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| Civics Group | Index Number | Name (use BLOCK LETTERS) |
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H1



**ST. ANDREW'S JUNIOR COLLEGE
2017 JC2 BT2**

H2 BIOLOGY

9744/1

Paper 1: Multiple Choice Mark Scheme

Tuesday

19th September 2017

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser (not supplied)
Soft pencil (type B or HB is recommended)

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Write your name, civics group and index number on the multiple choice answer sheet in the spaces provided.

There are **30** 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 multiple choice answer sheet.

INFORMATION TO CANDIDATES

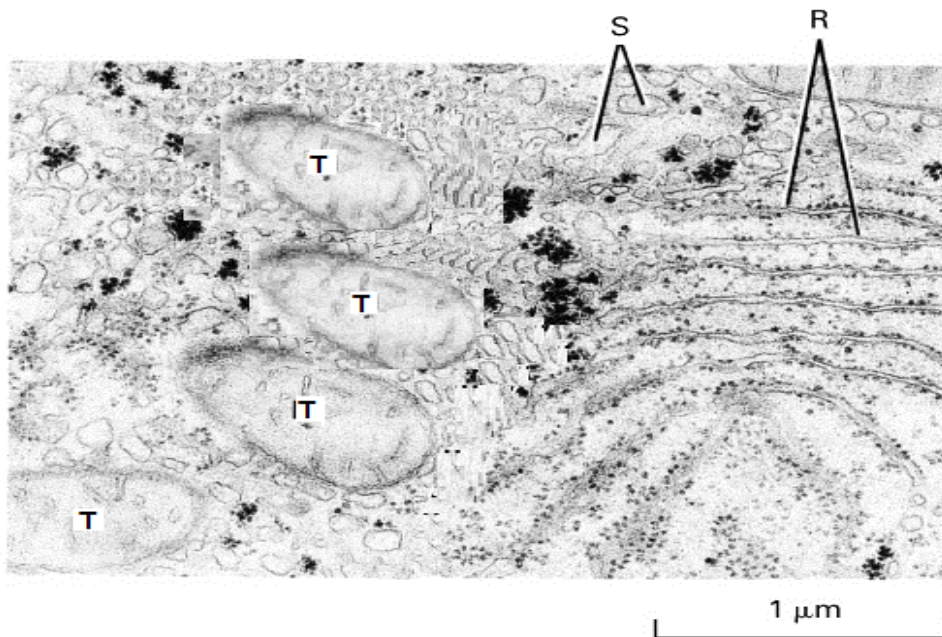
Each correct answer will score one mark. A mark will not be deducted for wrong answer. Any rough working should be done in this booklet.

At the end of the examination, submit both question paper and multiple choice answer sheet.

This document consists of **16** printed pages.

[Turn over

1 The figure below shows an electron micrograph of an eukaryotic cell.



Which of the following option correctly matches the structures **R**, **S** and **T** to their respective functions?

| | R | S | T |
|----------|------------------------------------|-----------------------------------|--|
| A | Involved in proteins glycosylation | Site of lipid synthesis | To convert light energy to chemical energy |
| B | Site of protein synthesis | Site of detoxification reaction | Supplying cellular energy |
| C | Site of detoxification reaction | Involved in protein glycosylation | Remove worn out organelles |
| D | Site of protein synthesis | Contains proteins to be secreted | Storage of starch |

2 Which comparative statement(s) concerning biological molecules is/are correct?

- 1 A collagen molecule is a fibrous protein that contains many amino acids with hydrophobic R-groups whereas a haemoglobin molecule is a globular protein with no amino acids with hydrophobic R-groups.
- 2 Sucrose hydrolysis results in glycosidic bond breakage and the production of equal proportions of fructose and α -glucose molecules, whereas cellulose hydrolysis results in only β -glucose molecules.
- 3 The glycosidic bonds of glycogen are formed between two α -glucose molecules, whereas in amylopectin, the bonds are formed between an α -glucose molecule and a β -glucose molecule.

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

3 Which two features contribute to the great tensile strength of cellulose?

- 1 glycosidic bonds linking the long chains of 1,4 α -glucose molecules
- 2 the -OH groups of the glucose molecules project outwards and form H bonds with neighbouring chains
- 3 the strength of the glycosidic bonds between the neighbouring chains of molecules
- 4 the successive glucose molecules are orientated at 180° to each other

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

4 The statements below are about bonds found in biological molecules.

- 1 They are formed by condensation.
- 2 Oxygen is part of the bond.
- 3 ATP is hydrolysed to form the bonds.
- 4 The bonds contain potential energy.

Which statements are correct for the bonds in the primary structure of proteins?

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

5 The cell surface membrane structure is described as a 'fluid mosaic'.

Which statement describes the 'mosaic' part of the cell surface membrane?

- A** the different patterns that are obtained by the moving phospholipid molecules
B the random distribution of cholesterol molecules within the phospholipid bilayer
C the regular pattern produced by the phospholipid heads and membrane proteins
D the scattering of the different proteins within the phospholipid bilayer

6 What supports the view that a membrane protein is involved in active transport?

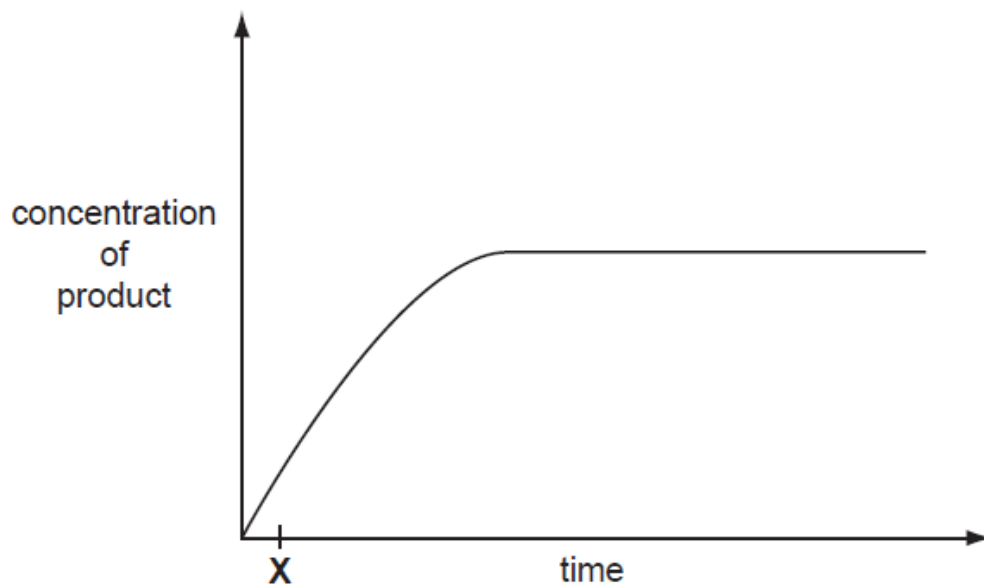
- A** It allows movement of molecules across a membrane if concentration differences exist.
B It can only function if mitochondria are supplied with sufficient oxygen.
C It has a tertiary structure with a binding site with a specific shape.
D It is found in the cell surface membranes and the mitochondrial membranes.

7 What would be shown by a microscopic examination of a root tip squash?

- 1 cells with large nuclei at interphase
- 2 cells not dividing and nuclei undergoing mitosis
- 3 nuclei with paired homologous chromosomes visible
- 4 cell walls forming

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

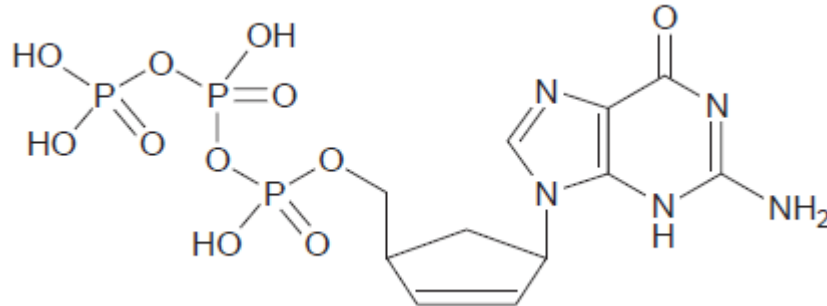
8 The graph shows the course of an enzyme-catalysed reaction at 30 °C.



What is true at time X?

- A** Most enzyme molecules will have free active sites.
B The number of available substrate molecules is high.
C The number of enzyme-substrate complexes is low.
D The rate remains the same if more enzyme is added.

- 9 The diagram shows the molecular structure of a chemical that can inhibit the activity of reverse transcriptase (which catalyses the reaction of synthesis of complementary deoxyribonucleic acid using ribonucleic acid as template). It is an analogue of a naturally occurring nucleic acid monomer.



Which option is correct?

| | Analogue | Naturally occurring monomer |
|----------|-------------------------------------|--------------------------------|
| A | Acts as a competitive inhibitor | Is an activated DNA nucleotide |
| B | Acts as a non-competitive inhibitor | Is an activated RNA nucleotide |
| C | Acts as a competitive inhibitor | Is an activated RNA nucleotide |
| D | Acts as a non-competitive inhibitor | Is an activated DNA nucleotide |

- 10 Which row is correct for adenine?

| | has a single ring structure | is a purine | joins to its complementary base with 3 hydrogen bonds |
|----------|-----------------------------|-------------|---|
| A | ✓ | ✓ | ✓ |
| B | ✓ | ✗ | ✗ |
| C | ✗ | ✓ | ✗ |
| D | ✗ | ✗ | ✓ |

key
 ✓ = correct
 ✗ = incorrect

- 11** Meselson and Stahl investigated DNA in bacteria. They grew bacteria in a medium with only heavy nitrogen, ^{15}N , until all of the bacterial DNA contained only heavy nitrogen.

These bacteria were then moved from the heavy nitrogen medium and cultured in a medium with only light nitrogen, ^{14}N .

Some bacteria were collected from each of the next three generations and their DNA was analysed.

Hybrid DNA contains both heavy and light nitrogen.

Which row shows the correct DNA of the first and third generations?

| | DNA of first generation | DNA of third generation |
|----------|-------------------------|---|
| A | all hybrid | half hybrid, half light |
| B | all hybrid | one quarter hybrid, three quarter light |
| C | half hybrid, half heavy | half hybrid, one quarter heavy, one quarter light |
| D | half hybrid, half light | one quarter hybrid, three quarter light |

- 12** Scientists have made a nucleic acid (HNA) that has a sugar with the same number of carbon atoms as glucose instead of deoxyribose. Although genetic information can be stored by HNA, naturally occurring DNA polymerase cannot replicate HNA.

Which statements could explain why naturally occurring DNA polymerase cannot replicate HNA?

- 1 DNA polymerase cannot form bonds between the sugars of two HNA nucleotides.
- 2 DNA polymerase cannot form hydrogen bonds between two HNA nucleotides.
- 3 HNA nucleotides do not fit into the active site of DNA polymerase.
- 4 The shape of an HNA nucleotide is slightly larger than that of a DNA nucleotide.

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

13 Rifampicin is an antibiotic used to treat tuberculosis.

It works by inhibiting RNA polymerase in bacteria.

Which of these processes will be directly inhibited by this antibiotic?

- 1 ATP synthesis
- 2 transcription
- 3 translation

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

14 Transcription in eukaryotic cells results in the formation of pre-mRNA, which is made up of exons and introns.

Which of the following statements correctly describes what happens during the formation of mature mRNA from the pre-mRNA?

- A** The 5' of the intron is cut, and joined to the branch-point sequence, followed by the cutting of the 3' end to form the lariat loop.
- B** RNA splicing occurs, where all introns are recognised as they share highly similar sequences and are excised.
- C** RNA splicing occurs, where all the introns are excised and some of the exons joined together so that they can be transcribed.
- D** The addition of the 5' cap and the 3' poly-A tail occurs, followed by RNA splicing.

15 Electron micrographs may show large numbers of ribosomes forming chains along mRNA molecules.

What is the advantage of this arrangement, compared to when ribosomes appear singly on the mRNA?

- A** Different polypeptides can be produced simultaneously.
- B** Fewer tRNA molecules are required to translate the polypeptide.
- C** Large polypeptide chains can be produced.
- D** Polypeptides can be produced more rapidly.

- 16** In dogs, a gene on chromosome 27 is responsible for the curliness of the dog's hair. One form of this gene produces an enzyme with arginine at residues 151, but a mutant allele of the gene produces an enzyme which has cysteine at this point.

This latter form causes kinks in the keratin so that the coat is curlier. In heterozygotes, both alleles are co-dominant so an intermediate 'wavy' coat can be observed in the phenotype.

In this context, what is meant by gene mutation?

- A** change in the gene locus
- B** chromosome 27 inversion
- C** production of a new protein
- D** structural change in DNA

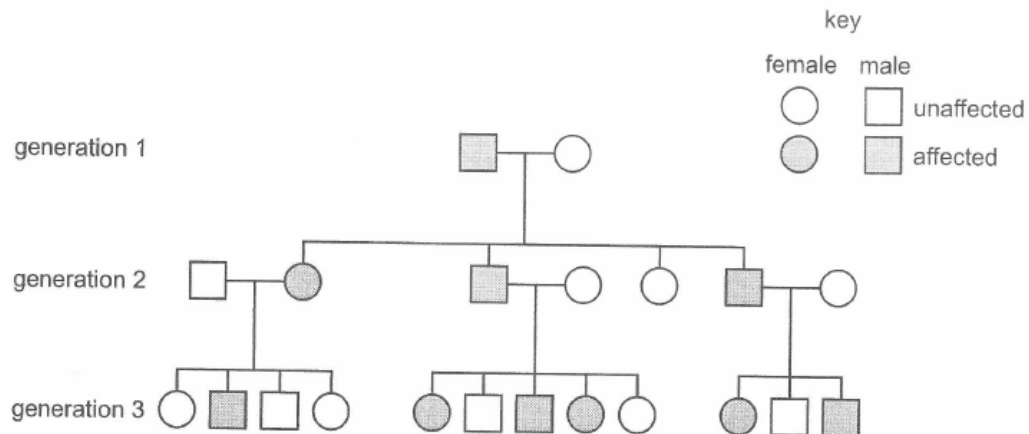
- 17** In mice, the allele for black hair colour (B) is dominant and brown hair colour (b) is recessive.

The agouti allele (A) causes banding on hairs so that the colour of the coat appears paler, black hair appears grey and brown hair appears beige. The recessive, non-agouti allele (a) gives a continuous pigment in the hairs so that the coat appears darker.

What would be the expected ratio of grey : beige : black : brown offspring if the parents had the genotypes Aabb and aaBb?

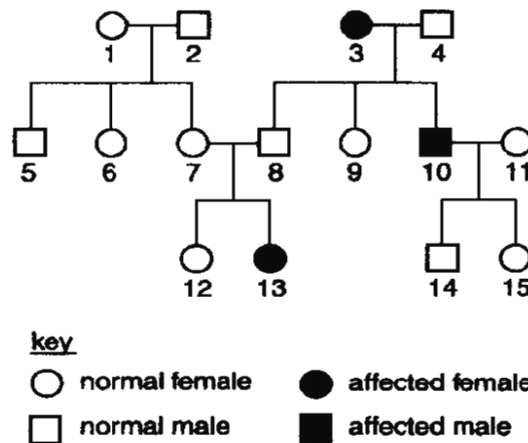
- A** 1 : 1 : 1 : 1
- B** 3 : 3 : 1 : 1
- C** 6 : 3 : 3 : 1
- D** 9 : 3 : 3 : 1

- 18 The pedigree shows the inheritance of a genetic condition in a family for three generations.



Which evidence indicates that this genetic condition is autosomal?

- A Affected females always have affected sons.
 - B Affected males do not pass it on to their sons.
 - C Affected parents always have affected offspring.
 - D Males and females are equally affected.
- 19 The family tree shows the inheritance of a condition caused by the change in nucleotide sequence of gene R.



What is the probability that the first child is an affected girl when individual 7 mated with an affected male instead?

- A 0
- B 0.25
- C 0.50
- D 0.75

20 Stages of aerobic respiration are shown below.

- 1 Glycolysis
- 2 Citric acid cycle
- 3 Electron transfer chain

Which stage(s) involve(s) **both** phosphorylation of intermediates and generation of ATP?

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

21 The table below shows reactions occurring in a plant cell, and their respective locations.

| | Reaction | Location in a cell |
|---|---|--------------------|
| 1 | ribulose biphosphate + CO ₂ → glycerate-3-phosphate | Stroma |
| 2 | glucose + ATP → glucose-6-phosphate + ADP | Matrix |
| 3 | oxygen + 4H ⁺ + 4e ⁻ → 2 H ₂ O | Stroma |
| 4 | oxaloacetate + acetyl-CoA → citrate | Matrix |

Which of the following is / are **incorrectly** matched?

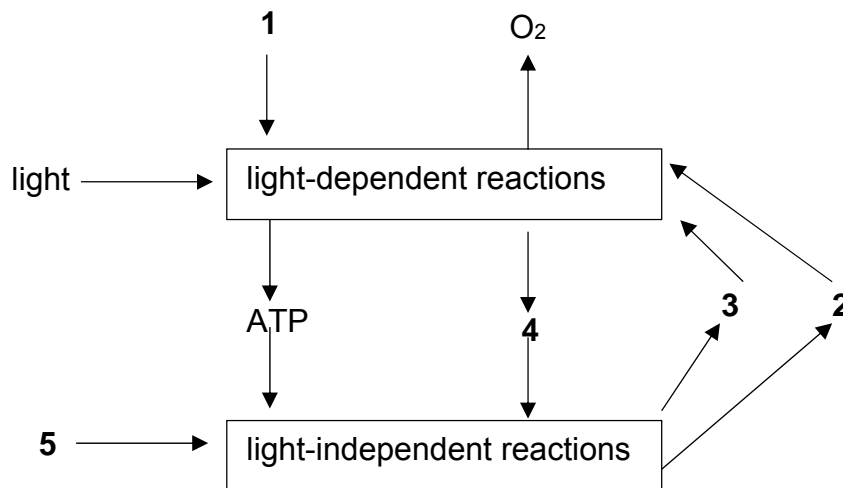
- A** 2 only
B 4 only
C 2 and 3 only
D 1, 2 and 3

22 Which statements help to explain the low yield of ATP from anaerobic respiration compared to aerobic respiration?

- 1 Energy in the chemical bonds of lactate can be obtained only after oxidation to pyruvate.
- 2 The electron transport chain is responsible for most of the transfer of chemical bond energy from glucose to ATP.
- 3 The decarboxylation of pyruvate in anaerobic respiration in yeast is not linked to ATP synthesis.
- 4 As a result of glycolysis, there is a net gain of only two molecules of ATP from each glucose molecule.

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

23 The diagram summarises the process of photosynthesis.



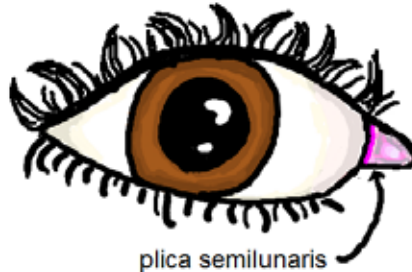
Which row identifies the reactants 1, 2, 3, 4 and 5?

| | 1 | 2 | 3 | 4 | 5 |
|---|----------------|-----------------|-----------------|-----------------|----------------|
| A | Carbon dioxide | ADP + phosphate | reduced NAD | NAD | water |
| B | Carbon dioxide | reduced NAD | ADP + phosphate | NADP | water |
| C | water | NAD | reduced NAD | ADP + phosphate | Carbon dioxide |
| D | water | NADP | ADP + phosphate | reduced NADP | Carbon dioxide |

24 Which of the following is **not** the consequence of natural selection?

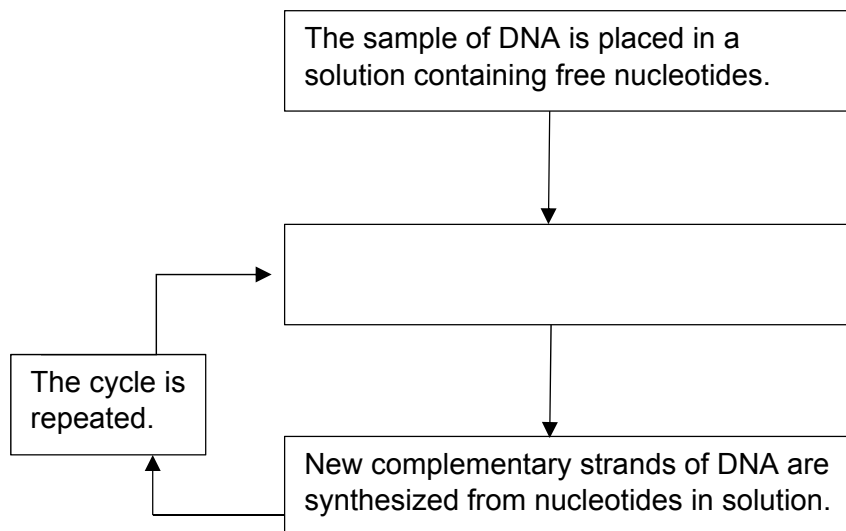
- A The field mustard plant survived a summer drought in southern California because some individuals contained alleles that made them flower earlier. Plants with flowers wilt more easily than plants without flowers. Now, almost all the field mustard plants in California flower in spring.
- B In areas with fewer predators of herbivorous insects, plants which produce higher concentrations of alkaloids (which are toxic to insects) dominated the landscape. Most of the herbivorous insects in these areas are found to be able to accumulate alkaloids in their bodies without affecting their metabolism.
- C Endemic to New Zealand, the kakapo (a large flightless bird) had no natural predators before the humans arrived. They have evolved to have very few offspring throughout their entire lifespan. This phenomenon is also common for other island species which do not have natural predators in their respective habitats.
- D Maple probably has the most variation in bark of any tree species. Japan experiences tornadoes which destroy large trees like the maple. Over the last few decades, it was observed that only the Japanese maple with dark-coloured bark remained.

- 25** The plica semilunaris is a small fold of tissue on the inside corner of the eye. It is the vestigial remnant of the nictitating membrane, an organ that is fully functional in some other species of mammals. For example, in diving animals like beavers and manatees, the nictitating membrane is transparent and moves across the eye to protect it while under water.



Which of the following statements **least** explains the presence and structure of plica semilunaris in humans?

- A** Early ancestors of humans were not divers.
 - B** Any presence of nictitating membrane in non-diving mammals posed a selective disadvantage for individuals who had it.
 - C** Mutations occurred to reduce the size of nictitating membrane in humans to its present-day vestigial structure as there was no use for it.
 - D** The genes involved in producing the plica semilunaris were inherited from a common ancestor shared by humans, beavers and manatees.
- 26** The polymerase chain reaction is summarised in the flowchart below.



Which statement completes the flow chart?

- A** Complementary strands of DNA are separated.
- B** Free nucleotides join on the end of DNA strands.
- C** Small sections of DNA are formed.
- D** Strands of DNA bind to RNA primers.

27 The statements are about restriction enzymes, which are naturally occurring molecules used in genetic engineering.

- 1 Restriction enzymes cut foreign DNA into smaller fragments.
- 2 Restriction enzymes are made by bacteria in response to bacteriophages.
- 3 Restriction enzymes cut DNA creating sticky ends.
- 4 Restriction enzymes cut at specific sequences of six nucleotides within the strands of a DNA molecule.

Which statements correctly describe the natural role of **all** restriction enzymes?

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

28 Some of the features of different types of stem cells are listed.

- 1 They are able to develop into all cell types of the body to form a whole organism
- 2 They can develop into a wide range of different types of cell
- 3 They have active telomerase enzyme
- 4 They can only develop into a limited range of cell types

Which of the following will be shown by embryonic stem cells?

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

29 The following statements are about genetically modified crops.

- 1 All crops, including genetically modified crops, are unnatural as they have been produced by artificial methods.
- 2 Genetically modified crops are produced by adding single genes.
- 3 Genetically modified crops can cross-fertilise with non-modified crops.
- 4 Genetically modified crops can be adapted to their environment.
- 5 Genetically modified crops can produced more quickly than selectively bred crops.

Which statements best support the view that genetically modified crops could help resolve world food shortages?

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

30 One type of genetically modified corn has

- a gene for the production of Bt toxin which protects the plant against a specific insect;
- a 'pat'-gene for tolerance to the herbicide 'Basta'. This gene is used to select plants with the Bt toxin gene;
- an 'amp'-gene which was introduced in the plant together with the Bt toxin gene. This gene gives 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 statement 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 'amp' gene to be expressed.
- B** Bacteria cannot take up any DNA released during digestion of the plants by human nuclease enzyme, without the presence of a vector.
- C** 50% of the enterobacteria isolated from humans are '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.

END OF PAPER

**SAJC H1 PRELIM 2017 PAPER 1
ANSWER SCHEME**

| | | | | | |
|----|----------|----|----------|----|----------|
| 1 | B | 11 | B | 21 | C |
| 2 | A | 12 | D | 22 | A |
| 3 | D | 13 | C | 23 | D |
| 4 | A | 14 | A | 24 | D |
| 5 | D | 15 | D | 25 | C |
| 6 | B | 16 | D | 26 | A |
| 7 | B | 17 | A | 27 | B |
| 8 | B | 18 | D | 28 | C |
| 9 | A | 19 | B | 29 | D |
| 10 | C | 20 | A | 30 | D |