

DUNMAN HIGH SCHOOL Preliminary Examination Year 6

# H2 BIOLOGY

Paper 1 Multiple Choice Questions Additional Materials: Multiple Choice Answer Sheet 9744/01

25 September 2023 1 hour

### **READ THESE INSTRUCTIONS FIRST**

Write in soft pencil. Do not use staples, paper clips, glue or correction fluid. Write your centre number, index number, name and class at the top of this page.

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.

This document consists of **25** printed pages **1** blank page.

1 Four students, **A** – **D**, were asked to match the function with the appearance of some cell structures in an animal cell.

The functions were listed by a number.

- 1 mRNA passes through to the ribosome
- 2 organises microtubules to produce the spindle during cell division
- 3 packaging of hydrolytic enzymes that will remain in the cell

The appearances were listed by a letter.

- V membranes which surround an enclosed inner cavity
- W non-membrane bound, spherical structures
- X a double membrane interspersed with pores
- Y non-membrane bound, cylindrical structures
- Z membrane-bound sacs, arranged as a flattened stack

Which student correctly matched the numbered function with the appearance of the cell structure?

	1	2	3
Α	V	W	Y
В	V	Y	Z
С	Х	W	Y
D	Х	Y	Z

- **2** The electron micrograph shows a chloroplast.

Which row correctly shows the function or characteristic of the labelled structure?

	help to maintain high H <sup>+</sup> concentration	made up of phospholipid	where ATP is synthesised
Α	1 and 2	<b>3</b> and <b>4</b>	2
В	2 and 3	<b>2</b> and <b>4</b>	<b>3</b> and <b>4</b>
С	1 and 2	1, 2 and 3	<b>3</b> and <b>4</b>
D	<b>3</b> and <b>4</b>	1, 3 and 4	2

- Starch Glycogen Cellulose Α Highly branched Highly compacted Provides structural support amylose due to  $\alpha$ -1,6 molecule that serves as and prevents cells from glycosidic bonds a good energy storage bursting when turgid in animal cells В Insoluble due to the -Made up of  $\alpha$ -glucose Cellulose chains are OH groups projecting monomers with 1,4 organised into microfibrils into the interior of glycosidic bonds and macrofibrils helices resulting in highly branched chains С Can be easily Angle of  $\alpha$ -1,4 bonds Made up of long linear hydrolysed to release and CH<sub>2</sub>OH side chains chains due to 180° rotation results in helical chains α-alucose monomers of alternate β-glucose D Highly compacted Made up of  $\alpha$ -glucose High tensile strength is due molecule that serves as monomers with 1,6 to the accumulative a good energy storage glycosidic bonds strength of the covalent in plant cells resulting in highly cross linkages between branched chains cellulose chains
- 3 Which row describes starch, glycogen, and cellulose?

- **4** Which statements about glycosidic bonds are correct?
  - 1 A hydroxyl group is formed on each molecule when a glycosidic bond is hydrolysed.
  - 2 Only glycosidic bonds can be formed between glucose molecules.
  - 3 The formation and breakage of glycosidic bonds are reversible.
  - 4 The same enzymes are involved in the formation and breakage of glycosidic bonds.
  - **A** 1 and 3
  - **B** 1 and 4
  - **C** 2 and 3
  - **D** 2 and 4

**5** The diagram shows the structure of two lipid molecules.



Which statements correctly describe the two lipid molecules?

- 1 Both molecules are esters of glycerol.
- 2 Both molecules are made by condensation reactions.
- 3 The hydrocarbon chains of molecule **X** are always from saturated fatty acids.
- 4 The hydrocarbon chains of molecule **Y** may be from saturated or unsaturated fatty acids.
- 5 The hydrocarbon chains of molecule **Y** are always the same length.
- A 1, 2 and 4
- **B** 1, 3 and 5
- **C** 2 and 4
- **D** 3 and 5

**6** The diagram shows some interactions between amino acid R-groups in a polypeptide chain.



Which row describes the nature of the interactions?

	can be disrupted by extreme pH	can be disrupted by high temperatures	located within the core of a globular protein	located within the transmembrane domain of a membrane protein
Α	1, 3, 4	1, 2, 3, 4	2	1, 2, 4
В	1, 2, 4	3	1, 4	2, 3
С	3	1, 4	2, 3	1, 2, 3, 4
D	1, 4	1, 2, 4	2, 3	2, 3

- 7 A student investigated the hydrolysis of lipids in high-fat milk, using the enzyme lipase.
  - 1 cm<sup>3</sup> of enzyme solution was added to 10 cm<sup>3</sup> of high-fat milk.
  - The temperature was kept constant.
  - The pH of the reaction mixture was recorded at 0 minutes and every minute for 20 minutes.

Which statements could explain the possible results of the investigation?

- 1 Less product is made as time proceeds because the amount of substrate was decreasing.
- 2 The pH of the reaction mixture changed more rapidly in the first few minutes and then changed less rapidly.
- 3 The product gradually caused more lipase molecules to denature.
- **A** 1, 2 and 3
- **B** 1 and 2
- **C** 1 and 3
- **D** 2 and 3

8 Reindeers are well adapted to survive in extreme cold winters. One of these adaptations is having a unique cell membrane composition at different parts of its body. The graph shows the percentage composition of the components of cell membranes A and B taken from two different parts of the reindeer's body.



Which statement best explains the differences in the membrane composition in cell A and cell B?

- A Cholesterol decreases the membrane fluidity and prevents the membrane from breaking up by restraining the movement of phospholipids.
- **B** Cell membrane A is taken from a lower part of the reindeer's leg as the unsaturated hydrocarbon tails will prevent the fatty acids from packing close to each other.
- **C** Cell membrane B is taken from a lower part of the reindeer's leg as the saturated hydrocarbon tails will prevent the fatty acids from packing close to each other.
- **D** Transmembrane proteins maintain the osmotic balance between the interior and exterior of the cell, hence preventing the cell membrane from solidifying at low temperatures.

**9** The diagram shows part of a DNA molecule.



How many hydrogen bonds are present in this diagram?

**A** 6 **B** 8 **C** 10 **D** 12

#### **10** The mechanism of action of four drugs that inhibit DNA replication is stated below:

- Drug 1 inhibits the action of DNA ligase
- Drug 2 resembles the shape of a DNA nucleotide
- Drug 3 attaches irreversibly to the DNA molecule
- Drug 4 binds irreversibly to the active site of DNA polymerase

Which row matches the drugs to their effects on DNA replication?

	Daughter strands of varying lengths are synthesized	Only fragments are synthesised at the end of replication process	Phosphodiester bonds cannot be formed	Template strands become inaccessible by the enzyme.
Α	4	3	2	1
В	2	4	3	1
С	2	1	4	3
D	3	2	1	4

**11** A sample of DNA is cut at the positions indicated by the letter **X** below.



After performing gel electrophoresis, which lane shows the expected banding pattern?



- **12** Two students were discussing the involvement of DNA and RNA in transcription and translation.
  - Student 1 always stated correct facts.
  - Student 2 gave further information, which were sometimes correct.

	correct facts given by student 1	correct facts given by student 2	
1	A length of mRNA is 747 nucleotides long, including stop and start codons.	The mRNA can produce a polypeptide that is 249 amino acids long.	
2	Adjacent mRNA codons of AAU and CUG bind to complementary tRNA anticodons.	There is a total of 14 hydrogen bonds formed between these two codons and their anticodons.	
3	RNA polymerase catalyses the formation of the mRNA from the template strand of DNA.	During translation, an RNA adenine nucleotide will pair with a DNA thymine nucleotide.	
4	A DNA adenine nucleotide is structurally different from an RNA adenine nucleotide.	The difference is in the hexose sugars. DNA is deoxyribose and RNA is ribose.	

Which further information, given by student 2, are correct?

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

**13** Exceptions to the universal genetic code are found in mammalian mitochondria as shown in the table.

mRNA codon	Corresponding amino acid coded for in mammalian cytoplasm	Corresponding amino acid coded for in mammalian mitochondria
AGA	arginine	stop
AGG	arginine	stop
AUA	isoleucine	methionine
UGA	stop	tryptophan

A short length of messenger RNA was synthesised with the following base sequence.

#### 3' AGUGGAAGAAUA 5'

How many peptide bonds would be formed by ribosomes translating this mRNA in mammalian cytoplasm and in mammalian mitochondria?

	mammalian cytoplasm	mammalian mitochondria
Α	2	1
В	3	0
С	2	0
D	3	1

- **14** Which statements are true of HIV and influenza virus?
  - 1 Both contain negative strand RNA.
  - 2 Uncoating occurs after fusion of envelope with host membrane.
  - 3 Viral particles contain specific enzymes that are not found in the host cells.
  - 4 Replication of viral genetic material takes place in the nucleus immediately upon infection.
  - 5 Changes in the genome are due to the lack of proofreading mechanism only.
  - A 1, 4 and 5
  - **B** 2, 3 and 5
  - **C** 1 and 4
  - **D** 2 and 3

15 Salmonella typhi bacteria is known to be a viable host for a newly discovered temperate phage, but the site of prophage integration is unknown. The following gene map shows the loci of four genes on the *S. typhi* chromosome – arg, his, leu and cys – responsible for the biosynthesis of four essential amino acids. Four possible prophage integration sites, W, X, Y, Z are indicated.



The phages are allowed to replicate using a strain of *S. typhi* capable of synthesising all four amino acids ( $arg^+ his^+ leu^+ cys^+$ ). The replicated phages are then added to a mutant strain of *S. typhi* of genotype  $arg^- his^- leu^- cys^-$ .

After a short incubation, samples of these bacteria are plated on four different media supplemented with different amino acids. The following table shows whether colonies were observed on the various media (+ indicates the presence of an amino acid in the medium while – indicates its absence).

Medium	Supplementation of amino acids in medium			Presence	
	Arg	His	Leu	Cys	of colonies
1	_	+	+	+	No
2	+	_	+	+	No
3	+	+	_	+	Yes
4	+	+	+	_	Yes

What is the most likely prophage integration site?

- A Site W
- **B** Site X
- **C** Site Y
- **D** Site Z

- **16** Which statements regarding telomerase are correct?
  - 1 A high concentration of telomerase in cancerous cells enhances the rate of tumour growth.
  - 2 The high concentration of telomerase in stem cells means that these cells can divide an unlimited number of times.
  - 3 The gene coding for telomerase is only found in stem cells and cancer cells.
  - **A** 1, 2 and 3
  - **B** 1 and 2
  - **C** 2 and 3
  - **D** 1
- **17** Two men who are identical twins marry two women who are also identical twins. Each couple has a daughter. The daughters are more genetically similar than is usual for first cousins.

Which statement describes the degree of genetic similarity between the daughters?

- A They are genetically different from each other due to independent assortment in meiosis.
- **B** They are genetically different from each other due to random mutation.
- **C** They are genetically identical because random mutation is rare.
- **D** They are genetically identical because they share the same parental gene pool.

**18** The diagrams represent a pair of chromosomes during prophase I of meiosis. Q and q are alleles of one gene, and R and r are alleles of another gene.

Which diagrams show situations where allele Q will segregate from allele q during anaphase I?



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





Which statements can be inferred from this multistep model of carcinogenesis?

- 1 Cells whose *APC* and  $\beta$ -catenin genes are inactivated have lost densitydependent inhibition.
- 2 **APC** and  $\beta$ -catenin genes are tumour suppressor genes.
- 3 High levels of **Ras** protein are produced only when both copies of **Ras** gene are mutated.
- 4 Two copies of normal *p53* alleles must be present to inhibit cell division.
- 5 Gain-of-function mutation in **COX-2** gene is a pre-requisite for the formation of carcinoma.
- A 1, 4 and 5
- **B** 1, 2 and 5
- **C** 2, 3 and 4
- **D** 2, 3 and 5

**20** The diagram shows how a stem cell can differentiate into different specialised cell types.



Which statement is not correct?

- A Myeloid and lymphoid stem cells are multipotent.
- **B** The stem cells can be found in both a fetus and an adult body.
- **C** The stem cells can differentiate into the three germ layers in the adult body.
- **D** The stem cells may be used in a bone marrow transplant to treat a patient with leukemia, a form of blood cancer.

**21** Exposure of DNA to ultraviolet (UV) light can result in the covalent linking of adjacent thymine bases on the same strand of DNA, forming a T-dimer.

Individuals with the genetic disease xeroderma pigmentosum have a greatly increased risk of developing cancer in skin that has been exposed to UV light. This is because the normal repair of T-dimers by an excision endonuclease enzyme (excinuclease) does not occur.

	Presence of adjacent thymine bases in DNA	Mutation in gene for excinuclease
Α	$\checkmark$	$\checkmark$
В	$\checkmark$	×
С	×	$\checkmark$
D	×	×

Which individual is most likely to develop skin cancer?

**22** A Robertsonian translocation is a type of chromosomal translocation in which the long arms of two chromosomes fuse together. The diagram shows an example of this event occurring between chromosomes 14 and 21.



An individual who inherits the translocated chromosome will either have Down's syndrome or be a carrier of the condition.

A couple have a child. The mother is a carrier and the father is genetically normal. The diagram shows one of the somatic cells of the mother.



Which statement cannot be concluded?

- **A** The mother does not have Down's syndrome.
- **B** The mother has a higher risk of having a child with Down's syndrome compared to the general population.
- **C** The father's genetic makeup can influence the severity of Down's syndrome in the child.
- **D** The child has a 50% chance of inheriting the translocated chromosome from the mother.

**23** The diagram shows the pedigree of a family carrying the sex-linked allele for red-green colour blindness.

From which labelled member of this family did individual **E** inherit the allele for colour blindness?



24 Fur colour in cats is partly controlled by a gene on the X chromosome. The gene has two alleles, one coding for black fur and one coding for ginger fur. The two alleles are codominant, so a heterozygous cat has patches of black and patches of ginger fur, a pattern called tortoiseshell.

When a black female cat was mated with a ginger male cat, the F1 generation consisted of black males and tortoiseshell females.

What phenotypic ratio would be expected in the F2 generation?

- **A** 1 black female : 1 tortoiseshell female : 2 black males
- **B** 1 black female : 1 ginger female : 2 black males
- **C** 1 black female : 1 ginger female : 1 black male : 1 ginger male
- **D** 1 black female : 1 tortoiseshell female : 1 black male : 1 ginger male

**25** In an experiment to investigate the effects of wavelength of light on photosynthesis, a student added blue DCPIP solution to a suspension of isolated chloroplasts. DCPIP turns from blue to colourless when it accepts hydrogen ions and electrons. The DCPIP-chloroplast mixture was kept in the dark until needed, when a sample was drawn into a capillary tube and illuminated by coloured light of a known wavelength.

Which statements about the expected results of the experiment are correct?

- 1 DCPIP will decolorise at different rates in different wavelengths of light.
- 2 DCPIP will decolorise faster in red than in green wavelengths of light.
- 3 The end point of the reaction will be a colourless solution.
- **A** 1, 2 and 3
- **B** 1 and 2
- **C** 2 and 3
- **D** 1
- **26** An investigation was carried out to study the effect of three inhibitors, **A**, **B** and **C**, on the electron transport chain in mitochondria. In each of three experiments, a different inhibitor was added. The table shows the state of the electron carriers, **W**–**Z**, after the addition of the inhibitor.

Inhibitor	Electron carrier				
added	w	x	Y	Z	
Α	oxidised	reduced	reduced	oxidised	
В	oxidised	oxidised	reduced	oxidised	
С	reduced	reduced	reduced	oxidised	

What is the order of the electron carriers in this electron transport chain?

- **A W**, **X**, **Y**, **Z**
- $\textbf{B} \qquad \textbf{X}, \, \textbf{W}, \, \textbf{Z}, \, \textbf{Y}$
- C Y, X, W, Z
- D Z, X, Y, W

**27** A scientist is investigating the effects of Poison T on the cell signalling pathway of glucagon. It is found that Poison T diminishes the effect of glucagon.

The table shows the different components of the cell signalling pathway of glucagon and their statuses.

Component	Status
G-Protein Coupled Receptor	Configuration can be changed
G-protein	Can exchange GDP for GTP
cAMP levels	Low
Protein Kinase A	Inactivated

Which statements can be concluded from the results?

- 1 Poison T interferes with reception.
- 2 Poison T prevents G-protein from hydrolysing GTP.
- 3 Poison T inactivates the enzyme adenylate cyclase.
- 4 Poison T stops the relaying of message down the phosphorylation cascade.
- **A** 1 and 2
- **B** 2 and 3
- **C** 1 and 4
- **D** 3 and 4

**28** The mating calls of six different species of frogs belonging to the *Hyla* genus are recorded and shown.



Which statement cannot be inferred from the chart?

- A Mating calls of these frog species are homologous.
- **B** Differences in mating calls could result in reproductive isolation.
- **C** Frogs with more similar mating call patterns are more likely to be closely related.
- **D** The evolutionary relationship among species can be established by the duration, intensity, and frequency of mating calls.
- **29** Below are some features of the immune system.
  - 1 Ability to distinguish self antigens from foreign particles.
  - 2 Ability to launch a faster response against a re-infecting infectious agent.
  - 3 Ability to prevent an infectious agent from proliferating within the organism.

Which row shows the features of molecules in the human immune system?

	Phagocytic cells	Antibodies	Natural killer cells
Α	1, 2, 3	1, 2, 3	1, 2, 3
В	1, 2, 3	1, 2, 3	1, 3
С	1, 3	2, 3	2, 3
D	2	1	1, 2

**30** Indonesia is among the world's largest cocoa producers, and most of the cocoa beans come from Sulawesi island. Farmers plant cocoa during the rainy season (November to April) and harvest during the dry season (May to October).

In recent years, cocoa production has been threatened by climate change. The mean yearly precipitation in Sulawesi island from 2000 to 2021 has increased from 4000 mm to 4021 mm. The monthly anomalies of precipitation in years 2000 and 2021 in Sulawesi island is shown.



The anomaly indicates if a month had more or less precipitation than the 30-year climate mean from 1980 to 2010. Positive values indicate wetter than normal and negative values indicate drier than normal. The dry season is boxed out.

Which statement can explain how cocoa production is threatened in Sulawesi island?

- **A** When the cocoa plants are harvested during the dry season, which is becoming wetter than usual, the plants may be water damaged.
- **B** When the cocoa plants are harvested during the dry season, which is becoming drier than usual, the plants may wither.
- **C** When the cocoa plants are planted during the rainy season, which is becoming drier than usual, there may be more good weather days for planting.
- **D** When the cocoa plants are planted during the rainy season, which is becoming wetter than usual, the plants may be damaged by excess humidity and mould growth.

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