YISHUN INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CANDIDATE NAME

CG | INDEX NO

BIOLOGY 9744/01

Paper 1 Multiple Choice **19 September 2019**

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid/tape.
Write your name and class on the Answer Sheet in the spaces provided unless this has been done for you.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **18** printed pages and **2** blank pages.

©YIJC

[Turn over

www.KiasuExamPaper.com

1 Lysosomes vary in shape and size, making them difficult to identify.

What describes a lysosome?

A a vesicle containing enzymes, enclosed by a double membrane, that is budded off the endoplasmic reticulum

B a vesicle containing hydrolytic enzymes and surrounded by a single membrane, found only in phagocytes

C vesicle enclosed by a single membrane, containing several different hydrolytic enzymes that may act inside or outside the cell

D vesicle surrounded by a double membrane, containing enzymes which can hydrolyse damaged organelles in a cell

2 The table compares three molecules, X, Y and Z, which contain the elements carbon, hydrogen and oxygen only.

The percentage of carbon, hydrogen and oxygen atoms in each molecule is shown.

molecule	% carbon	% hydrogen	% oxygen
X	25.0	50.0	25.0
Y	28.5	47.7	23.8
Z	34.6	61.6	3.8

Which row correctly identifies molecules X, Y and Z?

	molecule		
	X	Y	Z
A	monosaccharide	disaccharide	polysaccharide
B	monosaccharide	polysaccharide	triglyceride
C	polysaccharide	triglyceride	monosaccharide
D	triglyceride	monosaccharide	polysaccharide

3 When a peptide bond is formed, which statement is correct?

A One amino acid loses a hydroxyl group from its amine group.

B One amino acid loses a hydroxyl group from its carboxyl group.

C Both amino acids lose a hydrogen atom from their amine group.

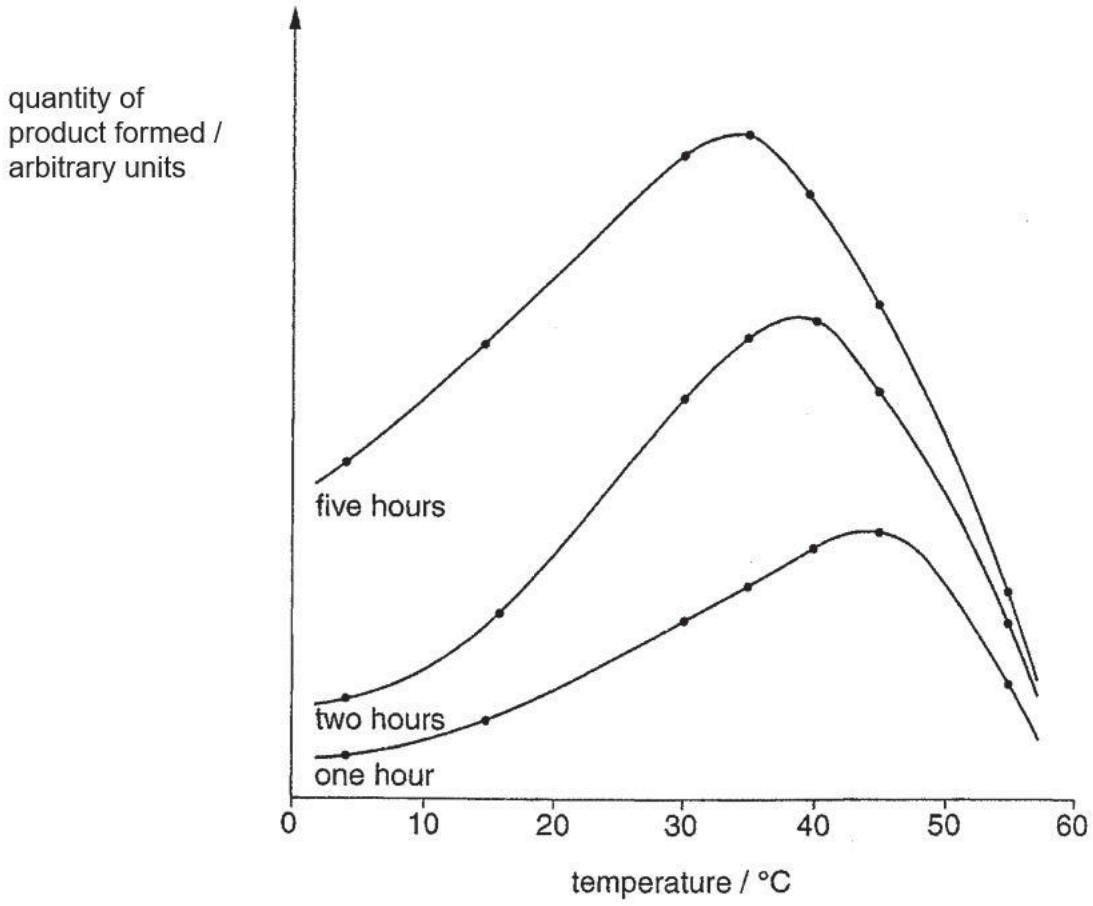
D Both amino acids lose a hydrogen atom from their carboxyl group.

©YIJC

[Turn over

www.KiasuExamPaper.com

4 The following figure shows the results of an experiment in which samples containing the same concentration of enzyme and substrate were kept at different temperatures for periods of one, two and five hours. The quantities of product formed were then determined.



Which statement below does not describe the graphs?

A As the duration of the experiment decreased, the smaller the quantity of products formed.

B As the duration of the experiment increased, the rate of denaturation of the enzyme becomes faster.

C As temperature increased, the quantity of products formed increased.

D Optimum temperature for the experiment held over one hour was higher as the enzyme had more disulfide bonds in stabilizing its structure.

©YIJC

www.KiasuExamPaper.com

5 Which row correctly describes the structure of collagen?

A	covalent bonds hold the polypeptides within the triple helices together	about one third of the amino acids in a molecules are glycine	collagen does not have a quaternary structure
B	each of the three polypeptide strands forms a right-handed helix	there is a high proportion of the amino acids proline and glycine	the triple helices are insoluble in water
C	the polypeptides in a triple helix are held together by hydrogen bonds	the triple helices are cross bonded to one another by hydrogen bonds	the glycine side chains are always on the outside of the helix
D	three polypeptide helices are twisted together into a right-handed triple helix	triple helices cross bond to one another with staggered ends	every third amino acid in a polypeptide is usually glycine

6 The mechanism of action of four drugs that inhibit DNA replication is stated below.

- Aphidicholine inhibits DNA polymerase.
- Cytarabine is converted into a molecule that can substitute for a DNA nucleotide and also inhibits DNA repair mechanisms.
- Epirubicin inhibits an enzyme involved in the unwinding of DNA and separation of strands.
- Hydroxycarbamide inhibits an enzyme involved in the production of deoxyribonucleotides.

Which row correctly matches a drug to an explanation of the mechanism of action?

	Explanation of mechanism of action			
	Decreased pool of available nucleotides inhibits chain elongation	DNA strands not available as templates for replication	DNA damaged during replication and cell death occurs	Exposed DNA template strands unable to be copied
A	aphidicholine	epirubicin	cytarabine	hydroxycarbamide
B	epirubicin	cytarabine	hydroxycarbamide	aphidicholine
C	hydroxycarbamide	aphidicholine	epirubicin	cytarabine
D	hydroxycarbamide	epirubicin	cytarabine	aphidicholine

©YIJC

www.KiasuExamPaper.com

7 Exceptions to the universal genetic code are found in mammalian mitochondria, as shown in the table.

mRNA codon	in mammalian cytoplasm, codes for	in mammalian mitochondria, codes for
AGA	arginine	stop / termination
AGG	arginine	stop / termination
AUA	isoleucine	methionine
UGA	stop / termination	tryptophan

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

AUAAGAAGGUGA

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

	mammalian cell cytoplasm	mammalian mitochondria
A	2	1
B	2	0
C	3	0
D	3	1

8 Which feature of the life cycle of some viruses may result in the development of cancer?

A Viral RNA can integrate into the chromosomes of host cells.

B Viruses can cause cell lysis and spread to other host cells.

C Viruses can cause loss of function mutations in proto-oncogenes.

D Viruses can increase the rate of the cell cycle of host cells.

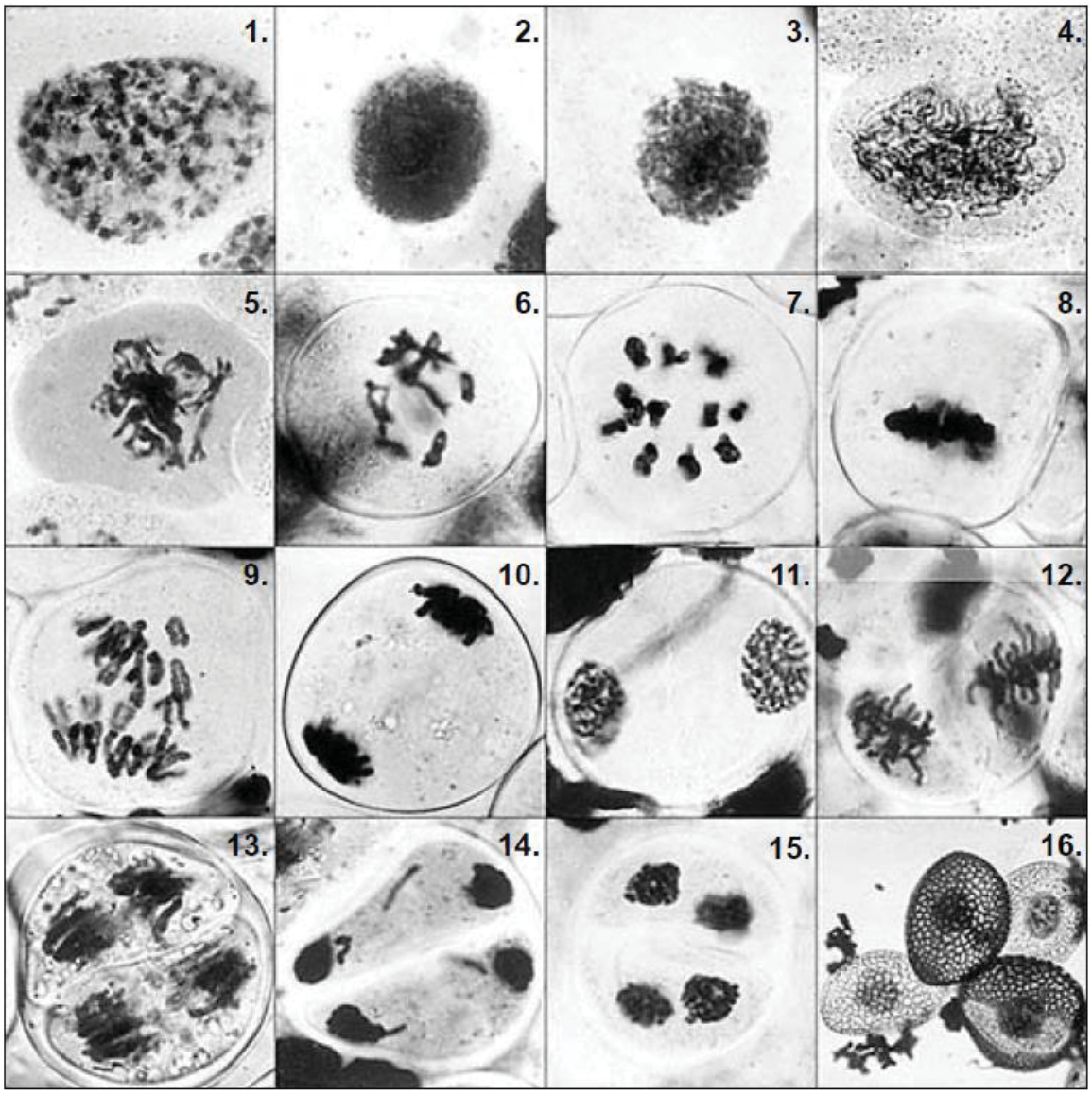
9 Which of the following identifies the genome of an influenza virus?

	percentage of nucleotides needed with particular base				
	adenine	cytosine	guanine	thymine	uracil
A	15	20	25	0	40
B	40	10	10	40	0
C	30	15	15	0	30
D	10	35	35	10	10

©YIJC

www.KiasuExamPaper.com

10 The following images show stages in meiosis in the order in which they occur.



Source: Radbound University Nijmegen, Faculty of Science
www.vcbio.science.ru.nl (Virtual Classroom Biology)

Which one of the following statements is correct?

A During the stage shown in image 9, chromatids separate.

B Cells after the stage shown in image 10 are haploid.

C During the stage shown in image 11, DNA will be replicated.

D Homologous chromosomes pair up in the stage shown in image 12.

©YIJC

www.KiasuExamPaper.com

11 Students examined the nuclei in cells from the tip of an onion root using the high power of a light microscope.

They counted the number of cells in each stage of the mitotic cell cycle, which they recognised from the appearance of the chromosomes, nuclear envelope and nucleolus. The onion had been kept in conditions in which the cell cycle was known to take 24 hours.

	interphase	Stages of mitosis			
		P	Q	R	S
appearance	nuclear envelope and nucleolus visible chromosomes invisible	nuclear envelope and nucleolus invisible chromosomes visible in random arrangement	nuclear envelope and nucleolus invisible chromosomes arranged on spindle equator	nuclear envelope and nucleolus invisible chromosomes arranged in two groups spindle microtubules visible between the groups	nuclear envelope and nucleolus invisible chromosomes arranged in two groups cell plate visible between the groups
number of cells (out of 96 counted)	80	10	3	1	2

Approximately how long was the duration of metaphase?

A 15 minutes

B 30 minutes

C 45 minutes

D 2 hours 30 minutes

©YIJC

www.KiasuExamPaper.com

12 If DNA is damaged, checkpoints in the cell cycle can either trigger DNA repair, allowing the cell to progress through the cell cycle or, if this cannot be carried out, divert the process to programmed cell death (apoptosis).

Breaks in double-stranded DNA can be repaired using proteins such as p53 and Chk1.

About half of all cancer cells have non-functional p53 proteins.

An inhibitor for Chk1 protein has been developed as a treatment for cancer patients to improve tumour shrinkage during radiation treatment.

How would this Chk1 inhibitor benefit these patients?

A Chk1 genes would be damaged and unable to repair DNA.

B Fewer healthy cells would have damaged DNA.

C More cells with non-functional p53 protein would undergo apoptosis.

D The radiation treatment would kill all the tumour cells.

13 In a mouse model experiment, deletion of the multi-drug resistance (mdr) gene in liver cells leads to the development of liver cancer. Loss of mdr gene and its encoded protein leads to the accumulation of bile acids that initiates liver inflammation, a process that recruits white blood cells to the target site.

These white blood cells secrete Tumour Necrosis Factor-α (TNF-α) that binds to the corresponding receptor on liver cells, which in turn activates a specific transcription factor. Activation of this transcription factor has been shown to result in the elevated levels of an anti-apoptotic protein and a growth-promoting protein produced by liver cells. These proteins are involved in the progression of liver cells to turn cancerous.

Based on the information above, which of the following can be concluded?

A mdr gene is a tumour suppressor gene which codes for a protein involved in apoptosis.

B The progression to liver cancer requires mutations in proto-oncogenes and tumour suppressor genes.

C The progression to liver cancer can occur when a loss-of-function mutation in the mdr gene results in the over-expression of the other proto-oncogenes.

D The metastasis of liver cancer is accelerated with the recruitment of more white blood cells due to elevated levels of TNF-α.

©YIJC

www.KiasuExamPaper.com

14 The following describes some aspects of operons.

1 is an anabolic operon
2 is a metabolic operon
3 has more than 1 structural gene controlled by a single promoter
4 function as transcription unit with more than 1 structural genes
5 repressor binds to inducer to be inactivated
6 repressor binds to silencer to be activated

Which row correctly describes the *lac* and *trp* operon?

	lac operon	trp operon
A	2 and 5	1 and 6
B	2 and 3	1, 3 and 4
C	2, 3 and 4	3 and 5
D	3 and 4	1 and 3

15 The following statements describe bacterial conjugation.

1 The F plasmid is made of single-stranded DNA
2 When an F^+ donor gives an F plasmid to an F^- recipient, both become F^-
3 When an F^+ donor gives an F plasmid to an F^- recipient, both become F^+
4 When an F^+ donor gives an F plasmid to an F^- recipient, the donor becomes F^-
5 When F^+ cells are mixed with F^- cells, eventually all the cells will become F^+

Which of the statements is / are true?

A 1, 2 and 4

B 3 and 5

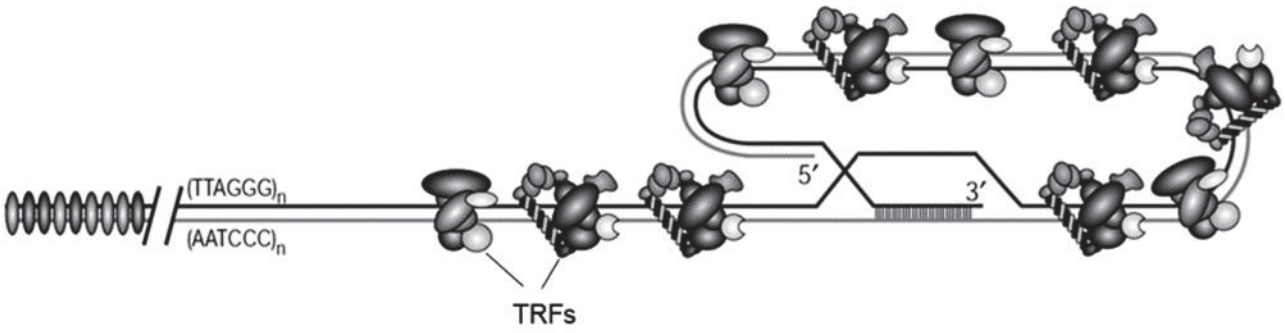
C 2 and 4

D 3, 4 and 5

©YIJC

www.KiasuExamPaper.com

16 A telomere is comprised of a 230-kb array of duplex TTAGGG repeats. This DNA sequence exists as a telomere loop, in which the 3' overhang folds back on itself. Proteins known as TTAGGG repeat-binding factors (TRFs) are associated with the duplex repeats.



Which of the statements below explains the significance of the formation of the telomere loop?

A Telomeres are DNA-protein complexes that have regulatory functions in preserving the length of genes found at the chromosomal ends.

B Telomeres are highly conserved across all eukaryotic species with little variation in the base sequences.

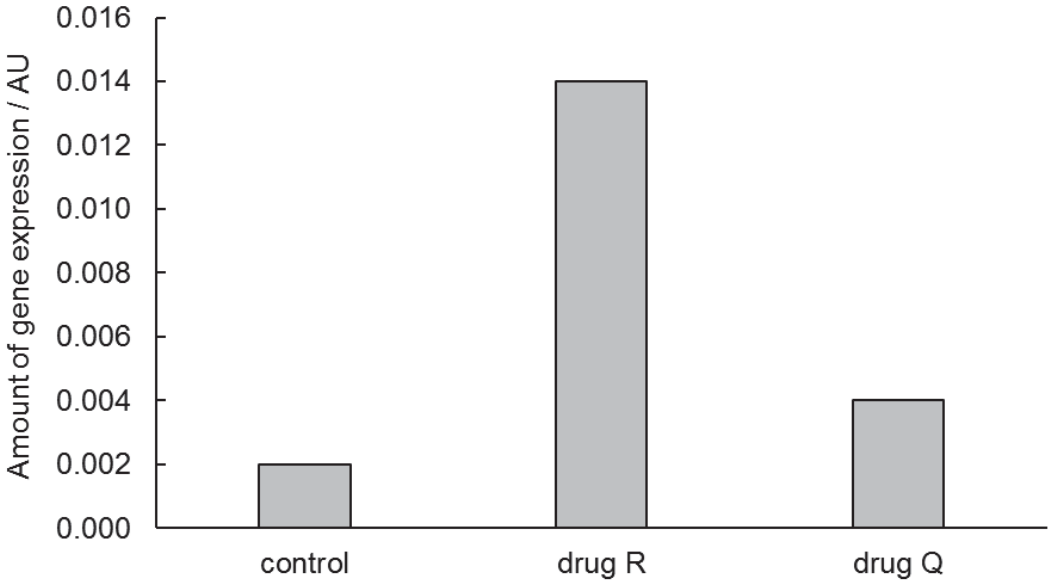
C Telomeres are repetitive sequences that are permanently cross-linked by proteins such that the chromosome ends will not be truncated after every cell division.

D Telomeres protect the ends of chromosomes from enzymatic degradation or fusion with other chromosomes.

©YIJC

www.KiasuExamPaper.com

17 Drug R is a DNA methyltransferase inhibitor and drug Q is a histone deacetylase inhibitor. An experiment was carried out to investigate the effects of drugs R and Q on expression of a gene. The graph shows the experimental results.



Which are possible explanations to the results shown?

1 Drug Q results in weaker binding of histones to DNA.

2 Drug Q increases gene expression by increasing accessibility of RNA polymerase to the promoter.

3 Drug R increases gene expression by preventing methylation at CpG islands at the promoter.

4 Inhibiting DNA methylation is more effective in increasing gene expression than inhibiting histone deacetylation.

A 1 and 2 only

B 2 and 4 only

C 1, 2 and 3 only

D All of the above

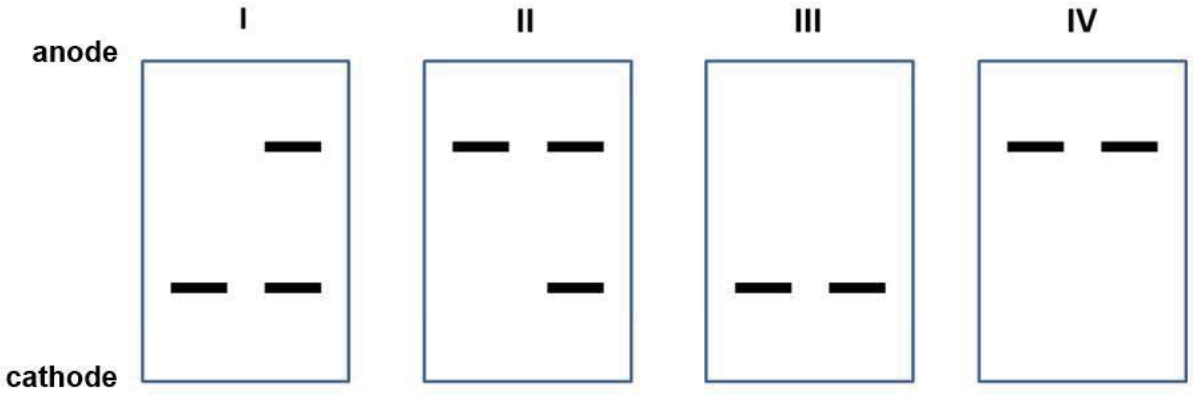
©YIJC

www.KiasuExamPaper.com

18 Cystic fibrosis (CF) is an autosomal recessive genetic disorder. An individual must have two copies of the mutated CFTR gene to express the disease phenotype. One of the most common CF-causing mutation resulted in a loss of phenylalanine located at position 508 of the protein.

The DNA sequence of the CF locus from the offspring of 2 carriers are removed and separated by gel electrophoresis.

Which pattern of bands corresponds to two of the offspring that are phenotypically normal?



A I only

B II only

C I and III

D II and IV

19 What is the probability of obtaining a gamete of genotype **abCd** from an individual whose genotype is **AaBbCCDd**, assuming the four genes are unlinked?

A 1 in 4

B 1 in 8

C 1 in 16

D 1 in 32

©YIJC

www.KiasuExamPaper.com

20 A naturally occurring mutant tomato plant with yellow fruit was crossed with the red wild type.

The first generation plants were self-pollinated and were also backcrossed with both parents. The results are below.

- The first generation plants all produced red coloured fruit.
- The second generation plants produced fruits in a ratio of 3 red : 1 yellow.
- Plants from a backcross with red wild type all produced red fruits.
- Plants from a backcross with the yellow mutant produced fruits in a ratio of 1 red : 1 yellow.
- The mutant yellow fruit had a higher rate of chlorophyll breakdown during fruit ripening.
- The red fruit from the first generation showed lower rates of chlorophyll breakdown, as similarly observed in red wild type fruits.

From the results above, what can be concluded?

1 Yellow phenotype is due to a recessive allele at the same locus as the red allele.

2 The dominant red allele influences chlorophyll metabolism in fruits.

3 The effect of the red allele on chlorophyll metabolism is inhibited by the yellow allele.

A 1 only

B 1 and 2

C 1 and 3

D 2 and 3

21 The wings of fruit flies, *Drosophila melanogaster*, can be normal or vestigial, and eye colour can be red or purple. Pure-breeding flies with normal wings and purple eyes produced F1 offspring with all normal wing, red eyes when mated with pure-breeding flies with vestigial wings and red eyes.

F1 females were crossed with pure-breeding males with vestigial wings and purple eyes to produce 200 offspring.

Which of the following are most likely the offspring of the cross if the two genes are found on the same chromosome?

	normal wings and red eyes	normal wings and purple eyes	vestigial wings and red eyes	vestigial wings and purple eyes
A	50	54	50	46
B	35	65	70	30
C	80	25	20	75
D	68	28	72	32

©YIJC

www.KiasuExamPaper.com

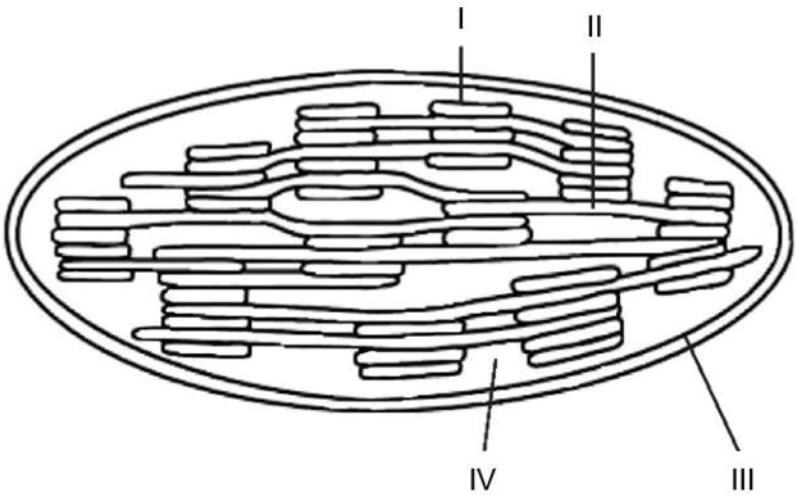
22 Two genes involved in coat colour of goats are at loci on different chromosomes. The colour of the fruit of a species of plant can be black, brown or yellow. Fruit colour in this species is controlled by two genes, each with two alleles. The two genes are on different chromosomes.

A cross between a pure-breeding plant with black fruit and a pure-breeding plant with yellow fruit resulted in F1 generation with all black fruit. Interbreeding of F1 plants produced offspring with black, brown and yellow fruits in the ratio of 12 : 3 : 1.

Which of the following are possible genotypes of pure-breeding plants with black, brown or yellow fruit?

	black	brown	yellow
A	AABB	AAbb	aabb
B	AABB	aabb	aaBB
C	aaBB	AABB	AAbb
D	aabb	aaBB	AAbb

23 Where are the light-dependent and light-independent reactions taking place in the diagram below?



	Light-dependent	Light-independent
A	I	IV
B	II	III
C	III	II
D	IV	I

©YIJC

www.KiasuExamPaper.com

24 An inhibitor of the enzyme catalysing the oxidative decarboxylation of α-ketoglutarate (5C) was added to respiring animal tissues.

What would have been the effect of the inhibitor on the concentration of oxaloacetate, pyruvate and ATP?

	oxaloacetate	pyruvate	ATP
A	decreases	increases	decreases
B	decreases	decreases	increases
C	increases	increases	decreases
D	increases	decreases	increases

25 Which of the following processes do not occur during the conversion of glucose to two molecules of pyruvate?

1 hydrolysis of ATP
2 phosphorylation of hexose
3 release of CO_2
4 reduction of NAD
5 oxidative phosphorylation of ADP

A 1 and 3 only

B 2 and 4 only

C 3 and 5 only

D 1, 2 and 5 only

26 Two different trees have been classified as *Pinus pinea* and *Pinus nigra.* Which of the following statement is correct?

A Both trees belong to the same class but a different genus.

B Both trees belong to the same family and same genus.

C The species name of both trees is *Pinus*.

D The family names are *pinea* and *nigra*.

©YIJC

www.KiasuExamPaper.com

27 Bacteria in the genus *Wolbachia* infect many species of insects. The bacteria live as parasites within the cells of their insect hosts and are passed from one generation of host to the next through the eggs of infected females. Infected males cannot pass the infection on to the next generation, since sperms are too small to be parasitised by *Wolbachia*.

Wolbachia has evolved several strategies to increase the probability that the infection will be passed on from one generation of host to the next. These include:

- feminisation, in which infected males become fertile females
- male killing, in which male embryos that are developing from infected fertilised eggs die
- parthenogenesis, in which infected females become capable o reproducing asexually
- cytoplasmic incompatibility, in which infected males are unable to reproduce successfully with uninfected females.

Which of these statements could explain how these strategies benefit *Wolbachia* through natural selection?

1 Feminisation increases the number of insects infected with *Wolbachia* that can pass on the infection to their offspring.

2 Male killing decreases the proportion of uninfected individuals in the offspring of an infected female.

3 Parthenogenesis increases the probability that an infected female will pass on the infection to its offspring, since there is no need to find a mate.

4 Cytoplasmic incompatibility increases the fitness of infected females by allowing infected females to reproduce with uninfected males.

A 1, 2 and 3

B 1, 2 and 4

C 1 and 3 only

D 2 and 4 only

©YIJC

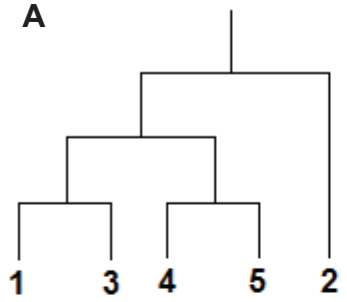
www.KiasuExamPaper.com

28 The following shows a section of the homologous gene between 5 different species.

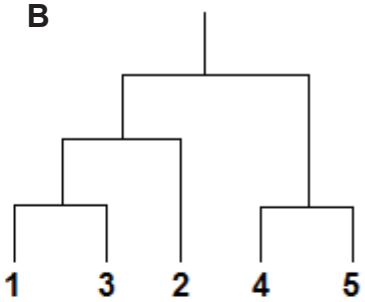
Species 1	A	A	T	T	A	G	C	G	T	A	T	T	A	A	G
Species 2	A	A	T	A	A	T	T	G	T	A	G	T	T	A	G
Species 3	A	T	T	T	A	G	C	G	T	A	T	T	A	A	G
Species 4	T	G	T	A	C	T	C	T	C	A	G	T	A	C	G
Species 5	T	G	T	A	C	T	C	A	C	A	G	T	A	C	G

Which of the following is the correct phylogenetic tree for species 1 to 5?

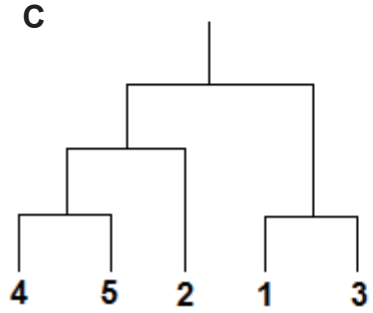
A



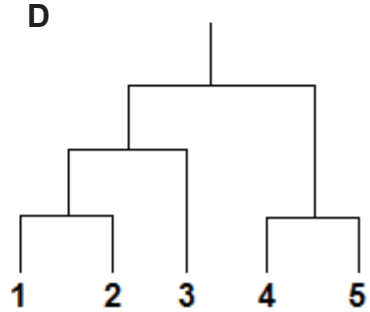
B



C



D



©YIJC

www.KiasuExamPaper.com

29 Tuberculosis is caused by the bacteria *Mycobacterium tuberculosis* (*M. tuberculosis*) and can be spread when infected people release the bacteria in droplets of liquid when they cough or sneeze.

The following are some of the events that follow the entry of the bacteria into the respiratory tract of a human.

1 Formation of granuloma consisting of foam cells and lymphocytes

2 Macrophages die and release *M. tuberculosis* into the cavity

3 Lung tissues destruction and spread to other organs

4 Cytokines released induces the recruitment of more immune cells to the site of infection

5 Phagocytosis of bacteria by resident alveolar macrophages

Which sequence of events correctly describes the infection of *M. tuberculosis*?

A 4 → 5 → 1 → 2 → 3

B 4 → 1 → 5 → 2 → 3

C 5 → 4 → 2 → 1 → 3

D 5 → 4 → 1 → 2 → 3

30 Which of the following is **not** a direct greenhouse gas?

A carbon dioxide

B carbon monoxide

C nitrous oxide

D water vapour

©YIJC

www.KiasuExamPaper.com

BLANK PAGE

©YIJC

www.KiasuExamPaper.com
1941

BLANK PAGE

©YIJC

www.KiasuExamPaper.com
1942

YISHUN INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CANDIDATE NAME

CG | INDEX NO

BIOLOGY 9744/02

Papers 2 Structured Questions **2 September 2019**

2 hours

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name and class in the spaces at the top of this page.
Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid/tape.

Answer **all** questions in the spaces provided on 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.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
1	/8
2	/8
3	/12
4	/7
5	/14
6	/10
7	/10
8	/9
9	/11
10	/11
	/100

This document consists of **23** printed pages and **1** blank page.

©YIJC

[Turn over

www.KiasuExamPaper.com

Answer **all** questions.

1 Cholesterol is synthesized in the smooth endoplasmic reticulum (sER) in liver cells by a series of enzyme-catalysed reactions.

Within the sER, molecules of cholesterol and triglycerides are surrounded by proteins and phospholipids to form lipoproteins. These lipoprotein particles enter the Golgi apparatus where they are packaged into vesicles and pass to the blood.

Fig. 1.1 is an electron micrograph of part of a liver cell showing lipoprotein particles within the Golgi apparatus.

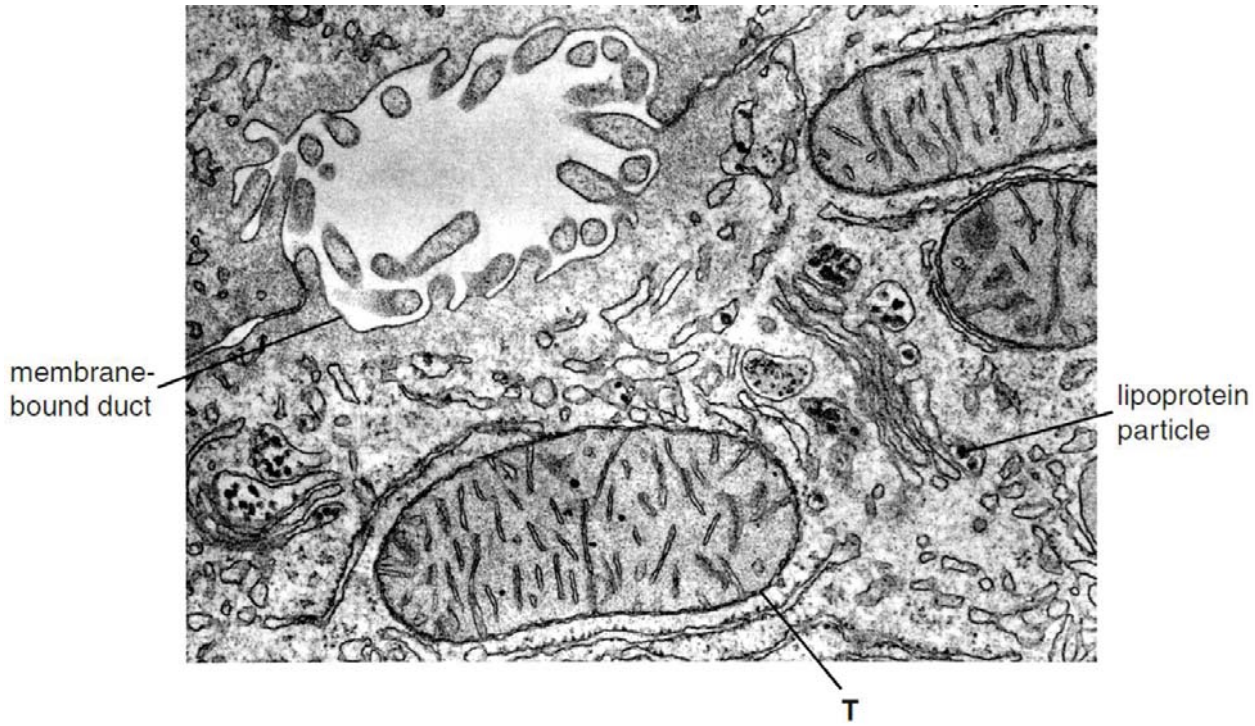


Fig. 1.1

(a) **(i)** Name structure **T** in Fig. 1.1.

.....[1]

(ii) Explain how the structure of **T** is adapted to its function in liver cells.

.....

.....

.....

.....

.....

.....[3]

©YIJC

www.KiasuExamPaper.com
1944

The low-density lipoprotein (LDL) receptor is a transmembrane glycoprotein made in the liver cell that allows for uptake of excess cholesterol from the body into liver cells.

Once attached to LDL receptors on the liver cell surface membrane, LDLs release their cholesterol and triglycerides. The cholesterol is stored or oxidised to bile salts.

(b) Describe the sequence of events following the translation of LDL receptor polypeptide chain at the bound ribosomes on the rough endoplasmic reticulum, to the insertion of the LDL receptor in the liver cell surface membrane.

[4]

[Total: 8]

©YIJC

www.KiasuExamPaper.com
1945

2 **(a)** Fig. 2.1 represents a molecule of triglyceride.

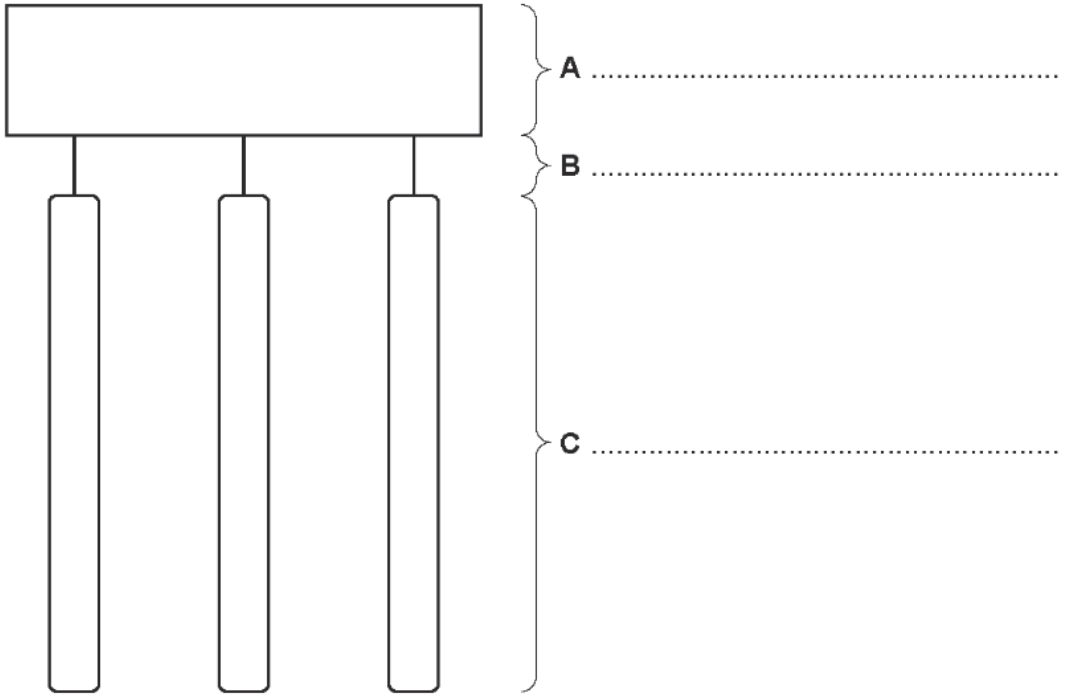


Fig. 2.1

(i) Name the components **A** and **C** and name the bond **B**.

Write your answers on the dotted lines provided in Fig. 2.1. [3]

(ii) Describe how bond **B** is broken.

.....

..... [1]

(b) A phospholipid is sometimes described as a modified triglyceride;

(i) State how the structure of a phospholipid differs from a triglyceride.

.....

.....

.....

..... [2]

©YIJC

www.KiasuExamPaper.com

(ii) Explain how a phospholipid is suited to its role in cell membranes.

.....

.....

.....

..... [2]

[Total: 8]

©YIJC

www.KiasuExamPaper.com

3 Enzymes are globular proteins

(a) State what is meant by the term *globular*.

.....

.....

.....

..... [2]

(b) Fig. 3.1 shows an enzyme-catalysed reaction.

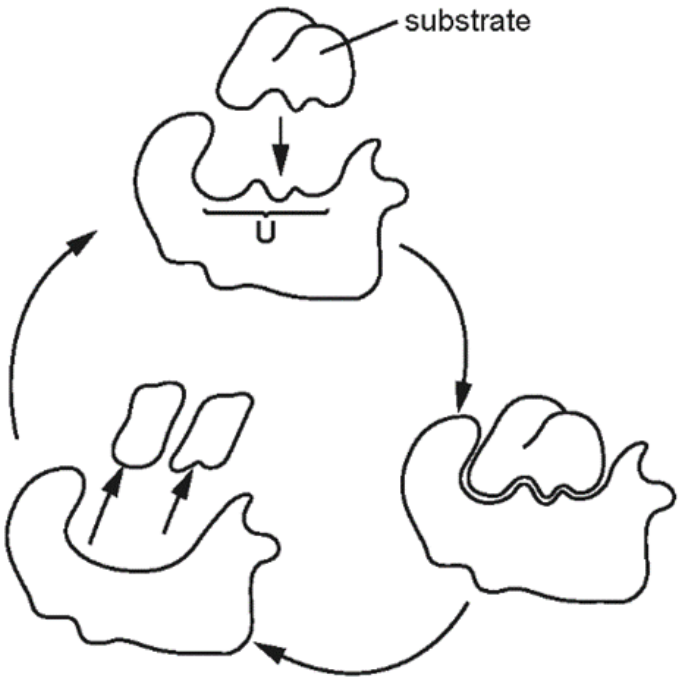


Fig. 3.1

(i) Name the part of the enzyme labelled **U**.

..... [1]

©YIJC

[Turn over

www.KiasuExamPaper.com

(ii) With reference to Fig. 3.1, explain the mode of action of enzymes.

[4]

(c) The enzyme urease is known to be affected by competitive inhibitors. A student carried out an investigation to determine the percentage of urea hydrolysed by ureases at various time intervals,

- without any inhibitor;
- with a competitive inhibitor.

The experiment was carried out in test tubes set up as follows:

Tube **A** – 1 cm^3 of urease solution, 10 cm^3 pH 7.5 buffer solution, 1 cm^3 urea solution

Tube **B** – 1 cm^3 of urease solution, 9 cm^3 pH 7.5 buffer solution, 1 cm^3 of competitive inhibitor 1 cm^3 urea solution

Tube **C** – 1 cm^3 of water, 10 cm^3 pH 7.5 buffer solution, 1 cm^3 urea solution

The results are shown in Table 3.1 below.

Table 3.1

Time/ min	Percentage of urea remaining / %		
	Tube A	Tube B	Tube C
0	100	100	100
5	55	99	100
10	29	98	100
15	14	96	100
20	8	95	100
25	5	92	100
30	3	90	100

©YIJC

www.KiasuExamPaper.com

(i) State how Tube **C** acts as a control for this investigation.

[1]

(ii) Explain the difference in results between Tube **A** and Tube **B**.

[4]

[Total: 12]

©YIJC

www.KiasuExamPaper.com
1950

4 Epithelial tissue, liver tissue and cardiac muscle tissue each respond differently to damage.

- Epithelial tissue of the gas exchange system contains stem cells.
- Liver tissue contains cells in a non-dividing state that can enter a cell cycle when stimulated.
- Cardiac muscle tissue contains cells that cannot divide at all. Damage is permanent and is associated with scar tissue formation.

(a) Explain the importance of mitosis in the repair of damaged tissue.

.....

.....

.....

..... [2]

(b) One of the reasons why stem cells are important in tissue repair is their ability to divide continually.

(i) Describe **one other** reason why stem cells are important in tissue repair.

.....

.....

.....

..... [2]

(ii) Explain how stem cells are able to divide continually.

.....

.....

.....

..... [2]

(c) Suggest how stem cells in the epithelial tissue can help with cardiac damage.

.....

..... [1]

[Total : 7]

©YIJC

www.KiasuExamPaper.com
1951

5 The *STAT5* gene, a member of the *STAT* family, is widely expressed in hematopoietic stem cells (HSC) to regulate the self-renewal and differentiation of the stem cells.

(a) Explain how the different cell types such as T cell and B cell can arise from a single HSC.

[3]

Fig. 5.1 shows the process of transcription in a eukaryotic cell that produces ribosomal RNA (rRNA), an important component of ribosomes, which serve as the site of synthesis of STAT proteins.

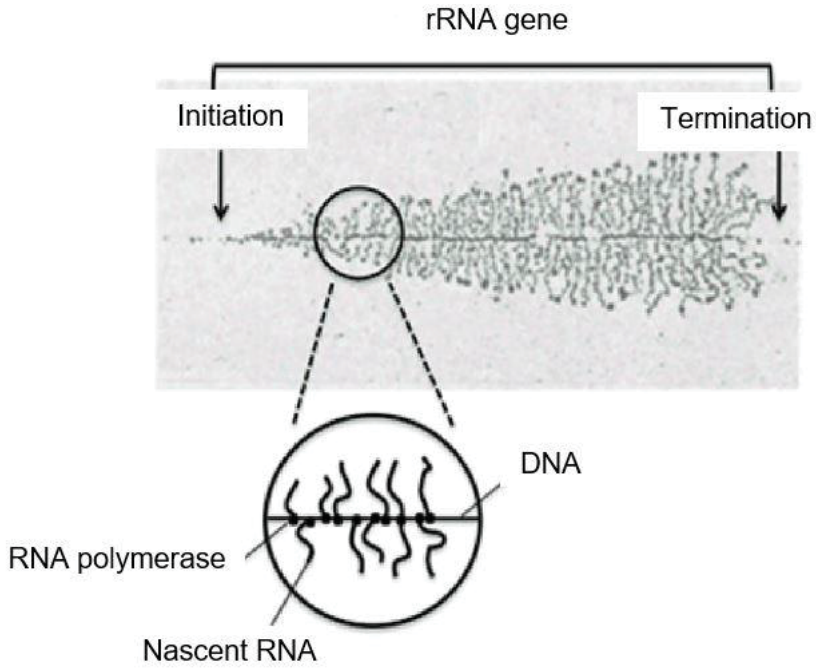


Fig. 5.1

(b) **(i)** Suggest how RNA polymerase is able to recognise and bind to the promoter on DNA and not to other DNA regions.

[2]

www.KiasuExamPaper.com

(ii) Account for the observed pattern of transcription in Fig. 5.1.

[2]

(iii) State **one** role of rRNA in protein synthesis.

[1]

(c) STAT proteins are transcription factors that play important roles in the development and differentiation of many cell types.

In humans, there are different forms of STAT5 protein, each playing a slightly different role in different cell types.

Explain how the same *STAT5* gene can produce different forms of STAT5 protein.

[2]

©YIJC

www.KiasuExamPaper.com

Upon external stimulation, STAT protein is activated from its inactive form and binds to another activated STAT protein to form a dimer. This protein dimer then translocates to the nucleus and regulates the expression of other genes as shown in Fig. 5.2.

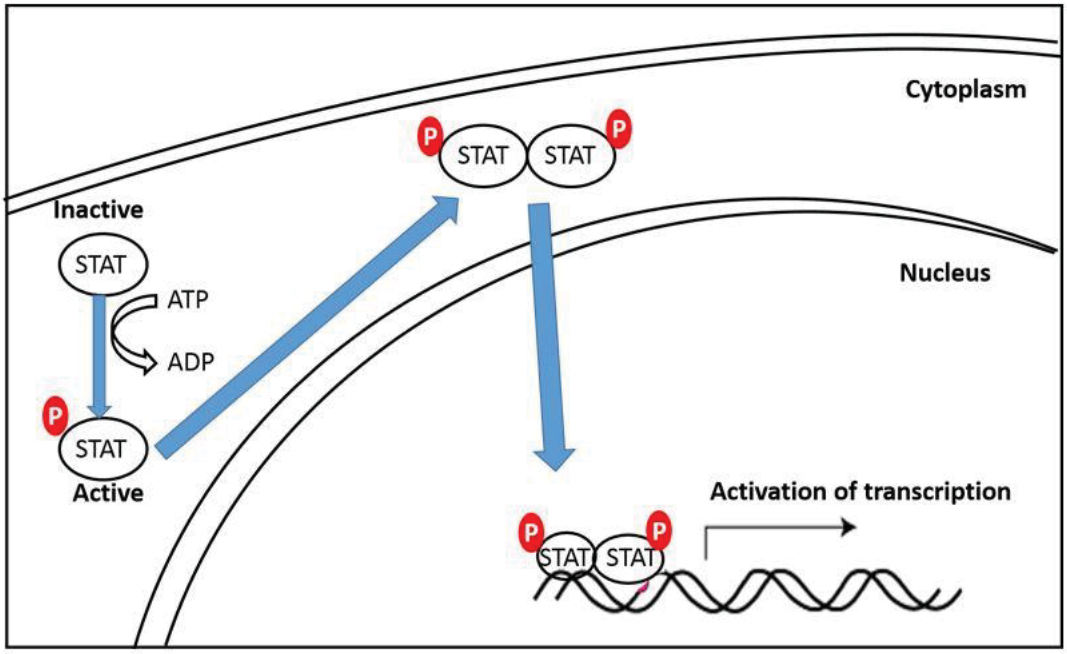


Fig. 5.2

(d) **(i)** With reference to Fig. 5.2, explain how the inactive STAT protein is converted to its active form.

.....

.....

.....

..... [2]

(ii) Besides chemically modifying the STAT protein, describe how the level of the active STAT protein may be controlled after its production.

.....

.....

.....

..... [2]

[Total: 14]

©YIJC

[Turn over

6 Fig 6.1 shows an electron micrograph of a bacteriophage.

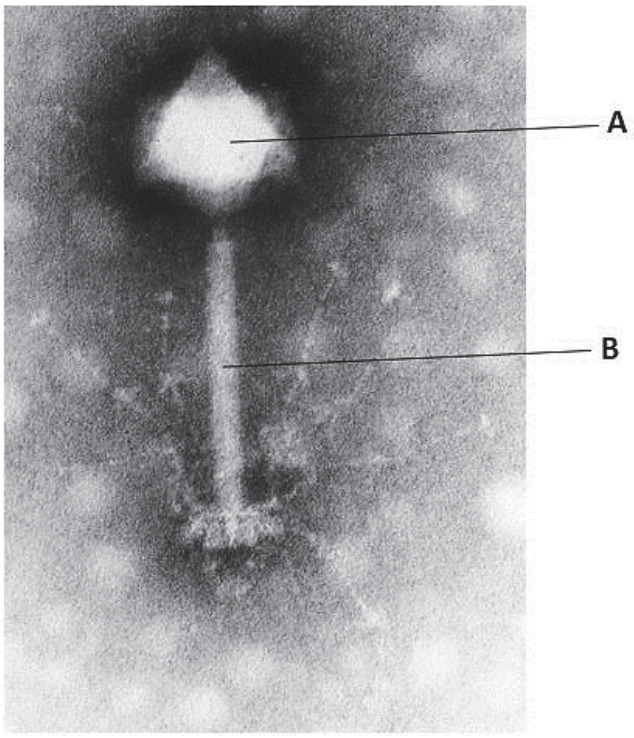


Fig. 6.1

(a) **(i)** Identify the structures labelled **A** and **B**.

A: .....

B: ..... [2]

(ii) Name precisely the type of nucleic acid found inside **A**.

..... [1]

(b) Since ancient times, there have been documented reports of river water having the ability to cure infectious diseases, such as leprosy. In 1896, Ernest Hanbury Hankin reported that something in the waters of the Ganges and Jumna rivers in India had marked antibacterial action against cholera and could pass through a very fine porcelain filter. In 1915, British bacteriologist Frederick Twort, superintendent of the Brown Institution of London, discovered a small agent that infected and killed bacteria.

French-Canadian microbiologist Félix d'Hérelle, announced on September 3, 1917 that he had discovered "an invisible, antagonistic microbe of the dysentery bacillus". D'Hérelle called the virus he discovered a bacteriophage or bacteria-eater (from the Greek *phagein* meaning to eat).

(i) With reference to your knowledge of bacteriophages, explain how the presence of bacteriophages in river water can cure infectious diseases.

.....

.....

.....

.....

.....

..... [3]

(ii) Name a bacteriophage that may be found in river water, which can cure infectious diseases.

..... [1]

(iii) Explain your choice in **(b)(ii)**.

.....

..... [1]

(iv) Suggest a possible limitation of using bacteriophages to cure infectious diseases.

.....

.....

.....

..... [2]

[Total : 10]

©YIJC

www.KiasuExamPaper.com
1956

7 Galactose-1-phosphate uridylyltransferase (GALT) is an enzyme coded by a gene locus on chromosome 9. It catalyses one of the reactions in galactose metabolism that converts ingested galactose to glucose. Deficiency in the enzyme results in a recessive condition known as galactosaemia in humans where galactose accumulates to toxic levels, and can be fatal during the newborn period. However, those afflicted with galactosaemia can live relatively normal lives by avoiding lactose-containing food like milk products.

(a) Explain why avoidance of milk products can help galactosaemia patients live relatively normal lives.

.....

.....

.....

..... [2]

(b) Explain why galactosaemia is a recessive condition.

.....

.....

.....

..... [2]

©YIJC

www.KiasuExamPaper.com
1957

(c) The gene locus determining ABO blood group is also found on chromosome 9. A woman with normal galactose metabolism and blood group A married a man with blood group O with galactosaemia. The woman's father has blood group O and suffered from galactosemia.

Using a genetic diagram, explain how their first child had blood group A and galactosaemia.

[4]

(d) Explain **two** factors that determines the probability that their first child has blood group A and galactosaemia.

.....

.....

.....

..... [2]

[Total: 10]

©YIJC

www.KiasuExamPaper.com
1958

8 Fig. 8.1 shows the absorption spectrum for two types of chlorophyll.

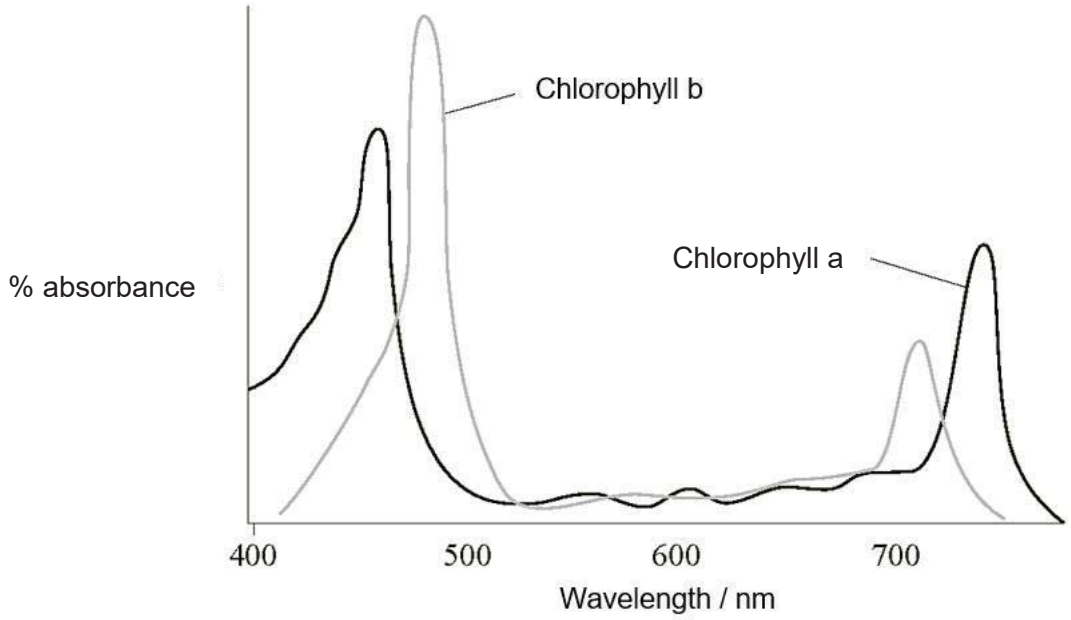


Fig. 8.1

(a) **(i)** Sketch on Fig. 8.1, the action spectrum of photosynthesis. [1]

(ii) Explain the relationship between the absorption spectrum for chlorophyll and action spectrum of photosynthesis for green plants.

.....

.....

.....

..... [2]

(b) Outline the photoactivation of photosystem II in the light-dependent reaction of photosynthesis.

.....

.....

.....

..... [2]

©YIJC

www.KiasuExamPaper.com

Pepper plants can be grown in glasshouses, where extra light can be supplied from electric lamps.

The amount of carbon dioxide in a glasshouse was measured on two different days, M and N. On one of these days, the lamp could not be used, because there was no electricity.

Fig. 8. 2 shows the amount of carbon dioxide in the air around the pepper plants on day M and N.

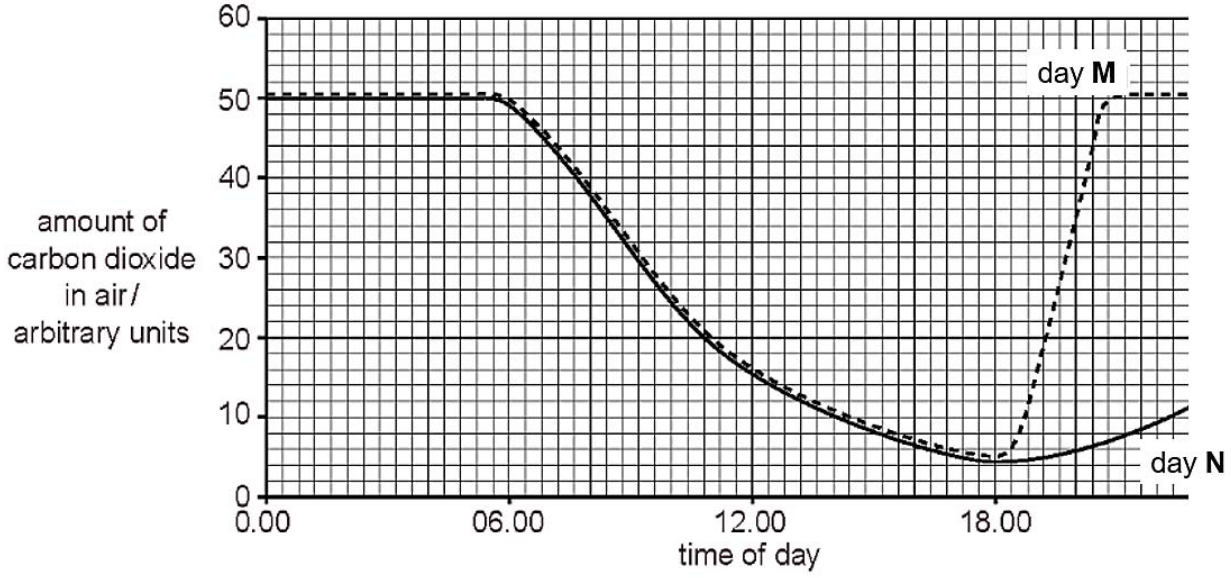


Fig. 8.2

(c) With reference Fig .8.2,

(i) state the time of the day when the pepper plants had removed most of the carbon dioxide,

.....[1]

(ii) state the day where there was no electricity. Explain your answer.

.....

.....

.....

.....

.....

.....[3]

[Total: 9]

9 **(a)** Antibodies are glycoproteins.

State what is meant by the term *glycoprotein*.

[1]

(b) The genes responsible for antibody production are found on different chromosomes, such as chromosome 2 and 14 in humans.

Explain how one antibody molecule is the product of more than one gene.

[2]

(c) Describe and explain how the structure of an antibody molecule is related to its functions.

[4]

©YIJC

www.KiasuExamPaper.com
1961

(d) A human can make more than 10^{12} different antibody molecules. Explain how different specific antibodies are generated.

[4]

[Total: 11]

www.KiasuExamPaper.com
1962

10 Increase in emission of greenhouse gases like carbon dioxide leads to an increase in global temperature due to greenhouse effect. This can affect animals and plants both on land and in water.

(a) Explain how an increase in atmospheric carbon dioxide can lead to global warming.

.....

.....

.....

..... [2]

Sea lions and iguanas feed in the sea around the tropical Galapagos Islands. Sea lions are mammals and iguanas are reptiles. Both species spend some time on land. Fig. 10.1 shows the core body temperature of an iguana and a sea lion at different external temperatures.

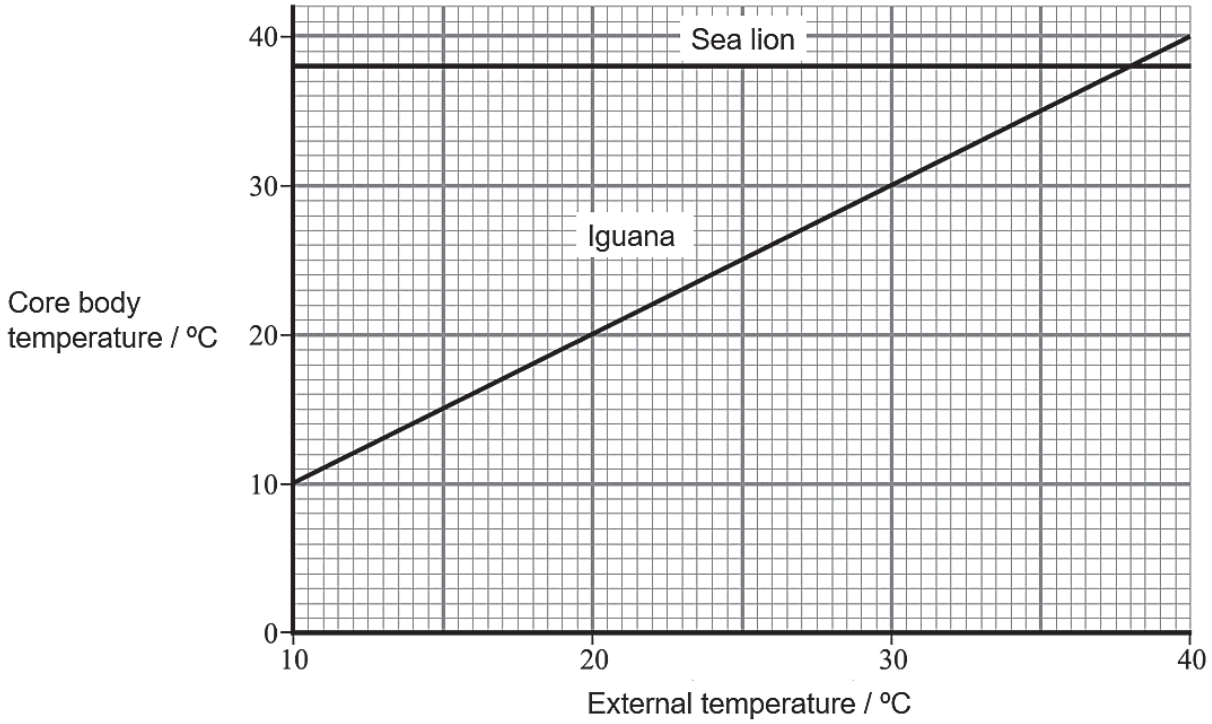


Fig. 10.1

(b) With reference to Fig. 10.1, explain the difference in core body temperature of the two animals at different external temperatures.

.....

.....

.....

..... [2]

Fig. 10.2 shows the oxygen consumption of an iguana and a sea lion at different external temperatures.

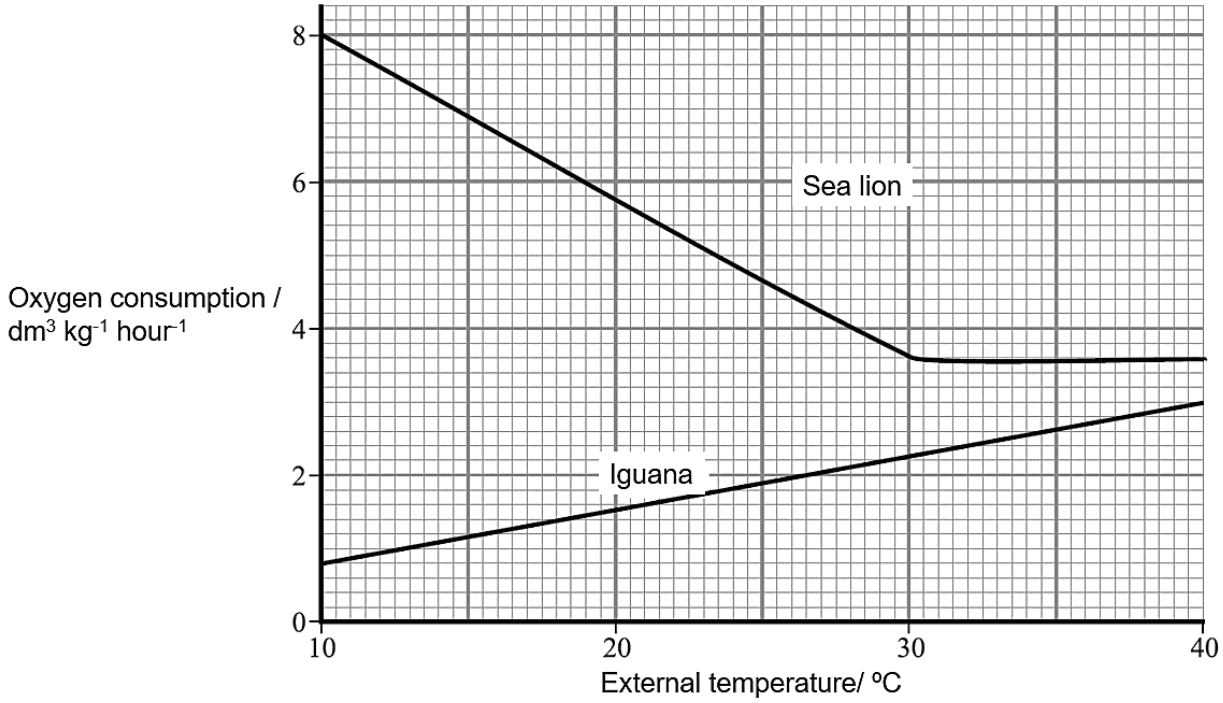


Fig. 10.2

(c) **(i)** The mean temperature of the sea surrounding the Galapagos Islands is 21 °C while the mean air temperature during the day is higher than this.

Suggest why the iguana feeds for only short periods in the water before returning to the land.

.....

.....

.....

..... [2]

(ii) Predict the feeding behavior of iguanas if global warming increases sea temperature by 2 ºC.

.....

..... [1]

©YIJC

www.KiasuExamPaper.com

(iii) Describe **one** abiotic effect of raising sea temperatures.

[2]

(iv) Explain the link between core body temperature and the rate of oxygen consumption in the sea lion between the external temperatures of 10 °C and 30 °C.

[2]

[Total: 11]

©YIJC

www.KiasuExamPaper.com
1965

BLANK PAGE

www.KiasuExamPaper.com
1966

YISHUN INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CANDIDATE NAME

CG

INDEX NO

BIOLOGY 9744/03

Paper 3 Long Structured and Free-Response Questions **17 September 2019**

2 hours

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name and class in the spaces at the top of this page.
Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid/tape.

Section A
Answer **all** questions in the spaces provided on the Question Paper.

Section B
Answer any **one** question in the spaces provided on 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.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	/28
2	/8
3	/14
Section B	
4 or 5	/25
Total	/75

This document consists of **20** printed pages and **2** blank pages.

©YIJC

www.KiasuExamPaper.com

Section A

Answer **all** questions in this section.

1 Dengue fever is a disease caused by the dengue virus (DENV) from the *Flaviviridae* family, *Flavivirus* genus. The disease is transmitted to humans via the bite of an infective *Aedes aegypti* mosquito. There are four different serotypes of dengue virus (DENV1 - 4) circulating in the world, including Singapore. Hence, individuals can be infected with dengue up to four times. Repeat dengue infections have been associated with a higher occurrence of severe dengue. In Singapore, the Ministry of Health (MOH), together with the National Environment Agency (NEA), track and report all dengue-related cases quarterly.

(a) Based on your understanding of the characteristics of viruses, discuss if the *Flaviviridae* family is a valid phylogenetic grouping.

[3]

(b) **(i)** Explain how the dengue virus is transmitted from person to person.

[2]

(ii) Explain why individuals can be infected up to four times with DENV.

[3]

(iii) Explain why repeated dengue infections have been associated with a higher occurrence of severe dengue.

[3]

An individual suspected of being infected by DENV can undergo dengue fever testing to determine if the infection is indeed due to DENV. DENV infection can be difficult to diagnose without laboratory tests because symptoms may initially resemble those of other diseases, such as chikungunya infection. Two primary types of testing available are:

- molecular testing which detects the genetic material of DENV in blood within the first week after symptoms appear, using reverse transcriptase (RT) in polymerase chain reaction (RT-PCR);
- antibody tests which detect two different classes of antibodies produced by the body in response to a dengue fever infection. This helps diagnose if the infection is current or has occurred recently.

(c) DENV genetic material in the blood occurs in small amounts. Thus, the genetic material needs to be amplified before it can be identified.

(i) Suggest how the DENV genetic material is amplified using RT-PCR.

[4]

(ii) State the **two** classes of antibodies that are tested for.

[1]

(iii) Explain what is meant by *'classes of antibodies'*.

.....

.....

.....

..... [2]

Wolbachia are natural bacteria present in up to 60% of insect species, including some mosquitoes. However, the *Wolbachia* bacterium is not usually found in the *A. aegypti* mosquito. For many years, scientists have been studying *Wolbachia*, looking for ways to use it to potentially control the mosquitoes that transmit human viruses. The World Mosquito Program's research has shown that when introduced into the *A. aegypti* mosquito, *Wolbachia* can help to reduce the transmission of these viruses to people.

(d) State **one** structural difference between dengue virus and *Wolbachia* bacteria.

.....

..... [1]

(e) Explain how the introduction of *Wolbachia* into *A. aegypti* can reduce transmission of DENV to people.

.....

.....

.....

..... [2]

In 2017, a trial was conducted at different parts of Singapore to investigate the effectiveness of *Wolbachia*-carrying male mosquitoes in controlling mosquito populations. One of the areas selected was Nee Soon East.

Fig. 1.1 shows the location of the trial site at Yishun Street 21 and the control site at Yishun Street 11.

Fig. 1.1

(f) **(i)** Suggest **two** considerations for the selection of trial and control sites.

.....

.....

.....

..... [2]

(ii) Explain why only male mosquitoes carrying *Wolbachia* were released.

.....

..... [1]

www.KiasuExamPaper.com

The number of *A. aegypti* caught in ovitraps during the pre- and post-release periods in the trial site were compared to the control site. Table 1.1 shows part of the data collected.

Table 1.1

Number of *A. egypti* caught per 100 ovitraps			
Pre-release		Post -release	
Street 11	Street 21	Street 11	Street 21
20	21	42	15
25	24	35	19
17	22	48	22
22	18	44	25
16	16	32	13

©YIJC

www.KiasuExamPaper.com

(g) Using the following formulae and t-table,

$$t = \frac{(x_1 - x_2)}{\sqrt{\frac{(s_1)^2}{n_1} + \frac{(s_2)^2}{n_2}}}$$

$$S = \sqrt{\frac{\sum(X - \overline{X})^2}{N}}$$

where s = standard deviation
$\sum$ = sum of
x = observation
$\overline{x}$ = mean
n = sample size

df	*probability*				
	0.25	*0.10*	*0.05*	*0.025*	*0.01*
1	1.00	3.08	6.31	12.71	31.82
2	0.82	1.89	2.92	4.30	6.96
3	0.76	1.64	2.35	3.18	4.54
4	0.74	1.53	2.13	2.78	3.75
5	0.73	1.48	2.02	2.57	3.37
6	0.72	1.44	1.94	2.45	3.14
7	0.71	1.42	1.90	2.37	3.00
8	0.71	1.40	1.86	2.31	2.90
9	0.70	1.38	1.83	2.26	2.82
10	0.70	1.37	1.81	2.23	2.76

conduct a t-test on appropriate samples to determine if the release of *Wolbachia*-carrying mosquitoes was effective in reducing the mosquito population at the trial site.

t-value .....

probability .....

conclusion .....

.....

.....

..... [4]

[Total: 28]

©YIJC

[Turn over

www.KiasuExamPaper.com

2 Occasionally during meiosis, homologous chromosomes fail to separate at anaphase. This is known as non-disjunction. Turner's syndrome is the most common chromosome mutation in human females. It can occur due to non-disjunction in meiosis during gametogenesis. Some resulting gametes will be missing an X chromosome.

Some forms of Turner's syndrome occur when one of the pair of X chromosomes is not missing but has become damaged. The damaged X chromosome may have been broken and re-formed so that part of its structure is lost.

Fig. 2.1 is a diagram of a normal X chromosome and two forms of 'damaged' X chromosomes, X_1 and X_2.

- In X_1, a section of the 'p' arm of the chromosome is missing. This deletion leads to reduced height of the affected female and abnormalities such as narrowing of the aorta.
- In X_2, a section of the 'q' arm of the chromosome is missing. This deletion leads to little or no development of the ovaries in an affected female.

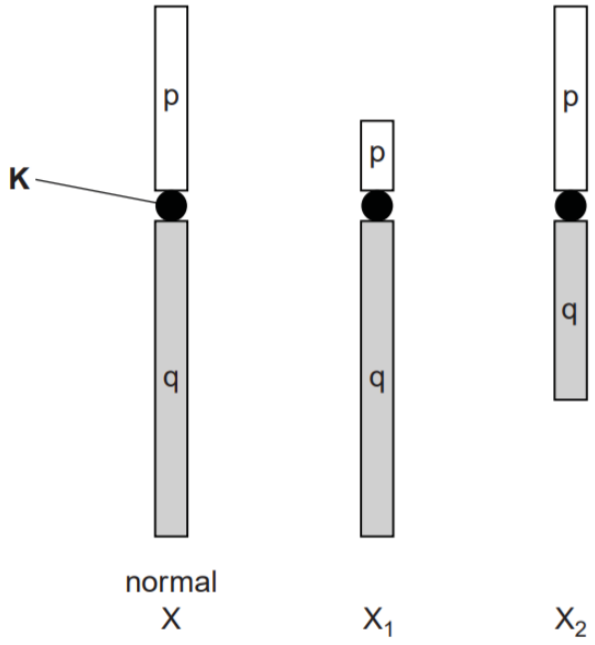


Fig. 2.1

(a) Name structure **K**.

.....

[1]

(b) **(i)** Name the type of chromosome mutation that resulted in X_1 and X_2.

.....

[1]

(ii) Explain why X_1 and X_2 result in different phenotypes.

[3]

(iii) Describe **one** similarity and **one** difference between chromosome mutation and gene mutation.

Similarity:

Difference:

[2]

(c) Mothers with the X_1 form of Turner's syndrome can pass on the chromosome mutation to their daughters while females with X_2 form of Turner's syndrome often do not produce any offspring.

Suggest why females with X_2 form of Turner's syndrome often do not produce any offspring.

[1]

[Total: 8]

©YIJC

www.KiasuExamPaper.com

3 There are two indigenous eel species in New Zealand: the shortfin eel (*Anguilla australis*) and the longfin eel (*Anguilla dieffenbachii*). The longfin eel is endemic to New Zealand and is found in rivers and streams well inland, while the shortfin eel is limited more to coastal areas. Young eels (elvers) migrate from the sea into freshwater streams, where they live as adults for many years (up to 100 years for longfins) before migrating back to sea to reproduce in the Pacific Ocean.

Table 3.1 shows the timing and age of migration in the two species of eels.

Table 3.1

	Timing of migration	Age of migration in females	Age of migration in males
Longfin eel	Males in April and females follow soon after	Females at 34 years (75 – 180 cm)	Males at an average of 23 years (48 – 74 cm)
Shortfin eel	Males in February – March and females follow soon after	Females at 22 years (50 – 100 cm)	Males at an average of 14 years (38 – 58 cm)

The breeding area for shortfin eels is thought to lie to the northeast of New Zealand near Samoa. Evidence obtained by satellite tracking of the eels indicates that the longfin breeding area is in the southwest tropical regions of the Pacific Ocean – somewhere near Fiji and New Caledonia.

The females release their eggs, the males fertilise them, and the adults die after spawning. The eggs hatch into larvae that float to the surface and drift back towards New Zealand. They may take about 17 months to arrive. Larvae then change into transparent juvenile eels.

Fig. 3.1 shows the migration patterns and the breeding grounds of the eels.

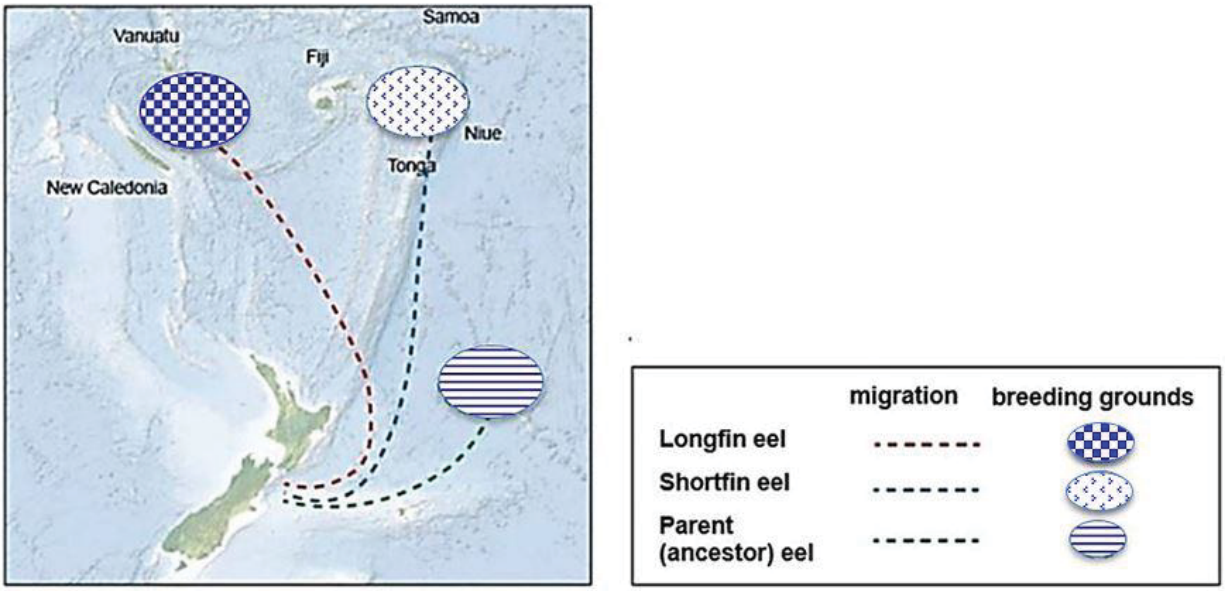


Fig. 3.1

It is thought that the ancestral species had a shorter migration, which was genetically programmed and has changed to provide the migrations seen in the shortfin and longfin eels today.

(a) Compare sympatric and allopatric speciation.

[2]

(b) With reference to the information provided, explain how natural selection could have led to the evolution of the two species of eels.

[5]

©YIJC

www.KiasuExamPaper.com

Fig. 3.2 shows the phylogenetic tree of the eels in the genus *Anguilla.*

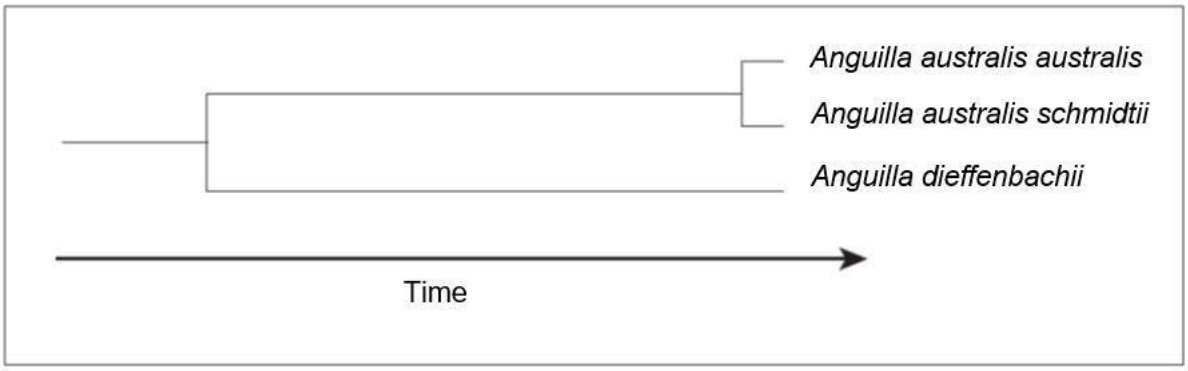


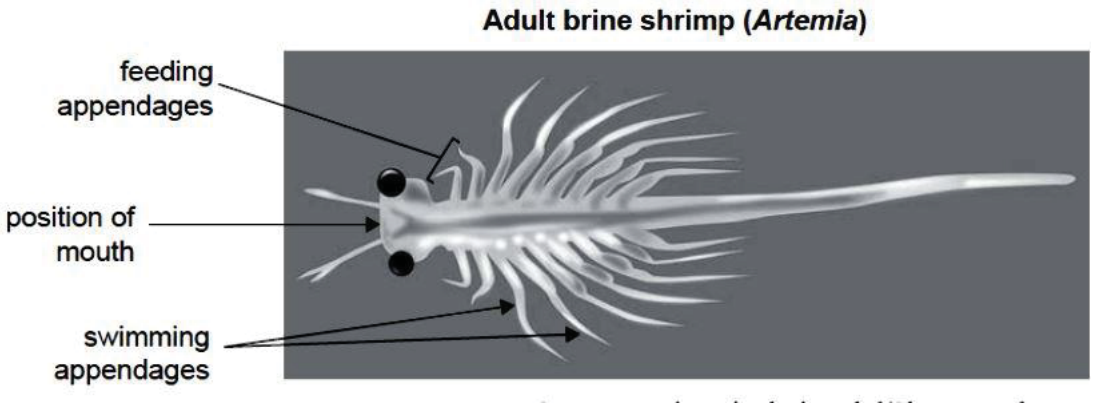
Fig. 3.2

(c) Explain how molecular methods can be used to determine the evolutionary relationships of the different species of *Anguilla* fishes.

[3]

The *Hox* genes are master regulatory genes that influence cells in a particular location of an animal embryo in order to develop structures for that part of the body.

In the brine shrimp, *Artemia*, the expression of the *Hox* genes *Ubx* and *Scr* results in the growth of either a swimming appendage or a feeding appendage, depending on whether the genes are expressed in cells that are in the mid-region of the body or that are near the mouth. These specialised appendages are labelled in Fig. 3.3 below.



Source: patrimonio designs ltd/Shutterstock.com

Fig. 3.3

(d) Suggest **one** way that genes are regulated so that the same genes can produce different appendages when the genes are expressed in different locations in the *Artemia* embryo.

.....

..... [1]

(e) Explain why it is impossible for evolution to occur at the individual level.

.....

.....

.....

.....

.....

..... [3]

[Total: 14]

©YIJC

www.KiasuExamPaper.com

Section B

Answer **ONE** question in this section.

Write your answers on the lined paper provided at the end of this Question Paper.
Your answers should be illustrated by large, clearly labelled diagrams, were appropriate.
Your answers must be in continuous prose, where appropriate.
You answers must be set out in parts **(a)**, **(b)**, etc., as indicated in the question.

4 **(a)** Compare the signaling pathways between G protein coupled receptor and receptor tyrosine kinase in relation to blood glucose regulation. [11]

(b) Using named examples, describe the various functions of biological receptors and explain their importance in organisms. [14]

[Total: 25]

5 **(a)** Using named examples, compare continuous and discontinuous variation, and explain how the environment can affect phenotypes. [11]

(b) Describe how variation arises and how recessive alleles are preserved in a population. [14]

[Total: 25]

©YIJC

www.KiasuExamPaper.com
1980

©YIJC

www.KiasuExamPaper.com
1981

©YIJC

www.KiasuExamPaper.com
1982

©YIJC

www.KiasuExamPaper.com
1983

©YIJC

www.KiasuExamPaper.com
1984

©YIJC

www.KiasuExamPaper.com
1985

©YIJC

www.KiasuExamPaper.com
1986

BLANK PAGE

©YIJC

www.KiasuExamPaper.com
1987

BLANK PAGE

©YIJC

www.KiasuExamPaper.com
1988

YISHUN INNOVA JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATION
Higher 2

CANDIDATE NAME			
CG		DATE	

H2 BIOLOGY

9744/04

29th August 2019

2 hours 30 minutes

READ THESE INSTRUCTIONS FIRST

Write your name and class in the spaces at the top of this page.

Write in dark blue or black pen only.
You may use a soft pencil for any diagrams or graphs.
Do not use paper clips, highlighters, glue or correction fluid.

Answer **all** questions in the spaces provided on 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.
The number of marks is given in brackets [ ] at the end of each question or part question.

Shift
Laboratory

For Examiner's Use	
1	/27
2	/9
3	/19
Total	/55

This document consists of **18** printed pages and **2** blank pages.

Answer **all** questions.

Before you proceed, read carefully through the **whole** of Questions 1 Part I.

QUESTION 1

Part 1

Plants transport sucrose through vascular bundles in stems and roots. You are required to investigate the movement of sucrose solution.

The apparatus will be set up as shown in Fig. 1.1, using a boiling tube and a 5 cm^3 syringe.

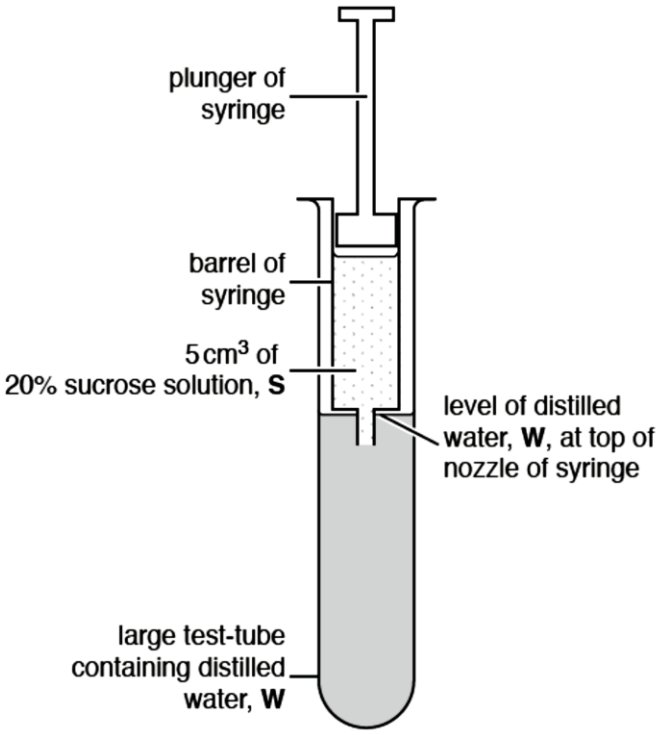


Fig. 1.1

You are provided with the materials shown in Table 1.1.

Table 1.1

labelled	contents	hazard	Volume / cm^3
S	20% sucrose solution	None	40
W	Distilled water	none	300

Carry out step 1 to step 5 to investigate the movement of sucrose from the syringe.

1. Set up the apparatus as shown in Fig. 1.1 but **without** any distilled water, **W**, in the boiling tube.

2. Observe and record in **(a)(i)** your observations of any movement of the sucrose solution.
3. Put **W** into the boiling tube. The level of **W** must be to the top of the nozzle of the syringe, as shown in Fig. 1.1.

4. Observe and record in **(a)(i)** your observations.

5. Empty the syringe and the boiling tube into the container labelled **For waste**.

(a) Complete Table 1.2.

Table 1.2

Contents of boiling tube	Observations
Without distilled water	
With distilled water	

[1]

(b) You will need to investigate the movement of sucrose solution out of the syringe by:

- setting up the apparatus, as shown in Fig. 1.2
- collecting the sucrose solution released from the syringe during each of the first four two-minute periods after setting up the apparatus, as shown in Fig. 1.2
- testing the mixtures of sucrose solution and water collected during each of the four two-minute periods, using the non-reducing sugar test
- recording the time taken for the first colour change to occur when heating each mixture with Benedict's solution during the non-reducing sugar test.

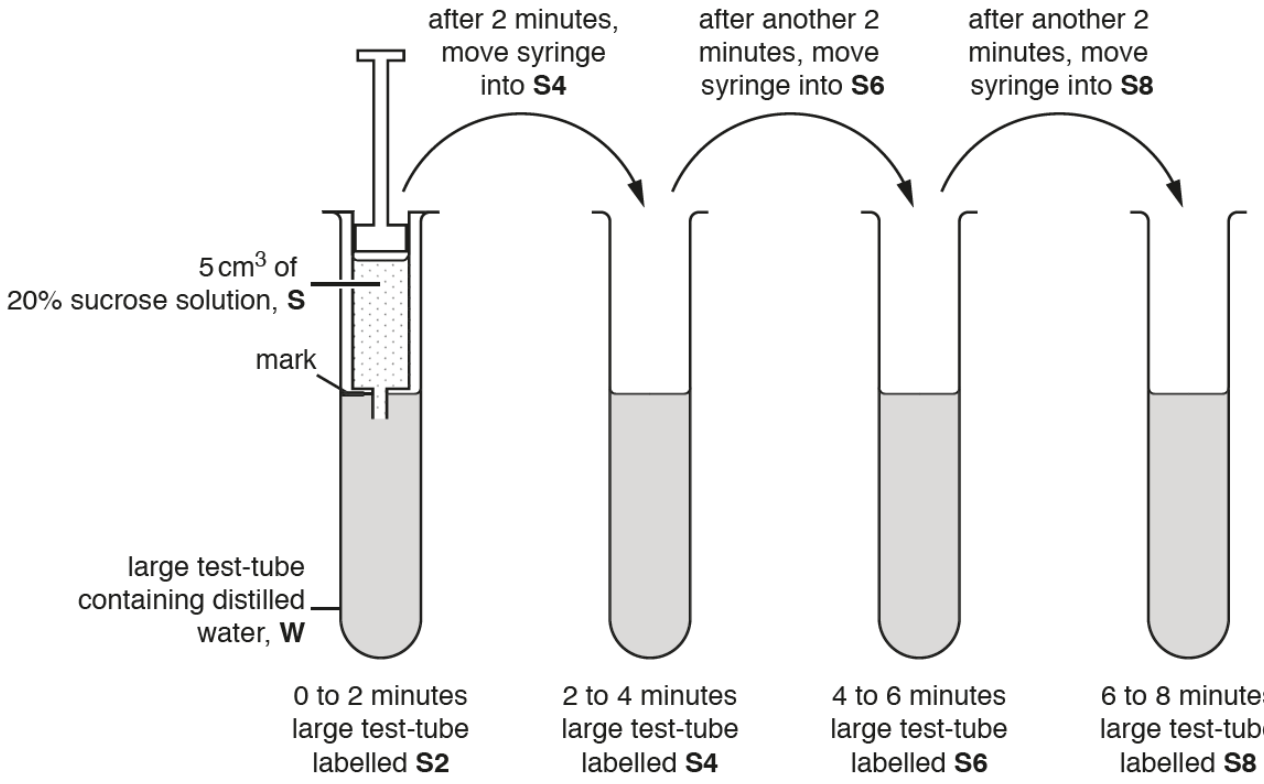


Fig. 1.2

6. Set up a water-bath and heat the warm water to boiling. This will be used in step 20 and step 27 during the tests for non-reducing sugar.

7. Label the four boiling tubes **S2, S4, S6** and **S8**.

The apparatus needs to be set up as shown in Fig. 1.2 so that at the start there is a standard volume of distilled water in each of the boiling tubes **S2, S4, S6** and **S8**.

8. Put the empty 5 cm^3 syringe from step 5 into the boiling tube labelled **S2**.

9. Put a mark on the boiling tube labelled **S2**, as shown in Fig. 1.2, so that the mark is level with the top of the nozzle of the syringe.

(i) Describe how you will use the apparatus provided to find the volume of distilled water, **W**, needed to fill the boiling tube to the mark, **when the syringe is in place**.

.....

.....

.....

..... [2]

(ii) Find the volume of distilled water, **W**, needed to fill the boiling tube to the mark, using the method you described in **(b)(i)**.

volume ..... [1]

10. Put the volume of distilled water, **W**, stated in **(b) (ii)** into each of the four boiling tubes, **S2, S4, S6** and **S8**.

11. Fill a 5 cm^3 syringe with more than 5 cm^3 of sucrose solution, **S**. Push the plunger in to the 5 cm^3 mark to make sure there are no air bubbles in the nozzle.

12. Put the syringe into the first boiling tube, **S2**, as shown in Fig. 1.2. The nozzle of the syringe must be below the surface of the distilled water, **W**. Start the stopwatch.

13. Leave the syringe in the boiling tube **S2** for 2 minutes, then remove the syringe and put it immediately into the next boiling tube, **S4**. The nozzle o the syringe must be below the surface of the distilled water, **W**. Leave a further 2 minutes. Do **not** stop the stopwatch.

14. Repeat this process with each of the two remaining boiling tubes, **S6** and **S8**, removing the syringe from the last boiling tube, **S8**, at 8 minutes. Each time, the nozzle of the syringe must be below the surface of the distilled water, **W**.

To estimate the rate of movement of the sucrose solution into distilled water, **W**, the solution collected in each boiling tube will be tested for non-reducing sugar.

After hydrolyzing any non-reducing sugar present, the measurement used will be the time taken for the first colour change to occur when the solution is heated with Benedict's solution. This measurement allows the test to be semi-quantitative.

(iii) A student suggested the hypothesis that:

the rate of movement of the sucrose solution from the syringe into the water in the boiling tube will decrease with time.

If the student's hypothesis is correct, describe the expected trend in the time taken for the first colour change to occur when each solution collected in the boiling tube **S2, S4, S6** and **S8** is heated with Benedict's solution.

.....

..... [1]

You will test the samples of the solution collected during each two-minute period for non-reducing sugar, using step 15 to step 31.

You are provided with the materials shown in Table 1.3.

Table 1.3

labelled	contents	hazard	Volume / cm^3
H	Dilute hydrochloric acid	Irritant	50
A	10 g sodium hydrogencarbonate powder	None	-
Benedict's	Benedict's solution	harmful	50

It is recommended that you wear suitable eye protection. If any of these materials come into contact with your skin, wash them off immediately under cold water.

15. Put a bung into one of the boiling tubes, **S2, S4, S6** or **S8**, and, with a finger on top of the bung, shake the solution to mix well.

16. Remove the bung and pour the solution from this boiling tube into a labelled beaker.

17. Put 2 cm^3 of the solution in the beaker into a labelled test tube.

18. Put 2 cm^3 of dilute hydrochloric acid, **H**, into the same test tube. Shake this test tube gently to mix.

19. Repeat step 15 to step 18 for **each** of the solutions in the remaining boiling tubes.

20. Put all the test-tubes into the boiling water-bath (set up in step 6). Leave the test-tubes for 2 minutes.

21. After 2 minutes, remove the test-tubes from the water-bath and put them into the beaker of water labelled **For cooling**.

You will need the boiling water-bath again for step 27.

22. Leave the test-tubes in the beaker to cool for 3 minutes. After 3 minutes, continue with step 23.

23. Put a small amount of sodium hydrogencarbonate, **A**, into each test-tube. The mixture will fizz and rise up inside each test-tube.

24. Repeat step 23 until there is no more fizzing.

*Note: There may be a small amount of sodium hydrogencarbonate, **A**, left in the bottom of each test-tube.*

25. Put 3 cm^3 of Benedict's solution into the test-tube containing **S2**.

26. Shake the test-tube gently to mix.

27. Put this test-tube into the boiling water bath. Start timing.

28. Measure the time taken for the first appearance of a colour change in the test-tube.

*If there is no colour change after 180 seconds, **stop timing** and record the result in **(b)(iv)** as 'more than 180'.*

29. Record in **(b)(iv)** the result from step 28.

30. Remove the test-tube from the boiling water-bath. Put the test-tube in the test-tube rack.

31. Repeat step 25 to step 30 with each of the other solutions instead of **S2**.

(iv) Record your results in an appropriate table.

[4]

Turn over for remainder of Question 1

(v) The student's hypothesis stated that:

The rate of movement of the sucrose solution from the syringe into the water in the boiling tube will decrease with time.

State whether your results provide evidence to **support** or **reject** this hypothesis.

Explain how your results provide evidence for this decision.

support or reject .....

explanation .....

..... [1]

(c) A student modified the procedure by:

- using a 10% sucrose solution in the syringe
- collecting sucrose solution from the syringe in four-minute periods over a total time of 1200 seconds
- collecting any precipitate formed during the Benedict's test when testing each solution for non-reducing sugar
- drying and weighing the precipitate from each test to determine the mass of sucrose that had been present.

After carrying out the procedure, the student processed and analysed the results to calculate the rate of movement of the sucrose solution at specific times after placing the syringe in the boiling tube of water for the first time.

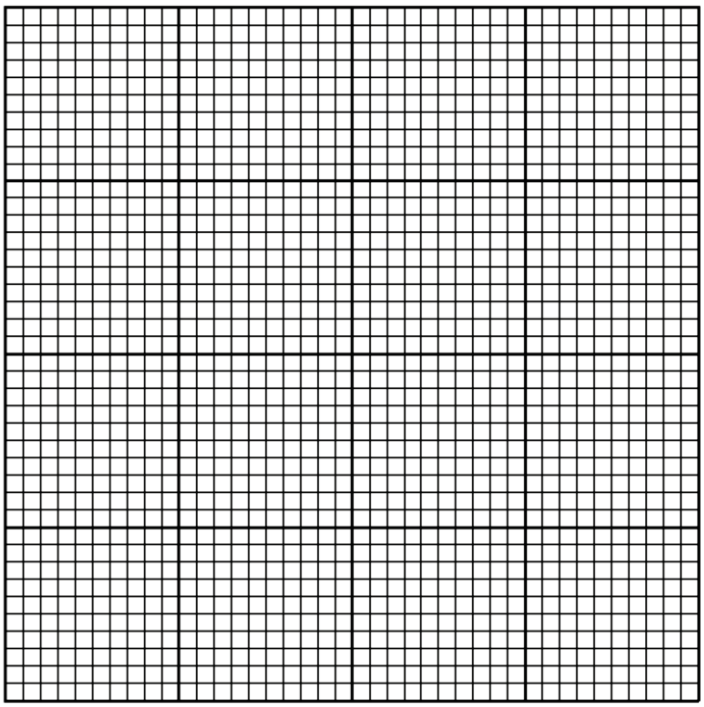
The calculated rates are shown in Table 1.4.

Table 1.4

Time / s	Rate of movement of sucrose solution / arbitrary units
240	0.18
480	0.09
720	0.04
960	0.02
1200	0.01

(i) Plot a graph of the data in Table 1.4 on the grid provided.

Use a sharp pencil for drawing graphs.



[4]

(ii) Use your graph to find the rate of movement of sucrose solution at 5 minutes.

Show on the graph how you determined your answer.

rate of movement ..... [2]

(iii) The procedure investigated how the rate of movement of sucrose from the syringe changed with time.

The procedure can be modified to investigate the effect of sucrose concentration, instead of time, on the rate of movement of sucrose solution. In the modified procedure, the sucrose solution from the sringe only needs to be collected once. The time period over which the sucrose solution is collected in the procedure needs to be standardised.

Use the graph to suggest a suitable time period for collecting the sucrose solution from the syringe.

Give a reason for your answer.

time period .....

reason .....

..... [1]

(iv) You are to modify this procedure to investigate the effect of using different concentrations of sucrose on the rate of movement of the sucrose solution.

State the concentrations of sucrose solution you would use.

.....

Describe how the concentrations of sucrose solution would be prepared.

.....

.....

.....

..... [3]

Part 2

A set of 5 different glucose concentrations were prepared using a 10% stock glucose concentration. To obtain a set of colour standards, Benedict's test for reducing sugars was carried out on these glucose solutions. A 1 : 10 ratio of glucose solution: Benedict's solution was used in the preparation. The colour change in the solutions was recorded after incubation in a boiling water bath for 2 minutes.

Table 1.5 shows the results for the colour standards after carrying out Benedict's test.

Table 1.5

Concentration of glucose /%	Description of colour change and suspension
10.0	Brick red precipitate in reddish brown solution
5.00	Reddish orange precipitate in reddish solution
2.50	Orange precipitate in orange solution
1.25	Trace amount of greenish precipitate in bluish-green solution
0.625	Faint amount of greenish precipitate in blue solution
Orange juice	

(d) (i) You are provided with 5 cm^3 of orange juice, labelled **O**. Plan and carry out a procedure to estimate the glucose concentration of the orange juice from the results in Table 1.5. Indicate your observation in Table 1.5

.....

.....

.....

.....

.....

Estimated glucose concentration of the orange juice ..... [3]

(ii) Describe **two** other modifications to your method that would increase confidence in the conclusion and explain how these modifications would achieve this.

[4]

[Total: 27]

QUESTION 2

Resistance to antibiotics within a population of bacteria is due to selection pressure. This can be linked to the use of antibiotics by patients.

A study was carried out into the link between antibiotic use and the presence of resistant *Escherichia coli (E. coli*) populations in human communities.

- Over 30 000 patients were involved in the study.
- Only patients attending large medical clinics took part in the study.
- The number of prescriptions issued by each clinic was used as an estimate of antibiotic use.
- Urine from patients attending the clinics was used as a possible source of antibiotic resistant *E. coli*.
- Antibiotic resistance of *E. coli* in the urine samples was measured using the disc diffusion method.

The disc diffusion method measures sensitivity of bacteria to an antibiotic. A bacterial population with low sensitivity to an antibiotic is resistant to that antibiotic.

In the disc diffusion method a Petri dish is filled with nutrient agar and urine samples containing *E. coli* are spread evenly across the agar.

Discs containing different antibiotics are placed on top of the agar. A lid is put on the Petri dish and the plate is incubated overnight.

Fig. 2.1 shows an example of a Petri dish from the study after incubation.

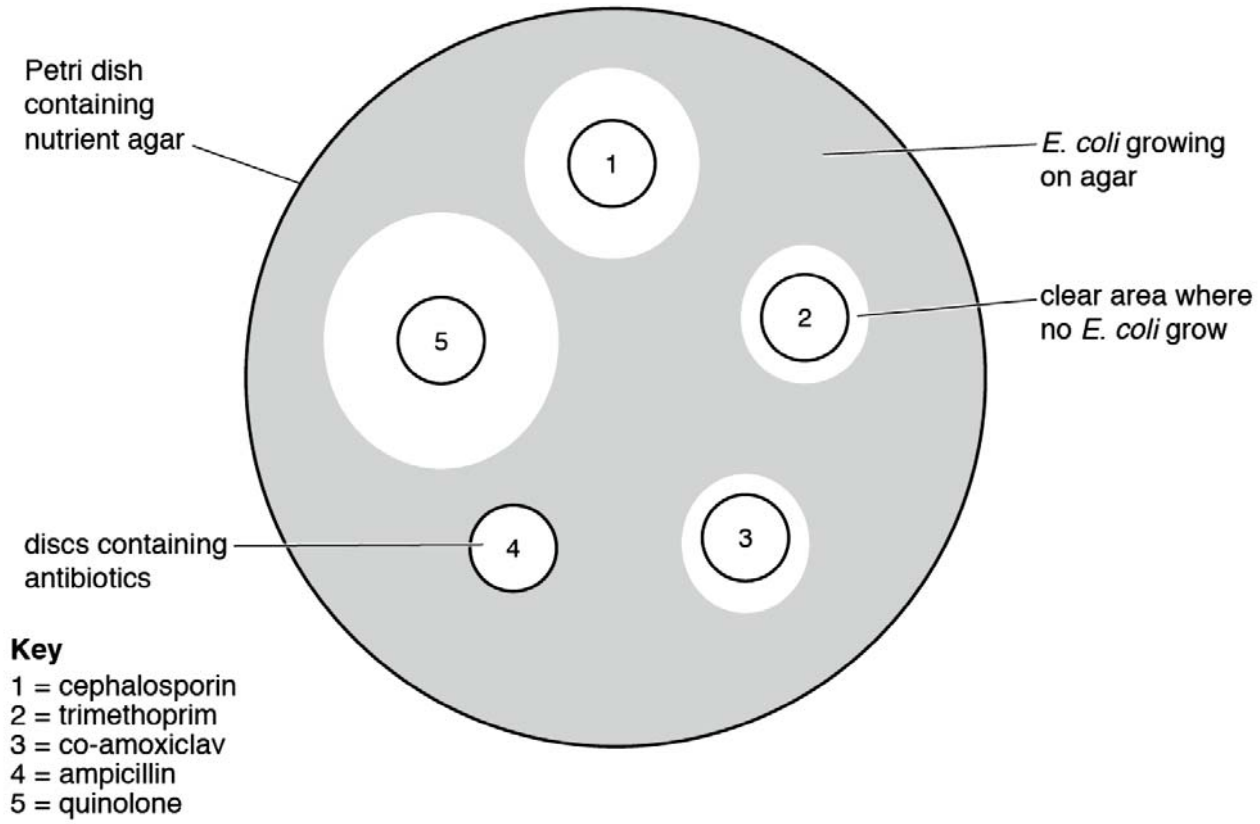


Fig. 2.1

(a) **(i)** Suggest two variables that need to be standardised when using the disc diffusion method in this study.

1 .....

.....

2 .....

..... [2]

(ii) Describe how you would determine the sensitivity of *E.coli* to each antibiotic.

.....

.....

.....

.....

..... [2]

(b) Table 2.1 shows the results of this investigation.

Table 2.1

antibiotic	antibiotic use /prescriptions per thousand patients per year		percentage *E. coli* resistance	
	mean ($\bar{x}$)	standard deviation (s)	mean ($\bar{x}$)	standard deviation (s)
cephalosporin	107.0	83.0	6.5	3.5
trimethoprim	62.6	25.6	26.3	5.8
co-amoxiclav	75.5	43.9	8.4	5.7
ampicillin	351.9	171.1	53.2	7.2
quinolone	33.6	18.3	2.2	1.9

Comment on the standard deviations for **antibiotic use** as shown in Table 2.1.

.....

.....

.....

..... [2]

(c) Outline how use of antibiotics e.g. ampicillin, can be linked to the development of antibiotic resistance in *E. coli.*

[3]

[Total: 9]

QUESTION 3

During this question, you will require access to a microscope and slide **S1**.

Fig. 3.1 is a photomicrograph of a stained transverse section through a plant stem.

The stem of this plant grows submerged in water and contains air spaces.

You are not expected to be familiar with this specimen.

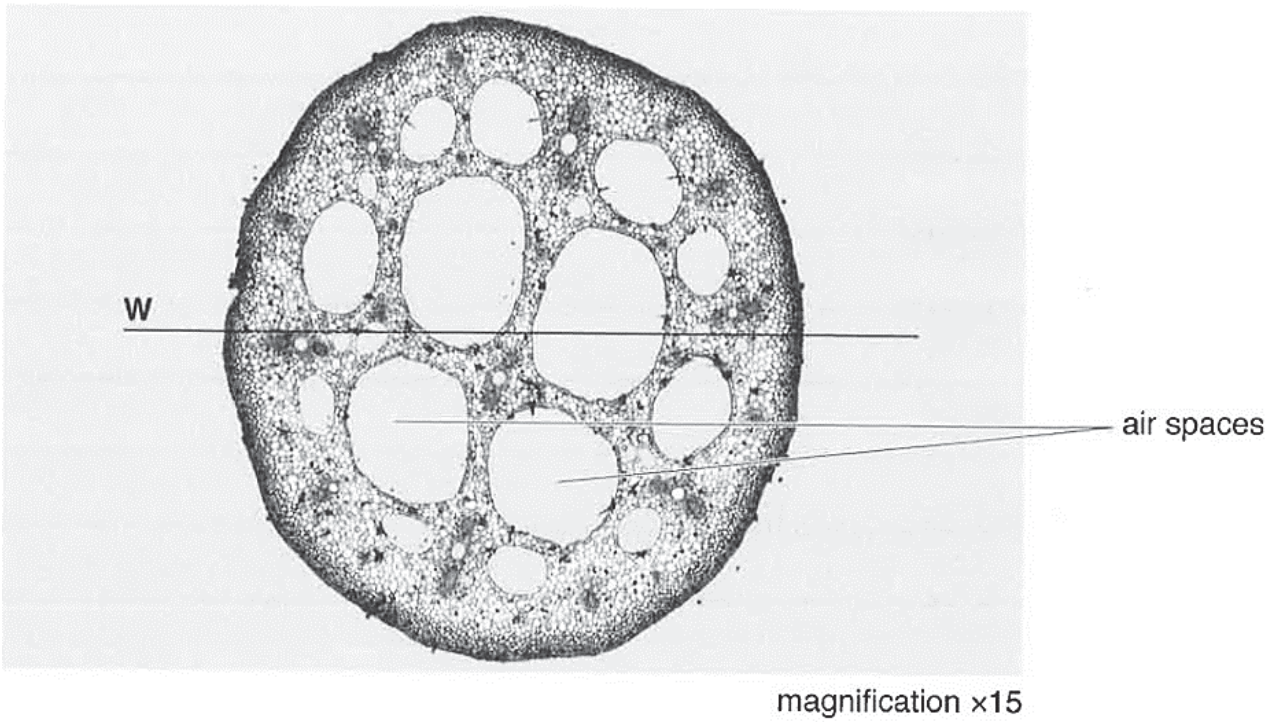


Fig. 3.1

Slide **S1** is a microscope slide of a stained transverse section through the stem of a different species of plant. This stem also grows submerged in water and contains air spaces.

(a) Use a suitable table to record observable differences between the specimen in Fig. 3.1 and the specimen on slide **S1**.

[3]

(b) **(i)** Calculate the actual radius of the stem at the position marked by line **W** in Fig. 3.1.

You should show your working and use appropriate units.

actual radius of stem ..... [1]

You are required to estimate the radius of the stem on slide **S1**.

(ii) Put the clear plastic ruler on the stage of the microscope and view the scale lines on it using low power (×10 objective lens).

Estimate the diameter of the field of view to 1 decimal place of a mm.

diameter of field of view ..... mm [1]

(iii) View the stem on slide **S1** using low power.

Estimate the fraction of the diameter of the field of view occupied by the radius of the stem on slide **S1**.

fraction of diameter of field of view ..... [1]

(iv) Using your estimates from **(b)(ii)** and **(iii)**, calculate the radius of the stem on slide **S1**, using appropriate units.

radius of **S1** ..... [1]

(v) Describe how to obtain a more accurate measurement of the radius of the stem on slide **S1**.

State any appropriate pieces of apparatus that you might need.

.....

.....

.....

.....

.....

..... [3]

(c) (i) You are required to use a sharp pencil for drawings.

Use the space provided to draw a plan diagram of part of the stem on slide **S1**, as shown in the shaded area of Fig. 3.2. A plan diagram only shows the arrangement of the different types of tissues. Individual cells must **not** be drawn in plan diagrams.

Within this part of the stem there will be a number of air spaces.

You should only draw three of these air spaces.

Your drawing should show the correct shape and proportion of the tissues **and** three air spaces.

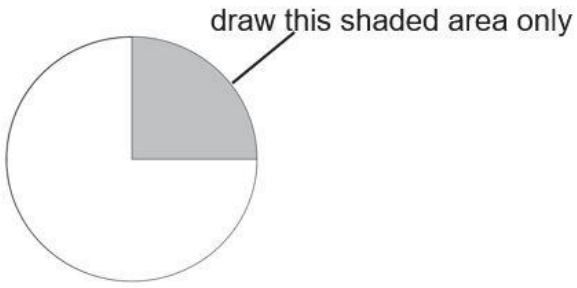


Fig. 3.2

[4]

(ii) Observe the cells that are found between the air spaces in slide **S1**.

Select **one** group of **three** touching cells that are found between two air spaces.

Each cell of the group must touch at least one of the other cells.

Make a large drawing of this group of **three** cells.

[4]

(d) Suggest **one** advantage of having air spaces in plant stems that grow submerged in water, as shown in Fig. 3.1, and slide **S1**.

.....

..... [1]

[Total: 19]

BLANK PAGE

BLANK PAGE

Apparatus / Material List

SN	Apparatus	Quantity
Question 1		
1	20% sucrose solution in a container, labelled **S**, provided at room temperature	At least 40 cm^3
2	Distilled water in a beaker or container, labelled **W**, provided at room temperature	At least 300 cm^3
3	1.0 $moldm^{-3}$ hydrochloric acid in a container, labelled **H**, provided at room temperature	At least 50 cm^3
4	Sodium hydrogen carbonate (bicarbonate) powder in a container, labelled **A**	At least 10 g
5	**[MH][N]** Benedict's solution in a container, labelled **Benedict's**, provided at room temperature	At least 50 cm^3
6	Fresh orange juice in a covered container, labelled **O**, provided at room temperature	At least 5 cm^3
7	Glass rod	1
8	10 cm^3 syringe	1
9	5 cm^3 syringes	2
10	3 cm^3 syringes	2
12	1 cm^3 syringes	1
13	Pasteur pipette, plastic	1
14	50 cm^3 measuring cylinder	1
15	Beakers, capacity approximately 100 cm^3	4
16	Beaker, capacity approximately 250 cm^3	1
17	Test tubes	4
18	Boiling tubes	5
19	Rubber bung to fit boiling tube	1
20	Test-tube rack	1
21	Boiling tube rack	1
22	Wooden test-tube holder	1
23	Bunsen burner, bench mat, wire gauze and tripod to support water-bath	1 each
24	Beaker, approximately 400 cm^3, with approximately 200 cm^3 of tap water at 40 - 45°C, suitable for heating as a water-bath, labelled as **water-bath**.	1
25	Beaker, capacity approximately 400 cm^3, with approximately 200 cm^3 of tap water at room temperature, labelled **For cooling**	1
26	Spatula	1
27	Container with approximately 400 cm^3 of tap water, labelled **For washing**	1
28	Container, capacity approximately 400 cm^3, labelled **For waste**	1

SN	Apparatus	Quantity
29	Paper towels	~ 10
29	Glass marker pen (permanent)	1
30	Stop-watch showing seconds	1
31	Eye goggles	1 pair
Question 3		
1	Microscope with • An eyepiece lens, ×10 magnification • A low-power objective lens, ×10 magnification • A high-power objective lens, ×40 magnification • An eyepiece graticule fitted into the eyepiece lens	1 between 2
2	Slide **S1** placed on a Petri dish	1 between 2
3	Clear plastic ruler, marked in mm	1 between 2

2019 JC2 H2 BIOLOGY PRELIM EXAMINATION PAPER 1 ANSWERS

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

KIASU ExamPaper
Islandwide Delivery | Whatsapp Only 88660031

©YIJC

[Turn over

YISHUN INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CANDIDATE NAME

CG

INDEX NO

BIOLOGY

9744/02

Papers 2 Structured Questions

2 September 2019

2 hours

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name and class in the spaces at the top of this page.
Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid/tape.

Answer **all** questions in the spaces provided on 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.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
1	/8
2	/8
3	/12
4	/7
5	/14
6	/10
7	/10
8	/9
9	/11
10	/11
	/100

KIASU ExamPaper
Islandwide Delivery | Whatsapp Only 88660031

This document consists of **23** printed pages and **1** blank page.

Suggested Mark Scheme

1 Cholesterol is synthesized in the smooth endoplasmic reticulum (SER) in liver cells by a series of enzyme-catalysed reactions.

Within the SER, molecules of cholesterol and triglycerides are surrounded by proteins and phospholipids to form lipoproteins. These lipoprotein particles enter the Golgi apparatus where they are packaged into vesicles and pass to the blood.

Fig. 1.1 is an electron micrograph of part of a liver cell showing lipoprotein particles within the Golgi apparatus.

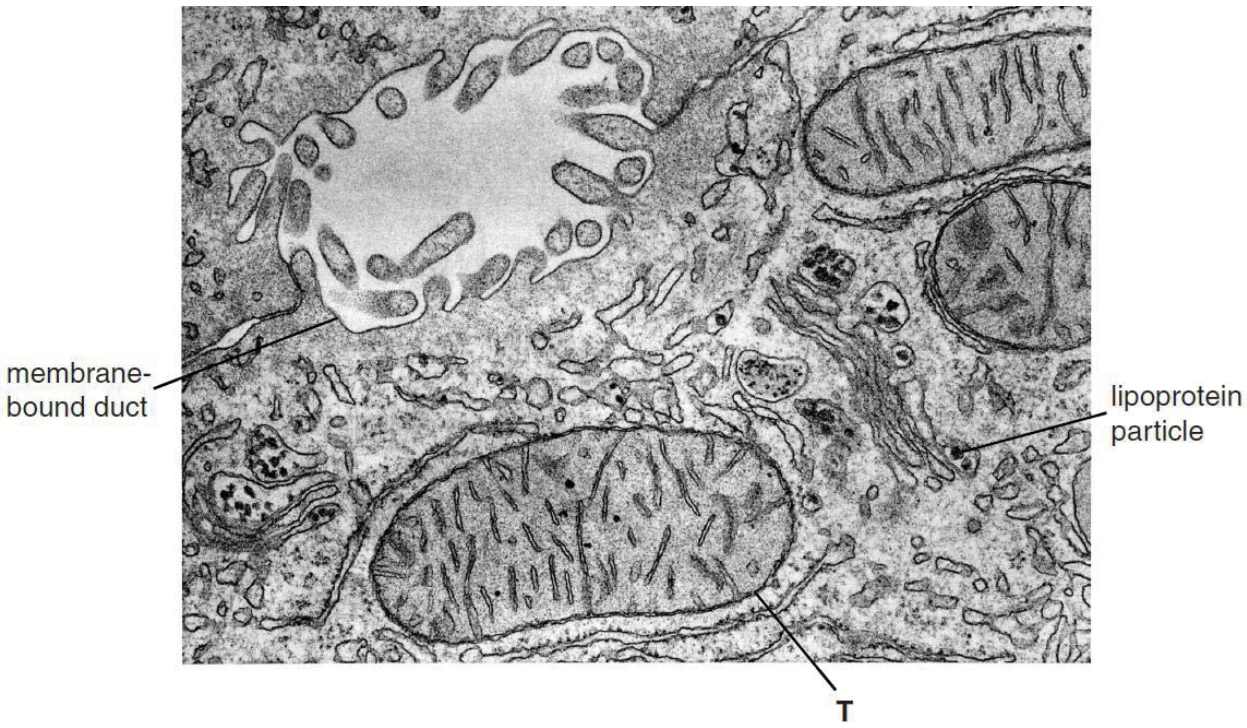


Fig. 1.1

(a) **(i)** Name structure **T** in Fig. 1.1.

1. Mitochondrion

(Reject: mitochondria) [1]

(ii) Explain how the structure of **T** is adapted to its function in liver cells.

1. Inner membrane of T is highly folded to form cristae;
2. which increases the surface area for attachment of many proteins (e.g. ATP synthase) required for the process of oxidative phosphorylation to synthesise ATP;

OR

1. Fluid-filled matrix enclosed by the inner membrane of T contains enzymes required for the Krebs cycle;
2. so that organic substrates can be oxidised to form ATP via substrate level phosphorylation;

OR [3]

KIASU ExamPaper Islandwide Delivery Within One Working Day

1. **Fluid-filled matrix enclosed by the inner membrane of T contains enzymes required for the Krebs cycle;**
2. **So that NAD^+ and FAD can undergo oxidation by dehydrogenation to form reduced NAD / NADH and reduced FAD / NADPH that carry electrons to the inner membrane of T for ATP synthesis via oxidative phosphorylation;**

3. **For the process of (any 1 below):**

   - ✓ **amino acid activation to form liver cell surface membrane receptor proteins**
   - ✓ **For the movement of transport vesicles between the parts of the endomembrane system / to the cell surface membrane;**
   - ✓ **For the movement of secretory vesicles carrying secretory proteins to the cell surface membrane for exocytosis / release to the extracellular environment;**
   - ✓ **For synthesis of cholesterol / triglycerides / glycogen;**

The low density lipoprotein (LDL) receptor, is a transmembrane glycoprotein made in the liver cell that allows for uptake of cholesterol from the body into liver cells.

Once attached to LDL receptors on the liver cell surface membrane, LDLs release their cholesterol and triglycerides. The cholesterol is stored or oxidised to bile salts.

(b) Describe the sequence of events **following the entry** of LDL receptor **polypeptide chain** synthesised at the bound ribosomes on the rough endoplasmic reticulum (rER) **into the rER lumen**, to the **insertion** of the LDL receptor **in** the **liver cell surface membrane**.

1. **linear polypeptide glycosylated in the rER lumen / cisternae and also folds into its native three-dimensional configuration with the help of rER chaperone proteins;**

2. **(glyco)protein enclosed inside a transport vesicle that pinches off from the rER & transported to (cis face of) Golgi apparatus (GA) for further modification / for addition, deletion or substitution of sugar monomers on oligosaccharide chains of (glycol)protein / LDL receptor;**

3. **protein is **inserted / embedded into the membrane of transport vesicle which then buds off from (trans face of) GA, guided to cell surface membrane by microtubules, with the expenditure of ATP;**

   Reject: secretory vesicle

4. **Membrane of transport vesicle fuses with cell surface membrane and the protein is inserted / embedded in the liver cell surface membrane.**

   Reject: exocytosis [4]

[Total: 8]

KIASU ExamPaper Islandwide Delivery Whatsapp ONE 8666

2 **(a)** Fig. 2.1 represents a molecule of triglyceride.

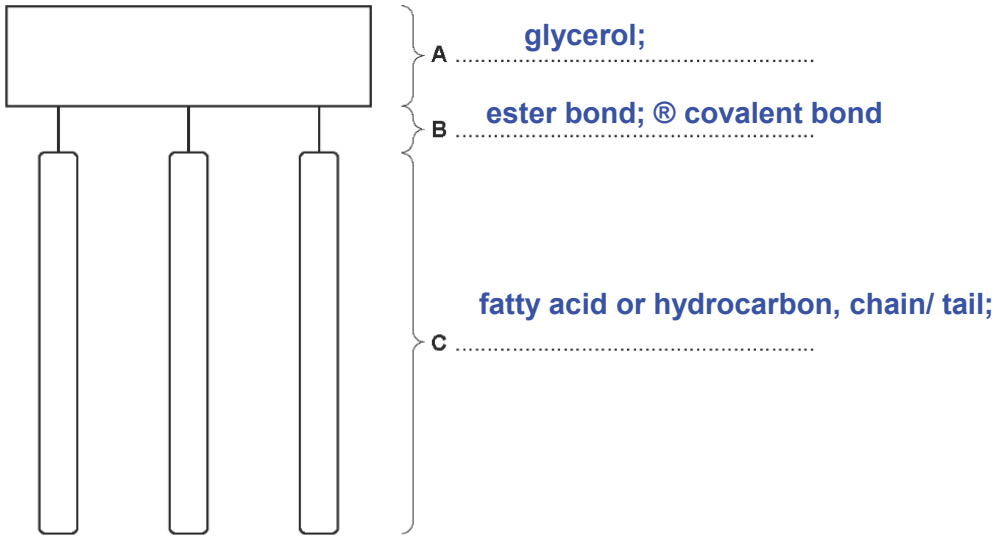


Fig. 2.1

(i) Name the components **A** and **C** and name the bond **B**.
Write your answers on the dotted lines provided in Fig. 2.1. [3]

(ii) Describe how bond **B** is broken.

1. **hydrolysis reaction**
2. **with a molecule of water is added *Reject: water is needed***

[1]

(b) A phospholipid is sometimes described as a modified triglyceride;

(i) State how the structure of a phospholipid differs from a triglyceride.

1. **2 fatty acid/ hydrocarbon, chain/ tails instead of 3;**
2. **with phosphate group vs without**
3. **most contain N / choline (attached to phosphate in, head/ polar portion);**

[2]

Reject: amphipathic vs hydrophobic

(ii) Explain how a phospholipid is suited to its role in cell membranes.

1. **is amphipathic, thus able to form bilayer**

   with hydrophilic head (reject: polar head) interacting with aq. medium inside & outside the cell
2. **FA tails form hydrophobic core,**

   to prevent (free) movement of / form barrier to hydrophilic substances conferring membrane selective permeability (reject: charged molecules)
3. **weak hydrophobic interactions btw FA tails**

   allow lateral movement of phospholipid within monolayer → fluidity

[2]

[Total: 8]

©YIJC

[Turn over

www.KiasuExamPaper.com

3 Enzymes are globular proteins.

(a) State what is meant by the term *globular*.

1. **spherical; *(reject: ball, round, cylindrical, circular)***

2. **tertiary structure**

   maintained by R group interactions like hydrophobic interactions, ionic, hydrogen bonds, disulfide bridges (any 2) [2]

(b) Fig. 3.1 shows an enzyme-catalysed reaction.

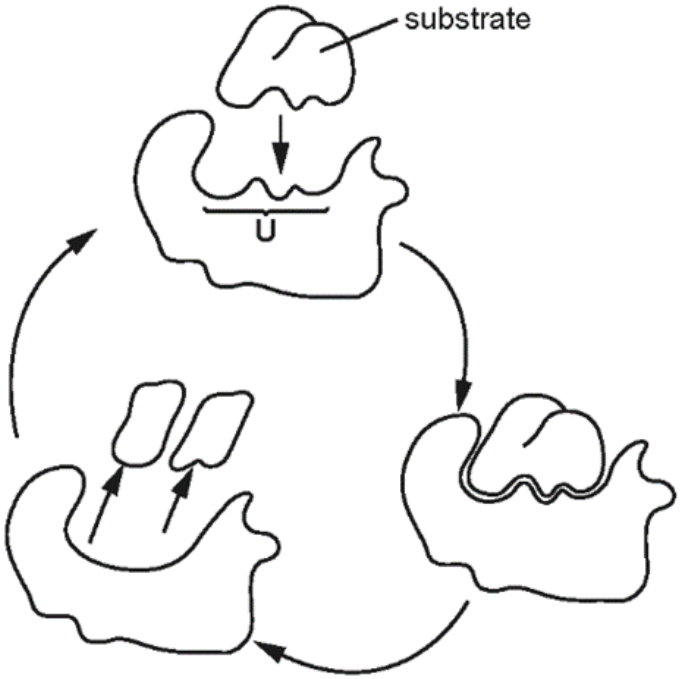


Fig. 3.1

(i) Name the part of the enzyme labelled **U**.

1. **active site *(Reject: binding site)*** [1]

(ii) With reference to Fig. 3.1, explain the mode of action of enzymes.

1. **substrate binds to active site which is complementary**

   in terms of shape / charge;

2. **via weak bonds like hydrogen bonds / hydrophobic interactions**

   to form enzyme-substrate complex;

3. **causes bond stress in substrate / holds substrate in correct orientation and in close proximity /**

   alter charged in substrate, increasing reactivity / creates conducive microenvironment (any 2);

4. **lowering activation energy, speeding up reaction**

   enzymes remain unchanged at the end of the reaction; [4]

KiasuExamPaper Instant Delivery, Whatsapp Only 88

(c) The enzyme urease is known to be affected by competitive inhibitors. A student carried out an investigation to determine the percentage of urea hydrolysed by ureases at various time intervals,

- without any inhibitor;
- with a competitive inhibitor.

The experiment was carried out in test tubes set up as follows:

Tube **A** – 1 cm^3 of urease solution, 10 cm^3 pH 7.5 buffer solution, 1 cm^3 urea solution
Tube **B** – 1 cm^3 of urease solution, 9 cm^3 pH 7.5 buffer solution, 1 cm^3 of competitive inhibitor 1 cm^3 urea solution
Tube **C** – 1 cm^3 of water, 10 cm^3 pH 7.5 buffer solution, 1 cm^3 urea solution

The results are shown in Table 3.1 below.

Table 3.1

Time/ min	Percentage of urea remaining / %		
	Tube A	Tube B	Tube C
0	100	100	100
5	55	99	100
10	29	98	100
15	14	96	100
20	8	95	100
25	5	92	100
30	3	90	100

(i) State how Tube **C** acts as a control for this investigation.

1. **to show that urea is not hydrolysed**

   in the absence of urease [1]

(ii) Explain the difference in results between Tube **A** and Tube **B**.

1. **urea hydrolysed more quickly in Tube A than Tube B**

   Tube A only has 3% urea remaining while Tube B has 90% urea remaining at the end of 30 minutes;

2. **in Tube A, substrate binds enzyme at active site**

   via complementary fit to form enzyme-substrate complex;

3. **in Tube B, competitive inhibitor has similar shape / structure as substrate**

   thus compete with substrate binding at active site;

4. **forming enzyme-inhibitor complex**

   prevents / blocks substrate from binding; [4]

[Total: 12]

KIASU ExamPaper Worldwide Delivered Whatsapp 88660037

4 Epithelial tissue, liver tissue and cardiac muscle tissue each respond differently to damage.

- Epithelial tissue of the gas exchange system contains stem cells.
- Liver tissue contains cells in a non-dividing state that can enter a cell cycle when stimulated.
- Cardiac muscle tissue contains cells that cannot divide at all. Damage is permanent and is associated with scar tissue formation.

(a) Explain the importance of mitosis in the repair of damaged tissue.

1. **genetically identical daughter cells ;**

2. **to replace to play the same function; *(reject: repair damaged cells)*** [2]

(b) One of the reasons why stem cells are important in tissue repair is their ability to divide continually.

(i) Describe **one other** reason why stem cells are important in tissue repair.

1. **multipotent ;**

2. **capable of differentiating / specializing into cells of epithelial tissue that has the same function ;** [2]

Reject: unspecialised / undifferentiated

(ii) Explain how stem cells are able to divide continually.

1. **presence of active telomerase**

   prevents shortening of telomere during DNA replication in each cell cycle / prior to each cell division; *(Reject: prevent end-replication problem)*

2. **prevents from telomere from reaching critical length**

   that triggers apoptosis; *(Reject: cell will not die)* [2]

(c) Suggest how stem cells in the epithelial tissue can help with cardiac damage.

1. **chemically induce epithelial stem cells to change from multipotent to pluripotent / ref to plasticity;** [1]

[Total : 7]

KIASU ExamPaper
Islandwide Delivery | Whatsapp Only 88660031

5 The *STAT5* gene, a member of the *STAT* family, is widely expressed in hematopoietic stem cells (HSC) to regulate the self-renewal and differentiation of the stem cells.

(a) Explain **how** the different cell types such as T cell and B cell can arise from a single HSC.

1. **differential gene expression occurred during differentiation;**
2. **The specific combination of activators present in the cells are different. They bind to their respective enhancers to up-regulate transcription of T cell-specific genes and B cell-specific genes respectively / idea of repressors and silencers;**

Or

3. **Different sets of cell type specific genes were switched on / off by DNA methylation / histone deacetylation / histone methylation;**
4. **Different sets of proteins are synthesized, causing the two cells to have different structures and hence functions;** **[3]**

Fig. 5.1 shows the process of transcription in a eukaryotic cell that produces ribosomal RNA (rRNA), an important component of ribosomes, which serve as the site of synthesis of STAT proteins.

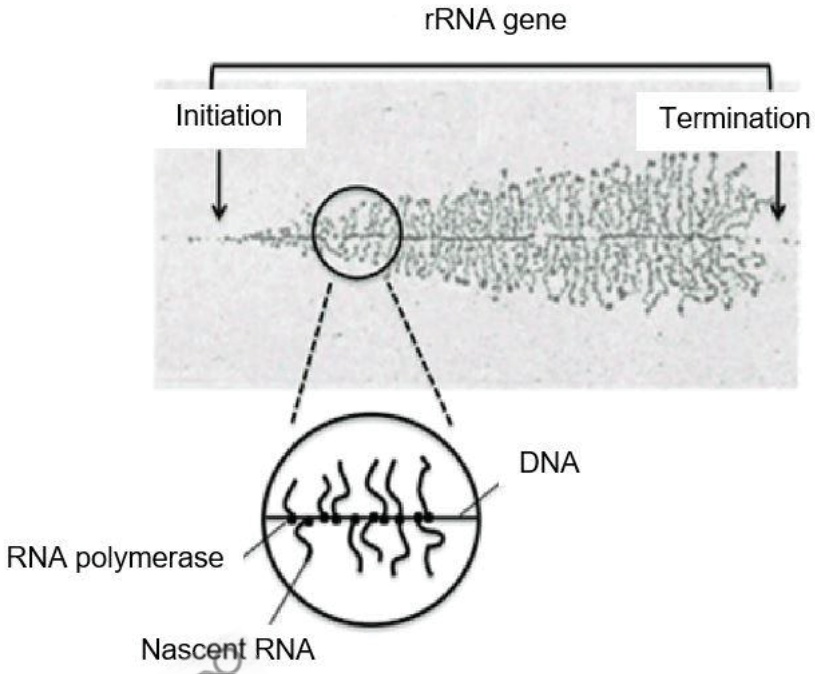


Fig. 5.1

KIASU Exam Paper Islandwide Delivery Hotline Only 88660031

(b) **(i)** Suggest how RNA polymerase is able to recognise and bind to the promoter on DNA and not to other DNA regions.

1. RNA polymerase contains a **DNA-binding site/domain** ***(Reject: active site, promoter sequence not transcribed)*** which recognises and binds to specific DNA sequence in the **promoter / is complementary in terms of shape, size and charge to specific DNA sequence in the promoter**;

2. ref. **Nucleotide sequence** of promoter offers a **complementary shape** to DNA-binding site/domain of RNA polymerase;
(Reject: complementary base pairing) [2]

©YIJC

[Turn over

(ii) Account for the observed pattern of transcription in Fig. 5.1.

1. **Description: Shorter** RNA transcripts seen at the **beginning** of the DNA template strand, which get **longer** till the **end** of the transcription unit, (where the transcripts detach from the DNA template after transcription termination);

2. **Explain:** Due to simultaneous transcription of rRNA gene **by multiple RNA polymerases**, causing RNA transcripts to extend perpendicularly from DNA template strand; [2]

(iii) State **one** role of rRNA in protein synthesis.

Any 1 below:

1. The rRNA in ribosomes holds the tRNA and mRNA together in **close proximity**, via complementary base pairing / hydrogen bonds;
2. the rRNA in the small ribosomal subunit has a **recognition sequence (mRNA binding site)** which allows it to bind to the 5' end of the mRNA so that initiator tRNA bearing the amino acid methionine can attach to the start codon AUG on mRNA, facilitating the formation of a translation initiation complex;
3. rRNA **peptidyl transferase** activity catalyses formation of a **peptide bond** between the new amino acid and the polypeptide chain;
4. Ref. rRNA associate with ribosomal proteins to form ribosomal subunits

Reject: rRNA forms the ribosomes / use as template for synthesis of ribosomes

[1]

(c) STAT proteins are transcription factors that play important roles in the development and differentiation of many cell types.

In humans, there are different forms of STAT5 protein, each playing a slightly different role in different cell types.

Explain **how** the **same *STAT5* gene** can produce **different forms** of STAT5 protein.

1. **Alternative RNA splicing;**
   Reject: splicing

2. **Different spliceosomes** in different cell types bind to specific **splicing sites** in the introns of pre-mRNA;

3. **All introns are removed and different combinations of exons** are **spliced** together to form three different mature mRNA hence different protein forms of STAT5 protein;

Reject: reference to mutations to STAT5 gene [2]

KIASU ExamPaper Handwritten Solutions Whatsapp Only 88660031

Upon external stimulation, STAT protein is activated from its inactive form and binds to another activated STAT protein to form a dimer. This protein dimer then translocates to the nucleus and regulates the expression of other genes as shown in Fig. 5.2.

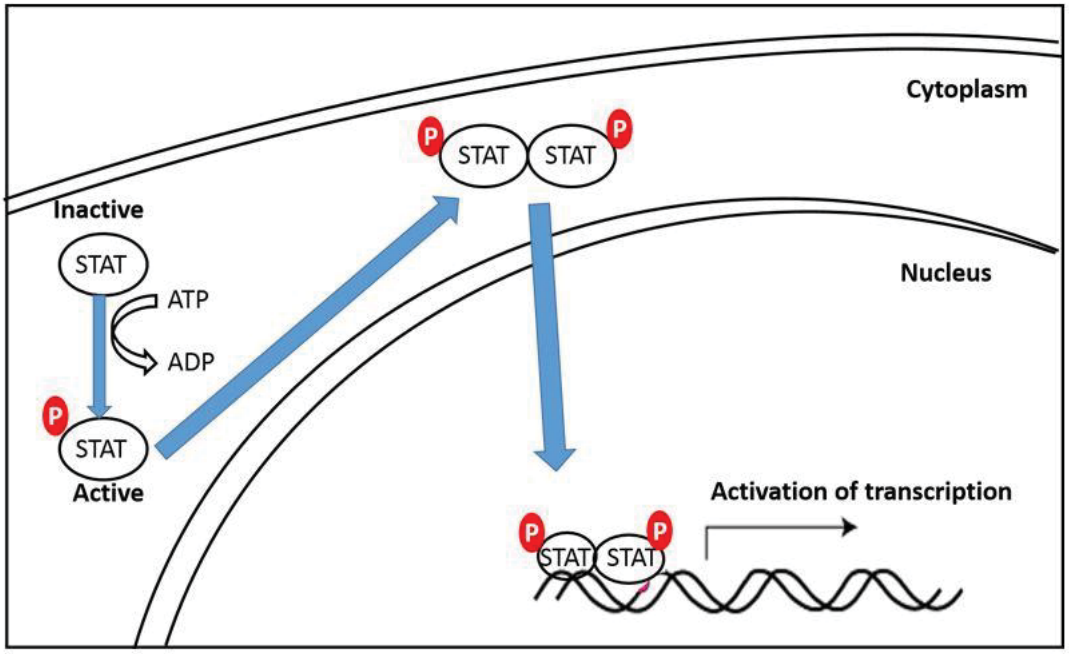


Fig. 5.2

(d) **(i)** With reference to Fig. 5.2, explain how the inactive STAT protein is converted to its active form.

1. Via **Post-Translational modification / phosphorylation;**

2. **ATP** is hydrolysed to **donate a phosphate group** to the inactive STAT to form an active STAT protein; [2]

(ii) Besides chemically modifying the STAT protein, describe how the level of the active STAT protein may be controlled **after its production**.

1. Active STAT proteins may be **tagged with ubiquitin** proteins which are recognized by and **degraded in proteasomes;**

2. This **decreases the concentration / amount** of STAT;

Reject: reference to any form of chemical modification, including addition / removal of phosphates groups [2]

[Total: 14]

KIASU ExamPaper
Islandwide Delivery | Whatsapp Only 8668 0931

6 Fig 6.1 shows an electron micrograph of a bacteriophage.

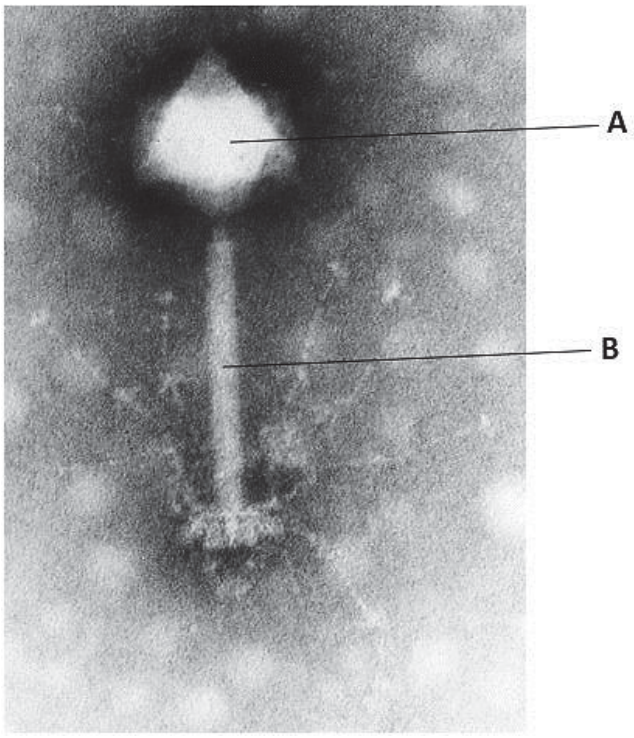


Fig. 6.1

(a) **(i)** Identify the structures labelled **A** and **B**.

A: icosahedral head / capsid;
B: tail sheath /sheath; [2]

(ii) Name precisely the type of nucleic acid found inside **A**.

1. double-stranded linear DNA / deoxyribonucleic acid [1]

KIASU ExamPaper
Islandwide Delivery | Whatsapp Only 88660031

(b) Since ancient times, there have been documented reports of river water having the ability to cure infectious diseases, such as leprosy. In 1896, Ernest Hanbury Hankin reported that something in the waters of the Ganges and Jumna rivers in India had marked **antibacterial action against cholera (is a disease caused by the bacterium *Vibrio cholerae*)** and could **pass through a very fine porcelain filter**. In 1915, British bacteriologist Frederick Twort, superintendent of the Brown Institution of London, discovered a small agent that **infected and killed bacteria**.

French-Canadian microbiologist Félix d'Hérelle, announced on September 3, 1917 that he had discovered "an invisible, antagonistic microbe of the dysentery bacillus". D'Hérelle called the virus he discovered a **bacteriophage** or **bacteria-eater** (from the Greek *phagein* meaning to eat).

(i) With reference to your knowledge of bacteriophages, explain how the presence of bacteriophages in river water can cure infectious diseases.

1. **Bacteriophages infect the bacterial cells causing the infectious disease as part of their life cycle;**
2. **The bacteriophages would inject their DNA into the bacterial cells, causing the bacteria to synthesise viral proteins and DNA;**
3. **The viral proteins and DNA will assemble into new bacteriophages, which will exit via lysis of the host cell, thus killing the bacterial cells;**

[3]

(ii) Name a bacteriophage that may be found in river water, which can cure infectious diseases.

1. **T4 phage;**

[1]

(iii) Explain your choice in **(b)(ii)**.

1. **T4 phage only undergoes lytic cycle which will definitely result in the lysis/ death of host bacteria cells;**

[1]

(iv) Suggest a possible limitation of using bacteriophages to cure infectious diseases.

1. **Bacteria have specific receptors on their cell membranes / Bacteriophages can only bind to bacterial cells with the receptors complementary to their tail fibres / complementary receptors;**
2. **hence limiting the kinds / number of infections they can cure;**

® *Bacteriophages can cause diseases in humans*

[2]

[Total : 10]

KIASU ExamPaper
Islandwide Delivery | Whatsapp Only 88660037

7 Galactose-1-phosphate uridylyltransferase (GALT) is an enzyme coded by a gene locus on chromosome 9. It catalyses one of the reactions in galactose metabolism that converts ingested galactose to glucose. Deficiency in the enzyme results in a recessive condition known as galactosaemia in humans where galactose accumulates to toxic levels, and can be fatal during the newborn period. However, those afflicted with galactosaemia can live relatively normal lives by avoiding lactose-containing food like milk products.

(a) Explain why avoidance of milk products can help galactosaemia patients live relatively normal lives.

1. **milk products contain lactose**

   that is broken down into glucose and galactose ;

2. **avoidance of milk products prevents accumulation of galactose**

   in patients that leads to toxic effects; *(credit only if source of galactose is clear)* [2]

(b) Explain why galactosaemia is a recessive condition.

1. **need two copies of the allele / homozygous for the gene locus for galactosemia to develop;**
2. **as one copy of the normal GALT allele can produce sufficient enzyme to break down galactose;** [2]

KIASU ExamPaper
Islandwide Delivery | Whatsapp Only 88660031

(c) The gene locus determining ABO blood group is also found on chromosome 9. A woman with normal galactose metabolism and blood group A married a man with blood group O with galactosaemia. The woman's father has blood group O and suffered from galactosemia.
Using a genetic diagram, explain how their first child had blood group A and galactosaemia.

parental phenotype **woman** **x** **man**

parental genotype $\frac{I^A\ G}{I^O\ g}$ $\frac{I^O\ g}{I^O\ g}$

gametes $I^A\ G$ $I^O\ g$ $I^A\ g$ $I^O\ G$ (recombinant gametes) $I^O\ g$

mating via Punnett sq

	$I^A\ G$	$I^O\ g$	$I^A\ g$	$I^O\ G$
$I^O\ g$	$\frac{I^A\ G}{I^O\ g}$	$\frac{I^O\ g}{I^O\ g}$	$\frac{I^A\ g}{I^O\ g}$	$\frac{I^O\ G}{I^O\ g}$

offspring genotypic ratio 1 $\frac{I^A\ G}{I^O\ g}$: 1 $\frac{I^O\ g}{I^O\ g}$: 1 $\frac{I^A\ g}{I^O\ g}$: 1 $\frac{I^O\ G}{I^O\ g}$

offspring phenotypic ratio

1 blood grp A :	1 blood grp O :	1 blood grp A :	1 blood grp O
normal galactose metabolism	galactosemia	galactosemia	normal galactose metabolism

[4]

(d) Explain two factors that determines the probability that their first child has blood group A and galactosaemia.

1. **distance between the 2 gene loci,**

   which determines the frequency of crossing over (in the woman) thus proportion of recombinant gametes with $I^o\ g$ alleles ;

2. **random fertilization of gametes during sexual reproduction;**

[2]

[Total: 10]

KIASU ExamPaper
Islandwide Delivery | Whatsapp Only 88660031

8 Fig. 8.1 shows the absorption spectrum for two types of chlorophyll.

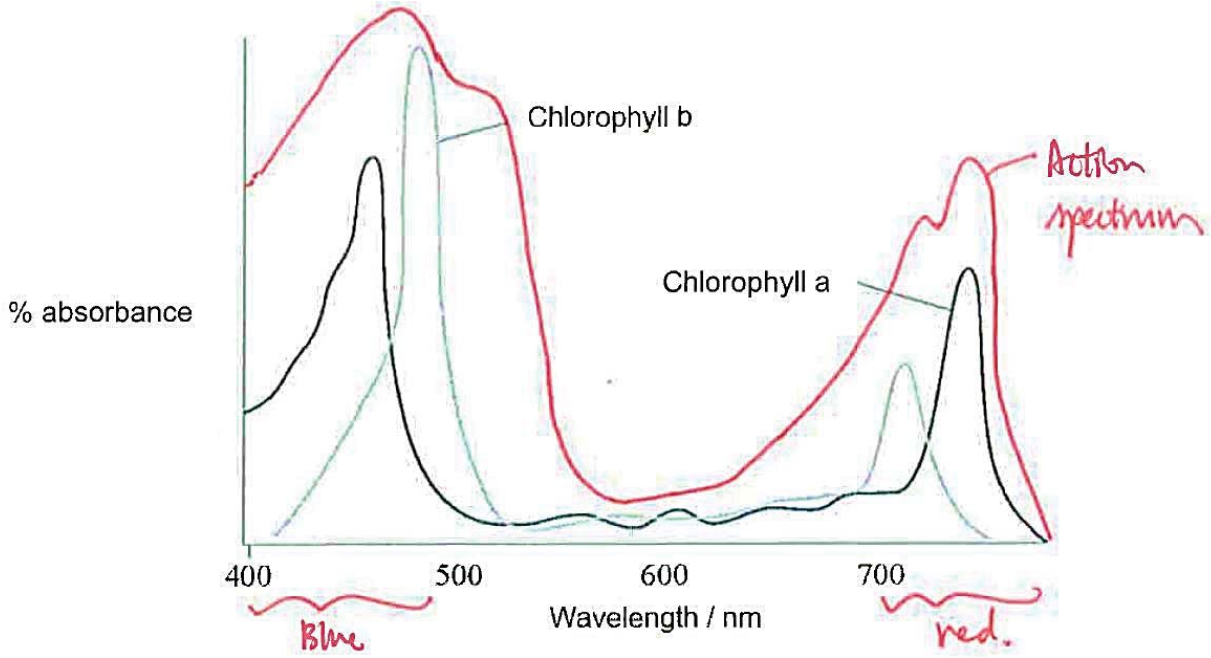


Fig. 8.1

(a) **(i)** Sketch on Fig. 8.1, the action spectrum of photosynthesis. [1]

1. line slightly <u>above</u> absorption spectrum with <u>peaks</u> in red and blue and a trough between but not as low for absorption spectrum;

(ii) Explain the relationship between the absorption spectrum for chlorophyll and action spectrum of photosynthesis for green plants.

1. **the higher the absorbance of wavelength, the <u>higher the rate</u> of photosynthesis;** *@**<u>peaks</u>** in action spectrum correspond to peak absorption by chlorophyll*
2. **light/ photon absorbed by chlorophyll is used for photosynthesis during the light-dependent stage;**
3. **Differences in two graphs due to light being absorbed by other accessory pigments e.g. carotene/ carotenoids;**
4. **Least absorption in green/ approximately 600nm as most light is reflected;** [2]

(b) Outline the photoactivation of photosystem II in the light-dependent reaction of photosynthesis.

1. light energy/photon is absorbed by <u>pigment molecules/ LHC/</u> in photosystem II;

2. light energy/ photon is passed to <u>special chlorophyll a molecule, P680</u>, in reaction centre via inductive resonance; [2]

KiasuExamPaper Islander Delivery | Whatsapp 88660031

Pepper plants can be grown in glasshouses, where extra light can be supplied from electric lamps.

The amount of carbon dioxide in a glasshouse was measured on two different days, M and N. On one of these days, the lamp could not be used, because there was no electricity.

Fig. 8. 2 shows the amount of carbon dioxide in the air around the pepper plants on day M and N.

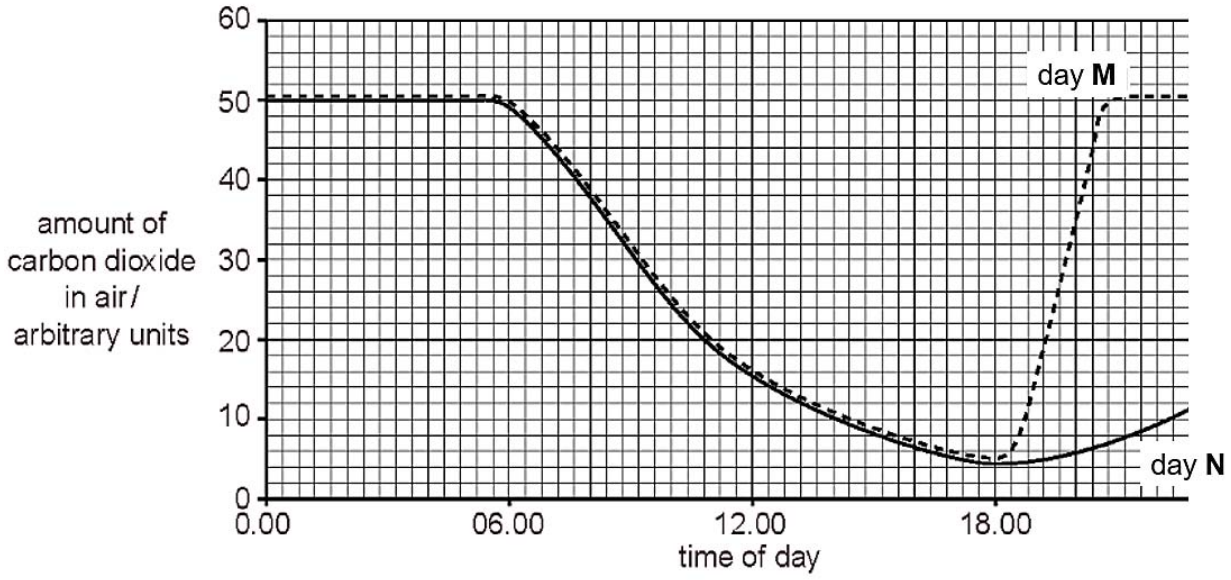


Fig. 8.2

(c) With reference Fig .8.2,

(i) state the time of the day when the pepper plants had removed most of the carbon dioxide,

18.00 / 6pm

[1]

(ii) state the day where there was no electricity. Explain your answer.

1. **Day M,**

   as amount of CO_2 in air increases from 4 arbitrary units to 50 arbitrary units; *Reject: A.U.*

2. **without electricity to power lamp ➡ reduced amount of light available sun sets from 18.00,**

   thus no light dependent reactions / photophosphorylation to produce ATP and NADPH;

3. **thus less C reduction & RuBP regeneration in Calvin Cycle,**

   leading to lower CO_2 fixation; [3]

[Total: 9]

©YIJC

www.KiasuExamPaper.com

9 **(a)** Antibodies are glycoproteins.

State what is meant by the term *glycoprotein*.

1. A protein combined with a carbohydrate;

Reject: protein with glycogen/polysaccharide because the carbohydrates may consist of several sugar units, usually an oligosaccharide.
Reject: reference to function of glycoprotein [1]

(b) The genes responsible for antibody production are found on different chromosomes, such as chromosome 2 and 14 in humans.

Explain how one antibody molecule is the product of more than one gene.

1. **One antibody molecule is made up of 2 heavy and 2 light chains / two different types of polypeptides;**
2. **Each type of chain/polypeptide is coded by a different gene / 2 genes;** [2]

(c) Describe and explain how the structure of an antibody molecule is related to its functions.

	Structure	Function
1.	**Antigen binding site (Fab) of a specific antibody with either:** **1. is complementary in shape to a specific epitope of an antigen;** **OR** **2. due to the precise folding of the variable heavy and light chains that gives rise to its unique 3D structure;**	**Hence antibodies can carry out neutralisation by binding to specific antigen of pathogen thus preventing pathogen from binding to host cell receptors and infecting the host cells;** ***Reject: epitopes are found on antibodies***
2.	**Fc region of antibody/constant region of heavy chain has a conformation that is complementary in shape to Fc receptors on phagocytes;**	**Hence opsonisation can occur as once antibodies bind to the pathogen, Fc regions of antibodies bind to Fc receptors of phagocytes and promote phagocytosis;**
3.	**Disulfide bridges between heavy and light chains / two heavy chains;**	**This gives stability to the quaternary structure by holding the heavy and light chains together / heavy chains together;**
4.	**Each antibody has a hinge region;**	**This give antibody flexibility when binding to antigen/pathogen;**
5.	**Ig G has two antigen binding sites;**	**Each antibody can bind to two epitopes/antigens at the same time which will cause pathogens to aggregate/agglutinate/clump together to facilitate clearance by macrophages;**
6.	**Constant region of heavy chains**	**determine the class of antibody thus their different functions;**

[4]

[1 mark for structure, 1 mark for related function; max 4 marks]

KIASU ExamPaper Islandwide Delivery in as fast as 30mins Only 88660037

(d) A human can make more than 10^{12} different antibody molecules. Explain how different specific antibodies are generated.

1. The specificity of antibodies depends on the **variable regions** which are encoded by the **variable**, **joining**, and **diversity gene segments**, each of which are present in **multiple copies** in the genome, conferring **germline diversity**; (less important point);
2. **Somatic recombination** enables **different combination of these gene segments** to form the variable region, leading to **combinatorial diversity**;

   Reject: different combinations of genes / different combination of regions
3. **Combinatorial diversity** is also created from the **association of different light and heavy chains** to form an antibody;
4. **Somatic hypermutation** at the **rearranged VDJ gene segment** of heavy chain gene locus and the **rearranged VJ gene segment** light chain gene locus also increases the diversity of antibodies;

Reject: reference to class switching [4]

[Total: 11]

KIASU ExamPaper
Islandwide Delivery | Whatsapp Only 88660031

10 Increase in emission of greenhouse gases like carbon dioxide leads to an increase in global temperature due to greenhouse effect. This can affect animals and plants both on land and in water.

(a) Explain how an increase in atmospheric carbon dioxide can lead to global warming.

1. **sun emits solar radiation onto Earth**

   which emits the absorbed radiation as infrared radiation / heat from its surface;

2. **infrared radiation / heat is absorbed by CO_2 (a greenhouse gas)**

   re-emitted as weaker radiation which is unable to pass through the atmosphere resulting in increase in global temperature; [2]

Sea lions and iguanas feed in the sea around the tropical Galapagos Islands. Sea lions are mammals and iguanas are reptiles. Both species spend some time on land. Fig. 10.1 shows the core body temperature of an iguana and a sea lion at different external temperatures.

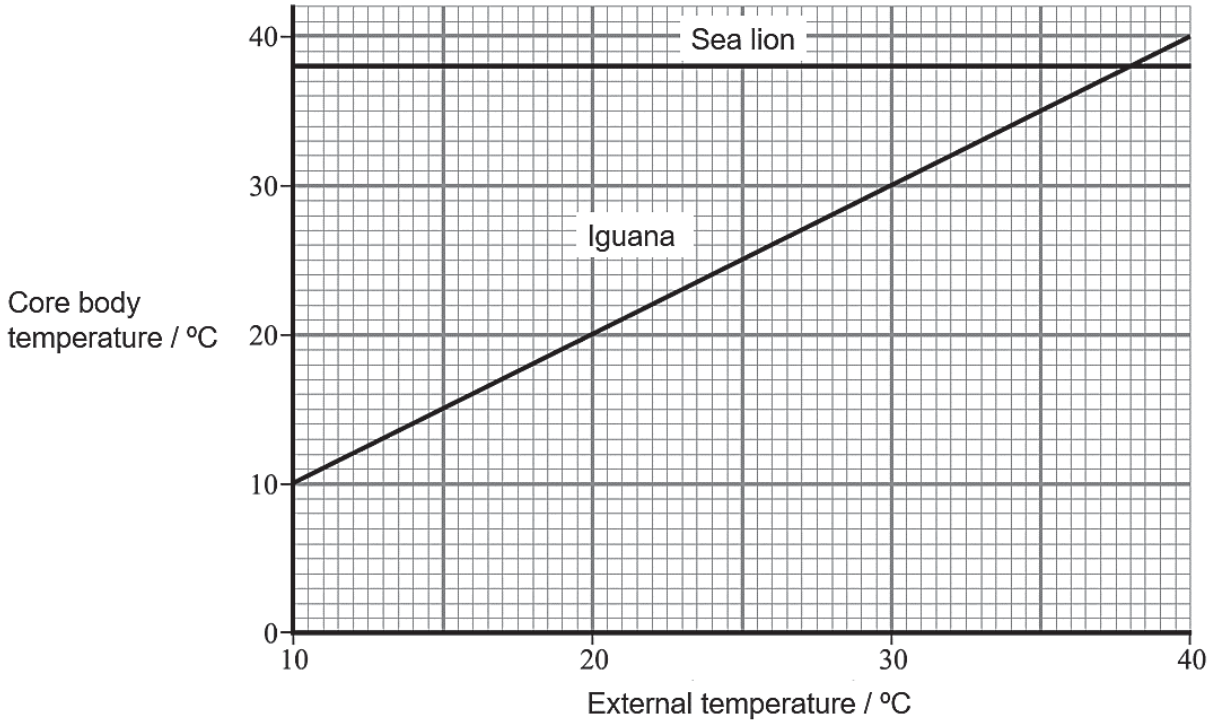


Fig. 10.1

(b) With reference to Fig. 10.1, explain the difference in core body temperature of the two animals at different external temperatures.

1. **as external temperature increase from 10 – 40°C, core body temperature of iguanas increase from 10 – 40°C**

   but sea lion's temperature remains constant at 38°C

2. **iguanas are ectotherms that do not keep internal temperature constant /**

   sea lions are endotherms / have homeostatic mechanisms to regulate internal body temp [2]

KIASU ExamPaper

Fig. 10.2 shows the oxygen consumption of an iguana and a sea lion at different external temperatures.

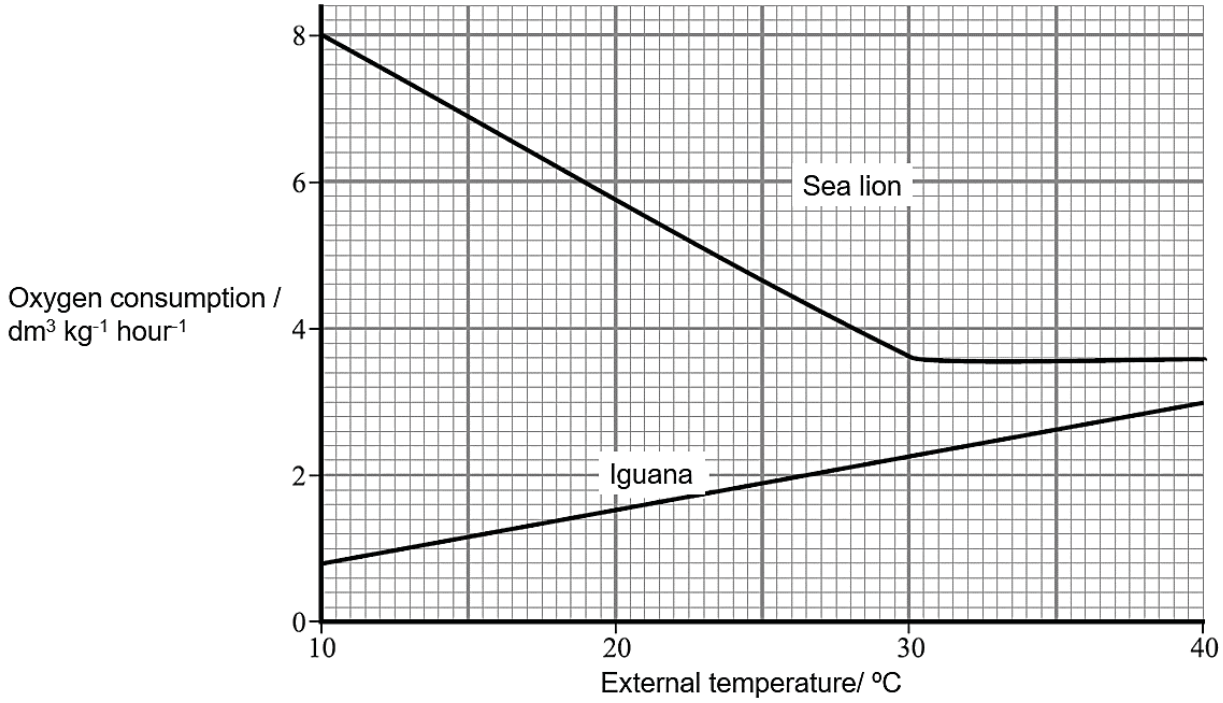


Fig. 10.2

(c) **(i)** The mean temperature of the sea surrounding the Galapagos Islands is 21 °C while the mean air temperature during the day is higher than this.

Suggest why the iguana feeds for only short periods in the water before returning to the land.

1. **At 21 ºC, O_2 consumption is low at 1.6 dm^3 kg^{-1} hour $^{-1}$;**
2. **body cools down too much / hypothermia if iguana stays too long in water; OR**
3. **low temp ➡ slower respiration (due to low enzymatic activity)**

   less ATP synthesized may ➡ drowning / unable to escape predators; [2]

(ii) Predict the feeding behavior of iguanas if global warming increases sea temperature by 2 ºC.

1. **feed for longer periods (as they can now stay in water for longer) ® feed more** [1]

KIASU ExamPaper Islanders Delivery Whatsapp Only 88660031

(iii) Describe **one** abiotic effect of raising sea temperatures.

1. **thermally expanded water OR**

   melting of ice bergs ® vague ref to polar ice caps;
2. **leads to increasing sea levels,**

   which may (cite relevant e.g.) cause salt water intrusion of aquifers / intensified water cycle leading to heavy rains etc; [2]

(iv) Explain the link between core body temperature and the rate of oxygen consumption in the sea lion between the external temperatures of 10 °C and 30 °C.

1. **O_2 consumption decreases from 8 to 3.6 dm^3 kg^{-1} $hour^{-1}$**

   as external temperature decrease from 10 – 30 °C;

2. **sea lion increases respiration rate**

   to increase heat production to maintain core body temperature at 38 °C; [2]

[Total: 11]

KIASU ExamPaper
Islandwide Delivery | Whatsapp Only 88660031

YISHUN INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CANDIDATE NAME

CG

INDEX NO

BIOLOGY

9744/03

Paper 3 Long Structured and Free-Response Questions

17 September 2019

2 hours

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name and class in the spaces at the top of this page.
Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid/tape.

Section A
Answer **all** questions in the spaces provided on the Question Paper.

Section B
Answer any **one** question in the spaces provided on 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.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	/28
2	/8
3	/14
Section B	
4 or 5	/25
Total	/75

KIASU ExamPaper
Islandwide Delivery | WhatsApp Only 88660031

This document consists of **20** printed pages and **2** blank pages.

2019 YIJC H2 Paper 3 Suggested Mark Scheme

Section A

1 Dengue fever is a disease caused by the dengue virus (DENV) from the *Flaviviridae* family, *Flavivirus* genus. The disease is transmitted to humans via the bite of an infective *Aedes aegypti* mosquito. There are four different serotypes of dengue virus (DENV1-4) circulating in the world, including Singapore. Hence, individuals can be infected with dengue up to four times. Repeat dengue infections have been associated with a higher occurrence of severe dengue. In Singapore, the Ministry of Health (MOH), together with the National Environment Agency (NEA), tracks and reports all dengue-related cases quarterly.

(a) Based on your understanding of virus characteristics, discuss if the *Flaviviridae* family is a valid phylogenetic grouping.

No

1. **viruses are non-living particles that do not 'reproduce' thus has no ancestor-descendent relationship;**
2. **recombination of different viruses can occur within a single host cell without 'reproductive barrier' thus cannot be classified by Biological Species Concept;**

Yes

3. **can classified by phenotypic characteristics e.g. morphology / nucleic acid / mode of replication / host / type of disease they cause etc. using Morphological Species Concept;**
4. **virus progeny 'inherits' alleles that determines phenotypes like host type, from 'predecessors' that first infected the host;**

any 3 MP from either argument [3]

(b) (i) Explain how the dengue virus is transmitted from person to person.

1. **female mosquito takes blood meal from individual infected with DENV (before laying eggs)**

   DENV spreads to salivary glands of mosquito;

2. **infected mosquito becomes a vector when it takes blood meal from uninfected individual**
   spreads virus to individual by injecting its saliva into human bloodstream; [2]

(ii) Explain why individuals can be infected up to four times with dengue.

1. **exposure to 1 DENV serotype triggers adaptive immune response**

   that results in production of memory B cells with BCR specific to Ag of this serotype (conferring immunological memory);

2. **however, the 4 DENV serotypes have slightly different antigen / surface protein structure / antigenicity;**

   BCR of memory B cells are not fully complementary to Ag of DENV of a different serotype;

3. **thus subsequent exposure to different DENV serotype will trigger primary immune response**

   rather than a secondary response; [3]

KIASU ExamPaper Islandwide Delivery | Whatsapp Only 88660031

(iii) Explain why repeated dengue infections have been associated with a higher occurrence of severe dengue.

1. **memory B cells may be triggered to differentiate into plasma cells to produce Ab when individual is infected by a different DENV serotype**
   Ab produced bind to the new DENV serotype but are unable to neutralise the virus;
2. **Ab-virus complexes bind to Fc receptors on macrophages**
   triggering receptor-mediated endocytosis of the virus into the cells;
3. **antibody-dependent enhancement occurs where Ab assist the spread the DENV**
   results in increase viraemia thus more severe dengue; [3]

An individual suspected of being infected by DENV can undergo dengue fever testing to determine if the infection is indeed due to DENV. DENV infection can be difficult to diagnose without laboratory tests because symptoms may initially resemble those of other diseases, such as chikungunya infection. Two primary types of testing available are:

- Molecular testing which detects the genetic material of DENV in blood within the first week after symptoms appear using reverse transcriptase (RT) in polymerase chain reaction (RT-PCR)
- Antibody tests which detect two different classes of antibodies produced by the body in response to a dengue fever infection. This helps diagnose a current or recent infection.

(c) DENV genetic material in the blood occurs in small amounts. Thus, the genetic material needs to be amplified before it can be identified.

(i) Suggest how the DENV genetic material is amplified using RT-PCR.

1. **at optimum temp of RT,**

   RT reverse transcribes DENV RNA genome into cDNA using dNTPs available;

2. **allow annealing of primers to occur to cDNA template at 55°C,**

   via hydrogen bonds between complementary base pairs;

3. **allow elongation of primers at 72°C,**

   by *Taq* polymerase which brings in dNTPs complementary to cDNA template;

4. **denaturation of double-stranded DNA to single-stranded DNA at 95°C,**

   by breaking hydrogen bonds between complementary base pairs with increased kinetic energy

   no denaturation required at 1st stage as DENV RNA is single-stranded; [4]

KIASU ExamPaper
Islandwide Delivery | Whatsapp Only 88660031

(ii) State the **two** classes of antibodies that are tested for.

1. **IgM and IgG;** [1]

(iii) Explain what is meant by *'classes of antibodies'*.

1. **antibodies that have different constant regions,**

   generated during class switching in activated B cells,

2. **which spliced different constant gene segments to already rearranged VDJ segments,**

   5 possible classes – IgG, IgM, IgD, IgE and IgA; [2]

Wolbachia are natural bacteria present in up to 60% of insect species, including some mosquitoes. However, *Wolbachia* is not usually found in the *A. aegypti* mosquito. For many years, scientists have been studying *Wolbachia*, looking for ways to use it to potentially control the mosquitoes that transmit human viruses. The World Mosquito Program's research has shown that when introduced into the *A. aegypti* mosquito, *Wolbachia* can help to reduce the transmission of these viruses to people.

(d) State **one** structural difference between dengue virus and *Wolbachia* bacteria.

1. **absence of cell wall in DENV**

   presence in Wolbachia;

2. **linear RNA genome in DENV**

   circular DNA genome in Wolbachia;

any 1 MP [1]

(e) Explain how introduction of *Wolbachia* can reduce transmission of DENV to people.

1. **when male *Wolbachia*-carrying *A. aegypti* mate with female wild-type *A. aegypti* / that do not carry Wolbachia**

   resulting eggs do not hatch due to cytoplasmic incompatibility;

2. **male *Wolbachia*-carrying *A. aegypti* released will compete with wild-type males for wild-type females**
   leading to a reduction in the population of *A. aegypti* over time; [2]

KIASU ExamPaper
Islandwide Delivery | Whatsapp Only 88660031

In 2017, a trial was conducted at different parts of Singapore to investigate the effectiveness of *Wolbachia*-carrying male mosquitoes in controlling mosquito populations. One of the areas selected was Nee Soon East. Fig. 1.1 shows the location of the trial site at Yishun Street 21 and the control site at Yishun Street 11.

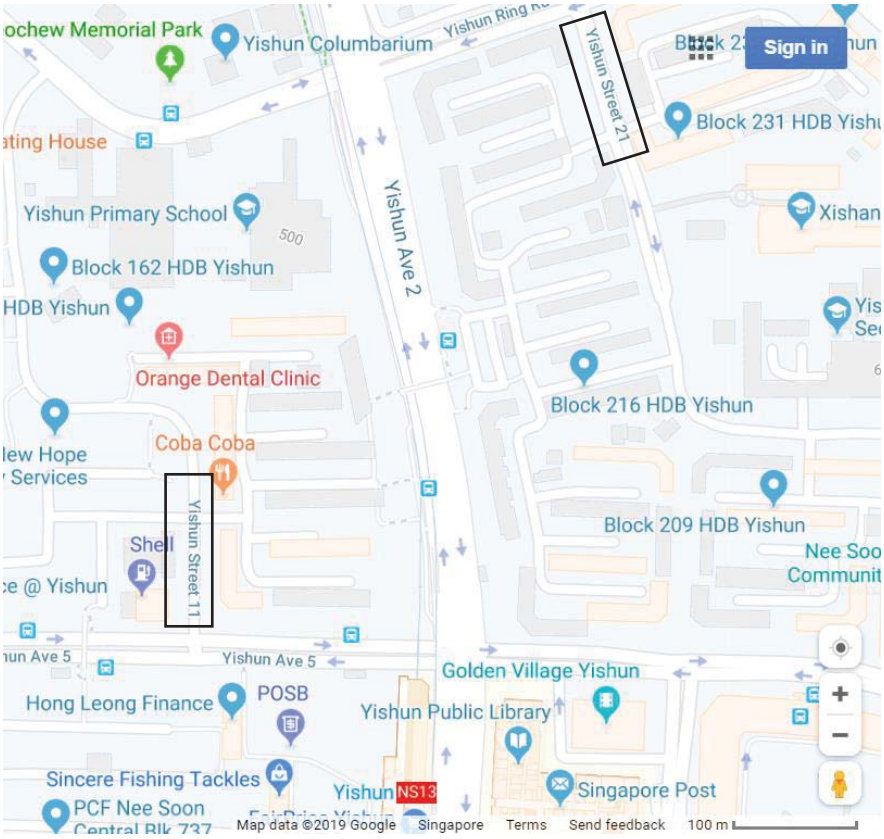


Fig. 1.1

(f) **(i)** Suggest **two** considerations for the selection of trial and control site.

1. similar conditions

e.g. number of breeding sites / blocks etc.;

2. distance

must not be too near for released *Wolbalchia*-carrying males to fly over; [2]

(ii) Explain why only male mosquitoes carrying *Wolbachia* were released.

1. male mosquitoes do not bite humans / take blood meal (feed on nectar); [1]

KIASU ExamPaper
Islandwide Delivery | Whatsapp Only 88660031

The number of *A. egypti* caught in ovitraps during the pre and post release periods in the trial site were compared to the control site. Table 1.1 shows part of the data collected.

Table 1.1

Number of *A. egypti* caught per 100 ovitraps			
Pre-release		Post -release	
Street 11	Street 21	Street 11	Street 21
20	21	42	15
25	24	35	19
17	22	48	22
22	18	44	25
16	16	32	13

(g) Using the following formulae and t-table,

$$t = \frac{(x_1 - x_2)}{\sqrt{\frac{(s_1)^2}{n_1} + \frac{(s_2)^2}{n_2}}}$$

$$S = \sqrt{\frac{\Sigma(X - \overline{X})^2}{N}}$$

where s = standard deviation
Σ = sum of
x = observation
$\overline{x}$ = mean
n = sample size

df	*probabillity*				
	0.25	*0.10*	*0.05*	*0.025*	*0.01*
1	1.00	3.08	6.31	12.71	31.82
2	0.82	1.89	2.92	4.30	6.96
3	0.76	1.64	2.35	3.18	4.54
4	0.74	1.53	2.13	2.78	3.75
5	0.73	1.48	2.02	2.57	3.37
6	0.72	1.44	1.94	2.45	3.14
7	0.71	1.42	1.90	2.37	3.00
8	0.71	1.40	1.86	2.31	2.90
9	0.70	1.38	1.83	2.26	2.82
10	0.70	1.37	1.81	2.23	2.76

KIASU ExamPaper Islandwide Delivery | Whatsapp Only 88660031

conduct a t-test on appropriate samples to determine if the release of *Wolbachia*-carrying mosquitoes was effective in reducing the mosquito population in the trial site.

Post-release

St 11					St 21			
		x		$(x-\bar{x})^2$		x		$(x-\bar{x})^2$
		42		3.24		15		14.44
		35		27.04		19		0.04
		48		60.84		22		10.24
		44		14.44		25		38.44
		32		67.24		13		33.64
Σx	Σx	201	$\Sigma(x-\bar{x})^2$	172.8	Σx	94	$\Sigma(x-\bar{x})^2$	96.8
$\bar{x}$	$\bar{x}_1$	40.2	s_1 =	6.57	$\bar{x}_2$	18.8	s_2 =	4.4
			s_1^2 =	43.2			s_2^2 =	24.2
			$\lvert\bar{x}_1 - \bar{x}_2\rvert$ =	21.4				
			t =	5.83				

t-value **5.83;**

probability **$p < 0.01$;**

conclusion **$t_{calculated} > t_{critical}$, 5.83 > 2.90;**
difference between means is statistically significant, difference not due to chance,
trial site / St 21 has less mosquitoes than control site / St 11;

OR

***Wolbachia*-carrying mosquitoes are effective in reducing mosquito population;** [4]

[Total: 28]

KIASU ExamPaper
Islandwide Delivery | Whatsapp Only 88660031

2 Occasionally during meiosis, homologous chromosomes fail to separate at anaphase. This is known as non-disjunction. Turner's syndrome is the most common chromosome mutation in human females. It can occur due to non-disjunction in meiosis during gametogenesis. Some resulting gametes will be missing an X chromosome.

Some forms of Turner's syndrome occur when one of the pair of X chromosomes is not missing but has become damaged. The damaged X chromosome may have been broken and re-formed so that part of its structure is lost.

Fig. 2.1 is a diagram of a normal X chromosome and two forms of 'damaged' X chromosomes, X_1 and X_2.

- In X_1, a section of the 'p' arm of the chromosome is missing. This deletion leads to reduced height of the female and abnormalities such as narrowing of the aorta.
- In X_2, a section of the 'q' arm of the chromosome is missing. This deletion leads to little or no development of the ovaries.

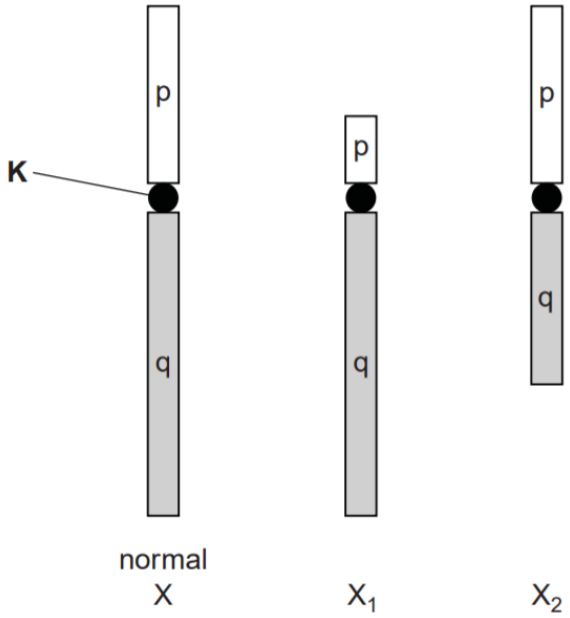


Fig. 2.1

(a) Name structure K.

1. Centromere; [1]

(b) **(i)** Name the type of chromosome mutation which resulted in X_1 and X_2.

1. *Chromosomal deletion;* [1]

(ii) Explain why X_1 and X_2 result in different phenotype.

1. Different sections of the chromosome were deleted, X_1 had a section deleted in the p arm while X_2 had a section deleted in the q;

2. thus different segments of coding sequences were removed from the chromosome in X_1 and X_2;

3. Different proteins were not produced/ produced resulting in different phenotype;

[3]

KIASU Exam Paper

(iii) Describe one similarity and one difference between chromosome mutation and gene mutation

Similarity: **Both involves changes to the nucleotide sequence in our DNA;**

Difference: **Gene mutation could result in no change in phenotype while chromosome mutation usually results in a change in phenotype;**

Gene mutation usually only affects one gene while chromosome mutation can affect many genes; [2]

(c) Mothers with the X_1 form of Turner's syndrome can pass on the chromosome mutation to their daughters while females with X_2 form of Turner's syndrome often do not produce any offspring.

Suggest why females with X_2 form of Turner's syndrome often do not produce any offspring.

Females with the X_2 form of Turner's syndrome do not have ovaries thus unable to produce eggs, are infertile;

[1]

[Total: 8]

KIASU ExamPaper
Islandwide Delivery | Whatsapp Only 88660031

3 There are **two indigenous eel species** in New Zealand: the shortfin eel (*Anguilla australis*) and the longfin eel (*Anguilla dieffenbachii*). The **longfin eel** is **endemic to New Zealand** and is found **in rivers and streams well inland (NOT = on land)**, while the **shortfin eel** is **limited more to coastal areas**. **Young eels** (elvers) **migrate from the sea into freshwater streams**, where **they live as adults for many years** (up to 100 years for longfins) **before migrating back to sea to reproduce in the Pacific Ocean.**

Table 3.1 shows the **timing and age of migration** in the two species of eels.

Table 3.1

	Timing of migration	Age of migration in females	Age of migration in males
Longfin eel	Males in April and females follow soon after	Females at 34 years (75 – 180 cm)	Males at an average of 23 years (48 – 74 cm)
Shortfin eel	Males in February – March and females follow soon after	Females at 22 years (50 – 100 cm)	Males at an average of 14 years (38 – 58 cm)

The **breeding area** for **shortfin eels** is thought to lie to the northeast of New Zealand **near Samoa**. Evidence obtained by satellite tracking of the eels indicates that the **longfin breeding area** is in the **southwest tropical regions** of the Pacific Ocean – somewhere **near Fiji and New Caledonia.**

The females release their eggs, the males fertilise them, and the adults die after spawning. The **eggs hatch into larvae** that **float to the surface and drift back towards New Zealand**. They may take about 17 months to arrive. Larvae then change into transparent juvenile eels.

Fig. 3.1 shows the migration patterns and the **breeding grounds** ***(NOT where young eels live & mature to become adults)*** of the eels.

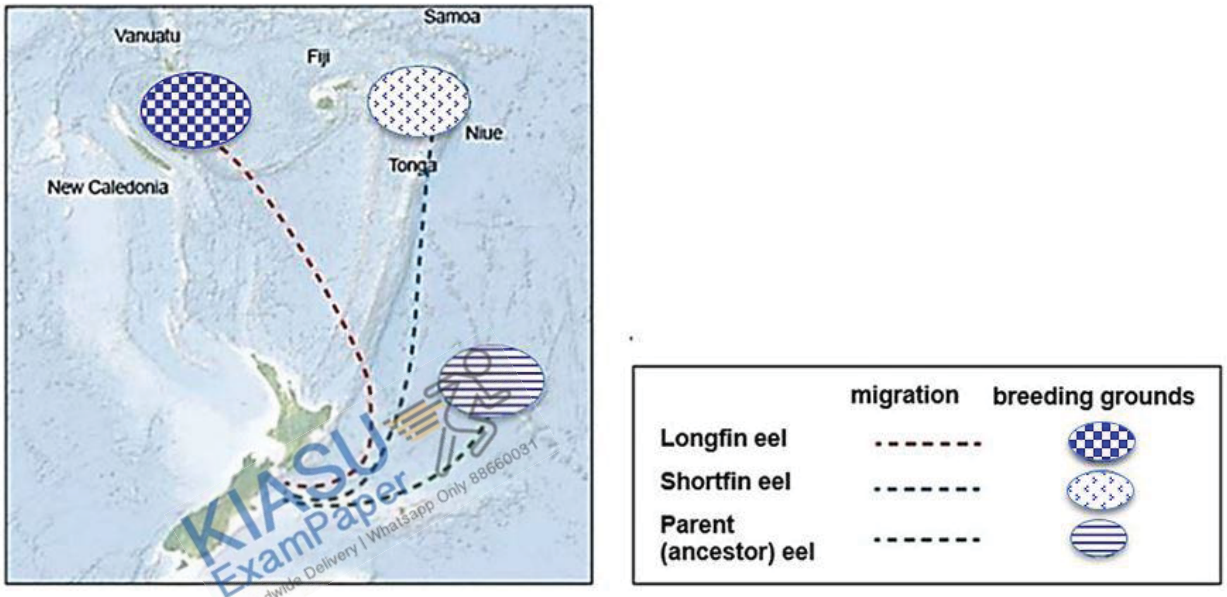


Fig. 3.1

It is thought that the **ancestral species** had a **shorter migration**, which was **genetically programmed** and has **changed to provide the migrations seen in the shortfin and longfin eels today.**

(a) **Compare (= BOTH similarities & differences)** sympatric and allopatric **speciation**.

1. **Similarity: Both require disruption of gene flow;**
   Ignore: Both will result in the formation of new species.

2. **Difference: Allopatric speciation is formation of species from populations due to geographic isolation between 2 populations *(Reject: btw species)* whereas sympatric speciation is the formation of species from populations in the same geographic location / by means other than geographic isolation - such as behaviour, physiological isolation**

   Ignore: if only mention geographical versus physiological / behavioural / temporal isolation w/o reference to process happening to populations of the same species.

Max 1 mark if only similarity or difference mentioned. [2]

(b) With **reference to the information provided**, **explain how** natural selection could have **led to** the evolution of the **two species of eels**.

Ignore: reference to climate change / overfishing

EITHER:

1. **(Ancestral eel population heads to the same breeding ground), however a mutation in the gene coding for navigation to breeding grounds, results in different migration patterns (in some eels) in the ancestral eel population;**

2. **∴ Ancestral eels migrate to different breeding grounds – one population that travels to Samoa will be separated by physical distance from the other population that travels to New Caledonia / southwest tropical regions of Pacific Ocean;**

3. **The selection pressure is the distance to the breeding grounds, ∴ eels with advantageous / favourable traits of shorter fins *(Reject: shortfin eels)* to travel to Samoa while eels with longer fins *(Reject: longfin eels)* to travel to New Caledonia / southwest tropical regions of Pacific Ocean;**

4. **are selected for and experience greater reproductive success / fertilisation *(Ignore: survive to sexual maturity because only adult eels move to breeding grounds)* in the respective breeding grounds and pass on their advantageous alleles (e.g. short finned allele in breeding ground near Samoa) to their offspring / larvae, resulting in a change in allele frequency in each population's gene pool;**

5. **Eel populations may also be subjected to additional selection pressures (e.g. changes in water currents / water temperatures) that existed during migration and at the respective breeding grounds;**

6. **Due to the absence of gene flow, the gene pools of the separated populations accumulate different alleles independently from mutations and presence of different selection pressures, leading to increasing genetic divergence; resulting in the formation of reproductive barrier;**

KIASU ExamPaper Islandwide Delivery / Whatsapp only 88660037

7. When larvae that successfully arrive back in New Zealand and change into juvenile eels, the different eel populations occupy different habitats (longer fin eels in inland water bodies, shorter fin eels in coaster areas), they are also geographically isolated;

8. New species of eels arise by descent with modifications from ancestral species over time, that prevented interbreeding between the two populations and the formation of fertile viable offspring subsequently;

[max 5]

OR

1. Ancestral eel population has variation in migration time (temporal isolation), hence longer finned eels migrate in April while shorter finned eels migrate between February to March, to their respective breeding grounds;

2. This disrupts gene flow between the 2 populations of eels, ∴shorter finned eels and longer finned eels will only reproduce / undergo fertilisation within their own populations at the breeding grounds;

3. The gene pools of the separated populations accumulate different alleles independently from mutations and presence of different selection pressures along their migration routes, leading to increasing genetic divergence; resulting in the formation of reproductive barrier;

4. Eel populations that successfully arrive at the respective breeding grounds may also be subjected to additional selection pressures that exist there;

5. Idea of founder effect;

6. Eels with advantageous traits are at a selective advantage in the different waters, survived to reproduce / for fertilisation *(Ignore: survive to sexual maturity because only adult eels move to breeding grounds)* and pass on their advantageous alleles to their offspring / larvae, resulting in a change in allele frequency in each population's gene pool;

7. When larvae that successfully arrive back in New Zealand and change into juvenile eels, the different eel populations occupy different habitats (longer fin eels in inland water bodies, shorter fin eels in coaster areas), they are also geographically isolated;

8. New species of eels arise by descent with modifications from ancestral species over time, that prevented interbreeding between the two populations and the formation of fertile viable offspring subsequently;

[max 5]

KiasuExamPaper
Islandwide Delivery | Whatsapp Order 8808 6004

Fig. 3.2 shows the phylogenetic tree of the eels in the genus *Anguilla.*

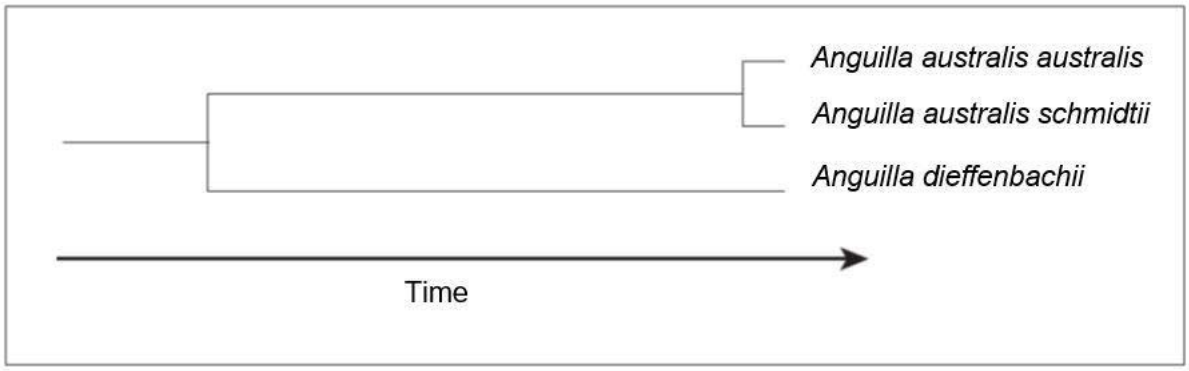


Fig. 3.2

(c) Explain **how molecular methods** can be used to **determine the evolutionary relationships** of the different species of *Anguilla* fishes.

1. **compare DNA sequence of a common gene (between different species of fish);**

OR

comparison of / alignment of homologous DNA sequences

E.g. mitochondrial rRNA genes, cytochrome *b* gene (give an example);

2. **number of mutation / substitutions in genetic sequence is used to calculate the length of time since divergence**

OR

% sequence homology indicates degree of evolutionary closeness;

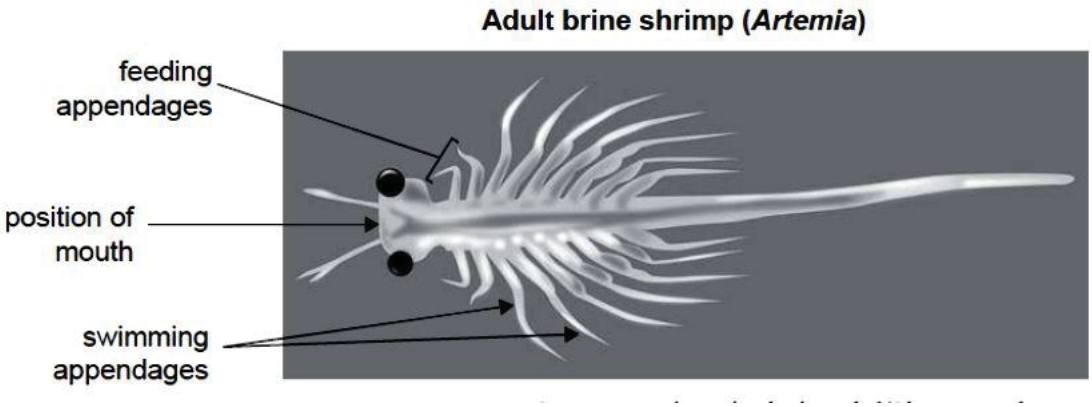
3. **increase in number of differences between specific gene / nucleotide sequence compared from the different species, increase in time since divergence from a common ancestor, ∴ less recent common ancestor shared between *Anguilla dieffenbachii* and *Anguilla australis,***

***Anguilla australis australis* and *Anguilla australis schmidtii* belong to the same species but have accumulated enough differences (but lesser when compared to *A. dieffenbachii*) in their nucleotide sequences to classify them as distinct subspecies / distinct groups within the same species;** [3]

KIASU ExamPaper
Islandwide Delivery | Whatsapp Only 88660031

The *Hox* genes are **master regulatory genes** that influence cells in a particular location of an animal embryo in order to develop structures for that part of the body.

In the brine shrimp, *Artemia*, the expression of the *Hox* genes *Ubx* and *Scr* results in the growth of either a swimming appendage or a feeding appendage, **depending on whether the genes are expressed in cells** that are in the **mid-region** of the body or that are **near the mouth**. These specialised appendages are labelled in Fig. 3.3 below.



Source: patrimonio designs ltd/Shutterstock.com

Fig. 3.3

(d) Suggest **one** way that genes are regulated so that the **same genes** can **produce different appendages** when the genes are **expressed in different locations** in the *Artemia* embryo.

Any 1 below:

1. **There may be different regulatory sequences associated with the genes that interact with different specific transcription factors that control the expression / non-expression of the genes at each location;**

2. **Genes are expressed for different lengths of time in the embryo. The shorter limb could be a result of the gene switching off earlier or switching on later;**

3. **Post-transcriptional modification / alternative splicing *(Reject: splicing)* where different exons cut out leads to different types of mature mRNA that will form different regulating proteins when expressed, in each location.** [1]

(e) Explain **why** it is **impossible** for evolution to occur at the **individual level**.

1. **Evolution refers to changes in allele frequencies in a gene pool of a population over time;**

2. **A population is a group of interbreeding individuals belonging to a particular species and sharing a common geographic area**

3. **There must be phenotypic variation in a population before selection can take place,**
individuals are selected for or against by natural selection;

4. **Individuals can only pass down their favourable / advantageous alleles to the next generation, it is the population that actually evolve;** [3]

KIASU ExamPaper Islandwide Delivery Whatsapp Only 8866000

5. **Individuals can only introduce new allele to the next generation through mutation during the formation of gametes;**

[Total: 14]

KIASU ExamPaper
Islandwide Delivery | Whatsapp Only 88660031

Section B

Answer **ONE** question in this section.

Write your answers on the lined paper provided at the end of this Question Paper.
Your answers should be illustrated by large, clearly labelled diagrams, were appropriate.
Your answers must be in continuous prose, where appropriate.
You answers must be set out in parts **(a)**, **(b)**, etc., as indicated in the question.

5 (a) Compare the signaling pathways between G protein coupled receptor and receptor tyrosine kinase in relation to blood glucose regulation. [11]

Similarities

1. **Both ligands bind to the extracellular domain of the receptor;**
2. **Termination occurs when the ligand is removed from the receptors;**

Differences

	Feature of comparison	GPCR	Receptor Tyrosine Kinase
3.	Ligands/ Signal molecules;	Glucagon	Insulin
4.	Change to receptor upon ligand binding;	Conformational change of the 7-helix transmembrane protein.	Dimerization of RTK.
5.	Chemical modifications of receptors	Absent.	Phosphorylation of tyrosine residues on the RKT subunit.
6.	Proteins associated with receptors;	Causes a GTP molecule to displace the GDP molecule and activates the G protein.	Insulin response substrate (IRS) proteins binds to phosphorylated tyrosine residues on the receptor.
7.	Signal transduction ;	Activated adenylyl cyclase catalyses the conversion of ATP to cAMP.	Phosphorylated IRS proteins phosphorylate other relay proteins.
8.	Effect of second messengers / activated proteins;	cAMP acts as a second messenger and activates intracellular proteins such as protein kinase A (PKA), which leads to a phosphorylation cascade.	Phosphorylated IRS proteins activate more than one signalling pathway.
9.	Enzymes involved;	Glycogen phosphorylase activated Glycogen synthase phosphorylated thus is inactivated	Glycogen synthase is activated

KIASU ExamPaper

10.	**Types of cellular response;**	**↑ glycogenolysis ↑ gluconeogenesis ↓ glycogenesis**	**Increase in number of glucose transporter ↑ glycogenesis ↑ protein synthesis ↑ lipogenesis ↓ gluconeogenesis**
11.	**Effect on blood glucose levels;**	**Increased blood glucose levels**	**Decreased blood glucose levels**
12.	**Termination of signals;**	**GTPase portion of Gα subunit hydrolyses GTP into GDP, cAMP hydrolysed to AMP by phosphodiesterase;**	**Endocytosis of the insulin-receptor complex.**

(b) Using named examples, describe the various functions of biological receptors and explain their importance in organisms. [14]

1. Cell Surface Receptors

General information of hormone action at named cell:

- **binding** of, ligand / hormone, to cell surface receptor;
- **conformational change** in receptor;
- **cell signalling pathway** / **second messengers**, activated;
- **phosphorylation cascade** / **signal amplification**;
- **response:** change in, gene expression / enzyme activity / cell metabolism;

Examples:

(1) **insulin**:

- **tyrosine kinase receptor** activated;
- **conversion of glucose to glycogen**;
- **restore elevated blood glucose levels to the norm / increase glycogen storage**;

(2) **glucagon**:

- **G-protein coupled receptor** activated;
- glycogen / lipid / amino acid, breakdown increased to **produce glucose molecules for respiration**;
- **raise the low blood glucose levels back to the norm** ;

(3) **ligated-gated ion channel receptors**

- have a hydrophilic channel which allows ions (e.g. Na^+, Ca^+, K^+) to move inside and outside of cells;
- **coordinate body responses** like reflex action, movement, maintenance of ion concentration in cells;

(4) **Carrier proteins**

- Thus **moving a solute across the membrane** → enable **uptake of solutes into cells** ;
- E.g. entry of glucose molecules into red blood cells.

(5) **T helper cells and T cell receptors (TCR)**

- **assist in regulating the activity of B cells and cytotoxic T cells by providing necessary signals and growth factors;**

KiasuExamPaper.com

(6) **B lymphocytes (B cells) and B cell receptors (BCR)**

1. **antibody-secreting plasma cells** → to **produce antibodies to fight off pathogens**;
2. **memory B cells** → to produce a **faster and stronger immune response** to subsequent infections;

(7) **Cell-cell recognition / cell-cell adhesion**

- carbohydrate moiety /chains on glycoproteins or glycolipids allow **cell-cell recognition** & / or **cell-cell adhesion**;
- allow **formation of tissues and organs**;

2. Receptor-mediated endocytosis

- The **receptor proteins** are usually **clustered** in regions of the membrane called **coated pits**.
- **Helps cell to acquire bulk quantities of specific substances** even though they may not be in very high concentration in the extracellular fluid.
  - E.g. Human cells use the process to take in **cholesterol** for use in the synthesis of membranes and as a precursor for the synthesis of other steroids.

3. Cytoplasmic Receptors / Kinase-linked receptors

- located in the **cytoplasm** and involves **enzymatic activation** by **phosphorylation**;
- stimulate **gene transcription** and **protein synthesis** which lead to cellular effects;
- e.g. effects of insulin

4. Nuclear Receptors

- located in the **cell nucleus** and are activated when ligand molecules enter the nuclear membrane and bind with them;
- stimulate **gene transcription** and **protein synthesis** which lead to cellular effects;
- e.g. **estrogen** and other **steroid hormones**;

QWC: at least 2 mechanisms of biological receptors (from part 1-4) + relevant examples

[Total: 25]

KIASU ExamPaper
Islandwide Delivery | Whatsapp Only 88660031

6 (a) Using named examples, compare continuous and discontinuous variation, and explain how environment can affect phenotypes. [11]

Named examples

1. **Continuous variation – height or mass in humans;**
2. **Discontinuous variation – ABO blood group in humans;**

Similarities

3. **Both are determined by genetic factors;**
4. **Both can be influenced by environmental factors;**

Differences

5. **A range of phenotypes is usually seen continuous variation while distinct phenotypes are seen in discontinuous variation;**
6. **Alleles of many genes are involved in continuous variation @polygenic while alleles of one or few genes are involved in discontinuous variation;**
7. **Each gene involved in continuous variation have very little effect on the phenotype, the additive effects of the genes give rise to the phenotype while in discontinuous variation one gene has a huge effect on the phenotype;**
8. **Environment has a large effect on phenotype in continuous variation while environment has a small effect on the phenotype in discontinuous variation;**

Environment on phenotypes

9. **Honey bee;**
10. **Queen and worker bees are females which develop from fertilized haploid eggs;**
11. **Difference is due to diet of larvae;**
12. **After hatching, all larvae are fed with royal jelly. From 3rd day onwards, larvae destined to be worker bees switched to a diet consisting of honey and pollen.**
13. **Larvae destined to be queen continue with royal jelly. High protein content in royal jelly stimulates the formation and stimulation of female reproductive system;**
14. **Himalayan rabbits; ®rabbits**
15. **Temperature affect the coat colour of Himalayan rabbits;**
16. **Tyrosinase is one of the enzymes required for the synthesis of pigment melanin;**
17. **Himalayan rabbits are homozygous for the recessive ch allele of the gene for tyrosinase, which codes for heat-sensitive form of tyrosinase;**
18. **At central part of rabbit's body where body temperature is above 33°C, tyrosinase is inactivated thus no melanin is produced, giving rise to light coloured fur;**

KiasuExamPaper

19. **At extremities, temperature is below 33°C, tyrosinase is active, melanin is produced, giving rise to dark coloured fur;**

QWC: Correct named examples (3) + at least 3 valid comparison

(b) Describe how variation arises and how recessive alleles are preserved in a population. [14]

Gene Mutations

1. **gene mutations* + change in nucleotide sequence;**
2. **any one e.g. substitution, deletion or insertion of a nucleotide;**
3. **in coding region that changes triplet code, then amino acid hence 3D conformation of polypeptide / protein**
4. **in non-coding regions such as e.g. promoter/enhancer/silencer/ that can increase/decrease transcription frequency/ alter gene expression;**
5. **and hence changes phenotype of organism;**

Chromosomal Mutations

6. **chromosomal mutations/aberrations which involve a change in number and structure of chromosomes resulting in a change of phenotype of organism;**
7. **(number of chromosomes) non-disjunction resulting in polyploidy/aneuploidy;**
8. **(structure) any one with elaboration;**

e.g. deletion - when a segment of a chromosome is missing

OR e.g. duplication - when an extra segment of a chromosome is present

OR e.g. inversion - when a chromosome segment is detached, flipped around 180 degrees & reattached to the rest of the chromosome

OR e.g translocation - when a segment from one chromosome is detached & reattached to a different chromosome;

Meiosis

9. **During metaphase I, independent assortment of homologous chromosomes occurs when arrangement of one pair of homologues at the metaphase plate is independent of the arrangement of the other pairs of homologues and subsequently separation of homologous chromosomes during anaphase I;**
10. **Random and independent arrangement of non-identical sister chromatids at the metaphase plate during metaphase II and subsequent separation of non-identical sister chromatids during anaphase II;**
11. **results in gametes with numerous combinations of maternal & paternal chromosomes;**
12. **crossing over during prophase I between non-sister chromatids of homologous chromosomes;**

KiasuExamPaper.com

13. results in new combinations of alleles;(must be linked with 12 as long as idea of crossing over)
14. random fusion of gametes add to the variety of genotypes. Different genotypes will result in different phenotypes and these will act as raw materials for natural selection;

AVP:

Continuous variation due where variation in phenotype/ characteristics (can be due to) interaction of genotypes and environment;

Heterozygote protection/Diploidy

15. Heterozygote protection/diploidy occurs in diploid organism with 2 copies of each gene;
16. 2 different alleles at 1 gene locus where dominant allele determines organism's phenotype/recessive allele remains hidden/masked;
17. Recessive homozygote with unfavourable phenotype selected against/dominant phenotype selected for + heterozygotes survive ;
18. thus heterozygotes pass on recessive allele to offspring when heterozygotes propagate/interbreed maintaining recessive allele in population;
19. e.g. heterozygous condition hides recessive Hb^S allele that is less favourable from natural selection which only acts on sickle cell anaemia phenotypes

or any relevant example with details (e.g. cystic fibrosis);

Heterozygote advantage

20. heterozygote advantage when individuals who are heterozygous at a particular locus have greater fitness than / selective advantage over / can survive and reproduce better than both kinds of homozygotes;
21. Heterozygote is selected for with named e.g. in malaria prone regions, Hb^AHb^S do not suffer from negative effects/do not die of sickle cell anemia or more resistant to malaria;
22. thus heterozygotes pass on recessive allele (Hb^S) to offspring when heterozygotes propagate/interbreed maintaining recessive allele in population;
23. Both homozygotes are selected against with named e.g. Hb^SHb^S individuals will be disadvantaged due to serious effect of sickle-cell anaemia and Hb^AHb^A will be susceptible to malaria;

KIASU ExamPaper Whatsapp Only 88660037

Frequency-dependent selection

24. frequency dependent selection is where fitness/selective advantage of phenotype depends on how common it is;
25. the frequency of each phenotype oscillates over time but is kept close to 50%, thus maintaining both alleles;
26. e.g. in Lake Tanganyika in Africa, there are two forms of scale-eating fish i.e. left-mouthed and right-mouthed. Prey of scale-eating fish guards itself against attack from whatever phenotype of scale-eating

fish is most common in the lake. So from year to year, selection favours whichever mouth phenotype is least common;

QWC: 2 variation arises and 2 how of recessive alleles are preserved;

[Total: 25]

KIASU ExamPaper
Islandwide Delivery | Whatsapp Only 88660031

2019 H2 Bio Preliminary Examination Paper 4 Mark Scheme

Before you proceed, read carefully through the **whole** of Questions 1 Part I.

QUESTION 1

Part 1

Plants transport sucrose through vascular bundles in stems and roots. You are required to investigate the movement of sucrose solution.

The apparatus will be set up as shown in Fig. 1.1, using a boiling tube and a 5 cm^3 syringe.

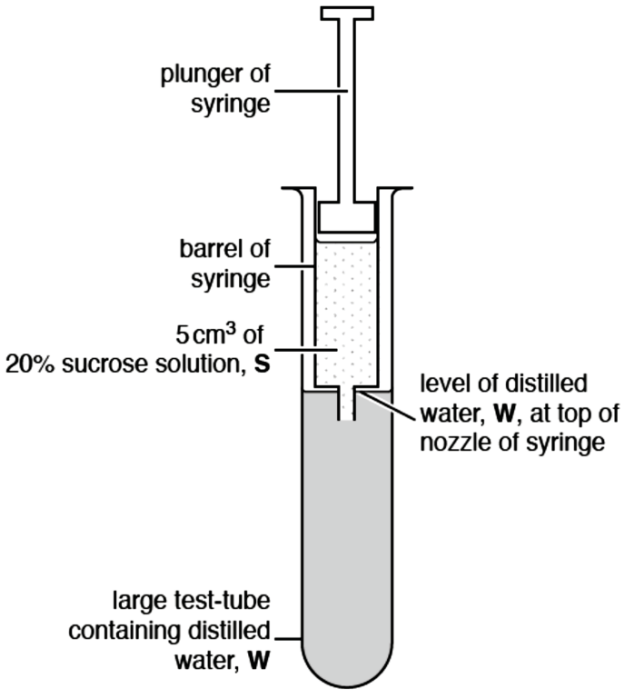


Fig. 1.1

You are provided with the materials shown in Table 1.1.

Table 1.1

labelled	contents	hazard	Volume / cm^3
S	20% sucrose solution	None	40
W	Distilled water	none	300

KIASU ExamPaper Worldwide Delivery Whatsapp Only 9360031

Carry out step 1 to step 5 to investigate the movement of sucrose from the syringe.

1. Set up the apparatus as shown in Fig. 1.1 but **without** any distilled water, **W**, in the boiling tube.

2. Observe and record in **(a)(i)** your observations of any movement of the sucrose solution.
3. Put **W** into the boiling tube. The level of **W** must be to the top of the nozzle of the syringe, as shown in Fig. 1.1.

4. Observe and record in **(a)(i)** your observations.

5. Empty the syringe and the boiling tube into the container labelled **For waste**.

(a) Complete Table 1.2.

Table 1.2

Contents of boiling tube	Observations
Without distilled water	no movement of sucrose solution observed ® level remains at 5 cm^3 ® no observable change
With distilled water	sucrose solution moves out of syringe ® there is movement (too vague) ® vol. of sucrose decreased

[1]

(b) You will need to investigate the movement of sucrose solution out of the syringe by:

- setting up the apparatus, as shown in Fig. 1.2
- collecting the sucrose solution released from the syringe during each of the first four two-minute periods after setting up the apparatus, as shown in Fig. 1.2
- testing the mixtures of sucrose solution and water collected during each of the four two-minute periods, using the non-reducing sugar test
- recording the time taken for the first colour change to occur when heating each mixture with Benedict's solution during the non-reducing sugar test.

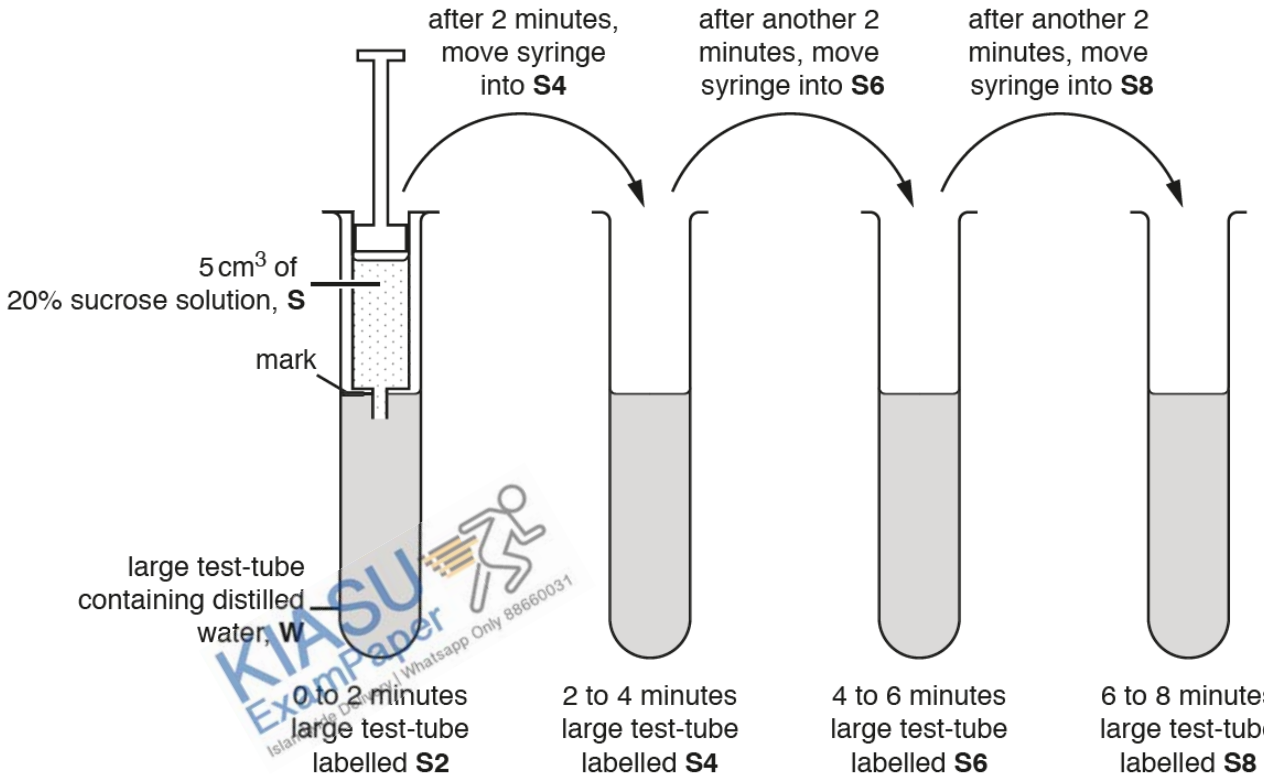


Fig. 1.2

6. Set up a water-bath and heat the warm water to boiling. This will be used in step 20 and step 27 during the tests for non-reducing sugar.

7. Label the four boiling tubes **S2, S4, S6** and **S8**.

The apparatus needs to be set up as shown in Fig. 1.2 so that at the start there is a standard volume of distilled water in each of the boiling tubes **S2, S4, S6** and **S8**.

8. Put the empty 5 cm^3 syringe from step 5 into the boiling tube labelled **S2**.

9. Put a mark on the boiling tube labelled **S2**, as shown in Fig. 1.2, so that the mark is level with the top of the nozzle of the syringe.

(i) Describe how you will use the apparatus provided to find the volume of distilled water, **W**, needed to fill the boiling tube to the mark, **when the syringe is in place**.

1. fill boiling tube with distilled water / W up to mark ;
2. measured / sum up volume of water using measuring cylinder or syringe ; [2]

(ii) Find the volume of distilled water, **W**, needed to fill the boiling tube to the mark, using the method you described in **(b)(i)**.

volume **30 – 38, in cm^3 to 1 dp (if syringe)** [1]

10. Put the volume of distilled water, **W**, stated in **(b) (ii)** into each of the four boiling tubes, **S2, S4, S6** and **S8**.

11. Fill a 5 cm^3 syringe with more than 5 cm^3 of sucrose solution, **S**. Push the plunger in to the 5 cm^3 mark to make sure there are no air bubbles in the nozzle.

12. Put the syringe into the first boiling tube, **S2**, as shown in Fig. 1.2. The nozzle of the syringe must be below the surface of the distilled water, **W**. Start the stopwatch.

13. Leave the syringe in the boiling tube **S2** for 2 minutes, then remove the syringe and put it immediately into the next boiling tube, **S4**. The nozzle o the syringe must be below the surface of the distilled water, **W**. Leave a further 2 minutes. Do **not** stop the stopwatch.

14. Repeat this process with each of the two remaining boiling tubes, **S6** and **S8**, removing the syringe from the last boiling tube, **S8**, at 8 minutes. Each time, the nozzle of the syringe must be below the surface of the distilled water, **W**.

KIASU ExamPaper
Islandwide Delivery | Whatsapp Only 88660031

To estimate the rate of movement of the sucrose solution into distilled water, **W**, the solution collected in each boiling tube will be tested for non-reducing sugar.

After hydrolyzing any non-reducing sugar present, the measurement used will be the time taken for the first colour change to occur when the solution is heated with Benedict's solution. This measurement allows the test to be semi-quantitative.

(iii) A student suggested the hypothesis that:

the rate of movement of the sucrose solution from the syringe into the water in the boiling tube will decrease with time.

If the student's hypothesis is correct, describe the expected trend in the time taken for the first colour change to occur when each solution collected in the boiling tube **S2, S4, S6** and **S8** is heated with Benedict's solution.

1. time to first colour change shortest for **S2** and longest for **S8** [1]
® increasing time without ref to which tubes

You will test the samples of the solution collected during each two-minute period for non-reducing sugar, using step 15 to step 31.

You are provided with the materials shown in Table 1.3.

Table 1.3

labelled	contents	hazard	Volume / cm^3
H	Dilute hydrochloric acid	Irritant	50
A	10 g sodium hydrogencarbonate powder	None	-
Benedict's	Benedict's solution	harmful	50

It is recommended that you wear suitable eye protection. If any of these materials come into contact with your skin, wash them off immediately under cold water.

15. Put a bung into one of the boiling tubes, **S2, S4, S6** or **S8**, and, with a finger on top of the bung, shake the solution to mix well.

16. Remove the bung and pour the solution from this boiling tube into a labelled beaker.

17. Put 2 cm^3 of the solution in the beaker into a labelled test tube.

18. Put 2 cm^3 of dilute hydrochloric acid, **H**, into the same test tube. Shake this test tube gently to mix.

19. Repeat step 15 to step 18 for **each** of the solutions in the remaining boiling tubes.

20. Put all the test-tubes into the boiling water-bath (set up in step 6). Leave the test-tubes for 2 minutes.

21. After 2 minutes, remove the test-tubes from the water-bath and put them into the beaker of water labelled **For cooling**.

You will need the boiling water-bath again for step 27.

KIASU ExamPaper Island-Wide Delivery Whatsapp Only 88660037

22. Leave the test-tubes in the beaker to cool for 3 minutes. After 3 minutes, continue with step 23.

23. Put a small amount of sodium hydrogencarbonate, **A**, into each test-tube. The mixture will fizz and rise up inside each test-tube.

24. Repeat step 23 until there is no more fizzing.

*Note: There may be a small amount of sodium hydrogencarbonate, **A**, left in the bottom of each test-tube.*

25. Put 3 cm^3 of Benedict's solution into the test-tube containing **S2**.

26. Shake the test-tube gently to mix.

27. Put this test-tube into the boiling water bath. Start timing.

28. Measure the time taken for the first appearance of a colour change in the test-tube.

*If there is no colour change after 180 seconds, **stop timing** and record the result in **(b)(iv)** as 'more than 180'.*

29. Record in **(b)(iv)** the result from step 28.

30. Remove the test-tube from the boiling water-bath. Put the test-tube in the test-tube rack.

31. Repeat step 25 to step 30 with each of the other solutions instead of **S2**.

(iv) Record your results in an appropriate table.

1. [L] appropriate layout
2. [IV] heading for independent variable with units e.g. time at which syringe was placed in boiling tube / min

   ® *test-tube*
3. [DV] heading for dependent variable with units e.g. time for first appearance of a colour change / s
4. [D] records times for S2, S4, S6 and S8 in seconds, in whole numbers [4]

Trend: increasing time for first appearance of colour change from S2 to S4

(v) The student's hypothesis stated that:

The rate of movement of the sucrose solution from the syringe into the water in the boiling tube will decrease with time.

State whether your results provide evidence to **support** or **reject** this hypothesis.

Explain how your results provide evidence for this decision.

support or reject state whether supports or rejects hypothesis

explanation state trend in time of 1st colour appearance, quote values

longer time indicates less reducing sugars present ORA [1]

KIASU ExamPaper Islandwide Delivery | WhatsApp Only 88660033

(c) A student modified the procedure by:

- using a 10% sucrose solution in the syringe
- collecting sucrose solution from the syringe in four-minute periods over a total time of 1200 seconds
- collecting any precipitate formed during the Benedict's test when testing each solution for non-reducing sugar
- drying and weighing the precipitate from each test to determine the mass of sucrose that had been present.

After carrying out the procedure, the student processed and analysed the results to calculate the rate of movement of the sucrose solution at specific times after placing the syringe in the boiling tube of water for the first time.

The calculated rates are shown in Table 1.4.

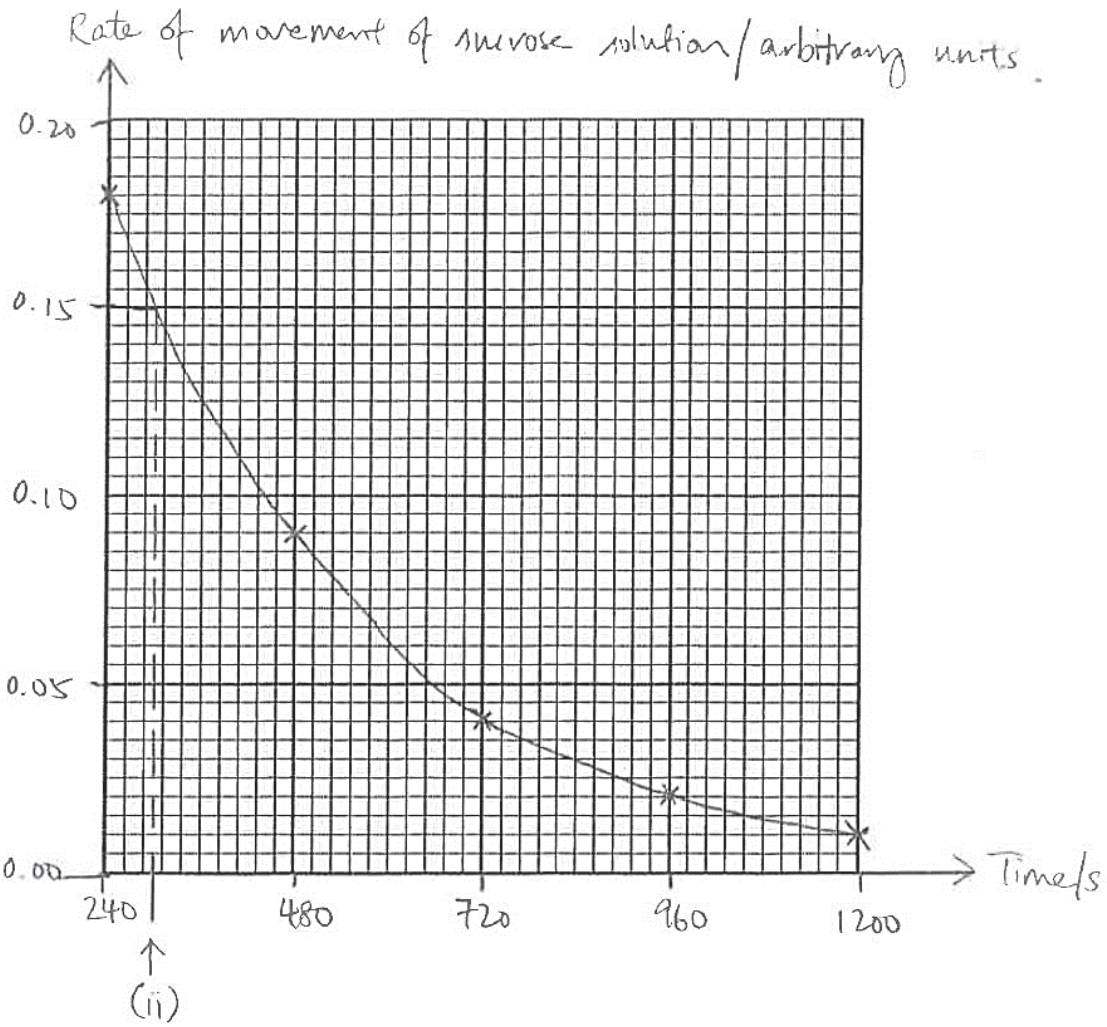
Table 1.4

Time / s	Rate of movement of sucrose solution / arbitrary units
240	0.18
480	0.09
720	0.04
960	0.02
1200	0.01

KIASU ExamPaper
Islandwide Delivery | Whatsapp Only 88660031

(i) Plot a graph of the data in Table 1.4 on the grid provided.

Use a sharp pencil for drawing graphs.



Marking points:

1. x-axis: time / minutes

   and

   y-axis: rate of movement of sucrose solution / arbitrary units**; Reject:** A.U.
2. x-axis scale: 240 units to 2 cm, labelled at least every 2 cm

   and

   y-axis scale: 0.05 units to 2 cm, labelled at least every 2 cm**;**

   OR an appropriate scale chosen for both axes, allowing plotted graph to occupy at least 70% 0f grid
3. 5 points plotted accurately with a visible cross**;**
4. 5 points connected point to point or connected with a curved line, without extrapolation

[4]

KiasuExamPaper Islandwide Delivery | WhatsApp Only 8660031

(ii) Use your graph to find the rate of movement of sucrose solution at 5 minutes.

Show on the graph how you determined your answer.

e.g. 0.15 arbitrary units

rate of movement _____ [2]

1. **shows on graph how answer determined;**
2. **correct answer for the rate of movement of sucrose solution at 5 minutes (300s) from candidate's graph;**

(iii) The procedure investigated how the rate of movement of sucrose from the syringe changed with time.

The procedure can be modified to investigate the effect of sucrose concentration, instead of time, on the rate of movement of sucrose solution. In the modified procedure, the sucrose solution from the sringe only needs to be collected once. The time period over which the sucrose solution is collected in the procedure needs to be standardised.

Use the graph to suggest a suitable time period for collecting the sucrose solution from the syringe.

Give a reason for your answer.

time period **240s / a value showing initial rate of reaction and unit of measurement must be in s.**

reason **Rate of movement of solution is the fastest**

_____ [1]

(iv) You are to modify **this procedure** to investigate the effect of using different concentrations of sucrose on the rate of movement of the sucrose solution.

State the concentrations of sucrose solution you would use.

1. **states at least 5 concentrations of sucrose solutions;**
   e.g. 2%, 4%, 6%, 8%, 10%
   For simple dilution, concentrations stated must be of equal intervals

KIASU ExamPaper
Islandwide Delivery | Whatsapp Only 88660031

Describe how the concentrations of sucrose solution would be prepared.

2. **Method: use simple dilution or serial dilution;**

3. **description of method to prepare the different concentrations using a table or in prose**

<u>Simple dilution</u>: Using 10% stock sucrose concentration, dilute with appropriate amounts of distilled water according to the table below to obtain the different sucrose concentrations with total volume of 10 cm^3.

Final sucrose concentration /%	Volume of 10% sucrose added / cm^3	Volume of distilled water added / cm^3
10	10.0	0.0
8	8.0	2.0
6	6.0	4.0
4	4.0	6.0
2	2.0	8.0
0	0.0	10.0

Serial dilution: 10%, 5%, 2,5%, 1,25%, 0.625% sucrose concentrations

[3]

Add 5 cm^3 of distilled water to 5 test tubes labelled 5%, 2,5%, 1,25%, 0.625% respectively. From a test tube (labelled 10%) containing 10 cm^3 of stock sucrose solution, transfer 5 cm^3 of 10% sucrose solution into the test tube labelled 5% to dilute the sucrose solution by a factor of 2.

Repeat the process for the subsequent sucrose concentrations by transferring 5 cm^3 of sucrose solution from the <u>preceding</u> test tube.

KIASU ExamPaper
Islandwide Delivery | Whatsapp Only 88660031

Part 2

A set of 5 different glucose concentrations were prepared using a 10% stock glucose concentration. To obtain a set of colour standards, Benedict's test for reducing sugars was carried out on these glucose solutions. A 1 : 10 ratio of glucose solution: Benedict's solution was used in the preparation. The colour change in the solutions was recorded after incubation in a boiling water bath for 2 minutes.

Table 1.5 shows the results for the colour standards after carrying out Benedict's test.

Table 1.5

Concentration of glucose /%	Description of colour change and suspension
10.0	Brick red precipitate in reddish brown solution
5.00	Reddish orange precipitate in reddish solution
2.50	Orange precipitate in orange solution
1.25	Trace amount of greenish precipitate in bluish-green solution
0.625	Faint amount of greenish precipitate in blue solution
Orange juice	

(d) (i) You are provided with 5 cm^3 of orange juice, labelled **O**. Plan and carry out a procedure to estimate the glucose concentration of the orange juice from the results in Table 1.5. Indicate your observation in Table 1.5

1. Add 1 cm^3 of orange juice to 10 cm^3 of Benedict's solution, mix and place into boiling water bath for 2 minutes;

2. Remove from water bath and **compare the colour** of the Benedict's test of orange juice with the colour standards to estimate glucose concentration of orange juice

Estimated glucose concentration of the orange juice

3. **Accept between 2.50 – 5% OR 5%** [3]

Observation must be stated in table 1.5 to gain this mark

(ii) Describe **two** other modifications to your method that would increase confidence in the conclusion and explain how these modifications would achieve this.

1. Prepare glucose solutions for colour standards using simple dilution with (smaller) intervals of 2% between each concentration;

2. Idea of as glucose concentration cannot be estimated accurately using existing concentrations in Table 1.5 as intervals between each concentration is too wide;

OR

1. Use colourimeter (**Reject**: calorimeter) to determine quantitatively the amount of glucose present by measuring the % light absorbance / % light transmission of both prepared glucose concentrations and orange juice after carrying out Benedict's test → results obtained from known glucose concentrations can be

KIASU Exam Paper

used to plot a standard curve from where glucose concentration in sample O can be identified.

Reject: measure colour / colour change

2. Difficulty in judging the colour differences between the Benedict's test results of sample O and the standard solutions / known glucose concentrations / cannot find accurate match with colour standards as there is subjectivity when doing visual comparison;

[4]

KIASU ExamPaper
Islandwide Delivery | Whatsapp Only 88660031

QUESTION 2

Resistance to antibiotics within a population of bacteria is due to selection pressure. This can be linked to the use of antibiotics by patients.

A study was carried out into the link between antibiotic use and the presence of resistant *Escherichia coli (E. coli*) populations in human communities.

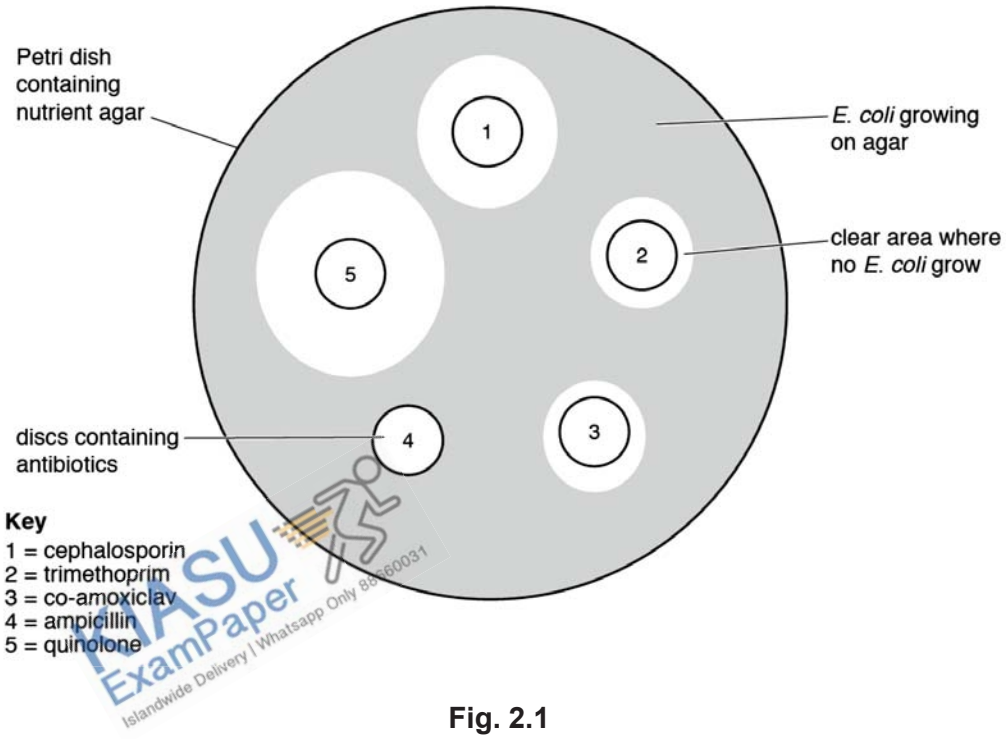
- Over 30 000 patients were involved in the study.
- Only patients attending large medical clinics took part in the study.
- The number of prescriptions issued by each clinic was used as an estimate of antibiotic use.
- Urine from patients attending the clinics was used as a possible source of antibiotic resistant *E. coli*.
- Antibiotic resistance of *E. coli* in the urine samples was measured using the disc diffusion method.

The disc diffusion method measures sensitivity of bacteria to an antibiotic. A bacterial population with low sensitivity to an antibiotic is resistant to that antibiotic.

In the disc diffusion method a Petri dish is filled with nutrient agar and urine samples containing *E. coli* are spread evenly across the agar.

Discs containing different antibiotics are placed on top of the agar. A lid is put on the Petri dish and the plate is incubated overnight.

Fig. 2.1 shows an example of a Petri dish from the study after incubation.



KIASU ExamPaper
Islandwide Delivery | Whatsapp Only 88560031

Fig. 2.1

(a) **(i)** Suggest two variables that need to be standardised when using the disc diffusion method in this study.

Any two below:

1. volume of urine;
2. volume / concentration / composition / pH, of agar;
3. concentration / volume, of antibiotics;
4. incubation temperature;
5. incubation time;
6. size / diameter / area / spacing / type / source, of discs;

[2]

(ii) Describe how you would determine the sensitivity of *E.coli* to each antibiotic.

1. measure the diameter / radius / area of clear zone around the antibiotic disc with a ruler;

2. the larger / wider / bigger the zone of clearing is, the more sensitive / less resistant, the bacteria are to the given antibiotic / idea of no clear zone means bacteria are resistant to / not affected by / not killed by / not sensitive to given antibiotic ;

[2]

(b) Table 2.1 shows the results of this investigation.

Table 2.1

antibiotic	antibiotic use /prescriptions per thousand patients per year		percentage *E. coli* resistance	
	mean ($\bar{x}$)	standard deviation (s)	mean ($\bar{x}$)	standard deviation (s)
cephalosporin	107.0	83.0	6.5	3.5
trimethoprim	62.6	25.6	26.3	5.8
co-amoxiclav	75.5	43.9	8.4	5.7
ampicillin	351.9	171.1	53.2	7.2
quinolone	33.6	18.3	2.2	1.9

KIASU ExamPaper Handwide Delivery | WhatsApp Only 88660031

Comment on the standard deviations for **antibiotic use** as shown in Table 2.1.

any two below:

1. it shows a large, spread of data around the mean / difference in data / deviation from the mean / variation with the mean ;
2. data is not very reliable / trustworthy / consistent;

3. standard deviation increases as mean increases / positive correlation between standard deviation and mean;

[2]

(c) Outline how use of antibiotics e.g. ampicillin, can be linked to the development of antibiotic resistance in *E. coli.*

1. Incomplete treatment where dose of antibiotic / ampicillin not finished, some bacteria survive;
2. Spontaneous mutation in bacterial population may produce strains that are resistant to antibiotic / ampicillin;
3. When antibiotic / ampicillin is added, it acts as a selection pressure, selecting for antibiotic resistant / ampicillin resistant bacteria,

   they reproduce by binary fission and pass the antibiotic / ampicillin resistance / advantageous allele to the daughter bacterial cells;
4. while those that are susceptible/sensitive/ non-resistant bacteria die;
5. increasing antibiotic resistance allele frequency within the populations of bacteria over time;

[max 3]

[3]

[Total: 9]

KIASU ExamPaper
Islandwide Delivery | Whatsapp Only 88660031

QUESTION 3

During this question, you will require access to a microscope and slide **S1**.

Fig. 3.1 is a photomicrograph of a stained transverse section through a plant stem.

The stem of this plant grows submerged in water and contains air spaces.

You are not expected to be familiar with this specimen.

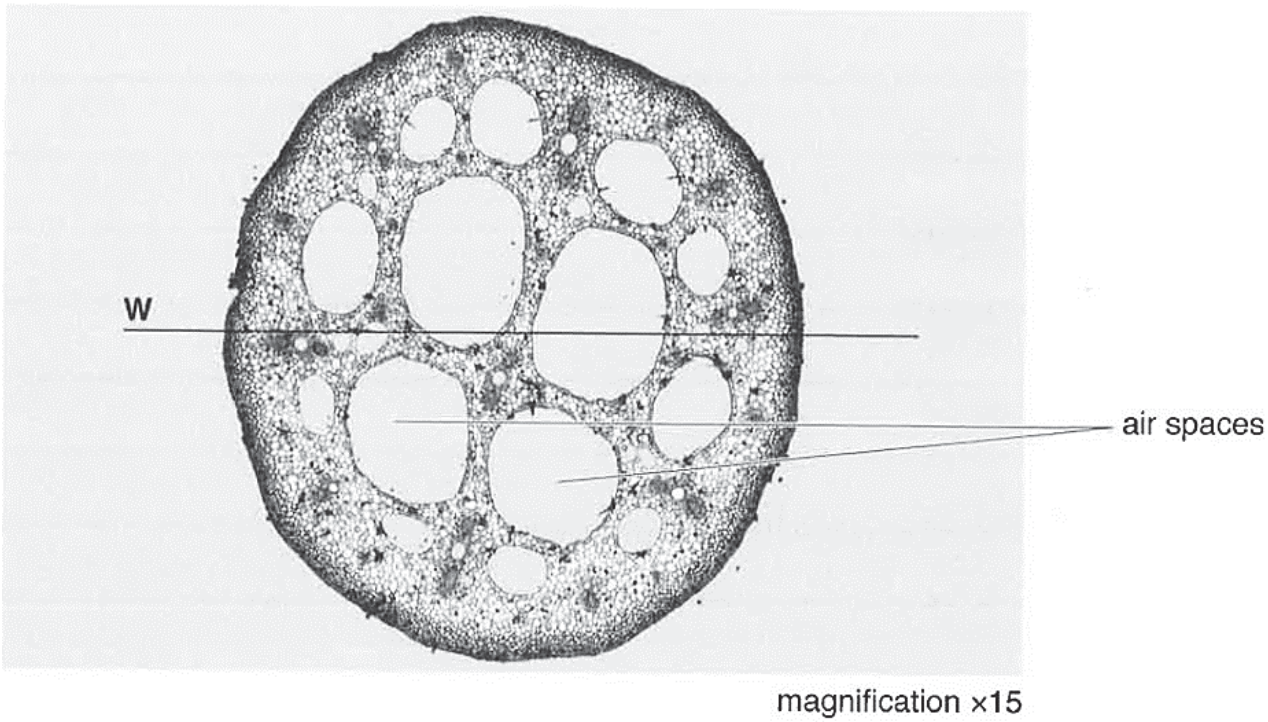
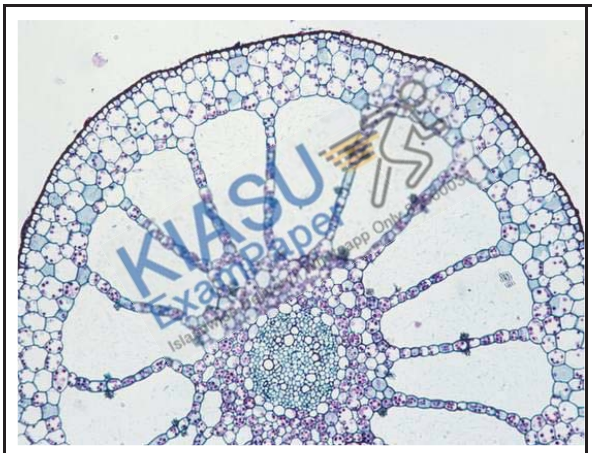
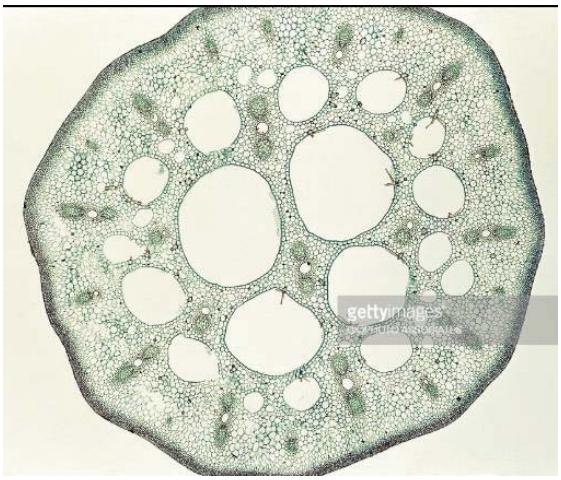


Fig. 3.1

Slide **S1** is a microscope slide of a stained transverse section through the stem of a different species of plant. This stem also grows submerged in water and contains air spaces.

(a) Use a suitable table to record observable differences between the specimen in Fig. 3.1 and the specimen on slide **S1**.

	
S1 (milfoil stem)	Fig. 3.1 (water lily stem)

Feature	S1	Fig. 3.1
Arrangement of airspace	In a ring;	scattered;
Shape of airspace	cone-shaped;	circular;
Arrangement of vascular bundle	In the middle of the stem;	scattered;
Number of vascular bundle	1 (in the middle of the stem);	Many (distributed throughout the stem);

Max 3

[3]

(b) **(i)** Calculate the actual radius of the stem at the position marked by line **W** in Fig. 3.1.

You should show your working and use appropriate units.

Total length of W = 73 ± 1 mm

Magnification = Fig. 3.1 diameter / actual diameter

15 = 73 / actual diameter
Actual diameter = 73 / 15 = 4.87 mm
∴ Actual radius = 4.87/2 = 2.4 mm

actual radius of stem ..... [1]

You are required to estimate the radius of the stem on slide **S1**.

(ii) Put the clear plastic ruler on the stage of the microscope and view the scale lines on it using low power (×10 objective lens).

Estimate the diameter of the field of view to 1 decimal place of a **mm**.

diameter of field of view **2.0 ± 1 mm** ..... mm [1]

(iii) View the stem on slide **S1** using low power.

Estimate the fraction of the diameter of the field of view occupied by the radius of the stem on slide **S1**.

fraction of diameter of field of view **Accept from ½ to ⅔** [1]

(iv) Using your estimates from **(b)(ii)** and **(iii)**, calculate the radius of the stem on slide **S1**, using appropriate units.

radius of **S1** **2.0 x ⅔ = 1.33 mm** [1]

KIASU ExamPaper Islandwide Delivery | WhatsApp 9560031

(v) Describe how to obtain a more accurate measurement of the radius of the stem on slide **S1**.

State any appropriate pieces of apparatus that you might need.

Use of **stage micrometer** with 100 divisions whereby 1 division is 0.01 cm / 0.1 mm;

1. Align the scale on the stage micrometer with the scale of the eyepiece graticule and measure the number of eyepiece division within 1 division of stage micrometer;
2. Divide 1 division of stage micrometer (i.e. 0.1 mm) with the number of eyepiece division to obtain measurement for 1 division of eyepiece;
3. Radius of S1 can then be calculated in mm by finding out how much eyepiece units span that radius and multiplying by one eyepiece unit in mm;
4. Obtain mean radius by having 3 radius from different parts of the stem

Reject: Ref. to measurement using ×4 objective lens (this lens was removed from the microscope).

For teacher's reference only:

Steps in calibration:

1. *Length of stage micrometer (SM) = 1 cm / 10 mm*
   ∴ 1 small division on SM
   = 10÷100 = 0.1 mm

2. *No. of eyepiece graticule units that cover 1 small division on SM*
   = 10 eyepiece graticule units

3. ***∴ 1 small division of eyepiece graticule***
   = 0.1 ÷ 10 mm
   = ***0.01 mm***

[3]

KIASU ExamPaper
Islandwide Delivery | Whatsapp Only 88660031

(c) (i) You are required to use a sharp pencil for drawings.

Use the space provided to draw a plan diagram of part of the stem on slide **S1**, as shown in the shaded area of Fig. 3.2. A plan diagram only shows the arrangement of the different types of tissues. Individual cells must **not** be drawn in plan diagrams.

Within this part of the stem there will be a number of air spaces.

You should only draw three of these air spaces.

Your drawing should show the correct shape and proportion of the tissues **and** three air spaces.

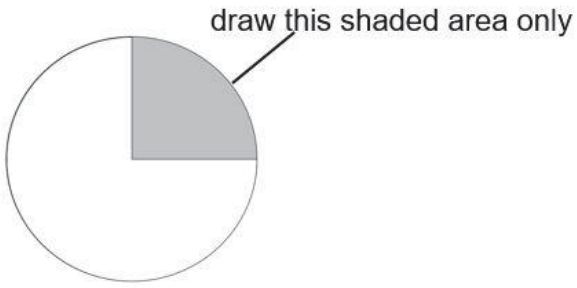


Fig. 3.2

Marking points:

1. drawing at the appropriate size + no shading + no cells ;
2. only area shaded in Fig. 3.2 drawn ;
3. correct position of air spaces relative to **whole depth** of stem ;
4. draws three air spaces;

[4]

(ii) Observe the cells that are found between the air spaces in slide **S1**.

Select **one** group of **three** touching cells that are found between two air spaces.

Each cell of the group must touch at least one of the other cells.

Make a large drawing of this group of **three** cells.

Marking points:

1. lines should be continuous, thin and sharp + drawn to occupy most of the space provided ;
2. draws **only** three cells + each cell **touching at least one** of the other cells ;
3. two lines drawn around each cell + three lines where cells touch ;
4. each cell should contain some **intracellular vesicles** ;

[4]

KIASU ExamPaper Islandwide Delivery | Whatsapp only 88660031

(d) Suggest **one** advantage of having air spaces in plant stems that grow submerged in water, as shown in Fig. 3.1, and slide **S1**.

1. Buoyancy, to allow the plant to float near the surface of the water;

OR

storage of oxygen, less oxygen available in the water

[1]

[Total: 19]

KIASU ExamPaper
Islandwide Delivery | Whatsapp Only 88660031