



ANGLO-CHINESE JUNIOR COLLEGE
Preliminary Examination 2016

BIOLOGY

8875/01

HIGHER 1

31 August 2016

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.

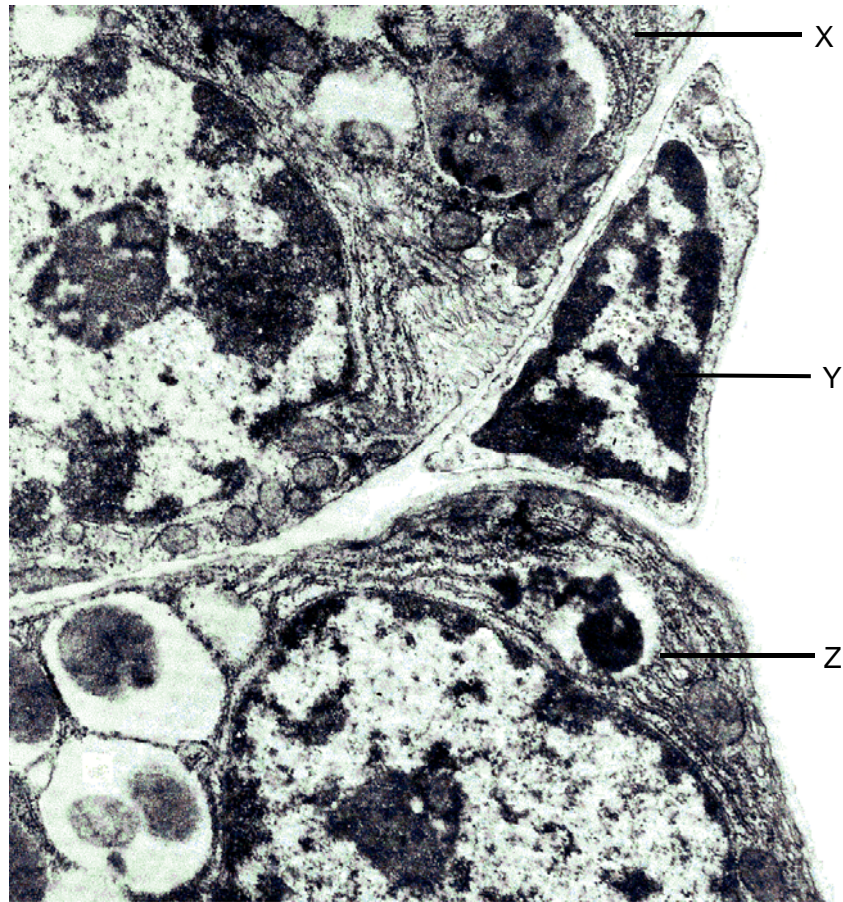
Read the instructions on the Answer Sheet very carefully.

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 **16** printed pages.

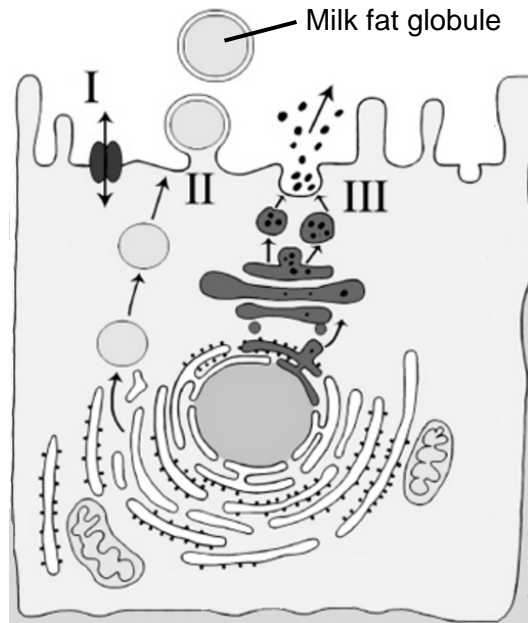
- 1 The following electron micrograph shows three adjacent cells, X, Y and Z.



Which of the following descriptions about these cells is **not** true?

- A Cell X contains both linear and circular molecules as its genetic material.
- B Cell Y has a rigid cellulose cell wall which resists osmotic lysis.
- C Cell Z contains 40S and 60S ribosomal subunits in its cytoplasm.
- D Both cell X and cell Z possess intracellular membranes.

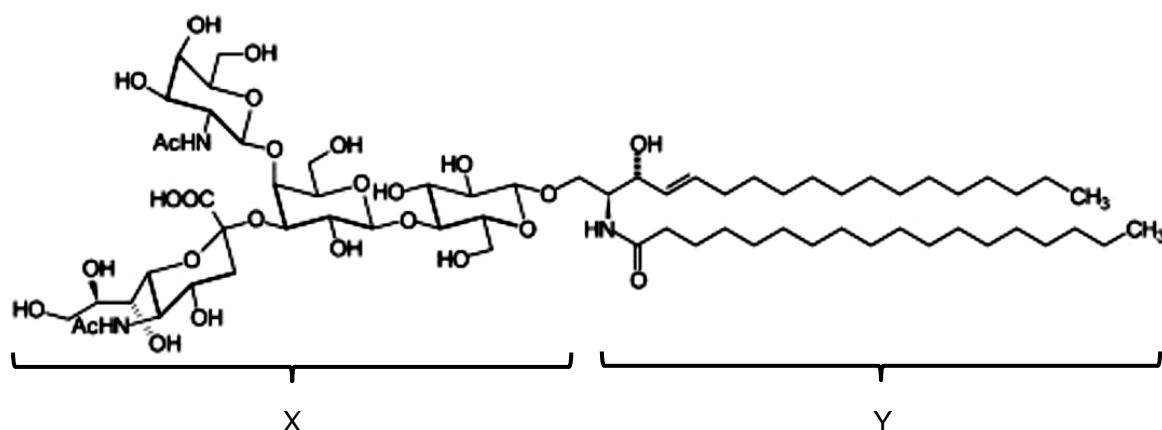
- 2 The diagram shows an epithelial cell in the mammary glands of a mammal. Such cells are responsible for the secretion of milk, an emulsion made up of lactose, lipids, proteins, ions and water. The various substances in milk are secreted through three different transport processes I, II and III.



Which of the following correctly describes the secretion of substances in milk?

- A** The secretion of large fat globules occurs by exocytosis, with the expenditure of ATP.
- B** Lactose and ions have to be secreted through process I due to their hydrophobicity.
- C** Water can be transported in vesicles budding from the rough endoplasmic reticulum and secreted through process II.
- D** Milk proteins are transported out of the cell through process III, due to their large molecular size.

- 3 A ganglioside is a molecule commonly found in cell membranes, and its structure comprises two main components, X and Y.



Which of the following statements regarding a ganglioside is true?

- A** It comprises two fatty acid chains joined to a glycerol molecule by ester bonds.
- B** Component X helps to regulate the permeability of the cell membrane.
- C** Component X is responsible for cell-to-cell recognition and acts as a receptor for other molecules.
- D** Component X is embedded in the cell membrane while component Y faces the extracellular fluid.
- 4 An unknown substance, X, is analysed for its identity. Scientists analysing the substance noted these properties:
- Presence of helices as part of its structure
 - Consists of linear polymer chains without branching structures
 - Tested positive for presence of oxygen atoms, but negative for phosphate atoms

Which of the following list of molecules could be substance X?

- 1 Amylose
- 2 Collagen
- 3 Cellulose
- 4 Deoxyribonucleic acid
- 5 Haemoglobin

- A** 1, 2 and 5 only
- B** 1, 2 and 4 only
- C** 1, 4 and 5 only
- D** 2, 3 and 5 only

- 5** The winged bean is a tropical crop that has high protein content. Winged beans have been reported to have a low level of protein digestibility. Protease inhibitors in the bean have been suggested to be responsible for the low digestibility.

In an experiment to study the effect of heat treatment on protein digestibility in winged beans, one of two winged beans was subjected to heat treatment. Trypsin was subsequently added to each reaction mixture and incubated for 30 minutes. The protein concentration of each reaction mixture at the beginning and at the end of the incubation period is shown in the table below.

Incubation period / min	Protein concentration of the reaction mixture / %	
	Trypsin + heat-treated winged bean	Trypsin + untreated winged bean
0	100	100
30	40	70

Which of the following statements is a likely explanation for the data shown?

- A** Heat treatment of winged bean caused the activation of trypsin inhibitors.
- B** Heat treatment of winged bean denatured trypsin by changing the 3-dimensional configuration of the enzyme.
- C** Heat treatment of winged bean disrupted cellular structure and improved accessibility of trypsin to protein.
- D** Heat treatment of winged bean lowered the activation energy of trypsin and increased the rate of enzyme-catalysed reaction.
- 6** Serine proteases, such as chymotrypsin and trypsin, are enzymes that cleave peptide bonds in proteins. Three specific amino acids (aspartic acid, histidine, serine) arranged in a special alignment, are found conserved in all serine proteases. This conserved alignment is often referred to as "the catalytic triad". At the active site, scientists also found a variable region between different members in this class of enzymes.

Which feature allows different serine proteases to bind to different substrates?

- A** Different R-group properties of amino acids lining the variable region
- B** Specific spatial arrangement of aspartic acid, histidine, and serine at the active site
- C** Presence of a specific cofactor required for catalysis
- D** Different R-group properties of amino acids in the catalytic triad

- 7 The amount of DNA present in a diploid germ cell of 12 chromosomes is 6 picograms (pg). During meiosis I, non-disjunction of a pair of homologous chromosomes occurred.

Which row correctly identifies the amount of DNA and number of chromosomes at different stages of nuclear division?

	Telophase I		Telophase II	
	Amount of DNA (pg) per cell	Number of chromosomes per nucleus	Amount of DNA (pg) per cell	Number of chromosomes per nucleus
A	12	5 or 7	5 or 7	5 or 7
B	12	12	5 or 7	4 or 14
C	6	5 or 7	2.5 or 3.5	5 or 7
D	6	12	2.5 or 3.5	4 or 14

- 8 Which of the following processes does not help to ensure the production of genetically identical cells at the end of each mitotic cell cycle in animals?
- A** Proofreading by DNA polymerase during DNA elongation
 - B** Complementary base pairing during DNA replication
 - C** Equal separation of homologous chromosomes to opposite poles of the cell
 - D** Attachment of spindle fibres to kinetochore complex at both sides of the centromeres
- 9 Which of the following is **not** a characteristic of cancer cells?
- A** Ability to induce angiogenesis
 - B** Contact inhibition
 - C** Anchorage independence
 - D** Metastasis
- 10 What occurs as a result of base pairing during DNA replication?
- A** Both strands of the DNA have the same sequence of purines and pyrimidines.
 - B** In each strand, the number of purine bases equals the number of pyrimidine bases.
 - C** Purine bases in one strand become hydrogen-bonded to purine bases in the other strand.
 - D** The number of purine bases in one strand equals the number of pyrimidine bases in the other strand.

11 Which of the following statement(s) is/are **not** true of the translation process in all eukaryotes?

- 1 Polypeptides are only synthesised in the cytosol.
- 2 Amino acids are linked by the formation of peptide bonds catalysed by a ribozyme.
- 3 Ribosomes contain an amino-acyl tRNA site that is occupied by the initiator tRNA attached to methionine.
- 4 Amino-acyl tRNA synthetase attaches an amino acid to the 5' end of a tRNA molecule.

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

12 RNA is involved in the process of protein synthesis. Which of the following descriptions is true about RNA in eukaryotes?

- A** rRNA, which is coded by genes found in nucleolus, associates with ribosomal proteins in the cytoplasm to form ribosomal subunits.
B Functional mRNA is formed as a result of post-transcriptional modifications of primary RNA transcript in the nucleus.
C The ribonucleotide sequence of tRNA molecules allows extensive folding and inter-strand complementarity to generate a three-dimensional structure.
D RNA is synthesised in the nucleus only.

13 The template DNA strand for a segment of polypeptide is shown below:

3' ----- GTA ACC GCA TCT CAG AGG ----- 5'

Which of the following will most likely occur if nitrous acid (a mutagenic agent) introduces mutation to this DNA strand by replacing cytosine bases with uracil bases?

- A** No polypeptide will be synthesised.
B A truncated polypeptide will be synthesised.
C Four new amino acids with different chemical properties will be found in the polypeptide.
D A polypeptide of original length but with a few new amino acids of different side chains will be synthesised.

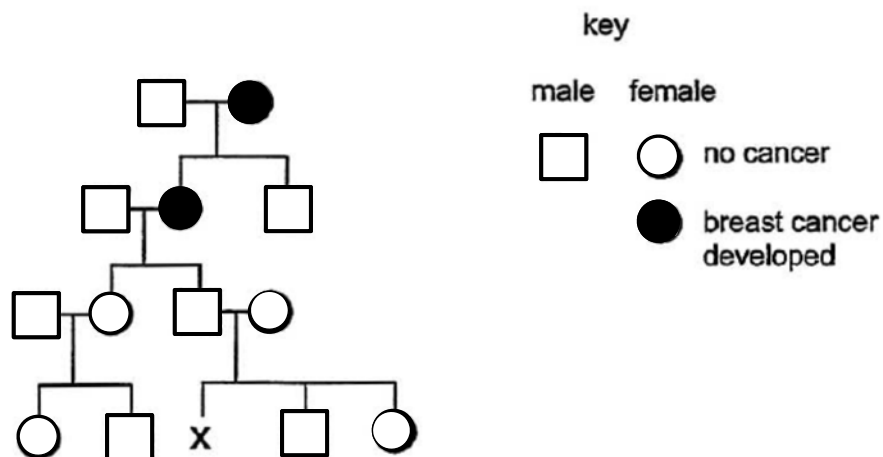
- 14 In Shorthorn cattle, the allele for the absence of horns is dominant to the allele for the presence of horns. Coat colour can be red (genotype $C^R C^R$), roan (genotype $C^R C^W$) or white (genotype $C^W C^W$).

A roan bull, heterozygous for the hornless trait, is crossed with a cow of the same genotype. Which of the following statement(s) regarding the F_1 offspring is/are true?

- 1 The probability that a calf from this cross would have the same phenotype as its parents is $3/8$.
- 2 The ratio of horned to hornless calves is 3:1.
- 3 The number of red and white calves is more than that of roan calves.

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

- 15 The diagram below shows the inheritance of a form of breast cancer associated with the presence of just one mutant allele of the autosomal gene *BRCA 1*.



What is the probability that woman X inherits the *BRCA 1* mutant allele associated with breast cancer?

- A 0.00
 B 0.25
 C 0.50
 D 1.00

- 16** Which statement regarding chrysanthemum plants, of the genus *Dendranthema*, is a valid example of how the environment may affect the phenotype?
- A** Anthocyanins and anthoxanthins are vacuolar pigments, whereas xanthophylls and carotenes are pigments found in membrane-bound organelles known as plastids. These, together with molecules known as co-pigments, are responsible for the variation observed in petal colour in *Dendranthema*.
 - B** Identical genetic crosses performed between varieties of *Dendranthema* result in a greater proportion of offspring plants with plastids exhibiting a yellow colour when grown in a field and a greater proportion of offspring plants with colourless plastids when grown in a glass house.
 - C** The seeds of a cross between *Dendranthema weyrichii* and *Dendranthema grandiflora* produce plants that are far more frost-tolerant and exhibit an extended flowering season compared with both parent plants.
 - D** The seeds of a cross between *Dendranthema weyrichii* (height varying between 12.5 – 15.0 cm) and *Dendranthema grandiflora* (height varying between 8.0 – 25.0 cm) produce plants, when grown in natural day length, of a height varying between 55.0 – 71.0 cm.
- 17** Induced chromosome mutations produced a fertile hybrid species from cabbage and radish.

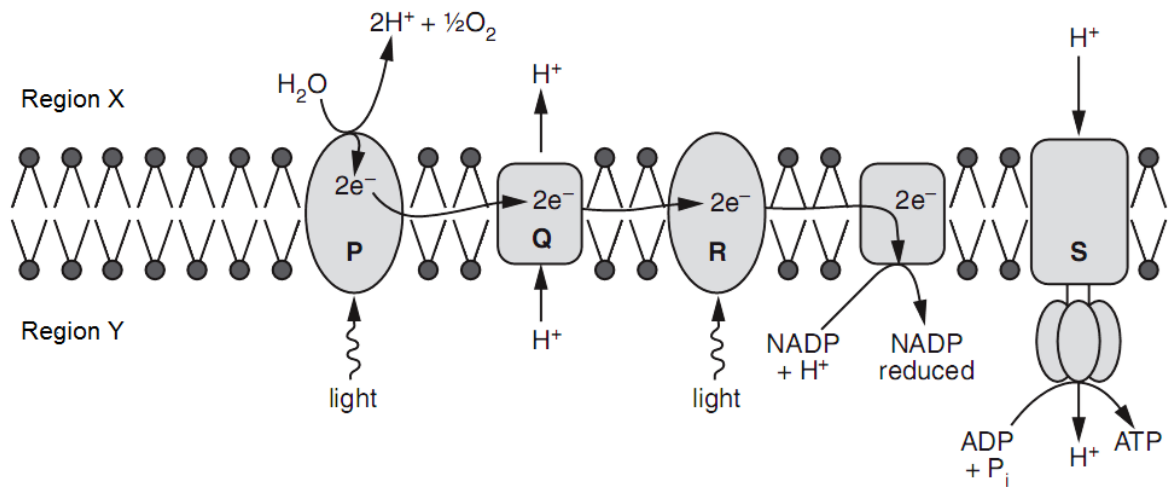
The table shows the chromosome numbers in the parental species and the hybrids.

Type of cell	Number of chromosomes per cell
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

At which stage did the chromosome mutation occur?

- A** During formation of the F₁ gametes
- B** During formation of the F₂ gametes
- C** During fusion of the parental gametes
- D** During fusion of the F₁ gametes

- 18 The diagram below represents a cross section of a thylakoid, showing some components which are involved in the light-dependent stage of photosynthesis.



Which of the following statements about the following components in the light-dependent stage is true?

- A An inhibitor which blocks electron flow through R would inhibit the production of oxygen at P.
- B In structures P and R, electrons are passed from one pigment molecule to another until it reaches chlorophyll *a*.
- C Region X is expected to have a higher pH than Region Y.
- D There is a non-cyclical flow of electrons through structures P, Q, R and S.

- 19** A scientist aims to investigate the relationship between two proteins, X and Y, in isolated chloroplasts. The table below shows the results of oxygen production and ATP formation when only one of either protein is present and when both proteins are present.

Experiment	Protein X	Protein Y	Oxygen evolved / arbitrary units	ATP formed / arbitrary units
1	✓	✗	2.5	1.4
2	✗	✓	5.9	3.1
3	✓	✓	3.0	2.9

✓ = presence ✗ = absence

Based on the above results of the experiment, which of the following statements regarding the possible functions or identities of the two proteins is true?

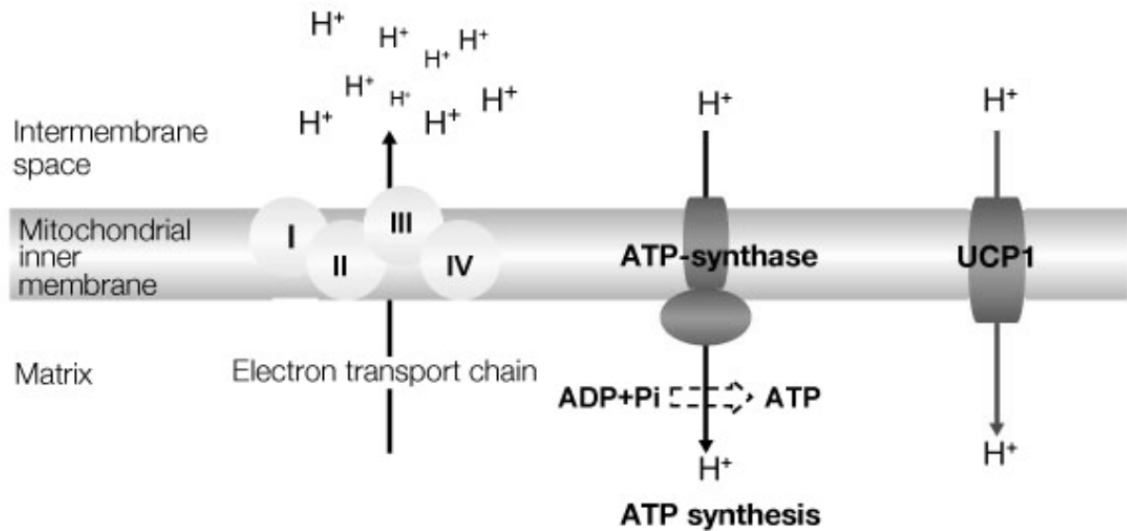
- A** Protein X could prevent the oxidation of reduced proteins in the electron transport chain.
 - B** Protein X could be a proton pump blocker.
 - C** Protein Y could facilitate the cyclic transfer of electrons between photosystem I and other electron carriers.
 - D** Protein Y could be an enzyme that transfers electrons from photosystem I to reduced NADP.
- 20** In respiration, the enzyme hexokinase uses ATP to transfer a phosphate group to glucose to form glucose-6-phosphate.

If a cell only has glucose available for energy and the activity of hexokinase is suddenly inhibited in this cell, which of the following will occur?

- 1 The cell will not be able to produce pyruvate through glycolysis.
- 2 Respiratory processes in the mitochondria would not proceed.
- 3 The use of oxygen by the cell will decrease.

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

- 21** Thermogenesis is a process that helps certain animals to maintain a constant body temperature. Such animals are found to contain a lot of mitochondria which have proton channels known as UCP1 embedded in the inner membrane as shown below.



Based on the above information, which of the following statements is a likely explanation for the role of UCP1 in thermogenesis?

- A** UCP1 disrupts the flow of electrons along the electron transport chain, channelling protons through it instead of ATP synthase, thus producing heat in the process.
- B** A proton gradient cannot be established as UCP1 allows protons to pass through the inner membrane passively, hence the energy released from electron transfer is used for heat production.
- C** The proton motive force is dissipated as heat due to protons flowing through UCP1 instead of passing through ATP synthase.
- D** The presence of UCP1 allows more protons to diffuse into the intermembrane space so that more protons can eventually diffuse through ATP synthase for ATP production to generate heat.

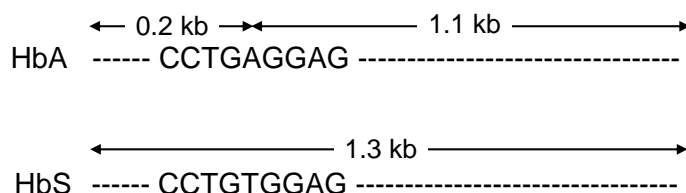
- 22** A large population of a certain species of freshwater fish lives in a South America lake. If there are no mutations and all immigration into the population is prevented, which one of the following statements best expresses the probable future of the population?
- A** All evolution will promptly cease because without mutation, there will be no raw material for evolution.
 - B** The population will begin to decrease in size after three to four generations because of excessive inbreeding that will result from the absence of immigration.
 - C** The population will continue to evolve as selection acts on the different allelic combinations formed during meiosis.
 - D** The population will cease to evolve and it may survive for a long time as there is no selection.
- 23** When organochlorine insecticides such as DDT were in widespread use, mosquitoes in malarial regions developed resistance more rapidly than did houseflies in Britain. What could account for the difference in the rates of the development of resistance?
- A** Mosquitoes produce fewer generations a year.
 - B** More insecticide was used in Britain.
 - C** More insecticide was used in malarial regions.
 - D** Mosquitoes show fewer random mutations per generation.
- 24** Fish in the Arctic and Antarctic have antifreeze proteins. However, these two population of fish diverged long before the antifreeze genes evolved. It was found that the genes that code for the antifreeze proteins in fish at the Arctic and Antarctica are quite different.

Which of the following processes is responsible for the antifreeze property in the two population of the fish?

- A** Reproductive isolation
- B** Divergent evolution
- C** Convergent evolution
- D** Geographical isolation

The information below is for Questions 25 and 26.

Sickle-cell anaemia is caused by a single mutation in the beta-globin gene, where the base A is replaced by T. This results in the substitution of the amino acid glutamic acid by valine. The diagram below show the normal allele for beta-globin, HbA, and the mutant allele, HbS. The sequence of bases in the region of the mutation is also shown.



25 Which of the following describe some of the possible advantages of subjecting the DNA to PCR before analysis?

- 1 Exponential amplification of the beta-globin gene.
- 2 Production of a sample containing only the beta-globin gene.
- 3 Able to use DNA Polymerase from the commonly available *Escherichia coli* bacterium.
- 4 Does not have to undergo further centrifugation to purify the DNA.

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

26 A restriction enzyme, MstII, recognises the base sequence CCTNAGG (where N can be any nucleotide), and cuts it to produce sticky ends. The products of the PCR was hence analysed by adding MstII to the DNA, and subsequently separating the fragments by gel electrophoresis.

Which of the following gel electrophoregrams confirms that the individual is indeed a carrier of sickle-cell anaemia?



- 27** Which of the following is an ethical concern of the Human Genome Project?
- A** Difficult to develop treatment for diseases involving multiple genes
 - B** Costly procedures limit genetic testing to those who can afford them
 - C** Genetic testing may not provide reliable and accurate information
 - D** Unborn foetuses detected with diseases may be aborted
- 28** Which of the following best illustrates totipotency?
- A** A somatic cell isolated from a root tip develops into a normal adult plant.
 - B** Stem cells are able to divide indefinitely.
 - C** Mesenchymal stem cells can differentiate into an extensive range of cell types, including bone cells, cartilage cells, muscle cells and fat cells.
 - D** The replacement of the nucleus of an unfertilised egg with that of a pancreatic cell converts the egg into a pancreatic cell.
- 29** Which of the following describes the normal function of stem cells in a living organism?
- A** Stem cells can divide and differentiate to repair damaged cells in the body.
 - B** Most stem cells in the adult human are multipotent stem cells which can give rise to all cell types in the body.
 - C** Stem cells allow the replacement of worn out cells in the adult tissue or organ.
 - D** The genetic manipulation of stem cells can be used in gene therapy to cure diseases caused by defective genes.

- 30** Transgenic crops expressing insecticidal toxins could provide an effective means of pest control. However, the widespread cultivation of such transgenic crops is expected to promote the development of toxin-resistant pests, hence eventually compromising the usefulness of the pest management strategy. Two planting strategies have thus been recommended to prevent the development of toxin-resistant pests:

Strategy 1: Separate fields of transgenic plants and non-transgenic plants are planted

Strategy 2: 'Seed mixtures' of such transgenic plants and non-transgenic plants in the same field are planted

Which of the following considerations would most likely encourage farmers to favour Strategy 1 over Strategy 2?

- A** Low mortality of susceptible insects on toxin-free plants
- B** Movement of randomly mating insects from plant to plant within a field
- C** Concern that 'superweeds' might emerge in fields with 'seed mixtures'
- D** When toxin resistance is recessive and frequency of recessive alleles is low