \times 10^{-1} \mu\text{m}$ B $1 \times 10^0 \mu\text{m}$ C $1 \times 10^1 \mu\text{m}$ D $1 \times 10^2 \mu\text{m}$

- 2 The electron micrograph shows part of a eukaryotic cell.
Which of the labelled organelles is a site of protein synthesis?

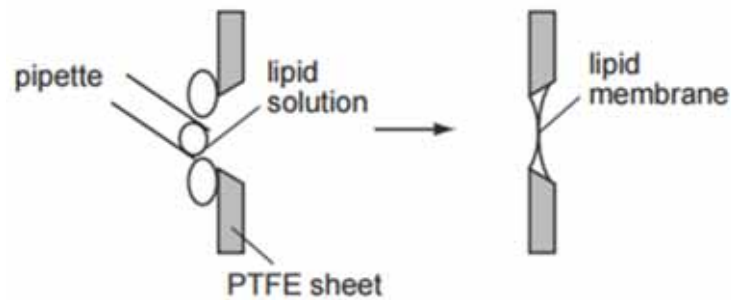


- 3 Which row correctly links molecules in the cell surface membrane with their roles?



	1	2	3	4
A	glycolipid	cholesterol	glycoprotein	phospholipid
B	glycolipid	glycoprotein	phospholipid	cholesterol
C	glycoprotein	phospholipid	cholesterol	glycolipid
D	phospholipid	cholesterol	glycolipid	glycoprotein

- 4 Lipid membranes can be formed in the laboratory by painting phospholipids over a 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 ions flowed across the membrane until a substance called gramicidin was added, at which time the ions flowed.

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.

- 5 The table shows some information about four carbohydrate polymers.

polymer	α -1,4 glycosidic bonds	α -1,6 glycosidic bonds	shape of molecule	key ✓ = present x = absent
1	✓	x	helical	
2	x	✓	branched	
3	✓	✓	helical	
4	✓	✓	branched	

Which two polymers form starch?

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

- 6 When proteins are mixed with some organic solvents, hydrophobic interactions and hydrogen bonding are changed in the protein molecules.

Which levels of protein structure would be affected?

	level of protein structure		
	secondary	tertiary	quaternary
A	✓	✓	x
B	✓	x	✓
C	x	✓	✓
D	✓	✓	✓

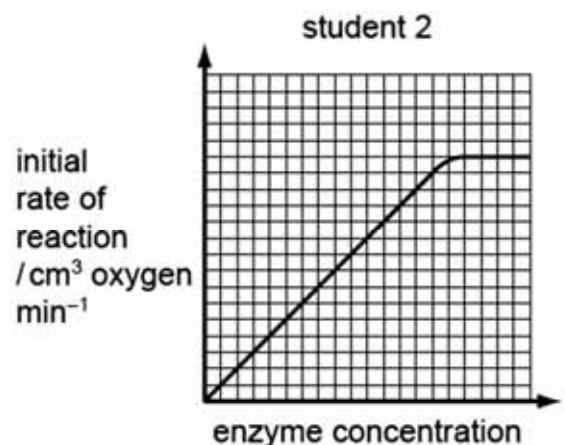
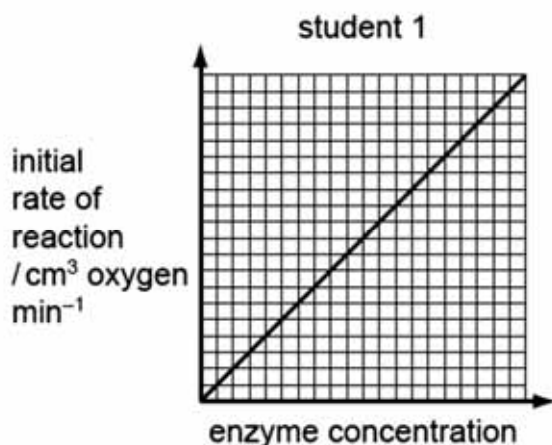
key

✓ = affected

x = not affected

- 7 Catalase is an enzyme that catalyses the conversion of hydrogen peroxide into water and oxygen.

Two students investigated the effect of enzyme concentration on the rate of reaction of the enzyme catalase. The students predicted their results would show the same trend. The graphs show the rates obtained by each student.



Which statement explains the different trend shown by student 2's results?

- A** Student 2 included a competitive inhibitor in the investigation.
- B** Student 2 performed the investigation at a higher temperature.
- C** Student 2 performed the investigation at pH6 compared to pH8.
- D** Student 2 used a lower concentration of substrate in the investigation.

- 8 The table below shows additional information about the enzymes that catalyse some of the reactions in respiration.

enzyme	information
fructose 1,6-bisphosphate aldolase	<ul style="list-style-type: none"> four identical subunits changes to any one of the subunits means that the enzyme cannot function
hexokinase	<ul style="list-style-type: none"> one subunit active site changes shape to enclose the reactants
phosphofructokinase	<ul style="list-style-type: none"> four identical subunits has allosteric sites in addition to an active site
phosphoglucose isomerase	<ul style="list-style-type: none"> two identical subunits has a cytokine function when secreted into the external medium
pyruvate kinase	<ul style="list-style-type: none"> four identical subunits ATP acts as an inhibitor to regulate glycolysis
triosephosphate isomerase	<ul style="list-style-type: none"> two identical subunits each subunit has 14 alpha helices and 8 beta-pleated sheets

A student made the following deductions using the information provided in the table:

- Phosphoglucose isomerase, when secreted, can have a non-catalytic role.
- Only three of the six enzymes display quaternary protein structure.
- The active site of phosphofructokinase will change shape to allow the enzyme to act as a regulator in glycolysis.
- Each enzyme is coded for by one gene.
- The reaction catalysed by hexokinase is an induced-fit mechanism.

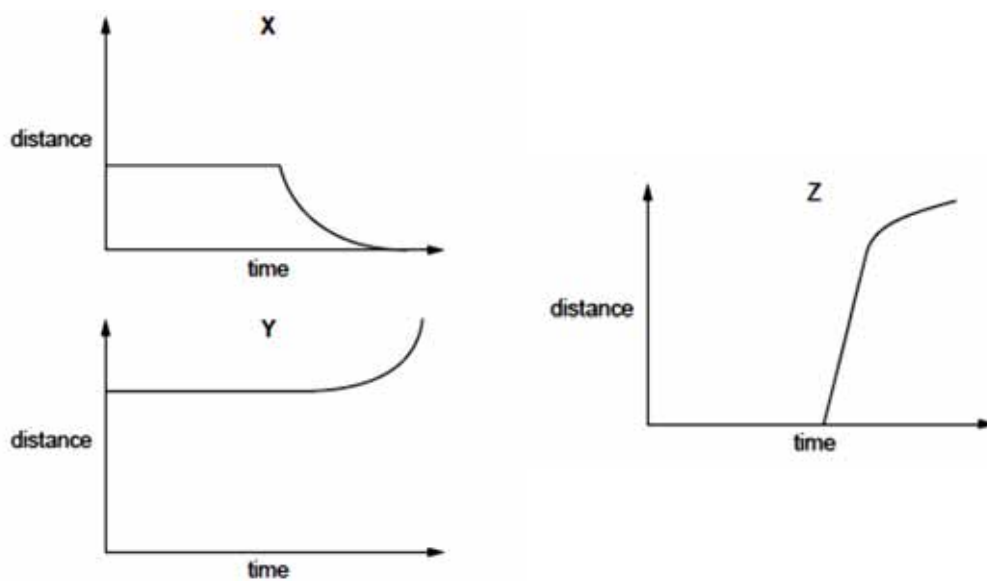
How many of the student's deductions are correct and can be supported using the information provided?

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

9 What are the conditions in a human cell just before the cell enters prophase?

	number of molecules of DNA in nucleus	spindle present	nuclear envelope present
A	46	yes	no
B	46	no	yes
C	92	yes	yes
D	92	no	yes

10 The graphs show various measurements taken from metaphase of mitosis onwards. The graphs are to scale when compared to one another.



Which row correctly describes each graph?

	X	Y	Z
A	Distance between poles of spindle	Distance between sister chromatids	Distance of centromere from pole of spindle
B	Distance between poles of spindle	Distance of centromere from pole of spindle	Distance between sister chromatids
C	Distance of centromere from pole of spindle	Distance between poles of spindle	Distance between sister chromatids
D	Distance of centromere from pole of spindle	Distance between sister chromatids	Distance between poles of spindle

11 DNA is said to replicate in a semi-conservative way.

Results of Meselson and Stahl's experiments gave overwhelming support to this theory. They used *E. coli* which has a generation time of 20 minutes.

Here are the steps in their experiment but they are in the wrong order.

- P** All bacteria contain ^{15}N DNA.
- Q** All bacteria contain hybrid DNA (^{15}N DNA and ^{14}N DNA).
- R** Bacteria contain either all ^{14}N DNA or hybrid DNA.
- S** Bacteria grown in a ^{15}N medium for many generations.
- T** Bacteria transferred to a ^{14}N medium and sampled every 20 minutes.

Which sequence of letters shows the correct order of the steps in the experiment?

- A** P → Q → R → S → T
- B** P S T R Q
- C** S P T Q R
- D** S P T R Q

12 Polypeptide synthesis is based on sequences of three nucleotides, each specific for an amino acid.

Which row shows the correct nucleotide sequences for an amino acid?

	nucleotide sequence of		
	non-transcribed DNA strand	mRNA codon	tRNA anticodon
A	GGT	CCA	GGU
B	GGG	CCC	CCC
C	CCG	CCG	GGC
D	CCT	CCU	CCU

13 Which statement(s) about tRNA structure is/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 phosphodiester 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.

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

14 The following table shows the mRNA codons for six different amino acids.

mRNA codons	amino acid
AAA AAG	lysine
AGA AGG CGG	arginine
GGU GGA GGC GGG	glycine
CCU CCA CCC CCG	proline
UGG	tryptophan
UAU UAC	tyrosine

The base sequence of mRNA coding for part of a polypeptide is shown below.

U	A	U	A	A	G	A	G	G	C	C	U	U	G	G
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

↑
start reading

From the information provided, which of the predictions stated below is **not** true?

- A The insertion of a nucleotide between positions 3 and 4 is expected to result in a greater change in the amino acid sequence than an insertion between positions 12 and 13.
- B The deletion of a nucleotide at position 5 would result only in an alteration of the second amino acid in the chain.
- C The substitution of a different nucleotide at position 12 would produce no alteration in the amino acid chain.
- D The substitution of a different nucleotide at position 13 would result in the alteration of one amino acid.

- 15** The following table shows the chromosome numbers in the hybrids formed between cabbage (*Brassica oleracea*) and radish (*Raphanus sativus*).

<i>type of cell</i>	<i>no. of chromosomes per cell</i>
parental cabbage	18
parental radish	18
parental gametes	9
F ₁ hybrids	18
F ₁ gametes	18
F ₂ hybrids	36
F ₂ gametes	18
F ₃ hybrids	36

During which of the following stages can the occurrence of non-disjunction explain the results?

- A** formation of the F₁ gametes
 - B** formation of the F₂ gametes
 - C** fusion of the parental gametes
 - D** fusion of the F₁ gametes
- 16** A In horses, there are 3 coat colour patterns, *cremello* (beige), *chestnut* (brown) and *palomino* (golden with pale coloured mane and tail). When 2 *palomino* horses were crossed, they produce 25% *cremello*, 25% *chestnut* and 50% *palomino* horses.

Which of the following statement is true about the cross?

- A** The *cremello* offspring are all heterozygotes.
- B** There are 3 alleles involved in the coat colour patterns of the horses.
- C** All the *palomino* offspring are heterozygotes.
- D** The allele that code for *chestnut* is recessive to the *cremello*.

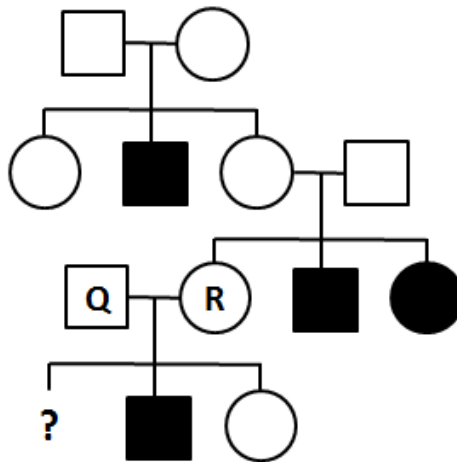
- 17 In mice, the alleles coding for coat pattern is located on the X chromosome. The 'dappled' coat allele is denoted D and its recessive allele for 'plain' coat, d. The alleles coding for 'straight' whiskers (W) and the recessive condition, 'bent' whiskers (w), are found on autosomes.

A male mouse with plain coat and bent whiskers was mated on several occasions to the same female and the large number of offspring consisted of males and females in equal numbers in all combinations of phenotypes, as shown in the table.

Offspring	
dappled, straight whiskers	plain, straight whiskers
dappled, bent whiskers	plain, bent whiskers

If X^D represents an X chromosome carrying the allele for 'dappled' coat and X^d represents an X chromosome carrying the allele for 'plain' coat, what is the genotype of the female parent?

- A $X^D X^D WW$
 B $X^D X^D Ww$
 C $X^D X^d WW$
 D $X^D X^d Ww$
- 18 Adducted thumb syndrome is a condition where affected individual will have malformation of the thumb and upper limbs. The figure below show a pedigree chart of a family with the history of adducted thumb syndrome.



If individual Q and R give birth to a son, what is the possibility that their son will be affected by the condition?

- A 0.125
 B 0.25
 C 0.50
 D 0.75

19 Which of the following would cause phenotypic variation among organisms of the same genotype?

- A** continuous variation within the species
- B** different varieties of the same species
- C** exposure to different environments
- D** mutation

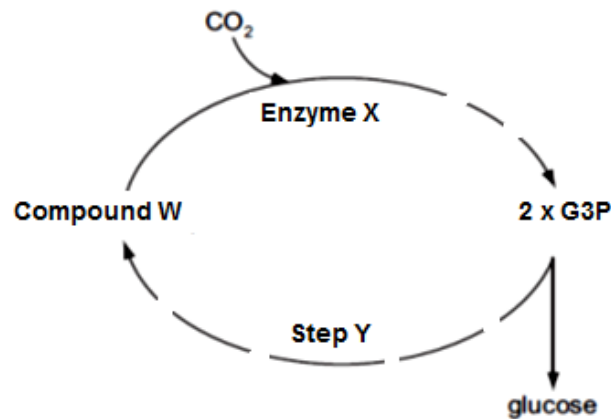
20 In a series of experiments, actively photosynthesizing plants were supplied with labelled reactants.

- 1** water containing ^{18}O isotope
- 2** carbon dioxide containing ^{17}O isotope
- 3** carbon dioxide containing ^{13}C isotope

Where in the chloroplast would the products of photosynthesis from these reactants be formed?

	^{18}O	^{17}O	^{13}C
A	stroma	stroma	thylakoids
B	stroma	thylakoids	stroma
C	thylakoids	stroma	stroma
D	thylakoids	stroma	thylakoids

- 21 The figure below summaries some key reactions which occur in the Calvin cycle. Note that the dashed lines would indicate that there is more than one reaction present.



Using the figure above and your knowledge of Calvin cycle, determine which one of the following statements below is **true**?

- A Compound W is expected to accumulate if carbon dioxide concentration increases under low light intensity.
- B Enzyme X is expected to accumulate when carbon dioxide concentration decreases.
- C Increase in temperature under high light intensity will increase the activity of enzyme X until the optimum temperature.
- D ATP from substrate level phosphorylation is required for Step Y to proceed and Compound W to be formed.

- 22 In an experiment, four tubes were set up as shown in the table below.

tube	contents
1	Glucose + homogenized animal cells
2	Glucose + mitochondria
3	Glucose + cytoplasm lacking organelles
4	Pyruvate + homogenized animal cells

If all other conditions are kept constant, which of the following shows the amount of ATP produced in each tube in **increasing** order?

- A 1 – 3 – 4 – 2
- B 2 – 3 – 4 – 1
- C 4 – 2 – 3 – 1
- D 3 – 2 – 1 – 4

- 23** Darwin's view of the process of evolution to form new species (speciation) has been reinforced by more recent discoveries in genetics and cell biology.

In this view, which sequence of events is considered most likely to lead to speciation?

A	adaptation of population → competition and predation leading to natural selection → behavioural isolation → sympatric speciation
B	adaptation of population → competition and predation leading to natural selection → behavioural isolation → allopatric speciation
C	competition and predation leading to natural selection → geographical isolation → adaptation of isolated populations → sympatric speciation
D	competition and predation leading to natural selection → geographical isolation → adaptation of isolated populations → allopatric speciation

24 Natural selection acts

- A** directly on an individual's genetic make-up, thereby changing the survival probability of the individual.
- B** on individuals by changing their genes so they are better able to adapt to their environment.
- C** on the structures, physiologies and behaviours expressed by individuals in a population to change allele frequencies.
- D** on phenotypes of individuals so that they change to adapt to their environment and pass on these changes to their offspring.

- 25 The map shows the distribution (shaded area) of the lizards belonging to the family Iguanidae. Most species of iguana are found in America but a few species inhabit Madagascar and the islands of Fiji and Tonga (arrows at the bottom centre and bottom right of map).



Two observations were made about the different species of iguana:

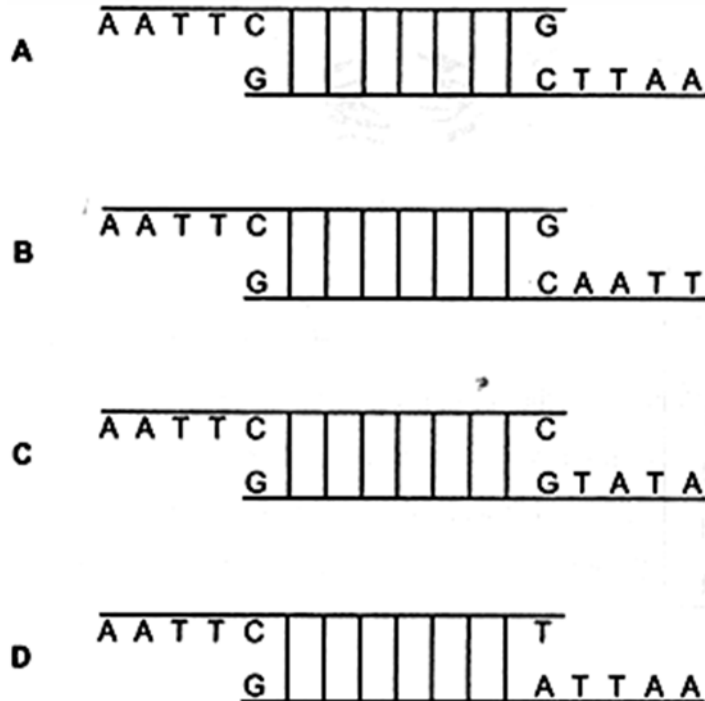
- 1 The various American iguana species shared more similar characteristics among themselves than with those iguana species on the island of Fiji.
- 2 The Madagascar iguana species was only distantly related to other lizard species on the African mainland.

Which observation and explanation best support the Darwinian concept of descent with modification?

	Observation	Explanation for the observation
A	1	The various American iguana species had a more recent common ancestor as compared to those iguana species on the island of Fiji that had diverged a longer time ago.
B	1	The various American iguana species shared more similarities among themselves as the degree of homology in their DNA was higher.
C	2	The Madagascan iguana species was reproductively isolated from the lizard species on the African mainland and thus diverged a long time ago.
D	2	The superficial similarities shared among the Madagascan iguana and the lizards on the African mainland were analogous, not homologous.

- 26 In genetic engineering, a restriction enzyme is used to cut plasmid DNA at a specific target site. The enzyme recognises a sequence of six bases and forms sticky ends.

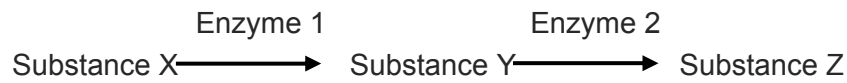
Which diagram of such a cut section of DNA is correct?



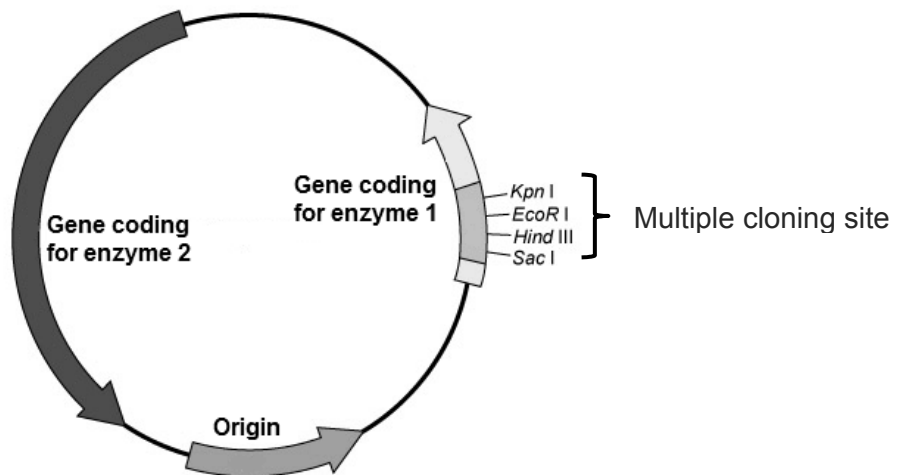
- 27 Which one of the following statements regarding polymerase chain reaction is **false**?

- A** Taq polymerase is chosen for use because of its heat-stable property.
- B** Amplification of the DNA products requires DNA primers to be added for initiation.
- C** Initiation of the amplification need not start at the promoter region of the gene.
- D** The amount of products formed by PCR is not limited by the nucleotides added into reaction mixture.

- 28** The metabolic pathway shown below is utilised by a species of bacteria to produce substance Z, which is essential for the replication of the bacterial chromosome. When provided with substance X or substance Y, wild-type bacteria are able to synthesise substance Z.



Mutant bacteria, lacking the genes coding for both enzyme 1 and 2, were genetically modified to contain the human insulin gene. The following plasmid was used as a vector for transformation.



The transformed cells were plated onto an agar plate containing only substance Y. Which of the following replica plates have to be prepared in order to identify the colony containing recombinant bacteria?

- A** Replica plate containing substance X only
- B** Replica plate containing substance X and Y
- C** Replica plate containing substance Y and Z
- D** Replica plate containing substance Z only

29 Which is a correct statement about obtaining human embryonic stem cells for research?

- A** Removal of these cells is considered to be ethically acceptable as normal development of the embryo is not inhibited.
- B** The cells must be removed at an early stage of development from a region of the blastocyst known as the inner cell mass.
- C** The cells must be removed within a day following the successful fertilisation of the ovum by the sperm, and after checking for normal mitotic division.
- D** The region of the blastocyst from where the cells are removed is an area that develops at a later stage into the placenta.

30 Efforts to develop salt-tolerant crop varieties using selective breeding techniques have been unsuccessful. Recently, plant biologists have developed a genetically engineered tomato plant that can thrive in salty water. This genetically modified plant produces significantly higher levels of a naturally occurring transport protein. This transport protein moves salt, in the form of sodium ions into the central vacuoles of leaf cells specifically.

Which statement correctly describes the benefit of genetic engineering of this tomato plant?

- A** Improving crop yield through maximizing the use of land.
- B** Improving crop quality since the fruit will be juicy due to influx of water via osmosis.
- C** Improving crop yield by changing the way the plant uses its energy resources.
- D** Improving crop quality since the tomato fruit can supplement salt loss to sweating.