Name:		Index Number:		Class:	

DUNMAN HIGH SCHOOL
Preliminary Examination
Year 6

H2 BIOLOGY

9744/01

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.

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.

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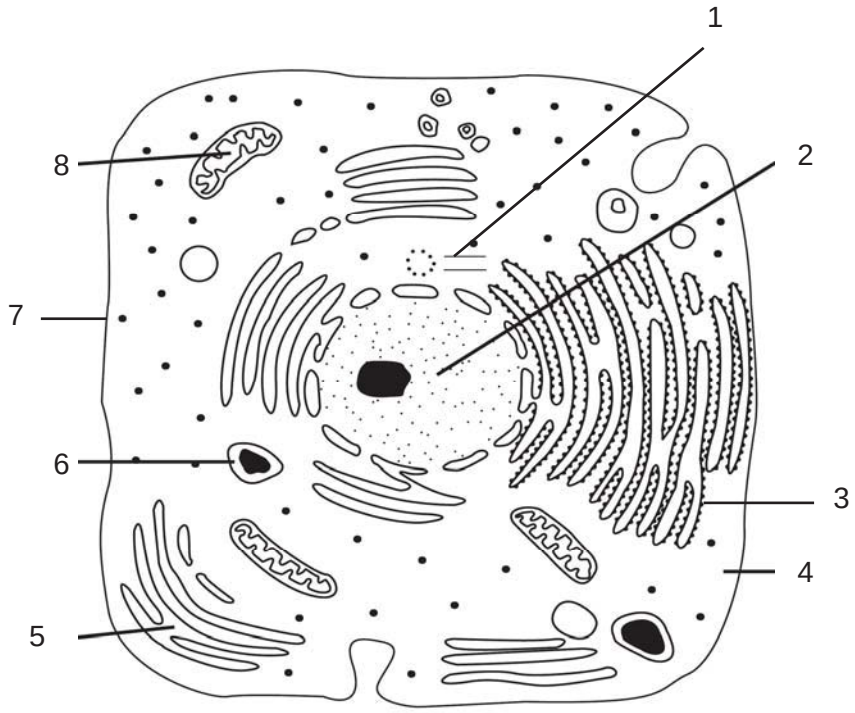
Multiple Choice Questions (30 marks)
Answer **all** questions in this section.

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

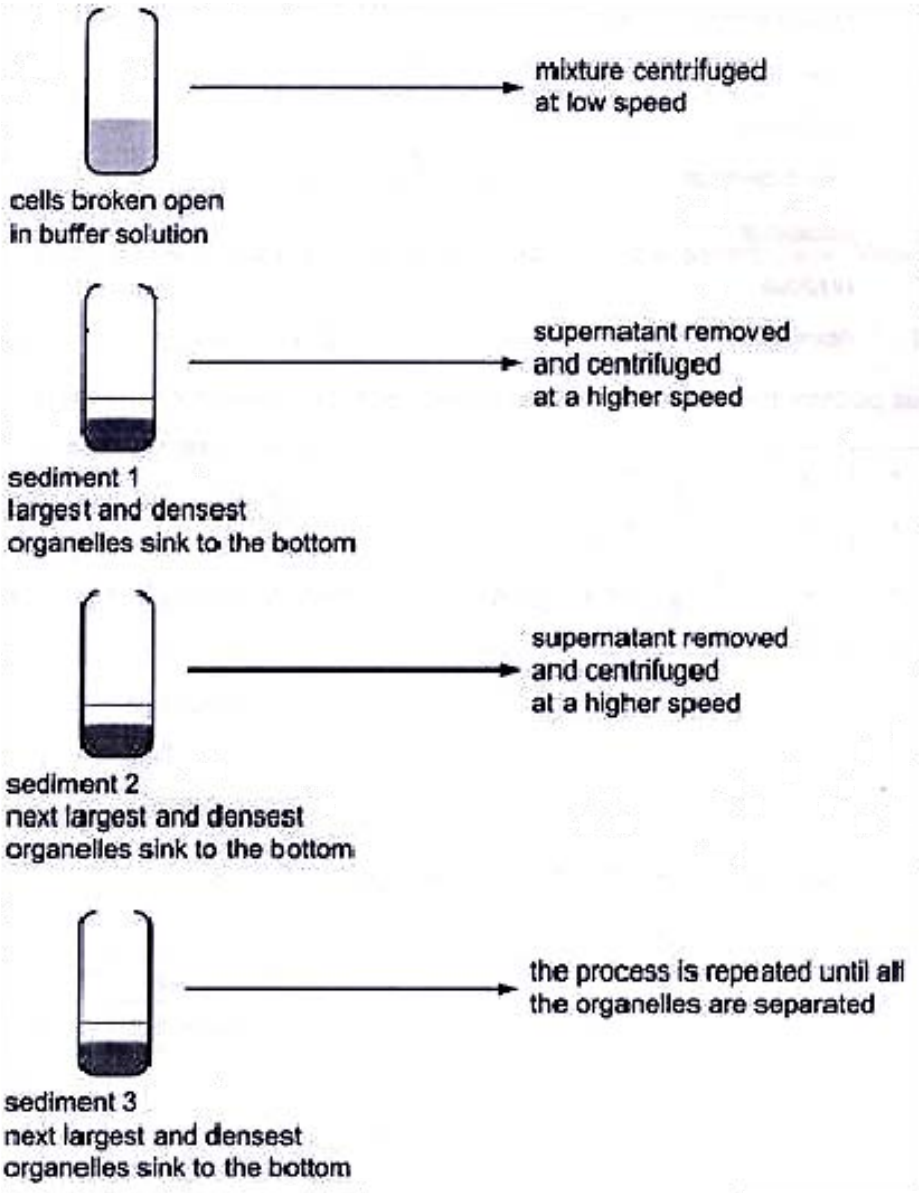
A It has hydrophilic and hydrophobic components.

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.

3 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 exposed to light for fifteen minutes. Sediment 2 caused the DCPIP to be reduced.

Which organelle present in Sediment 2 caused reduction of DCPIP?

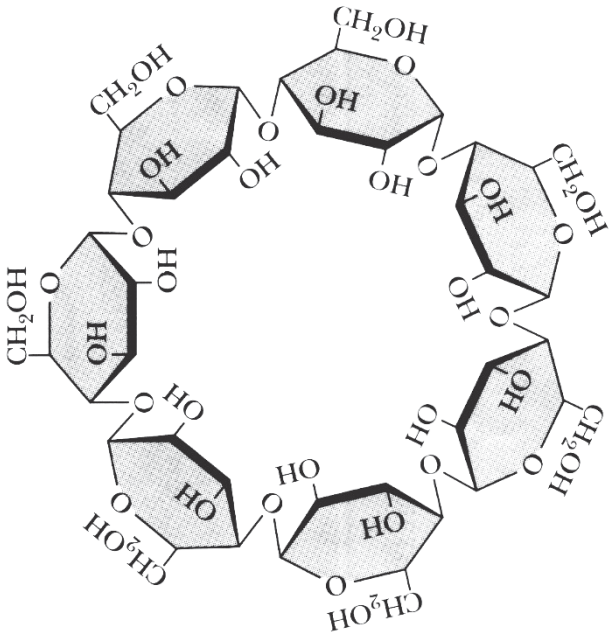
A chloroplast

B mitochondria

C chloroplast and mitochondria

D ribosomes

4 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

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.

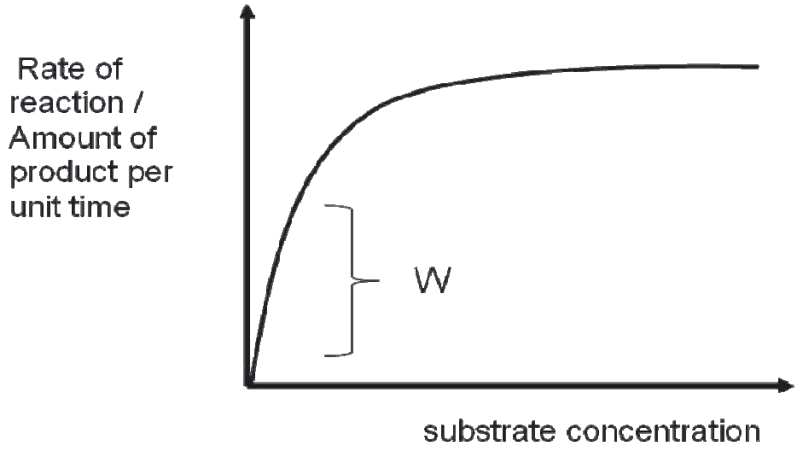
A 1 and 4

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 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.

9 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

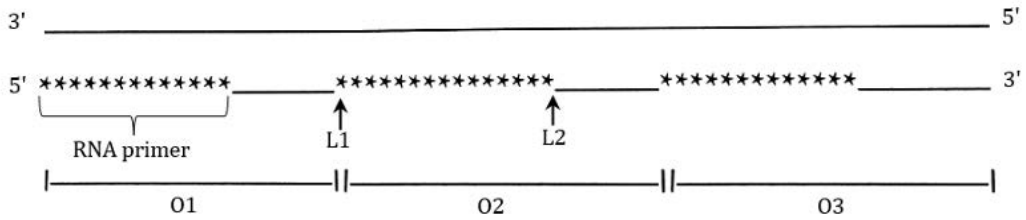
10 When DNA replicates, new nucleotides containing the common isotope of nitrogen (^{14}N) are used to build new nucleic acids.

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 nucleotides in the final molecules?

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

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 *Pithovirus* was recently discovered and classified as a species of giant virus. It is approximately 1.5 μm in length, larger than the smallest known eukaryotic cell and larger than any known giant virus. It carries double stranded DNA and replicates in the cytoplasm of amoeba, a single cell animal. It carries the genes for transcribing DNA to RNA and genes required for protein synthesis.

Which of the following explains why this organism was classified as a virus?

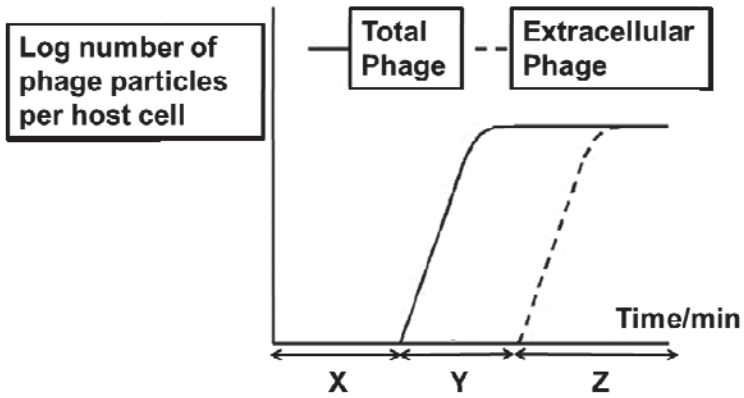
A It is only able to replicate within amoeba.

B It is too large to be known as a eukaryotic cell.

C It carries double stranded DNA, similar to bacteriophages.

D Similar to HIV and influenza virus, it carries enzymes that transcribes its genome.

14 The figure below shows a growth cycle of a T4 phage.



Which of the following statements about **X**, **Y** and **Z** of the growth cycle is correct?

A **Y** is the period where there is just active viral DNA replication and protein production.

B **X** is the eclipse period where the phage just infected the host cell.

C **X** corresponds to the period where the phage exists as a prophage.

D Period **Z** will correspond to the death of host cells.

15 When trypsin converts chymotrypsinogen to chymotrypsin, some molecules of chymotrypsin bind to a repressor, which in turn binds to the operator and prevents further transcription of trypsin gene. This is most similar to which of the following operons?

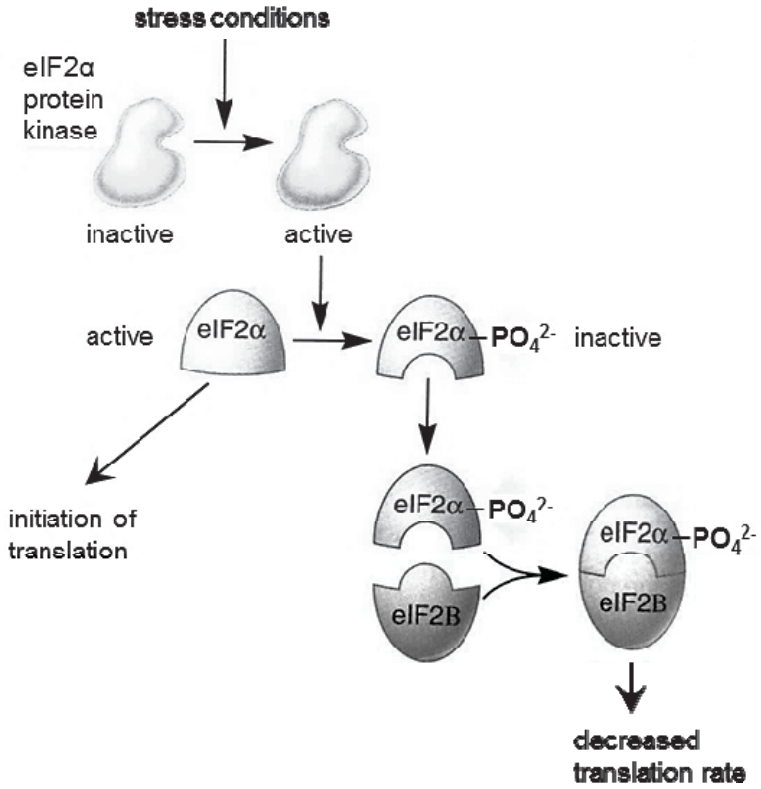
A trp operon during lack of tryptophan

B trp operon during abundance of tryptophan

C lac operon during lack of lactose

D lac operon during abundance of lactose

16 The diagram shows a mechanism by which gene expression is controlled during translation.



Which statements are correct?

1 Phosphorylation by eIF2α protein kinase changes the conformation of and activates eIF2α.

2 The concentration of eIF2B affects the rate of translation by inhibiting translation initiation.

3 This regulation results in decreased rate of mRNA translation under stress conditions.

4 The eIF2α-eIF2B complex is recognised by proteasomes for selective degradation due to the presence of the phosphate group.

A 1 and 2

B 1 and 4

C 2 and 3

D 3 and 4

17 The table compares the genomes of various organisms.

organism	classification	number of chromosomes	size of genome / Million base pairs	approximate number of protein-coding genes
Haemophilus influenzae	bacteria	1	1.8	1700
Saccharomyces cerevisiae (yeast)	eukarya	16	12.1	5900
Drosophila melanogaster (fruit fly)	eukarya	4	180	13000
Oryza sativa (rice)	eukarya	12	440	50000
Canis familiaris (dog)	eukarya	39	2400	19000
Homo sapiens (human)	eukarya	23	3000	19000

Which statement can be inferred from the table?

A On average, each gene in *Haemophilus influenzae* is about 1000 base pairs.

B On average, each gene in *Saccharomyces cerevisiae* is about 2000 base pairs.

C The more chromosomes there are in an organism, the larger the genome size.

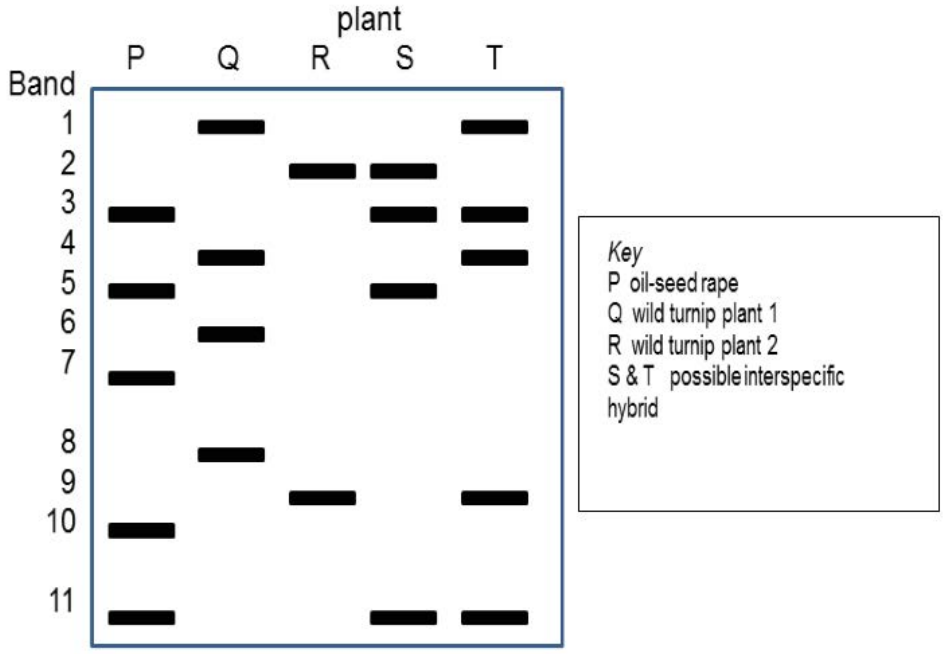
D The difference in the number of genes between *Canis familiaris* and *Homo sapiens* is due to the difference in size of genome.

18 Two populations of wild turnip growing next to large fields of a cultivar of oil-seed rape were studied. Seeds were collected from these plants and their DNA analysed using gel electrophoresis.

Plants S and T were suspected to be interspecies hybrids of oil-seed rape (P), and wild turnip plant 1 (Q) or wild turnip plant 2 (R).

Using the key provided below, determine

(i) whether plants S and/or T are interspecific hybrids and
(ii) the parental plants they are derived from



	(i) Interspecific hybrid	(ii) Parent plants
A	Both S and T	S: P x R T: P x Q
B	Both S and T	S: P x Q T: P x R
C	T only	Q x R
D	S only	P x R

19 Yeast cells without a *cdc25* gene cannot divide. This gene is active throughout the cell cycle, steadily building up the concentration of a protein, p80cdc25. This protein activates a kinase which regulates other proteins involved in cell division, but does not seem to affect other cell processes. When the p80cdc25 protein reaches a critical concentration, mitosis starts.

Which changes will be seen if p80cdc25 is produced at a faster rate than usual?

1 faster cell cycle

2 slower cell cycle

3 smaller cells

4 larger cells

A 1 and 3

B 1 and 4

C 2 and 3

D 2 and 4

20 Observations of cancer development show the following.

- Control genes code for the synthesis of proteins that act at different points of the cell cycle to promote or block its completion.
- There are a number of genes involved in the control of cell division.
- The risk of cancer developing increases with age.
- Cancer cells no longer respond to signals that regulate cell division and growth of most cells.

Which statement could explain why cancer occurs?

A Mutated alleles of control genes produce proteins that inhibit the proteins produced by the normal alleles of these genes.

B Mutation of an allele of any of the genes involved in the cell cycle allows faulty cells to be replicated leading to a tumour.

C Mutations of control genes that accumulate in a cell over time slow down the cell cycle.

D Mutations of genes that code for cell surface receptors prevent the cell from receiving signals that stimulate cell division.

21 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.

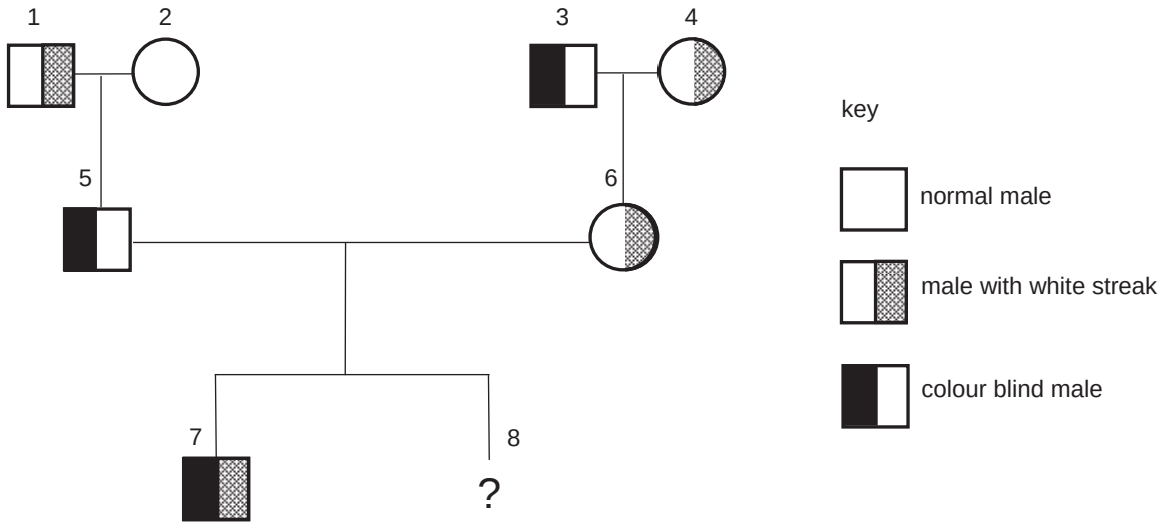
A blue-flowered morning glory plant was crossed with a purple-flowered plant. Their offspring consisted of plants which are blue-flowered, purple-flowered as well as white-flowered.

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

22 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?

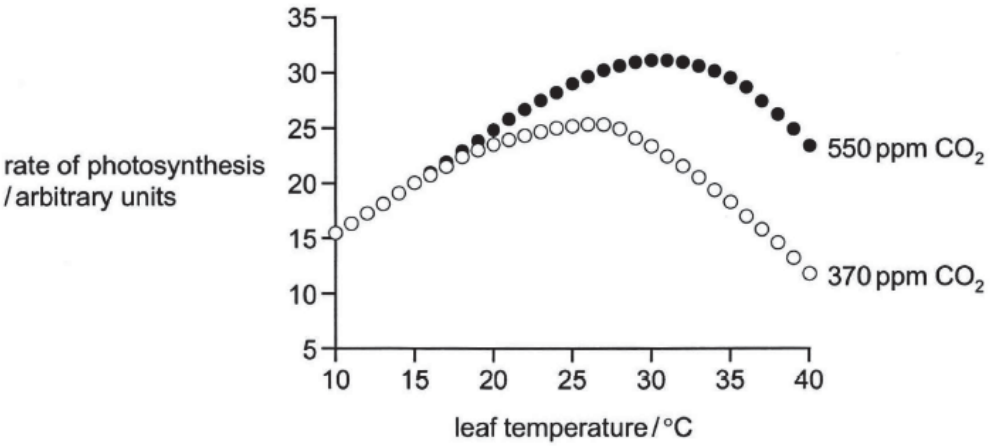
A 0.125

B 0.25

C 0.5

D 0.75

23 The graph shows the results of increased concentrations of carbon dioxide on soy bean photosynthesis at various leaf temperatures. Carbon dioxide concentration is measured in ppm (parts per million). Light intensity was at an optimum level.



Which conclusion concerning the data in the graph is valid?

A At all temperatures up to 15ºC, carbon dioxide concentration is limiting. Above 15ºC, temperature becomes the limiting factor.

B Supplementing plants with carbon dioxide is only effective at temperatures above 25ºC.

C The photosynthetic rate obtained at the optimum temperature for 370ppm CO_2 could be achieved at a temperature 5ºC lower using an increased concentration of CO_2.

D When light intensity and temperature are limiting, increased carbon dioxide concentration increases the rate of photosynthesis.

24 Some apples can be stored in controlled atmospheric conditions for up to a year. Taste and texture are maintained by using conditions that reduce the production of a fruit-ripening plant hormone while limiting the build-up of ethanol. Ethanol damages the fruit.

The storage conditions needed include low temperature (1ºC), high carbon dioxide concentration (1.2%) and low oxygen concentration (0.9%).

Why are these conditions needed?

1 Low oxygen concentration favours anaerobic respiration.

2 Enzyme activity is reduced.

3 Conversion of sugar to ethanol is minimised.

4 High carbon dioxide concentration promotes photosynthesis.

A 1, 2 and 3

B 1, 2 and 4

C 2 and 3 only

D 3 and 4 only

25 The concentration of second messenger is regulated during cell signalling process.

Which of the following statements support cAMP as an effective second messenger?

1 Activated adenyl cyclase converts ATP to cAMP.

2 Adenyl cyclase synthesizes many cAMP molecules.

3 cAMP is soluble in the nucleus.

4 Phosphodiesterase breakdown cAMP to AMP.

A 2 and 3 only

B 1 and 2 only

C 1, 2 and 4 only

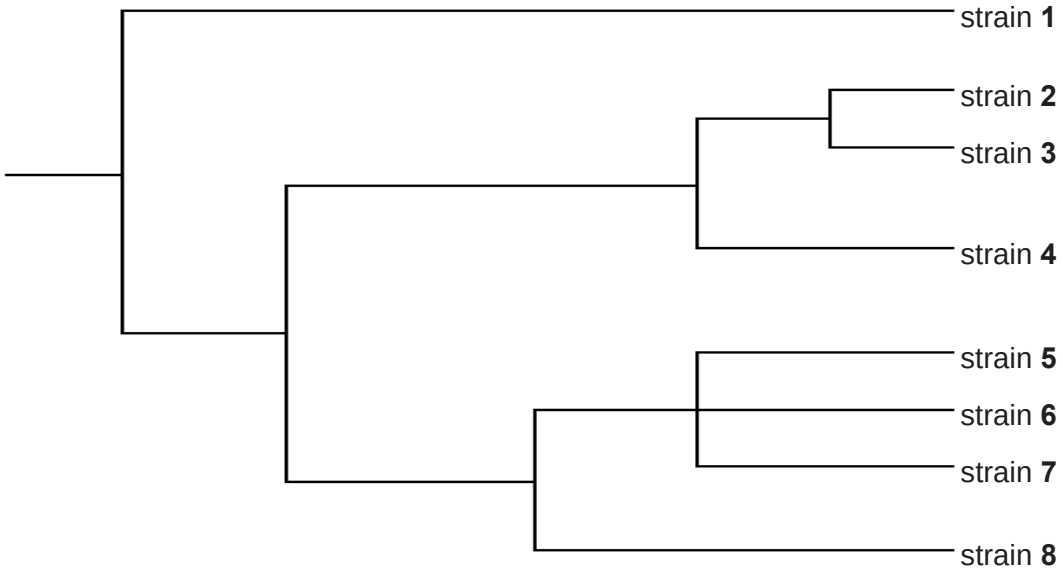
D 1, 3 and 4 only

26 In humans, Severe Acute Respiratory Syndrome (SARS) is a serious form of pneumonia. SARS is caused by a coronavirus that was first identified in 2003.

Scientists suspected that the virus had been transmitted to humans from some other animal. Testing was completed on several animal species. Strains of the coronavirus similar to those found in humans were identified in different species of horseshoe bats (genus *Rhinolophus*) and palm civets (*Paguma larvata*). Samples were taken from the different sources and the virus's RNA from each sample was sequenced.

The molecular information enabled the scientists to draw an evolutionary tree for different strains of the coronavirus.

The following evolutionary tree was drawn. Strain **7** is found in palm civets, and strains 5 and **6** in humans. All other strains are found in different species of horseshoe bats.



Which suggestion could provide an explanation for the evolution of strains **5**, **6** and **7**?

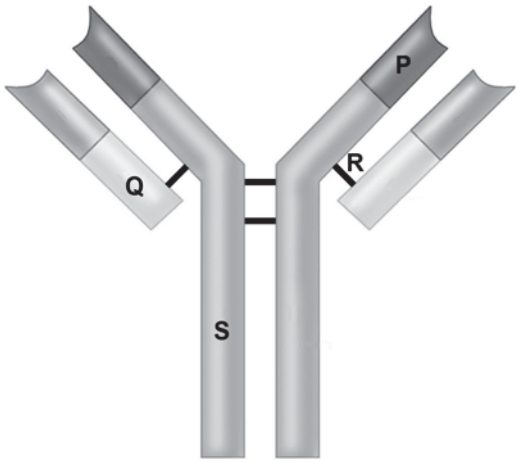
A Strains **5**, **6** and **7** share the most recent common ancestor, suggesting that strain **7** evolved into strains **5** and **6** over time.

B Strains **5**, **6** and **7** belong to the same genus and species but different families.

C Strains **5**, **6** and **7** possess a shared derived character that distinguishes them from strain **8**.

D Strain **1** is the most distant common ancestor of strains **2** to **8** as it underwent allopatric speciation in the process of evolution.

27 The diagram below shows an antibody.



Which statement correctly match the structure to its function?

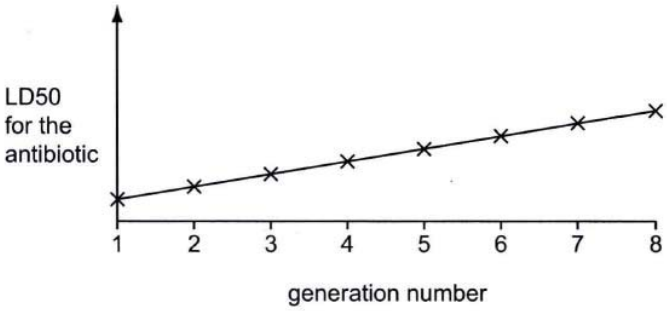
A Structure **P** has a unique antigen binding site that recognise the antigen on the bacteria.

B Structure **Q** is the constant region which binds to receptors on the macrophages and induce phagocytosis of the bacteria.

C Structure **R** ensures flexibility of the antibody to coat surface of the bacteria.

D Structure **S** is the variable region that determines the isotype of the antibody.

28 LD50 (lethal dose 50) is the concentration of a substance that kills 50% of a population. The LD50 was assessed in a population of bacteria constantly exposed to an antibiotic.



What explains the results shown in the graph?

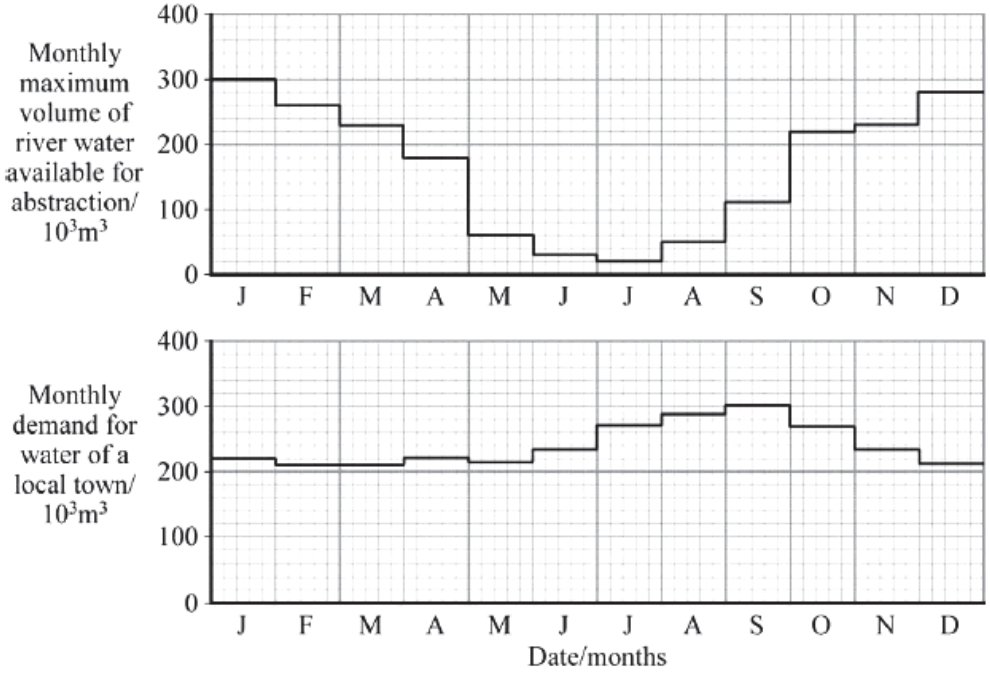
A Sudden mutations occur in all bacteria in the population.

B The bacteria develop an enzyme to destroy the antibiotic.

C The bacteria develop metabolic pathways to destroy the antibiotic.

D Bacteria that survive pass on genes for resistance to the next generation.

29 A small town depends on a river for water supply. The graph shows the projected water availability from the river and the demand for water in the town. The winter months are from July to September and the summer months are from January to April.



Which of the following cannot be concluded from the information given?

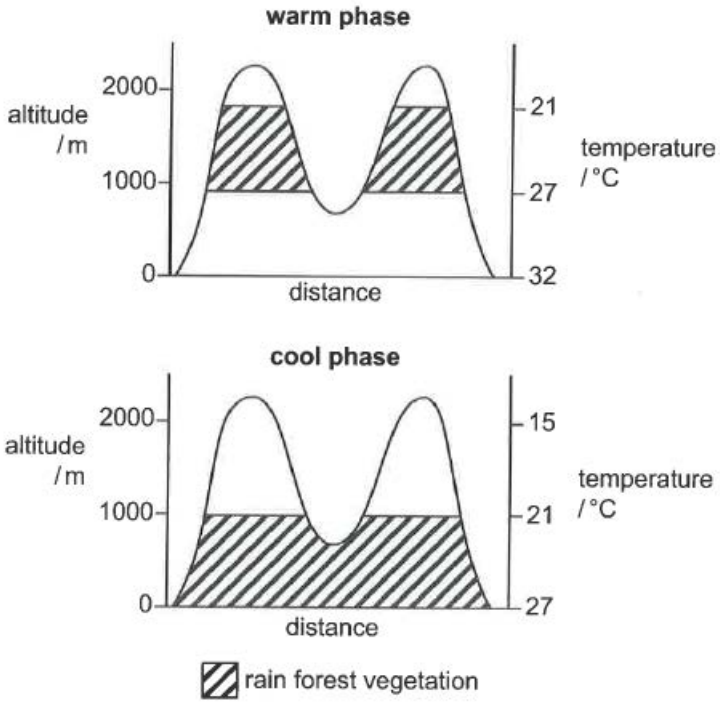
A The town faces severe water stress in the months of June and July.

B Climate change will increase the water stress on the town by causing the winter ice to melt more rapidly than normal in December and January.

C The increase in temperature will result in more precipitation to occur as rain rather than snow thus the town will suffer from low water supplies by summer's end.

D The town faces no water shortage as it is natural for the river to change its volume and water level due to the seasons.

30 The diagram shows the topographical profile of two mountains in the tropics during natural warm and cool phases in the Earth's climate. The shape of the lines corresponds to a vertical section through the mountains to show their height and shape. The distribution of rain forest vegetation is also shown.



Which of the following statement is correct?

A The rain forest vegetation moves to stay in the suitable range of temperatures of 21 to 27°C.

B The lower altitudes are too hot during the warm phase in the Earth's climate for the growth of the rain forest vegetation.

C Climate change causes the rain forest vegetation distribution to increase in altitude when the cool phase changes to the warm phase.

D The changing rain forest vegetation distribution decreases evolution as selection pressure remains the same.

END OF PAPER

2017 Y6 Preliminary Exam H2
MCQ Answer Scheme

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

Name:		Index Number:		Class:	

DUNMAN HIGH SCHOOL
Preliminary Examination
Year 6

H2 BIOLOGY 9744/02

Paper 2 Structured Questions **14 September 2017**

2 hours

INSTRUCTIONS TO CANDIDATES:

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

READ THESE NOTES CAREFULLY.

Answer **all** questions.

Write your answers on space provided in the Question Paper.

INFORMATION FOR CANDIDATES

Essential working must be shown.

The intended marks for questions or parts of questions are given in brackets [ ].

For Examiner's Use	
1	/ 8
2	/10
3	/9
4	/ 11
5	/ 10
6	/ 11
7	/ 8
8	/ 12
9	/ 4
10	/ 7
11	/ 10
Total [100]	

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Structured Questions (100 marks)
Answer **all** questions in this section.

For Examiner's use

Question 1

Collagen is the main structural protein of the various connective tissues in animals. As the main component of connective tissue, it is the most abundant protein in mammal, making up from 25% to 35% of the whole-body protein content. **Fig. 1.1** shows the structure of a collagen fiber and collage fibrils.

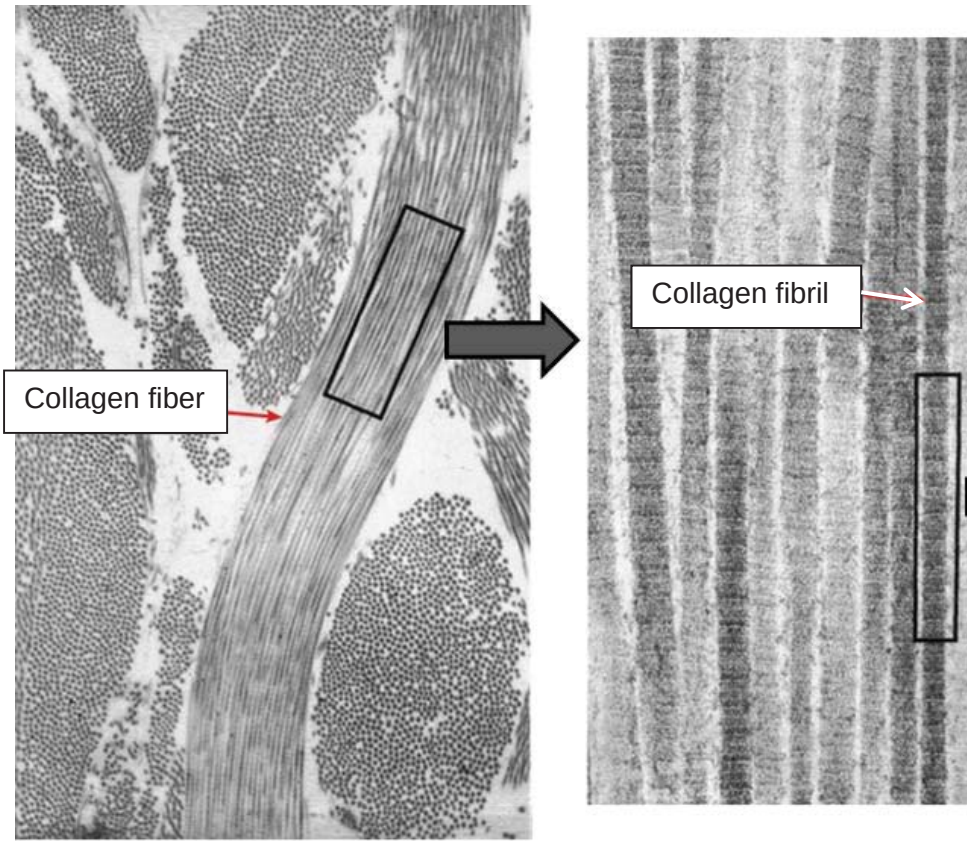

Fig. 1.1

(a) Describe the primary structure of a collagen polypeptide. [2]

For Examiner's use

(b) With reference to **Fig. 1.1**,

(i) Describe two ways how the structure of a collagen fiber differs from that of a DNA molecule. [2]

(ii) Draw a diagram to show why a collagen fibril has high tensile strength. Annotate your diagram appropriately. [2]

For Examiner's use

(c) **Fig. 1.2** shows two membrane-bound organelles commonly found in animal cells.

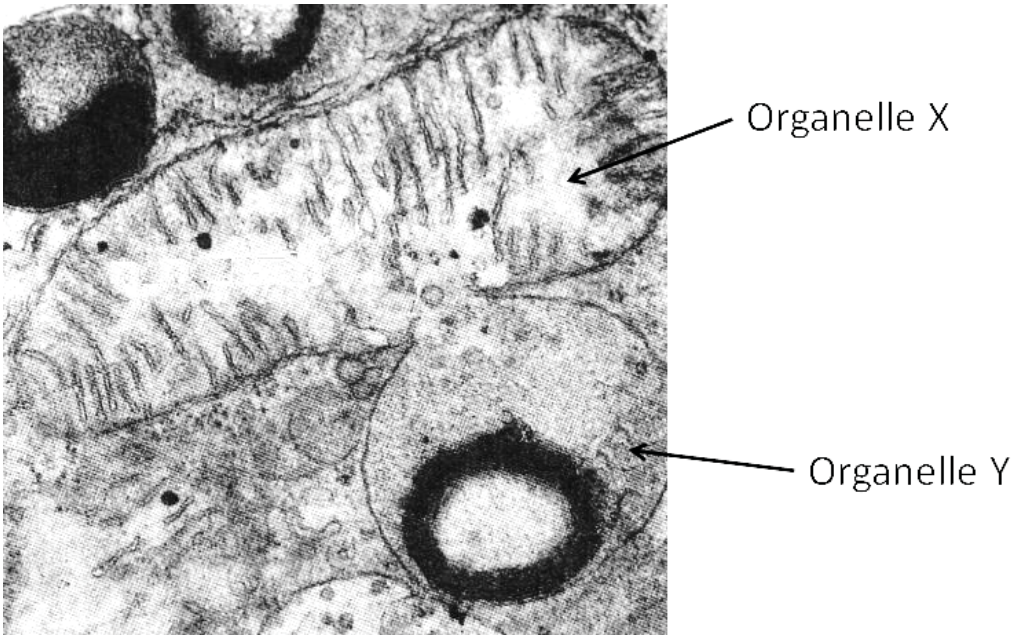

Fig 1.2

Describe two other functions of organelle Y not shown in **Fig. 1.2**. [2]

Total: [8]

Question 2

For Examiner's use

A research group discovers a hydrolytic enzyme in the aleurone of the barley seed that converts lipids to simpler molecules and begins to characterize it. Aleurone is a protein found in protein granules of maturing seeds and tubers.

The researchers found that the three essential catalytic groups in the active site are contributed by histidine 57, aspartate 102 and serine 195, where the numbers denote the position of the amino acid in the amino acid sequence.

(a) (i) Describe one advantage of storing lipids rather than starch in a seed. [1]

(ii) Explain what determines the precise position of these three amino acids in the structure of the hydrolytic enzyme. [3]

The researchers discovered that the seed germinates best if the soil is cool at close to

For

5˚C. In an investigation into the properties of the hydrolytic enzyme, they set up three water baths at 15, 20 and 25˚C. Into each bath was placed a tube containing 1 cm^3 of the enzyme solution and a tube containing 10 cm^3 of concentrate substrate solution. On reaching the required temperature, the enzyme and substrate were quickly mixed and kept in the water bath.

Examiner's use

There was a large excess of the substrate, so that the substrate concentration was not a limiting factor.

Samples were taken from each tube at regular intervals and the concentration of the product in these samples was determined. The results are shown in **Fig. 2.**

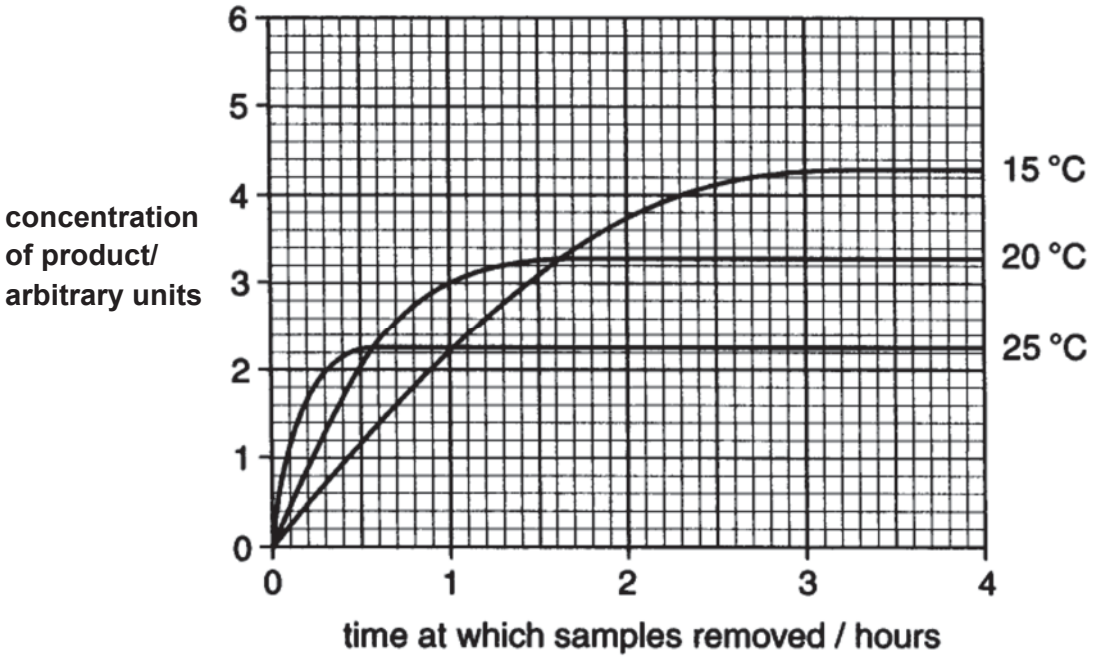

Fig. 2

(b) (i) Account for the curve at 15˚C in **Fig. 2**. [3]

For

Examiner's use

(ii) Predict and explain the effect of carrying out the procedure at 5˚C. Sketch your prediction on **Fig. 2**. Label it as **Y**. [3]

Total:[10]

Question 3

For Examiner's

use

(a) **Fig. 3** shows replication of a part of the glucagon receptor gene.

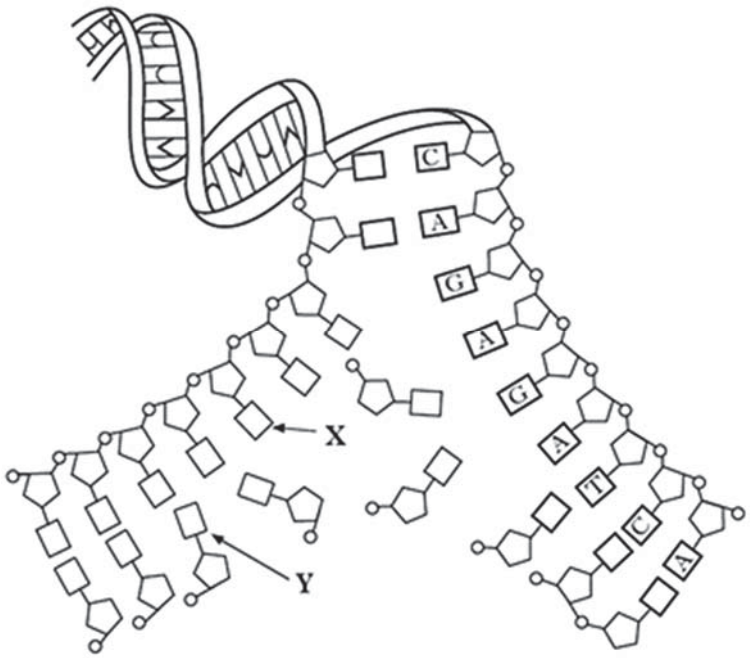

Fig. 3

(i) Name the bases labelled **X** and **Y** on **Fig. 3**. [1]

X _____

Y _____

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

_____

_____

_____

_____

_____

_____

(b) DNA replication involves a number of enzymes including DNA polymerase.

For Examiner's

Describe two other enzymes and their functions in DNA replication. [2]

use

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

Total:[9]

Question 4

For

Examiner's use

A student wanted to introduce ampicillin resistance gene (Amp^R) to a strain of bacteria. **Fig. 4.1** shows a drawing done by the student to summarize his experimental procedure and expected results.

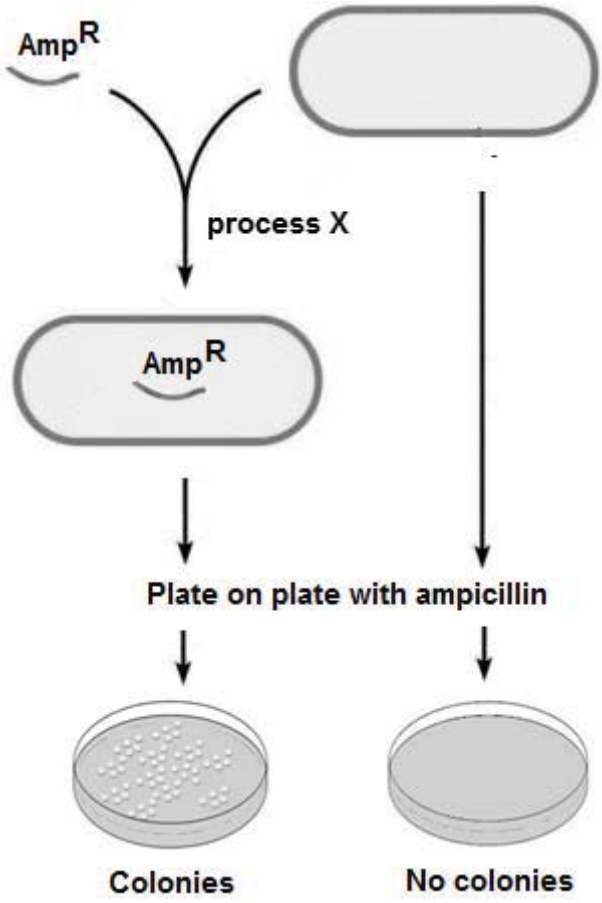

Fig. 4.1

(a) (i) What is process **X**? [1]

(ii) What is the significance of the plate with no colonies? [2]

(iii) When the student carried out the experiment, he did not obtain any colonies on either plates. Explain why. [1]

For Examiner's use

In bacteria, genes coding for enzymes involved in the same metabolic pathway are arranged into operons. **Fig. 4.2** shows the changes in the concentration of enzymes that synthesise tryptophan and utilise lactose in a bacteria cell after the addition of tryptophan and lactose.

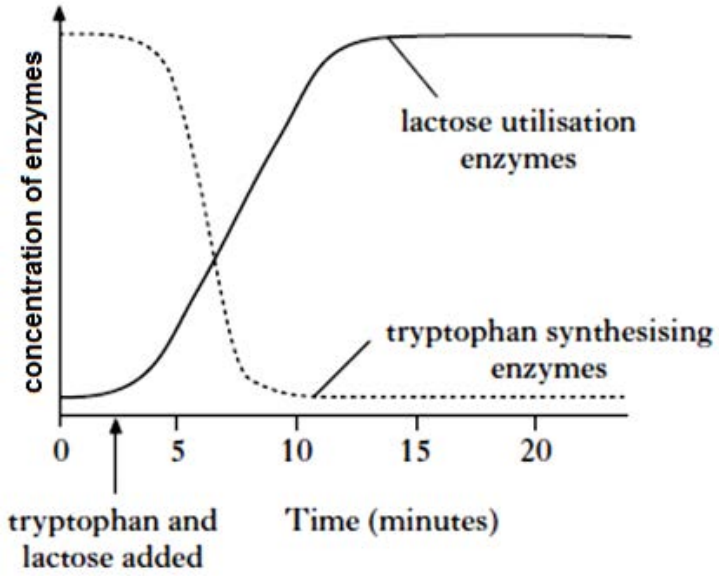

Fig. 4.2

(b) (i) Describe the difference in the shape of the graph after the introduction of tryptophan and lactose. [2]

(ii) Explain the change in concentration of tryptophan synthesizing enzyme after the introduction of tryptophan. [3]

For Examiner's use

(c) Name one lactose utilisation enzyme and suggest why the bacteria cells maintain some of this enzyme before the introduction of lactose? [2]

Total: [11]

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Question 5

For Examiner's use

Fig. 5 shows the early development of a human embryo after fertilisation.

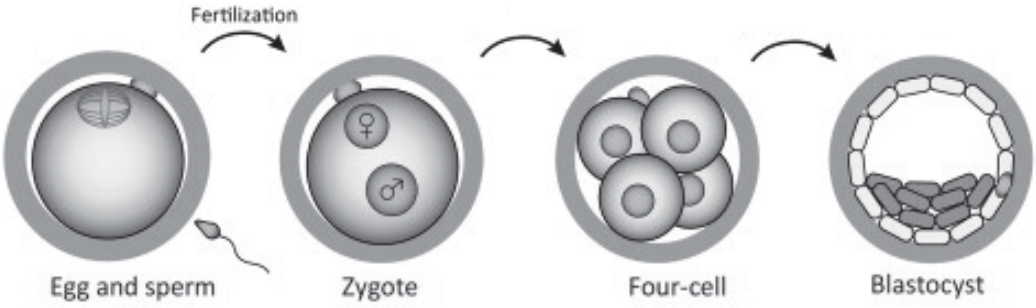
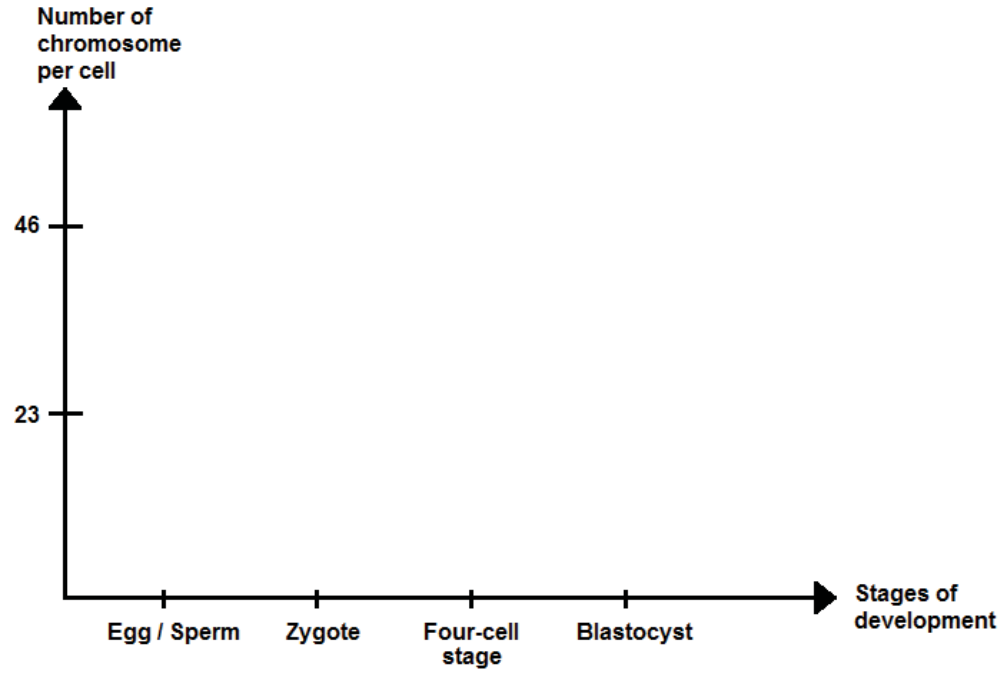


Fig. 5

(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 and complete with a line graph. [2]



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

For Examiner's use

(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 5.1

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

(i) **Table 5.1** shows a segment of the HbA and HbS polypeptide sequence. Identify this mutation. [1]

Table 5.2 shows the DNA triplet code.

For Examiner's use

Table 5.2

First Letter	Second Letter: T	Second Letter: C	Second Letter: A	Second Letter: G	Third Letter
T	TTT, TTC: Phe TTA, TTG: Leu	TCT, TCC, TCA, TCG: Ser	TAT, TAC: Tyr TAA: Stop TAG: Stop	TGT, TGC: Cys TGA: Stop TGG: Trp	T C A G
C	CTT, CTC, CTA, CTG: Leu	CCT, CCC, CCA, CCG: Pro	CAT, CAC: His CAA, CAG: Gln	CGT, CGC, CGA, CGG: Arg	T C A G
A	ATT, ATC, ATA: Ile ATG: Met	ACT, ACC, ACA, ACG: Thr	AAT, AAC: Asn AAA, AAG: Lys	AGT, AGC: Ser AGA, AGG: Arg	T C A G
G	GTT, GTC, GTA, GTG: Val	GCT, GCC, GCA, GCG: Ala	GAT, GAC: Asp GAA, GAG: Glu	GGT, GGC, GGA, GGG: Gly	T C A G

With reference to **Table 5.1** and **5.2**,

(ii) explain the **minimum** number of mutation that resulted in HbS. [2]

(iii) Identify the **maximum** number of gene mutations HbA can undergo such that the polypeptide sequence shown in **Fig 5.1** is unchanged. [1]

Total: [10]

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Question 6

For Examiner's use

(a) **Fig. 6.1** shows the methylation pattern of a segment of DNA from a human chromosome taken from three different cell types.

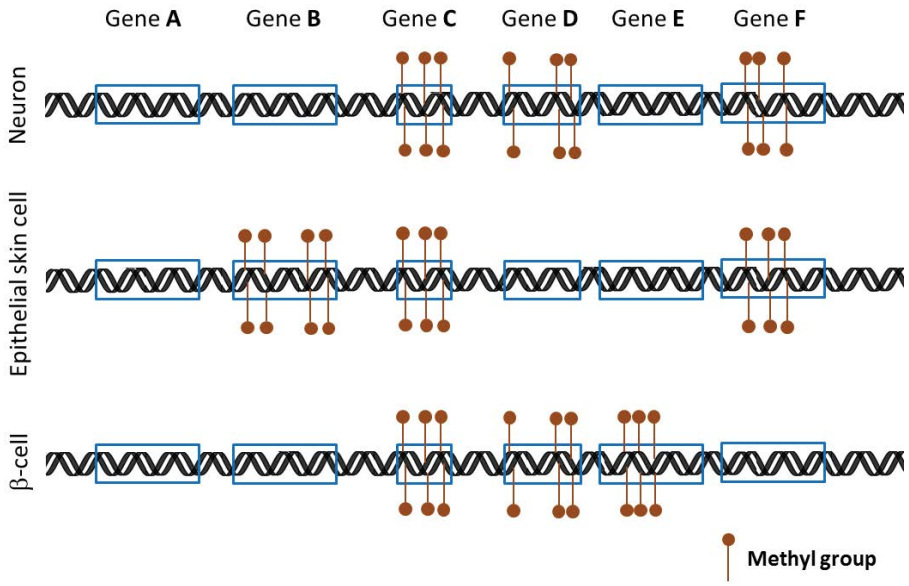

Fig. 6.1

(i) With reference to the **Fig. 6.1**, describe and explain the effect of DNA methylation on gene expression in the neuron. [4]

For Examiner's use

(ii) Gene **D** codes for melanin which is a type of pigment found in most organisms. Melanin is produced only in skin cells and functions as the primary determinant of skin colour.

Explain why the pattern of DNA methylation in gene **D** differs in the three cell types. [3]

(iii) Suggest why gene **A** is not methylated in all the cell types and hence suggest a possible identity of gene **A**. [2]

For Examiner's use

(b) Methylation of DNA always occurs on the cytosine base of a CG dinucleotide. The methylation pattern is heritable when a cell divides by mitosis. **Fig. 6.2** illustrates this process.

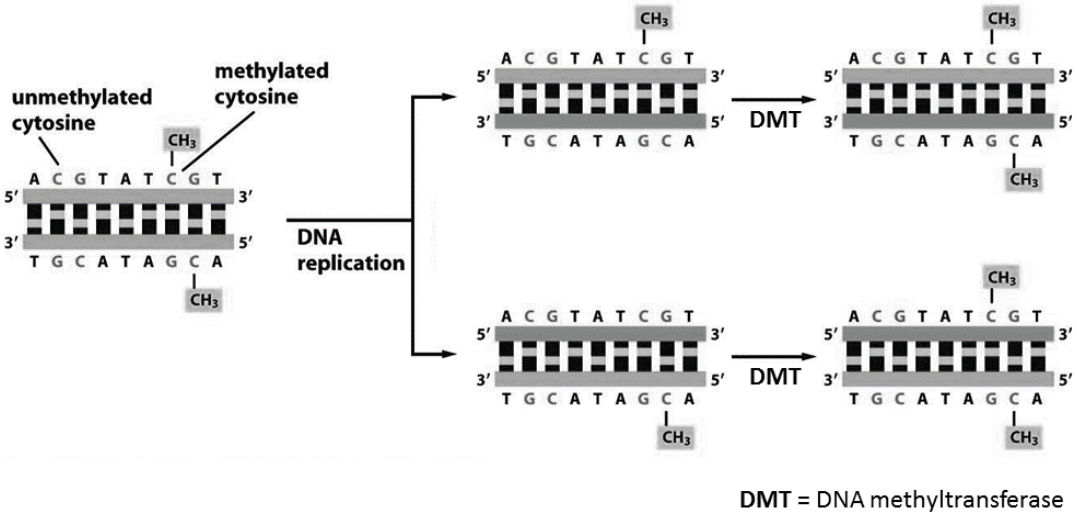

Fig. 6.2

Using information in **Fig. 6.2**, suggest how it is possible for the methylation pattern to be inherited. [2]

Total:[11]

Question 7

For Examiner's use

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

(a) List down all possible genotypes of their zygotes if these two cats were to mate. [2]

For Examiner's use

48 offspring were obtained from the above cross and the phenotype of the offspring were as follow:

Number	**Phenotype**
17	Tortoiseshell female with no tail
7	Tortoiseshell female with tail
14	Orange male with no tail
10	Orange male with tail

John and Mary were studying the genetic inheritance of Manx and coat colour in cats and each of them came to a different conclusion about the expected ratio of phenotypes of offspring from the cross of these two cats. Below are their respective conclusions.

John's conclusion

Ratio	Phenotype
3	Tortoiseshell female with no tail
1	Tortoiseshell female with tail
3	Orange male with no tail
1	Orange male with tail

Mary's conclusion

Ratio	Phenotype
2	Tortoiseshell female with no tail
1	Tortoiseshell female with tail
2	Orange male with no tail
1	Orange male with tail

For Examiner's use

Degree of freedom	Probability, *p*				
	0.1	**0.05**	**0.02**	**0.01**	**0.001**
1	2.71	3.84	5.41	6.64	10.83
2	4.61	5.99	9.21	9,21	13.82
3	6.25	7.82	11.35	11.35	16.27
4	7.78	9.49	13.28	13.28	18.47

$$\chi^2 = \Sigma \frac{(O-E)^2}{E} \qquad v = c - 1$$

where Σ = 'sum of…' O = observed 'value'

v = degrees of freedom E = expected 'value'

c = number of classes

Using the formula for the χ^2 test and the table of χ^2 values above,

(b) **(i)** Calculate the value of the χ^2 test based on John's conclusion. Show your working in the space provided below. [2]

(ii) Calculate the value of the χ^2 test based on Mary's conclusion. Show your working in the space provided below. [2]

(c) In your opinion, who do you think is **MORE CORRECT**? Explain your choice. [2]

For Examiner's use

Total:[8]

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Question 8

For Examiner's use

Studies were carried out on soil-dwelling aerobic bacteria. Soil samples were taken at two depths, **A** and **B**. The samples were taken at intervals over six years to determine the activity of dehydrogenases, involved in the Krebs cycle.

Fig. 8 shows the mean dehydrogenase activity of the bacteria in these samples.

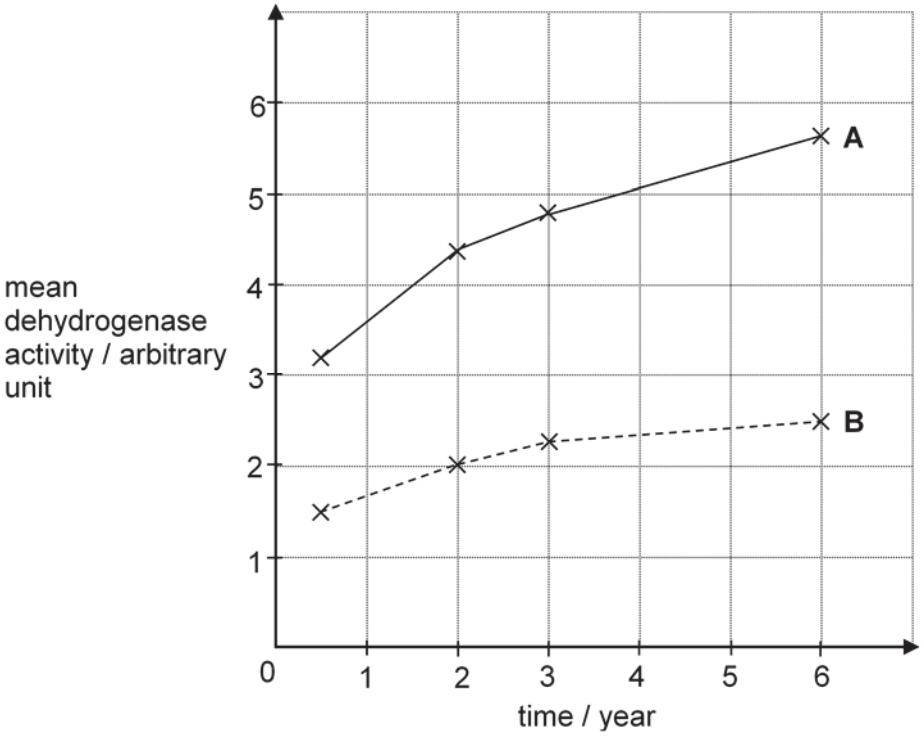

Fig. 8

(a) (i) Explain the importance of Krebs cycle dehydrogenase in ATP synthesis. [3]

For Examiner's use

(ii) With reference to **Fig. 8** and your knowledge on enzymes, explain which samples, **A** or **B**, were taken from a greater depth. [4]

(b) Dehydrogenase is also required for anaerobic respiration. Describe the process catalysed by the lactate dehydrogenase. [2]

For Examiner's use

(c) Photosynthetic bacteria can be found in the ocean. Samples of bacteria were collected at the same depth from different locations and the activity of the enzyme RUBISCO was studied. Results obtained show that the samples collected near factories had higher RUBISCO activities than samples collected near forests.

(i) Identify the factor which explains the differing result. [1]

(ii) Explain how the factor mentioned in **(c)(i)** affects the activity of RUBISCO in samples near factories. [2]

Total: [12]

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Question 9

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

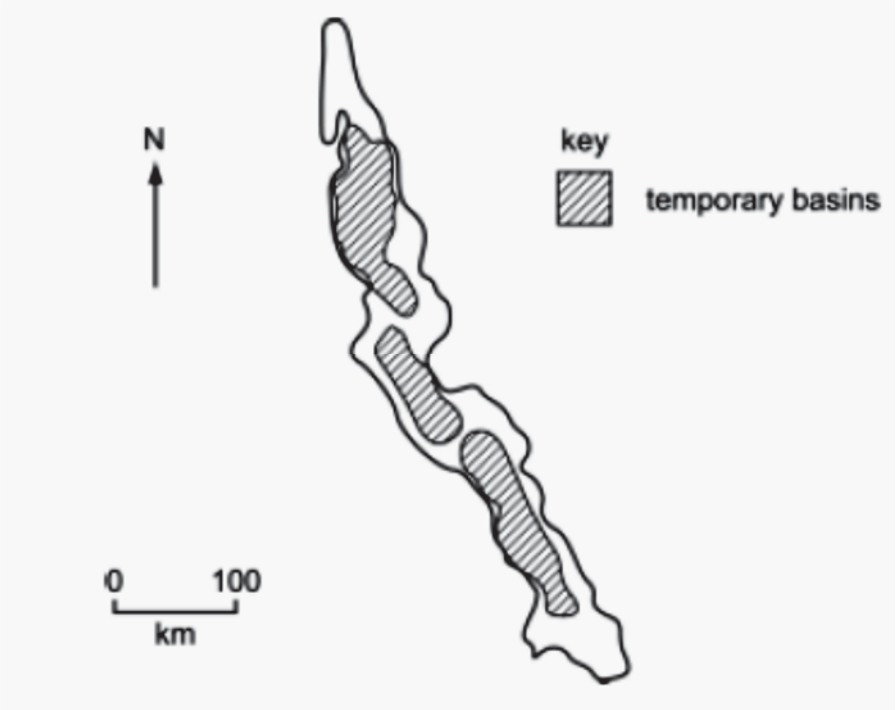


Fig. 9

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

For Examiner's use

Total:[4]

Question 10

For Examiner's use

Fig. 10 shows the infection of *Mycobacterium tuberculosis* in latent Tuberculosis infection (LTBI).

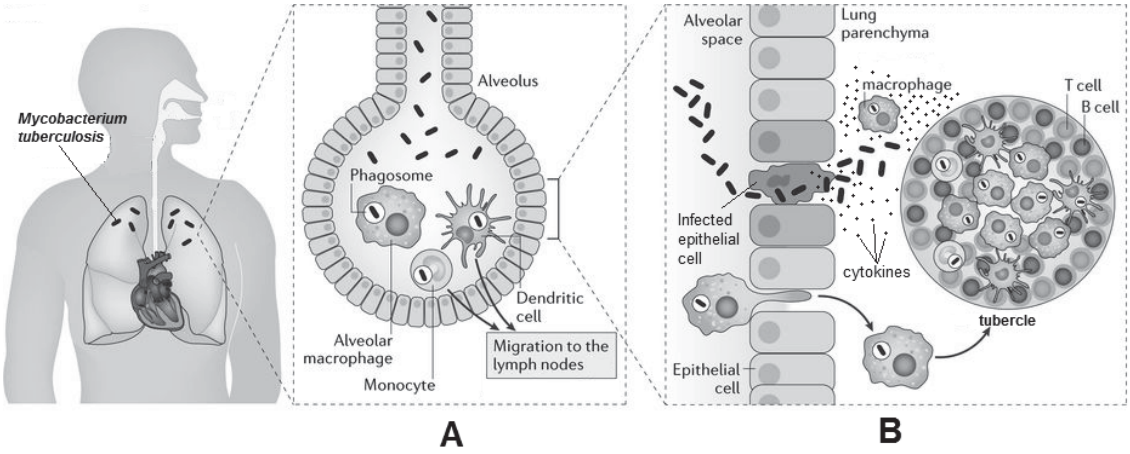


Fig. 10

(a) Describe how *M. tuberculosis* is transmitted. [2]

(b) **(i)** With reference to **Fig. 10A**, explain why the monocytes and dendritic cells migrate to the lymph nodes. [2]

(ii) With reference to **Fig. 10B** and using your own knowledge, describe how the tubercle is formed. [3]

For Examiner's use

Total: [7]

Question 11

For Examiner's use

Surface ocean carbon dioxide concentration can be determined by recording the concentration of carbon dioxide, in a closed volume of air that was circulated with a constantly renewed supply of water obtained two to three meters below the surface of the ocean.

Fig. 11.1A and **B** are graphs showing the changes in concentration of carbon dioxide in the air and changes in pH in the oceans of Bermuda and Hawaii from 1990 to 2010.

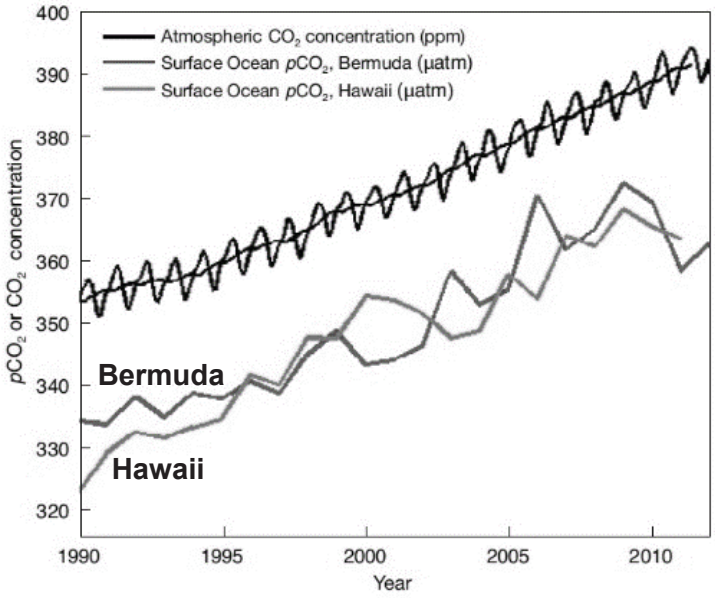


Fig 11.1A

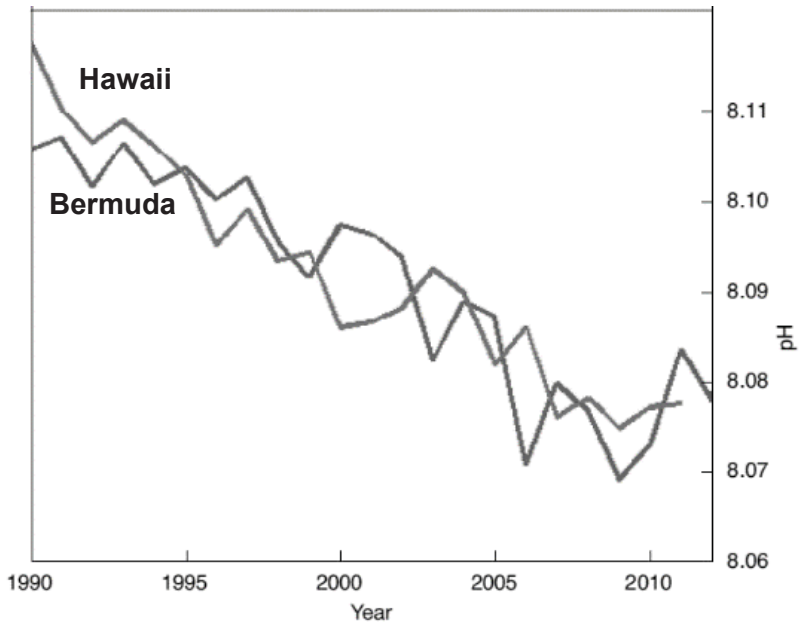


Fig 11.1B

For Examiner's use

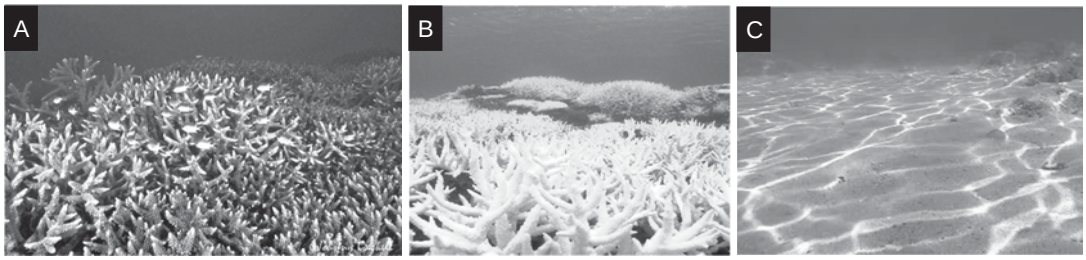
(a) **(i)** Explain three human activities that have resulted in increased emission of carbon dioxide into the atmosphere. [3]

(ii) With reference to **Fig. 11.1A** and **B**, describe and explain the relationship between atmospheric CO_2 concentration and ocean pH for both Hawaii and Bermuda. [3]

For Examiner's use

(b) The increase in carbon dioxide in the atmosphere causes warming of the Earth. The ocean absorbs most of these excess heat from the atmosphere. The top few meters of the ocean stores as much heat as Earth's entire atmosphere.

Fig. 11.2 shows examples of reefs from the Great Barrier Reef in different concentrations of surface ocean carbon dioxide.



	A	B	C
Temperature increase / ^{o}C	+1	+2	+3
Concentration of surface ocean carbon dioxide / ppm	375	450-500	>500

Fig. 11.2

With reference to **Fig 11.2**, describe and explain the effect of increasing concentrations of surface ocean carbon dioxide on coral reefs. [4]

Total:[10]

END OF PAPER

DUNMAN HIGH SCHOOL
PRELIMINARY EXAMINATION 2017
YEAR SIX
H2 BIOLOGY (9744)

Suggested Answers

Question 1

(a)

- Primary structure made up of amino acids joined together by peptide bonds
- Contains proline and glycine, hydroxyproline and hydroxylysine
- very third amino acid in the polypeptide sequence is glycine

(b)(i)

- A collagen fiber is made up of amino acids while DNA molecule is made up of deoxyribonucleotides
- A collagen fiber is made up of the aggregation of many polypeptide chains cross-linked together while DNA molecule is made up of 2 strands of DNA

(b)(ii)

- Staggered arrangement of tropocollagen, label tropocollagen
- Label covalent cross-linkages between tropocollagen

(c)

- fuse with endocytotic vesicles/ food vacuole to digest the materials within
- Release hydrolytic enzymes resulting in self-digestion of the cell / autolysis

Question 2

(a)(i)

- For the same weight/mass, lipid has a higher / twice the amount of energy than starch thus allowing less amount of fats to be stored for the same amount of energy

(a)(ii)

- due to a specific amino acid sequence which result in precise/specific folding into secondary and tertiary structure
- Bringing R groups of amino acids far apart to close proximity in the active site
- Interactions between R groups results in formation of hydrogen, ionic and disulphide bonds and hydrophobic interactions

(b)(i)

- Linear increase of concentration of product from 0 to 3.8 a.u as time increase from 0 to 2hr
- enzyme is still working at 15 ^{0}C even though optimum temperature is 5 ^{0}C

- beyond 2hr, curve starts to level off and plateau at 3 hr and concentration of product remain at 4.3 a.u
- at this point, the enzyme is denatured, because at 15 ^{0}C, heat energy causes the ionic and hydrogen bonds to be broken

(b)(ii)
Explanation: [2]

- Rate of reaction is slower because lower kinetic energy compared to the other temperatures. Lower number of effective collisions between enzyme and substrate, resulting in less enzyme-substrate complexes formed and hence less product formed
- Concentration of product is higher than for the other temperatures because it is the optimum temperature at which the hydrolytic enzyme works
- Graph: [1]

Rate of reaction slower than15˚C, should not show plateau

Question 3
(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)

- Helicase is involved in breaking of hydrogen bonds between the two DNA strands
- DNA ligase catalyses phosphodiester bond

(c)

- 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 4

(a) (i) Transformation

(a) (ii)

- It is a negative control
- to show that bacteria with no ampicillin resistance gene will not grow / multiply

(a) (iii)

- bacteria strain is not competent

(b) (i)

- The concentration of tryptophan synthesising enzymes deceases while that of lactose utilisation enzymes increases
- The concentration of lactose utilisation enzymes plateau at a higher level than tryptophan synthesizing enzymes

(b) (ii)
- Tryptophan binds to trp repressor proteins and activates it
- Trp repressor protein binds to the operator region on the trp operon and turns off the operon.
- Existing tryptophan enzymes are degraded by enzymes

(c)
- Permease. ;
- So that the lactose, when present, can be transported into the cells to induce the lac operon and turn on the transcription of more lactose utilisation enzymes. ;

Question 5

a(i)
Mitosis

a(ii)
- 1M correct plot
- 1M joining the 4 correct 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 T.
- Changes the codon from GAA / GAG, coding for Glu, to GTA / GTG, coding for Val.

c(iii)
7

Question 6
(a)(i)
- the genes C, D and F are methylated which results in long-term silencing of genes
- Methylated DNA recruits histone deacetylase which removes acetyl group from lysine and arginine residues on histone tail, restores positive charge
- Ionic bonds form between positively-charged histone tails and negatively charged DNA
- Methylation of DNA also changes the conformation of the DNA such that transcription factors and RNA polymerase cannot recognise and bind to access promoter of gene

(a)(ii)

- Methylation of gene D for neuron and β-cell but not skin cell allows only the skin cell to produce melanin
- Since all somatic cells contain the same set of genes
- There is differential methylation / gene expression for each specific cell type to carry out its specific function

(a)(iii)

- Gene A is an essential gene that is required for normal functioning of all cell types
- For example, gene A codes for RNA polymerase / aminoacyl tRNA synthetase

(b)

- The daughter molecule consist of one parental strand with methylated cytosine and one daughter strand.
- Parental strand with methylated cytosine of CG serves as a signal for DMT to methylate the cytosine of CG on the daughter strand

Question 7

(a)

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

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

1M for every 3 correct

(b)(i)

$$\chi^2 = \frac{(17-18)^2}{18} + \frac{(7-6)^2}{6} + \frac{(14-18)^2}{18} + \frac{(10-6)^2}{6}$$

≈ 3.78

(b)(ii)

$$\chi^2 = \frac{(17-16)^2}{16} + \frac{(7-8)^2}{8} + \frac{(14-16)^2}{16} + \frac{(10-8)^2}{8}$$

≈ 0.94

c

- Mary is correct. Although both calculated χ^2 values are smaller than the critical value, Mary has the smaller calculated χ^2 value.
- There is a higher probability, that any a difference between the observed and expected number is due to chance, there is a higher probability that the diffferncе is not significant.

Question 8

(a) (i)

- Dehydrogenase reduces NAD+ to NADH
- when isocitrate is converted to α-ketoglutarate / succinyl-CoA; OR when malate is converted to oxaloacetate.
- NADH carries the electron and proton to electron transport chain for ATP synthesis via oxidative phosphorylation.

OR

- Dehydrogenase reduces FAD^{2+} to $FADH_2$
- when succinate is converted to fumerate.
- $FADH_2$ carries the electron and proton to electron transport chain for ATP synthesis via oxidative phosphorylation.

(a)(ii)

- Depth B

- Mean dehydrogenase activity was lower, ranging from 1.5-2.5AU, while that of depth A was higher, ranging from approximately 3.2-5.5AU.
- At a greater depth, oxygen concentration is lower. Hence, rate of oxidative phosphorylation is lower.
- Regeneration of NAD^+ / FAD^{2+} is slower hence there is lesser substrates for effective collision.

(b)

- lactic acid fermentation
- Pyruvate converted to lactate, NADH oxidised to NAD.

(c)(i)

Carbon dioxide concentration

(c)(ii)

- Carbon dioxide concentration is higher near factories
- More CO_2 for fixation with Ribulose Bisphosphate

Question 9

- 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

Question 10

(a)

- airborne transmission / contact via respiratory droplets.
- when one who is infected with *M. tuberculosis* sneeze / cough and another person inhales the respiratory droplets.
- Only people suffering secondary/reactivated tuberculosis

2max

(b)(i)

- The monocytes and dendritic cells are able to present the antigens of M. tuberculosis / the bacteria to the CD4 T cells in lymph nodes
- Activated T cells will elicit the adaptive immune response against the bacteria.

(b)(ii)

- Cytokines released by infected epithelial cells and macrophages
- Attracts T cells and B cells to the lung parenchyma. ;
- These white blood cells tightly appress the macrophages which are infected by

Question 11

(a)(i)

- increasing energy usage which requires the combustion of fossil fuels to generate electricity
- Deforestation results in the removal of forests which are the carbon sink. Burning the forest releases the stored organic carbon back into atmosphere as CO2
- Increasing consumption of meat means that carbon dioxide is released indirectly by the agriculture industry rather than the consumers into the atmosphere.

(a)(ii)

- atmospheric carbon dioxide increases from 355 to 390ppm, the ocean surface CO2 concentration for both Hawaii and Bermuda increases from 325 to 360µatm and 335 to 360µatm
- ocean surface CO2 concentration for Bermuda increases from 335 to 360µatm, pH decreases from 8.105 to 8.078. ocean surface CO2 concentration for Hawaii increases from 325 to 360µatm, pH decreases from 8.115 to 8.078
- Ocean surface CO2 dissolves into the ocean water and forms a weak acid which decreases the pH

(b)

- increase of surface ocean carbon dioxide from 375ppm to 450-500ppm causes an increase of 2^{o}C water temperature while increase of more than 500ppm causes an increase of 3^{o}C in water temperature
- photosynthesis process in the zooxanthellae is disrupted at higher temperature, and it produces an excess of products that become toxic to itself
- The metabolism of the coral polyp is damaged and expels the zooxanthellae, leaving the coral skeleton ‘bleached’
- When there’s an increase of 3^{o}C in water temperature, the corals will eventually die from starvation and massive death

Name:		Index Number:		Class:	

DUNMAN HIGH SCHOOL
Preliminary Examination
Year 6

H2 BIOLOGY

9744/03

Paper 3 Long Structured and Free Response Questions

20 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 A Long Structured Questions

Answer **all** questions.

Write your answers on space provided in the Question Paper.

Section B 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.

INFORMATION FOR CANDIDATES

Essential working must be shown.

The intended marks for questions or parts of questions are given in brackets [ ].

For Examiner's Use	
Section A	
1	/ 25
2	/ 10
3	/ 15
Section B	/25
Paper 3 [75]	
Paper 2 [100]	
Paper 1 [30]	
Paper 4 [55]	
Grand Total [260]	

This document consists of **12** printed pages and **2** blank pages.

[Turn over

Section A: Long Structured Questions (50 marks)
Answer **all** questions in this section.

For Examiner's use

Question 1

(a) Describe how influenza virus infect cells. [4]

Influenza virus infected cells secretes interferon. **Fig. 1.1** shows the functions of interferon.

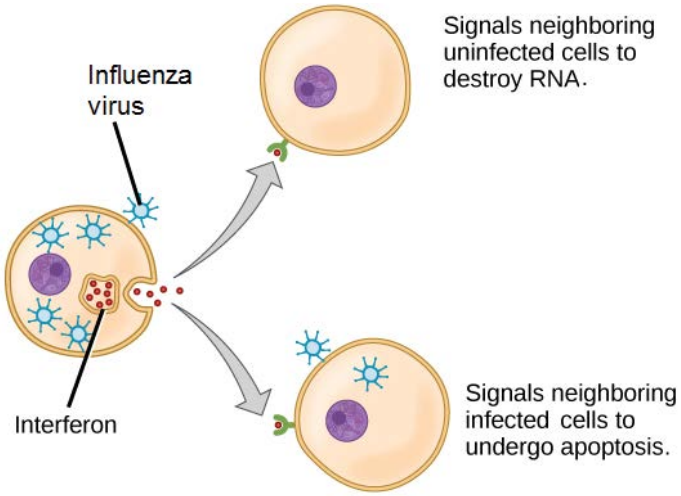


Fig. 1.1

For Examiner's use

(b) Using your knowledge, explain why the secretion of interferon is **NOT** considered an adaptive immune response. [2]

(c) **(i)** Suggest the importance of destroying RNA in virus infected cells. [2]

(ii) Interferon induces the expression of RNase L, the enzyme that degrades RNA. This enzyme also degrades mRNA and reduces protein expression. Infected cells are induced to undergo apoptosis due to low protein synthesis and high protein degradation. Name **TWO** molecules required for protein degradation. [2]

For Examiner's use

Fig. 1.2 shows the binding of interferon to Tyk2 and Jak1 tyrosine kinase receptors which led to the production of RNase L, enzyme which degrades RNA.

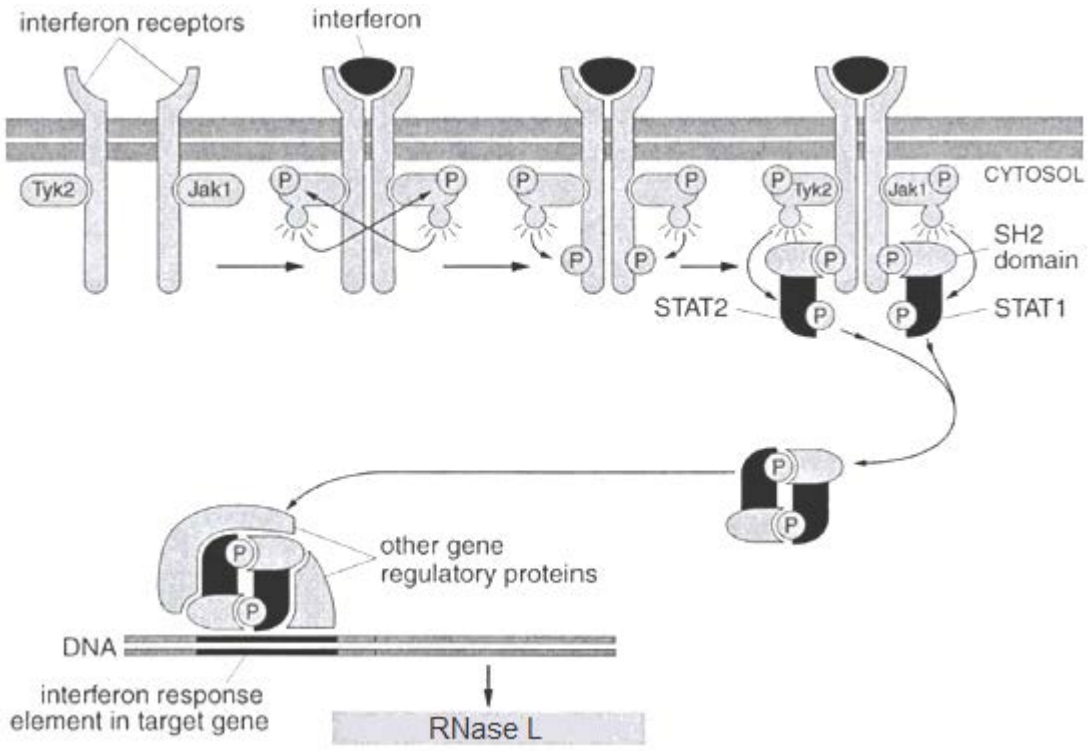


Fig. 1.2

(d) With reference to **Fig.1.2**, explain how extracellular interferon binding led to the intracellular expression of RNase L. [6]

For Examiner's use

(e) Outline how cells develop into cancer cells which divide uncontrollably. [4]

(f) Interferon also has anti-tumour activity. It can increase expression of MHC class I molecules in tumour cells.

(i) Suggest one tumour-specific antigen presented on these MHC class I molecules. [1]

(ii) Explain how interferon lead to cancer cell being destroyed. [4]

Total: [25]

For Examiner's use

Question 2

Cholera is a disease caused by the bacterium *Vibrio cholera*. The disease symptoms are caused by a toxin, produced by the bacterium.

The cholera toxin is a large globular protein with a mass of 84 kilodalton (kDa) and is composed of two domains, **A** and **B**. Enzymatic domain **A** is made from one polypeptide chain and receptor binding domain **B** is made up of five identical polypeptides.

Fig. 2.1 shows the structure of the cholera toxin.

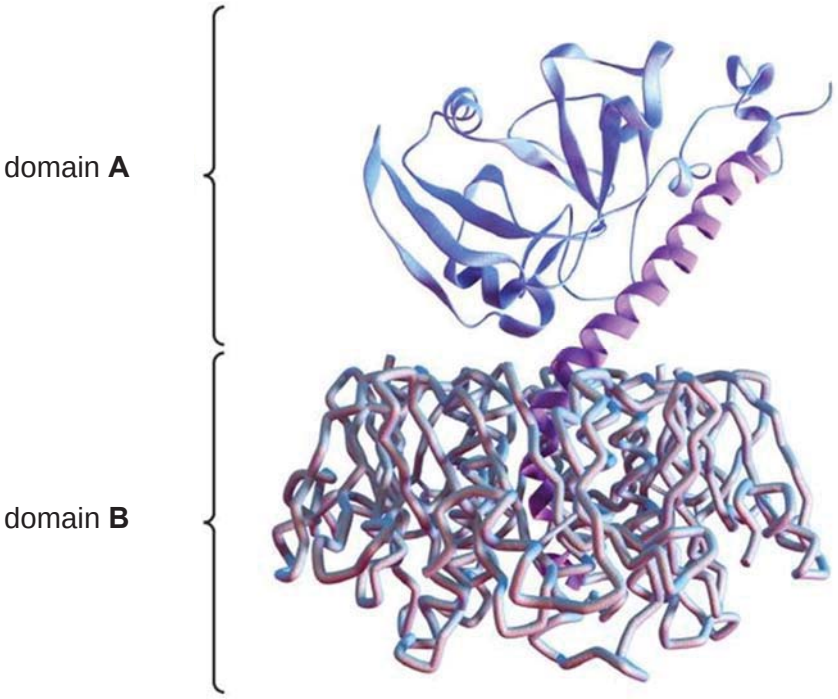


Fig. 2.1

(a) (i) Describe how the structure of domain **A** of the cholera toxin is maintained. [2]

For Examiner's use

(ii) Explain how a globular protein like cholera toxin differs from a fibrous protein such as collagen. [2]

(b) During an infection, the cholera toxin enters epithelial cells in the human intestine by interacting with receptors on the cell surface membranes. Suggest how the cholera toxin enters epithelial cells. [2]

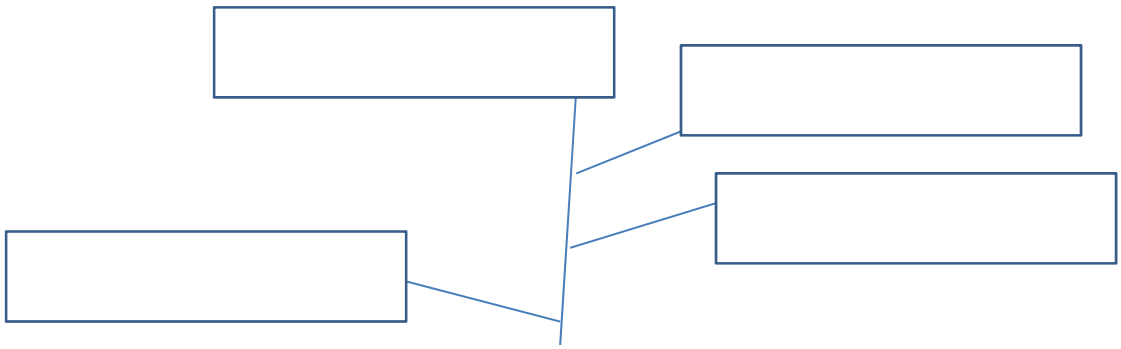
For Examiner's use

(c) There are over 26 strains of *Vibrio cholerae*, which are pathogenic and the cause for cholera disease.

Among *Vibrio* spp., *Vibrio mimicus* seemed to be genetically related to *V. cholerae*, since it was originally reported as an atypical biochemical group of *V. cholerae* strain. A clearer appreciation of the relationship came from the genome-based phylogenetic analysis, where both *V. cholerae* and *V. mimicus* were found to represent two genomically different groups of bacteria that correspond to separate species.

Two *Vibrio* strains, *V. rc341* and *V. rc586*, originally isolated from water samples in Chesapeake Bay, USA represent two novel phyletic lineages within the same clade as *V. mimicus*. These isolates are genetically different from *V. mimicus*, so they have been suggested of being two novel species. However *V. rc341* shows more genomic homology to *V. mimicus* than *V. rc586*.

(i) Using the information above, complete the phylogenetic tree diagram. [2]



(ii) Suggest how it is possible for there to be "over 26 strains of *Vibrio cholerae*". [2]

.....

.....

.....

.....

Total: [10]

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Question 3

For Examiner's use

A new mosquito vector control method involves the dominant lethal genetic system known as (Release of insects carrying a dominant lethal) RIDL. A genetically engineered RIDL system was first demonstrated in the mosquito *Aedes aegypti* which is responsible for the transmission of dengue and malaria.

In RIDL, the mosquito produces activator protein tTA which is toxic to the cell when accumulated in high levels. The regulation of tTA gene is shown in **Fig. 3.1.**

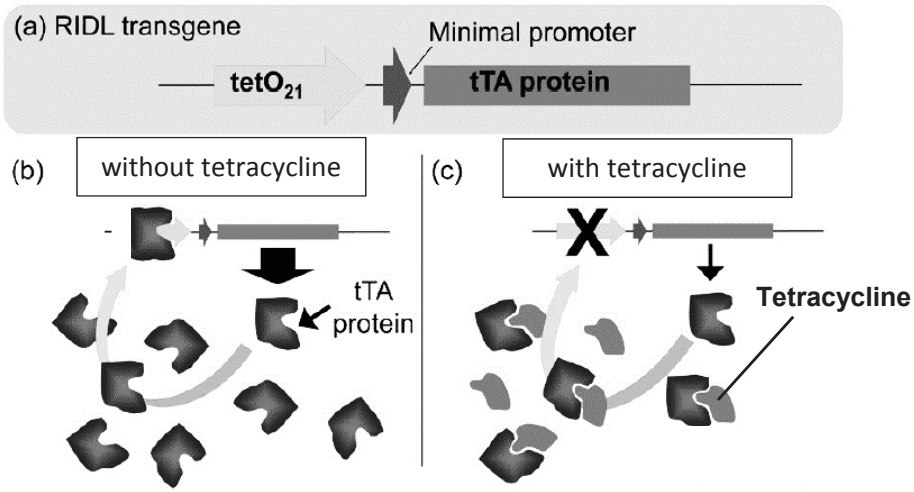

Fig 3.1

(a) (i) Define the term *control elements*. [2]

(ii) Contrast the regulation of RIDL and tryptophan operon. [3]

For Examiner's use

Fig 3.2 shows the numbers of mosquito larvae in traps set up in a control area and in an area where males of the transgenic OX513A strain containing the RIDL system of *Aedes aegypti* were released in Piracicaba county, Brazil in 2015.

Tetracycline is an antibiotic which is generally used in the treatment of infections of the urinary tract, respiratory tract, and the intestines. Tetracycline is not found naturally in the environment.

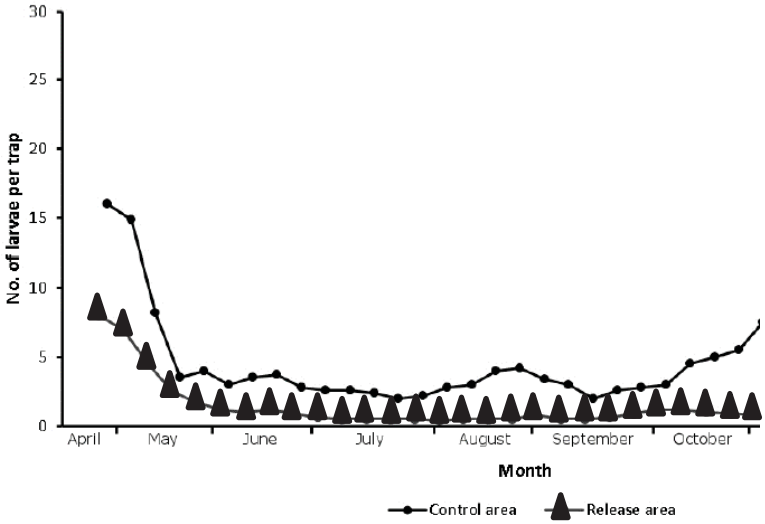

Fig 3.2

(b) (i) With reference to **Fig 3.1** and **3.2**, describe and explain the effect of releasing transgenic *Aedes aegypti* on the number of mosquito larvae in April. [2]

(ii) The RIDL mosquitoes are bred to be homozygous dominant for the tTA gene. These mosquitoes have similar mating competitiveness as compared to wild type mosquitoes.

Suggest the benefits of releasing only male homozygous dominant RIDL mosquitoes. [3]

For Examiner's use

(c) A field study was done to determine the distribution of RIDL mosquitoes after it was released into the wild. To identify RIDL mosquitoes from wild type mosquitoes, samples of mosquito DNA was extracted and tested for the presence of tTA gene.

(i) Describe the process of polymerase chain reaction which specifically amplifies the tTA gene from the DNA sample. [3]

(ii) Describe two limitations of polymerase chain reaction in amplifying the tTA gene. [2]

Total: [15]

Section B: Free-Response Question (25 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. [12]

(b) Describe ATP synthesis in respiration. [13]

Total: [25]

OR

Question 2

(a) Describe the various bonds and their importance in carbohydrates. [13]

(b) Describe the differences between Calvin and Krebs Cycles. [12]

Total: [25]

END OF PAPER

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DUNMAN HIGH SCHOOL
PRELIMINARY EXAMINATION 2017
YEAR SIX
H2 BIOLOGY (9744)

Paper 3

Suggested Answers

Long Structured Questions

1a

- Hemagglutinin bind to sialic acids on host cells.
- The virus enter the host cell by endocytosis forming an endosome.
- Acidic pH in the endosome induces the virus membrane to fuse with the endosome membrane, releasing the nucleocapsid into the cytoplasm.
- Capsid proteins are digested releasing the viral RNA genome into the host cell.

1b

- Secretion of interferon is not a specific response against influenza virus.
- There is no memory formed against influenza virus to give a faster response that is of higher affinity against the virus.
- There are no B and T lymphocytes involved in the removal of influenza virus.

Any 2

1c (i)

- Virus has RNA genome.
- Destroying RNA will prevent virus from replicating / synthesizing viral proteins

1c (ii)

- Proteosome
- Ubiquitin

1d

- binding of interferon to the extracellular binding sites of Tyk2 and Jak1 receptors, causing the receptors to dimerize.
- Tyk2 and Jak1 on the cytoplasmic/intracellular side receptor tails cross-phosphorylate
- Tyk2 and Jak1 adds phosphate group to tyrosine residues on their own tail
- receptor tails are recognised and bind by SH2 domain of STAT1 and STAT2 proteins.
- Tyk2 and Jak1 phosphorylated STAT2 and STAT1
- Phosphorylated STAT1 and STAT2 proteins are activated upon dimerization.
- STAT1 and STAT2 dimer move into the nucleus and bind to interferon response element of RNase L.
- RNase L expression is increased/turned on.

Any 6

1e

- Gain of function mutation in at least one allele
- resulting in overexpression of proteins that stimulates cell division.
- Loss of function mutation in both alleles/copies of tumour suppressor genes
- resulting in no inhibition of cell cycle.

1f (i)

- Telomerase / mutated oncogene

1f (ii)

- Interferon increases expression of MHC class I molecules on the surface of tumour cells, Cytotoxic T lymphocytes with T cell receptors bind complementary to the antigen.
- CD8 glycoproteins bind complementary to MHC class I molecules.
- Any 1 of Cytotoxic T lymphocytes action;
    - o Secretes perforin which forms pores in the cell membrane.
    - o Secretes granzymes which hydrolyses proteins.
    - o Secretes granulysin which induce apoptosis.

2a (i)

- primary structure folds into α helix and β pleated, maintained by hydrogen bonds formed between C=O and NH group
- further folding into a tertiary structure, maintained by hydrogen bonds, ionic bonds, disulfide bonds and hydrophobic interactions between R-groups of amino acid residues

2a (ii)

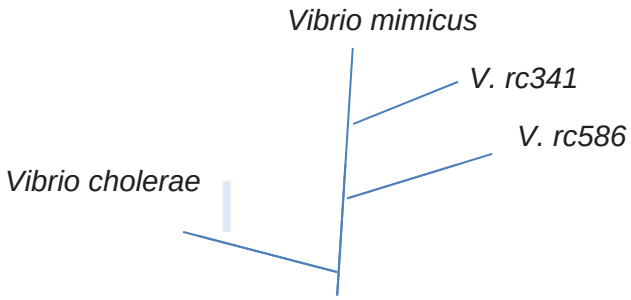
1. cholera toxin is soluble in water while collagen is insoluble
2. cholera toxin is made up of non-repetitive specific sequence of amino acids, while collagen is made up of repetitive sequence of amino acids
3. cholera toxin is compact in shape while collagen is elongated in shape/forms multimolecular parallel filament to strands/ collagen fibrils and collagen fibres

2max

2b

- receptor binding domain B of cholera toxin binds to receptors on cell membrane
- resulting in a conformational change in receptor
- cholera toxin enters by endocytosis, formation of a vesicle enclosing cholera toxin

2c (i)



2c (ii)

- Variation within a population is a result of random gene mutations;
- Result in different e.g. cholera toxin, surface antigens,
- in addition, conjugation / transduction / transformation, it is possible that a strain of *V. cholerae* can acquire other forms of variation

max 2

3a (i)

- Control elements are segments of non-coding DNA that help regulate transcription by binding transcription factors
- Promoter, silencer and enhancer are examples of control elements which are bound by RNA polymerase, repressors and activators

3a (ii)

- Negative feedback in tryptophan operon as compared to positive feedback in RIDL
- Trp operon uses repressor proteins to decrease the expression of the operon while RIDL uses activator protein tTA to increase the expression of tTA gene
- In trp operon, tryptophan acts as the co-repressor to activate the repressor protein while in RIDL tetracycline binds and inactivates the regulator protein tTA
- Trp operon is negatively regulated by repressor protein while RIDL is positively regulated by tTA activator protein.

3b (i)

- number of mosquito larvae per trap has dropped from 16 larvae per trap in April to 8 per trap
- As RIDL mosquitoes do not receive tetracycline in the natural environment, RIFL mosquito larvae die

3b (ii)

- Male mosquitoes do not bite and hence they do not transmit diseases
- Releasing homozygous dominant RIDL mosquitoes ensures that all the offspring will carry the RIDL gene
- Male RIDL mosquitoes and wild type male have equal chance to successfully mate with wild type female mosquitoes

3c (i)

- The temperature is increased to 95^{o}C so that the DNA denatures and the hydrogen bonds are broken, separating the double stranded DNA into single stranded DNA;
- The temperature is cooled to 55^{o}C so that primers can anneal to the sequences flanking the tTA gene and hybridize to the single-stranded DNA template via complementary base pairing;
- The temperature is cooled to 72^{o}C so that Taq polymerase recognises the 3' – OH group on the 3' end of the annealed DNA primer and starts the synthesis of complementary DNA strand;

3c (ii)

- Taq polymerase used in most PCR lacks a proofreading mechanism, which results in a relatively high copy error rate
- PCR can only amplify DNA sequences of lengths 0.1 to 5 kb

Free Response Questions

1a Describe the various roles of RNA in eukaryotes. [12]

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/gametes

QWC: 2 points from 3 sections

1b Describe ATP synthesis in respiration. [13]

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

Substrate level photophosphorylation

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.

Oxidative phosphorylation:

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, against its concentration gradient
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, in the mitochondria matrix.
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.

QWC: at least 3 points each from Substrate level photophosphorylation and Oxidative phosphorylation

2a Describe the various bonds and their importance in carbohydrates. [13]

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

Starch/glycogen
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. (10) 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. Form between between anomeric carbon 1 of α glucose and carbon 6 of the other
7. occurs at branch points
8. (4) resulting in a more compact shape for storage
9. Also, the many branch ends allow a number of amylase to act on starch/glycogen at any one time so it can be easily broken down

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

hydrogen bond
12. 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.
13. Microfibrils can be twisted into a threadlike fibril which further coiled and arranged in larger bundles to form macrofibrils.

QWC: at least 2 points from 3 bonds

2b Describe the differences between Calvin and Krebs cycles. [12]

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

QWC: 5 or more comparisons.

Name:		Index Number:		Class:	

DUNMAN HIGH SCHOOL
Preliminary Exam
Year 6

H2 Biology 9744/04

Paper 4 Practical

24 Aug 2017
2 hour 30 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name, class index number and class on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough working.

Answer **all** questions.

Write your answers in the space provided in the question paper.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

Give details of the practical shift and laboratory in the boxes provided.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

Shift	Laboratory

FOR EXAMINER'S USE Score	
1	/20
2	/20
3	/15
Total	/55

This document consists of **14** printed pages (including this cover page) and **0** blank page.

List of Apparatus and Materials

Please note that items **1** – **5** are only available to you for the first 75 minutes of this examination.

PLACE ITEM **1-5** BACK IN THE BASKET AFTER 75 MINUTES.

Item	Apparatus / Reagents / Chemicals	Quantity	Time allocation
1	Toothpick	2	0 – 75 minutes
2	Clean slide	2	
3	Cover slip	2	
4	Sun shade slide	1	
5	Stage micrometer 0.01mm	1	
6	Pipe cleaner	4	
7	White wire	1	
8	Label	4	
9	Transparent tape	1	

Item	Apparatus / Reagents / Chemicals	Quantity
10	Dried yeast	1 vial
11	Glucose powder	1 vial
12	250cm^3 beaker	1
13	Boiling tube	2
14	Bung and delivery tube	2
15	Test tube	2
16	Test-tube rack	1
17	10 cm^3 syringe	1
18	Styrofoam cup	1
19	Glass rod	1
20	Thermometer	1
21	Stop watch	1
22	Marker pen	1

Question 1

For Examiner's use

Prepare wet mount of your cheek cells.

Carefully use a toothpick to scrape the inside of your cheek. Transfer the scraping directly onto a clean slide. Add a very small drop of water onto the slide. Then cover with the cover slip.

(a) (i) Make a large, labelled, high-power drawing to show three cheek cells. [3]

(ii) Describe the procedure, including the use of the eyepiece graticule, to determine the ratio between the diameter of cheek cells and that of their nuclei from (a)(i). [4]

You are given a microscope slide of a sun leaf. Examine the slide under the high-power objective lens of your microscope and locate palisade mesophyll cells.

For Examiner's use

(b) (i) Make a detail, labelled drawing in the space below of three adjacent cells. [3]

(ii) Using the eyepiece graticule fitted in the eyepiece lens of your microscope, and the stage micrometer, find the actual length, in μm, of one of the cells that you have drawn.

Show the measurements that you have made and your working. [4]

Length of one of the cells = _____ μm

For Examiner's use

(c) Use the pipecleaners with which you have been provided to construct a model which shows the structure of a bivalent (i.e. a pair of homologous chromosomes at the end of the prophase stage of meiosis I).

(i) Use appropriately coloured pipecleaners to represent the parts of the bivalent derived from each different chromosome of the homologous pair and white wire to represent centromeres. [2]

(ii) Show one chiasma on your model by twisting the pipecleaners around each other. [1]

Assume that two different genes, A and B, are carried on these chromosomes and that the organism is heterozygous at these loci.

(iii) Write down the genotype of this organism. [1]

_____

(iv) Add appropriate sticky labels to your model to show a possible location for the relevant alleles if the gametes which result from this meiosis are of four different genotypes. [2]

At the end of the examination, use the transparent tape provided to securely stick your model in the space below.

[Total: 20 marks]

Question 2

For Examiner's use

Enzymes in respiring yeast convert glucose to carbon dioxide and water. You are required to investigate the effects of temperature on these enzymes by measuring the rate of carbon dioxide production.

Prepare a water-bath by half-filling a 250 cm^3 beaker with water and **maintain is temperature** between 35 ºC and 40 ºC.

Label two boiling tubes **T1** and **T2** respectively.

You are provided with 1 vial of dried yeast, and 1 vial of glucose powder. Add them into boiling tube **T1** and add 10 cm^3 of water to make the yeast suspension. Stir thoroughly with a glass rod until you get a homogenous yeast suspension. Fit the bung and delivery tube provided.

Add 10 cm^3 of tap water to **T2** and fit the bung and delivery tube provided. Ensure that the bungs are of a sufficiently tight fit to make them airtight.

Place the boiling tubes in the water-bath with the delivery tubes in test-tubes of cold water, as shown in **Fig. 1.1**.

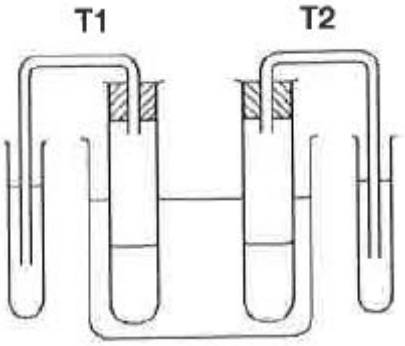


Fig. 1.1

You will soon notice bubbles of gas appearing from the ends of the delivery tubes.

Wait three minutes.

For Examiner's use

(a) (i) Count the number of bubbles produced by **T1** in 30 seconds. Enter your reading in **Table 1.1**. Wait 30 seconds and then count the bubbles produced by **T2** in the next 30 seconds. Repeat this procedure twice more. This will give you three readings for each boiling tube.

Table 1.1

	bubbles / 30 sec			
	35 ºC – 40 ºC		45 ºC – 50 ºC	
reading	**T1**	**T2**	**T1**	**T2**
1				
2				
3				
mean				

(ii) Increase the temperature of the water-bath to between 45 ºC and 50 ºC and repeat the experiment.

Enter your readings in **Table 1.1**.

(iii) Calculate the mean bubbling rates for all four sets of figures and enter your results in **Table 1.1**. [4]

(b) Explain why you waited three minutes before counting the gas bubbles. [2]

(c) With reference to your results, explain the effect of raising the temperature of **T1** to between 45 ºC and 50 ºC. [4]

For Examiner's use

(d) State the purpose of **T2** in your experiment and explain how it could be used to make your results more reliable. [2]

(e) Explain how you could improve the procedure even further to ensure that your results were even more reliable. [3]

For Examiner's use

(f) In another experiment, different carbohydrate sources were added to the yeast suspension. The amount of gas produced in 20 minutes was measured at 35 ºC – 40 ºC. The results are shown in table 1.2.

Table 1.2

Carbohydrate added	Amount of gas emitted in 20 min / cm^3	
glucose	2.7	
sucrose	2.9	
lactose	0.0	

(i) Calculate the rate of gas production and enter your results into Table 1.2. [2]

(ii) Explain the results. [3]

[Total: 20 marks]

Question 3

For Examiner's use

The enzyme amylase breaks down starch into maltose. There are several types of amylases, such as α, β and γ amylase which are used in the food and beverage industry.

Two newly identified α amylase and β amylase have yet to be tested for their activities at a range of enzyme concentration and temperatures. The optimal enzyme concentration is the lowest concentration of enzyme needed to reach the maximum rate of reaction.

Using your own knowledge, design an experiment to determine the greatest rate of activity for each of the two amylases α and β when used at its optimal enzyme concentration and temperature when subjected to the same pH.

Your planning must be based on the assumption that you have been provided with the following equipment and materials, which you must use:

- 5% α amylase,
- 5% β amylase,

- Distilled water,
- 2% starch suspension,
- 3% Iodine solution,
- timer, e.g. stopwatch
- thermostatically controlled water-bath and thermometer.

You may select from the following apparatus and use appropriate additional apparatus:

- a variety of different sized beakers, measuring cylinders or syringes for measuring volumes.
- a range of buffer solutions between pH 2 and pH 9,
- pH probe and digital meter.

Your plan should:

- have a clear and helpful structure such that the method you use is able to be repeated by anyone reading it,
- be illustrated by relevant diagrams, if necessary,
- identify the independent and dependent variables,
- describe the method with the scientific reasoning used to decide the method so that the results are as accurate and reliable as possible,
- show how you will record your results and the proposed layout of results tables and graphs,
- use the correct technical and scientific terms,
- include reference to safety measures to minimise any risks associated with the proposed experiment.

[Total: 15 marks]

For Examiner's use

END OF PAPER

DUNMAN HIGH SCHOOL
Preliminary Exam
Year 6

H2 Biology 9744/04

Paper 4 Practical

Answer Scheme

1

(a)(i)

- 3 large cheek cells with nucleus drawn
- drawing quality – clear continuous line with no shading, cell wall show as double line
- Label – cytoplasm, nucleus, membrane (at least 3)

(a)(ii)

- Record number of eyepiece unit of the 3 cheek cells from (i)
- Record number of eyepiece unit of their nuclei
- Find average of both
- Find ratio

(b)(i)

- 3 adjacent palisade mesophyll cells drawn
- drawing quality – clear continuous line with no shading, cell wall show as double line
- Label – cytoplasm, nucleus, membrane, chloroplasts, vacuole (at least 3)

(b)(i)

Calibration
Length of cell in eyepiece unit
Actual length
Answer in μm

(c)

(i)

- Homologous chromosomes represented by 2 sets of same colour wires
- Centrosome at same position

(ii)
Chiasma

(iii)
AaBb

(iv)
- AA/aa/BB/bb on same chromosome (same X)
- B/b below crossing over

2 (a) (iii)

Values for T2 columns stated as 0
Values for T1 (35-40 ºC) column lower than T1 (45-50 ºC)
Mean values correctly calculated to whole number

1 (b)

To allow content in the boiling tubes to acclimatize to the temperature in the water bath
This is to ensure the that number of bubbles counted is representative of the rate of respiration at that temperature

1 (c)
Quote data
Hence with raising the temperature from 35-40 ºC to 45-50 ºC, the rate of respiration increased
More CO_2 is released

increased temperature, the enzymes have higher kinetic energy. Rate of effective collision between the enzymes and its substrates are higher and hence there are more enzymes-substrate complexes

1 (d)
T2 is a negative control to show that the set-up itself will not emit gas / cause bubbles to be formed
Instead of tap water, 20 cm^3 of water with the same amount of glucose added to yeast suspension S1 should be used. This ensures that presence of yeast is the only dependent variable between T1 and T2.

1 (e)
At step (a) (ii), new yeast suspension should be used
After performing the experiment on the yeast suspension at 35-40 ºC, some glucose in the suspension would be used for respiration, changing the concentration of glucose
As a result, glucose concentration might become limiting when rate of respiration is measured on the same yeast suspension at 45-50 ºC, causing the measured rate to be lower than the actual rate.

1 (f) (i)
Appropriate heading with units (e.g. rate of gas production / $cm^3\ min^{-1}$) ;
Correctly calculated rate recorded to 3sf

1 (f) (ii)
glucose is the primary respiratory substrate
Yeast is able to respire with sucrose because it has the enzyme sucrose to hydrolyse the disaccharide into glucose and fructose, which are monosaccharides
Yeast is unable to respire lactose because it has no enzyme lactase to hydrolyse the disaccharide to monosaccharides glucose and galactose

3. Planning

Theory	Enzymes such as amylase are often made of proteins. Enzyme concentration determines the amount of active site available for formation of enzyme-substrate complex and hence the rate of reaction. Temperature affects the structure and shape of active site of the enzyme and hence the rate of reaction. At low concentrations of enzyme, enzyme is the limiting factor as there are more active sites than substrate. As enzyme concentration increases, the number of active sites available for formation of enzyme-substrate complex increases and rate of reaction increases. At high concentrations of enzyme, substrate is the limiting factor as there are empty active sites. As temperature increases towards the optimum temperature, the rate of reaction would increase, doubling for every increase of 10^0C. The rate of reaction of an enzyme is highest at its optimum temperature. After the optimum temperature, the rate would decrease sharply as the hydrogen and ionic bonds in the enzyme's active site are broken by the increase in kinetic energy and the enzyme is said to be denatured. The rate of reaction within each factor (enzyme concentration and temperature) can be compared by the amount of time required to digest starch into maltose which is indicated by the colour change of iodine from blue-black to yellow. The shortest time indicate fastest rate. After obtaining the optimum of each factor for both enzymes, the experiment is carried out at each enzyme's optimum enzyme concentration and temperature to obtain its highest rate of reaction.
Variables	Independent variable to obtain optimum enzyme concentration: 5 enzyme concentrations of : 1, 2, 3, 4, 5% Independent variable to obtain optimum temperature: 5 temperatures of: 10, 20, 30, 40, 50^0C. Dependent variables: Time taken for iodine to change from blue-black to yellow. Controlled variables for all experiments: pH of reaction mixture, kept constant at pH 7 Volume of substrate starch solution, kept constant at 5 cm^3 Volume of α and β amylase used in reaction, keep constant at 1 cm^3
Controls	A negative control can be set up by replacing α and β amylase with distilled water and carrying out the experiment.
Procedure	To determine optimum enzyme concentration: 1. Prepare 5 test tubes with 5 cm^3 of 2% starch suspension each using a 5 cm^3 syringe.

2. Prepare enzyme solutions of 5 different concentrations using simple dilution according to the table below. Label the beakers accordingly.

Label	Concentration of α amylase / %	Volume of 5% α amylase stock / cm^3	Volume of distilled water / cm^3	Total volume / cm^3
α1	5	10.0	0.0	10.0
α2	4	8.0	2.0	10.0
α3	3	6.0	4.0	10.0
α4	2	4.0	6.0	10.0
α5	1	2.0	8.0	10.0

3. Add 2 cm^3 of pH 7 buffer using 5 cm^3 syringe to the mixture and ensure that the pH is constant by monitoring with the pH meter.
4. Add 1 cm^3 of the enzyme into the substrate and immediately start the stop watch.
5. After every 1 minute, remove 0.5 cm^3 of mixture for iodine test.
6. Put the mixture on a white tile and add 3 drops of iodine using a dropper onto the mixture and mix well.
7. Record the time it takes for iodine test to give a yellow result in the table below.

Enzyme α amylase				
Enzyme concentration	Time taken for iodine to turn yellow / s			
	Reading 1	Reading 2	Reading 3	Average
5				
4				
3				
2				
1				

8. Repeat steps 1- 7 for enzyme β amylase.
9. Conduct 2 replicates and 3 repeats for both enzymes to ensure consistency and reproducibility.

For determining optimum temperature:

1. Prepare 5 test tubes with 5 cm^3 of 2% starch suspension each using a 5 cm^3 syringe.
2. Add 2 cm^3 of pH 7 buffer using 5 cm^3 syringe to the mixture and ensure that the pH is constant by monitoring with the pH meter.
3. Prepare 10 cm^3 of 5% enzyme using a 10 cm^3 syringe.
4. Equilibrate temperature of the substrate and enzyme by putting them into the thermostatically-controlled water bath of 10^oC for 5 minutes.
5. Measure the temperature of substrate and enzyme solution using the thermometer to check the desired temperature is reached.
6. Add 1 cm^3 of the enzyme into the substrate and immediately start the stop watch. Ensure that test tube with mixture is in water bath.
7. After every 1 minute, remove 0.5 cm^3 of mixture for iodine test.
8. Put the mixture on a white tile and add 3 drops of iodine using a dropper onto the mixture and mix well.
9. Record the time it takes for iodine test to give a yellow result in the table below.

Enzyme α amylase				
Temperature /^{o}C	Time taken for iodine to turn yellow / s			
	Reading 1	Reading 2	Reading 3	Average
10				
20				
30				
40				
50				

10. Repeat steps 1 – 9 for enzyme β amylase.
11. Conduct 2 replicates and 3 repeats for both enzymes to ensure consistency and reproducibility.

To determine the greatest rate of activity for each enzyme:

1. Prepare 1 test tube with 5cm^3 of 2% starch suspension.
2. Add 2 cm^3 of pH 7 buffer and ensure that the pH is constant.
3. Prepare 1 test tube with 5cm^3 of optimum concentration of α amylase as determined earlier.
4. Equilibrate both enzyme and substrate to the optimum temperature determined earlier by using the water bath.
5. Add 1 cm^3 of enzyme into the substrate and immediately start the stop watch.
6. After every 1 minute, remove 0.5 cm^3 of mixture for iodine test.
7. Put the mixture on a white tile and add 3 drops of iodine using a dropper onto the mixture and mix well.
8. Record the time it takes for iodine test to give a yellow result in the table below.
9. Repeat steps 1 – 8 for enzyme β amylase.

	Time taken for iodine to turn yellow / s				
	Reading 1	Reading 2	Reading 3	Average	Rate of reaction / s^{-1}
α amylase					
β amylase					

10. Plot the bar graph of rate of reaction against each type of enzyme.

Prep List (Confidential)

Item	Apparatus / Reagents / Chemicals	Quantity
1	Dried yeast, labelled **yeast**	0.5 g
2	Sucrose powder, labelled **glucose**	1 g
3	250cm^3 beaker	1
4	Boiling tube	2
5	Bung and delivery tube	2
6	Test tube	2
7	Test-tube rack	1
8	10 cm^3 syringe	1
9	Styrofoam cup	1
10	Glass rod	1
11	Thermometer	1
12	Stop watch	1
13	Marker pen	1
14	Hot water at 60 ºC	2 tanks per lab
15	Toothpick	2
16	Clean slide	2
17	Cover slip	2
18	Sun shade slide	1
19	Stage micrometer 0.01mm	1
20	Pipe cleaner	2 each color
21	White tie	1
22	Label	4