Name:		Index Number:		Class:	

DUNMAN HIGH SCHOOL
Preliminary Examination
Year 6

H1 BIOLOGY

8875/01

Paper 1 Multiple Choice Questions **25 September 2017**

1 hour

Additional Material: OTAS sheet

INSTRUCTIONS TO CANDIDATES:

DO NOT TURN THIS PAGE OVER UNTIL YOU ARE TOLD TO DO SO.

READ THESE NOTES CAREFULLY.

Section A MCQ [30 marks]

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.

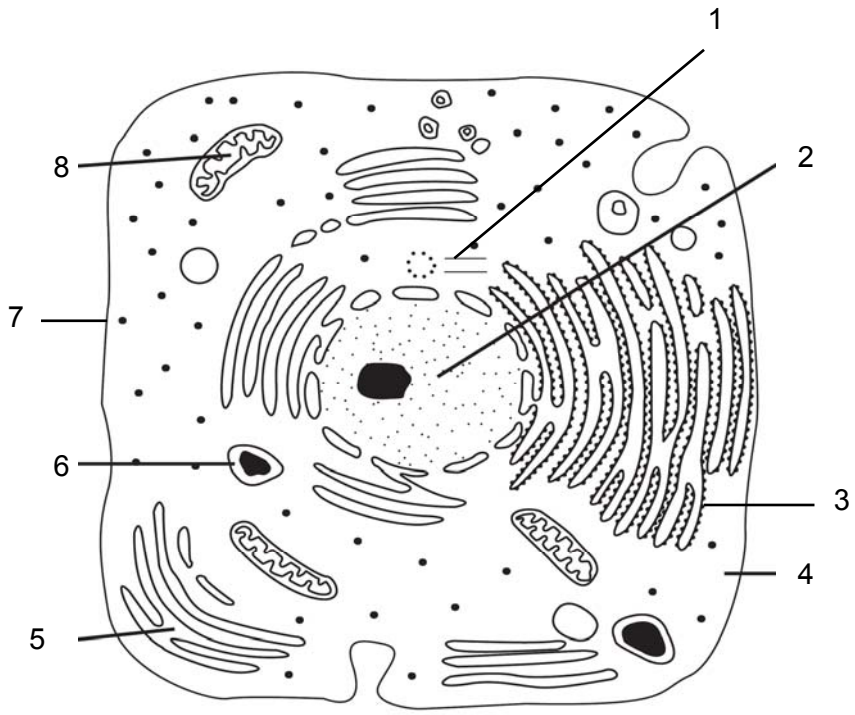
Each correct answer will score one mark. A mark will not be deducted for a wrong answer. Any rough working should be done in this booklet.

This document consists of **21** printed pages and **1** blank page.

[Turn over

Answer **all** questions in this section.

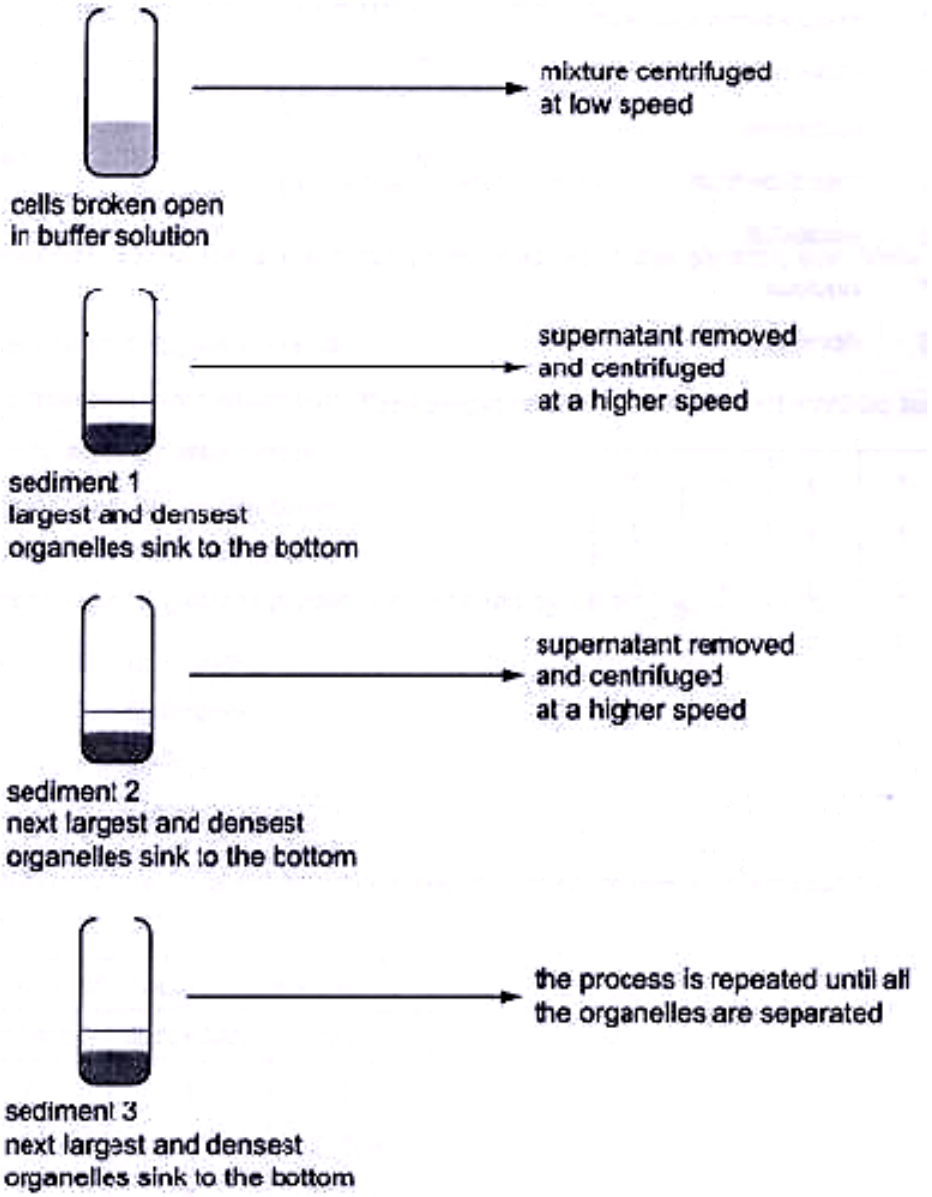
1 The diagram shows a drawing of an electron micrograph of an animal cell.



Which of the following describes the corresponding properties of the labelled structures?

	undergoes doubling during cell division	**contain enzymes**	**contains nucleic acids**
A	2	6, 8	2, 5, 8
B	2, 4, 8	5, 6, 8	2, 3, 8
C	1, 2, 8	2, 4, 6, 8	1, 2, 7, 8
D	1, 2	2, 3, 4, 5, 6	2, 3, 8

2 Fractionation is a process used to separate cell components according to their size and density. The diagram shows the main stages in fractionation of a plant cell.



DCPIP and buffer solution (containing glucose, fructose, sodium bicarbonate) were added to each of the sediments, and the mixtures were left in the dark for fifteen minutes. Sediment 2 caused the DCPIP to be reduced.

Which organelle present in Sediment 2 caused reduction of DCPIP?

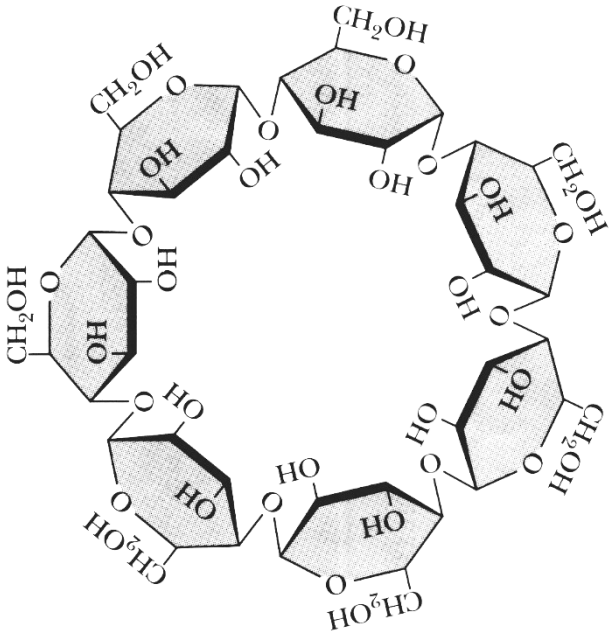
A chloroplast

B mitochondria

C nuclei

D ribosomes

3 The diagram shows a circular oligosaccharide molecule.



In which other molecule can a similar glycosidic bond be found?

A lactose

B maltose

C sucrose

D cellulose

4 Which statement is **TRUE** for phospholipids, but not for protein?

A It has hydrophilic and hydrophobic components.

B It is synthesized from non-identical sub-units.

C It can form a barrier to water soluble molecules.

D It is found in cell membranes.

5 The hydrolysis of triglycerides leads to _____.

1 formation of products which are more soluble in water than triglycerides.
2 formation of products which are less soluble in water than triglycerides.
3 an increase in pH.
4 a decrease in pH.

Choose the correct statements to complete the sentence.

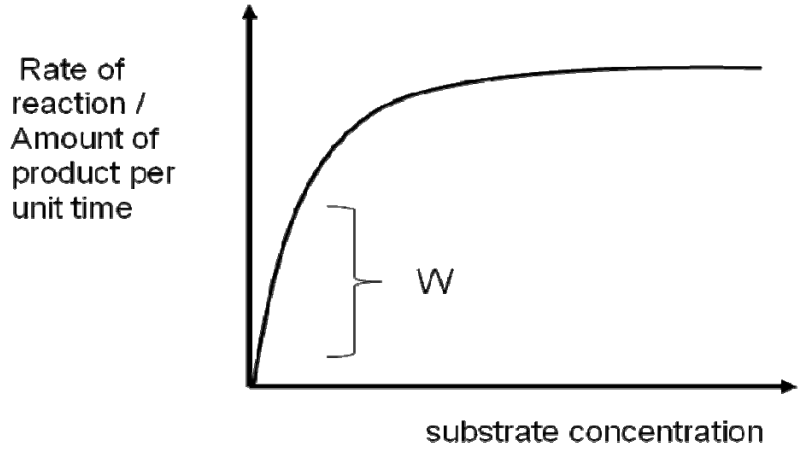
A 1 and 4

B 2 and 3

C 2 and 4

D 1 and 3

6 The graph below shows the rate of an enzyme catalyzed reaction occurring in lysosome with increasing substrate concentration. The reaction is carried out at 37°C and a pH of 4 for all substrate concentrations.



Which of the following(s) would result in a decrease in the rate of reaction at W?

1 Addition of co-factor
2 Decrease in temperature to 27°C
3 Increase in pH to 9
4 Addition of competitive inhibitor

A 1 and 4

B 2 and 3

C 2 , 3 and 4

D 1, 2, 3 and 4

7 Some inhibitors of enzyme reactions bind to the enzyme-substrate complex. Which statements about this type of inhibition are correct?

1 The active site changes shape.
2 The inhibitor is non-competitive.
3 The initial rate of reaction is reduced.
4 The maximum rate of reaction (Vmax) is increased.

A 1 and 2 only

B 1 and 3 only

C 2 and 3 only

D 2, 3, and 4 only

8 A 19-base pair long DNA molecule was analysed to find the number of nucleotide bases in each of the polynucleotide strands. Some of the results are shown.

	number of nucleotide bases			
	A	C	G	T
strand 1				4
strand 2		7		5

How many hydrogen bonds are present in this DNA molecule?

A 31 **B** 48 **C** 39 **D** 57

9 When DNA replicates, new nucleotides containing the common isotope of nitrogen (^{14}N) are used to build new nucleic acids.

In the laboratory, nucleotides can be synthesised using the heavy isotope of nitrogen (^{15}N). Cells grown in ^{14}N nucleotides for many generations are allowed to replicate once using these ^{15}N nucleotides, then twice more using ^{14}N nucleotides.

What will be the percentage of ^{14}N to ^{15}N nucleotides in the final molecules?

A 50% **B** 75% **C** 83% **D** 87.5%

10 An insertion mutation occurs in the gene coding for an enzyme, tyrosinase. Nucleotide sequences of the gene (the non-template strand), as well as the corresponding amino acid sequence of tyrosinase, are shown below.

	Wild-type allele	**ATG**	**AAG**	**TTG**	**GCT**	**AAA**	**TGG**	**GGA**
	Wild-type protein	**Met**	**Lys**	**Leu**	**Ala**	**Lys**	**Trp**	**Gly**
	Mutant allele	**ATG**	**AAG**	**TTA**	**GGC**	**TAA**	**ATG**	**GGG**
	Mutant protein	**Met**	**Lys**	**Leu**	**Gly**	**-**		

↑
Insertion of adenine

Which feature of the genetic code cannot be observed based on the information given?

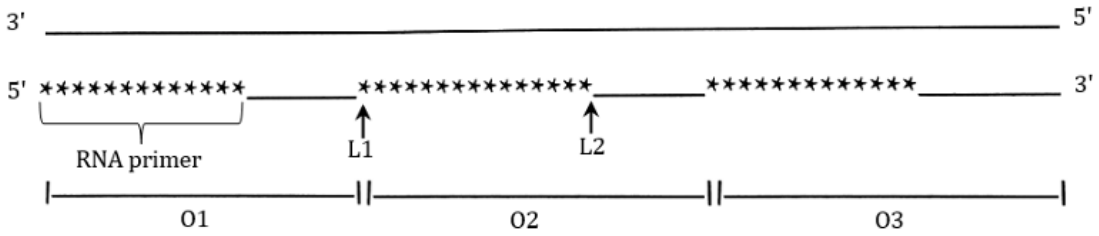
A The genetic code is degenerate.

B The genetic code is punctuated.

C The code is non-overlapping.

D The code is universal.

11 The diagram shows a DNA template with the lagging strand prior to the removal of the RNA primers.



Which row correctly shows the events taking place during the synthesis of the lagging strand?

	first Okazaki fragment synthesised	**site of phosphodiester bond formation catalysed by DNA ligase**
A	O1	L1
B	O1	L2
C	O3	L1
D	O3	L2

12 The following statements describe various steps in translation.

1 Large ribosomal subunit binds to mRNA.

2 Small ribosomal subunit binds to mRNA.

3 Anticodon of activated tRNA base pairs with codon AUG at the A site.

4 Anticodon of activated tRNA base pairs with codon AUG at the P site.

Which of the following statements describe the initiation phase?

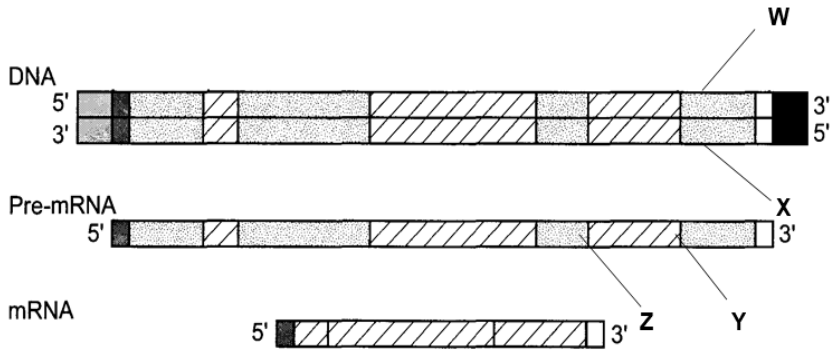
A 1 and 2 only

B 1, 2 and 3

C 1, 2 and 4

D All of the above

13 The diagram shows the processing of transcribed pre-mRNA in a eukaryotic cell.



Which of the following identifies structures **W** to **Z**?

	W	**X**	**Y**	**Z**
A	non-template strand	template strand	exon	intron
B	non-template strand	template strand	intron	exon
C	template strand	non-template strand	intron	exon
D	template strand	non-template strand	exon	intron

14 5’ – CAU – 3’ is a codon in mRNA that specifies the amino acid histidine (His) in position 58 in the α chain of haemoglobin. What is the corresponding anti-codon in tRNA?

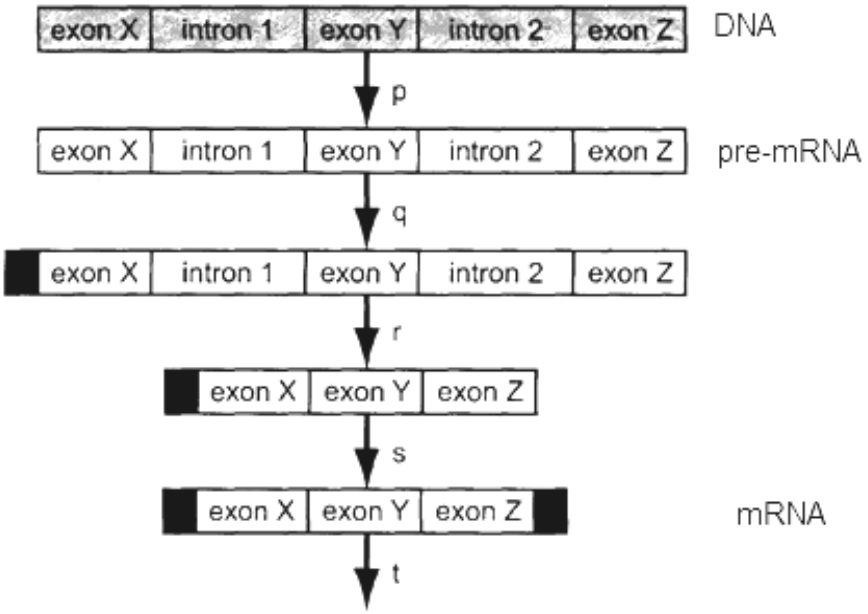
A 5’ – CAU – 3’

B 3’ – AUG – 5’

C 3’ – GUA – 5’

D 5’ – GUA – 3’

15 The diagram represents the processing of pre-messenger RNA.



During the process of pre-messenger RNA each of the listed events occurs:

1 capping

2 polyadenylation

3 splicing

4 transcription

5 translation

Which correctly identifies the processes **p**, **q**, **r**, **s** and **t**?

	p	**q**	**r**	**s**	**t**
A	5	1	3	2	4
B	4	1	3	2	5
C	5	2	1	3	4
D	4	2	1	3	5

16 Vincristine is a chemical which binds to the tubulin microtubules of the spindle and prevents them from functioning normally.

What effect would vincristine have on meiosis?

A Bivalents would fail to separate.

B Centromeres would fail to form.

C Centrioles would fail to move to the poles of the cell.

D Crossing over would fail to occur.

17 Below are descriptions of different gene mutations.

1 deletion toward the end of the code sequence

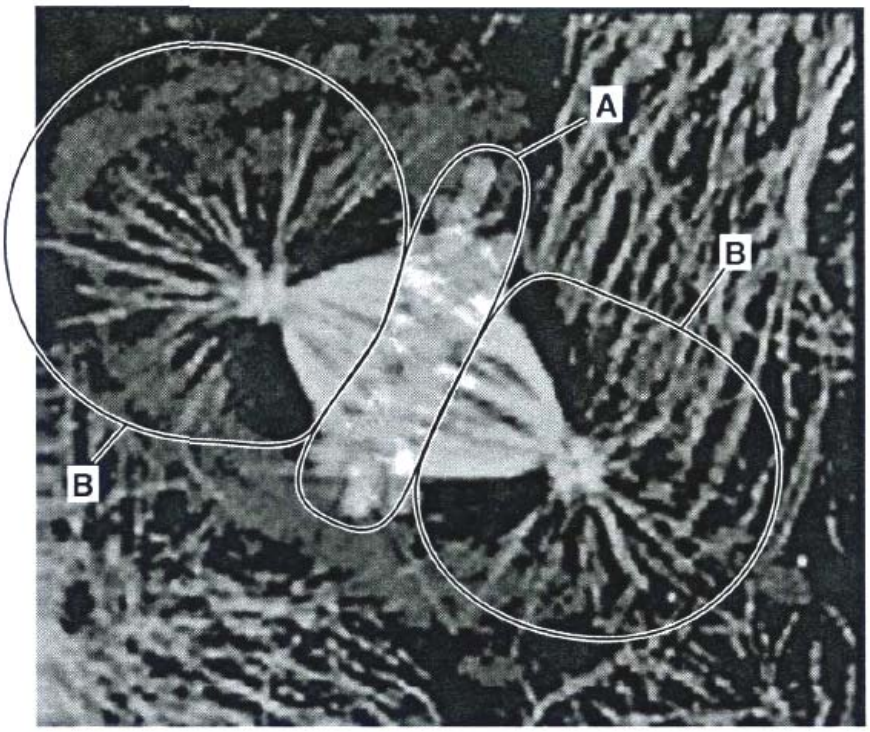
2 insertion in the middle of the code sequence

3 substitution close to the beginning of the code sequence

Which row correctly identifies the possible effects of these mutations on the synthesis of polypeptides?

	premature ending of a polypeptide	a non-functional polypeptide	a polypeptide with unchanged function	a polypeptide with a different function
A	2, 3 only	2, 3 only	1, 2, 3	2, 3 only
B	1, 2, 3	2 only	1, 3 only	1, 2 only
C	1, 3 only	1, 2, 3	3 only	1, 2, 3
D	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3

18 The figure below shows an immune-fluorescent image of a cell undergoing mitosis. In immune-fluorescence, specific antibodies with fluorescent dyes attached are used to target specific bio-molecules within a cell. In the figure, dark regions contained little fluorescent dye. The pale regions within A and B show the location of structures that have been stained with two fluorescent dyes.



Which of the following correctly explains the mitotic stage shown in the figure?

	Mitotic stage	Explanation
A	Metaphase	Structures in region B are the centrioles and they are at opposite poles.
B	Metaphase	Structures in region A are the chromosomes and they are seen aligned along the metaphase plate.
C	Anaphase	Structures in region A are the spindle fibres organised at the centrosome and are pulling the chromosomes in region B towards the pole.
D	Anaphase	Structures in region B are the spindle fibres and they are no longer attached at region A.

19 The diagram shows the banding pattern of two human chromosomes. **P** is a normal chromosome and **Q** carries a mutation.

What type of mutation occurred on chromosome **Q**?

A deletion of part of the chromosome

B duplication of part of the chromosome

C inversion of part of the chromosome

D translocation of part of another chromosome

20 Purple buds of the morning glory flower, *Ipomoea,* open into blue flowers. As the flower opens, the pH on the vacuoles of the flower epidermal cells increases and this results in a change of colour from purple to blue.

A mutant purple-flowered morning glory plant carries recessive alleles of a gene **B/b**, coding for a membrane-bound ion pump, and is unable to increase the pH of the vacuole.

Both normal blue flowers and mutant purple flowers have the same anthocyanin pigment, coded by the dominant allele of the gene **A/a**. Plants with **aa** cannot produce anthocyanin and they have white flowers.

The genes **A/a** and **B/b** are on different chromosomes.

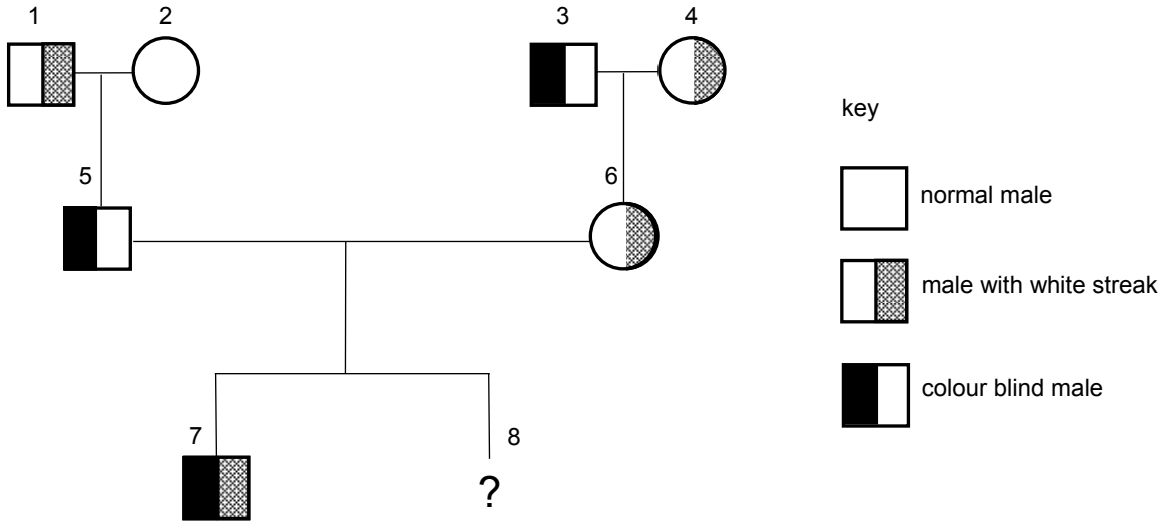
A blue-flowered morning glory plant was crossed with a purple-flowered plant. Their offspring consisted of plants which are blue-flowered, purple-flowered as well as white-flowered.

What were the genotypes of the blue-flowered and purple-flowered parents?

	Blue-flowered parent	**Purple-flowered parent**
A	AABB	AaBb
B	AaBb	Aabb
C	AaBB	Aabb
D	AABb	aabb

21 Colour blindness is controlled by a gene on the X chromosome. The allele for colour blindness, X^b, is recessive to the allele for normal colour vision, X^B. The gene controlling the presence of a white streak in the hair is not sex-linked, with the allele for the presence of a white streak, H, being dominant to the allele for the absence of a white streak, h.

The diagram shows a pedigree in which some of the individuals have colour blindness or have a white streak present in the hair.



What is the probability that individual 8 is a male with the same phenotype as individual 7?

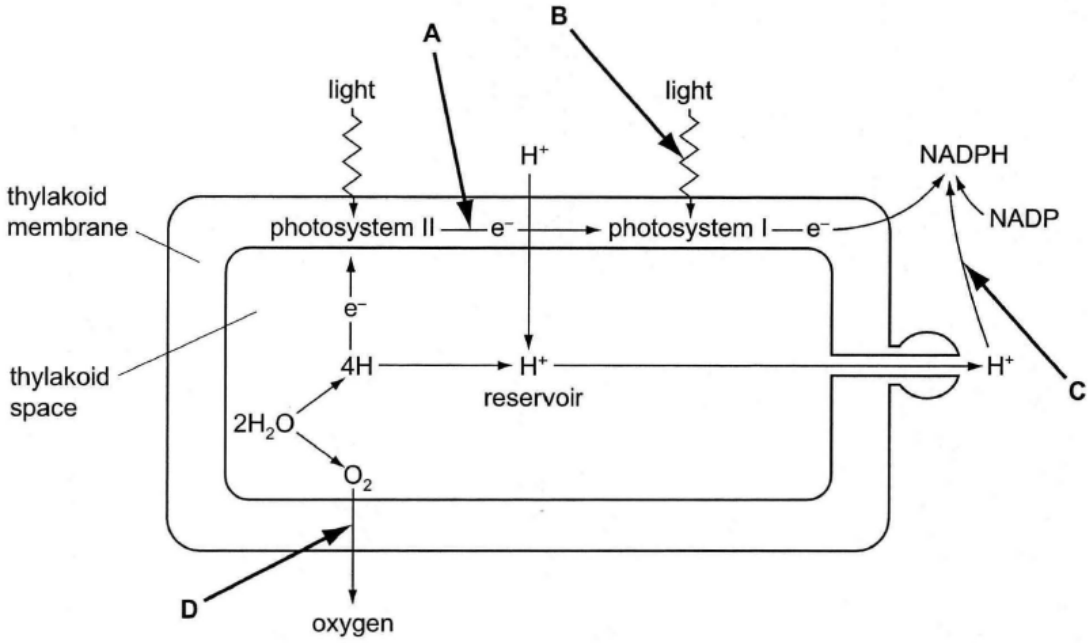
A 0.125

B 0.25

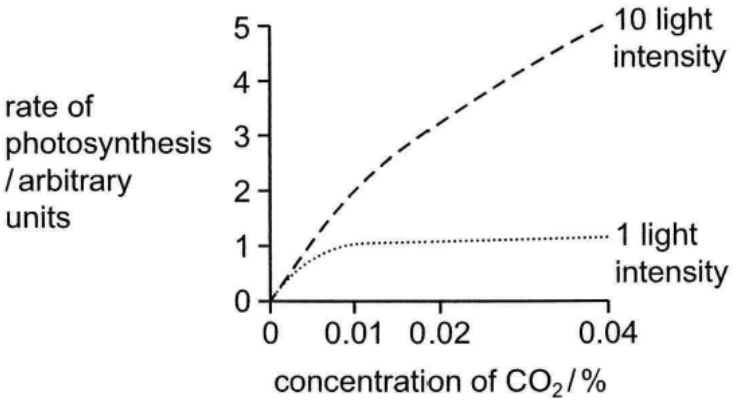
C 0.5

D 0.75

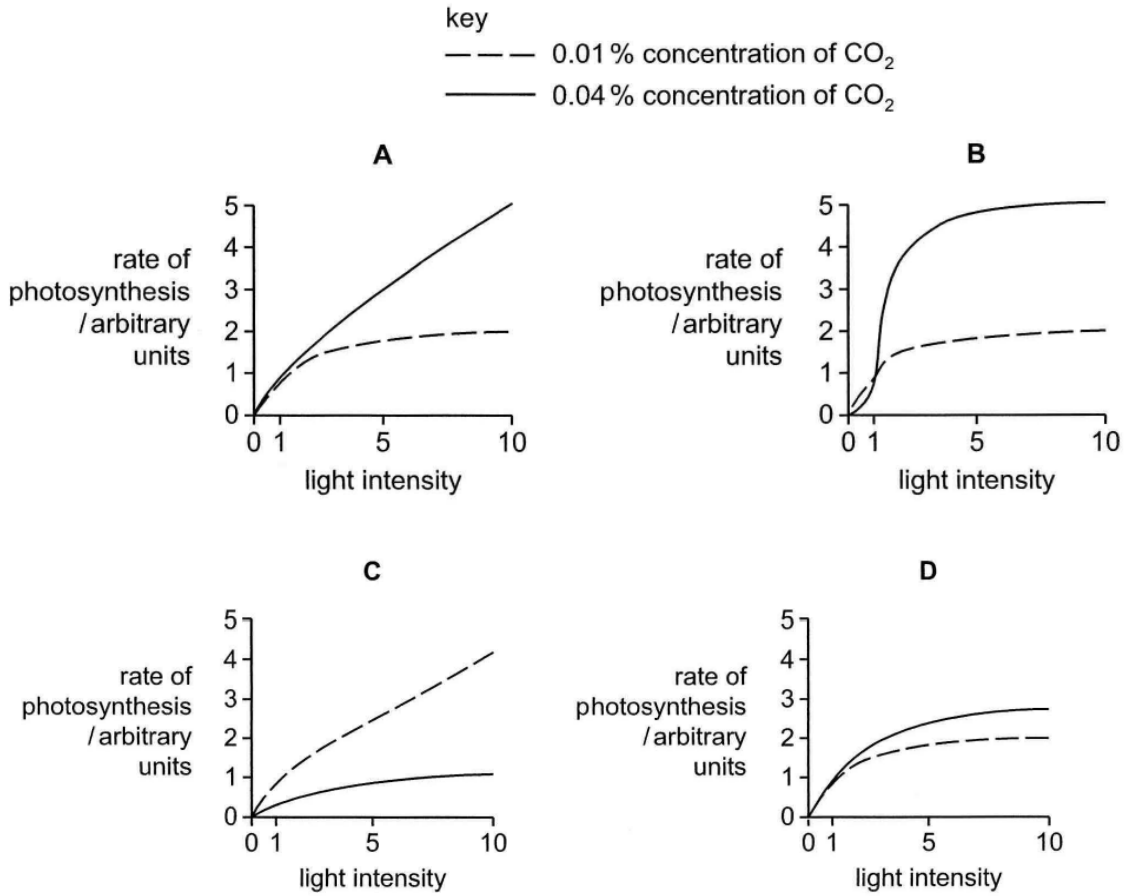
22 The diagram shows light dependent reactions of photosynthesis in a chloroplast. Where does the transfer of some of the energy required for the subsequent reduction of carbon dioxide occur?



23 The graph shows the effect of carbon dioxide concentration on the rate of photosynthesis, at two different light intensities.



Which graph correctly shows the effect of light intensity on the rate of photosynthesis, at two different carbon dioxide concentrations?



24 Which of the following will increase the pH of the chloroplast stroma?

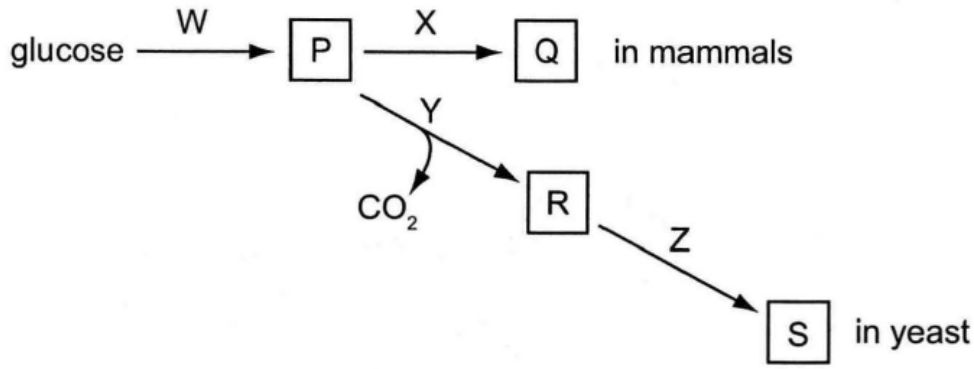
A Increasing O_2 concentration

B Increasing temperature

C Addition of electron transport chain inhibitor

D Addition of ATP synthase inhibitor

25 The diagram shows a summary of the processes of anaerobic respiration.



Which process(es) results in the formation of reduced NAD?

A W only

B X and Z only

C W, X and Y only

D W, X and Z only

26 Before the settlement of California in the 1800s, the elk population was very large. By about 1900 there were only a few dozen elk left. Owing to protection, there are now about 3000 elk living in a small number of isolated herds. Unfortunately, some of the elk in all the herds have difficulty grazing due to a shortened lower jaw.

1 The early settlers only hunted elk that could graze.

2 There was a mutation affecting jaw size.

3 There is random mating within each herd.

4 There was directional selection favouring short jaws

Which statements best explain this?

A 1 and 2

B 1 and 3

C 2 and 3

D 3 and 5

27 A piece of mouse DNA sequence is to be amplified by PCR.

5’ AGAGGGCGGT CCGTATCGGC CAATCTGCTC ACCACTAAGC 3’

Which pair of primers should be used?

A	5’ AGAGGGCGGT3’	5’ CGTTAGTGGT 3’
B	5’ CCGTATCGGC 3’	5’ TGGTGATTCG 3’
C	5’ CCGTATCGGC 3’	5’ GCTTAGTGGT 3’
D	5’ AGAGGGCGGT3’	5’ GCTTAGTGGT 3’

28 Some stages of a procedure involved in paternity testing are listed.

1 Alkali denatures DNA

2 Fragments migrate at different rate depending on the number of base pairs

3 Probes bind to DNA are identified using autoradiography

4 DNA samples are obtained from different individuals

5 Fragments are transferred from agarose gel to nylon membrane

6 Several STR loci are isolated using suitable restriction enzymes

Which sequence shows the correct order of these stages?

A 6 → 4 → 2 → 5 → 1 → 3

B 6 → 4 → 2 → 1 → 5 → 3

C 4 → 6 → 2 → 5 → 1 → 3

D 4 → 6 → 2 → 1 → 3 → 5

29 It has been found that stem cells transferred from the intestinal lining to the bone marrow produce all of the different types of blood cells instead of intestinal cells.

Which statement explains this?

A All stem cells are totipotent.

B Environmental factors change the expression of specific genes.

C Specific genes are destroyed by endonucleases.

D Specific genes are hidden by condensation of some chromosomes.

30 Which genetic modification would enable higher yield in crops grown on fertile soil in a tropical region?

A Drought tolerance

B Increased carbon fixation

C Increased vitamin A content

D Salt tolerance

END OF PAPER

BLANK PAGE

2017 Y6 Preliminary Exam H2
MCQ Answer Scheme

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

Name:		Index Number:		Class:	

DUNMAN HIGH SCHOOL
Preliminary Examination
Year 6

H1 BIOLOGY

8875/02

Paper 2 Structured and Free-Response Questions

14 September 2017
2 hours

Additional Materials: Writing paper

INSTRUCTIONS TO CANDIDATES:

DO NOT TURN THIS PAGE OVER UNTIL YOU ARE TOLD TO DO SO.

READ THESE NOTES CAREFULLY.

Section B Structured Questions

Answer **all** questions.

Write your answers on space provided in the Question Paper.

Section C Free-Response Questions

Answer **one** question. Your answer to Section C must be in continuous prose, where appropriate. Write your answers on the writing paper provided.

Answer each part (a) and (b) on a fresh piece of writing paper.

For Examiner's Use	
Section A [30]	
Section B [40]	
1	/ 7
2	/ 8
3	/ 5
4	/ 7
5	/ 6
6	/ 7
Section C [20]	
1 / 2	
Total [90]	

This document consists of **15** printed pages and **1** blank page.

[Turn over

Section B: Structured Questions (40 marks)
Answer **all** questions in this section.

For Examiner's use

Question 1

(a) **Fig. 1** shows replication of a part of the glucagon receptor gene.

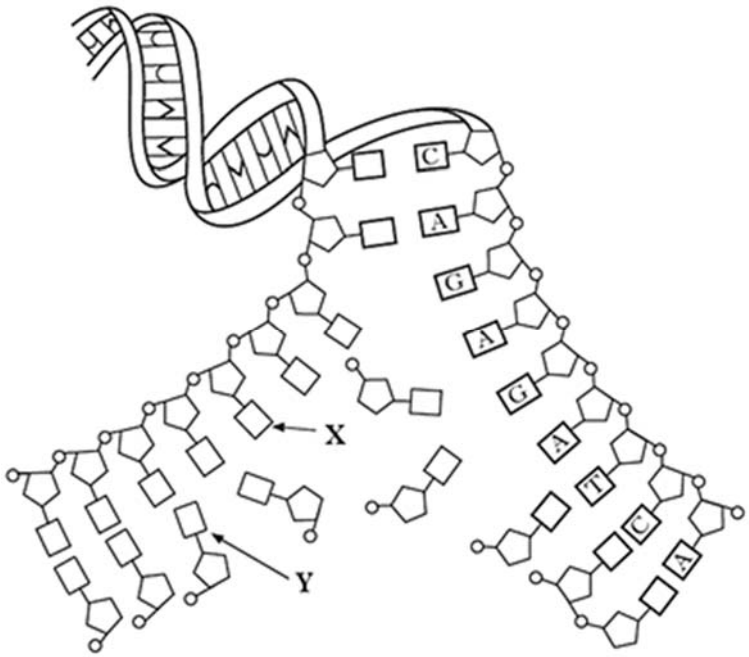


Fig. 1

(i) Name the bases labelled **X** and **Y** on **Fig. 1**. [1]

X

Y

(ii) Explain how **Fig. 1** shows semi-conservative replication DNA. [3]

(b) Contrast the elongation stage in DNA replication with translation. [3]

For Examiner's use

Total:[7]

For Examiner's use

Question 2

Fig. 2 shows the early development of a human embryo after fertilisation.

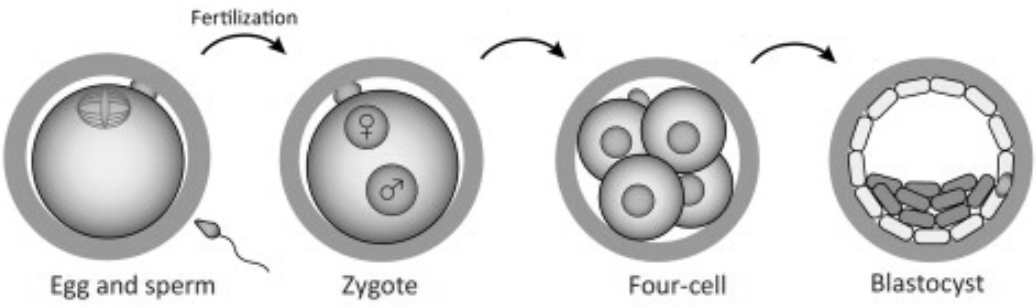
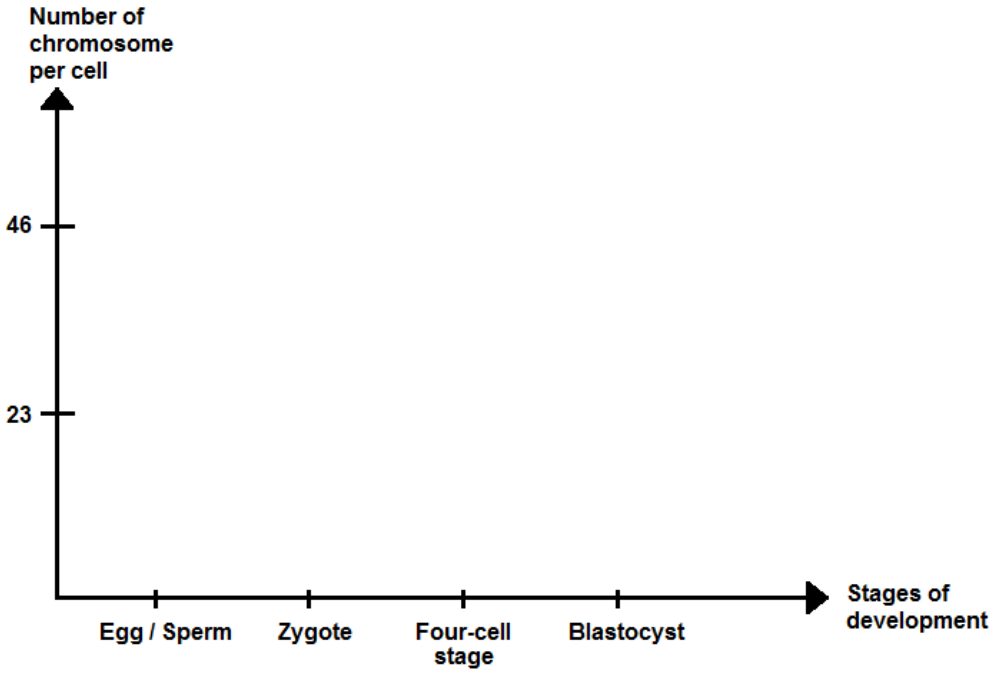


Fig. 2

(b) **(i)** Name the type of cell division undergone by the zygote to form the four-cell stage. [1]

(ii) Plot accurately, in the graph below, the number of chromosome per cell for the four stages of development. [1]



For Examiner's use

Hematopoietic stem cells divide ***asymmetrically*** to give specialized cells such as the red blood cells.

(b) (i) Explain the term "***asymmetrically***". [1]

(ii) How are hematopoietic stem cells different from their specialized cells? [2]

(c) Haemoglobin A (HbA) is the oxygen carrier protein that is found in normal red blood cells. HbS is found in sickle-shaped red blood cells.

Table 2.1

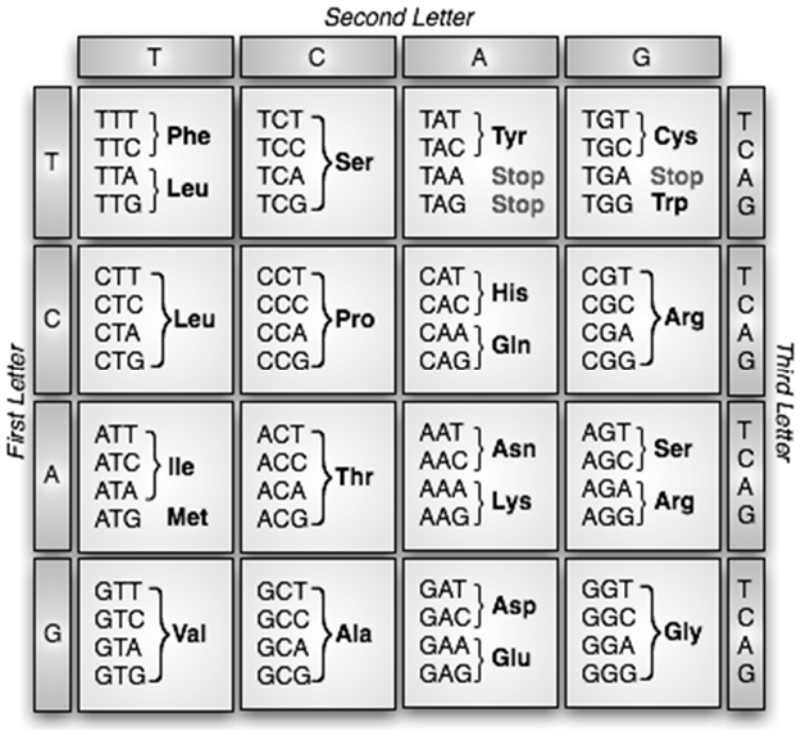
Hb A β globin	val – his – leu – thr – pro – glu – glu –lys…..
Hb S β globin	val – his – leu – thr – pro – val – glu –lys…..

(i) **Table 2.1** shows a segment of the HbA and HbS polypeptide sequence. Identify this mutation. [1]

For Examiner's use

Table 2.2 shows the DNA triplet code.

Table 2.2



(ii) With reference to **Table 2.1** and **2.2**, Explain the **minimum** number of mutation that resulted in HbS. [2]

Total: [8]

BLANK PAGE

For Examiner's use

Question 3

Cats possess a gene for producing tails. The tailless Manx phenotype in cats is produced by an allele that is lethal in the homozygous state. The Manx allele M^L severely interferes with normal spinal development. In heterozygotes (M^LM), this results in the absence of tail.

Female cats are homogametic while male cats are heterogametic. The gene for black/orange/tortoiseshell coat colour is located on X chromosome and has two alleles X^O and X^o. Table below shows the genotypes of cats of different colours.

X^oX^o, X^oY	Black coated female, male
X^OX^O, X^OY	Orange coated female, male
X^OX^o	Tortoiseshell (intermingled black and orange in fur) in female only

The table below shows the genotypes of two cats.

	Female cat	**Male cat**
Coat colour	Orange	black
tail	No tail	No tail
Genotype	$X^OX^OM^LM$	X^oYM^LM

Construct a genetic diagram to illustrate the outcome of the above cross on the next page. [5]

Answer Question 3 on this page.

For Examiner's use

Total: [5]

Question 4

For Examiner's use

In Lake Tanganyika in Africa, there are six species of fish of the genus Tropheus and a much larger number of distinctly coloured subspecies of each of the six species. Tropheus species are small fish that are confined to isolated rocky habitats around the shores of Lake Tanganyika.

The six species evolved during the primary radiation phase when the lake was first filled, about 1.25 million years ago. They arose from river dwelling ancestors and then filled all available niches in the lake.

Secondary radiations into the many subspecies occurred during the last 200 000 years. Sometime during this period, the water level in the lake fell, resulting in the formation of three separate lake basins. These basins persisted for many thousands of years before the water level rose again.

Fig. 4 shows an outline map of the lake and the location of the three temporary basins caused by lowering of lake levels.

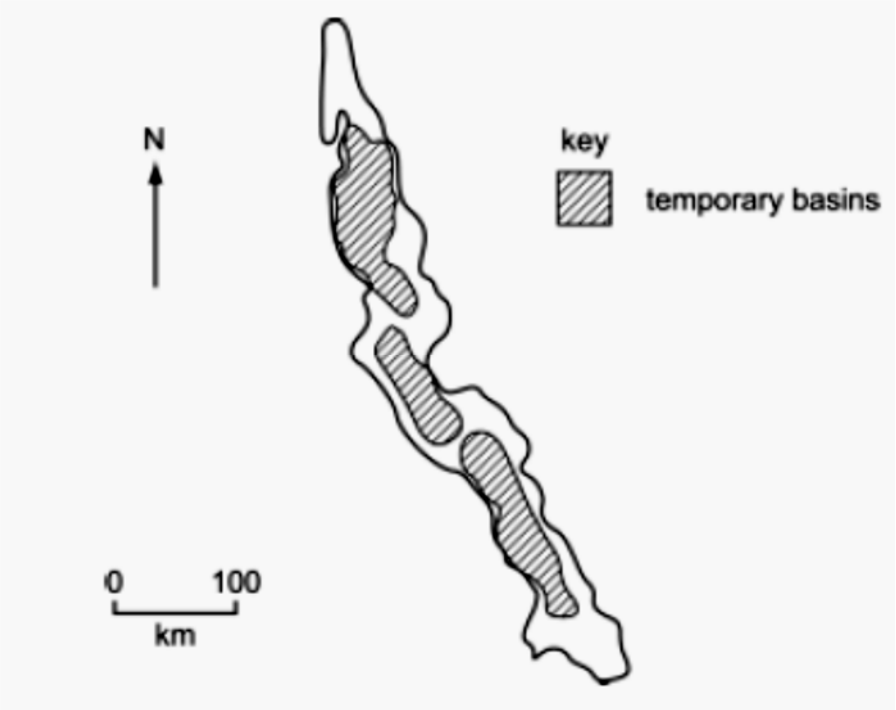


Fig. 4

For Examiner's use

(a) Explain how natural selection could have caused the evolution of the six closely related species in the primary radiation. [4]

(b) Outline how each type of homology (anatomical, embryological and molecular) supports Darwin's theory of descent with modification. [3]

Total:[7]

For Examiner's use

Question 5

Fig. 5.1 shows the pCMV6-XL5 plasmid. It is a plasmid with a multiple cloning site (MCS) that lies downstream of the CMV promoter. This plasmid can be inserted into both eukaryotic and prokaryotic host cells. The arrows denote the direction in which the genes are transcribed.

An artificially-synthesised human Growth hormone (hGH) gene with flanking HindIII restriction site sequences was created. The restriction sites for the restriction enzymes HindIII and SacI are shown in **Fig. 5.2**.

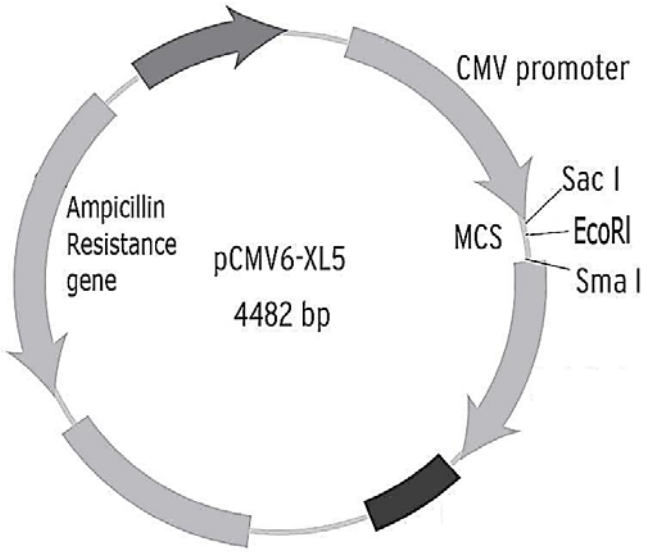


Fig. 5.1

HindIII

5′ . . . A A G C T T . . . 3′
3′ . . . T T C G A A . . . 5′

HindIII

SacI

5′ . . . G A G C T C . . . 3′
3′ . . . C T C G A G . . . 5′

SacI

▲ - point at which restriction enzymes cleave DNA.

Fig. 5.2

For Examiner's use

(a) With reference to **Fig. 5.1** and **Fig. 5.2**, explain how the hGH gene can be inserted into pCMV6-XL5. [3]

(b) The final step in determining the presence of the hGH gene involves the use of a radioactive gene probe.

Explain why there is a need to use a radioactive gene probe, instead of selecting using ampicillin. [2]

(c) State one problem of cloning human genes in bacteria. [1]

Total:[6]

Question 6

For Examiner's use

Scientists have identified the pectinase gene encoding an enzyme involved in the ripening of the tomatoes and have developed a genetic modification for the FlavrSavr tomatoes using an antisense RNA technology. During normal transcription, only one strand of a DNA is transcribed to mRNA. The complementary strand of DNA is the 'non-template' strand, which is not normally transcribed. By inserting a promoter at the end of a non-template sequence, thus forming an anti-mRNA gene, RNA transcription can occur from it. The sequence of events is shown **Fig. 6**.

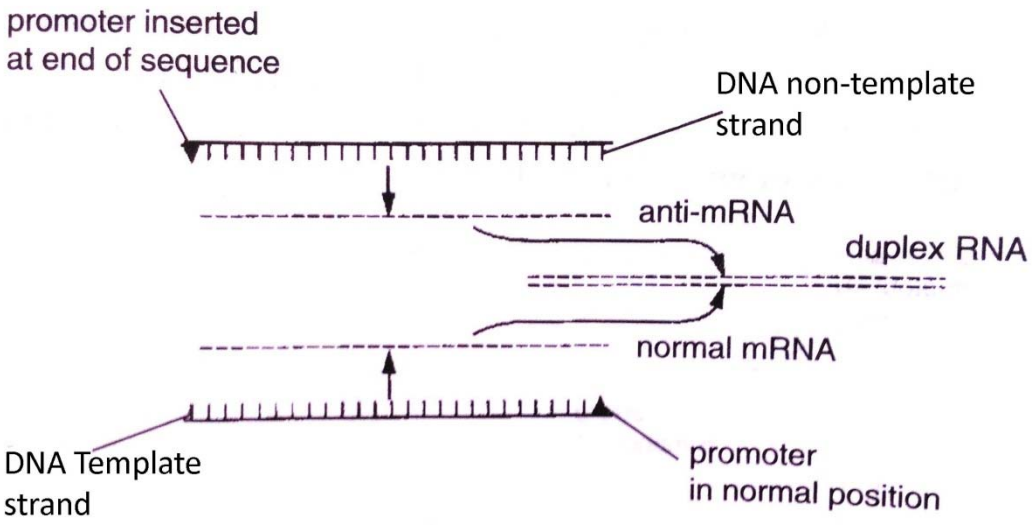


Fig. 6

(a) With reference to the **Fig. 6**, explain how duplex RNA is formed. [2]

For Examiner's use

(b) Explain how this genetic modification on the tomato plant benefits the farmers and merchants. [3]

(c) Outline the ethical implications of transgenic plants. [2]

Total: [7]

Section C: Free-Response Question (20 marks)

Answer only **one** question.
Write your answers on the writing paper provided.
Answer each part (a) and (b) on a fresh piece of writing paper.

Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.
Your answers must be in continuous prose, where appropriate.
Your answers must be set out in sections **(a)**, **(b)** etc., as indicated in the question.
A **NIL RETURN** is required.

Question 1

(a) Describe the various roles of RNA in eukaryotes. [10]

(b) Describe ATP synthesis in respiration. [10]

Total: [20]

OR

Question 2

(a) Describe the various bonds and their importance in carbohydrates. [10]

(b) Describe the differences between Calvin and Krebs cycles. [10]

Total: [20]

END OF PAPER

DUNMAN HIGH SCHOOL
PRELIMINARY EXAMINATION 2017
YEAR SIX
H1 BIOLOGY (8875)

Suggested Answers

Question 1
(a)(i)
X – Cytosine
Y – Thymine

(a)(ii)
- parental strand acts as template for the synthesis of the new strand
- parental strand CAGAGATCA will result in the newly synthesised strand with sequences GTCTCTAGT
- newly synthesised daughter DNA molecule consists of one original strand and one newly synthesised strand

(b)
- The enzyme required for elongation in DNA replication is DNA polymerase while the enzyme involved in translation is peptidyl transferase
- The bonds catalysed between subunits of monomers in DNA replication is phosphodiester bond while the bonds catalyzed for translation is peptide bonds
- The monomers used for DNA replication is deoxyribonucleotides while the monomers for translation is amino acids

Question 2
a(i)
Mitosis

a(ii)
1M correct plot
1M joining the dots with a straight line

(b) (i)
The parental stem cell divides to give 2 different cells. One remains as a stem cell while the other differentiate into a specialized cell

(b) (ii)
- Hematopoietic stem cell is undifferentiated while its specialised cells are differentiated to have a specific function / structure
- Stem cell can divide and renew itself indefinitely / without limit but red blood cells cannot divide

c(i)
missense mutation

c(ii)
- **1 nucleotide** change from A to U
- Changes the codon from GAA / GAG, coding for Glu, to GTA / GTG, coding for Val

Question 3

Parental phenotypes:	Orange, no tail female	x	Black, no tail male	
Parental genotype:	$X^{O}X^{O}M^{L}M$	x	$X^{o}YM^{L}M$	
Gametes formed:	$X^{O}M^{L}$ $X^{O}M$	x	$X^{o}M^{L}$ $X^{o}M$ YM^{L} YM	√

F_1 genotypes:

	$X^{o}M^{L}$	$X^{o}M$	YM^{L}	YM
$X^{O}M^{L}$	$X^{O}X^{o}M^{L}M^{L}$	$X^{O}X^{o}M^{L}M$	$X^{O}YM^{L}M^{L}$	$X^{O}YM^{L}M$
$X^{O}M$	$X^{O}X^{o}M^{L}M$	$X^{O}X^{o}MM$	$X^{O}YM^{L}M$	$X^{O}YMM$

√

√

F_1 genotypes: $X^{O}X^{o}M^{L}M^{L}$ (died) $2X^{O}X^{o}M^{L}M$ $X^{O}X^{o}MM$ $2X^{O}YM^{L}M$ $X^{O}YMM$ $X^{O}YM^{L}M^{L}$ (died)

√

F_1 phenotypes:	Tortoiseshell No tail female		Tortoiseshell **Normal** tail female		Orange No tail male		Orange **Normal** tail male
F_1 phenotypic ratio:	2	:	1	:	2	:	1

√

Question 4

(a)

- Variations in population due to random mutation resulting in different alleles;
- primary radiation phase, different niches in the lake with different selection pressure;
- fish with at selective advantage survive and reproduce viable offspring, passing on advantageous genes/alleles to the next generation;
- accumulation of many genetic changes over a long period of time to evolve into different species;
- geographical isolation/ accept hundreds of km apart thus no gene flow between different populations;

4 max

(b)

- Anatomy homology can be used to support Darwin's Theory by comparing anatomy, observing vestigial organ and Imperfect adaptations. These physical traits can used to hypothesize the relatedness of species

- Comparative embryology reveals additional anatomical homologies not visible in adult organisms. All vertebrate embryos look very similar during the earlier stages of development, including having gill pouches and tails

- In Molecular homology, as the descendents evolve independently, more and more differences are accumulated in their DNA. Two species that are more distantly related have more differences in their DNA whereas two species that are more closely related share a more similarities in their DNA

Question 5

(a)

- Cleave gene using HindIII to generate sticky ends
- Cleave plasmid with SacI to generate complementary sticky ends to the HindIII sticky ends flanking the hGH gene
- Mix the cleaved gene and plasmid together and add DNA ligase to seal the nicks / form phosphodiester bond between gene and plasmid

(b)

- Gene probe identifies bacterial colonies that contain hGH gene
- However, ampicillin selects for all transformed bacteria containing wither re-annealed plasmid or recombinant plasmid

(c)

- Introns in human gene which cannot be spliced out in bacteria and resulting in the protein produced to be non-functional
- Lack of organelles in bacteria such as the Golgi apparatus for final chemical modification of proteins such as glycosylation / phosphorylation resulting in the protein produced to be non-functional

Question 6

(a)

- DNA non-template strand with the inserted promoter is transcribed in the GM tomato plant to form the anti-mRNA
- anti-mRNA and the normal mRNA binds via hydrogen bonds between complementary base pairs of A-U and G-C to form duplex RNA

(b)

- The pectin in the GM tomato plant breaks down more slowly
- Hence the tomatoes can be harvested later to allow production of bigger / better quality fruits for sale for increased profit
- The delay in ripening also allowed the tomatoes to have a longer shelf-life so that they can be sold for more profit

(c)

- Animal genes may be introduced to plant genomes, leading to concern of vegetarians and some religious groups which followers are not allowed to consume certain animals
- GM plants grown as crops may lead to consumers having allergies as foreign proteins are produced in the plants, companies need to label their GM crops for consumers to make informed choices
- development and growing of GM crops requires large amounts of funds and technology which only large companies have access to, monopolizing agriculture, resulting in inequality against small scale farmers
- AVP;

2 max

Essay

1a Describe the various roles of RNA in eukaryotes. [10]

mRNA

1. role in transferring genetic information from nucleus to cytoplasm
2. DNA triplet codes are carried in the form of codons in mRNA
3. Each codon corresponds to one amino acid

tRNA

4. role in carrying the corresponding amino acid to ribosome to match with the condon in translation
5. 3'end binds to corresponding amino acid via covalent bond Attached by to amino acid by aminoacyl tRNA synthetase
6. Contains anti-codon which is complementary to codon on mRNA for translation

rRNA

7. Role in forming ribosome for translation
8. makes up peptidyl transferase which catalysed peptide bond between adjacent amino acid
9. align tRNA and mRNA in ribosome

RNA primer

10. providing 3'OH group for addition of complementary deoxyribonucleotide to growing DNA strand
11. Synthesize by primase

RNA template in telomerase

12. Role in lengthening telomere
13. Expressed in stem cells

1b Describe ATP synthesis in respiration. [10]

1. ATP is synthesized by substrate level photophosphorylation and oxidative phosphorylation

2. ATP is synthesized during glycolysis, in the cytoplasm, and during Kreb cycle in the mitochondrial matrix
3. 4 ATP / 2 nett ATP is synthesized per glucose molecule during glycolysis
4. In anaerobic respiration, ATP is synthesized only by substrate level phosphorylation in glycolysis
5. In the Kreb cycle, 2 ATP is synthesized per glucose when succinyl-CoA is converted to succinate

6. NAD and FAD are reduced during glycolysis, link reaction and Kreb cycle
7. Reduced NAD and FAD donates electrons to the electron transport chain on the inner mitochondrial membrane
8. As electrons are transported along a series of electron carriers of progressively lower energy levels, some energy is used to pump H^+ from the matrix to the intermembrane space
9. This creates a proton gradient across the inner mitochondrial membrane, driving protons to diffuse down its concentration gradient via ATP synthase on the inner mitochondrial membrane.
10. ATP synthase harness the proton motive force for phosphorylation of ADP to ATP
11. O_2 is the final electron carrier of the electron transport chain.
12. 3 ATP is synthesized per reduced NAD and 2 ATP per reduced FAD.

2a Describe the various bonds and their importance in carbohydrates. [10]

1. Form glycosidic bond by condensation with elimination of one water molecule

α(1→4) glycosidic bond
2. Form between between anomeric carbon 1 of α glucose and carbon 4 of the other
3. Chain coils helically
4. resulting in a more compact shape for storage

hydrogen bond
5. intra-chain H-bonding between hydroxyl groups helps stabilise helical structure

α(1→6) glycosidic bond
6. occurs at branch points
7. more compact for storage

β(1→4) glycosidic bond
8. form between β glucose which has180º rotation of alternating glucose residues
9. forms linear structure of cellulose chain

hydrogen bond
10. Hydroxyl groups project outwards, alternately from both sides of each chain, allowing for the formation of hydrogen bonds between adjacent chains, thus establishing a rigid cross-linking between the chains.
11. great tensile strength in cell wall

2b Describe the differences between Calvin and Krebs cycles. [10]

Marking Point		Krebs cycle	Calvin cycle
1	Location	Mitochondrial matrix	Chloroplast stroma
2	Substrate	Acetyl-CoA and oxaloacetate combines to form citrate	CO_2 and Ribulose bisphosphate (RuBP)
3	Products	Each glucose molecule gives rise to: 6 NADH 2 $FADH_2$ 2 ATP 4 CO_2	For every 3 molecules of CO_2 that enter the cycle, one triose phosphate / G3P is made
4	Regenerated / Starting material	Oxaloacetate is the starting material that is eventually regenerated	Ribulose bisphosphate (RuBP) is the starting material that is eventually regenerated
5, 6	ATP	Produced via susbstrate level phosphorylation	Used in reduction of glycerate-3-phosphate where energy Is required through hydrolysis of ATP
7, 8	Electron carriers / donors	Use NAD^+ and FAD for the oxidation of the intermediates of the cycle by serving as electron acceptors	Uses NADPH / reduced $NADP^+$ to reduce glycerate-3-phosphate to triose phosphate by serving as electron donors
9	Overall	Catabolic	Anabolic
10, 11	Role of CO_2	CO_2 is released as a result of decarboxylation reactions	Required for carbon fixation. CO_2 is used to convert Ribulose bisphosphate (RuBP) to form an unstable 6C compound that breaks down to form glycerate-3-phosphate
12	Role of O_2	Occurs only when O_2 is present	Does not require O_2