TEMASEK JUNIOR COLLEGE

**TEMASEK JUNIOR COLLEGE**
PRELIMINARY EXAMINATIONS
JC 2 / IP YEAR 6 2019

| | |
|---|---|
| CANDIDATE NAME | |
| CIVICS GROUP | C G / 1 8 |

# H2 BIOLOGY

Multiple Choice

**9744/01**
**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, glue or correction fluid.
Write your name, civics group on the Multiple Choice Answer Sheet in the spaces provided.

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 Multiple Choice Answer Sheet.

**Read the instructions on the Multiple Choice 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.

Answer **all** the questions in this section.

1 These events take place when glycoproteins are secreted from a cell.

1 addition of carbohydrate to protein
2 fusion of the vesicle with the plasma membrane
3 release of glycoprotein
4 budding of a vesicle from the Golgi apparatus

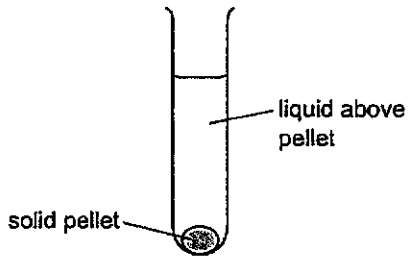
What is the sequence in which these events take place?

**A** 1 → 4 → 2 → 3
**B** 1 → 4 → 3 → 2
**C** 4 → 1 → 2 → 3
**D** 4 → 1 → 3 → 2

2 A scientist carried out an experiment to separate the organelles in an animal cell by density.

The scientist mixed the cells with a buffer solution which had the same water potential as the cells. The cells were lysed with a blender to release the organelles.

The mixture was filtered and then spun in a centrifuge at a high speed to separate the heaviest organelle. This sank to the bottom, forming a solid pellet, 1.




The liquid above pellet 1 was poured into a clean centrifuge tube and spun in the centrifuge at a higher speed to separate the next heaviest organelle. This organelle sank to the bottom, forming a solid pellet, 2.

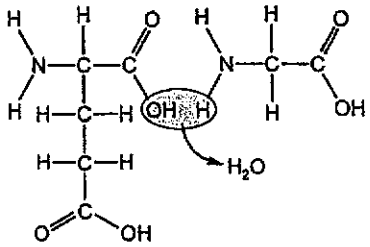
He repeated this procedure twice more to obtain pellet 3 and pellet 4, each containing a single type of organelle.

What is the possible function of the organelle extracted in pellet 3?

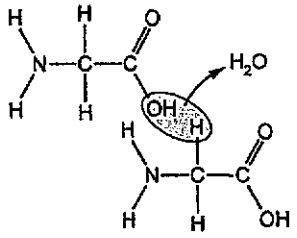
**A** digestion of old organelles
**B** production of ATP
**C** production of mRNA
**D** catalyse bond formation in polypeptides

3 Which diagram correctly shows the formation of a peptide bond between two amino acids?

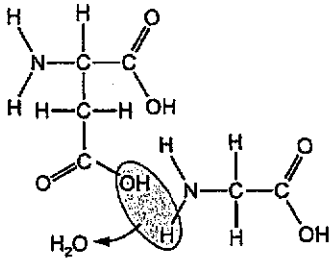
A



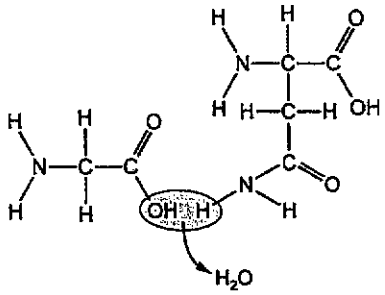
B



C



D



4 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 |

5 Which statements about the differences between phospholipids and triglycerides is/are correct?

1 Phospholipids have hydrophobic regions but triglycerides do not.
2 The fatty acids in a phospholipid may be saturated or unsaturated but in a triglyceride they are always saturated.
3 Phospholipids are amphipathic molecules but triglycerides are non-polar.

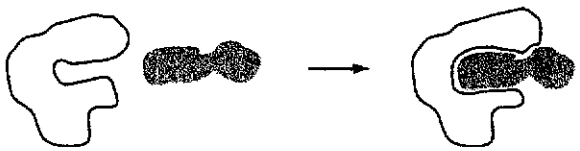
**A** 1 and 2
**B** 1 only
**C** 2 and 3
**D** 3 only

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

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

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

7 The diagram shows an enzyme, its substrate and an enzyme/substrate complex.




Which statement explains how the substrate is able to bind to the active site of the enzyme?

**A** Contact between the substrate and the enzyme causes a change in the enzyme shape.
**B** The shape of the active site and the shape of the substrate are exactly complementary.
**C** The substrate within the active site forms disulfide bonds with amino acids.
**D** When the enzyme-substrate complex forms, the primary structure of the enzyme changes.

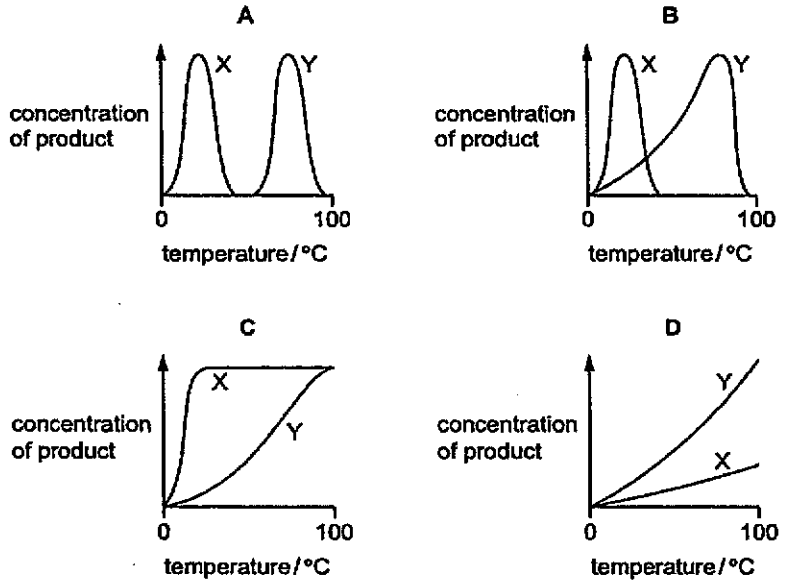
8 Two enzymes, X and Y, were used in an experiment.

Enzyme X was from bacteria that live in rivers and lakes at temperatures from 5°C to 20°C.

Enzyme Y was from bacteria that live in hot water springs at temperatures from 40°C to 85°C.

The experiment measured the concentration of product produced by each enzyme at temperatures between 0°C to 100°C.

Which graph shows the results?

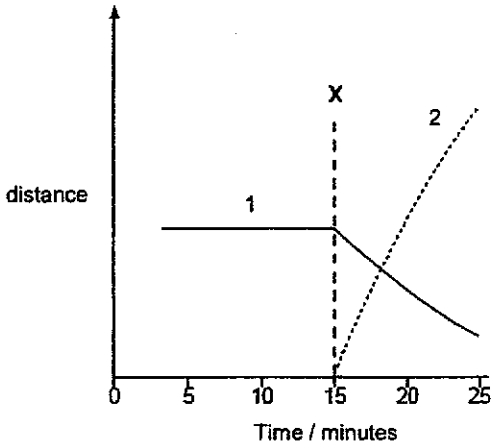



9 Which is always true of cytokinesis?

1 Cell organelles replicate.
2 Cell organelles are divided between two cells.
3 Nuclear envelope reforms.

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

**10** The graph shows measurements taken during one mitotic cell cycle




Which stage of mitosis begins at **X** and which measurements are shown by curve 1 and 2?

| | Stage beginning at X | Distance between centromeres of chromosomes and poles of spindle | Distance between centromeres of sister chromatids |
|---|---|---|---|
| **A** | Anaphase | 1 | 2 |
| **B** | Anaphase | 2 | 1 |
| **C** | Metaphase | 1 | 2 |
| **D** | Metaphase | 2 | 1 |

**11** The codons UGU and UGC code for the amino acid cysteine, which can form disulfide bonds in a polypeptide.

The codon UGG codes for the amino acid tryptophan, which does not contain a sulfur atom.

The codon UGA is a stop signal.

The DNA triplet code for the 10th amino acid in a particular polypeptide is ACA.

Which single base substitution(s) in this triplet code will result in **no** disulfide bond being formed with the 10th amino acid in the polypeptide?

**A** ACC and ACG

**B** ACG and ACT

**C** ACT and ACC

**D** ACT only

**12** An antibiotic, edeine, was isolated. It inhibits protein synthesis but has no effect on either DNA synthesis or RNA synthesis. When added to a translation mixture containing fully intact organelles, edeine stops haemoglobin translation after 10s.

Analysis of the edeine-inhibited mixture by centrifugation showed that no polyribosomes remained by the time protein synthesis had stopped. Instead, all the mRNA accumulated together with small ribosomal subunit and initiator tRNA.

What step in protein synthesis does edeine inhibit?

**A** It interferes with chain termination and release of the peptide.

**B** It inhibits the binding of amino acyl-tRNAs to the A-site in the ribosome.

**C** It blocks the translocation of peptidyl-tRNA from the A-site to the P-site of the ribosome.

**D** It prevents the formation of the translation initiation complex, which contains the initiator tRNA and both ribosomal subunits.

**13** Which of the following statements describe the purpose of transferring DNA fragments from a gel to a nitrocellulose paper during Southern blotting?

1 To permanently attach the DNA fragments to a substrate
2 To separate the two complementary DNA strands
3 To transfer only the DNA that is of interest
4 To separate out the PCR products

**A** 1 only

**B** 1 and 2

**C** 2, 3 and 4

**D** 1, 2 and 3

**14** How many PCR cycles would an original sample of DNA have to pass through in order to increase the sample to eight times in quantity?

**A** 2

**B** 3

**C** 4

**D** 6

**15** Stem cells are found in many tissues that require frequent cell replacement such as the skin, the intestine and the blood.

However, within their own environments, a bone marrow cell cannot be induced to produce a skin cell and a skin cell cannot be induced to produce a blood cell.

Which statement explains this?

**A** Different stem cells only have the genes required for their particular cell line.

**B** Genes not required for the differentiation of a particular cell line are methylated.

**C** Binding of repressor molecules prevents the expression of genes not required for a particular cell line.

**D** Expression of gene not required for a particular cell line is controlled at translational level.

**16** Which row best describes the ability of zygotic stem cells to differentiate?

| | Totipotent | Pluripotent | Multipotent |
|---|---|---|---|
| **A** | ✓ | ✓ | ✓ |
| **B** | ✓ | × | ✓ |
| **C** | ✓ | × | × |
| **D** | × | ✓ | ✓ |

key

✓ = ability

× = no ability

**17** Which of the following statements is true of post-transcriptional modification?

1 Nucleotides are added at both ends of the RNA which increases the stability of mRNA for translation.

2 The length of 3' end of RNA that was extended with adenine molecules by telomerase determines the half-life of the mRNA.

3 Enzymes remove nucleotides in the non-coding regions to create a continuous coding sequence.

4 mRNAs are transcribed from heavily methylated DNA regions.

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

**18** The *trp* operon is a

**A** negatively controlled inducible operon.
**B** positively controlled inducible operon.
**C** negatively controlled repressible operon.
**D** positively controlled repressible operon.

**19** 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.

**20** The neuraminidase of influenza virus exhibit all the following properties **except**

**A** facilitating the release of virus particles from infected cells.

**B** attaching with the sialic acid receptor present in upper respiratory tract.

**C** embedding in the outer surface of the viral envelope.

**D** carrying out enzyme activity.

**21** Which of the following materials can be taken up by a bacterium from the surrounding during transformation?

1 DNA from a bacteriophage
2 linear plasmid
3 rRNA from another bacterium

**A** 1 only

**B** 3 only

**C** 1 and 2

**D** 2 and 3

**22** Some plants with large pink flowers were allowed to interbreed. They produced hundreds of seeds. When the seeds germinated, fifty seedlings were selected at random and allowed to grow to maturity.

The resulting plants had red, pink or white flowers, which were either large or small.

The numbers of the different types of plant are shown in the table.

| | | flower colour | | |
|---|---|---|---|---|
| | | red | pink | white |
| flower size | large | 9 | 20 | 9 |
| | small | 4 | 6 | 2 |

For which plants can the genotype for both colour and size of flower be known for certain?

**A** all plants with large flowers

**B** all plants with small flowers

**C** plants with large pink or small red flowers

**D** plants with large red or small white flowers

23 Pure-breeding pea plants that produced yellow and round seeds were crossed with pure-breeding pea plants that produced green and wrinkled seeds.

All the first generation, F1, produced yellow and round seeds. Selfing of F1 was carried out and the results of the F2 generation was recorded in the table.

| Phenotype of seed | observed numbers (O) | expected numbers (E) | O – E | $(O - E)^2$ | $(O - E)^2 / E$ |
|---|---|---|---|---|---|
| Yellow, round | 50 | | | | |
| Yellow, wrinkled | 20 | | | | |
| Green, round | 16 | | | | |
| Green, wrinkled | 10 | | | | |
| total | 96 | 96 | 0 | | $\chi^2 =$ |

Assuming normal Mendelian inheritance, which of the following option is correct?

A $\chi^2 = 2.4$, degrees of freedom = 2
B $\chi^2 = 2.4$, degrees of freedom = 3
C $\chi^2 = 3.4$, degrees of freedom = 2
D $\chi^2 = 3.4$, degrees of freedom = 3

**24** Myxomatosis is a viral disease of rabbits caused by *Myxoma* virus. The virus spreads rapidly and most rabbits die within 14 days of being infected.

*Myxoma* virus was used to reduce the number of rabbits in countries where the rabbits are a significant crop pest.

The initial release of the virus caused rabbit populations to fall by over 90%. Resistance to the virus increased in the following 70 years, so at present time, up to 50% of infected rabbits are able to survive.

Which statement could explain the increasing frequency of rabbits that are resistant to *Myxoma* virus in the years following release of the virus?

1 During disease outbreaks there is greater food availability for the surviving rabbits, increasing the probability that they survive and breed.

2 The initial release of the virus led to a bottleneck event such that only rabbits with the resistant alleles were able to survive.

3 Infected rabbits die quickly, hence the genes that code for the *Myxoma* virus are eliminated from the population.

4 In populations with high incidences of myxomatosis, mutations leading to resistance are more likely to occur.

**A** 1 and 2

**B** 3 and 4

**C** 1 and 3

**D** 2 and 4

**25** Which statement is correct about a classification system based on phylogeny?

**A** It is based on evolutionary relationships.

**B** It is based on one feature, not a group of similar features.

**C** It is based on phenotypic structures.

**D** It is based on taxonomic groups.

**26** Many signal transduction pathways use second messengers to

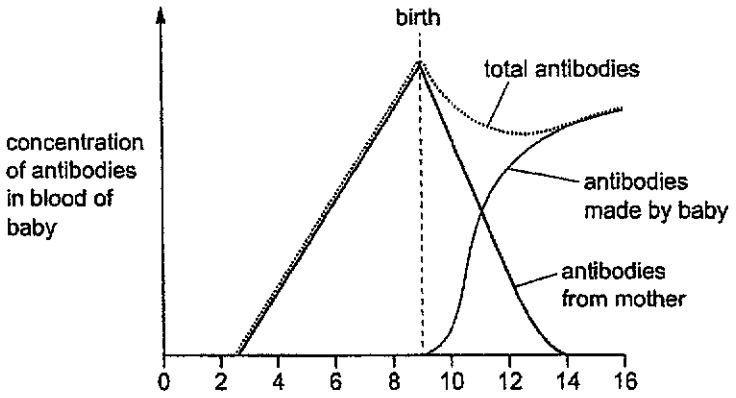
**A** transport a signal through the plasma membrane.

**B** relay a signal from the outside to the inside of the cell.

**C** relay a signal from the inside of the membrane throughout the cytoplasm.

**D** amplify the message by phosphorylating proteins.

**27** The graph shows the changes that occur in the concentration of antibodies in the blood of a baby before birth and during the first few months after birth.




Which description about the changes in immunity during the first few months after birth is correct?

**A** active artificial immunity decreases, active natural immunity increases

**B** active natural immunity decreases, active artificial immunity increases

**C** passive artificial immunity decreases, active natural immunity increases

**D** passive natural immunity decreases, active natural immunity increases

**28** Which of the following changes the variable region of an antibody?

1 Somatic recalibration

2 Somatic recombination

3 Somatic hyper-mutation

4 Class switching

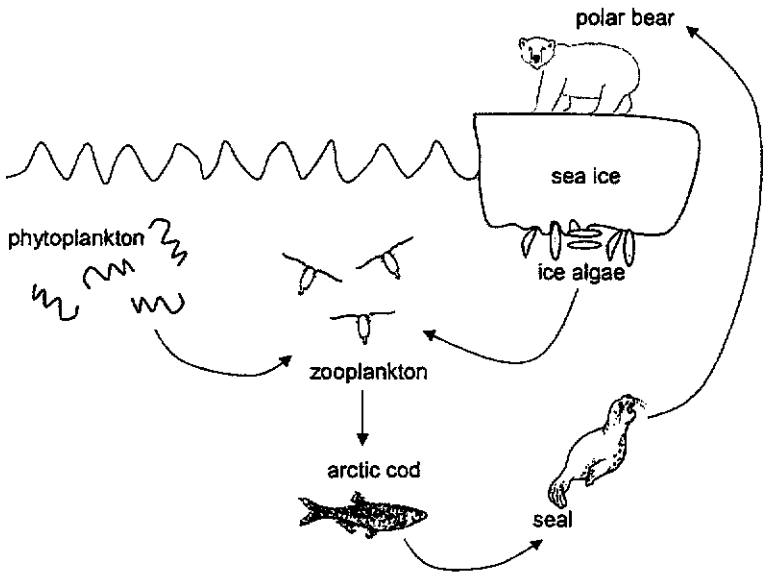
**A** 1 and 3

**B** 2 and 3

**C** 1 and 4

**D** 2 and 4

**29** The diagram shows an arctic food web. It features two primary producers (phytoplankton and ice algae) that fix carbon by photosynthesis. Ice algae thrive in nutrient-rich pockets in the ice, while phytoplankton are found freely floating in the ocean.




Which of the following is **not true** regarding the effect of climate change on this arctic habitat?

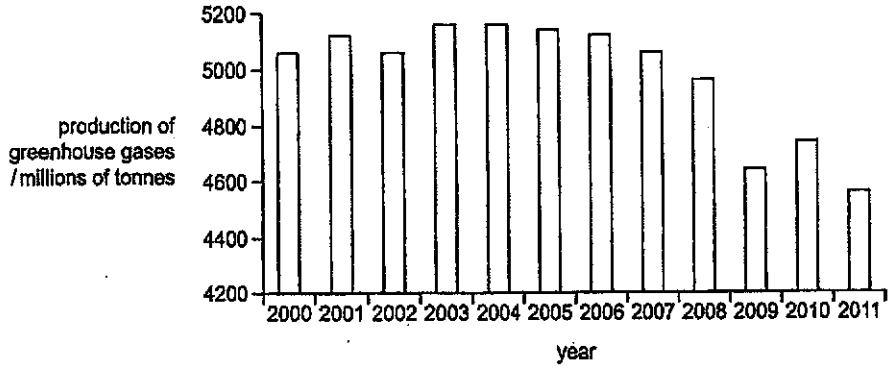
**A** Decline in ice algae can lead to the decline in polar bear population.

**B** Decline in ice algae will lead to an increase in phytoplankton because there is less competition between phytoplankton and ice algae for resources.

**C** The effect on arctic cod, seal, and polar bear populations depends on how much zooplankton population is affected by the decline in ice algae.

**D** Decline in zooplankton may lead to decline in seal population.

**30** The bar chart shows the production of greenhouse gases (carbon dioxide and methane) from agriculture in the European Union (EU) from 2000 to 2011, measured in millions of tonnes.




Which of the following could contribute to the trend seen between 2003 and 2009?

**A** Conversion of intensive farmland into woodland reserves.

**B** Greater use of agricultural machinery for harvesting.

**C** Increased consumption of meat-based products.

**D** Increased import and export of crops between EU countries.

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# H2 BIOLOGY

**9744/02**

Paper 2 Structured Questions **(Part I)**

**27 August 2019**

**2 hours**

Candidates answer on the Question Paper.

No Additional Materials are required.

**READ THESE INSTRUCTIONS FIRST**

**Do not open this booklet until you are told to do so.**
Write your name and civics group in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, 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.

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

| For Examiner's use | |
|---|---|
| 1 | / 10 |
| 2 | / 5 |
| 3 | / 8 |
| 4 | / 9 |
| 5 | / 8 |
| 6 | / 10 |
| Total | / 50 |





This document consists of **14** printed pages and **2** blank pages.

**Part I**

Answer **all** questions.

1 Cholesterol is synthesised 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. These lipoproteins containing cholesterol are transported to all parts of the body.

Fig. 1.1 is an electron micrograph of part of a liver cell showing the packaging of a lipoprotein particle.

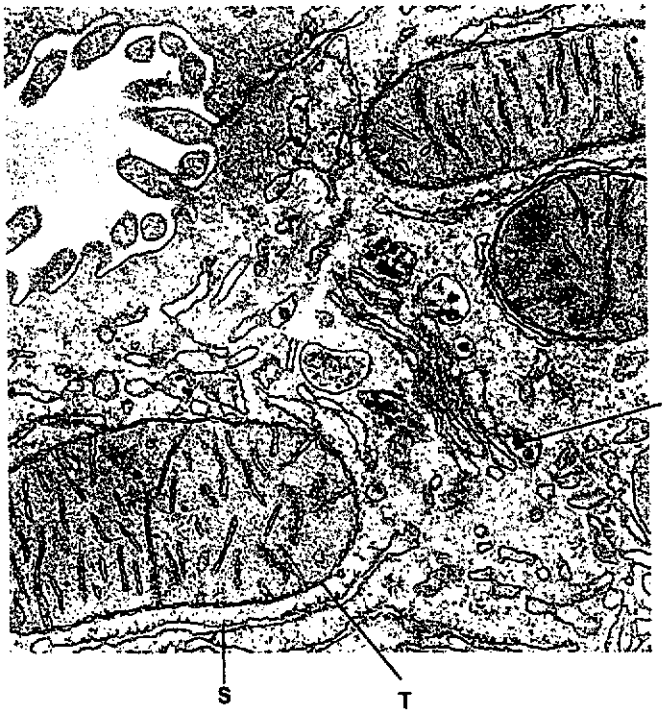


**Fig. 1.1**

**(a)** Name organelle **T** in Fig. 1.1 and describe its role in liver cells.

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.....[3]

**(b)** **(i)** Suggest why cholesterol is packaged into lipoproteins before release from liver cells into the blood.

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.....[1]

**(ii)** Explain why cells need to be supplied with cholesterol.

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.....[2]

Organelle **S** can be found attached to a membrane system that is distinct from SER. It is composed of a nucleic acid and another biological molecule.

**(c)** **(i)** Name the nucleic acid found in organelle **S**.

.....[1]

**(ii)** Describe the roles of the nucleic acid named in **(c)(i)**.

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.....[2]

**(d)** Evolutionary theorists suggested that organelle **T** used to be a free-living prokaryotic organism but was engulfed by a eukaryotic cell and eventually became a part of it.

Give an evidence to justify why they may be correct.

.....

.....

.....[1]

[Total: 10]

2 Mineral ion **X** is taken into plant cells. The transport of ion **X** is interrupted when a metabolic poison which affects the mitochondrial electron transport chain is present.

Some cells were placed in media containing different concentrations of ion **X** without the metabolic poison. After one hour, the cells were removed and the intracellular concentration of **X** was measured.

Fig. 2.1 shows the results.

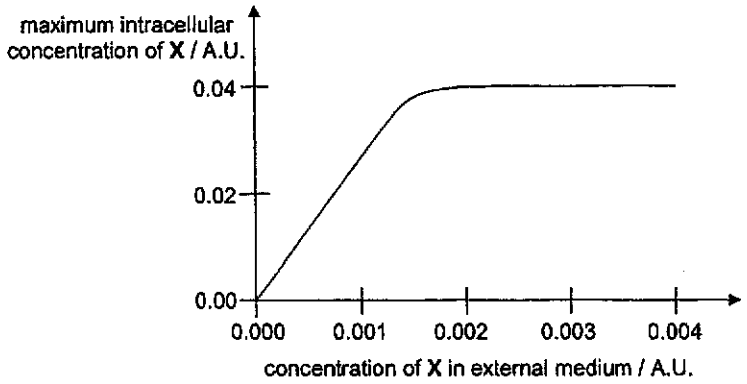


**Fig. 2.1**

**(a)** Describe the arrangement of the phospholipids in the plasma membrane.

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.....[2]

**(b)** With reference to Fig. 2.1,

**(i)** identify the process by which **X** is transported into the cell;

.....[1]

**(ii)** give a reason for your answer in **(b)(i)**.

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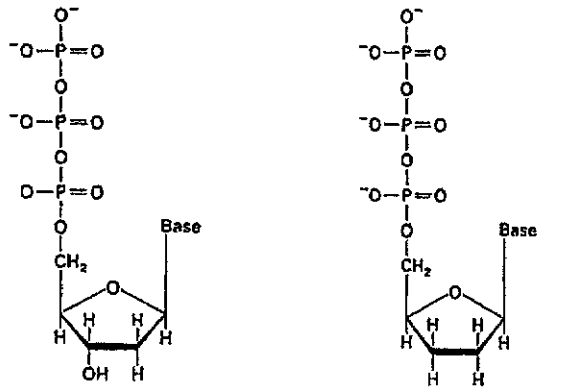
.....[2]

[Total: 5]

3 One of the substrates required by DNA polymerase is deoxyribonucleoside triphosphate (dNTP).

Dideoxyribonucleoside triphosphate (ddNTP) is a modified nucleotide that affects DNA polymerase activity.

Fig. 3.1 shows the structures of dNTP and ddNTP.




deoxyribonucleoside triphosphate (dNTP)

dideoxyribonucleoside triphosphate (ddNTP)

**Fig. 3.1**



In an investigation, the effect of different concentrations of ddNTP on the rate of DNA synthesis was determined.

The results of the investigation are shown in Fig. 3.2.

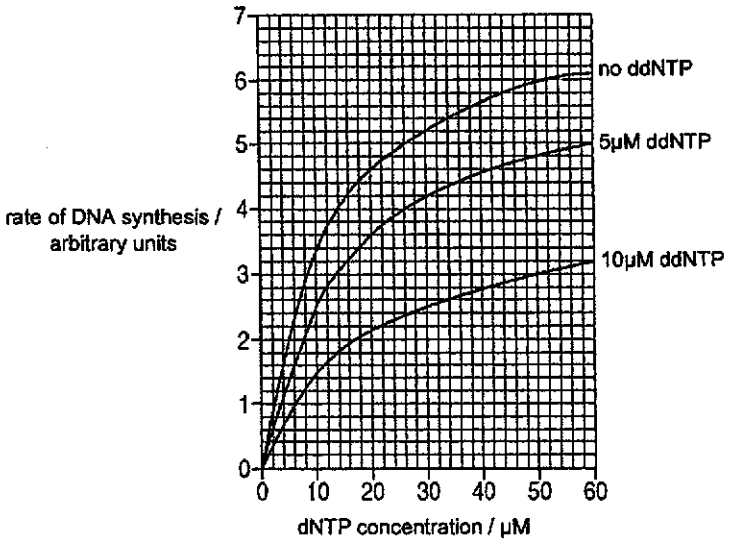



**Fig. 3.2**

**(a)** Describe the effect of increasing substrate concentration on the rate of DNA synthesis, in the absence of ddNTP.

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.....[2]

**(b)** With reference to Fig. 3.2, state the effects of ddNTP on the rate of DNA synthesis.

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.....[3]

**(c)** The optimum pH for DNA polymerase is pH 9.0.

Suggest **and** explain what happens to the rate of DNA synthesis when DNA polymerase is placed in a medium with pH 1.0.

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.....[3]

[Total: 8]

4 Fig. 4.1 shows a linear chromosome undergoing the first round of DNA replication.

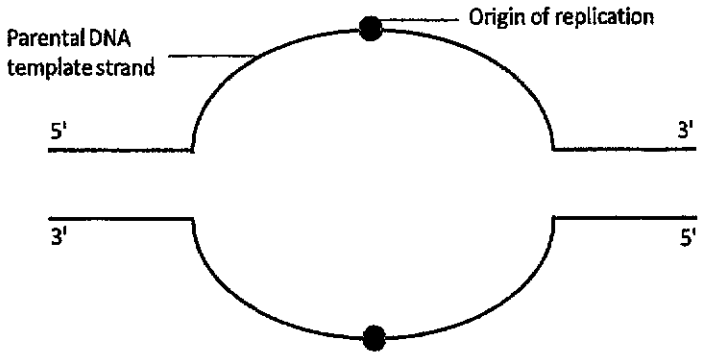


**Fig. 4.1**

**(a)** **(i)** On Fig. 4.1, draw the direction of DNA synthesis for the leading (⟶) and lagging strand (- - - - >) for both parental DNA template strands.

[1]

**(ii)** Describe **two** differences in the formation of the leading and lagging strands.

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.....[2]

During sexual reproduction, meiosis is an important source of genetic variation.

**(b) (i)** Describe the events that take place during prophase I of meiosis in an animal cell.

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.....[3]

**(ii)** Explain how independent assortment of homologous chromosomes leads to genetic variation during meiosis I.

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.....[3]

[Total: 9]

5 Fig. 5.1 shows the processes leading to the formation of a messenger RNA (mRNA) molecule that is eventually translated into a polypeptide.

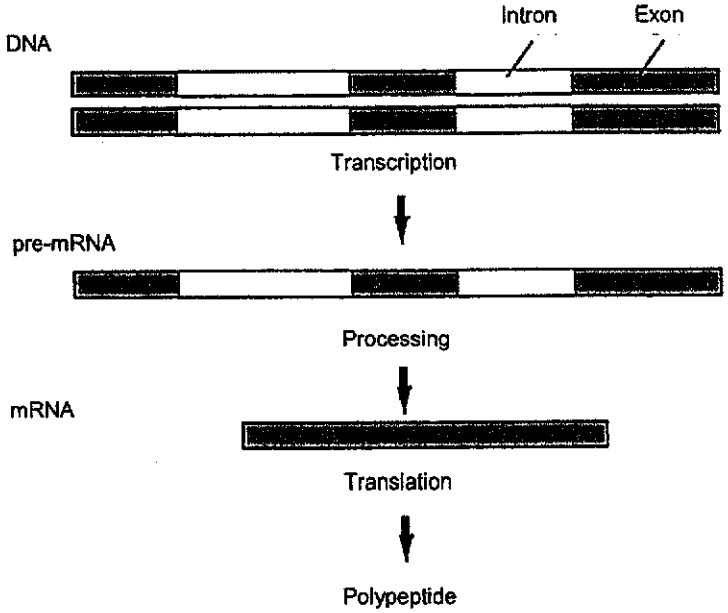


**Fig. 5.1**

**(a)** Explain why transcription is necessary for polypeptide synthesis.

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.....[2]

**(b)** Suggest why it is important that the mature mRNA only consists of exons.

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.....[2]

(c) Compare the process of replication and translation.

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.....[4]

[Total: 8]

6 Blood stem cells in the bone marrow differentiate into red blood cells.

**(a)** State **two** characteristics of a stem cell.

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.....[2]

Erythropoietin (EPO) is a large glycoprotein synthesised and secreted by specialised cells in the kidney. EPO acts at the surface of particular target cells, such as cells in the bone marrow. This triggers a signaling pathway, which stimulates bone marrow cells to form red blood cells.

**(b)** All cells of the body are exposed to circulating blood plasma containing EPO, but only particular target cells respond.

Explain why EPO acts on target cells and not other cells.

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.....[1]

Transcription factors c-myb and GATA-1 play important roles in red blood cell differentiation.

The amount of *c-myb* mRNA and *GATA-1* mRNA in the red blood progenitor cells can vary at different periods of red blood cell differentiation.

mRNA was extracted from samples of red blood progenitor cells at different time intervals and separated via gel electrophoresis. Nucleic acid hybridisation was carried out to identify the positions of *c-myb* mRNA and *GATA-1* mRNA.

Fig. 6.1 shows the results of the nucleic acid hybridisation, which indicates the amount of *c-myb* mRNA and *GATA-1* mRNA at different time intervals.

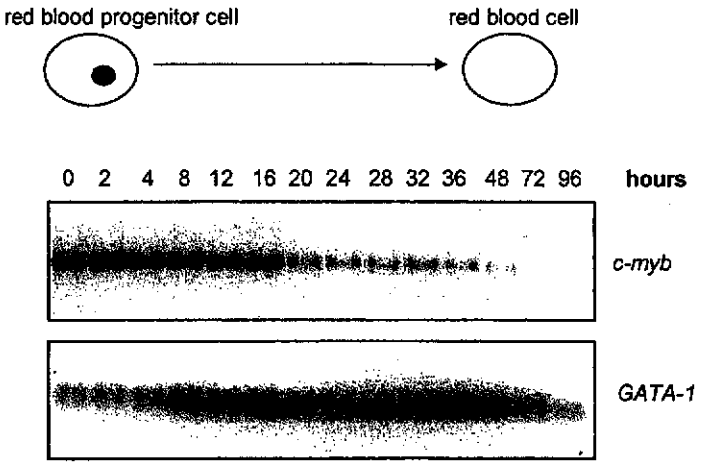


**Fig. 6.1**

**(c)** In order to detect mRNA, a process similar to Southern blot was carried out. Radioactive probes were used in nucleic acid hybridisation.

Explain the need to carry out nucleic acid hybridisation.

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.....[2]

(d) Describe the changes in the amount of *c-myb* mRNA between 0 and 72 hours.

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.....[2]

Research has shown that GATA-1 protein represses the *c-myb* gene expression during the later stage of red blood cell differentiation.

(e) Explain how GATA-1 protein acts as a repressor.

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.....[3]

[Total: 10]

**- End of Paper 2 Part I -**

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**TEMASEK JUNIOR COLLEGE**
PRELIMINARY EXAMINATION
JC2 / IP YEAR 6 2019

CANDIDATE NAME

CIVICS GROUP | C | G | | | / | 1 | 8 |

# H2 BIOLOGY

**9744/02**

Paper 2 Structured Questions **(Part II)**

**27 August 2019**

**2 hours**

Candidates answer on the Question Paper.

No Additional Materials are required.

**READ THESE INSTRUCTIONS FIRST**

**Do not open this booklet until you are told to do so.**
Write your name and civics group in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, 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.

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





| For Examiner's use | |
|---|---|
| 7 | / 8 |
| 8 | / 9 |
| 9 | / 10 |
| 10 | / 13 |
| 11 | / 10 |
| Total | / 50 |

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

## Part II

7 A wild type beetle normally has smooth and white outer wings while the mutant beetle has the recessive phenotypes, bumpy and grey.

An investigator carried out a cross between pure breeding wild type beetles and pure breeding mutant beetles. A test cross was then conducted for the two loci. This test cross took F1 females and crossed them with a male pure breeding for the recessive phenotype.

The results of the test cross are shown in Table 7.1.

**Table 7.1**

| Phenotypic class | Number of offspring |
|---|---|
| Smooth and white | 380 |
| Bumpy and grey | 380 |
| Smooth and grey | 20 |
| Bumpy and white | 20 |

**(a)** Draw a genetic diagram to explain the observed results of the test cross.

Use the following symbols,

**A** Smooth; **a** bumpy; **B** White; **b** grey

[4]



[TURN OVER

The investigator hypothesised that smooth wing beetles are longer than bumpy wing beetles. Measurements of the length of the wings were made and the results are shown in Table 7.2.

**Table 7.2**

| Phenotypic class | Number of beetles measured | Mean length of wing / mm | Standard deviation / mm |
|---|---|---|---|
| Smooth wing | 10 | 30 | 5 |
| Bumpy wing | 16 | 25 | 5 |

The formula used for *t*-test is: $$t = \frac{|\bar{x}_1 - \bar{x}_2|}{\sqrt{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}}$$

The formula for degree of freedom: $n_1 + n_2 - 2$

| Degree of freedom | SIGNIFICANCE LEVEL FOR ONE-TAILED T TEST | | | | |
|---|---|---|---|---|---|
| | 0.10 | 0.05 | 0.025 | 0.01 | 0.005 |
| | SIGNIFICANCE LEVEL FOR TWO-TAILED T TEST | | | | |
| | 0.20 | 0.10 | 0.05 | 0.02 | 0.01 |
| 24 | 1.318 | 1.711 | 2.064 | 2.492 | 2.797 |
| 25 | 1.316 | 1.708 | 2.060 | 2.485 | 2.787 |
| 26 | 1.315 | 1.706 | 2.056 | 2.479 | 2.779 |

**(b)** Calculate the *t*-value to three decimal places and conclude whether the investigator's hypothesis is valid. Show your working clearly.

Conclusion: .....

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.....[4]

[Total: 8]

8 Tuberculosis (TB) is an infectious disease caused by the bacterium *Mycobacterium tuberculosis*.

Streptomycin was the first antibiotic used to treat TB. During the first few years after the introduction of streptomycin treatment, an increasing number of *M. tuberculosis* bacteria developed resistance to streptomycin.

**(a)** Explain the increase in numbers of streptomycin resistant *M. tuberculosis* bacteria.

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.....[4]

The antibiotic rifampicin was introduced as an alternative to streptomycin. Rifampicin acts by inhibiting the bacterial enzyme RNA polymerase. *M. tuberculosis* and humans both use RNA polymerase for transcription.

**(b)** Distinguish the mode of action between rifampicin and penicillin.

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.....[2]

**(c)** Suggest why rifampicin does **not** affect transcription in human cells.

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.....[1]

Other drugs such as isoniazid are also used in the treatment of TB.

Some bacteria are now resistant to more than one of these drugs. These bacteria are known as multi-drug resistant (MDR) bacteria.

**(d)** Suggest **two** ways to reduce the emergence of drug resistance in bacteria.

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.....[2]

[Total: 9]

**Question 9 starts on page 8**

9 During a marathon, an athlete may have to carry out anaerobic respiration in addition to aerobic respiration to produce sufficient ATP.

Fig. 9.1 outlines both processes in the athlete.

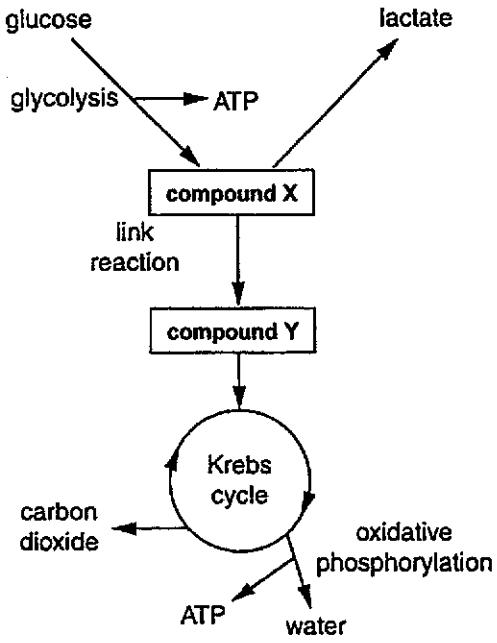


**Fig. 9.1**

**(a)** With reference to Fig. 9.1, identify compounds **X** and **Y**:

**X** .....

**Y** .....

[2]

**(b)** Complete Table 9.1 to show the number of reduced coenzymes that is/are formed at each stage of respiration, when one molecule of glucose is oxidised.

**Table 9.1**

| | Reduced NAD | Reduced FAD |
|---|---|---|
| glycolysis | | |
| link reaction | | |
| Krebs cycle | | |

[2]

**(c)** With reference to Fig. 9.1, explain why there is a need for compound **X** to be converted to lactate in the absence of oxygen.

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.....[4]

**(d)** Suggest whether anaerobic respiration alone is sufficient for the athlete to complete the marathon.

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.....[2]

[Total: 10]

10 Fig. 10.1 outlines the main reaction in the light-dependent stage of photosynthesis.

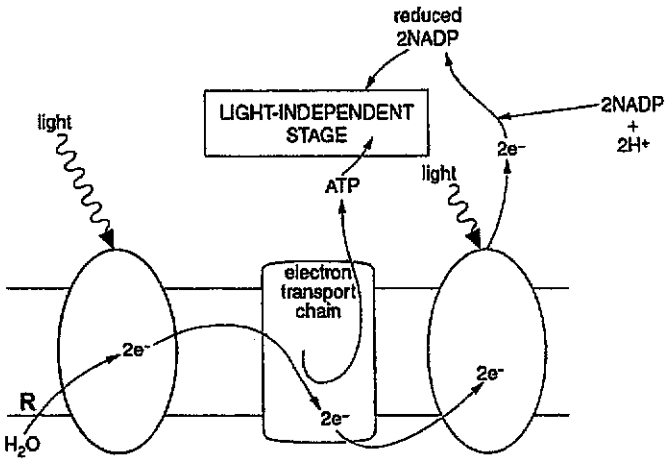


**Fig. 10.1**



**(a)** State precisely where

**(i)** the light-dependent stage occurs.

.....[1]

**(ii)** the light-independent stage occurs.

.....[1]

**(b)** Give the name of the process at **R**.

.....[1]

**(c)** Describe the role of reduced NADP in the light-independent stage.

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.....[2]

The unicellular photosynthetic green alga, *Chlorella*, was originally studied for its potential as a food source.

In one study into the productivity of *Chlorella*, carbon dioxide concentration was altered to investigate its effects on the light-independent stage of photosynthesis.

- A cell suspension of *Chlorella* was illuminated using a bench lamp.
- The suspension was supplied with carbon dioxide at a concentration of 1% for 200 seconds.
- The concentration of carbon dioxide was then reduced to 0.03% for a further 200 seconds.
- The concentrations of RuBP and GP (PGA) were measured at regular intervals.
- Throughout the investigation the temperature of the suspension was maintained at 25 °C.

The results are shown in Fig. 10.2.

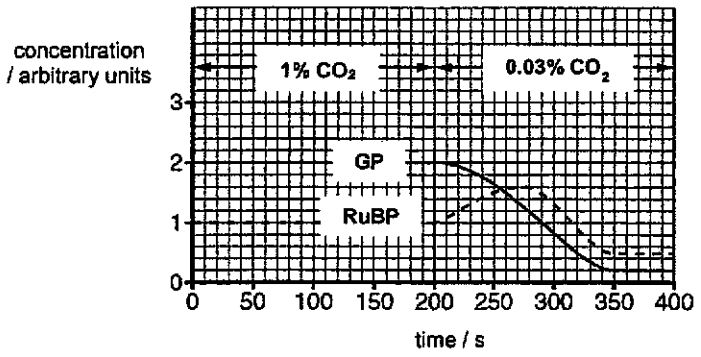


**Fig. 10.2**

**(d)** State **precisely** where in the chloroplast RuBP and GP are located.

.....[1]

**(e)** **(i)** Describe the change in concentration of RuBP between 200 and 350 seconds.

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.....[2]

(ii) Explain why the concentration of RuBP changed between 200 and 270 seconds.

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.....[3]

(f) State **two** differences between the structure of starch and cellulose.

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.....[2]

[Total: 13]

**Question 11 starts on page 14**

**11** The HIV/AIDS pandemic has had a very large impact on life expectancy in many African countries.

Table 11.1 shows estimated data for four African countries for
- the average life expectancy of an individual born in 2002
- the percentage of the population testing positive for HIV in 2002
- the average life expectancy of an individual born in 2002 **if there was no HIV/AIDS pandemic.**

**Table 11.1**

| Country | Life expectancy / years | | Percentage of population testing positive for HIV |
|---|---|---|---|
| | Without HIV/AIDS | With HIV/AIDS | |
| Kenya | 65.6 | 45.5 | 14.0 |
| Malawi | 56.3 | 38.5 | 16.0 |
| South Africa | 66.3 | 48.8 | 19.9 |
| Zambia | 55.4 | 35.3 | 20.0 |

**(a)** Using the 'without HIV/AIDS' and 'with HIV/AIDS' data shown in Table 11.1, calculate the percentage decrease in life expectancy for Zambia.

**Show your working and give your answer to the nearest whole number.**



Answer..... % [2]

**(b)** After studying the data in Table 11.1, a student concluded that:

"There is a correlation between the percentage of the population testing positive for HIV and the decrease in estimated life expectancy with HIV/AIDS."

With reference to Table 11.1, explain why the data do not fully support the student's conclusion.

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.....[2]

**(c)** A person who is confirmed as HIV-positive has been tested positive for the presence of antibodies to HIV.

Outline the events that leads to the production of antibodies specific to HIV.

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Various anti-HIV antibodies, which can bind to different parts of the same HIV virus, are found in the infected person.

**(d)** Suggest the significance of having various anti-HIV antibodies produced in the infected person.

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.....[1]

[Total: 10]

**- End of Paper 2 Part II -**

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# H2 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.

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Write your name and civics group in the spaces at the top of this page.
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You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

**Section A**
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.

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





| For Examiner's use | |
|---|---|
| 1 | / 29 |
| 2 | / 10 |
| 3 | / 11 |
| Section B | / 25 |
| Total | / 75 |

This document consists of **12** printed pages.

## Section A

Answer **all** the questions in this section.

**1** Cholera is an infectious disease that is caused by eating food or drinking water contaminated with a bacterium called *Vibrio cholerae*.

Fig. 1.1 shows a transmission electron micrograph of *Vibrio cholerae*.

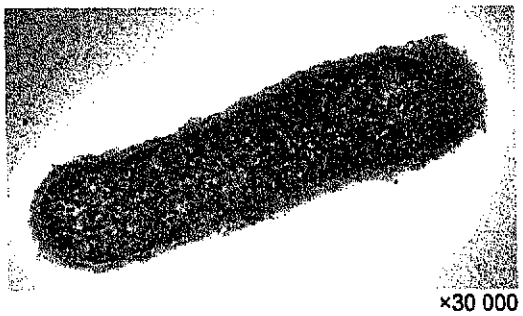


**Fig. 1.1**

**(a)** Explain what is meant by an infectious disease.

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.....[2]

The symptoms of cholera are caused by choleragen, a toxin released by the bacterium.

Choleragen is a protein made up of six polypeptides:

- a single polypeptide known as the **A** subunit that includes an extended alpha helix
- five polypeptides that together make the **B** subunit.

The **B** subunit of choleragen binds to a cell surface membrane component, known as GM1, of an intestinal epithelial cell. The complete choleragen protein then enters the cell by endocytosis. Once inside the cell, the **A** subunit of the protein acts as an enzyme, disrupting the normal functioning of the cell.

**(b)** List the levels of protein structure present in choleragen.

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.....[1]

**(c)** In the laboratory, it is possible to produce a form of choleragen consisting of only **B** subunit as a vaccine against cholera.

**(i)** Suggest why **B** subunit, rather than **A** subunit, is used in the production of the vaccine.

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.....[1]

**(ii)** Outline how the vaccine can provide protection against cholera.

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.....[4]

**(d)** Viruses that infect bacteria are called bacteriophages. Some bacteriophages that infect the cholera pathogen cause lysis of the bacterium.

**(i)** Compare the structures of *V. cholerae* and bacteriophage.

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.....[2]

(ii) Some scientists believe that bacteriophages could be used to treat people who are infected with cholera. Suggest the properties of the bacteriophages that would make this possible.

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Microbiologists consider the use of bacteriophages for treatment to be dangerous as these viruses could lead to gene transfer from harmful bacteria to normal gut bacteria.

(e) Name the process of gene transfer **and** suggest why such a gene transfer could be dangerous.

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Infection by *V. cholerae* causes severe watery diarrhoea, which leads to dehydration (loss of water and ions) and even death if untreated.

Fig. 1.2 shows the signalling pathway activated by choleragen.

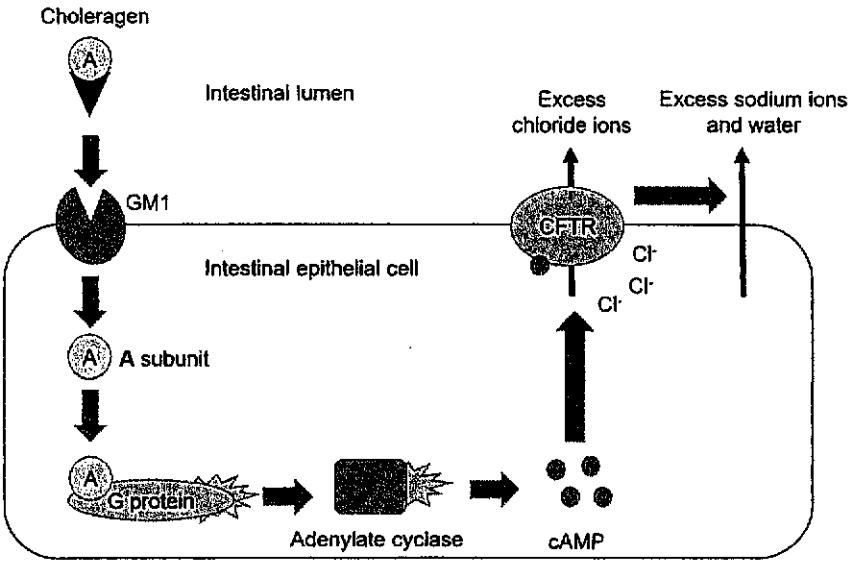


**Fig. 1.2**

**(f)** With reference to Fig. 1.2, outline how the **A** subunit inside the cell can result in diarrhoea.

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.....[3]

Insulin is a peptide hormone secreted by the pancreas. It triggers a different cell signalling pathway and cellular response from choleragen.

The binding of insulin to the insulin receptor found on target cells such as muscle cells, triggers specific responses that eventually helps to lower the blood glucose levels.

**(g)** Outline how the binding of insulin to its receptor is able to trigger a response inside a muscle cell.

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.....[3]

**(h)** Describe **one** effect of insulin on muscle cells.

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.....[1]

**(i)** In some diabetics, the insulin receptors are mutated and do not allow insulin to bind.

Explain how a mutation to the gene coding for the insulin receptor can affect blood glucose levels.

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.....[3]

The hormone insulin is synthesised in the beta cells of the pancreas as preproinsulin.

Preproinsulin is non-functional and has to undergo post-translational modification to form the functional insulin that is secreted out of the cell.

Fig. 1.3 shows the process of post-translational modification to form the functional insulin.

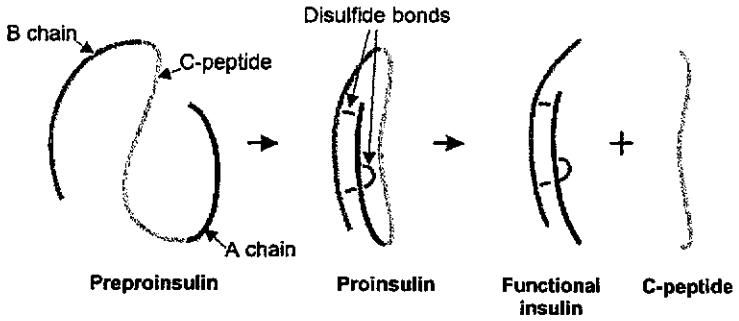


**Fig. 1.3**

**(j)** With reference to Fig. 1.3, describe how post-translational modification of preproinsulin can give rise to the functional insulin.

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C-peptide will be released into the bloodstream together with the insulin hormone. The C-peptide does not serve any function, but they are useful for monitoring the levels of functioning beta cells in people with diabetes.

**(k)** Predict the level of C-peptide in people with lesser number of functioning beta cells. Give a reason for your prediction.

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.....[2]

[Total: 29]

**2 (a)** The African clawed frog (*Xenopus laevis*) is a well-studied amphibian. Complete Table 2.1 to show the classification of *Xenopus laevis*.

**Table 2.1**

| | |
|---|---|
| Kingdom | ..... |
| Phylum | Chordata |
| Class | Amphibia |
| ..... | Anura |
| ..... | Pipidae |
| Genus | ..... |
| Species | *Xenopus laevis* |

[2]

The evolutionary origin of the four-legged amphibians from fish has been the subject of much debate for many years.

Among living fish, the rarely-caught coelacanth and the lungfish are thought to be most closely related to these amphibians.

Samples of blood were taken from two coelacanths that were recently captured near Comoros.

The amino acid sequences of the α and β chains of coelacanth and lungfish haemoglobin were compared with the known sequences of amphibian adults and their aquatic larvae (tadpoles). Organisms with more matches in the amino acid sequence of a polypeptide chain share a more recent common ancestor than those with fewer matches.

The comparisons with three species of amphibians, *Xenopus laevis (Xl)*, *X. tropicalis (Xt)* and *Rana catesbeiana (Rc)* are shown in Table 2.2.

**Table 2.2**

| | | Percentage of matches of amino acid sequence | | | | | |
|---|---|---|---|---|---|---|---|
| | | Species of amphibian adults | | | Species of amphibian larvae (tadpoles) | | |
| | fish species | *Xl* | *Xt* | *Rc* | *Xl* | *Xt* | *Rc* |
| α chains | Coelacanth | 42.0 | 47.5 | No data | 45.4 | 42.6 | 48.2 |
| | Lungfish | 40.4 | 42.1 | No data | 40.7 | 39.0 | 37.9 |
| β chains | Coelacanth | 42.1 | 43.2 | 40.7 | 52.1 | 52.1 | 58.2 |
| | Lungfish | 44.1 | 45.9 | 41.4 | 47.3 | 45.9 | 48.6 |

**(b)** Using the information in Table 2.2, evaluate whether the data supports the suggestion that coelacanths and amphibians share a more recent common ancestor than lungfish and amphibians.

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.....[4]

**(c)** Describe **one** advantage of the use of molecular systematics in determining the evolutionary relationship between amphibian, coelacanth and lungfish.

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**(d)** Explain the role of isolating mechanisms in the evolution of new species.

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.....[3]

[Total: 10]

3 Fig. 3.1 shows the global distribution of *Aedes aegypti* based on occurrence data from published literature between 1960 and 2014. Darker regions corresponded to regions with higher incidence of dengue disease that is transmitted by *A. aegypti*.

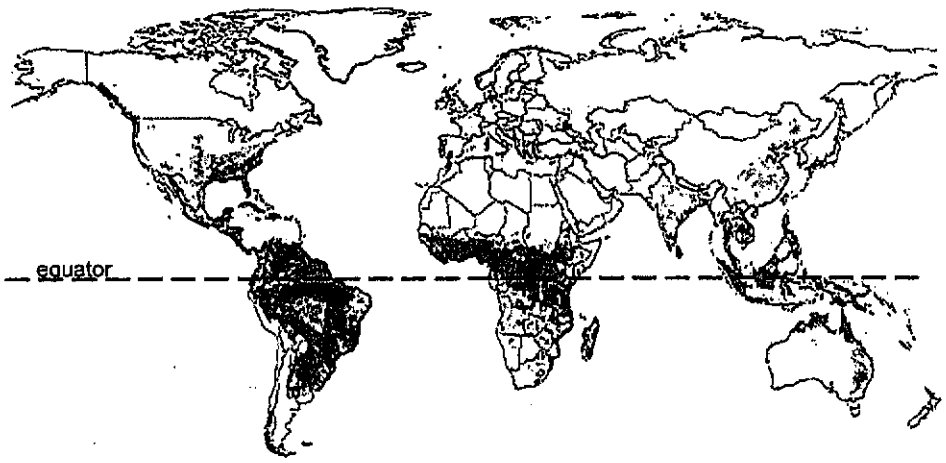


**Fig. 3.1**

**(a)** Explain why dengue disease is much more common in regions near the equator than in other parts of the world.

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.....[2]

**(b)** Suggest **two** reasons why governments in parts of the world other than regions near the equator, are also becoming increasingly concerned about dengue disease.

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**(c)** Outline the development of dengue virus in humans.

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.....[2]

One method to reduce the transmission of dengue is the Sterile Insect Technique (SIT). This involves releasing large numbers of sterile (infertile) male *A. aegypti* into the habitat. These males have been made infertile by radiation.

**(d)** Suggest how using the SIT could reduce transmission of dengue.

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.....[1]

**(e)** It was observed that the release of radiation-sterilised *A. aegypti* has not been very successful in controlling the transmission of dengue.

Give one reason for the observation.

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.....[1]

Recently, a new method was developed to control *A. aegypti*. Scientists produced transgenic males carrying a 'lethal gene'. The expression of this gene reduces the survival rate of the offspring.

The scientists released transgenic males every week in one location in a Brazilian city.

The number of *A. aegypti* in the area where transgenic males were released was determined regularly. This was also determined in a control area where no transgenic males were released. Fig. 3.2 shows their results.

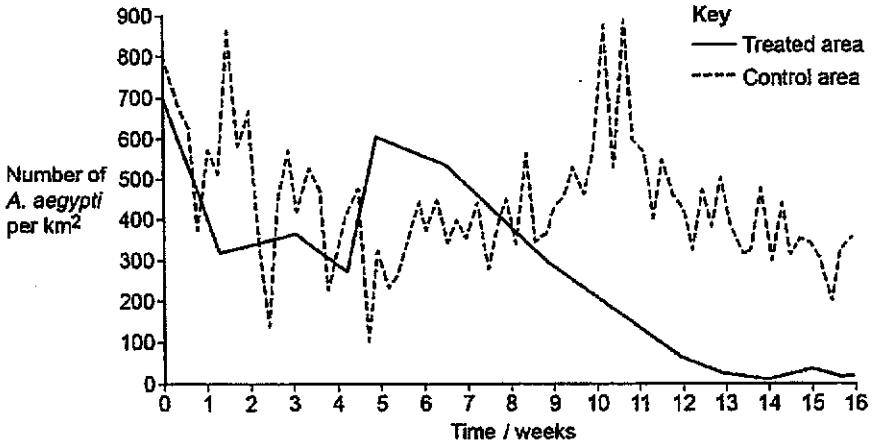


**Fig. 3.2**

**(f)** Suggest why the scientists released transgenic males **every** week.

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.....[1]

**(g)** The release of transgenic males proved successful in reducing the number of *A. aegypti*.

Describe how the results in Fig. 3.2 support this conclusion.

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.....[2]

[Total: 11]

**- End of Paper 3 Section A -**

**TEMASEK JUNIOR COLLEGE**
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# H2 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**

**Do not open this booklet until you are told to do so.**
Write your name and civics group in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

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

| For Examiner's use | |
|---|---|
| Q4 / Q5 * | |
| Section B | / 25 |
| *Circle the question that was attempted | |

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.

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





This document consists of 8 printed pages.

**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, where appropriate.

Your answers must be in continuous prose, where appropriate.

Your answers must be set out in parts **(a)** and **(b)** as indicated in the question.

**4** **(a)** Describe how the product of photosynthesis contributes towards the growth of a plant and suggest the effects on plant growth when the plant is grown at its compensation point for prolonged period of time. [12]

**(b)** Prokaryotes and eukaryotes respond differently to changes in the environmental conditions.

Describe how bacteria respond to changes in lactose supply.

Compare the advantages of a mammalian response to changes in blood glucose concentration with that of a bacterial response to changes in supply of lactose. [13]

[Total: 25]

**5** **(a)** An increase in DNA methylation at the promoter region of tumour suppressor genes could lead to greater tendency for an individual to develop cancer.

Compare the features of stem cells and cancer cells and suggest how DNA methylation at the promoter of tumour suppressor genes could contribute towards the development of cancer. [13]

**(b)** Climatic factors affect the duration of each season, resulting in mismatch of flowering timings and insect maturation. For example plants bloom earlier but bees are not available to pollinate the flowers. As a result, flowers are not pollinated and bees do not have enough food.

Discuss the possible impacts of climate change on microevolution of insects and plants that rely on insects as pollinators. [12]

[Total: 25]

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**- End of Paper 3 Section B -**

DO NOT WRITE IN THIS MARGIN

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**TEMASEK JUNIOR COLLEGE**
PRELIMINARY EXAMINATIONS
JC2 / IP YEAR 6 2019

CANDIDATE NAME

CIVICS GROUP | C | G | | | / | 1 | 8 |

**H2 BIOLOGY** **9744/04**
Paper 4 Practical
**4 September 2019**
**2 hours 30 minutes**

Candidates answer on the Question Paper
Additional Materials: As listed in the Confidential Instructions.

**READ THESE INSTRUCTIONS FIRST**

**Do not open this booklet until you are told to do so.**
Write your name and civics group on all the work you hand in.
Give details of the practical shift and laboratory, where appropriate, in the boxes provided.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do **NOT** use staples, paper clips, 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.

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

| **Shift** |
|---|
| |
| **Laboratory** |
| |

| **For Examiner's use** | |
|---|---|
| 1 | / 33 |
| 2 | / 22 |
| **Total** | / 55 |




This document consists of **19** printed pages and **1** blank page.

1 Plant cells contain an enzyme, catalase, which catalyses the hydrolysis (breakdown) of hydrogen peroxide into oxygen and water. An extract of plant tissue contains catalase.

You are required to investigate the effect of solution **X** on the activity of the catalase in a plant extract **P** by:

- preparing different concentrations of solution **X**
- investigating the effect of different concentrations of solution **X** by counting the number of bubbles of oxygen released in two minutes
- finding the rate of activity of the catalase by measuring the time taken to collect 2 $cm^3$ of the oxygen.

You are provided with:

| Labelled | Contents | Hazard level | Volume / $cm^3$ |
|---|---|---|---|
| **X** | 0.3% solution of **X** | Harmful | 20 |
| **W** | Distilled water | None | 100 |
| **P** | Plant extract solution | None | 90 |
| **H** | Hydrogen peroxide solution | Harmful irritant | 90 |
| **T** | Tap water | None | - |



When carrying out a practical procedure, the hazards of the use of all the apparatus and all of the reagents need to be considered, then the **level** of risk needs to be assessed as low or medium or high.

**(a) (i)** State the hazard with the greatest level of risk when using the apparatus and reagents in page 4.

State the **level** of risk of the procedure: low or medium or high.

Hazard .....

Level of risk.....[1]

**(ii)** Suggest the precaution to be taken to the hazard identified in **(a)(i)**.

.....[1]

**(b) (i)** You are required to prepare a **serial** dilution of the 0.3% solution of **X** which reduces the concentration of **X** by a **factor of 10** between each successive dilution.

You will need to prepare 10 $cm^3$ of each concentration of solution **X**.

You should use the beakers shown in Fig. 1.1 to show how you will prepare the **serial** dilutions.

You will need to use 9 $cm^3$ of each different concentration of **X** in the investigation.

For **each** beaker, complete Fig. 1.1 to show how you will dilute the solution by:

- stating, under the beaker, the **concentration** and **volume** of the solution available for use in the investigation
- using one arrow, with a label above the beaker, to show the **concentration** and **volume** of the solution **X** added to prepare the concentration
- using another arrow, with a label above the beaker, to show the **volume** of **W** added to prepare the concentration.



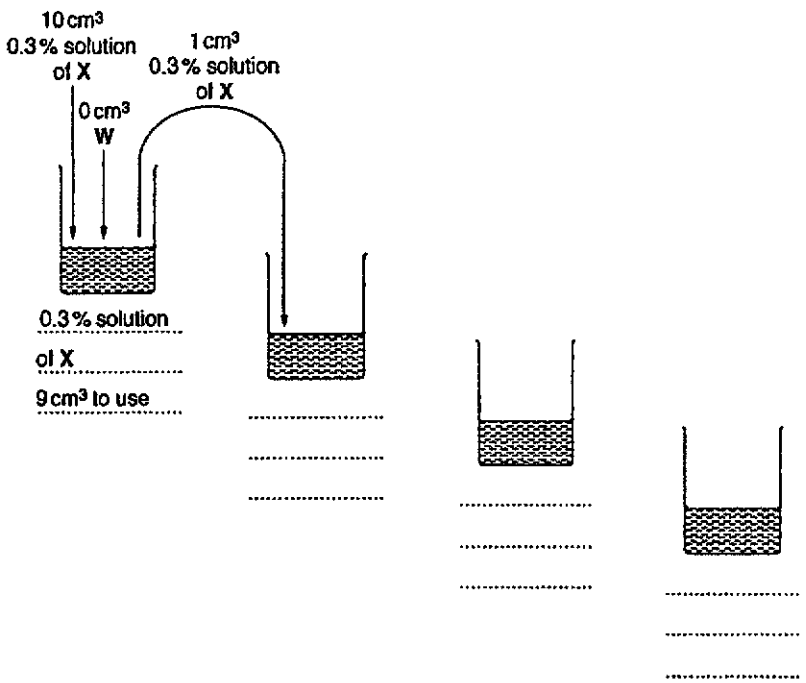


**Fig. 1.1**

**[3]**

You are required to investigate the effect of different concentrations of **X** on the activity of catalase by finding the number of bubbles of oxygen released in two minutes.

Proceed as follows:

1. Prepare the concentrations of **X** as shown in **(b)(i)**.
2. Put 10 $cm^3$ of **P** into each of the concentrations of **X**, including 0.3% **X**. Shake gently to mix.
3. Put 20 $cm^3$ of **P** and 18 $cm^3$ of **W** into a separate vial.
4. Leave for at least three minutes.

*Read step 5 to step 14 before proceeding.*

5. Prepare 400 $cm^3$ of tap water in the large beaker labelled **T**.
6. Put 10 $cm^3$ of **H** into each of the five boiling tubes.
7. Put 10 $cm^3$ of the mixture of **P** and **W** into one of the boiling tube.
8. Put the bung (with the delivery tube attached) into this boiling tube.
9. Put the end of the delivery tube into the large beaker containing water labelled **T**.
10. Start timing and count the number of bubbles of oxygen released in 2 minutes.
11. Record the result in **(b)(ii)**, on page 5.
12. Put 10 $cm^3$ of the mixture of **P** with the **lowest** concentration of **X** into another boiling tube containing **H**.
13. Repeat steps 8 to 11.
14. Repeat steps 12 and 13 with each of the other concentrations of **X**, including 0.3% **X**.

**(ii)** Prepare the space below and record your results.



[4]

(c) You are required to decide on the method to find the rate of activity of the catalase in the plant extract **P** by collecting 2 $cm^3$ of oxygen produced by the hydrolysis of **H**.

You are going to collect the oxygen released by displacement of water as shown in Fig. 1.2.

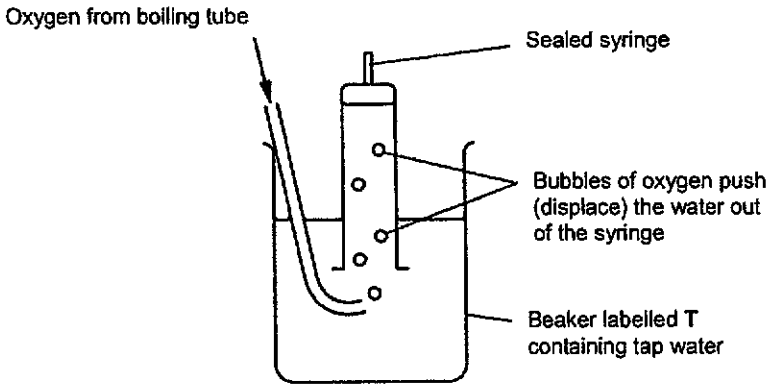


**Fig. 1.2**



(i) State the dependent variable.

.....[1]

**(ii)** You will need to use the mixture of **P** and **W** prepared in **(b)(i)** step 3.

The best volume of **H** to the mixture of **P** and **W** to use were in a ratio of 1:2.

Outline the steps in the method that you will use to collect results. The method should allow an assessment of the degree of confidence in the results to be made.

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.....[4]

**(iii)** Use the method you have described in **(c)(ii)** to collect results.

Record your results in a suitable table in the space below.

[3]

**(iv)** Use your results in **(c)(iii)** to calculate the rate of activity of the catalase. You may lose marks if you do not show your working.

Rate of activity: ..... $cm^3\ s^{-1}$ [2]

**(v)** Identify **two** significant sources of error when using each of the two methods to measure the dependent variable.

***two** significant errors in counting the number of bubbles*

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***two** significant errors in measuring the displacement of water*

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.....[4]

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**(d)** Some scientists investigated the effect of copper sulfate solution on the release of oxygen from hydrogen peroxide solution. Yeast extract, containing catalase was used in the investigation.

All the variables were standardised.

They set up two boiling tubes:

- one with 1 $cm^3$ of distilled water, hydrogen peroxide and yeast extract
- one with 1 $cm^3$ of copper sulfate solution, hydrogen peroxide and yeast extract.

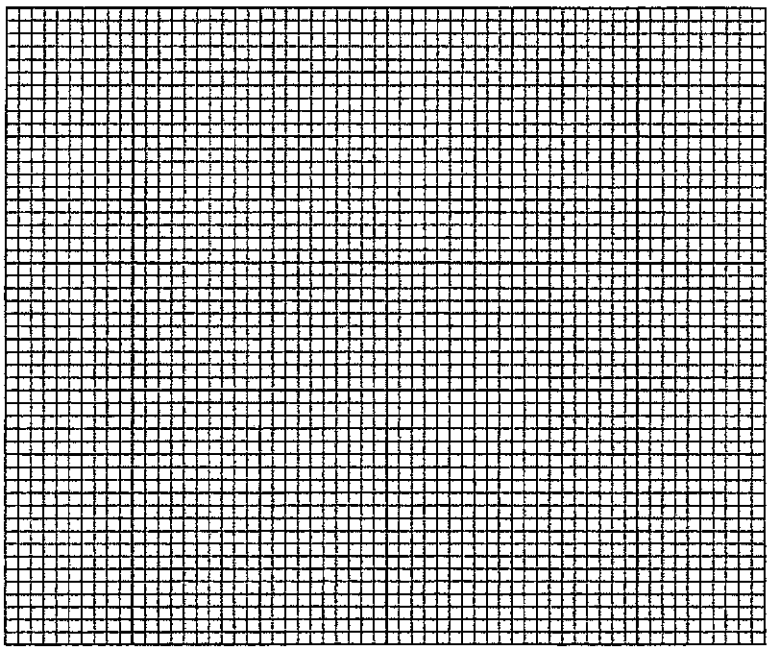
The number of bubbles of oxygen released in each 60 seconds for 300 seconds were recorded.

The results are shown in Table 1.1.

**Table 1.1**

| Time/s | Number of bubbles of oxygen released | |
|---|---|---|
| | With 1$cm^3$ of distilled water | With 1$cm^3$ of copper sulfate solution |
| 60 | 99 | 69 |
| 120 | 96 | 4 |
| 180 | 65 | 2 |
| 240 | 34 | 1 |
| 300 | 4 | 0 |

**(i)** Plot a graph of the data in Table 1.1.





**[5]**

**(ii)** Using your knowledge of enzymes, suggest how copper sulfate solution may change the activity of catalase.

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.....[3]

**(iii)** State one environmental variable that should be kept constant and the method to achieve it.

Variable .....

Method .....[2]

[Total: 33]

**Question 2 starts on page 14**

**2** **K1** is a slide of a stained transverse section through a plant root.

You are not expected to be familiar with this specimen.

You are required to:

- use the eyepiece graticule to measure across the root
- use these measurements to calculate the length of the cortex as a percentage of the diameter of the root
- draw a plan diagram of part of the root.

**(a)** The eyepiece graticule in the microscope can be used to measure different tissues.

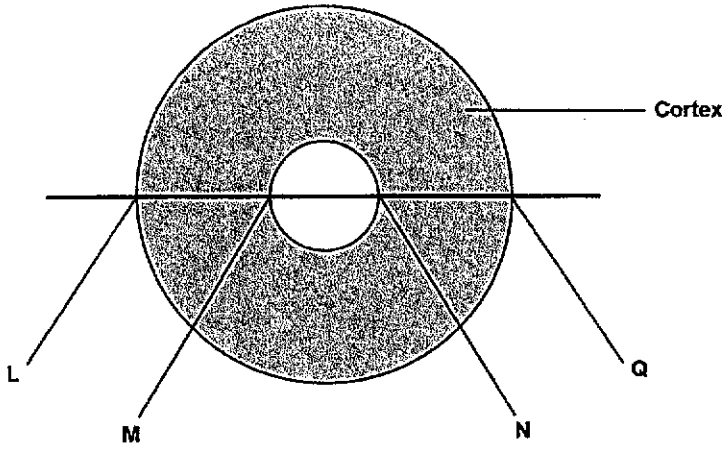


**Fig. 2.1**

**(i)** Use the eyepiece graticule in the microscope to measure across the diameter of the root as shown in Fig. 2.1:

**L** to **Q** = ..... eyepiece graticule units

**L** to **M** = ..... eyepiece graticule units

**M** to **N** = ..... eyepiece graticule units

**N** to **Q** = ..... eyepiece graticule units

[4]

**(ii)** Use the measurements from **(a)(i)** to state:

the length across the diameter of the root (**L** to **Q**) ..... eyepiece graticule units

the length of cortex across the diameter ..... eyepiece graticule units

Calculate the length of cortex as a percentage of the diameter of the root.

You may lose marks if you do not show your working.



Answer: ..... % [3]

**(iii)** Use the measurements from **(a)(i)** to help you draw a large plan diagram of part of the root on **K1**, shown by the shaded area in Fig. 2.2.

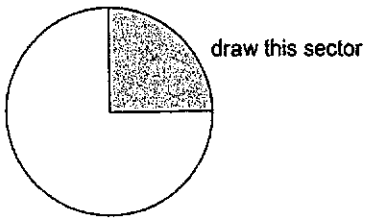


**Fig. 2.2**

*Use a sharp pencil for drawing.*

You are expected to draw the correct shape and proportions of the different tissues.

Use **one** ruled label line and label to identify the xylem.





**[5]**

**(iv)** Observe the xylem of the specimen on **K1**.

Select one group of **three** xylem vessels.

*Each vessel of the group must touch at least one of the other vessels.*

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

Use **one** ruled label line and the label **C** to identify a structure made of lignin.





[4]

**(b) (i)** Fig. 2.3 is a photomicrograph of a transverse section through a root of a different plant species.

You are not expected to be familiar with this specimen.

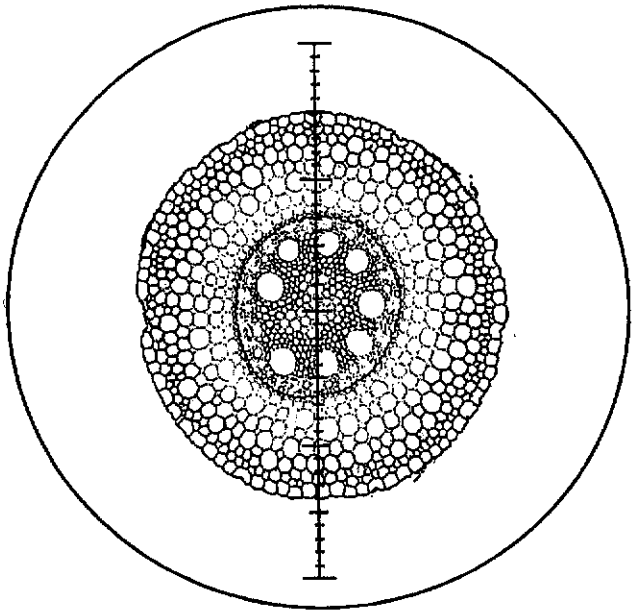

**Fig. 2.3**

A student calibrated the eyepiece graticule in a light microscope using a stage micrometer so that the actual diameter of the root could be found.

The calibration of one eyepiece graticule unit is equal to 29.5 µm.

Use the calibration of the eyepiece graticule unit and Fig. 2.3 to calculate the actual diameter of the root.

Show all the steps in your working and use appropriate units.

actual diameter of the root: .....[3]

**(ii)** The student may confuse the eyepiece graticule with the stage micrometer.

Other than relative lengths or colours of the two scales, suggest **one** way that the student could distinguish between the eyepiece graticule and the stage micrometer when looking into the eyepiece of the microscope.

.....

.....[1]

**(c)** Fig. 2.4 is the same photomicrograph without the eyepiece graticule scale.

Annotate on Fig. 2.4 to describe **two** observable differences between the root in Fig. 2.4 and the root on **K1**. Ignore any differences in colour and size.

- Draw label lines to **two** different features and use only the labels **P** and **Q**.
- Next to each letter, describe how each feature on the root in Fig. 2.4 differs from the root on **K1**.



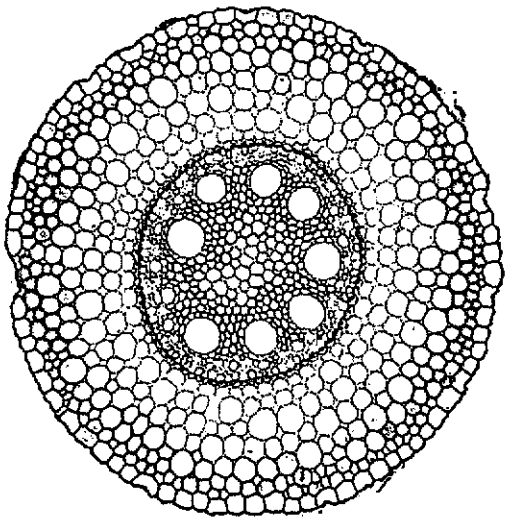

**Fig. 2.4**

[2]

[Total: 22]

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JC 2 / IP YEAR 6 2019

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|---|---|
| CANDIDATE NAME | |
| CIVICS GROUP | C G / 1 8 |

# H2 BIOLOGY

Multiple Choice

**9744/01**
**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, glue or correction fluid.
Write your name, civics group on the Multiple Choice Answer Sheet in the spaces provided.

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 Multiple Choice Answer Sheet.

**Read the instructions on the Multiple Choice 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.

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

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BP~309

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**TEMASEK JUNIOR COLLEGE**
PRELIMINARY EXAMINATION
JC2 / IP YEAR 6 2019

CANDIDATE NAME

CIVICS GROUP | C | G | | | / | 1 | 8 |

# H2 BIOLOGY

**9744/02**

Paper 2 Structured Questions

**27 August 2019**

**2 hours**

Candidates answer on the Question Paper.

No Additional Materials are required.

**READ THESE INSTRUCTIONS FIRST**

**Do not open this booklet until you are told to do so.**
Write your name and civics group in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, 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.

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

| For Examiner's use | |
|---|---|
| 1 | / 10 |
| 2 | / 5 |
| 3 | / 8 |
| 4 | / 9 |
| 5 | / 8 |
| 6 | / 10 |
| Total | / 50 |

This document consists of **14** printed pages and **2** blank pages.



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## Part I
Answer all questions.

**1** Cholesterol is synthesised 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. These lipoproteins containing cholesterol are transported to all parts of the body.

Fig. 1.1 is an electron micrograph of part of a liver cell showing the packaging of a lipoprotein particle.

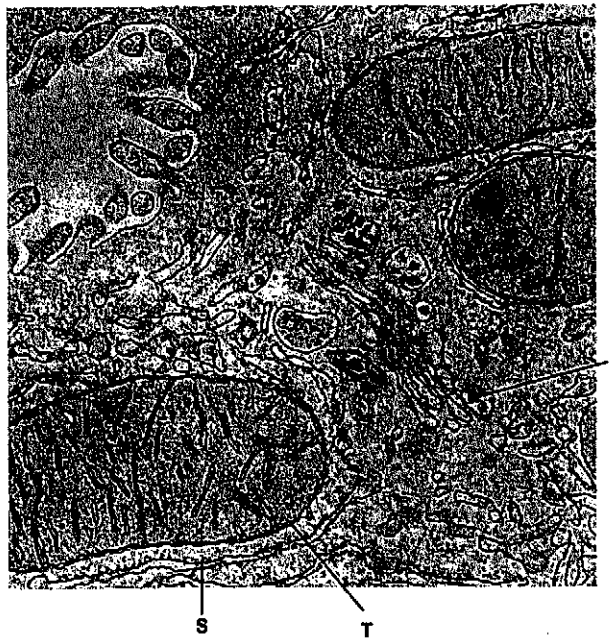



**Fig. 1.1**

**(a)** Name organelle **T** in Fig. 1.1 and describe its role in liver cells. [3]

**T: Mitochondrion** (*reject: mitochondria*)

1. **It synthesises ATP during aerobic cellular respiration for:**

***any one:***
2. **synthesis of cholesterol / triglycerides / glycogen / proteins;**
3. **intracellular movement of vesicles;**
4. **membrane transport processes e.g. exocytosis, active transport;**
5. **AVP;**

**(b)** **(i)** Suggest why cholesterol is packaged into lipoproteins before release from liver cells into the blood. [1]

*any one:*
1. **Cholesterol is largely hydrophobic, hence it is not soluble in blood;**
2. **Lipoproteins are soluble in blood / lipoproteins consist of hydrophilic phospholipid (phosphate) heads;**

**(ii)** Explain why cells need to be supplied with cholesterol. [2]

*any 2:*
1. **It is a component of cell membranes;**
2. **It is important for regulating membrane fluidity / required to maintain membrane stability;**
3. **It is a precursor / required for the production of steroid hormones;**

Organelle **S** can be found attached to a membrane system that is distinct from SER. It is composed of a nucleic acid and another biological molecule.

**(c)** **(i)** Name the nucleic acid found in organelle **S**. [1]

**S: Ribosomal RNA**

**(ii)** Describe the roles of the nucleic acid named in **(c)(i)**. [2]

1. **rRNA combines with ribosomal proteins to form the large subunit and small subunit of ribosomes;**
2. **In the large ribosomal subunit, the rRNA forms the binding sites for tRNA;**
3. **In the large ribosomal subunit, the rRNA forms the catalytic site for peptide bond formation;**
4. **rRNA interacts with mRNA and tRNA to ensure that the correct complementary base pairing occurs, for accuracy of protein synthesis;**

**(d)** Evolutionary theorists suggested that organelle **T** used to be a free-living prokaryotic organism but was engulfed by a eukaryotic cell and eventually became a part of it.

Give an evidence to justify why they may be correct. [1]

1. **The mitochondrion has 70S ribosomes which is also found in a prokaryotic cell;**
2. **Presence of multiple circular chromosomes / DNA which are different from the linear chromosomes / nuclear DNA in a eukaryotic cell;**
3. **Presence of double membrane, suggesting that the eukaryotic cell engulfed the prokaryotic cell;**
4. **The composition of the inner mitochondrial membrane (e.g. presence of electron transport chain) is the similar to those found in the plasma membrane of prokaryotes;**

[Total: 10]



**2** Mineral ion **X** is taken into plant cells. The transport of ion **X** is interrupted when a metabolic poison which affects the mitochondrial electron transport chain is present.

Some cells were placed in media containing different concentrations of ion **X** without the metabolic poison. After one hour, the cells were removed and the intracellular concentration of **X** was measured.

Fig. 2.1 shows the results.

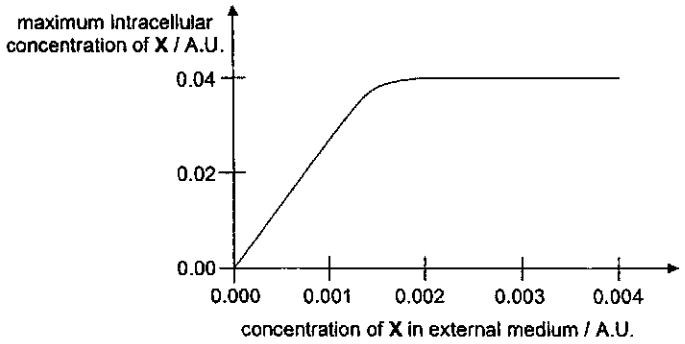



**Fig. 2.1**

**(a)** Describe the arrangement of the phospholipids in the plasma membrane. [2]

1. **Hydrophilic phosphate heads of phospholipids face outwards to aqueous exterior and interior (cytoplasm) of the cell.**
2. **Hydrophobic fatty acid tails of phospholipids face inwards and sandwiched between hydrophilic phosphate heads.**

**(b)** With reference to Fig. 2.1,

**(i)** identify the process by which **X** is transported into the cell; [1]

1. **Active transport.**

**(ii)** give a reason for your answer in **(b)(i)**. [2]

1. **[QF] Concentration of X in external medium (maximum of 0.004 A.U.) is always lower than maximum intracellular concentration of X (maximum of 0.04 A.U.) / OWTTE. [1]**

2. **Therefore, X is transported against concentration gradient,**

[Total: 5]



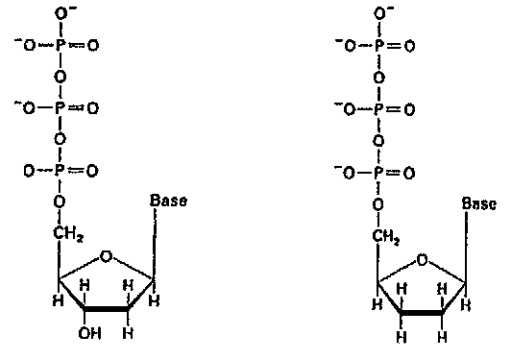




3 One of the substrates required by DNA polymerase is deoxyribonucleoside triphosphate (dNTP).

Dideoxyribonucleoside triphosphate (ddNTP) is a modified nucleotide that affects DNA polymerase activity.

Fig. 3.1 shows the structures of dNTP and ddNTP.




deoxyribonucleoside triphosphate (dNTP)

dideoxyribonucleoside triphosphate (ddNTP)

**Fig. 3.1**

In an investigation, the effect of different concentrations of ddATP on the rate of DNA synthesis was determined.

The results of the investigation are shown in Fig. 3.2.

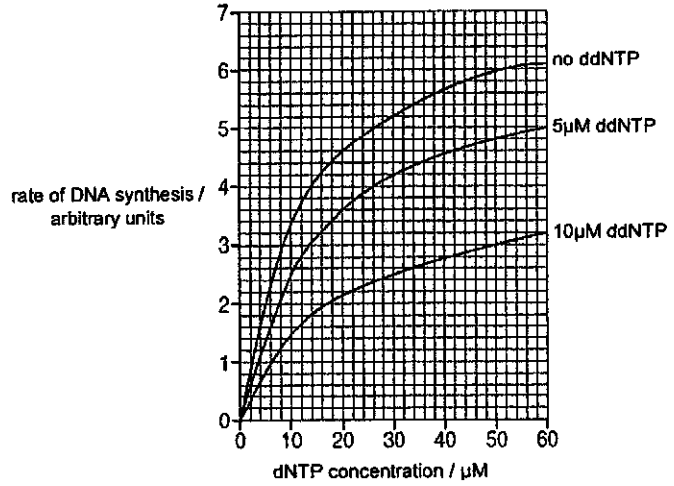



**Fig. 3.2**

**(a)** Describe the effect of increasing substrate concentration on the rate of DNA synthesis, in the absence of ddNTP. [2]

1. As dNTP concentration increases from 0 to 8μM, the rate of DNA synthesis increases rapidly from 0 to 3 arbitrary units (A.U.).
   or
2. As dNTP concentration increases from 0 to 9μM, the rate of DNA synthesis increases rapidly from 0 to 3.1 arbitrary units (A.U.).
   or
3. As dNTP concentration increases from 0 to 10μM, the rate of DNA synthesis increases rapidly from 0 to 3.4 arbitrary units (A.U.).

4. As dNTP concentration increases from 8 to 60μM, the rate of DNA synthesis increases gradually from 4 to 6.1 A.U.

**(b)** With reference to Fig. 3.2, state the effects of ddNTP on the rate of DNA synthesis. [3]

1. Presence of ddNTP causes a decrease in rate of DNA synthesis.
2. Higher ddNTP concentration causes a greater decrease in the rate of DNA synthesis.
3. Higher 10μM ddNTP concentration causes a greater decrease in the rate of DNA synthesis at high dNTP concentration of 60μM than lower dNTP concentration of 10μM.

**(c)** The optimum pH for DNA polymerase is pH 9.0.

Suggest and explain what happens to the rate of DNA synthesis when DNA polymerase is placed in a medium with pH 1.0. [3]

1. As pH decreases to extreme pH of 1.0, rate of DNA synthesis decreases. [1]

2. The increase / change in concentration of $H^+$

3. results in ionic bonds and hydrogen bonds being broken,
4. therefore loss of active site (denaturation) / change in shape of active site which is no longer complementary to shape of substrate.

5. Thus, substrate cannot bind at active site.
   [Accept: Phosphodiester bond between dNTP cannot be formed.]

[Total: 8]



**4** Fig. 4.1 shows a linear chromosome undergoing the first round of DNA replication.

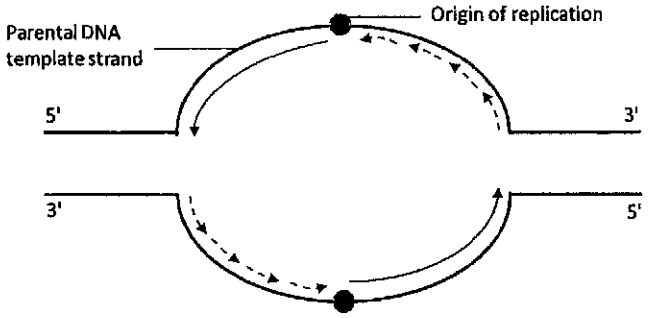



**Fig. 4.1**

**(a)** **(i)** On Fig. 4.1, draw the direction of DNA synthesis for the leading (⟶) and lagging strand (- - - - >) for both parental DNA template strands. [1]

**(ii)** Describe **two** differences in the formation of the leading and lagging strands. [2]

1. The leading strand is synthesised continuously while the lagging strand is synthesised discontinuously

2. There are presence of Okazaki fragments in the lagging strand while it is not present in the leading strand

3. There is presence of more than one RNA primer in lagging strand while only one primer is needed for synthesis of leading strand

4. The leading strand is synthesised towards the replication fork while the lagging strand is synthesised away from the replication fork

During sexual reproduction, meiosis is an important source of genetic variation.

**(b) (i)** Describe the events that take place during prophase I of meiosis in an animal cell. [3]

1. **chromosomes become visible due to condensation / coiling / supercoiling ;**
2. **nuclear envelope or nuclear membrane, disintegrates / disappears ;**
3. **nucleolus, disintegrates / disappears ;**
4. **centrioles migrate to (opposite) poles ; (ignore centrosomes)**
5. **spindle forms / microtubules assemble ;**
6. **[IMPT] synapsis / bivalents form / homologous chromosomes pair up ;**
7. **[IMPT] chiasmata formation / crossing over may occur;**

Max marking

**(ii)** Explain how independent assortment of homologous chromosomes leads to genetic variation during meiosis I. [3]

1. **Random / independent arrangement of homologous chromosomes at the equator during Metaphase I and separation of homologous chromosomes during and Anaphase I.**

2. **Random / independent arrangement of chromosomes at the equator during Metaphase II, and separation of chromatids of these chromosomes during Anaphase II**

3. **Gives rise to different combinations of alleles in daughter cells.**

[Total: 9]



**5** Fig. 5.1 shows the processes leading to the formation of a messenger RNA (mRNA) molecule that is eventually translated into a polypeptide.

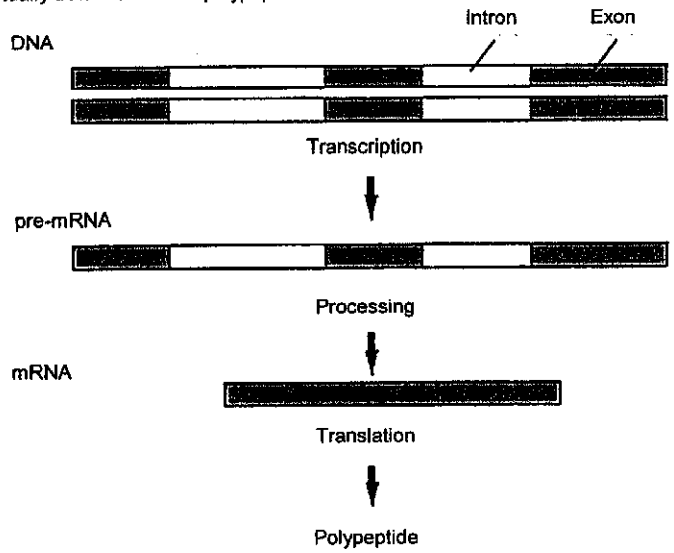



**Fig. 5.1**

**(a)** Explain why transcription is necessary for polypeptide synthesis. [2]

1. **Thus, mRNA acts as a carrier molecule which carries genetic information to the ribosomes / RER for translation to occur;**
2. **mRNA is smaller than DNA, hence it is able to move out of the nucleus via the nuclear pores;**
3. **Ribosomes can only recognize and bind to the 5' end of the mRNA to initiate translation.**

**(b)** Suggest why it is important that the mature mRNA only consists of exons. [2]

1. **Only exons code for the amino acid sequence in a polypeptide / introns do not code for the amino acid sequence in a polypeptide;**
2. **If introns are included, a non-functional polypeptide would be produced / OWTTE;**

**(c)** Compare the process of replication and translation. [4]

**Similarity:**

1. **Both involve condensation reactions with the elimination of water molecule during bond formation.**
2. **Complementary base pairing occurs between template strand and newly synthesised daughter strand during DNA replication and between anticodon of tRNA and codon of mRNA template strand during translation.**

| Point of comparison | Replication | Translation |
|---|---|---|
| 1. Location | • Nucleus | • Cytoplasm / cytosol |
| 2. Monomers | • Deoxyribonucleoside triphosphate / DNA nucleotides | • Amino acids |
| 3. Number of different monomers | • 4 (A, T, C, G) | • 20 |
| 4. Bonds formed between monomers | • Phosphodiester bonds | • Peptide bonds |

**AVP**



[Total: 8]



**6** Blood stem cells in the bone marrow differentiate into red blood cells.

**(a)** State **two** characteristics of a stem cell. [2]

1. **They are able to divide and are unspecialised**
2. **and can differentiate into mature red blood cell.**

Erythropoietin (EPO) is a large glycoprotein synthesised and secreted by specialised cells in the kidney. EPO acts at the surface of particular target cells, such as cells in the bone marrow. This triggers a signaling pathway, which stimulates bone marrow cells to form red blood cells.

**(b)** All cells of the body are exposed to circulating blood plasma containing EPO, but only particular target cells respond.

Explain why EPO acts on target cells and not other cells. [1]

1. **Only target cells (in the bone marrow) have EPO receptors.**

Transcription factors c-myb and GATA-1 play important roles in red blood cell differentiation.

The amount of *c-myb* mRNA and *GATA-1* mRNA in the red blood progenitor cells can vary at different periods of red blood cell differentiation.

mRNA was extracted from samples of red blood progenitor cells at different time intervals and separated via gel electrophoresis. Nucleic acid hybridisation was carried out to identify the positions of *c-myb* mRNA and *GATA-1* mRNA.

Fig. 6.2 shows the results of the nucleic acid hybridisation, which indicates the amount of *c-myb* mRNA and *GATA-1* mRNA at different time intervals.

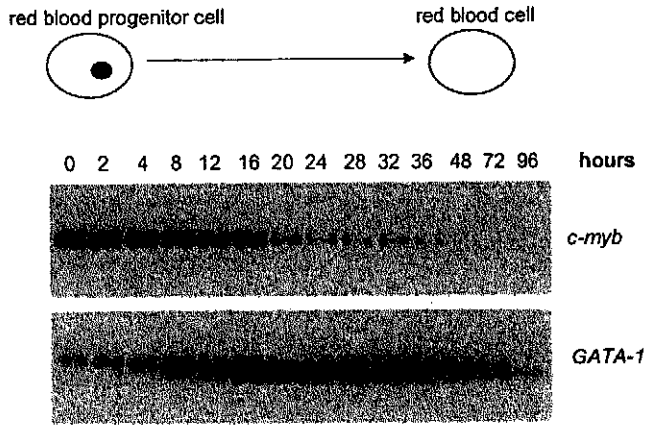



**Fig. 6.2**

**(c)** In order to detect mRNA, a process similar to Southern blot was carried out. Radioactive probes were used in nucleic acid hybridisation.

Explain the need to carry out nucleic acid hybridisation. [2]

1. There are many different mRNAs in the cell
2. such that these mRNAs will appear as a smear if all of them are visualised in the gel (electrophoresis).

3. Use of radioactive single-stranded probe which has complementary nucleotide sequence to *c-myb* and *GATA-1* mRNA
4. will ensure that they can be visualised as bands using autoradiography.



**(d)** Describe the changes in the amount of *c-myb* mRNA between 0 and 72 hours. [2]

1. From 0 to 20 hours, the amount of *c-myb* mRNA remained high.
2. From 20 to 72 hours, the amount of c-myb mRNA decreased.

Research has shown that GATA-1 protein represses the *c-myb* gene expression during the later stage of red blood cell differentiation.

**(e)** Explain how GATA-1 protein acts as a repressor. [3]

1. Gata-1 is a transcriptional repressor that binds to silencer

(Any 1 – for point 2)
2. Gata-1 recruits histone deacetylases such that DNA at the area of histone deacetylation binds to histones more tightly.

2. Interfering with the binding of activators or basal transcription factors to DNA by binding to the same site/ sites near those used by activators or basal transcription factors

3. This makes it harder for basal / general transcription factors and RNA polymerase II to access promoter in the deacetylated region.
4. Hence, preventing transcription of *c-myb* gene.

[Total: 10]

7 A wild type beetle normally has smooth and white outer wings while the mutant beetle has the recessive phenotypes, bumpy and grey.

An investigator carried out a cross between pure breeding wild type beetles and pure breeding mutant beetles. A test cross was then conducted for the two locl. This test cross took F1 females and crossed them with a male pure breeding for the recessive phenotype.

The results of the test cross are shown in Table 7.1.

**Table 7.1**

| Phenotypic class | Number of offspring |
|---|---|
| Smooth and white | 380 |
| Bumpy and grey | 380 |
| Smooth and grey | 20 |
| Bumpy and white | 20 |

**(a)** Draw a genetic diagram to explain the observed results of the test cross.

Use the following symbols,

**A** Smooth; **a** bumpy; **B** White; **b** grey





**TESTCROSS**

Testcross parental phenotype: Smooth, White wings × Bumpy, Grey wings

Testcross parental genotype: $\frac{A}{B}\frac{b}{b}$ × $\frac{a}{b}\frac{a}{b}$

Testcross parental gametes: $\frac{A}{B}\frac{a}{b}$ and $\frac{A}{b}\frac{a}{B}$ × $\frac{a}{b}$

Parental gametes (Large numbers) | Recombinant gametes (Small numbers)

Fusion of gametes:

| ♂ \ ♀ | $\frac{A}{B}$ (Large number) | $\frac{a}{b}$ (Large number) | $\frac{A}{B}$ (Small number) | $\frac{a}{b}$ (Small number) |
|---|---|---|---|---|
| $\frac{a}{b}$ | $\frac{A}{B}\frac{a}{b}$ Smooth, White wing (Large number) | $\frac{a}{b}\frac{a}{b}$ Bumpy, Grey wing (Large number) | $\frac{A}{b}\frac{a}{b}$ Smooth, Grey wing (Small number) | $\frac{a}{B}\frac{a}{b}$ Bumpy, White wing (Small number) |

| | Smooth, White wing | : | Bumpy, Grey wing | | Smooth, Grey wing | : | Bumpy, White wing |
|---|---|---|---|---|---|---|---|
| Offspring phenotypic ratio: | 1 | : | 1 | | 1 | : | 1 |
| Observed numbers: | 380 | : | 380 | | 20 | : | 20 |
| | Large numbers Non-recombinant phenotype | | | | Small numbers Recombinant phenotype | | |

[4]

**(b)** Complete Table 9.1 to show the number of reduced coenzymes that is/are formed at each stage of respiration, when one molecule of glucose is oxidised.

**Table 9.1**

| | Reduced NAD | Reduced FAD |
|---|---|---|
| glycolysis | 2 | 0 |
| link reaction | 2 | 0 |
| Krebs cycle | 6 | 2 |

[2]

**(c)** With reference to Fig. 9.1, explain why there is a need for compound **X** to be converted to lactate in the absence of oxygen. [4]

1. Pyruvate is converted to lactate to regenerate $NAD^+$.
2. This allows glycolysis to occur and glucose is broken down to pyruvate, and NADH is formed.
3. ATP can still be formed via glycolysis to provide energy for the cell's metabolism.

4. Oxidative phosphorylation cannot occur /The electron transport chain cannot function.
5. because $O_2$ is the final electron acceptor.
6. Thus $NAD^+$ and FAD are not regenerated / oxidised.
7. Pyruvate cannot be converted to acetyl-CoA (Link reaction cannot occur)
8. Krebs cycle cannot take place.

**(d)** Suggest whether anaerobic respiration alone is sufficient for the athlete to complete the marathon. [2]

1. Does not allow.
2. Only 2 net ATP produced during anaerobic respiration as compared to 38 from aerobic respiration, per glucose molecule oxidized.

[Total: 10]



**10** Fig. 10.1 outlines the main reaction in the light-dependent stage of photosynthesis.

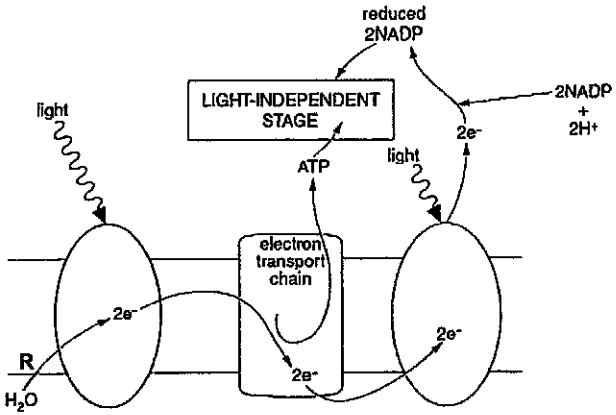



**Fig. 10.1**

**(a)** State precisely where

**(i)** the light-dependent stage occurs. [1]

thylakoids / grana

**(ii)** the light-independent stage occurs. [1]

stroma

**(b)** Give the name of the process at **R**. [1]

Photolysis of water

**(c)** Describe the role of reduced NADP in the light-independent stage. [2]

1. It is an electron / hydrogen carrier

2. and is used to reduce glycerate-3-phosphate
3. into glyceraldehyde-3-phosphate

4. during carbon reduction.

The unicellular photosynthetic green alga, *Chlorella*, was originally studied for its potential as a food source.

In one study into the productivity of *Chlorella*, carbon dioxide concentration was altered to investigate its effects on the light-independent stage of photosynthesis.

- A cell suspension of *Chlorella* was illuminated using a bench lamp.
- The suspension was supplied with carbon dioxide at a concentration of 1% for 200 seconds.
- The concentration of carbon dioxide was then reduced to 0.03% for a further 200 seconds.
- The concentrations of RuBP and GP (PGA) were measured at regular intervals.
- Throughout the investigation the temperature of the suspension was maintained at 25 °C.

The results are shown in Fig. 10.2.

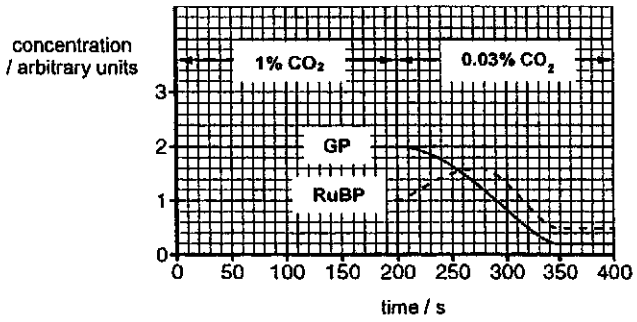



**Fig. 10.2**

**(d)** State **precisely** where in the chloroplast RuBP and GP are located. [1]

Stroma

**(e)** **(i)** Describe the change in concentration of RuBP between 200 and 350 seconds. [2]

1. As time increases from 200 to 275 seconds, the concentration of RuBP increases from 1 to 1.6 A.U.
2. As time increases from 275 to 350 seconds, the concentration of RuBP decreases from 1.6 to 0.5 A.U.

**(ii)** Explain why the concentration of RuBP changed between 200 and 275 seconds. [3]

1. As concentration of carbon dioxide decreases from 1 to 0.03%,
2. fewer RuBP are used to fix with (fewer) $CO_2$ (during carbon fixation).
3. Also, regeneration of RuBP continues as existing GP is converted to G3P and then RuBP

**(f)** State **two** differences between the structure of starch and cellulose. [2]

| Point of comparison | Starch | Cellulose |
|---|---|---|
| 1. Type of monomer | • α glucose | • β glucose |
| 2. Types of bonds between monomers | • Amylose consists of α(1-4) glycosidic bonds.<br>• Amylopectin consists of α(1-4) and α(1-6) glycosidic bonds. | • β(1-4) glycosidic bonds |

**AVP**

[Total: 13]

**11** The HIV/AIDS pandemic has had a very large impact on life expectancy in many African countries.

Table 11.1 shows estimated data for four African countries for
- the average life expectancy of an individual born in 2002
- the percentage of the population testing positive for HIV in 2002

• the average life expectancy of an individual born in 2002 if there was no HIV/AIDS pandemic.

**Table 11.1**

| Country | Life expectancy / years | | Percentage of population testing positive for HIV |
|---|---|---|---|
| | Without HIV/AIDS | With HIV/AIDS | |
| Kenya | 65.6 | 45.5 | 14.0 |
| Malawi | 56.3 | 38.5 | 16.0 |
| South Africa | 66.3 | 48.8 | 19.9 |
| Zambia | 55.4 | 35.3 | 20.0 |

**(a)** Using the 'without HIV/AIDS' and 'with HIV/AIDS' data shown in Table 11.1, calculate the percentage decrease in life expectancy for Zambia.

**Show your working and give your answer to the nearest whole number.**

1. 55.4.-35.3 = 20.1
2. (20.1 / 55.4) X 100% = 36.28% = 36% (WHOLE NUMBER)

[max 1 mark for correct calculation if answer is incorrect or not to nearest whole number]

Answer..... % [2]

**(b)** After studying the data in Table 11.1, a student concluded that:

"There is a correlation between the percentage of the population testing positive for HIV and the decrease in estimated life expectancy with HIV/AIDS."

With reference to Table 11.1, explain why the data do not fully support the student's conclusion. [2]

1. The decrease in life expectancy for countries with, similar/same, decrease (in life expectancy) have different % positive ; OR
2. The rank of % positive (of countries) is different to rank of difference in decrease in life expectancy

3. QF (any 1 of the following bullets to score full 2 marks)
   - Kenya 20.1 years decrease, 14% positive HIV, compared with Zambia 20.1 years decrease, but has more positive HIV (20%);
   - Malawi 17.8 years decrease, 16% positive HIV, compared with South Africa 17.5 years decrease, but has more positive HIV (19.9%).

4. Data for Kenya/South Africa does not support the trend that higher percentage of population testing positive for HIV correlates to higher decrease in life expectancy with HIV/AIDS.

5. QF (any 1 of the following bullets to score full 2 marks)
   - Kenya has larger decrease than Malawi/South Africa, but lower % positive HIV
   - Kenya 20.1 years decrease but only 14.0 % positive HIV, compared to Malawi lesser decrease (17.8 years) but with more positive HIV (16.0%) / South Africa lesser decrease (17.5 years) but with more positive HIV (19.9 %)

**(c)** A person who is confirmed as HIV-positive has tested positive for the presence of antibodies to HIV.

Outline the events that leads to the production of antibodies specific to HIV. [5]

1. HIV /viral antigen is taken up by an antigen-presenting cell (APC),
2. via phagocytosis.
3. The antigen is presented to naive CD4 T cells
4. Naive CD4 T cells become activated,
5. to form helper T cells
6. Helper T cells activate B cells,
7. via release of cytokines.
8. B cells proliferate
9. and differentiate to form plasma cells
10. that produce antibodies specific to the HIV.

Various anti-HIV antibodies, which can bind to different parts of the same HIV virus, are found in the infected person.

**(d)** Suggest the significance of having various anti-HIV antibodies produced in the infected person. [1]

(any 1)
1. To increase chances of binding to HIV
2. To increase chances of removal of HIV by macrophages
3. High mutation rates of HIV could lead to changes in antigen on the virus→ but having various anti-HIV antibodies means that the HIV virus could still be recognised by the antibodies

[Total: 10]

BP~323

**TEMASEK JUNIOR COLLEGE**
H2 BIOLOGY PRELIMINARY EXAMINATION
JC2 / IP YEAR 6 2019
ANSWERS

**PAPER 3 SECTION A:**

(a) Explain what is meant by an infectious disease. [2]

1. Infectious diseases are caused by pathogens that can spread from one organism to another.

2. The pathogens cause damage or injury to the host that impairs the normal function of the body.

(b) List the levels of protein structure present in choleragen. [1]
Primary, secondary, tertiary, quaternary

(c) In the laboratory, it is possible to produce a form of choleragen consisting of only B subunit as a vaccine against cholera.

(i) Suggest why B subunit, rather than A subunit, is used in the production of the vaccine. [1]

Any 1
1. B subunit is the portion that binds to cell, thus antibodies that target B subunit will prevents binding of choleragen to cell thus prevent entry to cell
2. B subunit is safer as it does not disrupt the normal functioning of the cell.
3. B subunit is larger, so more likely to stimulate immune response

(ii) Outline how the vaccine can give protection against cholera. [4]
1. In the primary immune response,
2. B subunit in the vaccine are taken up by B cells (by phagocytosis) to activate B cells, causing them to form plasma cells and memory B cells.
3. Memory B cells when re-exposed to same antigen,
4. undergo clonal expansion
5. and differentiate into plasma cells
6. secrete antibodies,
7. giving rise to a stronger secondary immune response
8. to destroy bacteria before it causes disease.

(d) Viruses that infect bacteria are called bacteriophages. Some bacteriophages that infect the cholera pathogen cause lysis of the bacterium.

(i) Compare the structures between *V. cholerae* and bacteriophage. [2]

1 similarity
- Both have DNA molecules. [Reject genetic material / nucleic acid → too vague]

1 difference
- DNA molecule in *V. cholorea* is circular but DNA molecule in bacteriophage is linear
- *V. cholorea* does not have capsid protein / tail fibre / tail sheath while bacteriophage has capsid protein / tail fibre / tail sheath.
- *V. cholorea* has cell wall / flagella while bacteriophage does not have cell wall

(ii) Some scientists believe that bacteriophages could be used to treat people who are infected with cholera. Suggest the properties of the bacteriophages that would make this possible. [2]

(Any 2)
1. infect only, *V. cholerae* / cholera bacteria OR do not infect human cells
2. able to replicate inside *V. cholerae* to produce more bacteriophage for treatment
3. Causes the lysis of the bacteria
4. Causes degradation the bacterial DNA, thus toxin cannot be synthesized
5. ref. to remaining, active / infective, with delivery method used / within gut

(e) Name the process of gene transfer and suggest why gene transfer could be dangerous. [2]

Name of process: Transduction [1]
Reason: Gene that could cause disease found in harmful bacteria could be transferred to normal gut bacteria

(f) With reference to Fig. 1.2, outline how the A subunit of choleragen can result in diarrhoea. [3]

1. The A subunit will bind and cause the activation of G protein
2. Activated G protein activates adenylate cyclase, which catalyses conversion of ATP to cAMP.
3. cAMP binds to CFTR protein,
4. causing excess chloride ions to be transported out of the intestinal epithelial cell/ into the intestinal lumen
5. Excess sodium ions and water
6. moves out of the intestinal epithelial cell into the intestinal lumen, leading to diarrhoea.

(g) Outline how the binding of insulin to its receptor is able to trigger a response inside a muscle cell.[3]

1. Insulin receptor is a type of receptor tyrosine kinase (RTK),
2. Binding of insulin to the insulin receptor, causes conformational change, and dimerisation of the receptors, activating the RTK.
3. The tyrosine kinase region of each subunit now phosphorylates the tyrosine residues on the intracellular tail of the OTHER monomer / subunit. (@ cross phosphorylation)
4. Insulin response substrate (IRS) proteins in the cell bind to phosphorylated regions of the receptor.
5. IRS proteins are phosphorylated.
6. Signal transduction via phosphorylation cascade occurs, leading to a cellular response.

(h) Describe one effect of insulin on muscle cells. [1]
(any 1)

1. Increases permeability of cell membrane to glucose/ increasing uptake of glucose
2. Increase rate of conversion of glucose to glycogen (glycogenesis)
3. Increases rate of oxidation of glucose in cellular respiration
4. Increases the rate of protein synthesis

(i) In some diabetics, the insulin receptors are mutated and do not allow insulin to bind.

Explain how a mutation to the gene coding for the insulin receptor can affect blood glucose levels. [3]

1. Mutation to gene of insulin receptor results in different coding / nucleotide sequence.
2. Different amino acid sequence / primary structure in the insulin receptor polypeptide chain
3. Different folding / conformation of the insulin receptor
4. Shape of insulin binding site of the insulin receptor will not be complementary in shape to the shape of insulin
5. Therefore signalling transduction pathway will not be activated
6. Glucose will not be taken up into the cell, resulting in high blood glucose levels.

(j) With reference to Fig. 1.3, describe how post-translational modification of preproinsulin can give rise to the functional insulin. [3]

1. Preproinsulin folds such that A chain and B chain are adjacent / close to each other
2. Disulfide bonds are formed between A and B chain, forming proinsulin
3. C-peptide is cleaved /removed from proinsulin using protease
4. resulting in the functional insulin

(k) Predict the level of C-peptide in people with lesser number of functioning beta cells. Give a reason for your prediction. [2]

Low level of C-peptide

People with lesser functioning beta cells will synthesize low quantity of insulin / preproinsulin, hence lesser C-peptide will be removed and released into the blood stream.

Q2

(a) The African clawed frog (*Xenopus laevis*) is a well-studied amphibian. Complete Table 2.1 to show the classification of *Xenopus laevis*. [2]

Table 2.1

| | |
|---|---|
| Kingdom | Animalia |
| Phylum | Chordata |
| Class | Amphibia |
| Order | Anura |
| Family | Pipidae |
| Genus | *Xenopus* |
| Species | *Xenopus laevis* |

(b) Using the information in Table 2.1, evaluate whether the data supports the suggestion that coelacanths and amphibians share a more recent common ancestor than lungfish and amphibians. [4]

1. coelacanth α chain has higher percentage of matches with both adult and larval amphibians,
2. QF e.g. coelacanth with Xl = 42.0 while coelacanth with lungfish = 40.4. .

OR

3. coelacanth β chain has higher percentage of matches with larval amphibians (rather than adults)
4. QF E.g. coelacanth with Xl larva is 52.1 while coelacanth with lungfish larval = 47.3.
5. supports closer relationship of coelacanth and amphibian ;
6. (but) lungfish β chain has higher percentage of matches with adult amphibian (than coelacanths) ;
7. does not support suggestion / supports closer relationship lungfish and amphibians

(c) Describe one advantage of the use of molecular systematics in determining the evolutionary relationship between amphibian, coelacanth and lungfish. [1]

1. Molecular methods can be used for all living organisms.
2. Molecular methods can be used for dead or living organisms as long as DNA or protein is available.
3. AVP

(d) Explain the role of isolating mechanisms in the evolution of new species. [3]

1. (same) species separated into separate populations ;
2. (by) geographical isolation / named example ;
3. prevents interbreeding between populations
4. thus no gene flow ;
5. each population of organisms experience different selection pressures ;
6. change in allele frequencies ;
7. allopatric speciation ;
8. ref. to genetic drift / founder effect



(a) Explain why dengue disease is much more common in regions near the equator than in other parts of the world. [2]

1. *A. aegypti* thrives in equatorial regions with high temperatures (20 to 30°C)
2. which shortens their life cycle / shorter EIP of dengue virus,
3. and abundance of rainfall
4. which gives rise to more breeding grounds;

(b) Suggest two reasons why governments in parts of the world other than regions near the equator, are also becoming increasingly concerned about dengue disease. [2]

1. Global warming (increased temperature, precipitation) spreads to other parts of the world, resulting in quicker *A. aegypti* development / faster replication of dengue virus;
2. Resistance to drugs as the dengue virus mutates rapidly and no one drug can effectively target all 4 DENV serotypes;
3. AVP (e.g. increased movement of infected people / inadvertent transport of infected *A. aegypti* / no herd immunity / lack of healthcare infrastructure)

(c) Outline the development of dengue virus in humans. [2]

1. Dengue virus infects dendritic cells, which then move to the lymph nodes.
2. At the same time, the virus replicates.
3. At the lymph nodes, the new synthesised viral particles are released from the infected dendritic cells, which then go on to infect more macrophages and dendritic cells.
4. This results in increased viremia in the blood.
5.

(d) Suggest how using the SIT could reduce transmission of dengue. [1]

1. Sterile male *A. aegypti* could compete with fertile males to mate / intraspecific competition / for food / resources;
2. Female *A. aegypti* that mate with sterile males do not produce offspring;

(e) It was observed that the release of radiation-sterilised *A. aegypti* has not been very successful in controlling the transmission of dengue.

Give one reason for the observation.[1]

1. Radiation affects their lifespan / survival / Nonrandom breeding / courtship
2. Higher numbers of fertile males than sterile males

**(f)** Suggest why the scientists released transgenic males every week. [1]

1. To maintain population numbers of transgenic males
2. The released transgenic males will die / have a short lifespan;

**(g)** The release of transgenic males proved successful in reducing the number of *A. aegypti.*

Describe how the results in Fig. 3.2 support this conclusion. [2]

1. As time increases from 9 to 16 weeks, the number of *A. aegypti* per $km^2$ in the treated area decreased from approximately 300 to nearly 0
2. but in the control area, the number of *A. aegypti* per $km^2$ fluctuates between 200 to 900 ;

[Total: 11]

**PAPER 3 SECTION B:**

**4 (a)** Describe how the product of photosynthesis contributes towards the growth of a plant and suggest the effects on plant growth when the plant is grown at its compensation point for prolonged period of time. [12]

**Max 9 marks**

1. Glyceraldehyde 3 phosphate (GALP) which is produced from the Calvin cycle can be used to form other organic compounds
2. GALP can be converted to amino acids
3. which is used for protein synthesis.
4. Example given about how protein can be used for cell growth (e.g. increase protoplasm, increase number of organelles)

5. GALP can also be converted to fatty acids
6. Which can be used to form phospholipids / triglycerides
7. Example given about how the lipid can be used for cell growth (e.g. formation of new cell membrane)

8. GALP can also be used to form glucose

9. Glucose will be oxidized during aerobic respiration / during oxidative phosphorylation
10. ATP will be produced
11. ATP is used for the synthesis of other macromolecules
12. Example given (e.g. proteins / enzymes / lipids / phospholipids, for cell division, mitosis) and described how it is used for plant growth. [E.g. Formation of phospholipids to allow the cell membrane to expand]

13. β glucose will be used to form the cellulose cell wall
14. Cellulose cell wall needed for the formation of new plant cells

15. Excess α glucose will form starch
16. Starch used as a storage molecule in e.g. leaf cells / roots / fruits / storage organs

17. Glucose combines with fructose to form sucrose
18. Sucrose used as transport molecule to other parts of the plant

**Compensation point**

19. Define compensation point: The rate of photosynthesis is equal to the rate of respiration at a particular light intensity.
20. The number of carbon dioxide fixed during photosynthesis is the number of carbon dioxide released during respiration.
21. If a plant is at its compensation point for a long period of time, there will not be net production of sugar
22. Hence no net gain in dry mass
23. Plant will be unlikely to grow

**QWC: At least 2 different points on how glucose contributes to plant growth + suggestion of effect of compensation point.**

**(b)** Prokaryotes and eukaryotes respond differently to changes in the environmental conditions.

Describe how bacteria respond to changes in lactose supply.

Compare the advantages of a mammalian response to changes in blood glucose concentration with that of a bacterial response to changes in supply of lactose. [13]

[Total: 25]

**Max 8 marks**

1. *lac* operon;
2. Is an inducible operon is one where it is usually turned off but can be stimulated (induced)
3. when an inducer molecule (lactose) interacts with a regulatory protein (*lac* repressor);
4. Structural genes (*lac Z, lac Y, lac A*) which code for enzymes (β-galactosidase, *lac* permease, β-galactoside transacetylase) responsible for uptake and hydrolysis of lactose;
5. In the absence of lactose,
6. active *lac* repressor is able to bind to operator
7. RNA polymerase cannot bind to the promoter to transcribe the genes of the operon
8. Response: There will be no uptake and hydrolysis of lactose
9. In the presence of lactose, lactose is taken up and cleaved to form allolactose
10. allolactose binds to *lac* repressor;
11. inactive *lac* repressor is unable to bind to operator and;
12. RNA polymerase can bind to the promoter to transcribe the genes of the operon;

13. When glucose levels are low, cAMP levels are high;
14. cAMP binds to catabolite activator protein (CAP) and activates it,
15. CAP binds to CAP binding site;
16. Attachment of CAP to CAP-binding site bends DNA,
17. which makes it easier for RNA polymerase to bind to promoter.
18. Operon is switched on, transcription of structural genes can occur.
19. Response: There will be increase in uptake and hydrolysis of lactose.

[For the following answers 1 mark for each point. Max 4]

Similarity
20. Both allow organism to utilise carbohydrates (glucose/ lactose) to survive.

Difference

| | Mammalian response | Bacterial response |
|---|---|---|
| 21. Rate of response | Respond faster than that of bacteria; because the hormones are already synthesized and thus can be secreted directly when required | Respond slower than that of mammals; because the proteins/ enzymes need to be expressed when required |
| 22. Synthesis of proteins/ Conservation of energy | Hormones (insulin and glucagon) are synthesized and stored. They are secreted when required. | Proteins/ enzymes are synthesized only when required. [Accept: Inducible] |
| 23. Storage of carbohydrate | Carbohydrates are stored for future use. | Carbohydrates are NOT stored for future use. |
| 24. Regulation of carbohydrate supply | Able to regulate glucose supply within the organism | Unable to regulate lactose supply within the organism |

QWC: Address all parts of the questions with at least 1 similarity AND 1 difference.

5 (a) An increase in DNA methylation at the promoter region of tumour suppressor genes could lead to greater tendency for an individual to develop cancer.

Compare the features of stem cells and cancer cells and suggest how DNA methylation at the promoter of tumour suppressor genes could contribute towards the development of cancer. [13]

Max 8 marks

| Stem cells | Cancer cells |
|---|---|
| 1. Controlled cell division | Uncontrolled cell division |
| 2. Ability to differentiate into specialize cells | Unable to differentiate into specialize cells |
| 3. Contact inhibition | Do not undergo contact inhibition |
| 4. angiogenesis does not occur in stem cells | Stimulate the growth of blood vessels towards themselves (angiogenesis) |
| 5. mostly localized except blood stem cells | invade nearby tissue and then metastasize to distant parts of the body. |
| 6. May undergo apoptosis | Unable to undergo apoptosis |
| 7. Are anchorage dependent | Are anchorage independent |
| 8. Is required for the normal functioning of the organism | Cause harm to the organism |
| 9. May have mutations but not nec in tsg, proto oncogene and telomerase gene | At least accumulated 6 mutations, tsg proto oncogene, teleromase gene |
| 10. Checkpoints are well regulated | Dysregulation of checkpoints |
| 11. Specific cell shape and sizes | Non-specific cell shape and sizes |
| 12. Same chromosome number and structures as normal cells. | Chromosomal aberrations: number or structures different from normal cells |
| 13. No DNA damage | DNA damage |
| 14. Both have active telomerase | |
| 15. Both undergoes mitosis | |
| 16. Both cells remained undifferentiated | |
| 17. Both are able to divide for long periods time. | |

[For the following answers 1 mark for each point. Max 4]

1. DNA Methylation of the promoter region of tumour suppressor gene such as p53 gene results in lower expression / no transcription of the *p53* tumour suppressor gene,
2. thus lower expression of the p53 tumour suppressor protein.
3. This results in inability to stop cell division.
4. When proto-oncogenes are mutated in the same cell, this leads to uncontrolled cell division, development of cancerous cells.
5. As the tendency of the promoter region to be methylated is higher in older people, there is a tendency of older people to develop cancer.

QWC: Address all parts of the questions with at least 2 similarity AND 2 difference.

(b) Climatic factors affect the duration of each season, resulting in mismatch of flowering timings and insect maturation. For example plants bloom earlier but bees are not available to pollinate the flowers. As a result, flowers are not pollinated and bees do not have enough food.

Discuss the possible impacts of climate change on microevolution of insects and plants that rely on insects as pollinators. [12]

[Define climate change]
1. Increase in the global temperatures [1/2]
2. Changes in precipitation leading to extreme weather conditions [1/2]

(e.g.) longer hotter season – warmer summer and milder winters, with more frequent and intense heat waves

[Possible impacts of climate change on plants AND insect pollinators. Max 3]

3. The plants may flower / bloom earlier / later and release pollen.
4. Longer / shorter flowering season for some plants.
5. Insects may not have completed maturation / life cycle disrupted
6. Different types of insects could now be involved in the pollination
7. Mismatch/ disruption / asynchrony between the timing of flowering and the activity of pollinators,
8. changing the co-evolutionary dynamics (OWTTE)
9. leading to changes in seed production and availability of resources [e.g. food / shelter]

[Define microevolution]

10. changes in allele frequencies of a population over many generations due to mutation, genetic drift and natural selection, resulting in new species. [1]

[Explain how CC affect microevolution of plants and insects, 6 marks]

For plants:

1. Phenotypic variation among plant population arise due to random spontaneous mutation
2. Selection pressure: availability of insect pollinators
3. Selective advantage : Plants that have pollen that can be pollinated differently
4. will survive to reproductive age to produce viable, fertile offspring.
5. They will pass the favourable allele to the next generation.
6. More individuals in the population with the desirable trait and frequency of favourable allele increases.
7. Change in flowering and pollination timing can lead to physiological isolation between individuals in a population.
8. Prevent gene flow between populations.
9. sympatric speciation occurs

For insects:

1. Phenotypic variation among plant population arise due to random spontaneous mutation
2. Selection pressure: availability of food
3. Selective advantage : Insects that can pollinate/feed on other sources
4. will survive to reproductive age to produce viable, fertile offspring.
5. They will pass the favourable allele to the next generation.
6. More individuals in the population with the desirable trait and frequency of favourable allele increases.
7. Different maturation timing / reproduction timing / physiological isolation between individuals in a population.
8. Prevent gene flow between populations.
9. sympatric speciation occurs

*Points in blue for natural selection, only mark once. Points in red = must have for plants and insects.*

QWC: Cover all aspects of the question: effects of climate change, impact on microevolution of plants and insect.

[Total: 25]

BP~329



**TEMASEK JUNIOR COLLEGE**
PRELIMINARY EXAMINATION
JC2 / IP YEAR 6 2019

## PRACTICAL ANSWERS

1

**(a)** Hazard hydrogen peroxide solution / solution X
Level of risk medium / high

(ii) Suggest the precaution to be taken to the hazard identified in (a)(i). [1]

- Wear googles,
- Wear gloves
- Wash hands when come into contact with the solution

**(b)** (i)

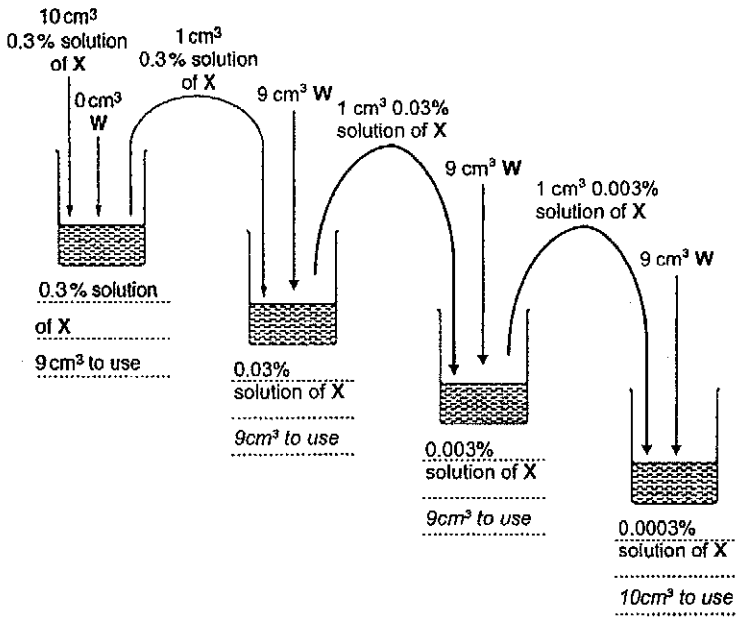



Fig. 1.1

[3]

1. **(labels under correct sequence of beakers) 0.03 + 0.003 + 0.0003 + % ;**
2. **shows transfer of 1 cm³ of solution from previous beaker to 2 beakers ;**
3. **adds 9 cm³ water / W to three beakers ;**

*Ignore "9cm³ to use"*

Note:
Students should follow the example given and draw the lines as in the 1st example.



(ii) Prepare the space below and record your results.

| Concentration of solution X / % | Number of bubbles of oxygen released in 2 minutes |
|---|---|
| 0 | 206 |
| 0.0003 | 188 |
| 0.003 | 162 |
| 0.03 | 81 |
| 0.3 | 5 |

[4]

**(c)**

**(i)** Time taken to collect 2 $cm^3$ of oxygen produced by the hydrolysis of H

**(ii)**

1. Fill the sealed syringe completely with water and turn it upside down keeping the open end of the syringe under the water.
2. Using a syringe, put 5 $cm^3$ of H into a clean test-tube.
3. Using another syringe, put 10 $cm^3$ of the mixture of P and W into the same test-tube.
4. Immediately put the bung (with the delivery tube attached) into this test-tube.
5. Put the end of the delivery tube into the beaker of water and into the syringe / opening of the syringe so that the bubbles of oxygen pass into the syringe.
6. Start timing using a stopwatch.
7. Stop the stopwatch once 2 $cm^3$ of oxygen is collected in the syringe.
8. Repeat steps 1 to 7 to obtain two more readings / triplicates.

**(iii)** Use the method you have described in **(c)(ii)** to collect results.

Record your results in a suitable table in the space below.

| mixture of P, W and H | Time taken for 2 $cm^3$ of oxygen to be collected / s | | |
|---|---|---|---|
| | Reading 1 | Reading 2 | Average |
| | | | |

[3]

**(iv)** Use your results in **(c)(iii)** to calculate the rate of activity of the catalase. You may lose marks if you do not show your working.

**Rate = 2$cm^3$ / average time taken to collect oxygen**

Rate of activity ..... $cm^3\ s^{-1}$ [2]

**(v)** Identify **two** significant sources of error when using each of the two methods to measure the dependent variable.

***two** significant errors in counting the number of bubbles [2]*

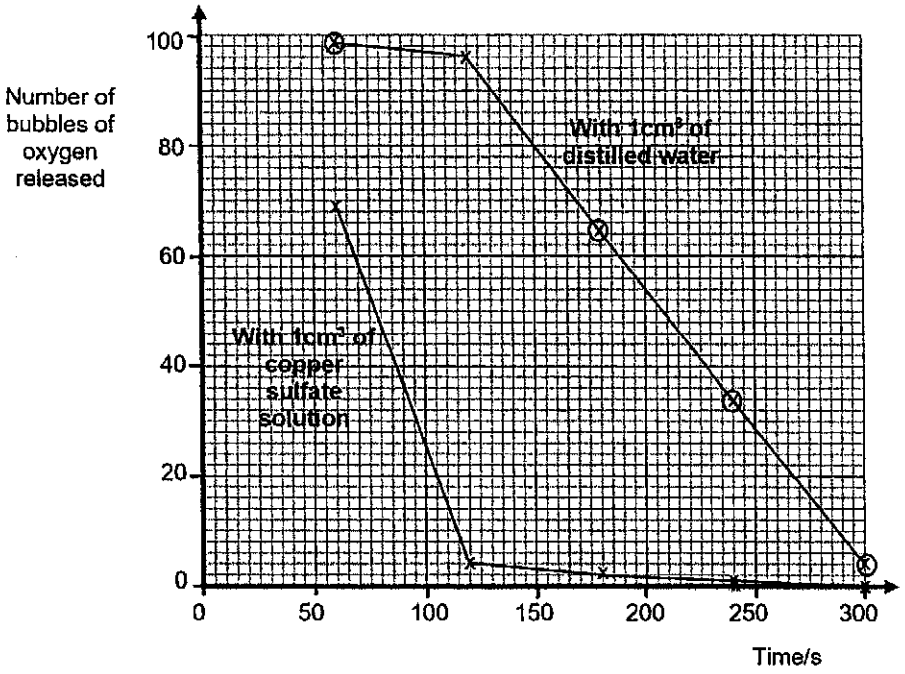
1. **different sizes**
2. **too fast / bubbles group together ;**

***two** significant errors in measuring the displacement of water [2]*

3. **gas dissolves in water hence affecting accuracy of results**
4. **gas escapes from delivery tube**
5. **not all bubbles go into syringe**
6. **parallax error ;**

**(d)**

**(i)** Plot a graph of the data in Table 1.1.




**(ii)** Using your knowledge of enzymes, suggest how copper sulfate solution may change the activity of the catalase.[3]

1. Competitive inhibitor
2. Shape of copper sulfate is complementary to the shape of the active site of catalase
3. Block hydrogen peroxide from binding the active site
4. Fewer enzyme-substrate complexes formed per unit time, thus lower activity of catalase.

Accept corresponding answer for Non-competitive inhibitor

**(iii)** State one environmental variable that should be kept constant and the method to achieve it. [2]

Variable Temperature
Method Thermostatically-controlled water bath

[Total: 33]



**2**

**(a)**

**(i)** Use the eyepiece graticule in the microscope to measure across the diameter of the root as shown in Fig. 2.1: [4]

**L** to **Q** = .....**200**..... eyepiece graticule units

**L** to **M** = .....**85**..... eyepiece graticule units

**M** to **N** = .....**30**..... eyepiece graticule units

**N** to **Q** = .....**85**..... eyepiece graticule units

1. states 4 measurements (**L** to **Q**, **L** to **M**, **M** to **N**, **N** to **Q**) & each measurement;
2. **M** to **N** is the lowest value;
3. measurements of **L** to **Q** equal to the sum of other measurements (i.e. **L** to **M**, **M** to **N**, **N** to **Q**)

**(ii)** Use the measurements from **(a)(i)** to state: [3]

the length across the diameter of the root (**L** to **Q**) 200 eyepiece graticule units [no marks]

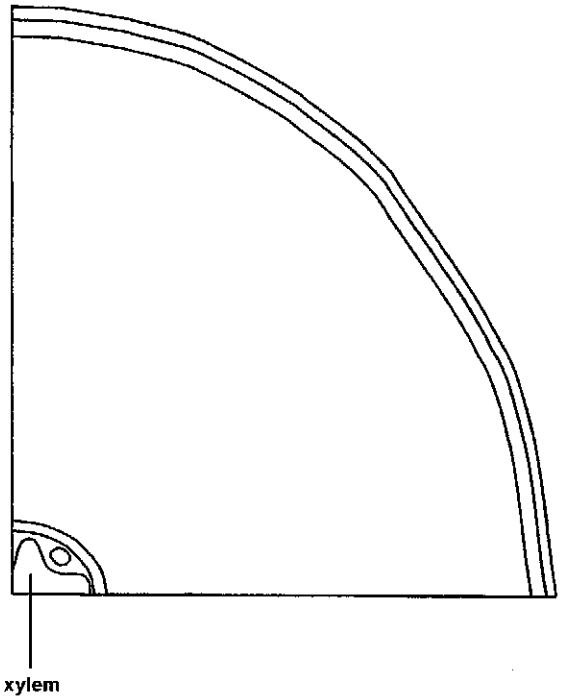
the length of cortex across the diameter 85 + 85 or 170 [1] eyepiece graticule units

Calculate the length of cortex as a percentage of the diameter of the root.

You may lose marks if you do not show your working.

1. shows length of cortex divided by measurement for **L** to **Q** multiplied by 100;
2. answer to the appropriate degree of accuracy;

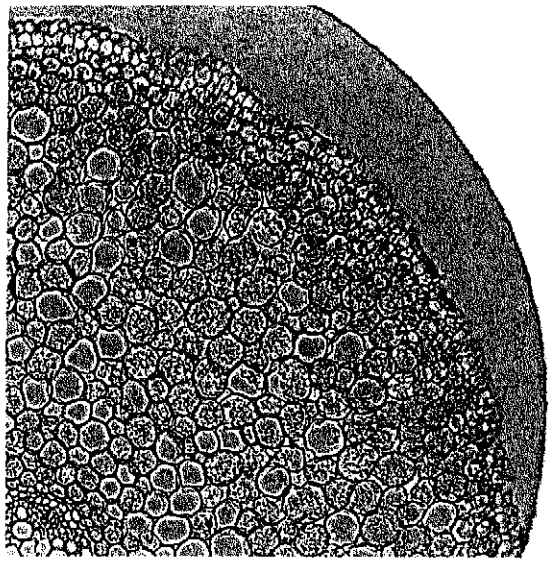
(iii)




[5]



| | | |
|---|---|---|
| **M 1** | 1. clear, sharp, unbroken lines<br>**AND**<br>2. no shading<br>**AND**<br>3. minimum size of at least 90mm;<br>must have at least 4 lines drawn | Reject:<br>- if drawn over the print of question<br>- feathery lines<br>- overlaps or gaps |
| **M 2** | 1. no cells drawn<br>**AND**<br>2. only the correct half of the root drawn | |
| **M 3** | 1. central vascular tissue (stele) drawn in correct proportion to the diameter of the root | |
| **M 4** | shows correct outline of xylem tissue | Reject:<br>- if circles are drawn representing xylem vessels |
| **M 5** | 1. Correct label with label line to xylem<br>2. Use ruler to draw label line | Reject:<br>- if any label is biologically incorrect e.g. regions belonging to other organs or animals.<br>- if any label within drawn area<br>- if any label to open space |



**(ii)** There are observable differences between the leaf sections in Fig. 2.2 and J1. Identify three differences between them.

For each of the three differences, draw one label line to a feature in Fig. 2.2 that shows the difference. Label the three differences **D**, **E** and **F**.

Complete Table 2.1 to describe the difference between the leaf sections for each of these **three** features.

**Table 2.1**

| Feature | Fig. 2.2 | J1 |
|---|---|---|
| D | | |
| E | | |
| F | | |

[4]

**[Total: 20]**

| Features | Fig. 2.2 | J1 |
|---|---|---|
| Number of layers | More layers | Less layers |
| Position of Vascular bundle at mid rib | More central | Nearer to lower epidermis |
| Palisade mesophyll | Present | Missing |
| Stomata | Only on lower epidermis | Present on both upper and lower epidermis |
| Size of cells on upper epidermis | Uniform size | Bigger (Buliform cells) and smaller cells |
| Layers below upper epidermis (at mid rib) | elongated | Irregularly shaped |

AVP