



**ANGLO-CHINESE JUNIOR COLLEGE**  
**Preliminary Examination 2015**

**BIOLOGY**

**8875/01**

**HIGHER 1**

**31 August 2015**

**Paper 1 Multiple Choice**

**1 hour**

Additional Material: Multiple Choice Answer Sheet

**READ THESE INSTRUCTIONS FIRST**

Write in soft pencil.

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

Write your name, centre number and index number on the Answer Sheet provided.

There are **thirty** questions in this paper. Answer **all** questions. For each question there are four possible answers, **A, B, C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate answer sheet.

**Read the instructions on the Answer Sheet very carefully.**

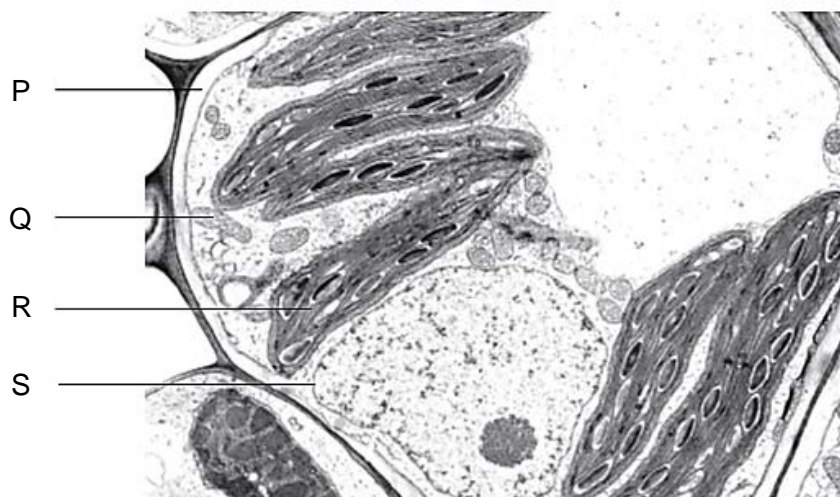
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

Calculators may be used.

This question paper consists of **18** printed pages.

- 1 The electron micrograph of a cell is shown below.



Which of the following statements are true?

- 1 Structure P is found in all eukaryotic cells.
  - 2 Organelle Q contains hydrolytic enzymes.
  - 3 Organelle R contains starch.
  - 4 Organelle S contains heterochromatin but not euchromatin.
  - 5 Organelles Q, R and S contain RNA polymerase.
- A** 1 and 3 only  
**B** 3 and 5 only  
**C** 1, 3 and 4 only  
**D** 2, 3 and 5 only
- 2 Three artificial cells of equal sizes, each surrounded by a partially permeable membrane, contained equal concentrations of different food reserves. One cell contained only fats, one cell contained only glycogen and one cell contained only glucose.

Which of the following shows the rate of expansion of these cells when immersed in distilled water, and their energy content?

(The sign  $\approx$  means approximately equal and the sign  $>$  means greater than.)

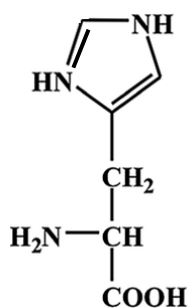
	Rate of expansion of cells	Respiratory energy content
<b>A</b>	glucose $\approx$ glycogen $>$ fat	fat $>$ glycogen $\approx$ glucose
<b>B</b>	glucose $\approx$ glycogen $>$ fat	fat $\approx$ glycogen $>$ glucose
<b>C</b>	glucose $>$ glycogen $>$ fat	fat $>$ glycogen $>$ glucose
<b>D</b>	glucose $>$ glycogen $>$ fat	fat $\approx$ glycogen $>$ glucose

- 3 Experiments were conducted to study the effects of cyanide on the rate of absorption of three monosaccharides by mammalian intestinal cells. Cyanide inhibits cytochrome c oxidases. The results of the experiments are shown in the table below.

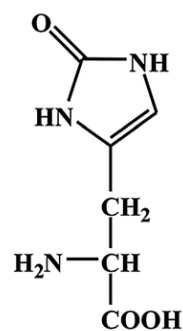
Monosaccharide	Relative rate of absorption by intestinal cells (arbitrary units)	
	In physiological saline	In physiological saline with added cyanide
Glucose	1.02	0.33
Xylose	0.33	0.33
Arabinose	0.27	0.28

Which of the following statements are consistent with these results?

- 1 Active transport is not involved in the uptake of xylose and arabinose.
  - 2 Xylose and arabinose enter the cells by facilitated diffusion.
  - 3 Aerobic respiration is necessary for the higher rate of uptake of glucose.
  - 4 Extrinsic proteins are involved in the uptake of all the three monosaccharides.
- A 1 and 2 only  
 B 2 and 4 only  
 C 1, 2 and 3 only  
 D 1, 3 and 4 only
- 4 One important amino acid at the oxygen-binding site of haemoglobin is histidine at position 87. When free radicals are produced in the body, the amino acid residue may be oxidised.



Histidine

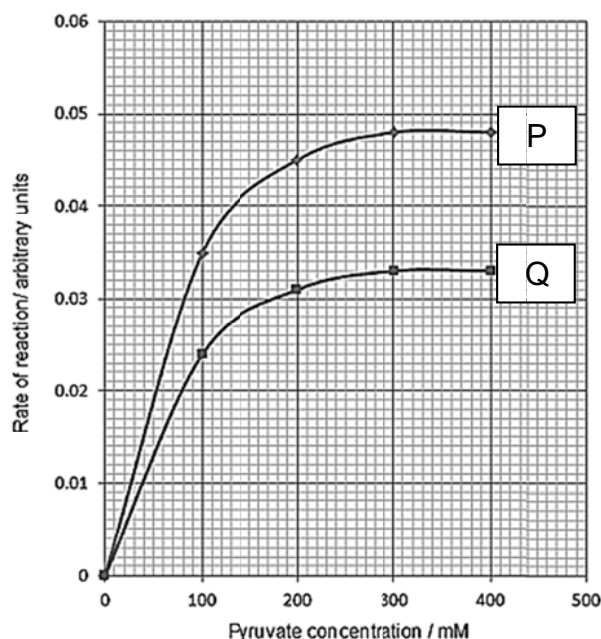


Oxidised histidine

Based on the above information, which of the following is a consequence of the oxidation of histidine?

- A The polypeptide is truncated and haemoglobin will not form a globular structure.  
 B The secondary structure of haemoglobin will be altered.  
 C The 3D configuration of haemoglobin will not be altered.  
 D The prosthetic haem group will not be able to bind to haemoglobin.

- 5 Curve P shows the rate of a reaction catalysed by lactate dehydrogenase under optimum conditions. A change was made to the reaction and curve Q shows the effect of this change on the reaction rate.



Which factor, operating to a constant extent throughout the experiment, could result in curve Q?

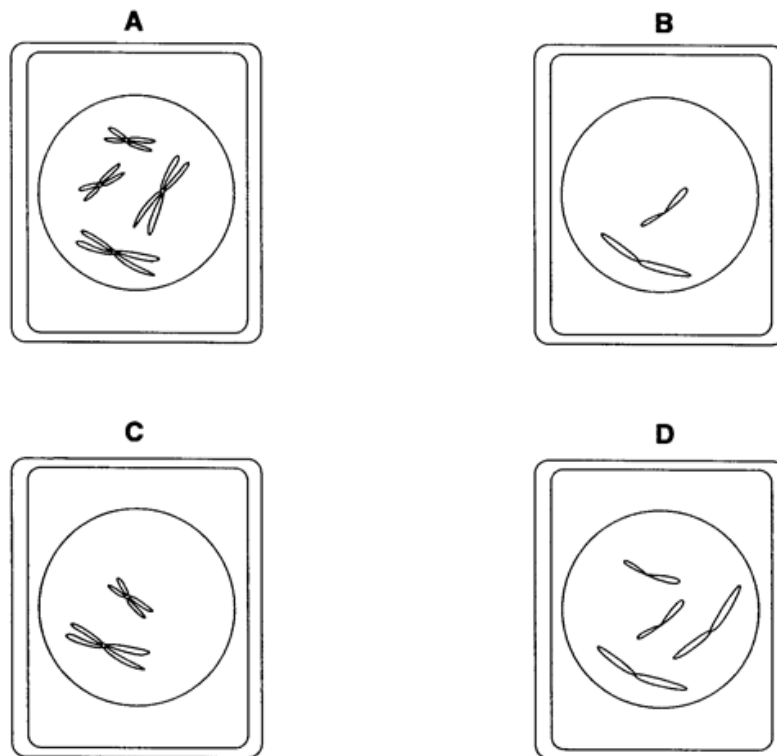
- A Addition of a compound that competes for the same binding site as pyruvate
  - B Addition of an inhibitor that differs in 3D configuration from pyruvate
  - C Addition of a co-enzyme such as  $\text{NAD}^+$
  - D An increase in enzyme concentration
- 6 Lysozyme is an antibacterial enzyme that hydrolyses the polysaccharide cell wall of bacteria. When the lysozyme binds to the polysaccharide, it changes the conformation of one of the sugars in the polysaccharide chain to a high-energy conformation, allowing the bonds between the monosaccharides to be broken easily. The energy needed to break the bonds between the monosaccharides is now lowered.

In a mutation, the lysozyme was able to bind to the bacterial polysaccharide cell wall but was not able to hydrolyse the bonds between the monosaccharides.

Which row correctly shows the mechanism of the enzyme and the position of the mutation?

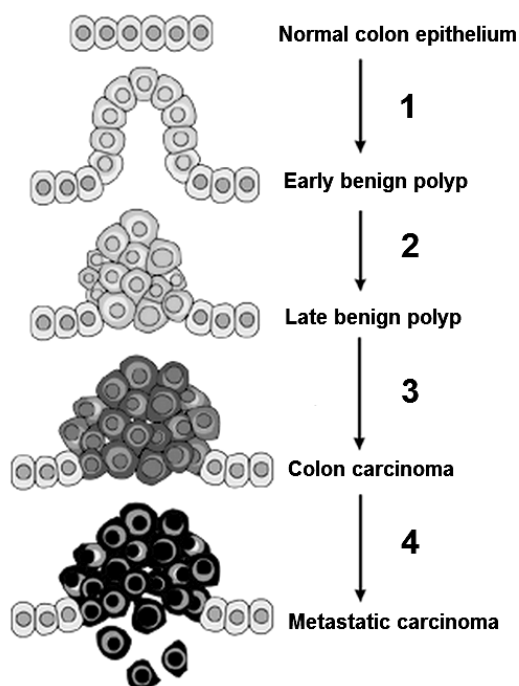
	Mechanism	Position of mutation
A	Proximity effect	Binding residue
B	Strain effect	Catalytic residue
C	Strain effect	Binding residue
D	Orientation surface	Structural residue

- 7 A diploid cell contains four chromosomes. Which diagram shows the nucleus at prophase of mitosis after a previous meiotic division?



- 8 During the mitotic cell cycle, which of the following would result if cytokinesis does not occur after mitosis is completed?
- A Cells with two nuclei
  - B Cells with insufficient organelles
  - C Cells with twice the amount of genetic material but without nuclei
  - D Cells which are unusually small in size

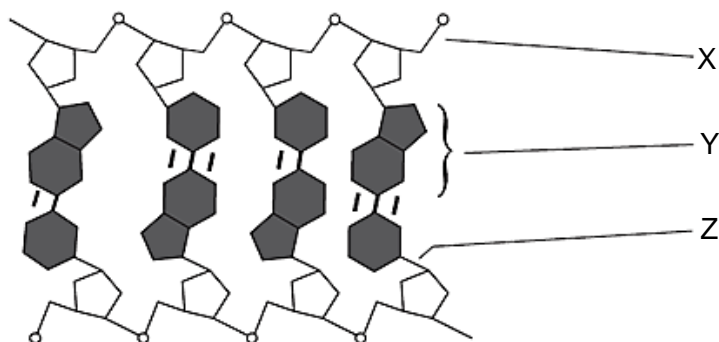
- 9 Carcinogenesis, the process of tumour formation, occurs over multiple steps as shown in the following diagram.



Which option best describes the genetic changes occurring at each step?

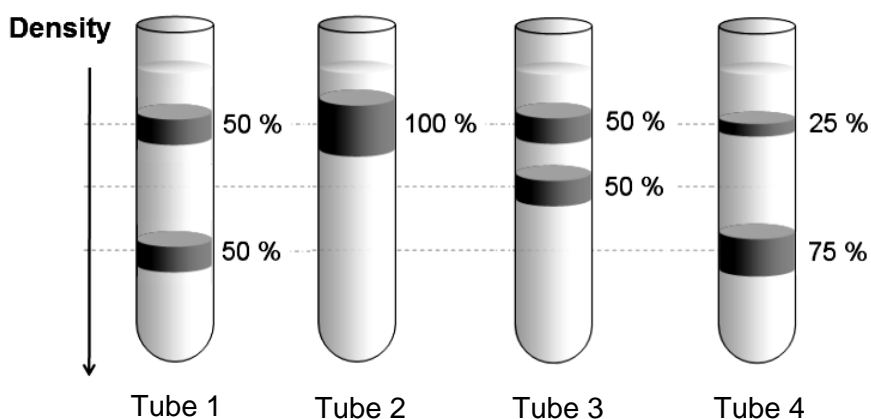
	Step 1	Step 2	Step 3	Step 4
<b>A</b>	Mutation in a tumour suppressor gene	Mutation leading to loss of density-dependent inhibition	Further accumulation of mutations	Mutation leading to loss of anchorage dependence
<b>B</b>	Mutation in a proto-oncogene	Mutation leading to loss of anchorage dependence	Further accumulation of mutations	Mutation in a tumour suppressor gene
<b>C</b>	Mutation leading to loss of density-dependent inhibition	Mutation in a tumour suppressor gene	Further accumulation of mutations	Mutation in a proto-oncogene
<b>D</b>	Mutation leading to loss of anchorage dependence	Mutation in a proto-oncogene	Further accumulation of mutations	Mutation leading to loss of density-dependent inhibition

- 10 The diagram below shows a short section of a DNA molecule. What are the correct labels for X, Y and Z?



	X	Y	Z
A	3' end	pyrimidine	hydrogen bond
B	3' end	purine	hydrogen bond
C	5' end	pyrimidine	covalent bond
D	5' end	purine	covalent bond

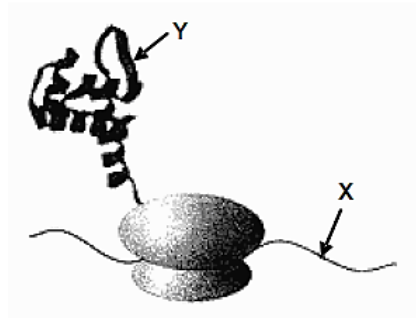
- 11 In a modification of the Meselson-Stahl experiment, cells belonging to a newly-discovered alien organism was grown for several generations in a medium containing  $^{31}\text{P}$  nucleotides. Subsequently, these cells were transferred to a medium containing  $^{32}\text{P}$  nucleotides and grown for two generations. DNA from the cells after two generations were extracted and separated by centrifugation in a caesium chloride mixture, and the relative amount of DNA in each band is indicated as a percentage.



Which of the above tubes shows that DNA replication in the cells occurs by a conservative mechanism?

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

- 12 The diagram below shows a particular stage of protein synthesis.



Which of the following statements is true of molecules X and Y?

- A The coiling of molecule Y is a direct result of the information on molecule X.
  - B Molecule X is double-stranded whilst molecule Y is single-stranded.
  - C In both molecules X and Y, the bonds between adjacent monomers of each molecule are phosphodiester bonds.
  - D The monomers of molecule X interact with the monomers of molecule Y through temporary hydrogen bonds.
- 13 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.

<b>U</b>	<b>A</b>	<b>U</b>	<b>A</b>	<b>A</b>	<b>G</b>	<b>A</b>	<b>G</b>	<b>G</b>	<b>C</b>	<b>C</b>	<b>U</b>	<b>U</b>	<b>G</b>	<b>G</b>
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.



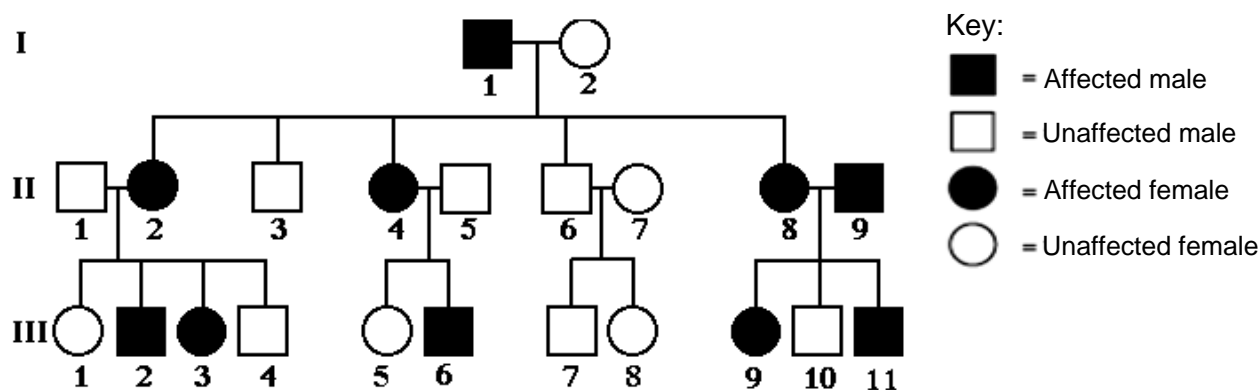
- 14 The colour of roses is controlled by one gene. There are three possible phenotypes – red, white, and white roses with red patches. Two crosses were conducted.

Cross 1	Homozygous red roses and homozygous white roses were crossed.
Cross 2	White roses with red patches from the F <sub>1</sub> generation were selfed.

Which of the following shows the correct set of ratios in the offspring?

	Cross 1				Cross 2		
	Red	Red and white	White		Red	Red and white	White
<b>A</b>	1	2	1		1	2	1
<b>B</b>	0	1	0		1	2	1
<b>C</b>	0	1	0		3	0	1
<b>D</b>	1	0	0		3	0	1

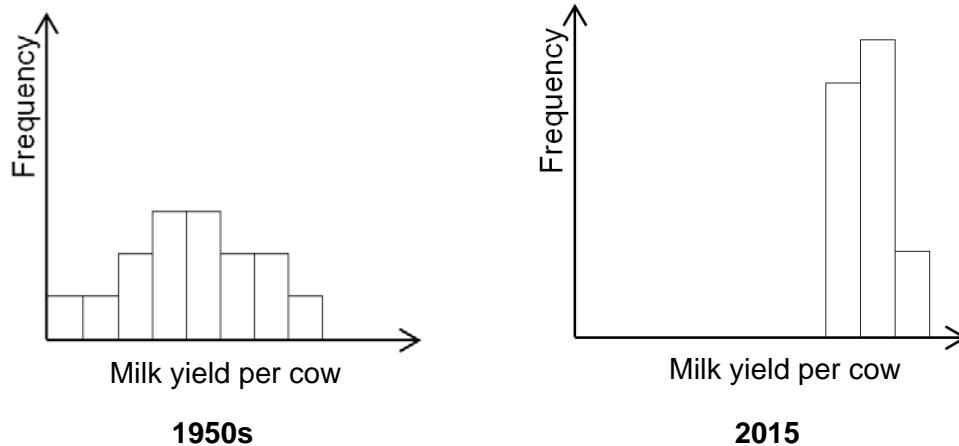
- 15 A diagram shows the pedigree of Rett's disease, a genetic neurological disorder which results in autism-like symptoms.



Which of the following statements can be concluded based on the diagram above?

- A** This genetic disorder is a X-linked dominant trait.  
**B** This genetic disorder is due to an autosomal recessive allele.  
**C** Individual II-1 must be heterozygous for the mutant allele as III-2 and III-3 are affected with the genetic disorder.  
**D** Individual III-11 was affected with the genetic disorder as a result of genetic mutation during his lifetime.

- 16 The graphs below show the distribution of milk yield in cows, indicating the number of cows and the milk yield per cow in the 1950s and in 2015.



Which of the following could **not** have led to the difference in both graphs?

- A Removing cows with lower milk yields from the herd
  - B Optimising the ambient temperature of the cows' holding area
  - C Increasing the number of cows in the herd
  - D Injecting cows with bovine growth hormone
- 17 Some commercial varieties of fruits, such as watermelons, are triploids, which is an advantage as these fruits are seedless.

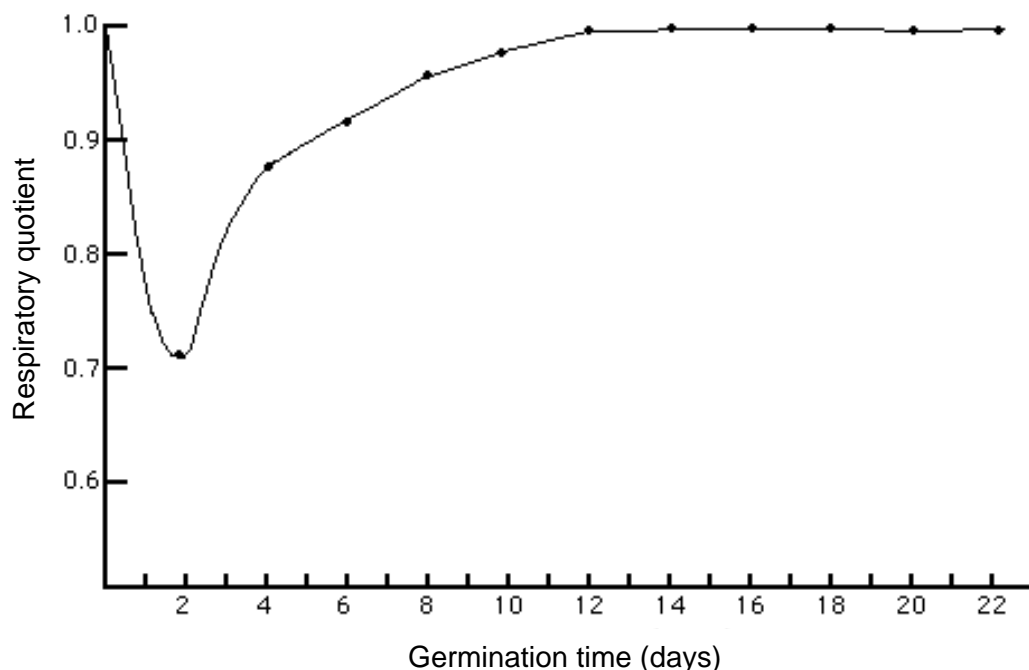
Which of the following statements are correct?

- 1 The advantageous feature arose because of the addition of new alleles to the gene pools of the commercial varieties in the form of gene mutations.
  - 2 The triploid state possibly came about due to non-disjunction of chromosomes during anaphase II of meiosis.
  - 3 These triploid commercial varieties can reproduce to form triploid progeny because they can undergo asexual reproduction.
  - 4 They are seedless because not all homologous chromosomes can pair up during meiosis.
- A 1, 2 and 3 only
  - B 1, 2 and 4 only
  - C 1, 3 and 4 only
  - D 2, 3 and 4 only

- 18 In cyclic photophosphorylation, when the reaction centre of Photosystem I absorbs light, its electron is excited and accepted by an electron acceptor X before it is passed on to a series of electron carriers.

Which of the following would **not** take place in the presence of an inhibitor of electron acceptor X?

- A Carbon dioxide gas diffuses through the stomata at a faster rate.
  - B Less oxygen gas is released.
  - C Less protons will be found in the thylakoid space.
  - D Reduced NADP is produced in smaller amounts.
- 19 The graph below shows the respiratory quotient of wheat over a period of 22 days of germination.



Which of the following statements is true?

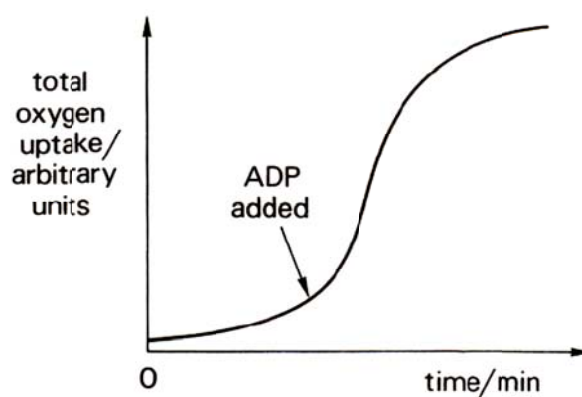
- A At day 2 of germination, the fuel source must be proteins since the respiratory quotient is 0.7.
- B Metabolism of the germinating wheat embryo during early germination is not dependent on the presence of oxygen.
- C After 12 days from the start of germination, wheat uses carbohydrates as the main respiratory substrate, shown by a respiratory quotient of 1.
- D From day 12 onwards, wheat switches to lipid metabolism as lipids have a higher calorific value when compared to carbohydrates.

- 20** It has been found that an aqueous suspension of isolated chloroplasts will evolve oxygen if illuminated in the presence of a certain type of compound.

What type of compound must be present and what quality of light is required for maximum oxygen evolution?

	Type of compound	Quality of light at which maximum oxygen evolution occurs
<b>A</b>	Electron acceptor	Blue and green
<b>B</b>	Electron acceptor	Blue and red
<b>C</b>	Electron donor	Green and red
<b>D</b>	Electron donor	Blue and red

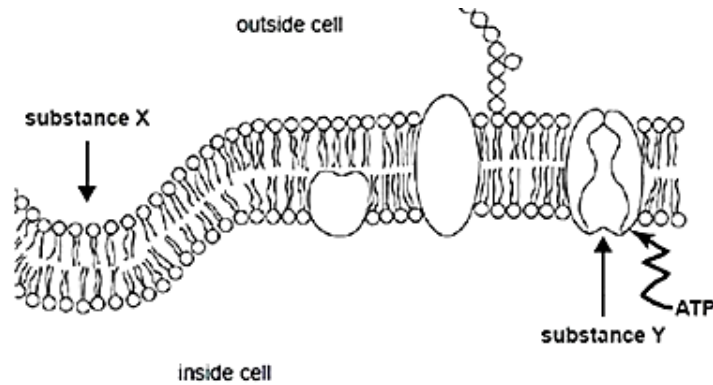
- 21** The graph shows the total oxygen uptake by a sample of homogenised liver tissue over a period of time.



Which statement explains the sharp rise in oxygen uptake after the addition of ADP?

- A** Electron transport is coupled to the phosphorylation of ADP.
- B** More protons move directly across the phospholipid bilayer of the cristae, generating the proton pool in the intermembrane space.
- C** Slower utilisation of reduced NAD and FAD causes molecular oxygen to be reduced to water.
- D** Oxidative phosphorylation occurs as protons are pumped back into the matrix through ATP synthase, phosphorylating ADP.

- 22 The figure below shows a cross section of the plasma membrane in a typical mammalian cell. The substances labelled X and Y are about to be transported across the membrane in the directions shown by the arrows (→).



Which of the following rows is correct?

	Substance X			Substance Y		
	type of movement	nature of molecule	size of molecule	type of movement	nature of molecule	size of molecule
<b>A</b>	diffusion	lipid soluble	small	facilitated diffusion	lipid soluble	large
<b>B</b>	diffusion	water soluble	small	active transport	lipid soluble	small
<b>C</b>	endocytosis	lipid soluble	large	facilitated diffusion	charged	large
<b>D</b>	endocytosis	water soluble	large	active transport	charged	small

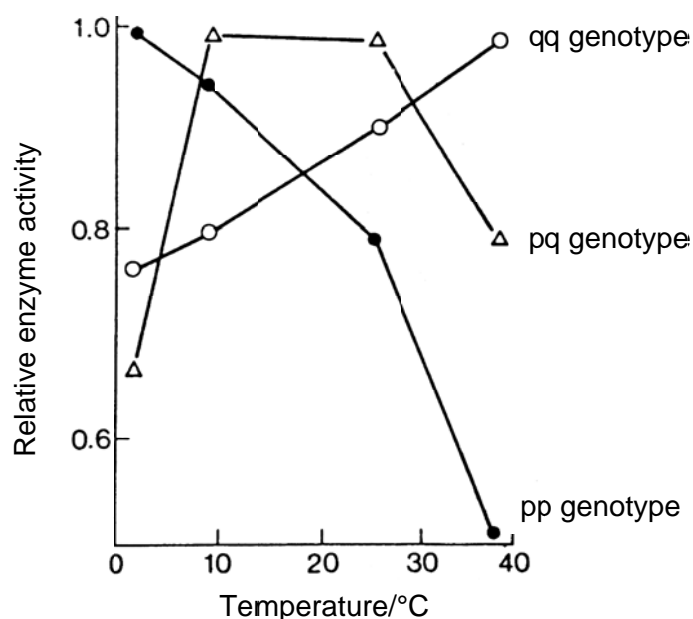
- 23 Nucleoside inhibitors are an example of drugs used in controlling the human immunodeficiency virus (HIV) which causes acquired immune deficiency syndrome (AIDS). These inhibitors compete with DNA nucleosides for the active site of the reverse transcriptase enzyme in HIV. This enzyme is vital to ensure the reproductive success of HIV. One of these nucleoside inhibitors, 3TC, is a molecular analogue of cytosine.

Soon after 3TC is first given to the patient, a modified form of reverse transcriptase which binds to cytosine but not 3TC, will appear at a very low frequency in the HIV population in a human body. The percentage of this drug-resistant HIV in the patient will then increase from the time the drug is first given to the patient, to 100% about three weeks later.

Which of the following statements best supports the above information?

- A** The presence of 3TC triggers the modification of reverse transcriptase which only binds to cytosine, and not 3TC.
- B** The presence of 3TC causes the virus to select for reverse transcriptase which only binds to cytosine, and not 3TC.
- C** The virus increases the expression of the gene coding for the modified form of reverse transcriptase.
- D** High mutation frequency in HIV would have resulted in the production of HIV variants, some with modified reverse transcriptase.

- 24 In the North American catfish *Catostomus clarki*, two alleles, represented by p and q, control the synthesis of a vital enzyme. The three possible genotypes (pp, pq, qq) lead to the synthesis of variations of the same enzyme with different optimal temperatures as shown in the graph below.



When the mean annual temperature is 5°C, which of the following statements is correct?

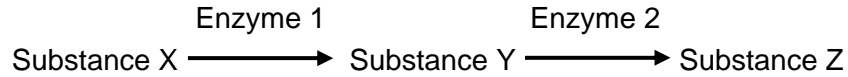
- A Frequency of allele p in the gene pool will increase.  
 B Frequency of allele q in the gene pool will increase.  
 C Allele p will become dominant and allele q will become recessive.  
 D The heterozygotes will have an advantage over the homozygotes.
- 25 Human blood, when mixed with antibodies to human blood, will give maximum precipitation. When other animals' blood was mixed with antibodies to human blood, the following experimental results were obtained.

Species	Human	M	N	O	P
Percentage of precipitation / %	100	37	75	79	17

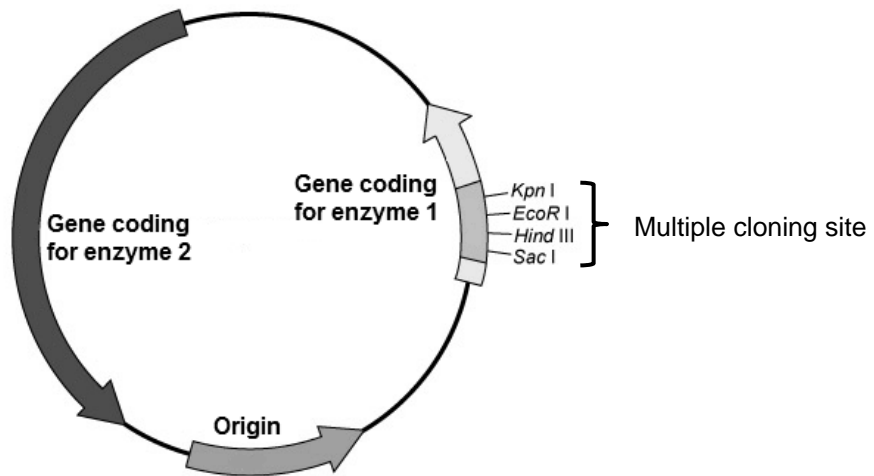
Which of the following conclusions is **not** valid?

- A Species O is more closely related to humans than species N.  
 B Species M and species P are most closely related among the different species tested.  
 C Differences in blood proteins in the different species tested is due to divergent evolution.  
 D The precipitation of other animals' blood by antibodies to human blood indicates molecular homology.

- 26 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.



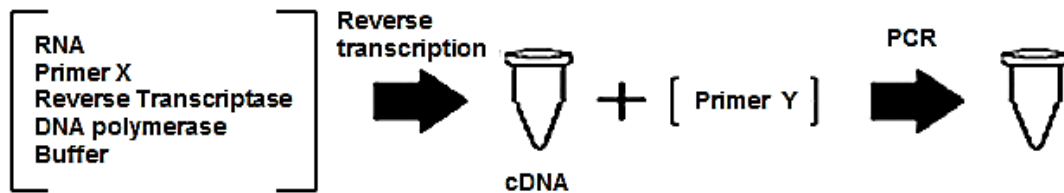
Mutant bacteria, lacking the genes coding for both enzyme 1 and 2, were genetically modified to contain the human insulin gene. The following plasmid was used as a vector for transformation.



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

- 27 Reverse transcriptase polymerase chain reaction (RT-PCR) is a technique which couples the process of reverse transcription to polymerase chain reaction. After extracting mRNA from a target eukaryotic cell, the extracted sample is subjected to RT-PCR as follows:



Which of the following statements describing RT-PCR is **false**?

- A Primer X used for reverse transcription can be an oligonucleotide sequence of repeating thymines.
  - B Both primer X and primer Y used for reverse transcription and for PCR are DNA primers.
  - C RT-PCR can lead to the exponential increase in the quantity of mRNA for analysis.
  - D RT-PCR can be used to study the expression of oncogenes and tumour suppressor genes in cancer cells.
- 28 After the human genome was fully sequenced in 2003, scientists launched a second project to study the human genome, The Encyclopedia of DNA Elements (ENCODE). The goal of ENCODE is to build a comprehensive list of functional elements in the human genome, including regulatory elements that control gene expression, with the aim of better understanding human biology and to predict potential risk of diseases.

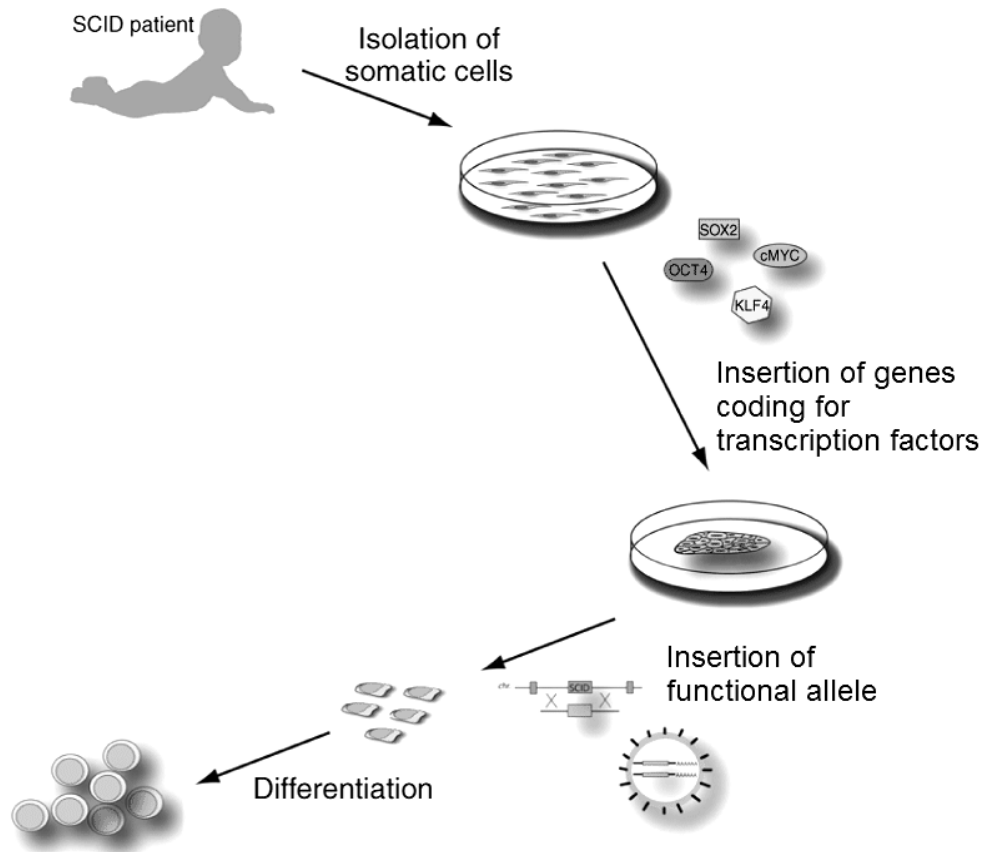
The project has identified previously undiscovered DNA regulatory elements, providing insights into the organization and regulation of human genes, and how differences in DNA sequence could influence the development of diseases.

Which of the following ethical concerns addressed by the Human Genome Project does **not** directly apply to the ENCODE project?

- A Fairness in access to advanced genomic technologies
- B Uncertainties associated with gene tests for susceptibilities and complex conditions
- C Stigmatization and discrimination due to an individual's genetic makeup
- D Health and environmental issues concerning genetically modified (GM) foods and microbes



- 29** In 2006, scientists have discovered a means to convert somatic cells, such as skin cells, into pluripotent stem cells. By inserting four specific genes which code for transcription factors, somatic cells are able to de-differentiate and achieve pluripotency. Such pluripotent stem cells may one day be used for gene therapy to treat diseases such as severe combined immunodeficiency (SCID), as shown in the following diagram.



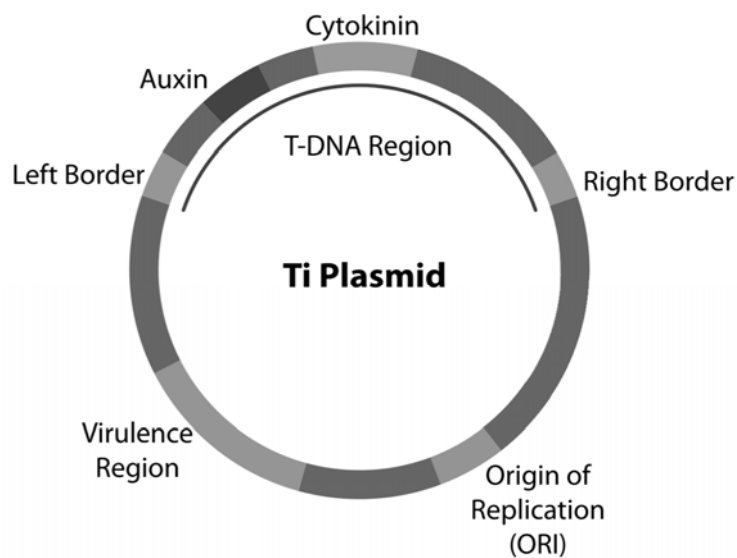
What is one benefit of using these novel pluripotent stem cells over embryonic stem cells?

- A** A functional copy of the allele could be inserted into these novel stem cells using a retroviral vector during gene therapy.
- B** These novel stem cells have the potential to differentiate into more types of cells, hence they can be used to treat a greater variety of diseases.
- C** These novel stem cells will not be rejected by the host after being transplanted back into the body.
- D** These novel stem cells are able to maintain the undifferentiated state for long periods of time due to the insertion of additional genes.

- 30** *Agrobacterium tumefaciens* is a soil bacterium that has been used in biotechnology for the insertion of foreign genes into the plant cells that it infects. It contains the Ti plasmid, which is shown in the diagram below.

After the infection of a plant cell, the T-DNA region is excised from the plasmid and introduced into the plant cell, leaving the remainder of the plasmid in the bacterial cell. The T-DNA subsequently enters the nucleus and is integrated into the host cell genome.

The T-DNA region contains genes coding for auxin and cytokinin. These plant growth regulators stimulate plant cell proliferation, leading to tumour formation in the infected plant.



Genes in the Ti plasmid which induce tumour formation are replaced with foreign genes which can confer pest resistance. Such modified plasmids are used to create transgenic sugarcane cultivars. Which of the following implications applies to the creation of these cultivars?

- A** It has the potential to benefit mankind due to the improved quality of food crops.
- B** When the transgenic sugarcane is consumed, genes responsible for the virulence of *Agrobacterium tumefaciens* may be passed on to other bacteria in the environment.
- C** The long-term consumption of transgenic sugarcane containing elevated levels of auxin and cytokinin may have unknown effects on human health.
- D** The large-scale use of transgenic sugarcane in agriculture can have undesirable effects on ecological balance.

**End of Paper**