

NANYANG JUNIOR COLLEGE  
JC 2 PRELIMINARY EXAMINATION  
Higher 1

CANDIDATE  
NAME

**MARK SCHEME**

CLASS

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## BIOLOGY

**8875/01**

Paper 1 Multiple Choice

**28 September 2016**

**1 hour**

Additional Materials: Multiple Choice Answer Sheet

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### READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

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

Write your name, Centre number and index number on the Answer Sheet in the spaces provided unless this has been done for you.

DO **NOT** WRITE IN ANY BARCODES.

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.

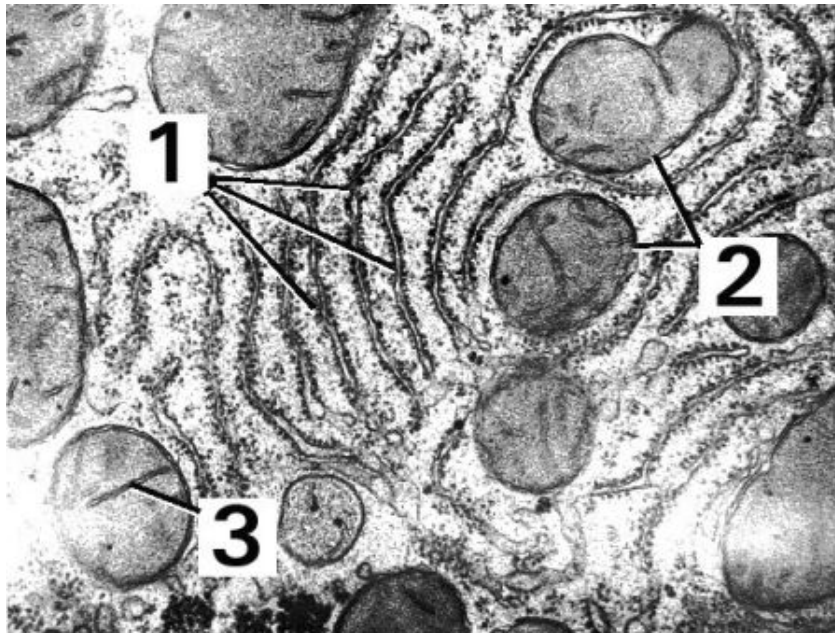
The use of an approved scientific calculator is expected, where appropriate.

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This document consists of **13** printed pages and **0** blank pages.

**[Turn over**

- 1 The electron micrograph below shows some organelles in a eukaryotic cell.



With reference to the electron micrograph above, which of the following pairs of statements regarding the two organelles labelled **1** and **2** is correct?

	Organelle 1	Organelle 2
<b>A</b>	Stack of membrane-bound sacs responsible for chemical modifications and packing of hormones.	Membrane-bound sac containing hydrolytic enzymes for intracellular digestion.
<b>B</b>	Stack of membrane-bound sacs responsible for the sorting and delivery of products to various parts of the cell.	Membrane-bound sac responsible for the chemosmotic synthesis of ATP.
<b>C</b>	Interconnected network of cisternae responsible for the synthesis of membrane proteins.	Membrane-bound sac responsible for the complete oxidation of organic compounds.
<b>D</b>	Interconnected network of tubules in which the membrane is continuous with that of the outer nuclear envelope.	Double membrane-bound organelle with the inner membrane dividing the organelle into two internal compartments.

2 Which set of factors will produce the **most** fluid cell surface membrane?

	a decrease in
<b>A</b>	<ul style="list-style-type: none"> <li>distance between phospholipid molecules</li> <li>proportion of short fatty acid chains</li> </ul>
<b>B</b>	<ul style="list-style-type: none"> <li>distance between phospholipid molecules</li> <li>temperature</li> </ul>
<b>C</b>	<ul style="list-style-type: none"> <li>proportion of phospholipids with saturated fatty acid chains</li> <li>proportion of long fatty acid chains</li> </ul>
<b>D</b>	<ul style="list-style-type: none"> <li>proportion of phospholipids with unsaturated fatty acid chains</li> <li>temperature</li> </ul>

3 Beetroot cells contain a water-soluble red pigment. Two test tubes were set up as described in the table below.

Tube 1	Pieces of washed raw beetroot in water
Tube 2	Pieces of washed raw beetroot in acetone

After 30 minutes, the acetone in tube 2 turned pink, but the water in tube 1 remained unchanged. Which statement explains the colour change in tube 2?

- A** Acetone has affected the structural integrity of the cellulose cell wall resulting in the pigments diffusing out of the cells.
- B** Acetone has affected the structural integrity of the cell membrane resulting in the pigment diffusing out of the cells.
- C** Acetone enters the cells and caused the cells to burst.
- D** The pigments are soluble in acetone and diffuse out of the cells with the solvent.

- 4 The key below can be used to separate the following carbohydrates:  
amylopectin, cellulose, maltose, ribulose, sucrose

<b>I</b>	(a) readily soluble in water (b) insoluble in water	..... .....	Go to <b>II</b> Go to <b>IV</b>
<b>II</b>	(a) is a reducing sugar (b) is a non-reducing sugar	..... .....	Go to <b>III</b> <b>V</b>
<b>III</b>	(a) phosphorylated form is the carbon dioxide acceptor in photosynthesis (b) product of starch digestion by amylase	..... .....	<b>W</b> <b>X</b>
<b>IV</b>	(a) linked by $\alpha(1\rightarrow4)$ glycosidic bonds and $\alpha(1\rightarrow6)$ glycosidic bonds (b) linked by $\beta(1\rightarrow4)$ glycosidic bonds	..... .....	<b>Y</b> <b>Z</b>

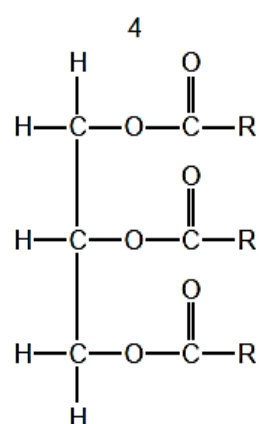
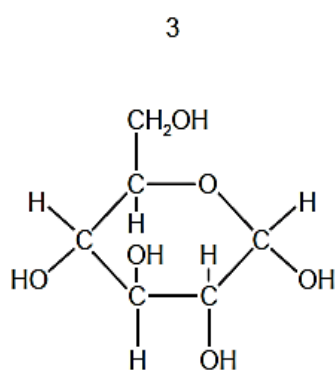
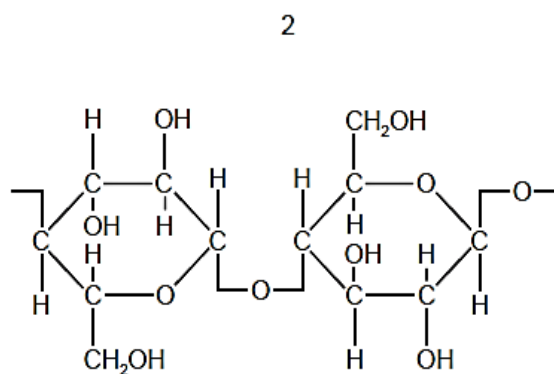
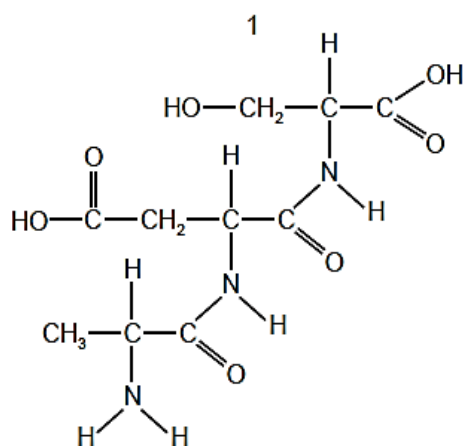
What are **V**, **W**, **X**, **Y** and **Z**?

	<b>V</b>	<b>W</b>	<b>X</b>	<b>Y</b>	<b>Z</b>
<b>A</b>	sucrose	maltose	sucrose	amylopectin	ribulose
<b>B</b>	maltose	ribulose	sucrose	cellulose	amylopectin
<b>C</b>	cellulose	ribulose	maltose	sucrose	amylopectin
<b>D</b>	sucrose	ribulose	maltose	amylopectin	cellulose

- 5 A student carried out four tests for biological molecules. The observations are shown in the table.

test	observations
iodine	orange
biuret	purple
Benedict's	orange
emulsion	clear

Which molecules are present in the solution?



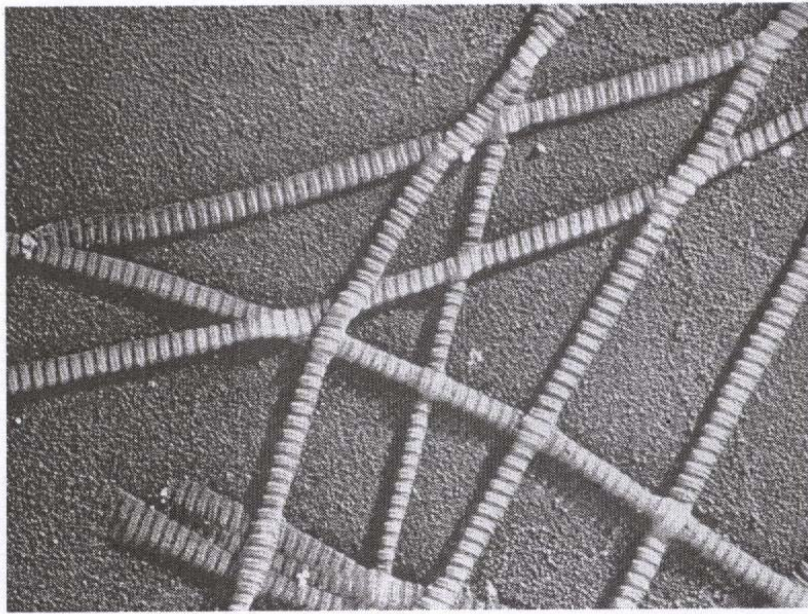
A 1 and 2

**B 1 and 3**

C 2 and 3

D 3 and 4

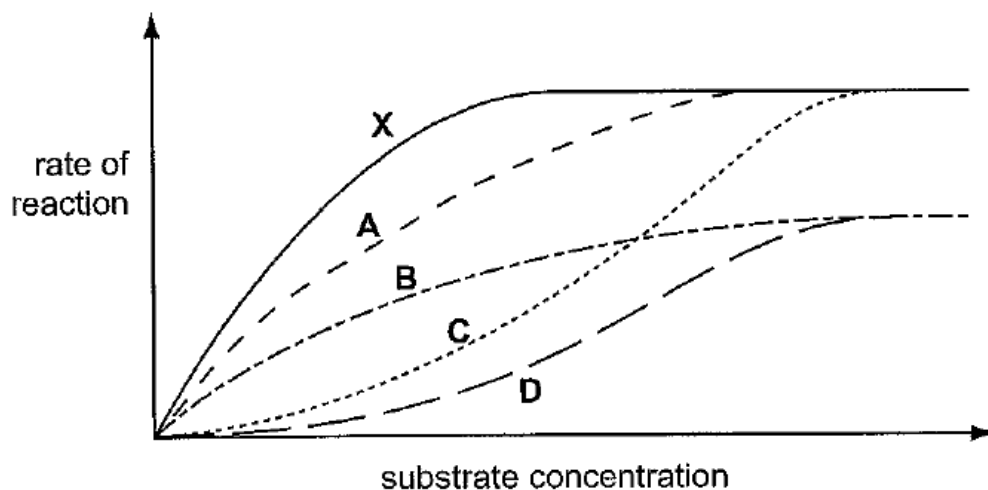
- 6 The electron micrograph shows collagen fibrils.



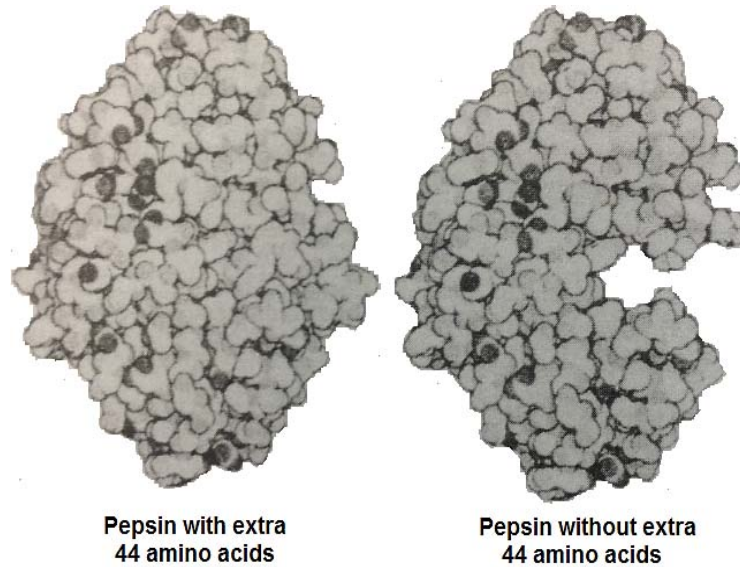
Which feature of collagen structure could explain the banded appearance of the fibril?

- A helices of three amino acids per turn
  - B hydrogen bonds between the collagen molecules
  - C longitudinal displacement of the collagen molecules**
  - D molecules formed of a triple helix of polypeptides
- 7 In the graph, X represents the initial rate of reaction of an enzyme in increasing substrate concentrations under optimum temperature and pH, in the absence of an inhibitor.

Which curve represents the result when the same experiment is carried out under a lower temperature? **BB**



- 8 Protein-digesting enzymes are synthesised inside cells as inactive pro-enzymes, which are then activated outside the cell. Pepsin is synthesised with an extra 44 amino acids. This extra chain is clipped off in the stomach and the enzyme begins to digest proteins.



Which of the following is incorrect?

- A There is a change in the tertiary structure of the protein molecule when the extra amino acids are removed.
  - B Removal of the 44 amino acids is a hydrolysis reaction.
  - C The extra 44 amino acids serve as competitive inhibitor, preventing the binding of the substrate to the active site of the enzyme.**
  - D The change in shape of the pepsin upon activation is due to a change in the primary structure.
- 9 The small sequence of 11 base pairs shown in the diagram is highly conserved in the DNA of chromosome centromeres in all species. Mutations within the shaded triplet inactivate the centromere.

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-T-G-A-T-T-T-C-C-G-A-A-
-A-C-T-A-A-A-G-G-C-T-T-

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How will the mutation affect the function of this DNA sequence?

- A Microtubules are no longer produced.
- B Kinetochore proteins cannot attach to the DNA sequence.**
- C Spindle fibres are unable to attach to the DNA sequence for alignment at metaphase.
- D Methylation cannot occur and the sequence is exposed for transcription.



- 10 The diagram shows the chromosomal behaviour in an animal cell during a particular stage of cell division.



Which of the following correctly describes the chromosomes shown?

	Stage of cell division	Number of chromosomes in a haploid set	Total number of DNA strands
A	Metaphase	4	16
B	Prophase	8	16
C	Prophase	4	32
D	Metaphase	8	32

- 11 When identical twins marry identical twins, the children of both couple are genetically
- A identical unless crossing over takes place
  - B different because of random segregation during parental meiosis
  - C different because non-disjunction of chromatids occurs
  - D identical because of the effect of semi-conservative DNA replication prior to nuclear division

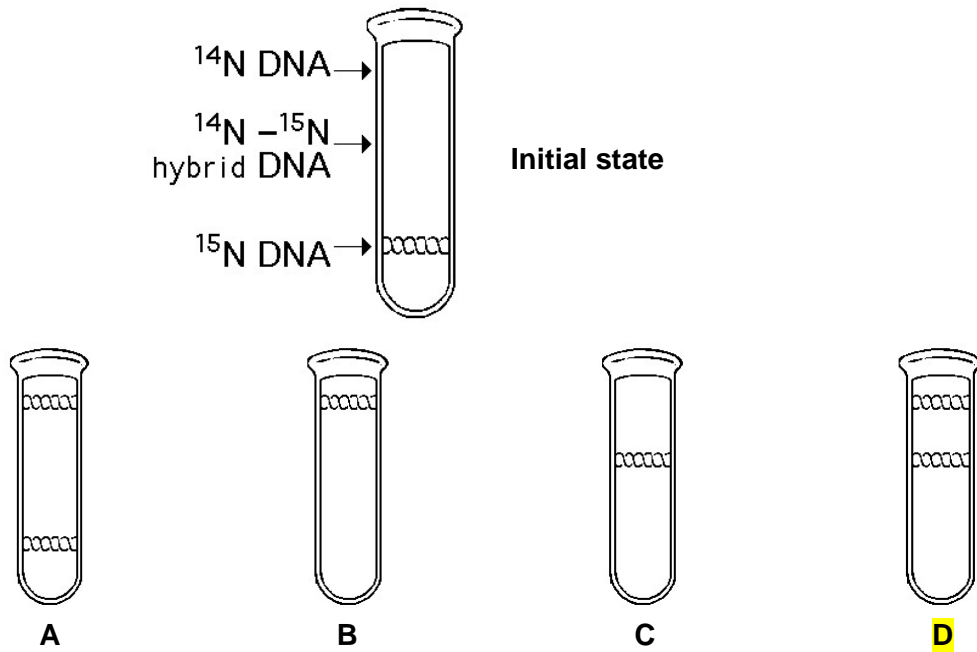
- 12 A virus has a base ratio of  $(A+G)/(U+C) = 1$

What type of virus is this most likely to be?

- A a single-stranded DNA virus
- B a single-stranded RNA virus
- C a double-stranded DNA virus
- D a double-stranded RNA virus

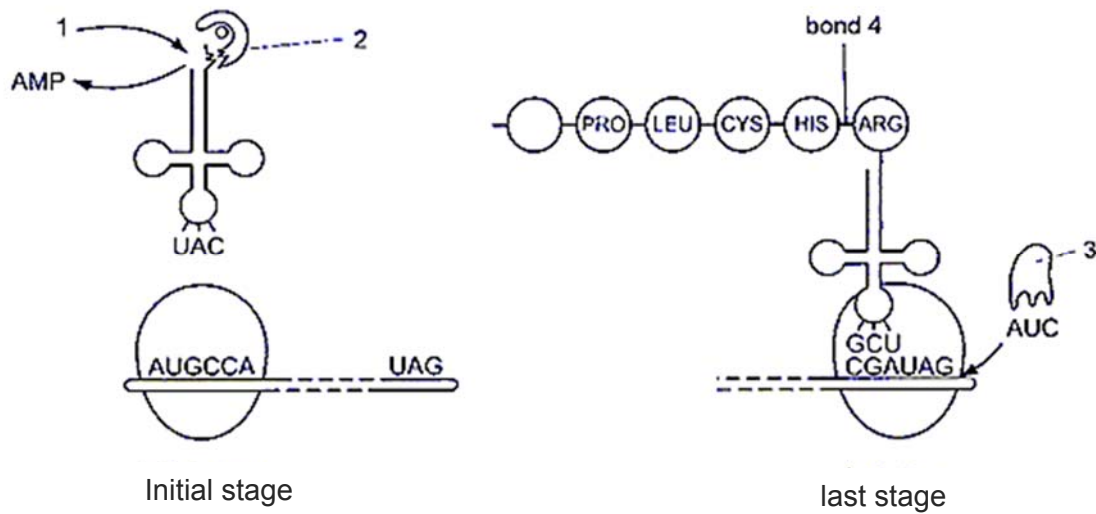


- 13 In the late 1950s, Meselson and Stahl grew bacteria in a medium containing "heavy" nitrogen ( $^{15}\text{N}$ ) and then transferred them to a medium containing  $^{14}\text{N}$ . Which of the following results would be expected after two rounds of DNA replication in the presence of  $^{14}\text{N}$ ?



14 A number of molecules other than tRNA and mRNA are involved during translation.

The diagram below shows some of these molecules and nucleotides in the codon and anticodon positions.



Which of the following is correct?

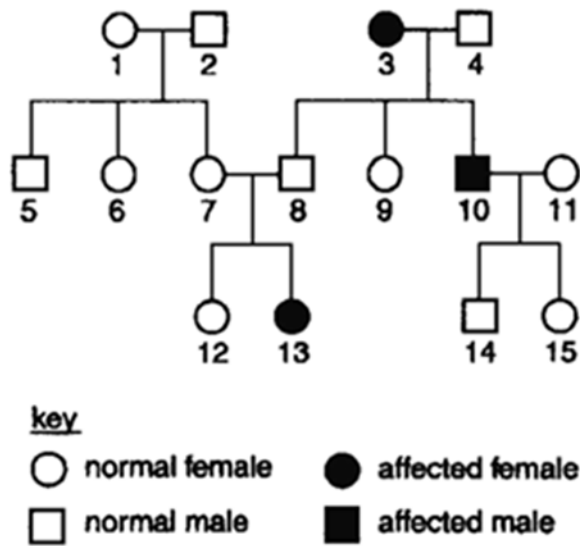
	1	2	3	4
<b>A</b>	ADP	Aminoacyl tRNA synthetase	Amino acid	Hydrogen bond
<b>B</b>	ADP	Amino acid	Translation releasing factor	Hydrogen bond
<b>C</b>	ATP	Amino acid	Aminoacyl tRNA synthetase	Peptide bond
<b>D</b>	ATP	Aminoacyl tRNA synthetase	Translation releasing factor	Peptide bond

15 In birds, the male is the homogametic sex. The male bird showing the recessive trait was mated with a female showing the dominant trait of a characteristic governed by a pair of alleles which are sex linked.

What is the possibility that the male offspring will show the dominant trait?

- A** 0.00
- B** 0.50
- C** 0.75
- D** 1.00

16 The family tree below shows the inheritance of a condition caused by the recessive allele  $r$ .



Which of the females are certain to have the genotype  $Rr$ ?

- A** 7, 9 and 15
- B** 1, 7 and 12
- C** 1, 6 and 7
- D** 9, 12 and 15

17 Two genes, **Q** and **R**, affect the appearance of flower petals.

Gene **Q** has two alleles,  $Q^L$  and  $Q^A$ . The genotype  $Q^LQ^L$  produces large petals,  $Q^LQ^A$  produces medium petals and genotype  $Q^AQ^A$  produces small petals.

Gene **R** has two alleles. **R** produces a red pigment and is dominant over the allele **r** that produces no pigment.

Two plants, both heterozygous for both genes, are crossed.

How many phenotypes are expected in the next generation?

- A** 4
- B** 6
- C** 9
- D** 12

- 18** In a plant, two genes affect the appearance of the petals of the flowers. The allele for large petals, **L**, is dominant to that for small petals, **l**. The allele for production of red pigment, **R** is dominant to the allele for no pigment production, **r**. Plants with large petals and red pigment production were crossed with those having small petals and no pigment production.

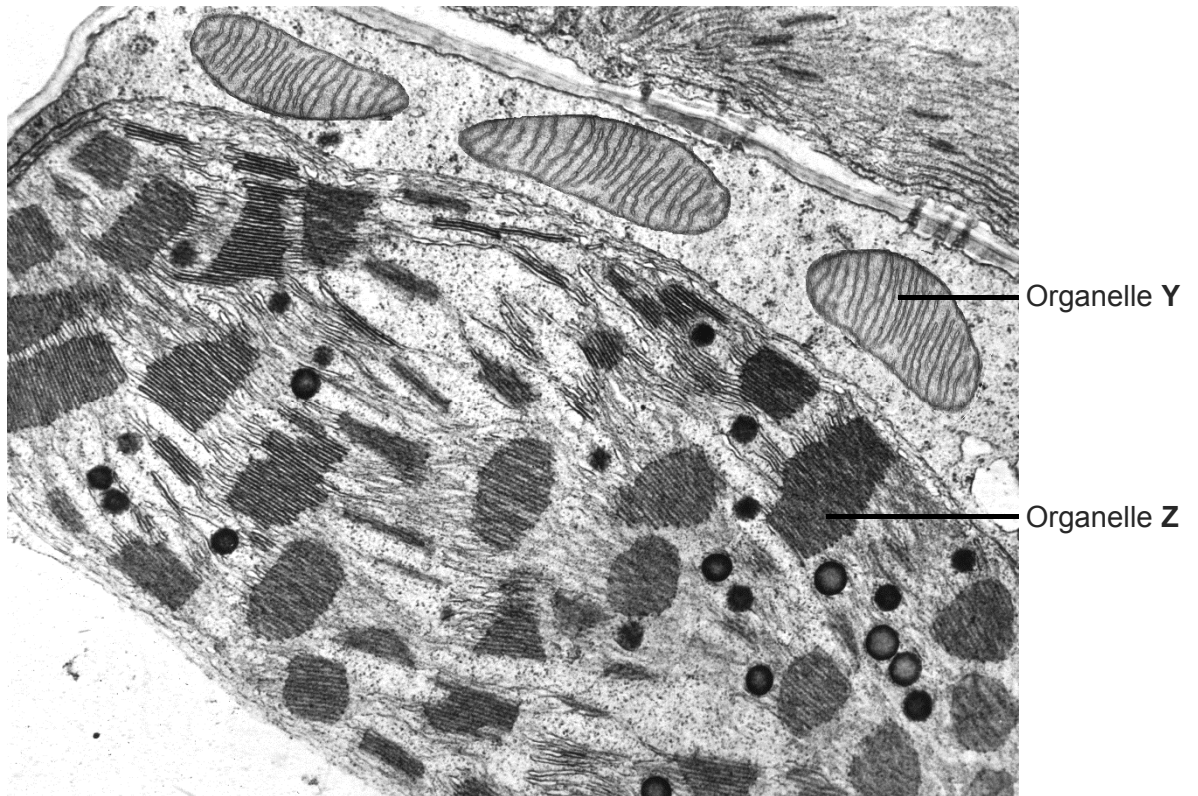
The table show the phenotypes of the 550 offspring.

number of offspring	petal size	pigment production
150	large	red
140	large	nil
140	small	red
120	small	nil

What were the genotypes of the parents?

- A** **LIRr x llrr**
- B** LLRr x Llrr
- C** LIRr x LIRr
- D** LIRR x llrr
- 19** Dinitrophenol is a metabolic poison that can lodge within the thylakoid membranes of chloroplasts. It then provides an alternate routes for  $H^+$  ions to diffuse across the thylakoid membranes. In what way will the Calvin cycle be affected in chloroplasts poisoned with dinitrophenol?
- A** No effect since Calvin cycle is an enzyme-controlled process.
- B** The rate of Calvin cycle will increase because pH in the stroma will drop towards the optimum.
- C** The rate of Calvin cycle will decrease with the accumulation of glycerate-3-phosphate (GP/PGA)
- D** The rate of Calvin Cycle will decrease with the accumulation of glyceraldehyde-3-phosphate i.e. Triose Phosphate (TP/ PGAL).

- 20 A new species of plant was recently discovered in the Amazon forest. The electron micrograph shows two organelles Y and Z in a leaf mesophyll cell of the plant.

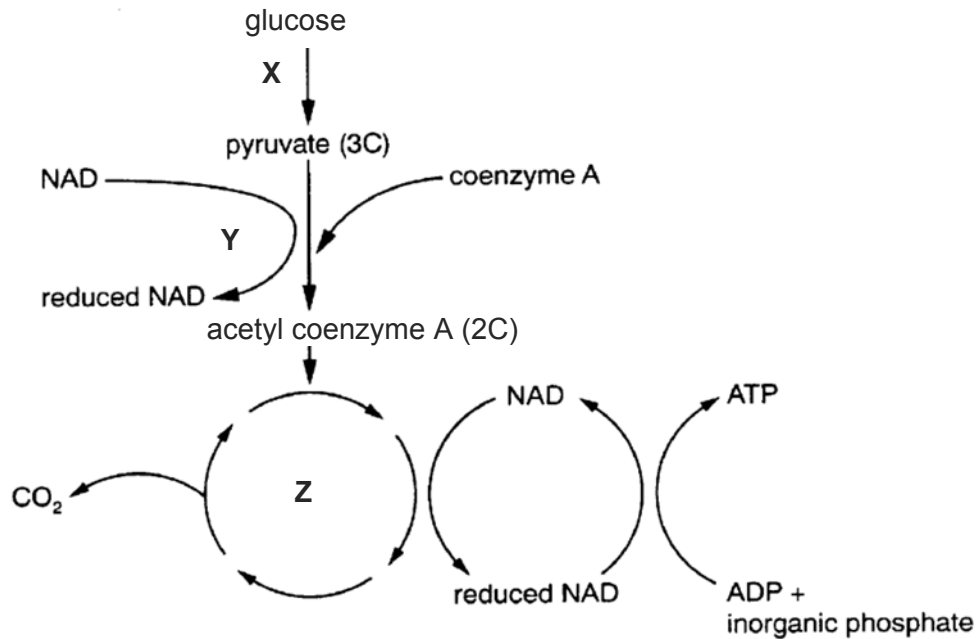


Which of the following statements are **not** true about organelles Y and Z?

I	Organelle Z utilises transporters to export ATP to organelle Y to drive cellular activities.
II	Oxygen released by organelle Z is used in organelle Y during Krebs cycle.
III	Phosphate ions in organelle Y is used for the production of ATP during Calvin cycle.
IV	NADPH molecules produced in organelle Z are used in organelle Y for the production of triose phosphate.

- A I and IV only  
 B II and III only  
 C II and IV only  
 D All of the above

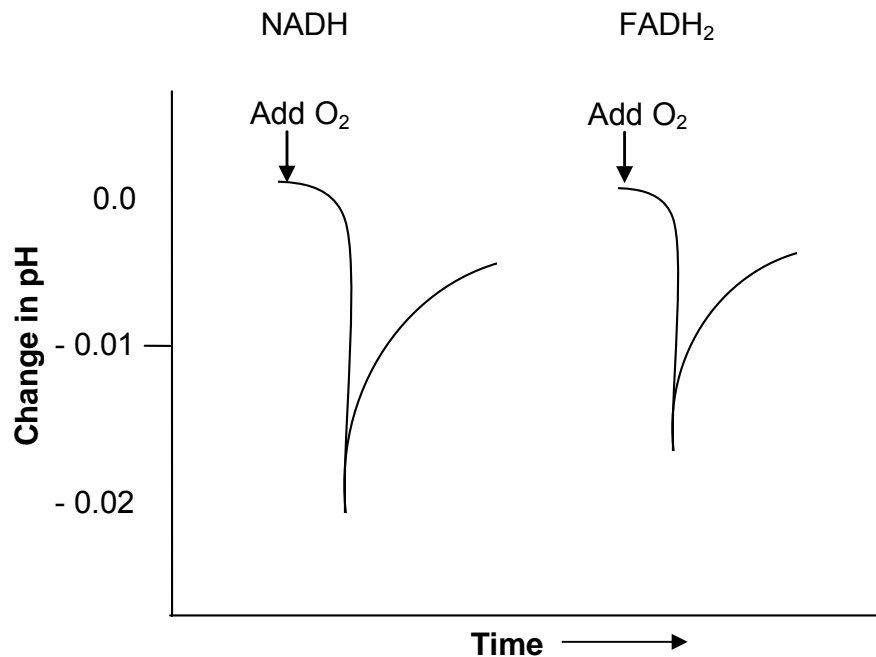
21 The flow chart shows a series of reactions occurring in an animal cell.



Which of the following statements correctly describes the flow chart?

- A Reaction X, which occurs in the cytosol, is an anabolic reaction.
- B Reaction Y involves the process of substrate-level phosphorylation, whereby pyruvate is first converted to a compound called acetyl coenzyme A.
- C Reaction Y occurs in the cytoplasm whereas reaction Z occurs in the mitochondria.
- D Reaction Z is a catabolic pathway which occurs twice for every glucose molecule to be completely oxidised.

- 22 Isolated mitochondria were incubated with NADH in one experiment and an equal amount of FADH<sub>2</sub> in another experiment. The mitochondria were initially deprived of oxygen. The pH of the intermembrane space was then monitored as a known quantity of oxygen was added. The results are shown in the graph.



Which of the following can be concluded based on the results?

I	Upon the addition of oxygen, glycolysis and subsequently, link reaction, Krebs cycle and oxidative phosphorylation occurred.
II	Electron transfer was initiated by the addition of oxygen.
III	The pH drop was greater with NADH than with FADH <sub>2</sub> , which is consistent with the greater ATP yield that accompanies the oxidation of NADH.
IV	The rapid decline in pH indicates that protons were pumped into the intermembrane space when oxygen was available.

- A I only  
 B II and IV only  
 C II, III and IV only  
 D All of the above



- 23** The Galapagos Islands are a group of volcanic islands in the eastern Pacific Ocean, about 1000km from South America. Thirteen species of finch are found on the islands; they resemble each other closely but differ in their feeding habits and in the shape of their beaks.

Assuming that an ancestral stock of finches came from the mainland, what is the most likely explanation for the existence of similar but distinct species of Galapagos finches?

- A** Finches developed different kinds of beak in order to feed on different kinds of food
  - B** Finches evolved separately according to the habitat in which they settled
  - C** Finches from the mainland bred with a resident population of a related species and produced new genotypes
  - D** Finches underwent convergent evolution to produce very similar species
- 24** *Lucilia cuprina*, the sheep blowfly, lays its eggs in wounds and the wet fleece of sheep. The larvae hatch and burrow into the sheep's skin, causing distress, reduced wool production and sometimes death. Chemicals were used in the past to control the *L. cuprina* but these became less effective as sheep blowfly developed a resistance to the chemicals. The cause of the increased resistance to the chemicals was most likely due to

- A** susceptible sheep dying and leaving behind the more resistant sheep which selects for the more resistant blowfly.
- B** the insecticide producing a change in a gene which enhanced the survival of the blowfly.
- C** a chance mutation in a blowfly gene conferring a survival advantage in the chemical environment.
- D** the insecticide producing a change in phenotype which enhanced reproduction of the blowfly.

- 25 The diagram shows part of the aligned DNA sequences for the same gene in six species of aquatic mammals.

Fin whale	TAAACCCCAATAGTCACAAAACAAGACTATTTCGCCAGAGTACTACTAGCAAC
Humpback whale	TAAACCCTAATAGTCACAAAACAAGACTATTTCGCCAGAGTACTACTAGCAAC
Sperm whale	TAAACCCAGGTAGTCATAAAACAAGACTATTTCGCCAGAGTACTACTAGCAAC
Beaked whale	TAAACCTAAATAGTCTCAAAAACAAGACTATTTCGCCAGAGTACTACTAGCAAT
Dolphin	TAAACTTAAATAATCCCAAAACAAGATTATTTCGCCAGAGTACTATCGGCAAC
Porpoise	TAAACCTAAATAGTCCTAAAACAAGACTATTTCGCCAGAGTACTATCGGCAAC

Which is a correct assumption when using this information as evidence for evolutionary relationships?

- A** Differences and similarities in DNA sequences reflect evolutionary relationships.
  - B** DNA sequences in different genes from the same six species will suggest different evolutionary relationships.
  - C** Point mutations in DNA sequences are not acted on by natural selection.
  - D** Mutations that do not change amino acid sequences in proteins are important for natural selection.
- 26 The dashed lines in the template sequence stand for a long sequence of bases that is to be amplified.

**Template**

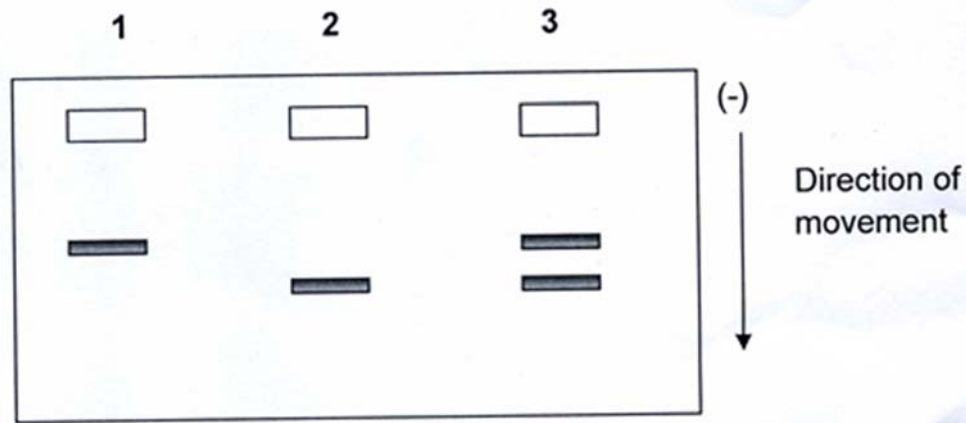
5' ATTCGGACTTG - - - - - GTCCAGCTAGAGG 3'  
 3' TAAGCCTGAAC - - - - - CAGGTCGATCTCC 5'

Which of the following sets of primers can be used in the PCR for the amplification of the following DNA sequence?

- A** 5' GTCCAGC 3' & 5' CCTGAAC 3'
- B** 5' ATTCGGA 3' & 3' GATCTCC 5'
- C** 5' GGACTTG 3' & 5' GCTGGAC 3'
- D** 5' AUUCGGA 3' & 3' GAUCUCC 5'

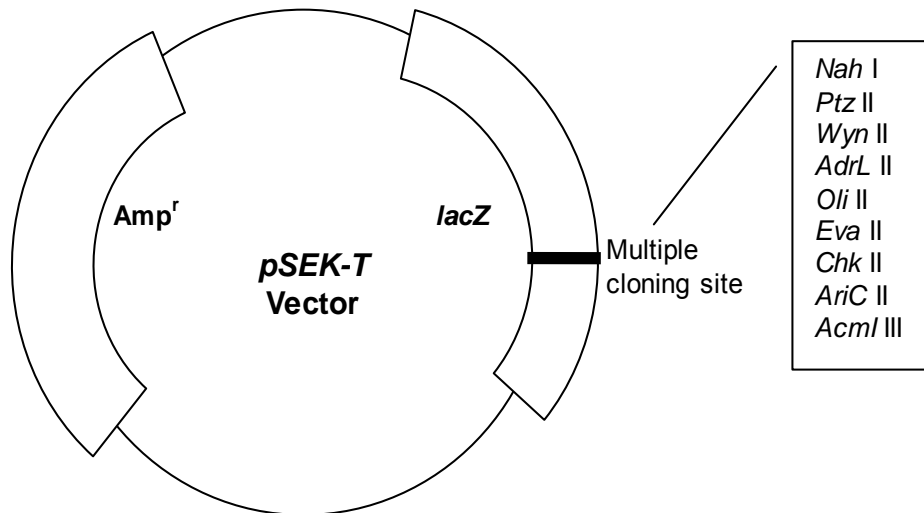
- 27 The  $\beta$ -globin gene can exist in two different alleles termed HbA (the normal allele) and HbS (the allele that causes sickle cell anemia in homozygotes). The polypeptides that are coded for by this two alleles differ by one amino acid. Blood samples from 3 individuals were obtained and the **proteins** separated by gel electrophoresis.

Using the gel pattern below, determine the genotypes of individuals 1 and 2 and the reason for your identification.



	<b>Genotype of 1</b>	<b>Genotype of 2</b>	<b>Reason for identification</b>
<b>A</b>	Hb <sup>A</sup> Hb <sup>A</sup>	Hb <sup>S</sup> Hb <sup>S</sup>	Since glutamic acid in the normal $\beta$ -globin is negatively charged, it will move faster towards the opposite pole.
<b>B</b>	Hb <sup>S</sup> Hb <sup>S</sup>	Hb <sup>A</sup> Hb <sup>A</sup>	Since valine in the normal $\beta$ -globin is negatively charged, it will move faster towards the opposite pole.
<b>C</b>	Hb <sup>A</sup> Hb <sup>A</sup>	Hb <sup>S</sup> Hb <sup>S</sup>	Since glutamic acid in the $\beta$ -globin that causes sickle cell is negatively charged, it will move slower towards the opposite pole.
<b>D</b>	Hb <sup>S</sup> Hb <sup>S</sup>	Hb <sup>A</sup> Hb <sup>A</sup>	Since valine in the $\beta$ -globin that causes sickle cell is neutral, it will move slower towards the opposite pole.

- 28 As part of the procedure to produce recombinant proteins in *E. coli*, you are asked to insert the gene encoding for the D-ONG protein into the pSEK-T vector. The restriction sites and selectable markers on the vector are shown below.



If the gene for D-ONG protein were to be inserted into the multiple cloning site, what should be added to the agar plate in order to screen for recombinant clones and how would the recombinant clones appear?

	<b>Chemicals to be added</b>		<b>Colour of colonies</b>
<b>A</b>	Ampicillin	X-gal	Blue
<b>B</b>	$\beta$ -galactosidase	X-gal	Blue
<b>C</b>	Ampicillin	X-gal	White
<b>D</b>	$\beta$ -galactosidase	lactose	White

- 29 In terms of containment (prevention of genetic pollution of wild plant or non-GM crop populations), which of the following is an advantage of chloroplast transformation (introducing foreign genes into chloroplasts of host plants) over nuclear transformation?

- A** Chloroplasts are surrounded by a double membrane
- B** There are no chloroplasts in pollen of most plant species
- C** Chloroplasts are smaller than the nucleus
- D** There is no DNA in chloroplasts

**30** In order to engineer a crop plant with protection against infestation by insects, scientists have transformed a strain of corn using a cloning vector carrying the following genes:

- a gene encoding a toxin from the bacteria *Bacillus thuringiensis* which is poisonous to insects.
- a 'pat'-gene which confers tolerance to the herbicide 'Basta'.
- an 'amp'-gene which confers resistance to the antibiotic ampicillin.

There is concern that the 'amp' gene may transfer to enterobacteria in the human intestine during nucleic acid digestion, making treatment with ampicillin ineffective for diseases caused by enterobacteria.

Which of the following statements explains why the transfer of this gene from the plant to bacteria in the human intestine is unlikely?

- A** An origin of replication and appropriate prokaryotic promoters are required for the expression of the 'amp' gene.
- B** Bacteria cannot take up any DNA released during digestion of the plants by human nuclease enzymes without a vector.
- C** 50% of the enterobacteria isolated from humans are already 'amp' resistant.
- D** All plant DNA is digested and destroyed in the human intestine during digestion of plant cells by enzymes including human nuclease enzymes.