

CANDIDATE NAME: _____

INDEX NUMBER _____



SERANGOON JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATION 2017

BIOLOGY 8875
Higher 1

CG _____

PAPER 1

Thursday
21 September 2017

1 hour

Additional materials:
Optical Mark Sheet

INSTRUCTIONS TO CANDIDATES

Write your name and CG in the spaces at the top of this page.

On the Optical Mark Sheet, enter your name, subject title, test name, class. For your index number, enter your full NRIC number. Shade the corresponding lozenges on the OMS according to the instructions given by the invigilators.

AT THE END OF THE EXAMINATION, HAND IN BOTH THE OMS AND QUESTION PAPER.

INFORMATION FOR CANDIDATES

There are **thirty (30) questions** in this paper. Answer **all** questions. For each question, there are four possible answers, **A, B, C, D**. Choose the **one** you consider correct and record your choice in **soft pencil** on the OMS.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer. Any rough working should be done on the question paper.

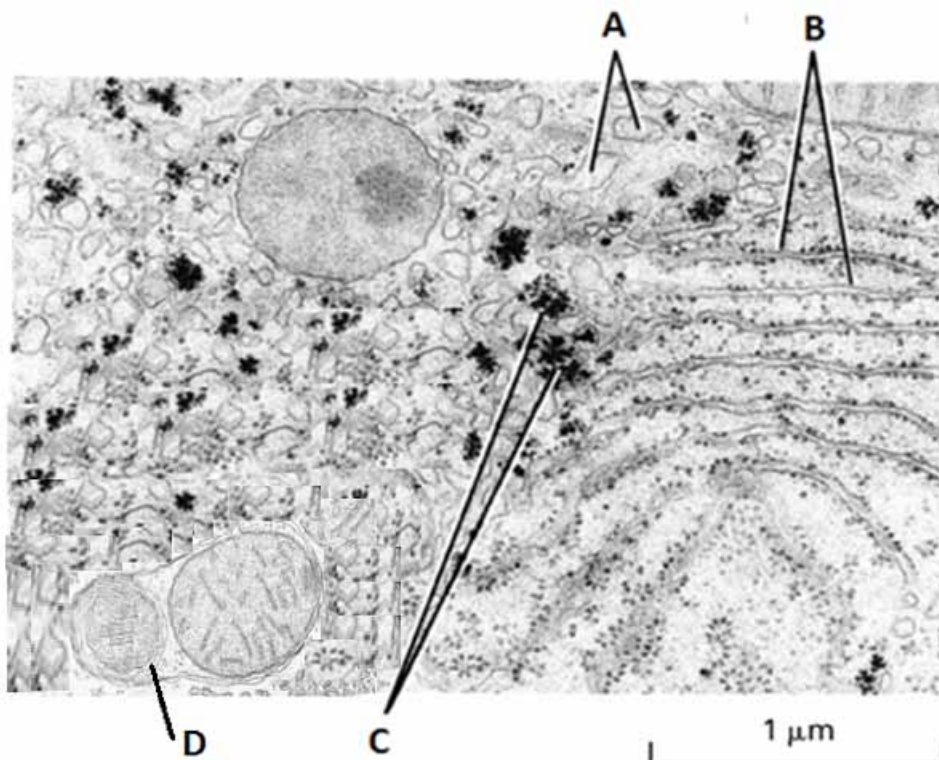
This question paper consists of 16 printed pages.

Answer all questions on the OTAS provided.

- 1 EDTA is used extensively as an anticoagulant for stored blood in blood banks. Thrombokinase plays a major role in the clotting of blood. EDTA decreases the reaction rate of thrombokinase by binding to calcium ions.

Which of the following describes the role of calcium ions?

- A Allosteric inhibitors
 - B Coenzymes
 - C Cofactors
 - D Competitive inhibitors
- 2 A cell in the G1 phase has two homologous pairs of chromosomes. It then undergoes two mitotic divisions. At the end of the second mitotic division, what is the total number of chromosomes and gene loci found in all the daughter cells formed?
- A 8 chromosomes and 4 times as many gene loci as the original parent cell.
 - B 8 chromosomes and 8 times as many gene loci as the original parent cell.
 - C 16 chromosomes and 4 times as many gene loci as the original parent cell.
 - D 16 chromosomes and 8 times as many gene loci as the original parent cell.
- 3 The electron micrograph below shows a liver cell.

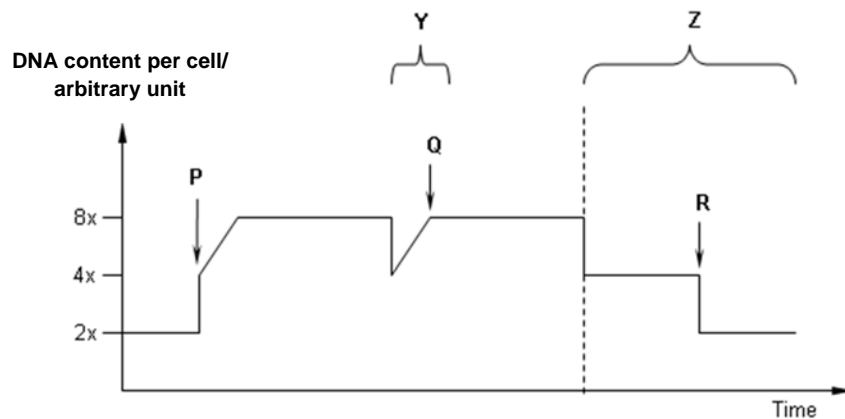


Which statement(s) correctly describe(s) the labelled structures?

- 1 Structure **A** transports proteins from Structure **B** to Golgi Apparatus.
- 2 Proteins enter the lumen of Structure **B**, where they undergo chemical modifications such as glycosylation.
- 3 Structure **C** is starch grain.
- 4 The process shown in structure **D** is autolysis.

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

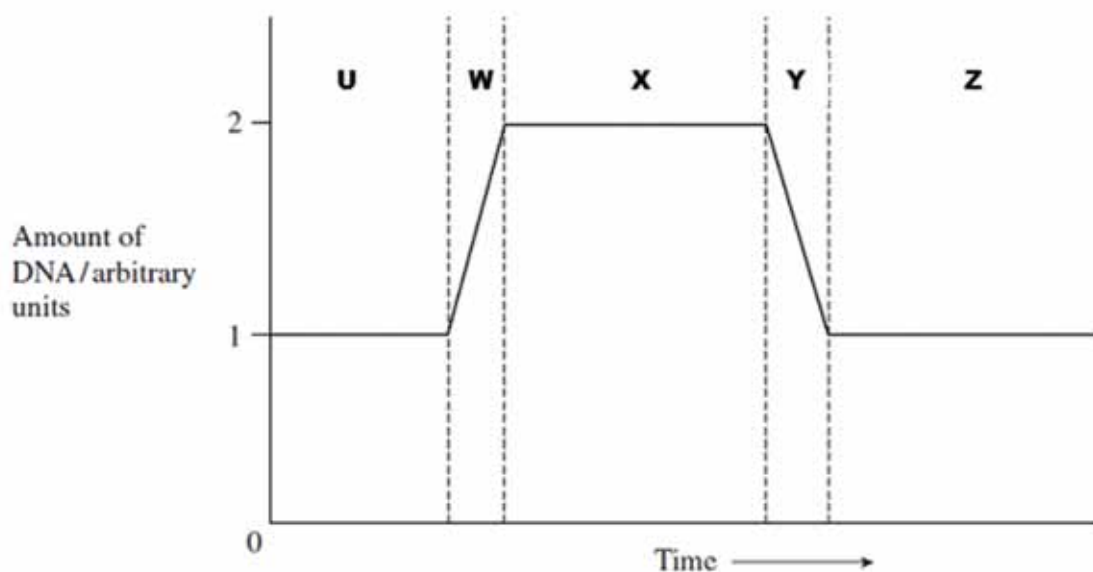
- 4 The graph represents the changes in the DNA content within a cell at different stages in the cell cycle.



Name the events occurring at **P**, **Q** and **R**, and identify the stage where meiosis is occurring.

	P	Q	R	Meiosis occurring at
A	S phase	Fertilisation	Cytokinesis	Y
B	Fertilisation	Interphase	Cytokinesis	Z
C	S phase	Prophase	Telophase	Y
D	Fertilisation	Metaphase	Telophase	Z

- 5 The graph shows changes in the amount of DNA in a cell during one cell cycle. The letters U – Z marks out the different phases in the cell cycle.



Many drugs that are used to treat cancer work at different time periods during the cell cycle.

- (i) Cisplatin binds to DNA and stops free DNA nucleotides from joining together.
- (ii) Drug B stops spindle fibres from shortening.

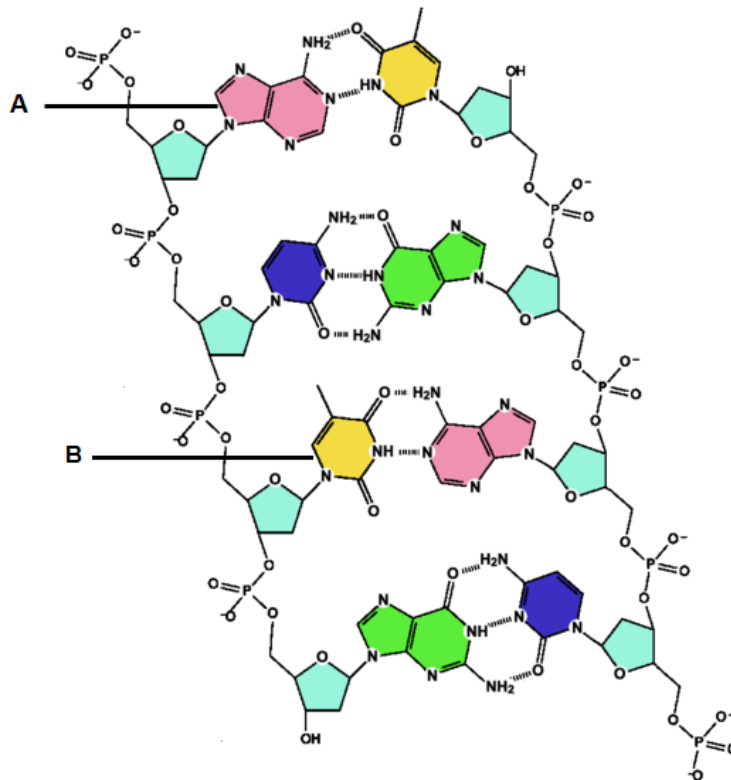
With reference to the cell cycle above, determine where these 2 drugs work.

	Cisplatin	Drug B
A	W	X
B	W	Y
C	U	X
D	U	Z

- 6 During the production of fruit juice, enzymes are used to break down the components of cell walls. Which carbohydrate will be produced by this hydrolysis?

- A** Sucrose
- B** Maltose
- C** α - glucose
- D** β - glucose

7 The figure below shows a DNA molecule.



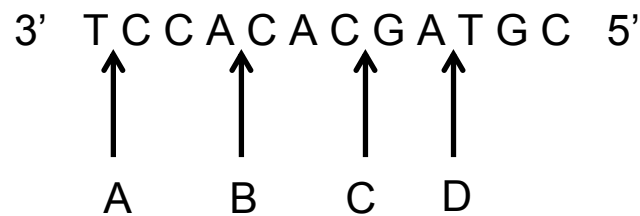
Which statement(s) correctly describe the polynucleotide?

- 1 The structure labelled **A** corresponds to that of a purine, while the structure labelled **B** corresponds to that of a pyrimidine.
- 2 The antiparallel nature of DNA double helix allows phosphodiester bonds to form between the nitrogenous bases of opposite strands.
- 3 Distance between adjacent deoxyribonucleotides is 3.4 Å and one turn consists of 10 deoxyribonucleotides. (Note: 10 Å = 1 nm)
- 4 The wound DNA double helix consists of alternating major grooves and minor grooves along its axis which are essential for the binding with proteins.

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

- 8 The RNA triplet UAG acts as a stop codon terminating the synthesis of a polypeptide. The diagram shows a template strand of DNA which codes for four amino acids.

Where would a mutation, introducing a thymine nucleotide, result in the termination of translation?



- 9 The non-template strand of a gene is analyzed and 20% of its bases are found to be adenine and 30% of its bases are cytosine. The corresponding template DNA strand of this gene has 10% cytosine.

What is the ratio of purine to pyrimidine found in pre-mRNA transcribed from this gene?

- A 1 : 1
- B 2 : 3
- C 3 : 2
- D 3 : 7
- 10 Which of the following statement(s) about cancer is / are true?
- I Individuals who inherit one mutant tumour suppressor gene are more likely to develop cancer than individuals with two non-mutant copies.
 - II Cancer is a result of increased cell division which promotes the mutation of a proto-oncogene.
 - III Mutagenic activation of a single oncogene is sufficient to cause a normal cell to develop into a cancerous cell.
- A I only
- B I and II only
- C I and III only
- D I, II and III

11 Which of the following statements correctly compares oxidative phosphorylation and non-cyclic photophosphorylation?

- A** Both types of phosphorylation produce ATP and oxygen as end products.
- B** Both types of phosphorylation produce ATP and the reduced form of a redox reagent.
- C** Oxidative phosphorylation is involved in the conversion of one form of chemical energy to another while non-cyclic photophosphorylation is involved in converting light energy to chemical energy.
- D** Water is an electron donor in non-cyclic photophosphorylation while it is an electron acceptor in oxidative phosphorylation.

12 What happens to most of the reduced NAD molecules in cell metabolism?

- A** They act as oxidising agents in glycolysis.
- B** They are oxidised in inner mitochondrial membrane for ATP formation.
- C** They are oxidised in the Calvin cycle.
- D** They combine with succinic acid as part of Krebs cycle.

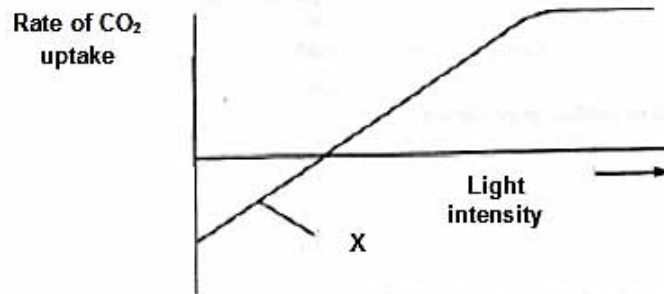
13 Rotene and oligomycin are two metabolic poisons which affect cellular respiration. The effects of rotene and oligomycin on aerobic respiration are summarised in the table.

	Ability to use glucose	Ability to use oxygen	ATP yield
Rotene	Yes	No	Decreases
Oligomycin	Yes	Yes	Decreases

Which of the following correctly identifies the specific functions of these two metabolic poisons?

	Rotene	Oligomycin
A	Electron transport inhibitor	Inhibits ATP synthase
B	Inhibits ATP synthase	Electron transport inhibitor
C	Dissipate proton gradient	Inhibits ATP synthase
D	Inhibits ATP synthase	Dissipate proton gradient

- 14 In the graph below, the rate of CO₂ uptake by plant cells is shown to vary with increasing light intensity.

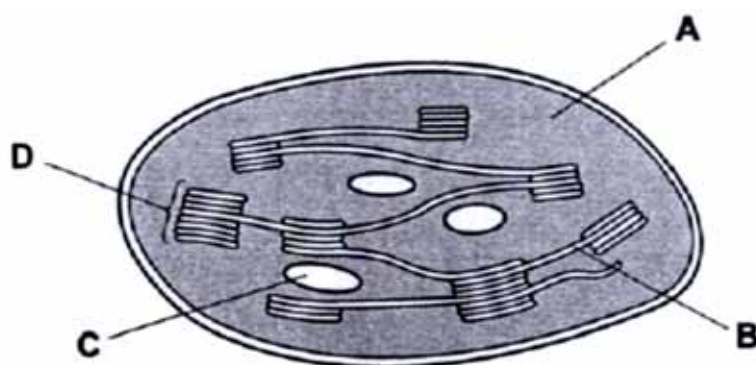


Which of the following is true at point X?

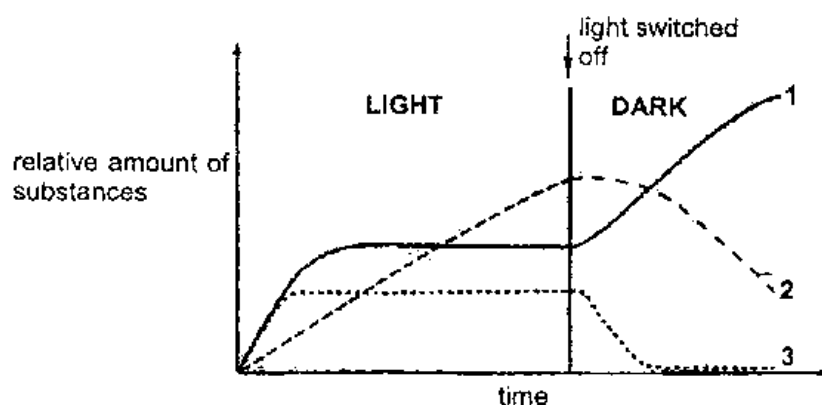
- A The plant is photosynthesizing.
 - B Rate of respiration equals rate of photosynthesis.
 - C CO₂ is a limiting factor.
 - D There is not enough light for photosynthesis to have commenced.
- 15 Which sequence of events correctly describes evolution?
- 1 Differential reproduction of the spiders occurs.
 - 2 A new selection pressure occurs.
 - 3 Allele frequencies within the spider population change.
 - 4 Poorly adapted spiders have decreased survivorship.

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

- 16 The diagram shows a section through a chloroplast. Where would the products of photophosphorylation be used?



- 17 ^{14}C -labelled carbon dioxide was supplied to photosynthesising algae. The relative amounts of three organic compounds were measured. The diagram shows the results.



Which of the following are correct explanations for the graph above?

- I GP level falls as shown in graph 2 due to the absence of reduced NADP when light is are switched off.
- II GP level rises as shown in graph 1 due to the absence of ATP when light is switched off.
- III Levels of RuBP and GP are constant during periods of light as they serve as intermediates in the Calvin cycle.
- IV RuBP level falls as carboxylation of RuBP is independent of light as shown in graph 3.
- V Sucrose level falls as shown in graph 3 due to the absence of ATP and reduced NADP.

- A I, II and V only
- B I, II and III only
- C II, III and IV only
- D III, IV and V only

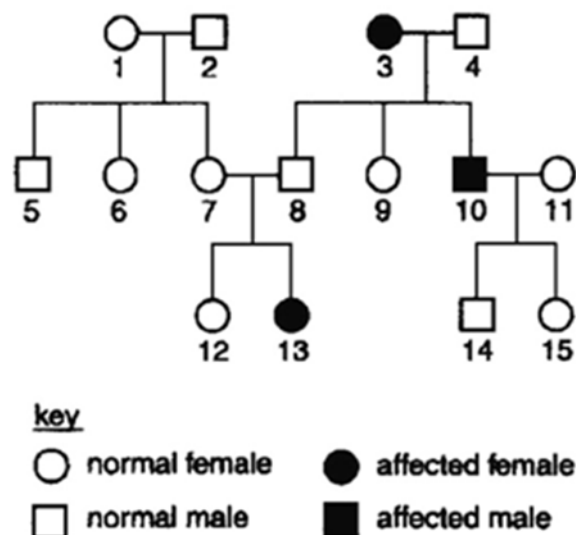
- 18 The following statements are some findings of scientists in an attempt to investigate the evolutionary relationship between the anteater, armadillo and pangolin.

- I Anteater, armadillo and pangolin feed primarily on insects such as ants.
- II Anteater, armadillo and pangolin have long tongue and strong digging limbs.
- III The tongues of the anteater and armadillo are connected to the hyoid bone while the tongue of pangolin is not.
- IV There is a higher percentage similarity between the DNA sequences of Anteater and armadillo than with the pangolin.
- V There is very low percentage similarity between the DNA sequences of anteater and pangolin as well as between the armadillo and pangolin.

Which of the following conclusions can be drawn from the statements given above?

- A The anteater and pangolin have experienced divergent evolution as shown by homologous structures between their hyoid bones and tongues.
- B The anteater and pangolin have experienced convergent evolution as shown by homologous structures in their hyoid bones and tongues.
- C The armadillo and pangolin have experienced divergent evolution as shown by the low similarity between their DNA sequences.
- D The anteater and armadillo have experienced divergent evolution as shown by similarities in their DNA sequences and homologous anatomical structures.

- 19 The pedigree chart below shows the inheritance of a recessive condition known as human albinism. Only homozygous recessive individuals are albinos.



What is the probability of individual 9 being a heterozygous carrier?

- A 0.00 B 0.25 C 0.50 D 1.00

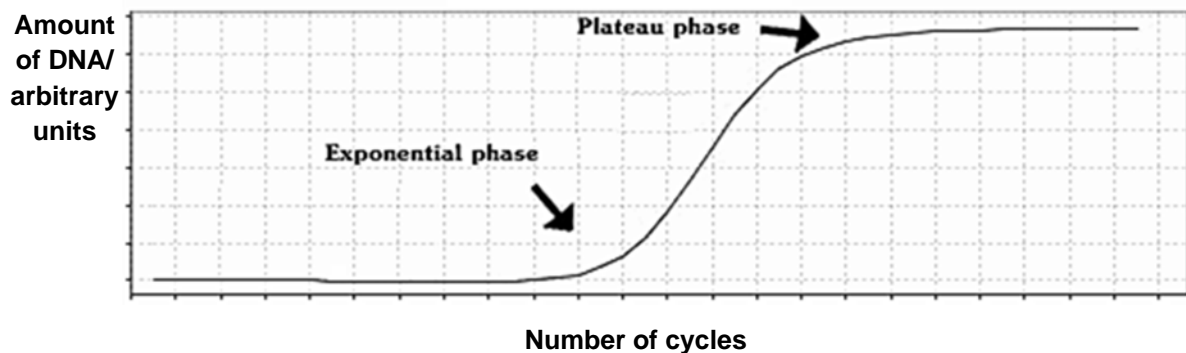
- 20 The feature of silky feathers in show fowl is caused by a recessive allele. A pure breeding bird with normal feathers was crossed with a bird with silky feathers and all the offspring were normal. The offspring were then allowed to interbreed.

Which of the following statements would be true about the F_2 generation?

- 1 The expected ratio of normal to silky would be 3:1.
- 2 Half of the F_2 birds would be heterozygous.
- 3 A quarter of the F_2 birds would be homozygous.
- 4 Some of the normal birds would be pure breeding.

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

- 21 During the process of polymerase chain reaction (PCR), the amount of DNA synthesised can be traced using fluorescent probes and the measurements are shown in the following plot. The process initially goes through an exponential phase followed by a plateau phase eventually.



Which of the following statements is **true**?

- A During the exponential phase, the number of DNA molecules synthesized after 15 cycles is 15^2 .
- B During the exponential phase, the temperature is always maintained at the optimum temperature of 72°C hence there is rapid amplification.
- C During the plateau phase, the reaction mixture is being depleted of ribonucleotides.
- D During the plateau phase, *Taq* polymerase may be denatured.

- 22 The dashed lines in the template sequence represent a long sequence of bases to be amplified.

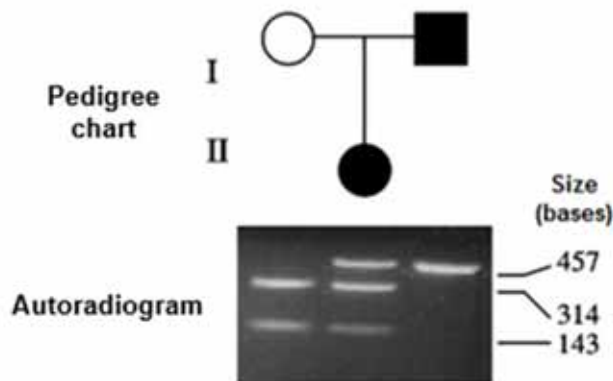
Template

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?

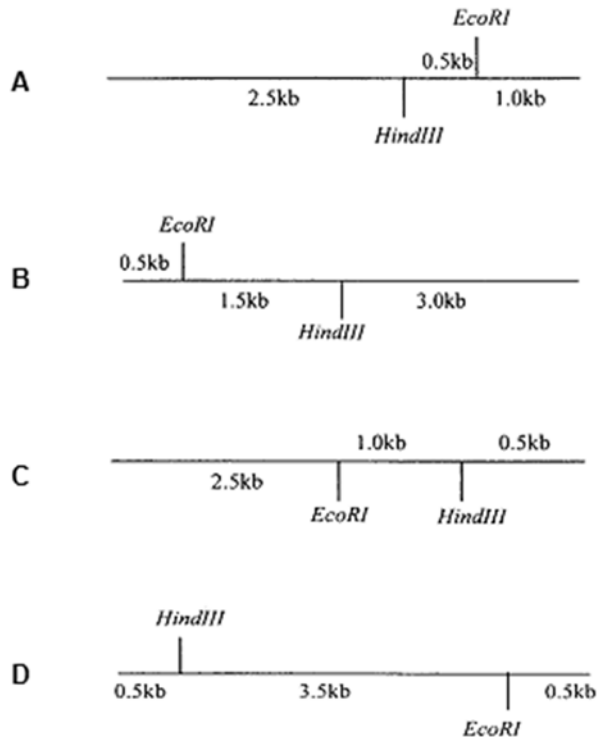
- A 5' GTCCAGC 3' & 5' CCTGAAC 3'
 B 5' ATTCGGA 3' & 5' CCTCTAG 3'
 C 5' GGACTTG 3' & 5' GCTGGAC 3'
 D 5' AUUCGGA 3' & 5' GAUCUCC 3'
- 23 A family with a history of a genetic disease is studied using restriction digestion of the DNA samples containing the gene responsible for the disease. The pedigree chart of the family is aligned with the autoradiogram obtained from Southern blotting. (Shaded symbols in the pedigree chart indicate individuals affected by disease.)



Based on the information given, which of the following can be deduced?

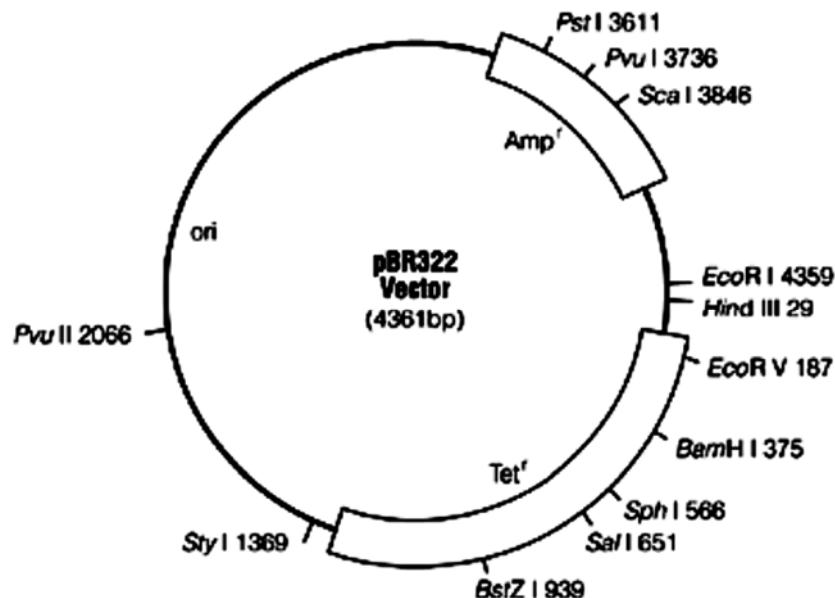
- A The disease allele is dominant to the normal allele.
 B The mutation creates a new restriction site in the affected gene.
 C One of the parents in generation I is a carrier.
 D The offspring in generation II is a carrier.

- 24 Digestion of a 4 kb DNA molecule with *EcoRI* yields two fragments of 1 kb and 3 kb each. Digestion of the same molecule with *HindIII* yields fragments of 1.5 kb and 2.5 kb. Finally, digestion with *EcoRI* and *HindIII* in combination yields fragments of 0.5 kb, 1 kb and 2.5 kb. How would a restriction map indicating the positions of the *EcoRI* and *HindIII* cleavage sites look like?



- 25 Which of the following statements about the human genome project (HGP) is **false**?
- A HGP aims to identify all the genes in human and to determine the DNA sequences of these genes.
 - B HGP aims to allow genetic testing to take place for earlier detection of genetic diseases
 - C HGP allows defective genes to be replaced through gene therapy
 - D HGP allows comparative studies to be made between humans and other organisms to identify similar genes associated with diseases.
- 26 Recent advances in the field of stem cell research have shown that induced pluripotent stem cells (iPS cells) can be artificially derived from adult somatic cells. iPS cells are mostly similar to natural pluripotent cells. This implies that iPS cells can
- A theoretically differentiate into all cell types.
 - B theoretically differentiate into any of the three germ layers.
 - C theoretically differentiate into gametes.
 - D theoretically capable of transdifferentiation.

- 27 Which of the following regarding embryonic stem cells and hematopoietic stem cells is true?
- A As embryonic stem cells develop, they turned into hematopoietic stem cells as they lose their ability to differentiate into all types of cells.
 - B Embryonic stem cells have more genes than hematopoietic stem cells and thus are able to form more types of cells.
 - C Under normal conditions, embryonic stem cells express more of their genes compared to the hematopoietic stem cells.
 - D Both stem cells are derived from the zygotic stem cells with the hematopoietic stem cells having a lower differentiation potential compared to the embryonic stem cells.
- 28 The pBR322 vector is used to clone a eukaryotic gene, which has been digested by the restriction endonuclease *Bam*HI.



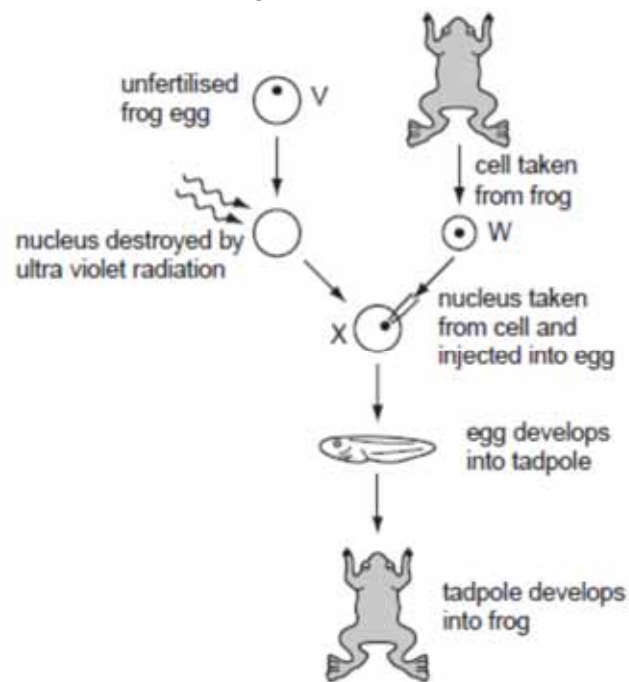
Following transformation, bacterial cells were grown in four different media, as shown below:

- 1 Nutrient broth containing ampicillin
- 2 Nutrient broth containing tetracycline
- 3 Nutrient broth containing ampicillin and tetracycline
- 4 Nutrient broth without ampicillin and tetracycline

Which of the following media would bacterial cells containing the recombinant plasmids grow in?

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

- 29 The diagram shows how genetically identical frogs can be developed from unfertilised frog eggs. The diploid number for frogs is 26.

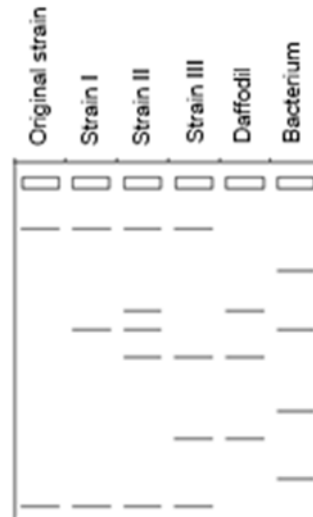


Which combination of numbers correctly identifies the number of chromosomes in each type of cell?

	V	W	X
A	13	13	26
B	13	26	13
C	13	26	26
D	26	26	13

- 30** An attempt was made to produce Golden rice. To determine whether or not DNA from the daffodils and the bacterium had been successfully incorporated in the DNA of the rice, scientists used PCR and gel electrophoresis to produce DNA profiles.

The following DNA profiles belong to the original strain of rice, three strains **I** to **III** of genetically modified Golden rice, and the species of daffodil and bacterium used to incorporate beta-carotene genes in the rice.



Which one of the strain(s) of Golden rice has successfully incorporated DNA from both the daffodil and the bacterium?

- A** Strain **I** only
- B** Strain **II** only
- C** Strain **I** and **III** only
- D** Strain **II** and **III** only

End of Paper