INNOVA JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATION
in preparation for General Certificate of Education Advanced Level
Higher 2

CANDIDATE NAME			
CLASS		INDEX NUMBER	

BIOLOGY

9744/01

Paper 1 Multiple Choice

15 September 2017

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in soft pencil.
Do not use staples, paper clips, and glue or correction fluid.

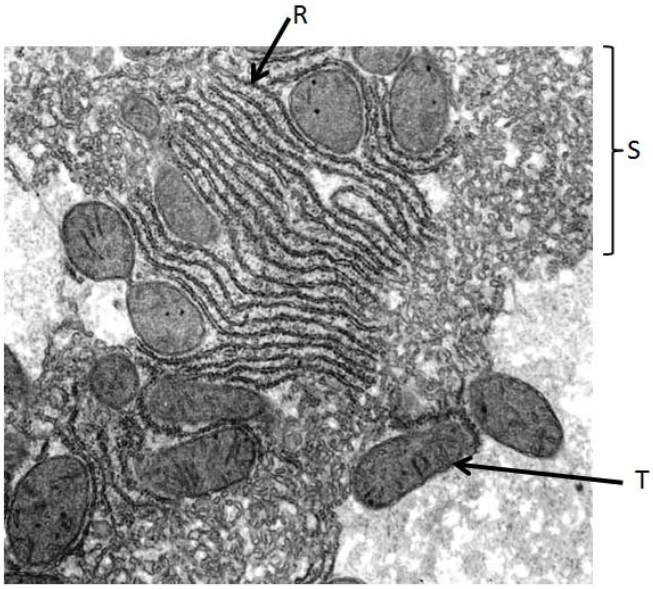
There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

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

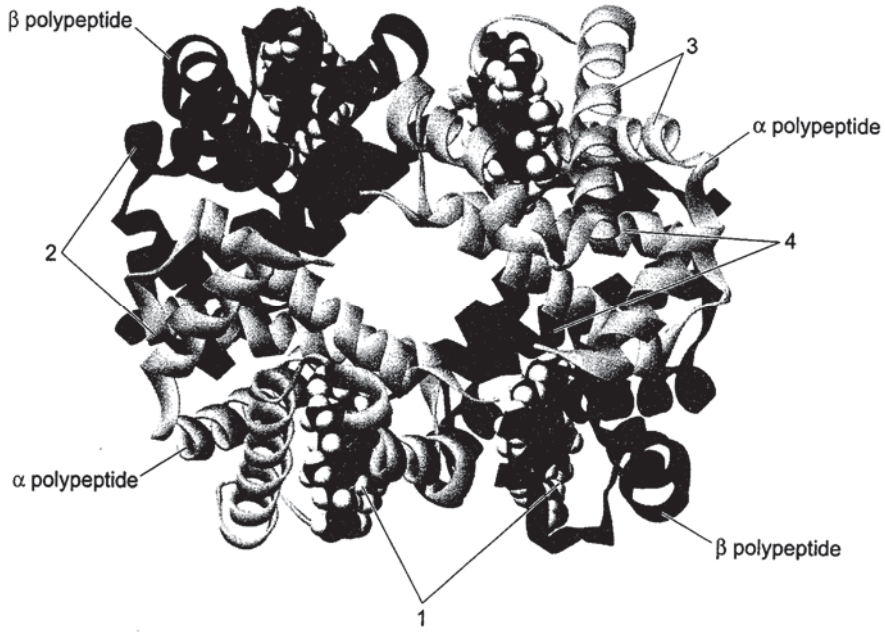
1 The figure below shows an electron micrograph of an eukaryotic cell.

Which of the following option correctly matches the structures **R, S** and **T** to their respective functions?



	R	S	T
A	Involved in proteins glycosylation	Site of lipid synthesis	To convert light energy to chemical energy
B	Site of protein synthesis	Site of detoxification reaction	Supplying cellular energy
C	Site of detoxification reaction	Involved in protein glycosylation	Remove worn out organelles
D	Site of protein synthesis	Contains proteins to be secreted	Supplying cellular energy

2 The diagram shows a haemoglobin molecule.



Which identifies the different parts of the molecule?

	1	2	3	4
A	prosthetic group	beta pleated sheet	alpha helix	hydrophilic amino acid
B	hydrophobic amino acids	beta pleated sheet	prosthetic group	binding site
C	prosthetic group	hydrophilic amino acids	alpha helix	hydrophobic amino acids
D	prosthetic group	hydrophilic amino acid	binding site	hydrophobic amino acids

3 Which of the following statements about enzymes are **false**?

1 All enzymes are globular proteins.

2 Enzymes catalyse reactions by decreasing the activation energy.

3 A prosthetic group is tightly bound to the enzyme, while a coenzyme is a loosely bound to the enzyme.

4 The effect of competitive inhibitors can be reduced by increasing substrate concentration.

5 An allosteric binding site refers to the active site that has undergone an induced fit.

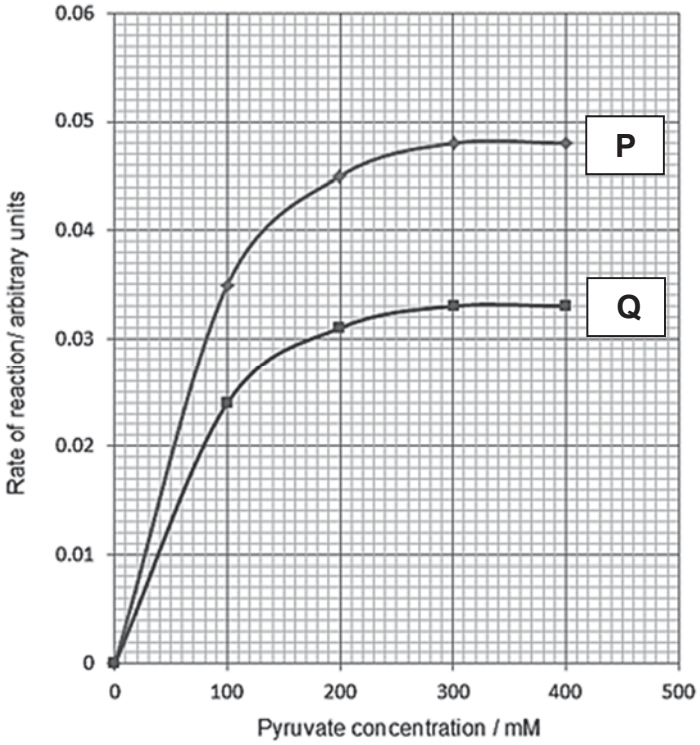
A 1 and 3

B 1 and 5

C 2 and 4

D 3 and 5

4 Curve **P** shows the rate of a reaction catalysed by lactate dehydrogenase under optimum conditions. A change was made to the reaction and curve **Q** shows the effect of this change on the reaction rate.



Which factor, operating to a constant extent throughout the experiment, could result in curve **Q**?

A Addition of a compound that competes for the same binding site as pyruvate

B Addition of an inhibitor that differs in 3D configuration from pyruvate

C Addition of a co-enzyme such as NAD^+

D An increase in enzyme concentration

5 During the mitotic cell cycle, which of the following would result if cytokinesis does not occur after mitosis is completed?

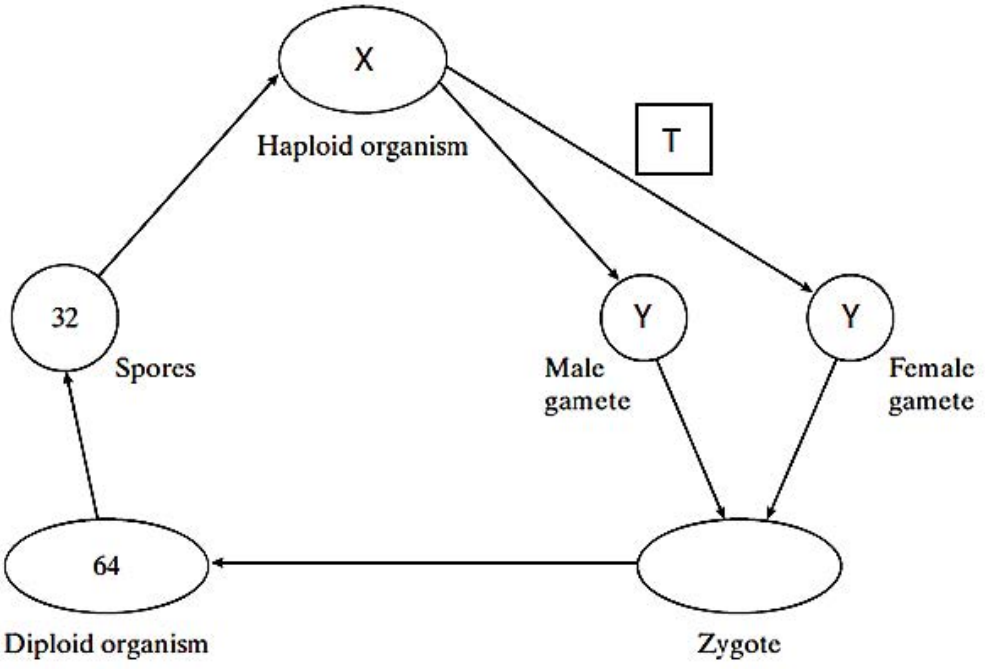
A Cells with two nuclei

B Cells with insufficient organelles

C Cells with twice the amount of genetic material but without nuclei

D Cells which are unusually small in size

6 The diagram shows the life cycle of an organism. The numbers show how many chromosomes are present in one cell at each stage of the life cycle.



Which of the following correctly shows the type of division and number of chromosomes?

	Type of cell division	Number of chromosomes	
	T	X	Y
A	Mitosis	16	8
B	Meiosis	16	16
C	Mitosis	32	32
D	Mitosis	32	16

7 The table shows the relative amounts of the bases adenine, thymine, guanine and cytosine in DNA from different organisms.

source	adenine	thymine	guanine	cytosine
bacterium	23.8	23.1	26.8	26.3
maize	26.8	27.2	22.8	23.2
fruit fly	30.7	29.5	19.6	20.2
chicken	28.0	28.4	22.0	21.6
human	29.3	30.0	20.7	20.0

Which statements account for the importance of the ratios of A to T and G to C to the structure of DNA?

1 Complementary base pairing can occur.

2 Mutation will occur when pairing ratio is lost.

3 Semi-conservative DNA replication can occur to copy DNA strands.

4 Phosphodiester bonds helps to hold two strands together.

5 Purines and pyrimidines have different sizes and shapes.

A 1 and 3 only

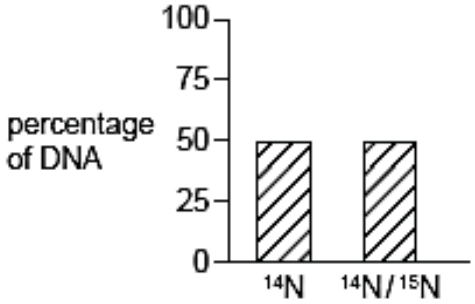
B 1, 2, 3 and 5 only

C 2, 3, 4 and 5 only

D 1, 2, 3, 4 and 5

8 Bacteria were grown in a medium containing ^{15}N. After several generations, all of the DNA contained ^{15}N. Some of these bacteria were transferred to a medium containing the common isotope of nitrogen, ^{14}N. The bacteria were allowed to divide once. The DNA of some of these bacteria was extracted and analysed. This DNA was all hybrid DNA containing equal amounts of ^{14}N and ^{15}N.

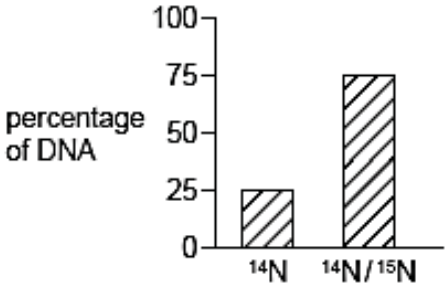
Some bacteria from the medium with ^{15}N were transferred into a medium of ^{14}N. The bacteria were allowed to divide twice. The graph shows the percentages of ^{14}N and ^{15}N in the DNA of these bacteria.



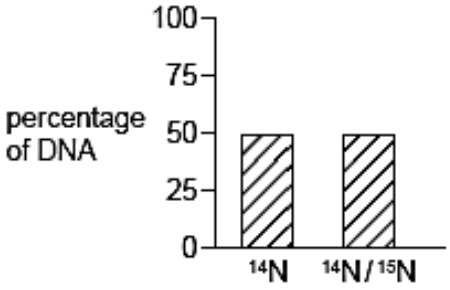
Some bacteria from the medium with ^{15}N were transferred into a medium of ^{14}N. The bacteria were allowed to divide three times.

What would be the percentages of ^{14}N and ^{15}N in the DNA extracted from these bacteria?

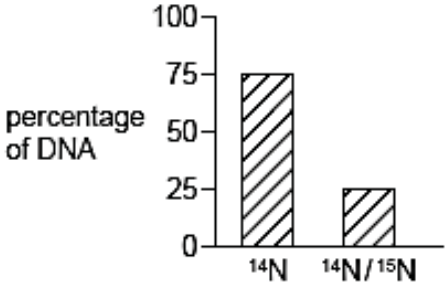
A



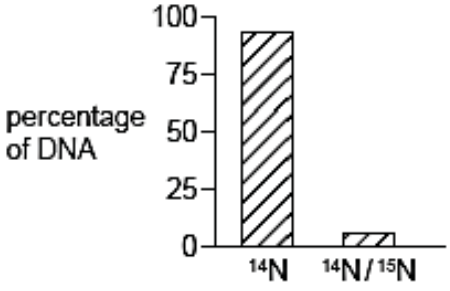
B



C



D



9 The following statements illustrate the processes that occur during translation, although not necessarily in this order.

1 The large subunit of the ribosome binds and forms the translation initiation complex.

2 The second amino acyl-tRNA complex now binds to mRNA at the “A” site of the ribosome.

3 The small ribosomal subunit, with initiator tRNA bound, binds to the 5’ cap of the mRNA and scans for the first start codon.

4 Soluble protein called release factor recognises the stop codon and binds at the “A” site.

5 Formation of a peptide bond between the first and the second amino acids by peptidyl transferase.

6 The second amino acyl-tRNA complex moves from the “A” site to the “P” site.

Using the information provided above, deduce the order in which these processes occur.

A 1 → 3 → 2 → 5 → 6 → 4

B 1 → 3 → 2 → 6 → 5 → 4

C 3 → 1 → 2 → 5 → 6 → 4

D 3 → 1 → 2 → 6 → 5 → 4

10 The following table shows the mRNA codons for six different amino acids.

mRNA codons	amino acid
AAA AAG	lysine
AGA AGG CGG	arginine
GGU GGA GGC GGG	glycine
CCU CCA CCC CCG	proline
UGG	tryptophan
UAU UAC	tyrosine

The base sequence of mRNA coding for part of a polypeptide is shown below.

From the information provided, which of the predictions stated below is **not** true?

A The insertion of a nucleotide between positions 3 and 4 is expected to result in a greater change in the amino acid sequence than an insertion between positions 12 and 13.

B The deletion of a nucleotide at position 5 would result only in an alteration of the second amino acid in the chain.

C The substitution of a different nucleotide at position 12 would produce no alteration in the amino acid chain.

D The substitution of a different nucleotide at position 13 would result in the alteration of one amino acid.

11 Some statements about the phages are listed as follows:

1 All types of phages are capable of undergoing lytic and lysogenic cycles.

2 A phage usually undergoes lysogenic cycle because a larger number of progeny phages can be produced rapidly as compared to the lytic cycle.

3 The release of lysozyme upon rupturing of lysosome leads to the osmotic lysis of host bacterium.

4 The phage gene codes for a repressor protein that prevents the expression of prophage.

Which of these statements about the reproductive cycles of a phage are **not** true?

A 1 and 2 only

B 3 and 4 only

C 1, 2 and 3 only

D 2, 3 and 4 only

12 The dengue virus is spherical, membrane-bound with a similar reproduction cycle as the influenza virus. However, unlike the influenza virus, its genetic material consists of one single positive sense strand of RNA.

Using the information above, which one of the following statements about the reproduction cycle of dengue virus is **false**?

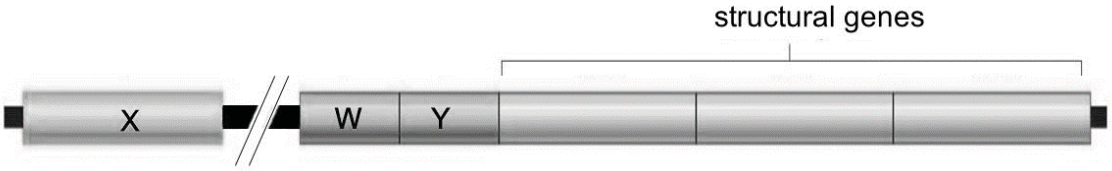
A RNA-dependent RNA polymerase is required to complete its cycle.

B The viral envelope fuses with the cell surface membrane of the host cell.

C The viral genome is directly used for translation of viral protein.

D Uncoating process involves fusion with endosome membrane.

13 The diagram shows a length of DNA responsible for metabolising lactose in prokaryotes. A mutation occurred in X such that its protein product became non-functional.



What is a possible outcome of the mutation if the bacteria cell is grown in a culture medium containing only lactose?

	Sequence bound by functional protein X	Positive control of gene regulation	Negative control of gene regulation	Transcription of structural genes
A	W	absent	present	no
B	Y	absent	present	no
C	W	present	absent	yes
D	Y	present	absent	yes

14 About 12,000 genes are expressed in both chick liver and oviduct. However an estimated additional 5,000 genes are expressed only in liver, while an additional 3,000 genes are expressed only in oviduct.

Which of the following could explain these observations?

1 The additional genes may have different methylation patterns in different tissues.

2 The concentrations of transcriptional enhancer elements for the additional genes vary in different tissues.

3 The number of genome copies is different in different somatic cells.

4 A common set of genes are expressed for normal functions in liver and oviduct.

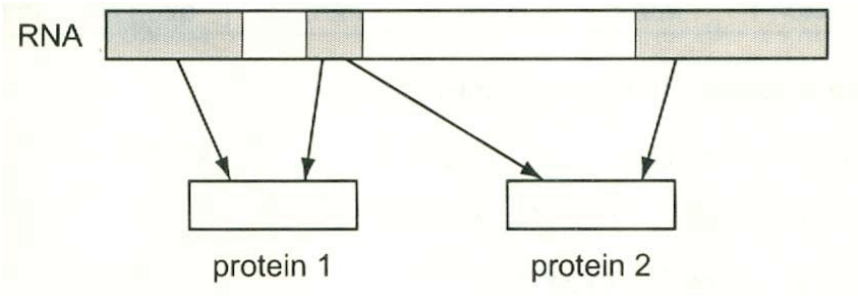
A 1 only

B 2 and 3 only

C 1 and 4 only

D 2 and 4 only

15 RNA transcribed from a length of DNA of a chromosome was found to code for two different proteins that function as enzymes, as shown in the diagram.



Which of the following best describes the two proteins?

A Protein 1 and protein 2 are a result of control of gene expression at translational level.

B Protein 1 and protein 2 are a result of the cleavage of a polyprotein.

C Protein 1 and protein 2 function sequentially in the same metabolic pathway.

D Protein 1 and protein 2 usually perform similar functions in different cell types.

16 Which of the following scenario has the highest risk of cancer?

	proto-oncogene	**tumour-suppressor gene**
A	gain of function in one allele	loss of function in both alleles
B	gain of function in both alleles	loss of function in one allele
C	loss of function in both alleles	gain of function in one allele
D	loss of function in one allele	gain of function in one allele

17 In a comparative study of brinjal plants, a test cross was made between the variety of plant producing purple and long brinjal and the variety producing green and short brinjal. The results of the following F_1 generation are shown below:

Phenotypes	Number
Purple, Long	28
Purple, Short	30
Green, Long	26
Green, Short	34
Total number	118

χ^2 test $\quad \chi^2 = \Sigma \frac{(O-E)^2}{E} \quad \nu = c - 1$

key to symbols

Σ = 'sum of …'
ν = degrees of freedom
c = number of classes
O = observed 'value'
E = expected 'value'

degrees of freedom	probability, p				
	0.10	0.05	0.02	0.01	0.001
1	2.71	3.84	5.41	6.64	10.83
2	4.61	5.99	7.82	9.21	13.82
3	6.25	7.82	9.84	11.35	16.27
4	7.78	9.49	11.67	13.28	18.47

Which of the following statements is **false**?

A The probability that the difference between observed and expected values is due to chance is greater than 10%.

B The two genes coding for the colour and shape are not linked.

C The difference between the expected number and the observed number of the phenotypes occurred by chance.

D The calculated χ^2 value is greater than the critical χ^2 value.

18 An insect collection contains 102 specimens of a species of butterfly. This specimen is sexually dimorphic, meaning that the males and females look different from each other. A student examined the specimens and collected the following data.

Observation	*Frequency*
Blue wing colour (male)	64
Brown wing colour (female)	38
Wing span 35-37 mm	15
Wing span 37-39 mm	68
Wing span 39-41 mm	19

How should this variation be classified?

	continuous	discontinuous
A	sexual dimorphism	colour
B	colour	sexual dimorphism
C	sexual dimorphism	wingspan
D	wingspan	sexual dimorphism

19 In certain breeds of mice, the two allelic pairs, **C/c** and **A/a** are known to regulate the formation of coat colour. Coloured coat is produced in the breed carrying at least one copy of **C** allele and two copies of **a** alleles, whereas agouti coat is produced when the breed carries at least one copy of **C** and **A** alleles. Albino coat is derived from the breed homozygous for c allele.

Which of the following description is valid when two agouti mice heterozygous for both **C** and **A** genes are crossed?

A The expected ratio of agouti mice to coloured mice and to albino mice is 9:6:1.

B The phenotypic effect coded by the allele **A** is masked in the mice homozygous for allele **c**.

C The production of coat colour is regulated sequentially first by gene **A** and then gene **C**.

D Agouti is an intermediate coat colour resulting from the codominant effect between gene **A** and gene **C**.

20 Two separate experiments were conducted to investigate the production of oxygen in photosynthesizing plants.

In experiment 1, an illuminated suspension of photosynthesizing algae *Chlorella* was given carbon dioxide containing a heavy isotope of oxygen, ^{18}O. The amount of radioactively labeled oxygen ($^{18}O_2$) produced from the *Chlorella* suspension was then measured.

The experiment was then repeated but with *Chlorella* suspension given water molecules containing ^{18}O (experiment 2).

The results are shown in the table below.

Time after introducing ^{18}O / min	**Amount of $^{18}O_2$ produced / arbitrary units**	
	Experiment 1 (with $C^{18}O_2$)	**Experiment 2 (with $H_2{}^{18}O$)**
0	0	0
5	0	0.05
10	0	0.24
15	0	0.44
20	0	0.77

Which of the following conclusions can be inferred from the above experimental results?

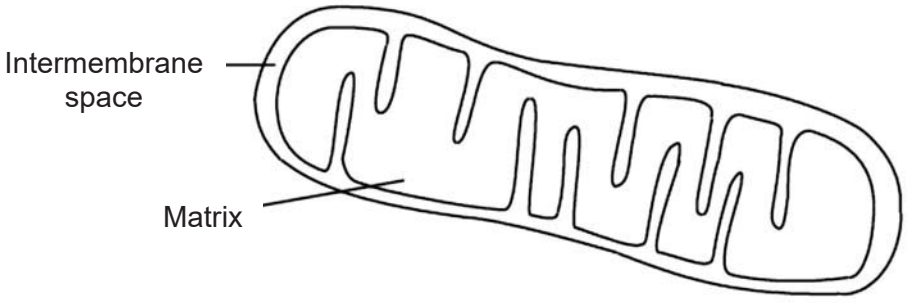
A Oxygen atoms in the carbon dioxide molecule is incorporated into Calvin cycle metabolites and subsequently sucrose molecules produced from photosynthesis.

B Water is the source of oxygen evolved during photosynthesis.

C Oxygen is the final electron acceptor of the non-cyclic photophosphorylation.

D The rate of photosynthesis increases with time.

21 The diagram below shows a mitochondrion as seen under the electron microscope.



What is the advantage of having a small volume inside the inter-membrane space of the mitochondrion?

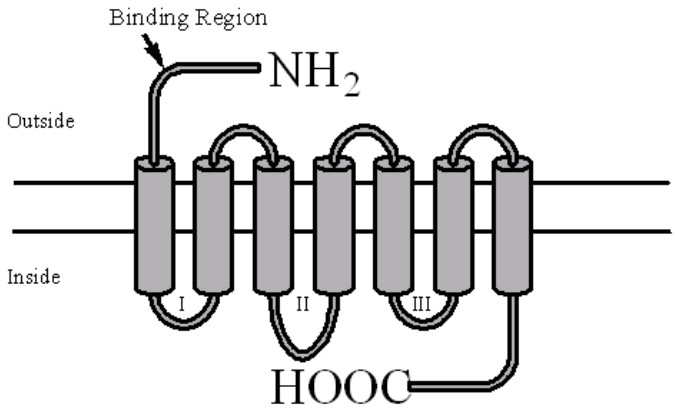
A A high electron concentration is rapidly developed.

B A high proton concentration is rapidly developed.

C Protein electron carriers are highly concentrated.

D ATP synthase is highly concentrated.

22 The figure below shows a protein receptor on a cell membrane.



Which statement correctly describes how this receptor responds upon binding to a ligand?

A It enters the nucleus, undergoes a conformational change and binds to DNA.

B It undergoes a conformational change, enters the nucleus and binds to DNA.

C It undergoes conformational change and binds to G-protein.

D It undergoes dimerisation, and hence a conformational change.

23 Which molecule maintains the fluidity of the cell surface membrane?

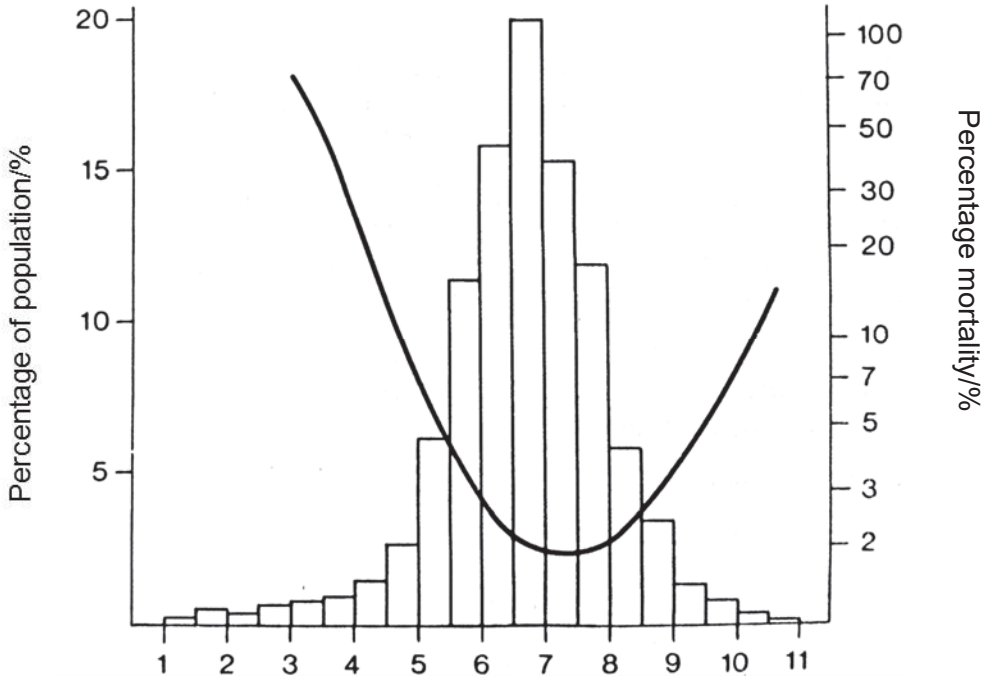
A Cholesterol

B Glycolipid

C Glycoprotein

D Phospholipid

24 The histogram represents the proportions of a population of new-born mammals falling into various birth weight classes. The line graph represents mortality.



From the information given, which conclusion is correct?

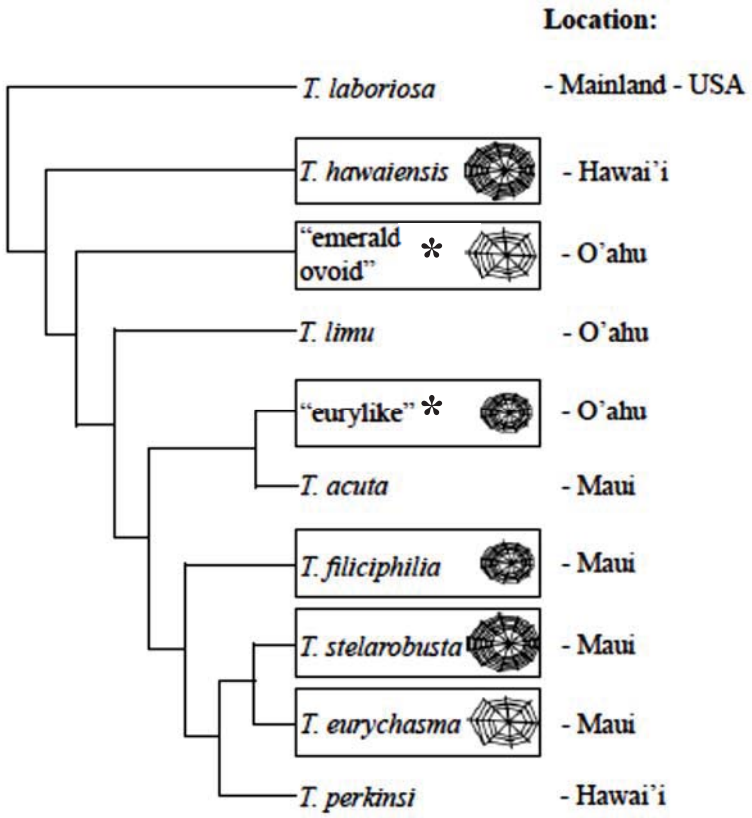
A Birth weight is undergoing stabilising selection.

B Birth weight is an example of discontinuous variation.

C Birth weight is genetically linked to mortality.

D Mortality is undergoing disruptive selection.

25 The cladogram below shows the classification of a group of spiders found on the Hawaiian islands. An asterisk (*) indicates that this species of spider has yet to be assigned a scientific name.



Based on information from the diagram above, deduce which of the following spiders are the most closely related species.

A *T. filiciphilia* and "eurylike"

B *T. hawaiensis* and "emerald ovoid"

C *T. stelarobusta* and *T. eurychasma*

D *T. stelarobusta* and *T. filiciphilia*

26 Calcitonin is a protein hormone found in humans, fish, birds, and mammals. It is 32 amino acids long. The table below shows the amino acid sequence of calcitonin in various organisms and the number of amino acid differences when compared with human calcitonin.

Organism	Amino acid sequence of calcitonin	Number of amino acid differences
Human	CGNLSTCMLGTYTQDFNKFHTFPQTAIGVGAP-NH_2	-
Salmon	CSNLSTCVLGKLSQELHKLQTYPRTNTGSGTP-NH_2	16
Eel	CSNLSTCVLGKLSQELHKLQTYPRTDVGAGTP-NH_2	16
Rat	CGNLSTCMLGTYTQDLNKFHTFPQTSIGVGAP-NH_2	2
Chicken	CASLSTCVLGKLSQELHKLQTYPRTDVGAGTP-NH_2	17

What conclusion can be drawn from the data above?

A Humans and salmon are more closely related than salmon and eel.

B Humans are most closely related to rats.

C Salmon and chicken share a recent common ancestor.

D Salmon and eel are more closely related than salmon and chicken.

27 The following events occur when a phagocyte responds to the presence of a pathogen.

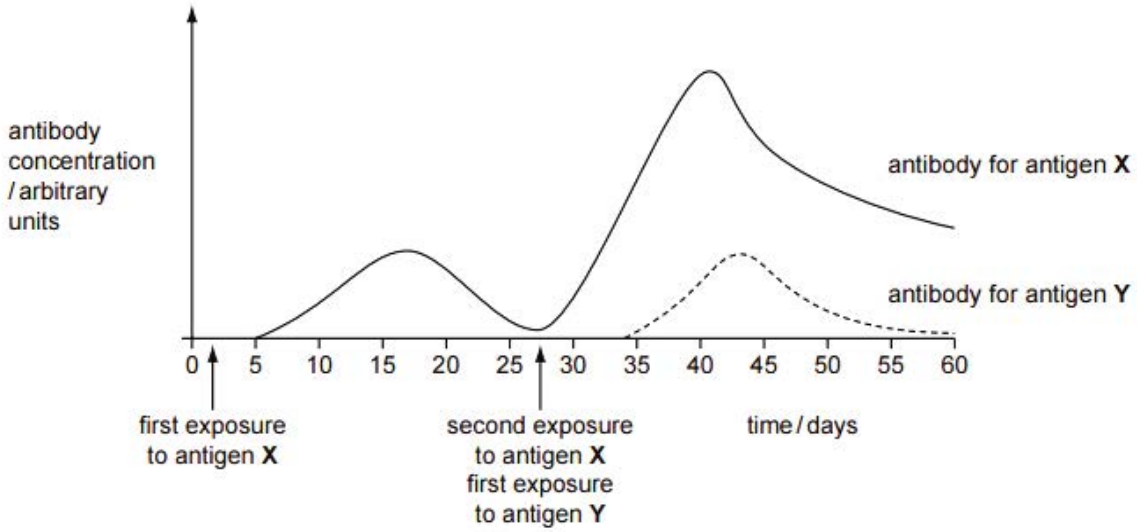
1 endocytosis
2 vesicle formation
3 exocytosis
4 phagocytosis
5 enzymatic digestion

Which is the correct sequence of events?

	first → last			
A	1	5	2	3
B	3	2	5	1
C	4	2	5	3
D	4	5	3	1

28 In an investigation into the immune response, a volunteer was exposed to two different antigens, **X** and **Y**. The relative antibody concentration in the blood was measured at regular intervals over 60 days.

The graph shows the time when the volunteer was exposed to each antigen and the antibody concentration against time for antigens **X** and **Y**.



What is the explanation for the results displayed on the graph?

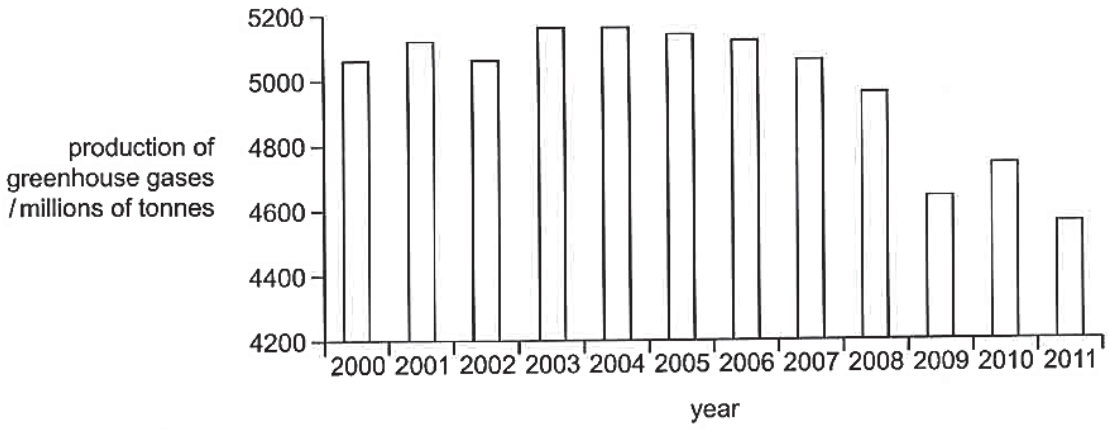
A A primary and secondary immune response against antigen **X** occurred, with the memory B-lymphocytes inhibiting the secondary immune response against antigen **Y**.

B A primary immune response to antigen **Y** occurred and memory B-lymphocytes specific to antigen **Y** enhanced the secondary immune response to antigen **X**.

C Memory B-lymphocytes specific to antigen **X** enabled a secondary immune response to occur; different B-lymphocytes were activated for a primary immune response for antigen **Y**.

D Plasma cells remaining from the first exposure to antigen **X** undergo rapid clonal selection to produce high levels of antibody against antigen **X** and lower levels of antibody against antigen **Y**.

29 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.

30 Rice crops in Japan are damaged by the green rice leafhopper (*Nephotettix cincticeps*), a pest that reduces crop yield.

In a study of the effect of climate change on crop damage by the green rice leafhopper, it was found that an increase in winter temperatures caused an increase in crop damage, while an increase in summer temperatures caused a decrease in crop damage.

Which of the following are possible explanations for these findings?

1 Increased temperatures in the summer cause a rise in metabolic rate that results in the pests reproducing more rapidly.

2 Increased temperatures in the summer raise the metabolic rate above the range that the pests can tolerate.

3 Increased temperatures in the winter disrupt the pests' life cycle and results in fewer being able to reproduce.

4 Increased temperatures in the winter allow more pests to survive and results in an increase in the pest population.

A 1 and 3 only

B 1 and 4 only

C 2 and 3 only

D 2 and 4 only

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INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
in preparation for General Certificate of Education Advanced Level
Higher 2

CANDIDATE NAME			
CLASS		INDEX NUMBER	

BIOLOGY

9744/02

Paper 2 Structured Questions

29 August 2017

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number 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 the brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	/12
2	/14
3	/10
4	/15
5	/13
6	/12
7	/12
8	/12
Total	/100

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

Answer **all** questions.

1 Fig. 1.1 shows a ligand binding to the G protein-coupled receptor (GPCR) which is embedded on the cell surface membrane.

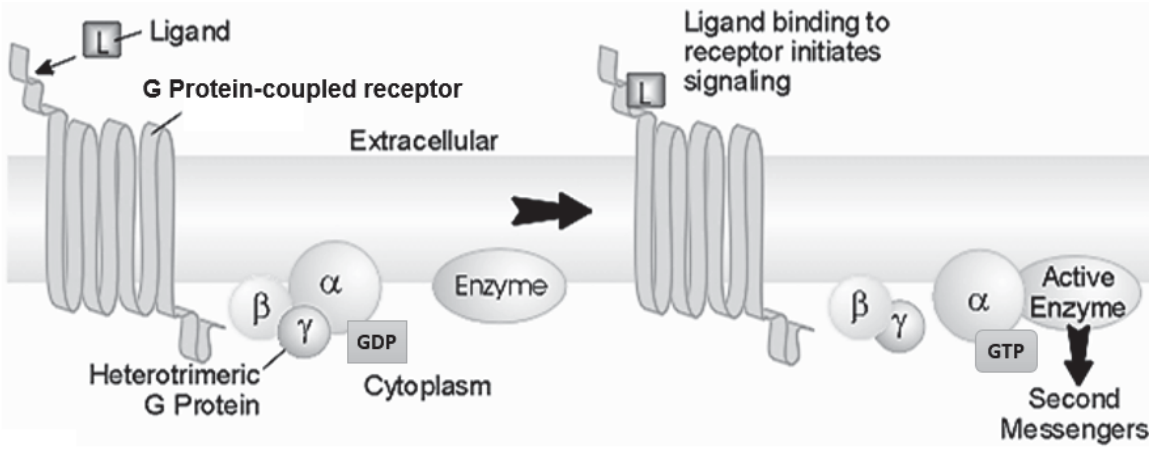

Fig. 1.1

(a) **(i)** Identify the ligand in Fig. 1.1.

.....

.....

[1]

(ii) Explain why ligand mentioned in **(a)(i)** unable to pass through the cell surface membrane.

.....

.....

.....

.....

.....

[2]

(b) With reference to Fig. 1.1, describe what happens when the ligand binds to the GPCR.

.....

.....

.....

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.....

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.....

.....

[3]

(c) With a named example, define “second messengers”.

[2]

(d) Explain how intracellular signal is terminated when ligand is released from the receptor.

[2]

(e) One of the side effects of a particular drug includes non-responsiveness of GPCR to ligands.

Suggest how the drug could have caused such non-responsiveness of GPCR to ligands.

[2]

[Total: 12]

2 Fig. 2.1 is a photomicrograph of plants cells, with some undergoing mitosis.

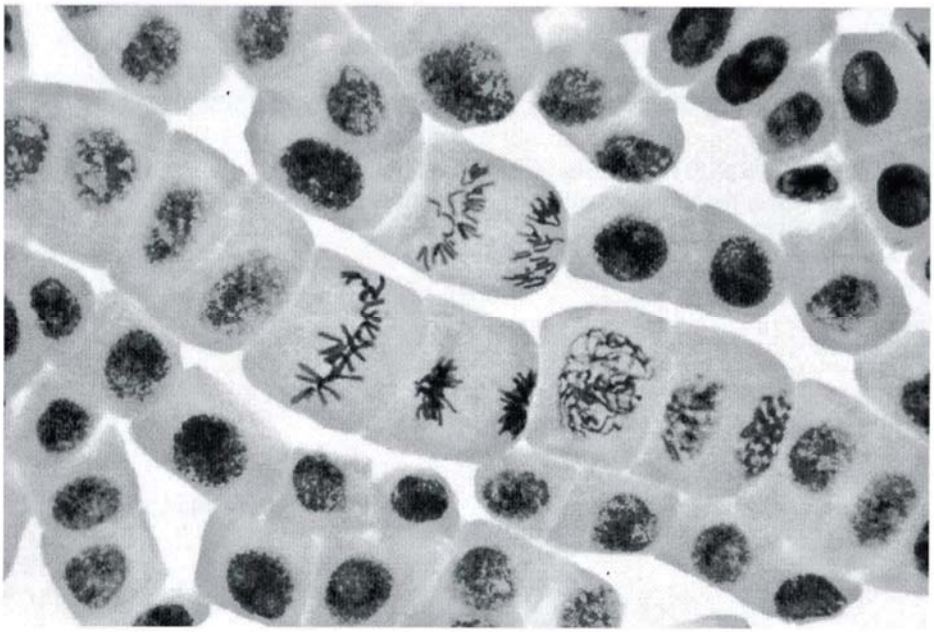


Fig. 2.1

(a) On Fig. 2.1, use labels and label lines to indicate **one** cell in anaphase stage of mitosis. [1]

(b) The longest stage of the mitotic cell cycle, interphase, is divided into three phases, **G1, S** and **G2**.

(i) Describe what happens in the G1 phase.

.....

.....

.....

.....

.....

..... [3]

(ii) There are various checkpoints in the mitotic cell cycle. One of them is present in the G1 phase called the G1 checkpoint.

Describe the function of G1 checkpoint.

.....

.....

.....

..... [2]

(iii) When cell cycle checkpoints are defective, cancer could arise.

With reference to two named genes, outline the development of cancer.

[4]

(c) Stem cells go through mitosis as well. But they go through asymmetrical division, where the fate of the two daughter cells are different.

(i) State the potency level of adult stem cells and their function in our body.

[2]

(ii) Suggest one similarity between stem cells and cancer cells.

[2]

[Total: 14]

3 Pure breeding sweet pea plants with purple flowers and long pollen grains were crossed with pure breeding plants with red flowers and round pollen. All the F_1 plants had purple flowers and long pollen grains. These F_1 plants were then allowed to self-pollinate and the seeds produced were grown.

The following results were obtained in this F_2 generation.

4831	purple flowers and long pollen grains
390	purple flowers and round pollen grains
393	red flowers and long pollen grains
1338	red flowers and round pollen grains

(a) Explain what is meant by the term “pure breeding”.

---

[1]

(b) State the expected phenotypic ratio of the F_2 generation.

---

[1]

(c) Using suitable symbols, draw a genetic diagram to explain the observed results of the F_2 generation.

[5]

(d) Suggest how similar crossing experiments with many different pairs of characters could be used to map the position of genes on the chromosomes of sweet pea plants.

[3]

[Total: 10]

4 Fig. 4.1 shows the life-cycle of *Aedes aegypti*, which are often vectors of viral diseases like dengue fever, chikungunya and yellow fever.

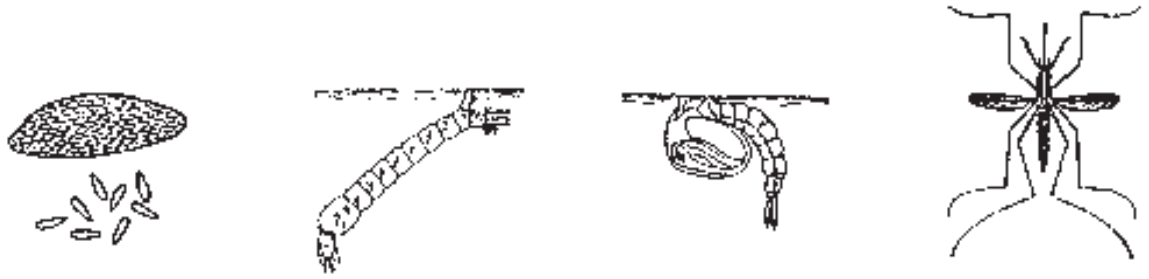


Fig. 4.1

(a) With reference to Fig. 4.1, name the four stages in a *Aedes aegypti* life-cycle.

---

[2]

(b) The following is an extract from an article *"Record 2,441 dengue cases reported in Singapore for January"* published on Singapore's The Straits Time website on 2nd Feb 2016.

"SINGAPORE - A total of 636 dengue cases were reported for the week of Jan 24 to 30 - the same number as the previous week - according to the latest figures released by the National Environment Agency (NEA) on Tuesday (Feb 2).

This brings the total number of cases for the first four weeks of the year to 2,441, an unusually high number for January given that it is traditionally the low season for dengue."

Fig. 4.2 shows the weekly number of dengue cases in Singapore from 2013 to 2016

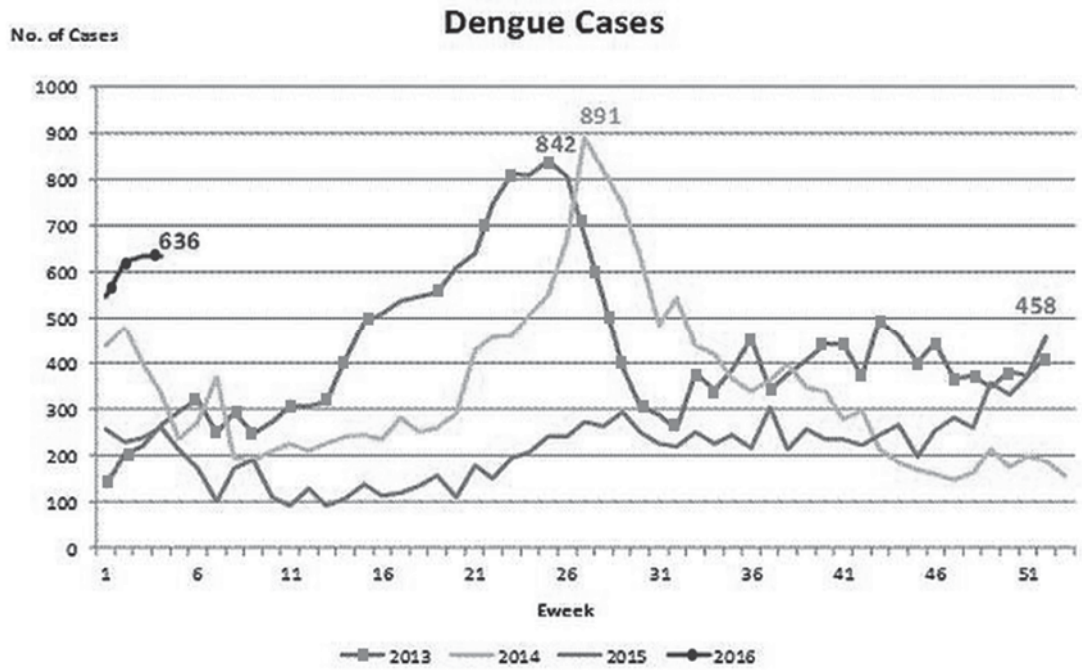


Fig. 4.2

(i) With reference to Fig. 4.2, describe the general trend in dengue cases in 2013.

.....

.....

.....

..... [2]

Fig. 4.3 shows average monthly temperature in Singapore in Year 2013.

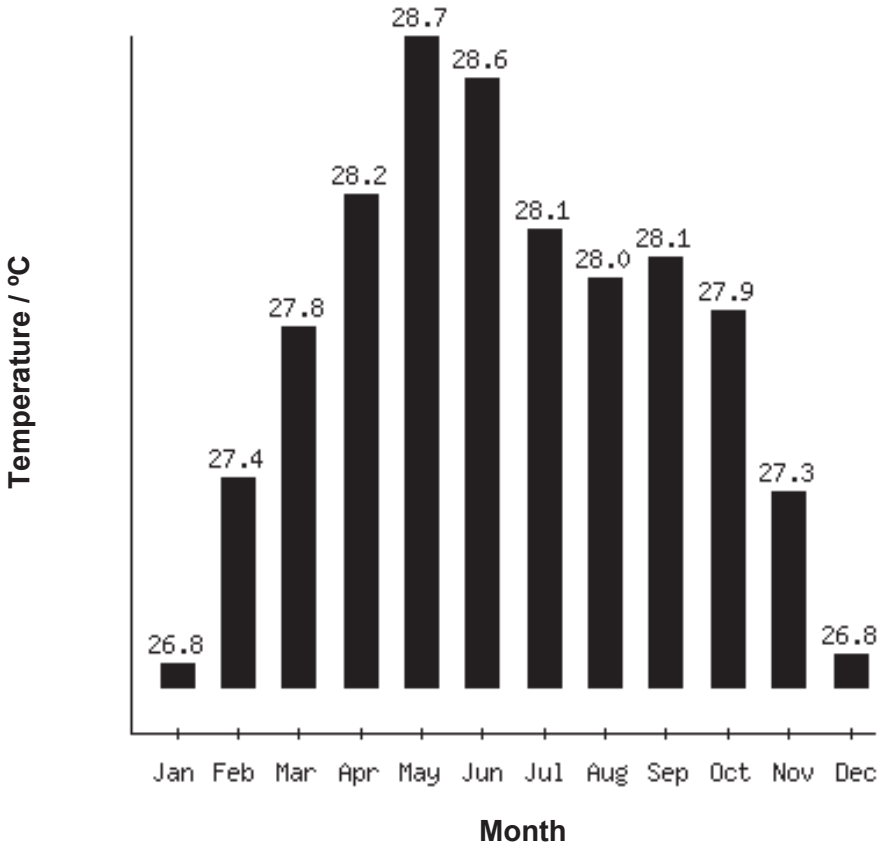


Fig. 4.3

(ii) With reference to Fig. 4.3, describe the temperature trend in Singapore in 2013.

.....

.....

.....

..... [2]

(iii) With reference to both Fig. 4.2 and 4.3, account for the relationship between temperature and dengue cases in Singapore in 2013.

.....

.....

.....

.....

.....

..... [3]

(c) Fig. 4.4 is a diagram of a dengue virus.

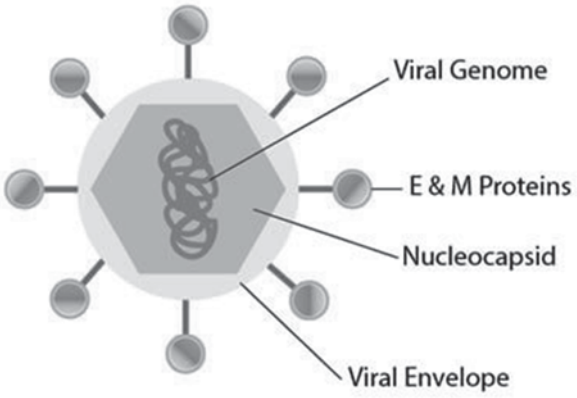


Fig. 4.4

(i) Describe the viral genome of dengue virus.

.....

..... [1]

(ii) The dengue virus and influenza virus are quite similar in terms of their structure and reproductive cycle.

Describe one structural similarity between dengue virus and influenza virus.

.....

..... [1]

(iii) Compare the reproductive cycles of dengue virus and influenza virus.

Giving one difference and two similarities.

Difference: .....

.....

Similarities: .....

.....

.....

..... [3]

(iv) Currently, there are no specific antiviral drugs for the treatment of dengue fever, due to the prevalence of drug resistance in dengue viruses.

Suggest one reason how drug resistance can arise in dengue viruses.

.....

..... [1]

[Total: 15]

For Examiner's Use

5 Fig. 5.1 and 5.2 are diagrams showing transcription and translation.

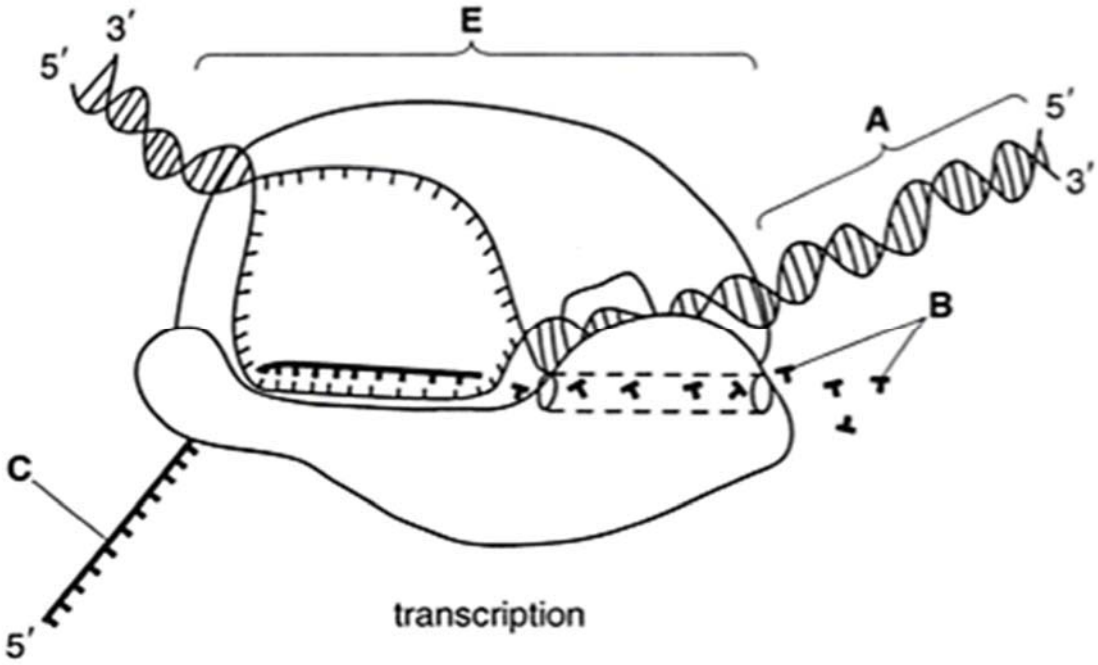


Fig. 5.1

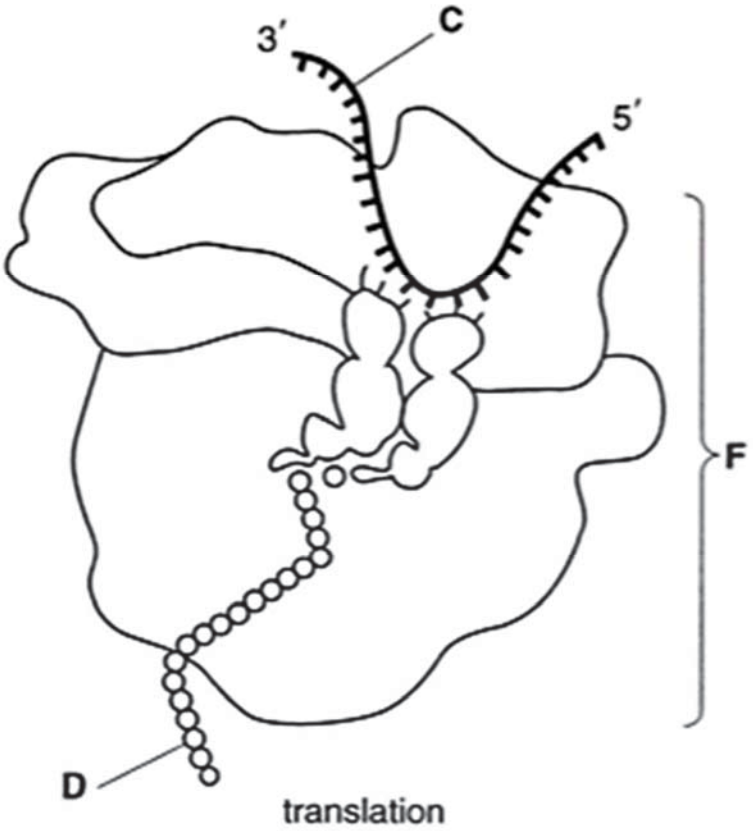


Fig. 5.2

(a) Identify the structures **A** to **C**.

A: .....

B: .....

C: ..... [3]

(b) Describe what happens to **D** after it is being synthesized to form a functional product.

.....

.....

.....

..... [2]

(c) Describe three ways in which the process of transcription differs from translation.

.....

.....

.....

.....

.....

..... [3]

(d) Briefly describe how the structure of **F** differs from the structure **E**.

.....

.....

.....

..... [2]

(e) Fig. 5.3 shows a proteasome degrading a protein.

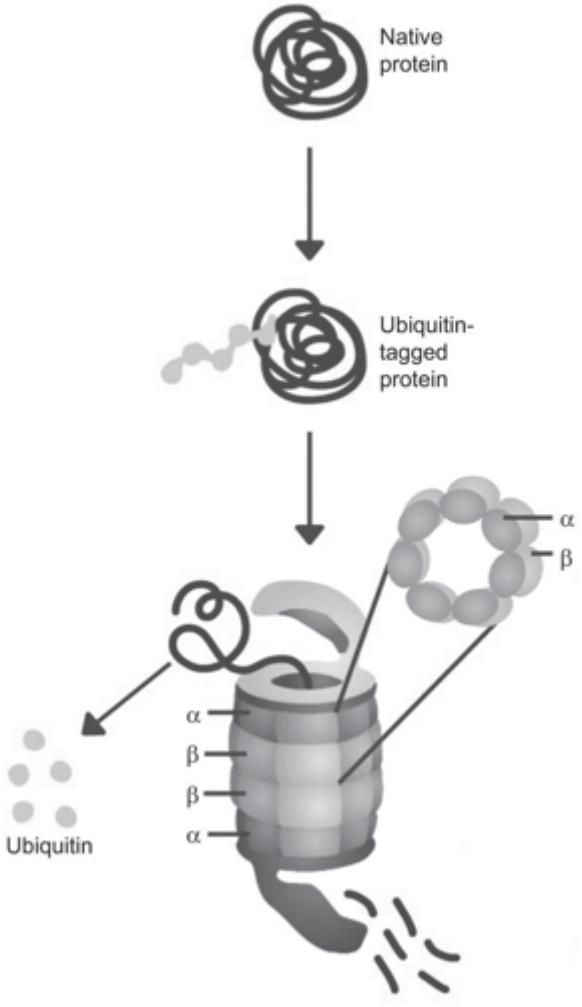


Fig. 5.3

With reference to Fig. 5.3, describe what happens during proteasomal degradation of proteins.

[3]

[Total: 13]

6 The marine threespine sticklebacks, *Gasterosteus aculeatus* is a freshwater fish living in the lakes of British Columbia, Canada as shown in Fig. 6.1.

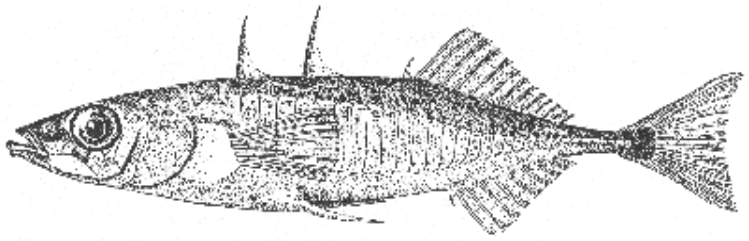


Fig. 6.1

In order to investigate the process of speciation in these populations, three small lakes were studied. Each lake contained two varieties of stickleback: a large, bottom-dwelling variety that fed on invertebrates near the shore and a small, plankton-eating variety that lived in the open water. The probability of breeding between pairs of individuals was measured under laboratory conditions in the following breeding combinations:

I	different varieties from the same lake
II	different varieties from different lakes
III	same variety from different lakes
IV	same variety from the same lake

The data are summarized in Fig. 6.2 below.

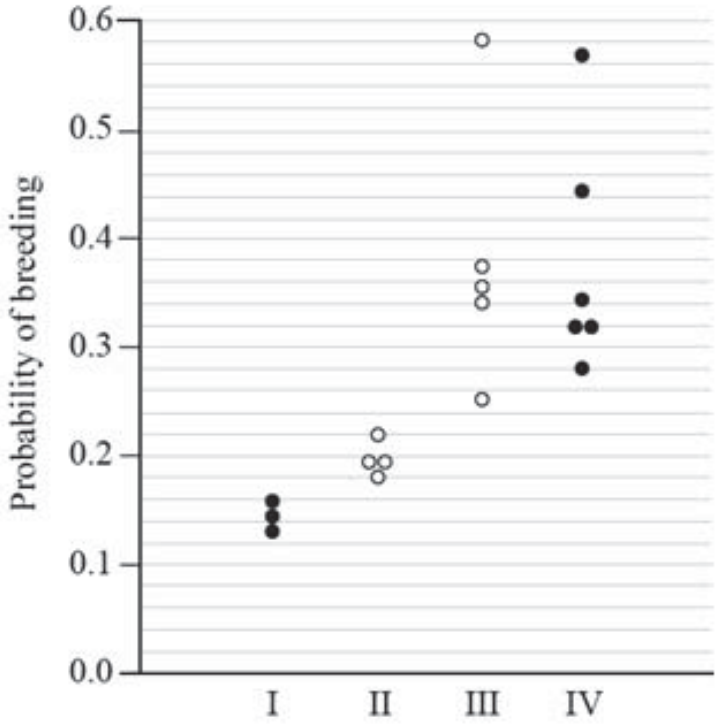


Fig. 6.2

(a) With reference to Fig. 6.2,

(i) identify the highest and lowest probabilities of breeding for individuals of the same variety;

[1]

(ii) describe the differences in probability of breeding between individuals from different lake;

[2]

(iii) describe the evidence that speciation is taking place in these populations and explain the type of speciation;

[3]

(iv) explain why all the individuals are still considered the same species.

[2]

(b) The freshwater lakes also contain many different types of parasites that infect the different varieties of marine threespine sticklebacks.

Explain why these parasites enable speciation of the marine threespine sticklebacks to occur.

[4]

[Total: 12]

7 Fig. 7.1 shows how innate immune system protects the body against pathogens.

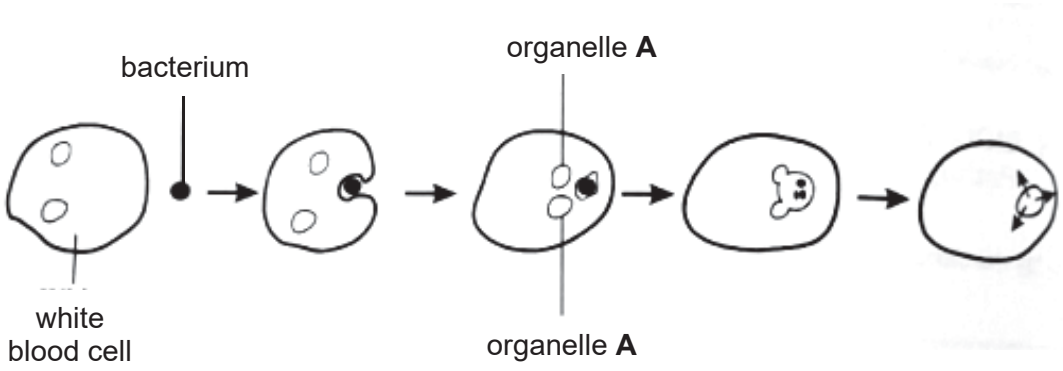


Fig. 7.1

(a) With reference to Fig 7.1,

(i) state the name of the white blood cell and organelle **A**.

.....

..... [1]

(ii) describe the role of organelle A in the defence against pathogen.

.....

.....

.....

..... [2]

It is found that ingested *Mycobacterium tuberculosis (M. tuberculosis)* is able to survive within the macrophage and cause tuberculosis in humans.

Bacillus Calmette–Guérin (BCG) is a vaccine primarily used against tuberculosis. It consists of live attenuated bacteria. In countries where tuberculosis is common, one dose is recommended in healthy babies as close to the time of birth. Babies with HIV/AIDS should not be vaccinated.

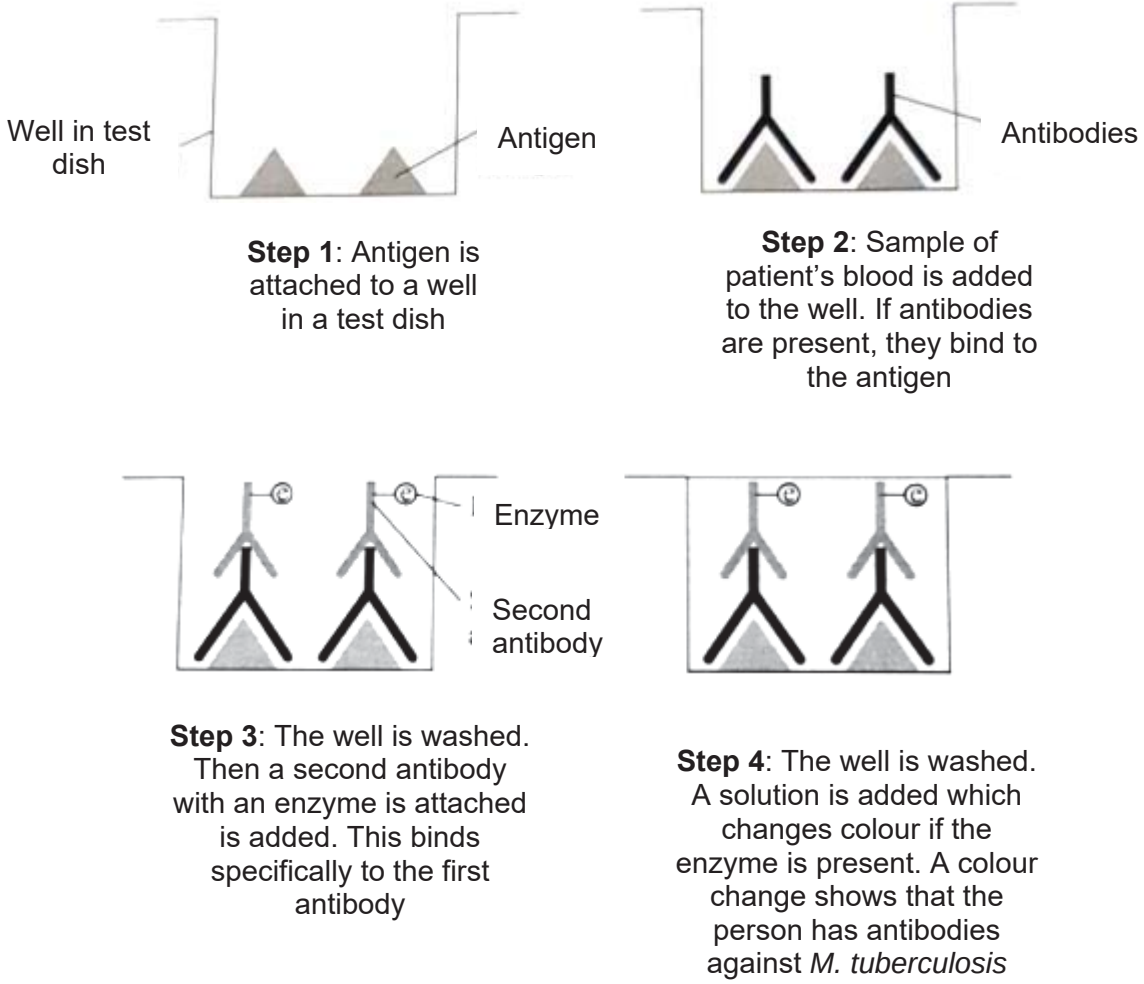
(b) (i) Explain how BCG vaccination provides long term immunity against tuberculosis.

[4]

(ii) Suggest why babies with HIV/AIDS should not be vaccinated.

[1]

A test as shown in Fig. 7.2 has been developed to find if a person has antibodies against *M. tuberculosis.*



Step 1: Antigen is attached to a well in a test dish

Step 2: Sample of patient's blood is added to the well. If antibodies are present, they bind to the antigen

Step 3: The well is washed. Then a second antibody with an enzyme is attached is added. This binds specifically to the first antibody

Step 4: The well is washed. A solution is added which changes colour if the enzyme is present. A colour change shows that the person has antibodies against *M. tuberculosis*

Fig. 7.2

(c) Predict and explain if the color of the solution will change if the patient is infected with influenza virus.

[4]

[Total: 12]

8 Corals are simple marine animals and usually exist in colonies of thousands of individuals. Zooxanthellae are group of unicellular algae that can photosynthesize. They live within cells if the coral and have a symbiotic relationship.

Corals absorb calcium carbonate from the sea to build their skeletons which provides structural support. Coral reefs provide home for about 25% of known fish species.

Corals are sometimes mistaken for members of plant kingdom.

(a) State one way in which coral cells differ from plant cells

---

--- [1]

Coral reefs are at risk of damage by human activities. A study was conducted to see the effects of climate change on coral reefs.

Coral reef sites were subjected to two different environmental conditions i.e. exposed site and sheltered site. Coral reefs in exposed site was exposed to climate change environmental conditions. Coral reefs in the sheltered site was exposed to normal environmental conditions.

Table 8 shows coral cover area at exposed and sheltered sites.

Table 8

Experimental site		Area of healthy coral reef/m^2	Average area of healthy coral reef/m^2
Exposed Site	Site 1	120	
	Site 2	100	
	Site 3	150	
Sheltered Site	Site 1	82	
	Site 2	75	
	Site 3	69	

(b) With reference to Table 8,

(i) complete Table 8 by calculating the average area of healthy coral reef in exposed and sheltered site. Show your working below.

[1]

(ii) conduct a *t*-test on the given data and determine if the difference in mean area of healthy coral reef in exposed and sheltered site are statistically significant.

standard deviation $s = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}}$

t-test $t = \frac{|\bar{x}_1 - \bar{x}_2|}{\sqrt{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}}$ $\nu = n_1 + n_2 - 2$

Key to symbols

s* = standard deviation $\sum$ = 'sum of' $\bar{x}$ = mean

n = sample size (number of observations) x = observation

ν = degrees of freedom

t Table

cum. prob	$t_{.50}$	$t_{.75}$	$t_{.80}$	$t_{.85}$	$t_{.90}$	$t_{.95}$	$t_{.975}$	$t_{.99}$	$t_{.995}$
one-tail	0.50	0.25	0.20	0.15	0.10	0.05	0.025	0.01	0.005
two-tails	1.00	0.50	0.40	0.30	0.20	0.10	0.05	0.02	0.01
df									
1	0.000	1.000	1.376	1.963	3.078	6.314	12.71	31.82	63.66
2	0.000	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925
3	0.000	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841
4	0.000	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604
5	0.000	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032
6	0.000	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707
7	0.000	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499
8	0.000	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355
9	0.000	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250
10	0.000	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169

[4]

(ii) Explain two ways how climate change damages coral reefs.

[6]

[Total: 12]

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INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
in preparation for General Certificate of Education Advanced Level
Higher 2

CANDIDATE NAME			
CLASS		INDEX NUMBER	

BIOLOGY

9744/03

Paper 3 Long Structured and Free-response Questions

11 September 2017

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number 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 A
Answer **all** questions in the spaces provided on the Question Paper.

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

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

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

For Examiner's Use	
Section A	
1	/25
2	/25
Section B	
3 OR 4	/25
Total	/75

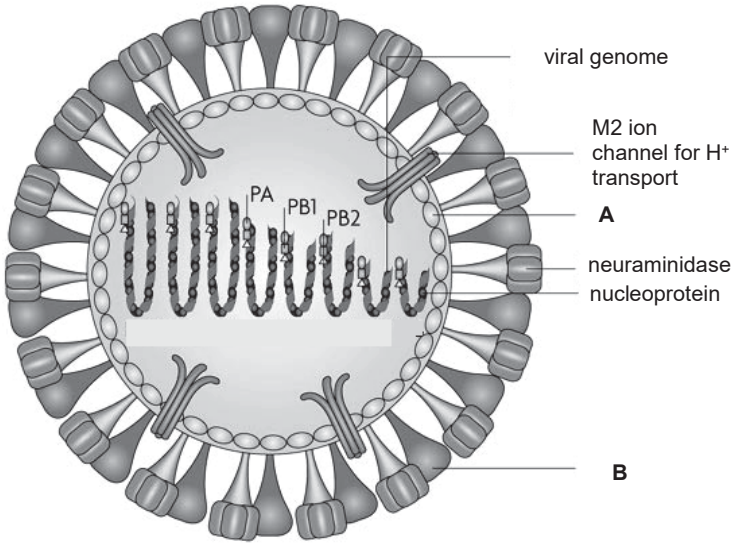
This document consists of **18** printed pages.

For Examiner's Use

Section A

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

1 Fig. 1.1 shows the influenza virus.



Legend
PA, PB1, PB2 are RNA polymerases

Fig. 1.1

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

A .....

B ..... [2]

(ii) Explain why the influenza virus needs its own RNA polymerase.

.....

.....

.....

..... [2]

For Examiner's Use

(b) With reference to B and T cells, describe the adaptive immune response upon primary exposure to influenza virus.

[5]

(c) Vaccine for influenza is readily available in many countries including Singapore. It is advised that members of the public get vaccinated yearly.

(i) Describe the benefits of vaccination.

[3]

(ii) Describe what happens when a person vaccinated for influenza is subsequently infected with the same strain.

[2]

For Examiner's Use

(iii) Explain why yearly vaccination is recommended for influenza.

.....

.....

.....

..... [2]

Doctors sometimes prescribe antibiotics to patients who are infected by influenza to combat secondary bacterial infections. Gramicidin A is an example of an antibiotic. Fig. 1.2 shows the molecular structure of Gramicidin A.

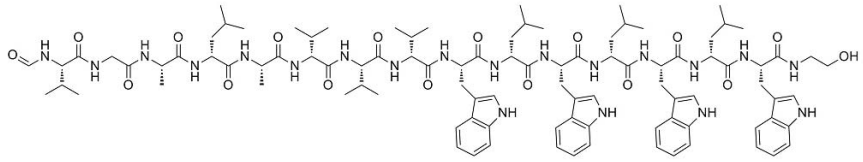


Fig. 1.2

(d) Illustrate the reaction that forms the peptide bonds between two amino acids.

[2]

For Examiner's Use

Gramicidin A folds into a 3-dimensional configuration that inserts itself into the bacterium's cell surface membrane. It allows non-specific movement of ions which eventually cause the bacterial cell to die. Fig. 1.3 shows the interaction of Gramicidin A with the bacterium's cell surface membrane.

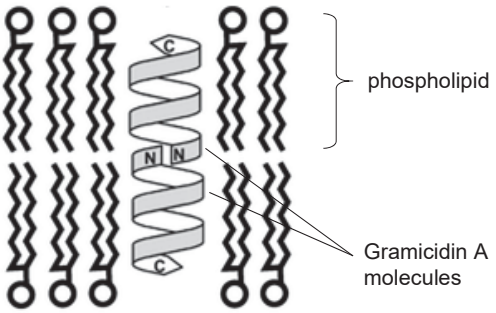


Fig. 1.3

(e) **(i)** Describe how the Gramicidin A shown in Fig. 1.2 folds into the 3-dimensional structure shown in Fig. 1.3.

.....

.....

.....

..... [2]

(ii) Using the information provided and Fig. 1.3, explain how Gramicidin A kills the bacterium.

.....

.....

.....

..... [2]

For Examiner's Use

(f) Upon prescription of antibiotics, doctors often advise patients to complete the course of antibiotics even if symptoms of disease have ceased. One of the reasons cited was that not completing the course of antibiotics may increase the chance of antibiotic resistant bacteria to evolve.

With reference to natural selection, explain the basis for the need to complete the prescribed course of antibiotic.

.....

.....

.....

.....

.....

..... [3]

[Total: 25]

For Examiner's Use

2 A researcher investigated the pathway by which carbon dioxide is converted to organic compounds during photosynthesis. The apparatus used is shown in Fig. 2.1.

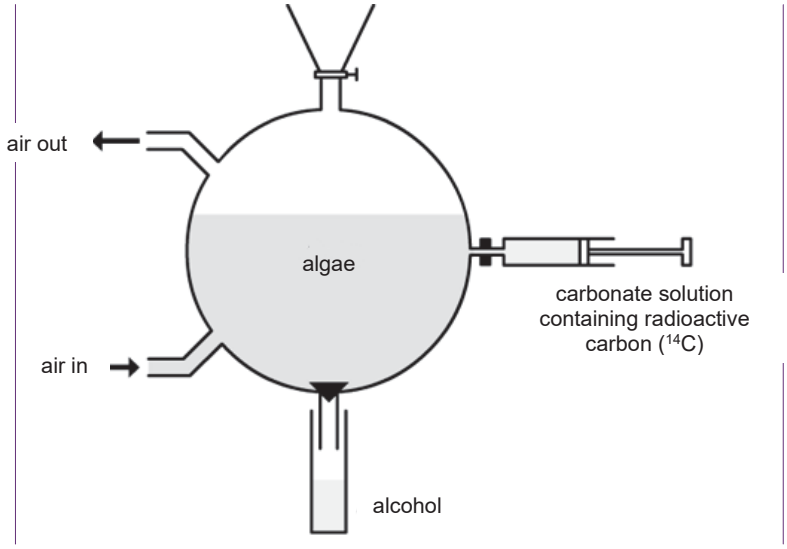


Fig. 2.1

While the apparatus was in the dark room, the researcher supplied the algal cells with $^{14}CO_2$. The contents of the apparatus were thoroughly mixed and light was switched on subsequently. At five-second intervals, a few of the cells were released into hot alcohol, which killed the cells very quickly. The intermediates of the reactions were subsequently analysed and the chromatograms in Fig. 2.2 showed the results of the analysed intermediates by chromatography (a separation technique) at different timings.

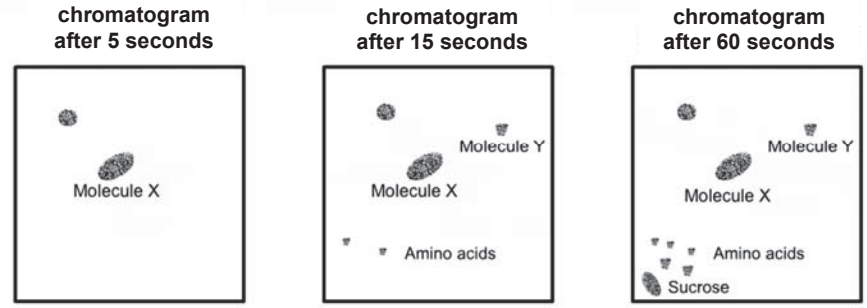


Fig. 2.2

(a) (i) Identify molecules **X** and **Y**.

X .....

Y ..... [2]

Commented [A1]: need to have an "air out" textbox? ok

Commented [A2]: Need to explain what chromatogram is? Are students expected to know chromatographic separation? This similar question also appeared in our PS tutorial. Also chromatogram is taught in Chem?

For Examiner's Use

(ii) Explain your answer in part **(i)**.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(iii) Explain why sucrose and amino acids are identified in the chromatogram only after 60 seconds.

.....

..... [1]

Commented [A3]: To give then idea that these molecules are synthesized later? So with the word only here will suffice?

Dinitrophenol is a metabolic poison that can embed within the thylakoid membranes of chloroplasts and provide an alternate route for H^+ to diffuse across the thylakoid membranes.

(b) Explain how the concentration of intermediates of the Calvin cycle is affected by dinitrophenol.

.....

.....

.....

.....

.....

..... [3]

For Examiner's Use

Another experiment was carried out by another student to determine the concentration of carbon dioxide in the leaves of plants at different times of the day. The results are shown in Table 2.3

Table 2.3

Mean carbon dioxide concentration (ppm)	
8pm to 4am	8am to 4pm
328	106

(c) Using knowledge on Calvin cycle and Krebs cycle, account for the difference in concentration of carbon dioxide in the leaves for the two periods shown in Table 2.3.

[4]

(d) Explain the effect of higher concentration of carbon dioxide on the rate of carbon fixation during the period 8am to 4pm.

[2]

For Examiner's Use

Studies were carried out on soil-dwelling aerobic and anaerobic bacteria. Samples were taken from different depths at intervals of one month and six months after the soil was put into a large heap for storage.

Table 2.4 shows the numbers of aerobic and anaerobic bacteria at different depths in the stored soil.

Table 2.4

depth in soil store / m	mean number of bacteria per gram of stored soil $\times 10^7$			
	aerobic bacteria		anaerobic bacteria	
	after one month	after six months	after one month	after six months
0.0	12.4	12.5	0.4	0.6
0.5	10.1	8.3	0.6	1.0
1.0	9.8	5.9	0.8	3.8
1.5	9.7	3.1	0.8	7.6
2.0	10.5	0.8	0.7	8.1
2.5	10.8	0.7	0.8	8.5
3.0	10.2	0.9	0.6	8.8

(e) **(i)** Account for the trends shown by the distribution of the two types of bacteria after six months.

[3]

(ii) Suggest how aerobic bacteria are structurally adapted for cellular respiration.

[2]

For Examiner's Use

In a further study, soil samples were taken at two depths, **A** and **B**, in the soil store. The samples were taken at intervals over six years. Soil samples of equal mass were used to determine the activity of dehydrogenases in aerobic bacteria.

Commented [A4]: Students may be confused as bacteria do not have mito. They may wonder why Krebs cycle is still possible. So remove 'Krebs cycle'?

Fig. 2.5 shows the mean dehydrogenase activity of the bacteria in these samples.

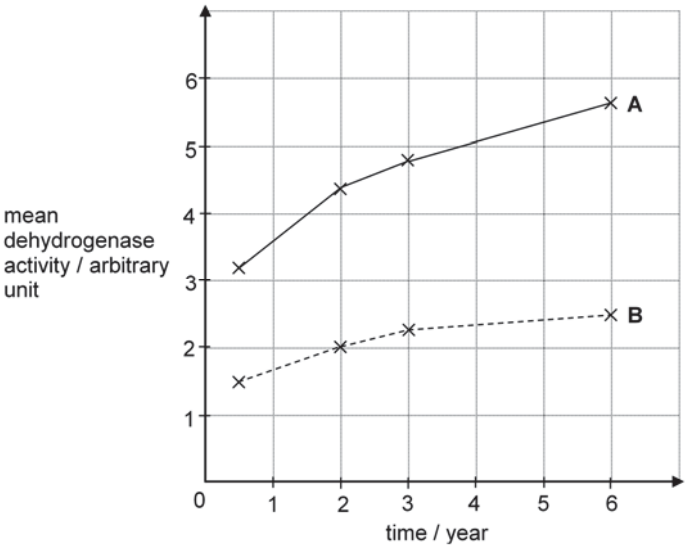


Fig. 2.5

(f) **(i)** State with evidence from Fig. 2.5 which depth, **A** or **B**, were samples taken from a greater depth.

.....

.....

.....

..... [2]

(ii) Explain the roles of dehydrogenase in Krebs cycle of the aerobic bacteria.

.....

.....

.....

..... [2]

[Total: 25]

For Examiner's Use

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), (b), etc., as indicated in the question.

3 **(a)** Greenhouse gases are key contributors to climate change affecting animals and plants in the environment they live in.

Discuss the effects of climate change in the global environment. [13]

(b) After viruses infect host organisms, they are able to make use of host cell machinery to replicate and reproduce thereby causing diseases in the host organism.

Describe how dengue causes viral disease in humans. [12]

[Total: 25]

Commented [A5]: what is the expected answer? the pathology of infection ? Yes. Perhaps change to "Describe how dengue causes viral disease in human"

4 **(a)** Effector molecules are responsible for the regulation of transcriptional units in prokaryotes.

Using named examples, explain the roles of these effector molecules in the negative feedback regulation of transcriptional unit in a prokaryote such as *Escherichia coli.* [12]

Commented [A6]: Should we state "using a named example"? Ok.

(b) Protein production in eukaryotes is controlled at all stages of the process.

Explain how protein production is controlled in eukaryotes and the advantages of regulating protein production at different stages [13]

[Total: 25]

Commented [A7]: do the students know about the advantage at each stage? **This is a question from specimen paper. Hence, need to let them know.**

[WMY] The MS only requires advantage from any 4 stages. Kind of misleading hor? Yes it is. Still can right?

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INNOVA JUNIOR COLLEGE
JC 2 MID YEAR EXAMINATION
in preparation for General Certificate of Education Advanced Level
Higher 2

BIOLOGY

9744/04

Paper 4 Practical

17 August 2017

Confidential Instructions

2 hours 30 minutes

Great care should be taken to ensure that any confidential information, including the identity of material on microscope slides where appropriate, does not reach the candidates either directly or indirectly.

This document consists of **4** printed pages

Question 1

Preparation List

SN	Apparatus/ Reagents / Chemicals	Quantity per student
1	5 cm^3 syringes	1
2	1 cm^3 syringe	3
3	dropper	1
4	container / beaker labelled **For washing**	1
5	test-tubes	7
6	test-tube rack	1
7	50 cm^3 beaker	2
8	glass rod	1
9	white paper (as background for visualising colour)	1 sheet
10	stop watch	1
11	marker pen	1
12	safety goggles	1
13	distilled water, labelled **E**	5 cm^3
14	10% glucose, labelled **S1**	10 cm^3
15	2%, 4%, 6%, 8%, 10% glucose, labelled **G1, G2, G3, G4, G5**	5 cm^3 each
16	1M H_2SO_4, labelled **A**	10 cm^3
17	0.01% $KMNO_4$, labelled **P**	5 cm^3
18	distilled water, labelled **W**	10 cm^3

.

Instructions for preparation

To prepare **E**

Provide distilled water, labelled **E**.

To prepare **S1**

10 % glucose solution, labelled **S1**.

This is prepared by dissolving 10 g of glucose in 75 cm^3 of distilled water and making up to 100 cm^3 with distilled water.

To prepare **G1 – G5**

2%, 4%, 6%, 8%, 10% glucose, labelled **G1 – G5**.

G1 is prepared by dissolving 2 g of glucose in 75 cm^3 of distilled water and making up to 100 cm^3 with distilled water.

G2 is prepared by dissolving 4 g of glucose in 75 cm^3 of distilled water and making up to 100 cm^3 with distilled water.

G3 is prepared by dissolving 6 g of glucose in 75 cm^3 of distilled water and making up to 100 cm^3 with distilled water

G4 is prepared by dissolving 8 g of glucose in 75 cm^3 of distilled water and making up to 100 cm^3 with distilled water.

G5 is prepared by dissolving 10 g of glucose in 75 cm^3 of distilled water and making up to 100 cm^3 with distilled water

To prepare **A**

1 mol dm^{-3} sulfuric acid, labelled **A**.

This is prepared from (98%) sulfuric acid by adding 55 cm^3 of the sulfuric acid to 500 cm^3 of distilled water and making up to 1 dm^3 with distilled water

This is an exothermic reaction, **add the acid to the water**.

To prepare **P**

0.01% potassium permanganate, labelled **P**.

This is prepared by dissolving 1.0 g of potassium permanganate in 100 cm^3 of distilled water. Then take 1 cm^3 of this solution and add to 99 cm^3 of distilled water.

Sulfuric acid is **harmful** and **corrosive;** potassium permanganate is **harmful** and should be disposed of with care to the environment.

It is advisable to wear safety glasses/goggles when handling these chemicals.

E, **S1** and **P** can be made up the day before the examination and stored in a refrigerator.
However, these must be at room temperature for the examination.

Question 2

Preparation List

SN	Apparatus/ Reagents / Chemicals	Quantity per student
1	light microscope with an eyepiece graticule, set up on **low power** objective lens	1
2	stage micrometer	1
3	Prepared slide of young root tip e.g. *Allium*, labelled **K1**	1

INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
in preparation for General Certificate of Education Advanced Level
Higher 2

CANDIDATE NAME

CLASS

INDEX NUMBER

BIOLOGY

9744/04

Paper 4 Practical

17 August 2017

2 hours 30 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name and class 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 on both sides of the paper.
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 in the Question Paper.

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

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

Shift
Laboratory

For Examiner's Use	
1	/24
2	/17
3	/14
Total	/55

Answer **all** questions

1 The enzyme **E** catalyses the hydrolysis of sucrose to produce fructose and glucose.

The products of the hydrolysis of sucrose will reduce potassium permanganate from purple to colourless as follows:

purple ⟶ colourless

You are required to investigate the effect of sucrose concentration on the progress of this enzyme-catalysed reaction by finding the time taken for the decolourization of potassium permanganate.

You are provided with

- 1% enzyme solution, labelled **E**
- 10% sucrose solution, labelled **S1**
- 2%, 4%, 6%, 8%, 10% glucose solution, labelled **G1 – G5**
- 1 mol dm^{-3} sulfuric acid, labelled **A**
- 0.01% potassium permanganate solution, labelled **P**
- distilled water labelled, **W**

☠**Sulfuric acid and potassium permanganate are harmful.**
If any comes into contact with your skin wash immediately under cold water.
It is recommended that you wear safety goggles.

Proceed as follows:

1 Prepare an appropriate volume of 5% sucrose and label it **S2**.

2 Put 1 cm^3 of **A** into a test-tube.

3 Add 1 drop of **P** into the same test-tube. Gently shake to mix.

4 Add 1 cm^3 of **G1** to the test-tube. Start the stopwatch.

5 Record the time taken for **P** to decolourise in step **12**.

6 Repeat step **2** to **5** for **G2** to **G5**. You may perform the test simultaneously.

7 Put 5 cm^3 of **S1** into a small beaker.

8 Add 1 cm^3 of **E** into the small beaker containing **S1**.

9 Stir to mix the solutions. Allow the reaction to take place for 2 minutes.

10 Perform step **2** to **5** for reaction mixture of **E** and **S1**.

11 Repeat step **7** to **10** for **S2** you have prepared in step **1**.

12 Record your data in a suitable format in the space provided below. If **P** does not decolourise, record 'more than 600'.

[5]

(a) **(i)** Using your results in step **12**, estimate the concentration of reducing sugar in the reaction mixture with

S1 ..... [1]

S2 ..... [1]

(ii) With reference to enzyme action, explain your observations for **S1** and **S2**.

.....

.....

.....

..... [2]

(b) Describe a suitable control for this investigation.

.....

.....

..... [2]

(c) Identify **two** significant sources of error in this investigation.

.....

.....

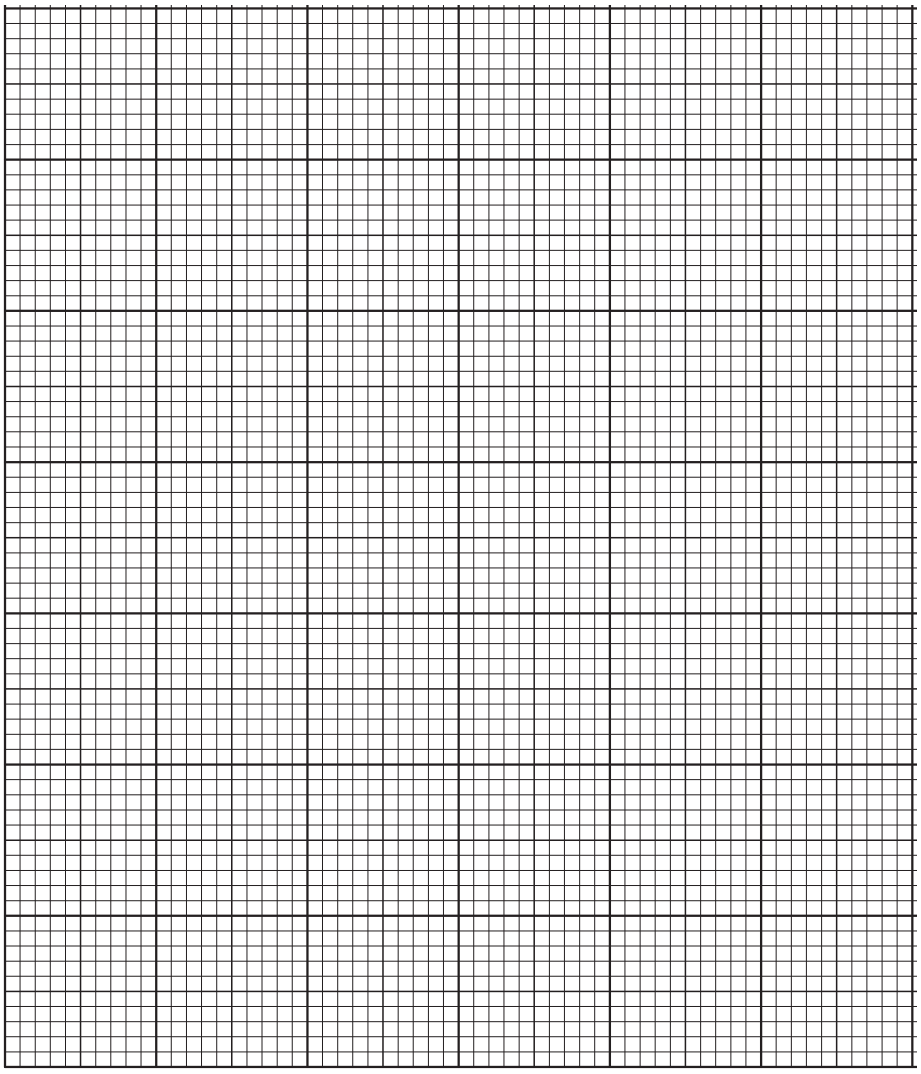
..... [2]

(d) Table 1.1 shows the results for a similar investigation which measured the mass of reducing sugars produced over a period of 400 seconds.

Table 1.1

time / s	mass of reducing sugars / mg ml^{-1}
60	0.32
120	0.64
180	0.95
300	1.55
400	2.05

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



[4]

(ii) Using your graph, find the rate of hydrolysis of the sucrose.
Show on your graph where you took the readings to calculate the rate. [1]

Show all working in your calculation.

rate of enzyme activity ..... [1]

(iii) Describe how results shown in Table 1.1 can be obtained if you are provided with Benedict's solution, 3 mg ml^{-1} reducing sugar solution and a colorimeter.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

[Total: 24]

2 **K1** is a stained, longitudinal section of a young root tip.

Use your microscope to examine carefully the regions labelled **X** and **Y** in Fig. 2.1.

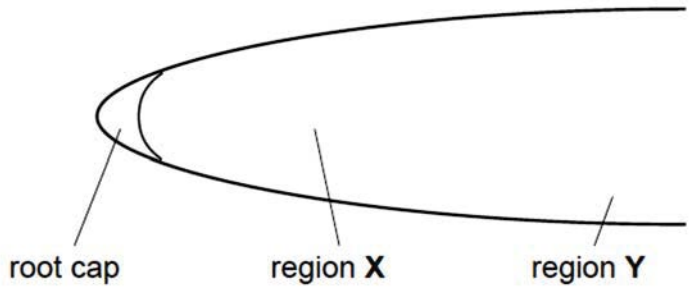


Fig 2.1

(a) Make a large, labelled, high-power drawing of a single cell at

(i) metaphase

Magnification =

[3]

(ii) anaphase

Magnification =

[3]

(b) **(i)** Using the eyepiece graticule fitted in the eyepiece lens of your microscope, state the objective lens you are using and the number of eye piece divisions equivalent to length of the cell you have drawn in **(a)(i)** and **(ii)**.

objective lens .....

number of eyepiece graticule divisions for **(a)(i)** = ... [1]

number of eyepiece graticule divisions for **(a)(ii)** = ... [1]

(ii) Using the stage micrometer, determine the length of one division on your eyepiece graticule at the objective stated in **(b)(i)**.

Show the measurements you have made and your working.

[2]

(iii) Using your results in **(b)(i)** and **(ii)**, find the actual length, in **μm**, of the length of the cells that you have drawn in **(a)(i)** and **(ii)**.

Show your working in the space provided.

[2]

(iv) Indicate the actual length of the cells in an appropriate manner on your diagram in **(a)**. [1]

(v) Calculate and state the magnification of your drawing in **(a)**. Show your working.[2]

(c) Describe **two** differences observed between cells at region **X** and **Y**.

.....

.....

.....

..... [2]

[Total: 17]

3 Respiratory quotient (RQ) is a measurement of the ratio of carbon dioxide given out to oxygen taken in. The RQ value acts as an indication of the respiratory substrate used.

$$RQ = \frac{CO_2 \text{ given out}}{O_2 \text{ taken in}}$$

Carbohydrates often give a RQ of 1.0, while protein and fats give 0.8 and 0.7, respectively.

Yeast are unicellular eukaryotic organisms that respire using a range of substrates.

You are required to plan, but not carry out, an experiment to investigate the RQ when yeast is metabolising different carbohydrates in respiration.

You must use:

- active yeast suspension in small conical flask
- 5% glucose
- 5% sucrose
- rubber bung with delivery tube
- soda lime in syringe
- T-shaped connecting tube
- capillary tube
- blue ink

Fig. 3.1 shows part of the experimental setup.

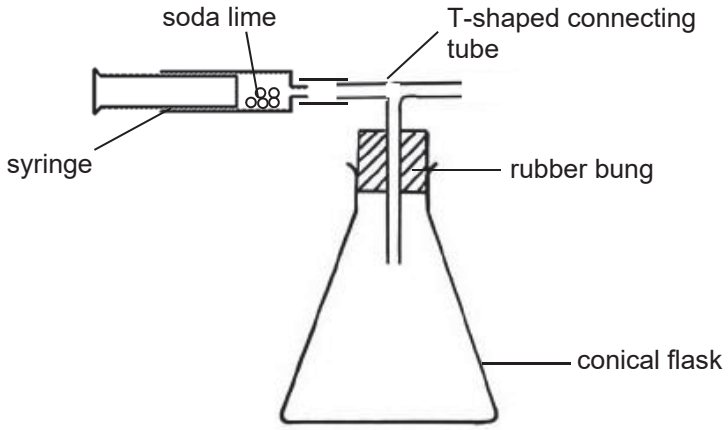


Fig. 3.1

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

- normal laboratory glassware, e.g. test-tubes, boiling tubes, beakers, measuring cylinders, graduated pipettes, glass rods, etc.
- syringes
- timer, e.g. stopwatch
- thermostatically regulated electrical water bath

Your plan should:

- have a clear and helpful structure such that the method you use is able to be repeated by anyone reading it
- be illustrated by relevant diagram(s), if necessary, to show, for example, the arrangement of the apparatus used
- identify the independent and dependent variables
- describe the method with the scientific reasoning used to decide the method so that the results are as accurate and repeatable as possible
- include layout of results tables and graphs with clear headings and labels
- use the correct technical and scientific terms
- include reference to safety measures to minimise any risks associated with the proposed experiment

[Total: 14]

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Answers

1	B
2	C
3	B
4	B
5	A
6	C
7	B
8	C
9	C
10	B
11	C
12	B
13	D
14	C
15	D

16	A
17	D
18	D
19	B
20	B
21	B
22	C
23	A
24	A
25	C
26	B
27	C
28	C
29	A
30	D

INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
in preparation for General Certificate of Education Advanced Level
Higher 2

CANDIDATE NAME	**ANSWER SCHEME**		
CLASS		INDEX NUMBER	

BIOLOGY

9744/02

Paper 2 Structured Questions

29 August 2017

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number 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 the brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	
2	
3	
4	
5	
6	
7	
Section B	
8 OR 9	
Total	**100**

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

Section A

Answer **all** questions.

1 Fig. 1.1 shows a ligand binding to the G Protein-coupled receptor (GPCR) which is embedded on the cell surface membrane.

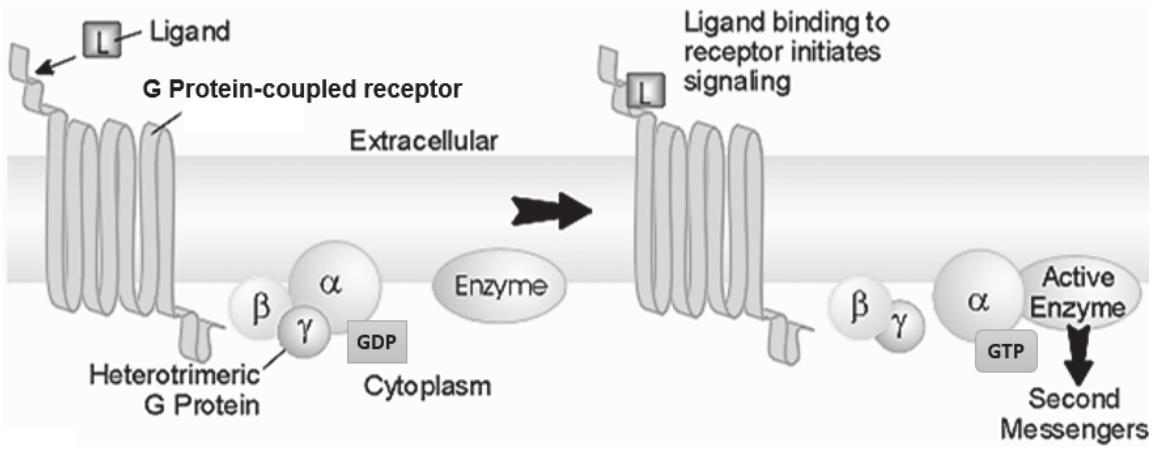


Fig. 1.1

(a) (i) Identify the ligand in Fig. 1.1.

glucagon;; [1]

(ii) Explain why ligand mentioned in (**a)(i)** unable to pass through the cell surface membrane.

1. glucagon is a peptide hormone/ prot

which is a large macromolecule/ contains amino acids with charged R groups;;

2. it is unable to pass thru small temporary gaps in CSM/ will be repelled by the hydrophobic core;;

/ no tpt prot (carrier/ channel) large enough to facilitate its tpt across CSM;; [2]

(b) With reference to Fig 1.1, describe what happens when the ligand binds to the GPCR.

1. when ligand binds to GPCR, receptor is activated & undergoes conformational △

activated receptor then interacts with G prot bound with GDP;;

2. causing it to exchange its bound GDP with GTP

activating G prot, causing β & γ subunits of G prot to dissociate from α subunit;;

3. α subunit together with bound GTP then binds to enz to activate it

activated enz will then activate 2nd messengers involved in signal transduction;; [3]

[Turn over

(c) With a named example, define "second messengers".

1. ***2nd messengers are small, non-prot, water soluble mols***

   that relays signals from cell surface receptors to target mols in cell;;

2. ***e.g. cyclic AMP (adenosine monophosphate)/ Ca^{2+}/ cyclic GMP (guanosine monophosphate)/ diacylglycerol;;*** [2]

(d) Explain how intracellular signal is terminated when ligand is released from the receptor.

1. ***GTPase in α subunit of G prot will hydrolyse bound GTP to GDP;;***
2. ***α subunit will associate together with β & γ subunits of G prot which forms inactive G prot;;***
3. ***cAMP will be converted back to AMP by phosphodiesterase;;*** [2]

(e) One of the side effects of a particular drug includes non-responsiveness of GPCR to ligands.

Suggest how the drug could have caused such non-responsiveness of GPCR to ligands.

1. ***(competitive inhibitor) drug has a similar 3D config as ligand (glucagon)***

   competes with ligand for ligand binding site ® active site

2. ***drug binds permanently to GPCR binding site / via strong permanent bonds***

   therefore, ligands unable to bind to GPCR to initiate signal transduction;; [2]

@ non-competitive inhibition → binds to al___ site → △ 3D config of GPCR → l___ b___ s___ ⊗ compl to ligand

[Total: 12]

2 Fig. 2.1 is a photomicrograph of plants cells, with some undergoing mitosis.

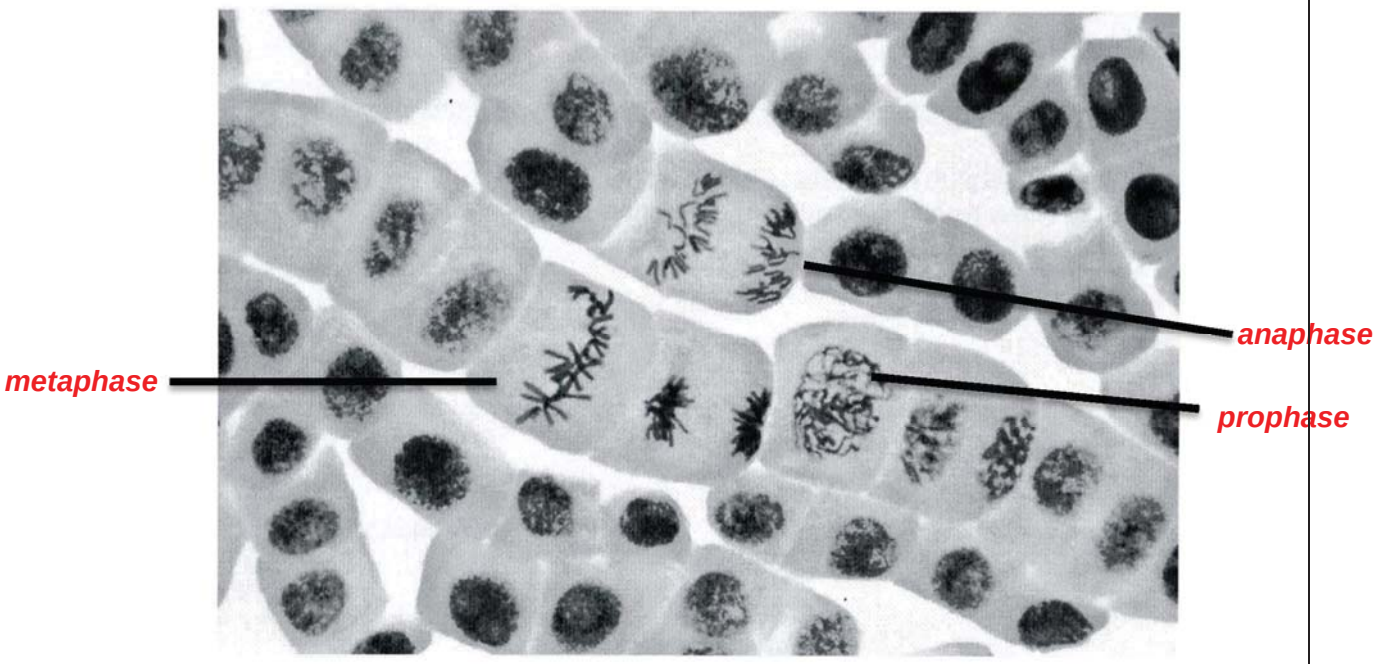


Fig. 2.1

(a) On Fig 2.1, use labels and label lines to indicate **one** cell in anaphase stage of mitosis. [1]

(b) The longest stage of the mitotic cell cycle, interphase, is divided into three phases, **G1, S** and **G2**.

(i) Describe what happens in the G1 phase.

1. synthesis of organelles e.g. ER, mito etc

2. synthesis of prots (needed for S phase – replication of DNA);;

3. increase in cytoplasmic vol resulting in an increase in cell size;;

4. nucleolus actively synthesises ribosomal RNA for formation of ribosomes;; [3]

(ii) There are various checkpoints in the mitotic cell cycle. One of them is present in the G1 phase called the G1 checkpoint.

Describe the function of G1 checkpoint.

1. checks for presence of growth factors;;

2. checks for DNA damage;;

3. checks for appropriate cell size and sufficient nutrients;; [2]

(iii) When cell cycle checkpoints are defective, cancer could arise.

With reference to two named genes, outline the development of cancer.

1. gain-of-function mutation of proto-oncogene to oncogene (Ras gene)

loss-of-function mutation of normal TSG to mutated TSG (p53 gene);;

2. cells with mutations are able to evade apoptosis resulting in proliferations of cells with mutations

telomerase genes are activated in cells which prevents shortening of telomeres;;

3. resulting in cells having limitless replicative potential

leading to uncontrolled cell division & over-proliferation resulting in formation of a mass of overlapping cells – tumour;;

4. as tumour grows in size, activation of genes involved in angiogenesis results in proliferation of blood vessels to tumour cells

activation of genes involved in invasion & metastasis allows tumour to migrate to distant sites;; [4]

(b) Stem cells go through mitosis as well. But they go through asymmetrical division, where the fate of the two daughter cells are different.

(i) State the potency level of adult stem cells and their function in our body.

1. multipotent;;

2. serve to maintain steady-state functioning of cells

by generating replacements for cells lost through disease/ tissue injury;; ®cell repair [2]

(ii) Suggest one similarity between stem cells and cancer cells.

1. both have active telomerase gene to pdc active telomerase ® active telomerase gene only

to prevent shortening of telomeres;;

2. thereby enabling both stem cells & cancer cells to divide indefinitely;; [2]

[Total: 14]

3 Pure breeding sweet pea plants with purple flowers and long pollen grains were crossed with pure breeding plants with red flowers and round pollen. All the F_1 plants had purple flowers and long pollen grains. These F_1 plants were then allowed to self-pollinate and the seeds produced were grown. The following results were obtained in this F_2 generation.

4831	purple flowers and long pollen grains
390	purple flowers and round pollen grains
393	red flowers and long pollen grains
1338	red flowers and round pollen grains

(a) Explain what is meant by the term "pure breeding".

homozygous for all genes (involved)/ having identical alleles for all genes (involved);; [1]

(b) State the expected phenotypic ratio of the F_2 generation.

9 purple flowers & long pollen grains : 3 purple flowers & round pollen grains

3 red flowers & long pollen grains : 1 red flowers & round pollen grains [1]

(c) Using suitable symbols, draw a genetic diagram to explain the observed results of the F_2 generation.

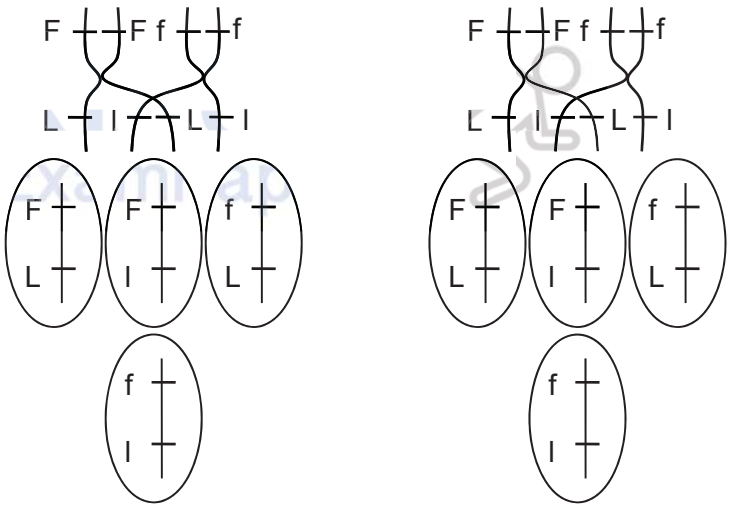
Legend:
Let F represent the dominant allele for purple flowers.
Let f represent the recessive allele for red flowers.
Let L represent the dominant allele for long pollen grains.
Let l represent the recessive allele for round pollen grains.

F_1 Phenotype:	***Purple flower, long pollen grains***	*x*	***Purple flower, long pollen grains***
F_1 Genotype:	***FfLl***	*x*	***FfLl***

;;

Crossing over during meiosis

After meiosis, F_1 Gametes:



;;

By random fertilization, Punnett Square:

	FL	Fl	fL	fl
FL	*FFLL*	*FFLl*	*FfLL*	*FfLl*
Fl	*FFLl*	*FFll*	*FfLl*	*Ffll*
fL	*FfLL*	*FfLl*	*ffLL*	*ffLl*
fl	*FfLl*	*Ffll*	*ffLl*	*ffll*

;;

F_2 Genotype:	***F_L_***	***F_ll***	***ffL_***	***ffll***
F_2 Phenotype:	***Purple flower, long pollen***	***Purple flower, round pollen***	***Red flower, long pollen***	***Red flower, round pollen***
Expected Phenotypic Ratio:	***9:***	***3:***	***3:***	***1***
Observed phenotype numbers	***4831***	***390***	***393***	***1338***
Observed phenotypic ratio	***12:***	***1:***	***1:***	***3***

;;

;;

[5]

(b) Suggest how similar crossing experiments with many different pairs of characters could be used to map the position of genes on the chromosomes of sweet pea plants.

1. if expected phenotypic ratio of 9:3:3:1 is observed

there is no linkage b/w two genes for that pair of characters are found on diff chr;;

2. if not, recombination freq which reflects dist of 2 genes on chr can be calculated;

using formula: no. of org showing recombinant phenotypes/ total no. of offspring x 100%

3. further apart two genes, higher possibility of crossing over;

higher recombination frequency; @vice versa [3]

[Total: 10]

4 Fig. 4.1 shows the life-cycle of *Aedes aegypti*, which are often vectors of viral diseases like dengue fever, chikungunya and yellow fever.

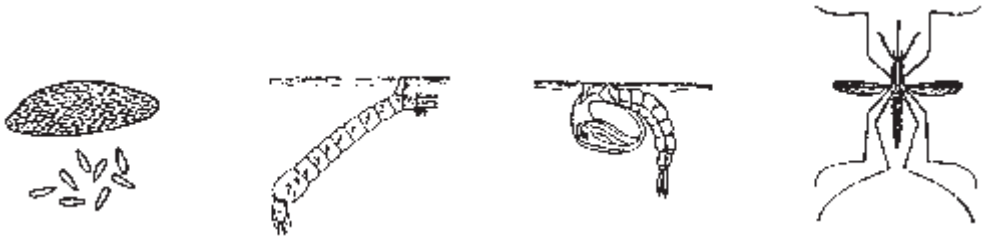


Fig. 4.1

(a) With reference to Fig 4.1, name the four stages in a *Aedes aegypti* life-cycle.

eggs, larva, pupa, adult

[2]

(b) The following is an extract from an article *"Record 2,441 dengue cases reported in Singapore for January"* published on Singapore's The Straits Time website on 2nd Feb 2016

"SINGAPORE - A total of 636 dengue cases were reported for the week of Jan 24 to 30 - the same number as the previous week - according to the latest figures released by the National Environment Agency (NEA) on Tuesday (Feb 2).

This brings the total number of cases for the first four weeks of the year to 2,441, an unusually high number for January given that it is traditionally the low season for dengue."

Fig 4.2 shows the weekly number of dengue cases in Singapore from 2013 to 2016

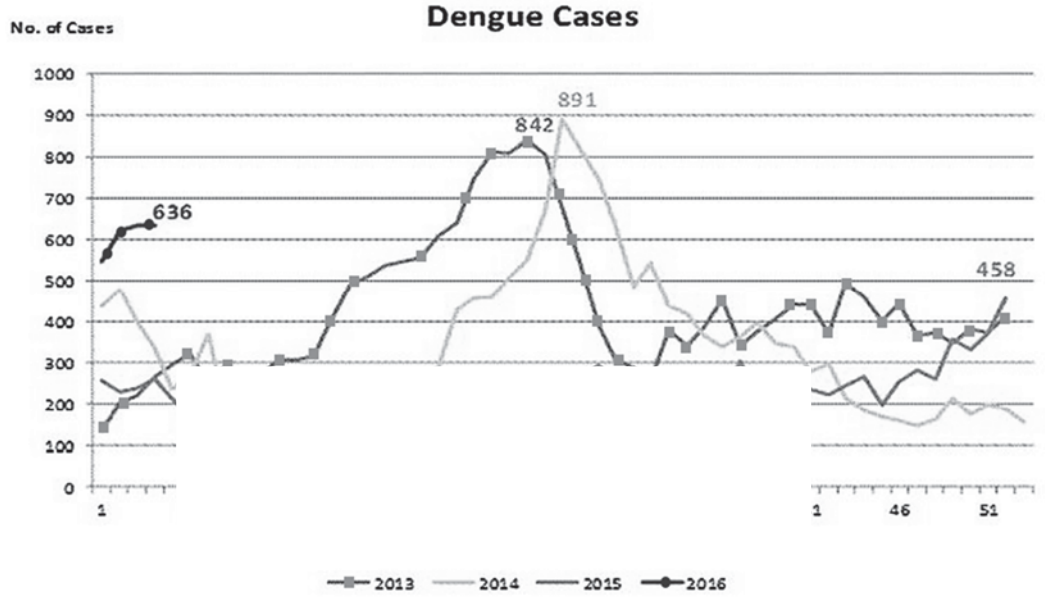


Fig. 4.2

(i) With reference to Fig 4.2, describe the general trend in dengue cases in 2013.

1. in 2013, no. of dengue cases in SG shown a general increase in first half of the year;

then it started to decrease & fluctuated in second half of the year;;

2. from about 140 cases in beginning of year, it then increased to a peak of 842 cases in Week 25;

then it decreased to about 410 cases at end of the year; [2]

Fig 4.3 shows average monthly temperature in Singapore in Year 2013.

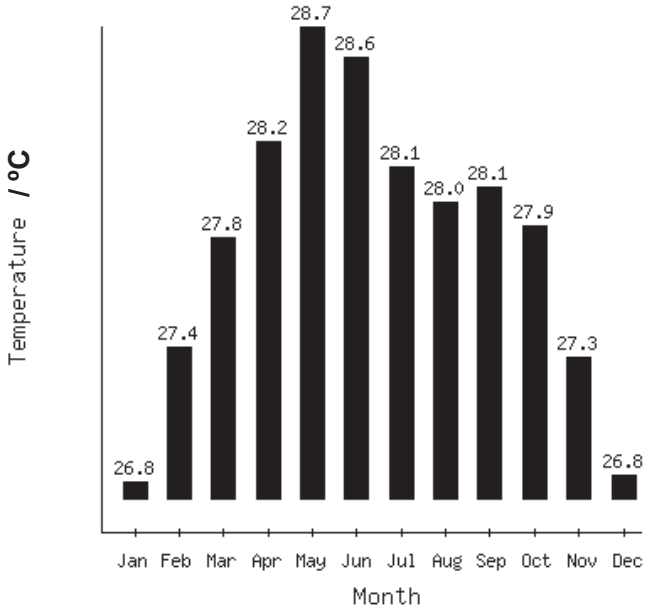


Fig 4.3

(ii) With reference to Fig 4.3, describe the temperature trend in Singapore in 2013.

1. temp increased from Jan 2013 to May 2013 then started to decrease till Dec 2013;;

2. from 26.8ºC in Jan, it increased to highest in May at 28.7ºC then it decreased back to 26.8ºC in Dec;; [2]

(iii) With reference to both Fig 4.2 and 4.3, account for the relationship between temperature and dengue cases in Singapore in 2013.

1. when temp was highest at 28.7 ºC/ 28.6 ºC in May/ June,

no. of dengue cases was also highest at 842 in Week 25 (end May/ early June);;

2. increase in temp increases amt of kinetic energy possessed by enz & substrates,

thereby increasing rate of many metabolic processes;;

3. shortens time taken to develop from egg to adult in Aedes aegypti,

increases survival rate & contributes to increase in no. of Aedes aegypti which helped to spread dengue virus more rapidly;; [3]

(c) Fig 4.4 is a diagram of a dengue virus.

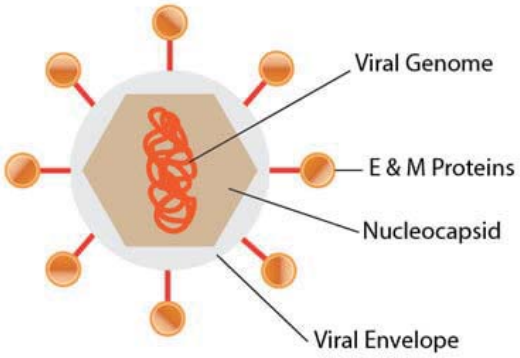


Fig. 4.4

(i) Describe the viral genome of dengue virus.

1 single-stranded, positive-sense RNA;; [1]

(ii) The dengue virus and influenza virus are quite similar in terms of their structure and reproductive cycle.

Describe one structural similarity between dengue virus and influenza virus.

1. both dengue & influenza virus are enveloped virus/ surrounded by viral envelope;;

2. both possess viral glycoprots/ prots on their envelopes;; [1]

(iii) Compare the reproductive cycles of dengue virus and influenza virus.

Giving one difference and two similarities.

Difference: ***translation takes place immediately using host ribosomes with +ve-sense RNA genome in dengue virus in influenza virus, synthesis of mRNA (+ve sense) have to take place first using viral RNA-dependent RNA pol before translation using host ribosome can occur;;***

Similarities: (any 2)

1. both enter their host cells via receptor-mediated endocytosis;;

2. acidification of endosome resulting in fusion of viral envelope with endosomal memb occurs during uncoating in both;;

3. both viral assembly occurs at host cell's rER, where both envelope prot are inserted into rER memb;; [3]

(iv) Currently, there are no specific antiviral drugs for the treatment of dengue fever, due to the prevalence of drug resistance in dengue viruses.

Suggest one reason how drug resistance can arise in dengue viruses.

1. dengue virus has high rate of mutation, due to lack of proofreading activity of viral RNA-dependent RNA pol, (resulting in high rate of errors during replication);; OR

2. genetic recombination could occur when a host cell is infected by more than one serotype, resulting in recombinant strains of virus;; [1]

[Total: 15]

5 Fig 5.1 and 5.2 are diagrams showing transcription and translation.

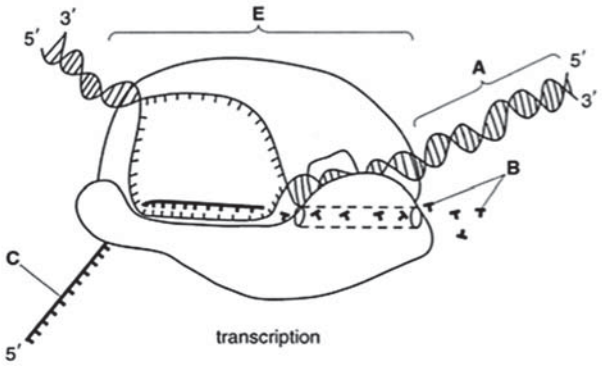


Fig 5.1

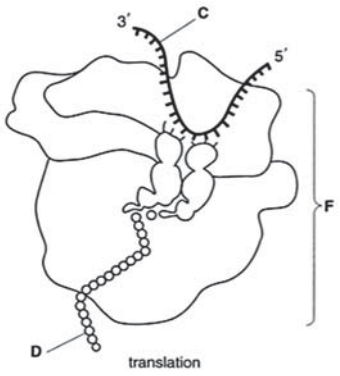


Fig 5.2

(a) Identify the structures A to C.

A ***deoxyribonucleic acid ® abbrev. DNA***

B ***ribonucleotide / ribonucleoside triphosphate ® nucleotide bases***

C ***messenger ribonucleic acid ® abbrev. mRNA*** [3]

(b) Describe what happens to **D** after it is being synthesized to form a functional product.

1. D will fold to form 2º struct of α-helices & β-pleated sheets

maintained by H bonds b/w peptide bonds

2. further coil & fold to form globular 3º struct

maintained by hydrophobic interxns, H bonds, ionic bonds & disulfide bridges b/w R grps [2]

(c) Describe **three** ways in which the process of transcription differs from translation.

	transcription	translation
1. template	1 strand of DNA	(mature) mRNA
2. enz	RNA pol	peptidyl transferase in ribo
3. bonds	phosphodiester	peptide
4. monomers	ribonucleotides	aa
5. product	RNA	polypeptide
6. location	nucleus	ribosome in cytoplasm
7. initiation	TATA box of core promoter	start codon at 5' end
8. termination	after polyadenylation signal	after stop codon

[3]

(d) Briefly describe how the structure of **F** differs from the structure **E**.

1. *F is made up of 2 subunits, 1 large & 1 small subunit while E is only composed 1 entire unit / multiple subunits / enz complex*
2. *F consists of ribosomal RNA & ribosomal prots while E consist of only prot*

[2]

® comparison of binding sites
® comparison of initiation complexes (process shown is clearly at elongation)

(e) Fig 5.3 shows a proteasome degrading a protein.

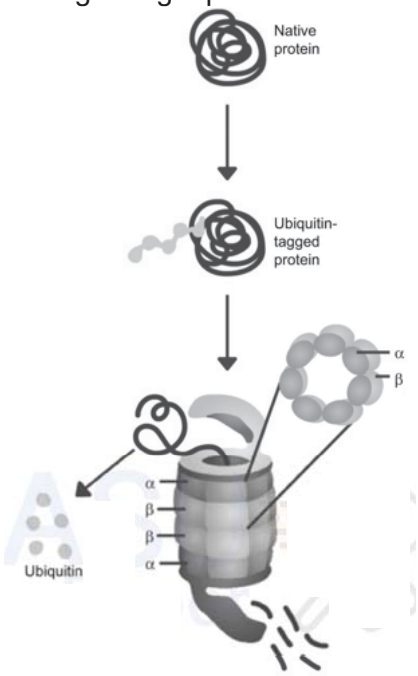


Fig. 5.3

With reference to Fig 5.3, describe what happens during proteasomal degradation of proteins.

1. ***<u>multiple</u> ubiquitin are added to target prot by enz in cytosol***

   to form ubiquitin-tagged prot

2. ***ubiquitin-tagged prot is recognised by proteasome, unfolded & enters core of proteasome***

   ubiquitin is released back into cytosol

3. ***proteasome catalyse hydrolysis of peptide bond in polypep chain***

   into short peptide fragments → release into cytosol for recycling [3]

[Total: 13]

6 The marine threespine sticklebacks, *Gasterosteus aculeatus* is a freshwater fish living in the lakes of British Columbia, Canada as shown in Fig. 6.1.

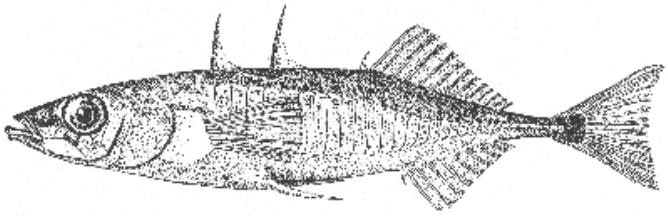
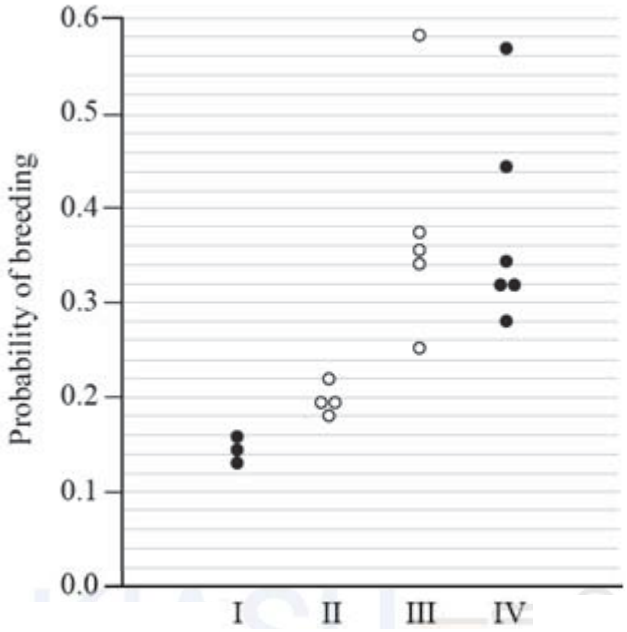


Fig. 6.1

In order to investigate the process of speciation in these populations, three small lakes were studied. Each lake contained two varieties of stickleback: a large, bottom-dwelling variety that fed on invertebrates near the shore and a small, plankton-eating variety that lived in the open water. The probability of breeding between pairs of individuals was measured under laboratory conditions in the following breeding combinations:

I different varieties from the same lake
II different varieties from different lakes
III same variety from different lakes
IV same variety from the same lake

The data are summarized in Fig. 6.2 below.



(a) With reference to Fig 6.2,

(i) identify the highest and lowest probabilities of breeding for individuals of the same variety

highest prob is 0.58 & lowest prob is 0.25;; [1]

[Turn over

(ii) describe the differences in probability of breeding between individuals from different lake.

1. individuals from diff variety have lower breeding prob

prob b/w 0.18 – 0.22;;

2. individuals from same variety have higher breeding prob

prob b/w 0.25 - 0.58;; [2]

(iii) describe the evidence that speciation is taking place in these populations and explain the type of speciation

1. prob of diff varieties interbreeding is low even if they are in the same lake

probability b/w 0.13 – 0.16;;

2. sympatric speciation

behavioural or physiological isolation within same habitat;;

3. accumulation of genetic differences b/w varieties

resulting in reproductive isolation/barriers (can be pre-zygotic or post-zygotic barriers);; [3]

(iv) explain why all the individuals are still considered the same species.

1. based on biological species concept, both varieties can still interbreed

to produce viable, fertile offsprings;;

2. probability of breeding of different variety from same lake is 0.13-0.16

probability of breeding of different variety from different lake is 0.18-0.22;; [2]

(b) The freshwater lakes also contain many different types of parasites that infect the different varieties of marine threespine sticklebacks.

Explain why these parasites help to speed up speciation of the marine threespine sticklebacks.

1. diff type of parasites have specificity to infect diff varieties of animal

presence of parasites acts as a selection pressure;;

2. animals with alleles which confer resistance to parasite infection are selected for

they have high survival & reproductive rate;;

3. pass down favourable alleles to next generation

changes allelic frequency in popn of diff varieties;;

4. as genetic differences increase b/w popn of animals results in reproductive isolation

prevents gene flow b/w popn & causes speciation to occur;; [4]

[Total: 12]

7 Fig. 7.1 shows how innate immune system protects the body against pathogens.

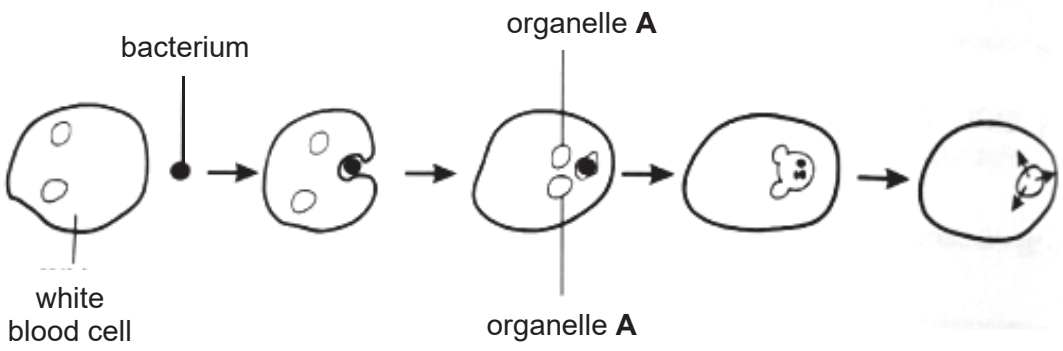


Fig. 7.1

(a) With reference to Fig 7.1,

(i) state the name of the white blood cell and organelle A.

white blood cell: macrophage/dendritic cell

organelle A: lysosome;; [1]

(ii) describe the role of organelle A in the defence against pathogen.

1. lysosomes fuse with phagosome

to form phagolysosome/secondary lysosome;;

2. lysosome has hydrolytic enz which digests pathogen

in an acidic environment within lysosome;; [2]

It is found that ingested *mycobacterium tuberculosis* is able to survive within the macrophage and cause tuberculosis in humans.

Bacillus Calmette–Guérin (BCG) is a vaccine primarily used against tuberculosis. It consists of live attenuated bacteria. In countries where tuberculosis is common, one dose is recommended in healthy babies as close to the time of birth. Babies with HIV/AIDS should not be vaccinated.

(b) **(i)** Explain how BCG vaccination provides long term immunity against tuberculosis.

1. attenuated virus retain ability to stimulate immune response

due to presence of specific surface Ags;;

2. APC take up virus by phagocytosis to present peptides of Ag

naïve helper T cell binds to Ag complex to be activated to effector T cell;;

3. effector T cell bind to Ag on naïve B cell to activate

clonal expansion of activated B cell OR clonal expansion of activated helper T cell;;

4. memory B cells & memory T cells formed via mitosis

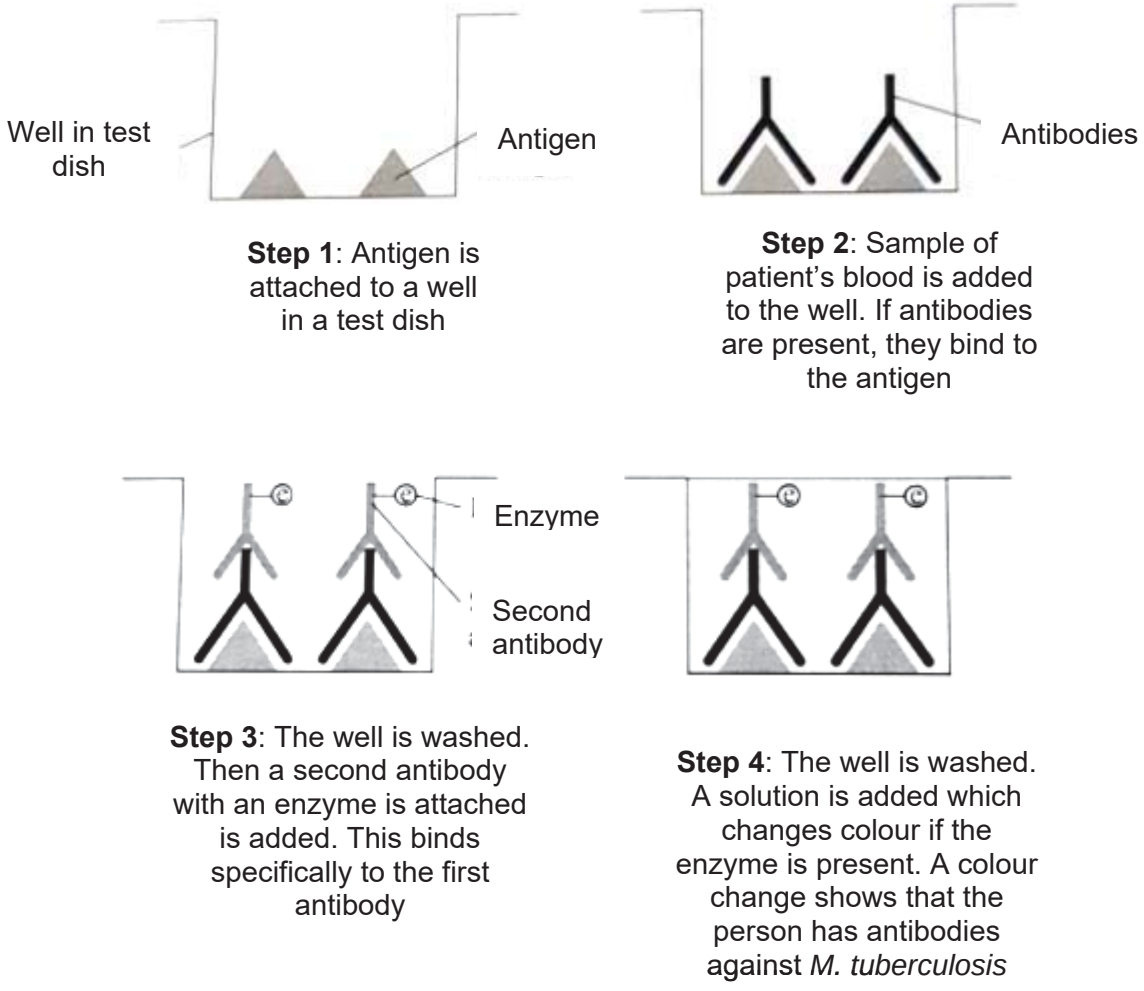
when exposed to same pathogen, memory cells can trigger a secondary immune response;; [4]

(ii) Suggest why babies with HIV/AIDS should not be vaccinated

1. HIV/AIDS leads to weak immune system/ reduced immunity due to reduced no. of helper T cells/ B cells / action of phagocytes

2. bacteria in vaccine, can multiply faster/ are not destroyed;; [1]

A test as shown in Fig. 7.2 has been developed to find if a person has antibodies against *M. tuberculosis.*



Step 1: Antigen is attached to a well in a test dish

Step 2: Sample of patient's blood is added to the well. If antibodies are present, they bind to the antigen

Step 3: The well is washed. Then a second antibody with an enzyme is attached is added. This binds specifically to the first antibody

Step 4: The well is washed. A solution is added which changes colour if the enzyme is present. A colour change shows that the person has antibodies against *M. tuberculosis*

Fig. 7.2

(c) Predict and explain if the color of the solution will change if the patient is infected with influenza virus.

1. No. colour of solution will not change if patient is infected with influenza virus;;

2. antigen binding site in Ab would be specific to Ag in M. tuberculosis

will not bind to any other Ags;;

3. second Ab thus will not be able to bind to 1st Ab

which would have been washed away;;

4. thus there would be no presence of enz

colour of soln will not change without enz;; [4]

[Total: 12]

8 Corals are simple marine animals and usually exist in colonies of thousands of individuals. Zooxanthellae are group of unicellular algae that can photosynthesize. They live within cells if the coral and have a symbiotic relationship.

Corals absorb calcium carbonate from the sea to build their skeletons which provides structural support. Coral reefs provide home for about 25% of known fish species.

Corals are sometimes mistaken for members of plant kingdom.

(a) State one way in which coral cells differ from plant cells

1. coral cells do not photosynthesize/do not have chloroplasts;; OR

coral cells do not have cellulose for structural support;; [1]

Coral reefs are at risk of damage by human activities. A study was conducted to see the effects of climate change on coral reefs.

Coral reef sites were subjected to two different environmental conditions i.e exposed site and sheltered site. Coral reefs in exposed site was exposed to climate change environmental conditions. Coral reefs in the sheltered site was exposed to normal environmental conditions.

Table 2.1 shows coral cover area at exposed and sheltered sites.

Table 2.1

Experimental site		Area of healthy coral reef/m^2	Average area of healthy coral reef/m^2
Exposed Site	Site 1	120	
	Site 2	100	
	Site 3	150	
Sheltered Site	Site 1	82	
	Site 2	75	
	Site 3	69	

(b) With reference to Table 2.1,

(i) complete Table 2.1 by calculating the average area of healthy coral reef in exposed and sheltered site.

x_1 ***= (120 + 100 + 150)/3***
= 123.3 m^2

x_2***= (82 + 75 + 69)/3***
= 75.3 m^2

[1]

(ii) conduct a *t*-test on the given data and determine if the difference in mean area of healthy coral reef in exposed and sheltered site are statistically significant.

standard deviation $s = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}}$

t-test $t = \frac{|\bar{x}_1 - \bar{x}_2|}{\sqrt{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}}$ $v = n_1 + n_2 - 2$

Key to symbols

s* = standard deviation $\sum$ = 'sum of' $\bar{x}$ = mean

n = sample size (number of observations) x = observation

v = degrees of freedom

t Table

cum. prob	$t_{.50}$	$t_{.75}$	$t_{.80}$	$t_{.85}$	$t_{.90}$	$t_{.95}$	$t_{.975}$	$t_{.99}$	$t_{.995}$
one-tail	0.50	0.25	0.20	0.15	0.10	0.05	0.025	0.01	0.005
two-tails	1.00	0.50	0.40	0.30	0.20	0.10	0.05	0.02	0.01
df									
1	0.000	1.000	1.376	1.963	3.078	6.314	12.71	31.82	63.66
2	0.000	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925
3	0.000	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841
4	0.000	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604
5	0.000	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032
6	0.000	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707
7	0.000	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499
8	0.000	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355
9	0.000	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250
10	0.000	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169

Null hypothesis: There is no significant difference between mean area of healthy coral reef in exposed and sheltered site

x_1 = 123.3m^2
x_2= 75.3m^2

s_1 = 25.166
s_2 = 6.506 ;;

n_1 = 3
n_2 = 3

$t_{calculated}$ = 3.198;;

Df = 6 – 2
= 4

$t_{critical}$ = 2.776;;

$t_{calculated}$ (3.198) is greater than $t_{critical}$ (2.776), null hypothesis is rejected.

Conclusion: The difference in the mean area of healthy coral reef in exposed site and sheltered site is statistically significant ;; [4]

(ii) Explain two ways how climate change damages coral reefs.

1. increase in green house gasses emission in atmosphere

traps heat in atmosphere warms atmospheric temp & absorbed by water bodies/ocean;;

2. at higher water temp, increased photosynthesis rate of zooxanthellae

leading to excess product which is toxic;;

3. this damages coral causing coral polyp to expel zooxanthellae

which results in coral being bleached;;

4. ocean absorbs increased amt of carbon dioxide in the air

causes ocean acidification/drop in pH of the ocean;;

5. corals will not be able to absorb calcium carbonate

thus unable to maintain their skeleton;;

6. skeleton that provides structural support to coral dissolves

leading to death of corals;; [6]

[Total: 12]

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INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
in preparation for General Certificate of Education Advanced Level
Higher 2

CANDIDATE NAME **ANSWER SCHEME**

CLASS _____ INDEX NUMBER _____

BIOLOGY 9744/03

Paper 3 Long Structured and Free-response Questions **11 September 2017**

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number 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 A
Answer **all** questions in the spaces provided on the Question Paper.

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

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

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

For Examiner's Use	
Section A	
1	/25
2	/25
Section B	
3 OR 4	/25
Total	/75

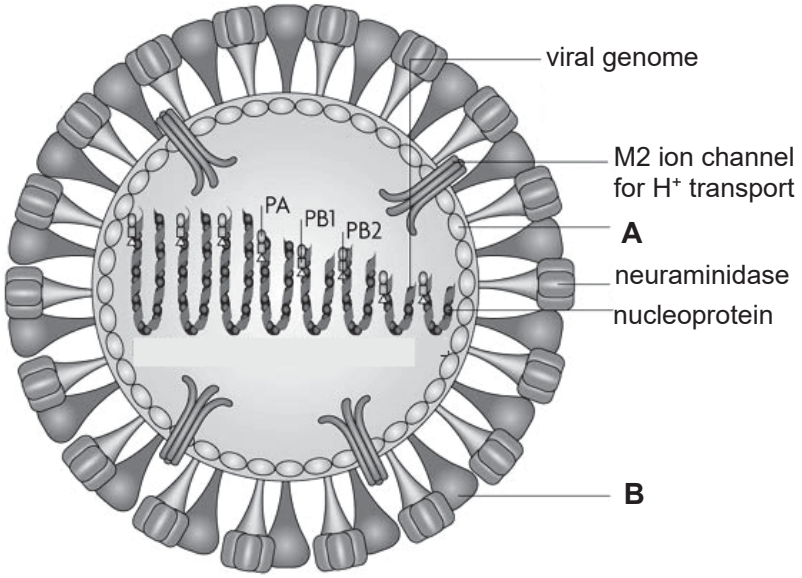
This document consists of **18** printed pages.

For Examiner's Use

Section A

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

1 Fig. 1.1 shows the influenza virus.



Legend
PA, PB1, PB2 are RNA polymerases

Fig. 1.1

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

A *matrix prot*

B *haemagglutinin* [2]

(ii) Explain why the influenza virus needs its own RNA polymerase.

1. needed to transcribe negative sense viral RNA into positive sense viral RNA

to act as mRNA for translation into new viral prot / templates for syn of new viral genome

2. host cell RNA pol transcribes DNA template to RNA / is DNA-dep RNA pol

virus need RNA-dep RNA pol [2]

(b) With reference to B and T cells, describe the adaptive immune response upon primary exposure to influenza virus.

1. influenza virus is engulfed by macrophages / dendritic cells

Ag is processed into short peptides / epitope

2. Ag / epitope is presented on MHC-II to Th / CD4+ cell at TCR

Th cell is activated

3. activated Th cell secretes interleukin / cytokines

and bind B cells (with Ag at MHC-II) to activate it

4. *activated B cells proliferate and differentiate into plasma cells*

that secretes Ab that binds Ag to precipitate / opsonise / neutralise virus

5. *activated Tc cells enz / chemicals / perforin*

to trigger apoptosis / cause lysis of / kill infected cells [5]

(c) Vaccine for influenza is readily available in many countries including Singapore. It is advised that members of the public get vaccinated yearly.

(i) Describe the benefits of vaccination.

1. *confer immunity to individuals not previously exposed to the virus*

prevents / protects against death / illness / disabilities caused by disease

2. *confer immunological memory / long term / lifetime immunity to individual*

due to production of memory B and T cells

3. *reduce spread of virus within human popn*

by conferring herd immunity / since virus relies only on human as host [3]

(ii) Describe what happens when a person vaccinated for influenza is subsequently infected with the same strain.

1. *more rapid / lag phase is shorter, more intense & prolonged immune response / high & steady levels of Ab*

due to immunological memory

2. *memory B cells rapidly undergo clonal expansion → plasma cells → large no. of Ab which bind and inactivate virus*

Ab produced remain in circulation longer to ensure infection is eliminated OR

BCR has higher affinity for Ag thus responding more rapidly [2]

(iii) Explain why yearly vaccination is recommended for influenza.

1. *due to antigenic drift → accumulation of mutations in the viral genome during replication ® antigenic shift (does not occur as frequently)*

due to the lack of proofreading mechanisms of RNA pol

2. *leading to △ in 3D config of HA & NA*

which is no longer recog / complementary to Ab, BCR & TCR on memory cells [2]

Doctors sometimes prescribe antibiotics to patients who are infected by influenza to combat secondary bacterial infections. Gramicidin A is an example of an antibiotic. Fig. 1.2 shows the molecular structure of Gramicidin A.

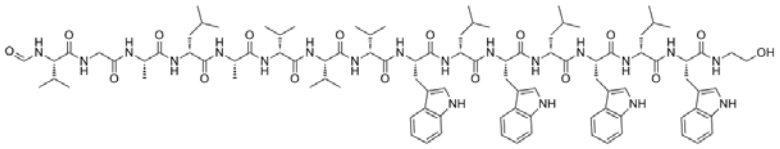


Fig. 1.2

(d) Illustrate the reaction that forms the peptide bonds between two amino acids.

1. indicate carboxylic grp + amine grp as rxting grps

2. condensation

3. loss of H_2O

4. label peptide bond in dipeptide (C=O and NH must be in trans position)

(any 2 MP for 1m)

[2]

Gramicidin A folds into a 3-dimensional configuration that inserts itself into the bacterium's cell surface membrane. It allows non-specific movement of ions which eventually cause the bacterial cell to die. Fig. 1.3 shows the interaction of Gramicidin A with the bacterium's cell surface membrane.

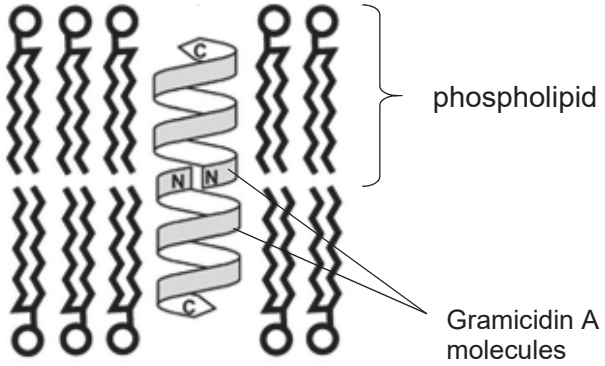


Fig. 1.3

(e) **(i)** Describe how the Gramicidin A shown in Fig. 1.2 folds into the 3-dimensional structure shown in Fig. 1.3.

1. forms α-helix of spiral shape (with 3.6 aa per turn)

held by H bonds

2. btw H of NH and O of CO of peptide bonds

n+4 aas away

3. 2 molecules assoc. with each other at N-ter

folded such that hydrophobic R grps face o/s to interxt with FA tails / hydrophilic R grps in/s facing channel to interxt with ions [2]

(ii) Using the information provided and Fig. 1.3, explain how Gramicidin A kills the bacterium.

1. Gramicidin A forms hydrophilic channel

allows non-specific / unregulated movement of ions in or out of bacterium (down conc. grad.)

2. disrupting ionic balance in the bact cell

cause disruption metabolic fn leading to cell death [2]

® osmotic lysis as cell walls are not weakened

(f) Upon prescription of antibiotics, doctors often advise patients to complete the course of antibiotics even if symptoms of disease have ceased. One of the reasons cited was that not completing the course of antibiotics may increase the chance of antibiotic resistant bacteria to evolve.

With reference to natural selection, explain the basis for the need to complete the prescribed course of antibiotic.

1. not completing prescribed course of antibiotics may leave small nos. of bact remaining

a mutation that confers antibiotic resistance may occur in the remaining bact popn

2. presence of antibiotics (in patient's circulation) act as a selection pressure

selecting for mutant resistant strain with favourable phenotype which experience ↑er survival rate & repro success

3. thus completing the antibiotic course ensures that all susceptible bact in the patient dies

and leave no bact popn for mutation to occur in presence of antibiotic in the bact's env

4. mutant resistant bact strain may not be selected for in env without antibiotics

as resistant strains may be outcompeted by susceptible strains due to o/r selection pressures [3]

(any 3 MP)

[Total: 25]

2 A researcher investigated the pathway by which carbon dioxide is converted to organic compounds during photosynthesis. The apparatus used is shown in Fig. 2.1.

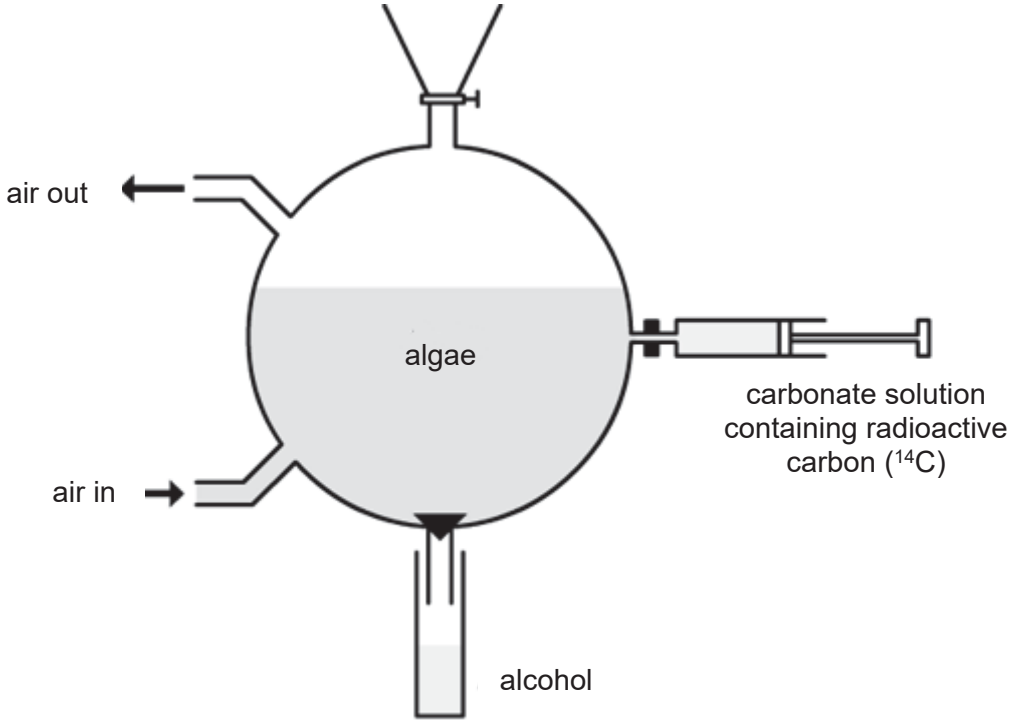


Fig. 2.1

While the apparatus was in the dark room, the researcher supplied the algal cells with $^{14}CO_2$. The contents of the apparatus were thoroughly mixed and light was switched on subsequently. At five-second intervals, a few of the cells were released into hot alcohol, which killed the cells very quickly. The intermediates of the reactions were subsequently analysed and the chromatograms in Fig. 2.2 showed the results of the analysed intermediates by chromatography (a separation technique) at different timings.

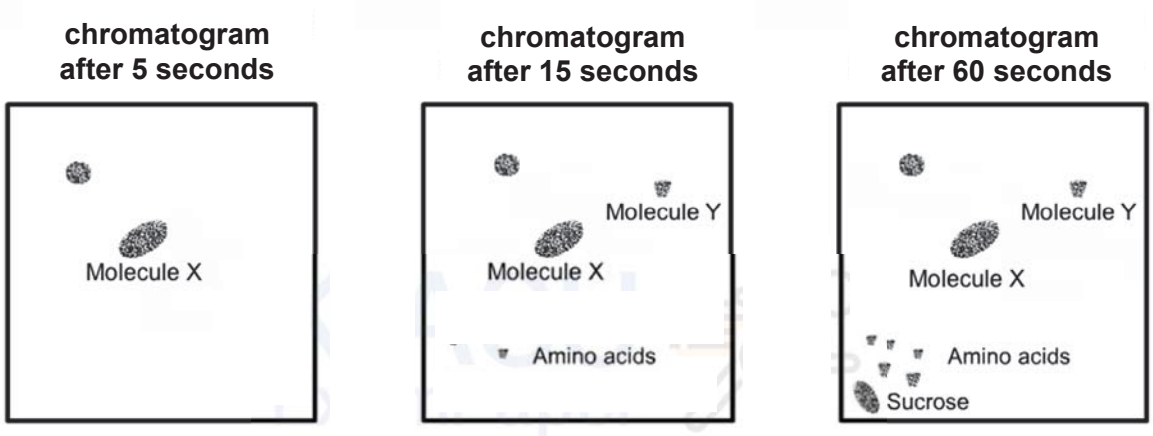


Fig. 2.2

(a) (i) Identify molecules **X** and **Y**.

X ***glycerate-3-phosphate;;***
@glycerate phosphate ***® short form***
@3-phosphoglycerate

Y ***glyceraldehyde-3-phosphate;;***
@triose phosphate

[2]

(ii) Explain your answer in part **(i)**.

1. $^{14}CO_2$ combines with 5C RuBP during carbon fixation

catalyzed by Rubisco / RuBP carboxylase;;

2. forming an unstable 6C intermediate

which is broken down to form molecule X, 3PGA (with ^{14}C incorporated);;

3. 3PGA is phosphorylated to form 1,3-bisphosphoglycerate

and undergoes reduction;;

4. using red NADP

to form molecule Y, G3P/ TP (with ^{14}C incorporated);; [4]

Part (i) must be correct in order to be awarded full marks for part (ii)

(iii) Explain why sucrose and amino acids are identified in the chromatogram only after 60 seconds.

1. with every 6 G3P/ TP (with ^{14}C incorporated) produced, 1 G3P/ TP exits the Calvin cycle

to be converted into other carbohydrates and organic compounds (with ^{14}C incorporated);; [1]

Dinitrophenol is a metabolic poison that can embed within the thylakoid membranes of chloroplasts and provide an alternate route for H^+ to diffuse across the thylakoid membranes.

(b) Explain how the concentration of intermediates of the Calvin cycle is affected by dinitrophenol.

1. less H+ diffuse through ATP synthase
@proton gradient less steep

less ATP produced (during light-dept rxn);;

2. less ATP for use in Calvin cycle

during carbon reduction and regeneration of RuBP;;

3. accumulation of 3PGA

↓ production of 1,3-bisphosphoglycerate / G3P/ TP/ RuBP;; [3]

Another experiment was carried out by another student to determine the concentration of carbon dioxide in the leaves of plants at different times of the day. The results are shown in Table 2.3

Table 2.3

Mean carbon dioxide concentration (ppm)	
8pm to 4am	8am to 4pm
328	106

(c) Using knowledge on Calvin cycle and Krebs cycle, account for the difference in concentration of carbon dioxide in the leaves for the two periods shown in Table 2.3.

1. more CO_2 produced from 8pm to 4am compared to 8am to 4pm

QV;;

2. 8pm to 4am – no light

light-dept rxn of photosynthesis ⊗ occur ➡ ⊗ produce ATP and red NADP;;

3. Calvin cycle ⊗ occur ➡ CO_2 ⊗ used up during carbon fixation

CO_2 produced in Krebs cycle during oxidative decarboxylation;;

4. 8am to 4pm – presence of light

CO_2 produced during Krebs cycle taken up during Calvin cycle;; [4]

(accept reverse argument)

(d) Explain the effect of higher concentration of carbon dioxide on the rate of carbon fixation during the period 8am to 4pm.

1. ↑ CO_2 ➡ ↑ [S]

↑ freq of effective collisions between CO_2 (& RuBP) and active site of Rubisco;;

2. ↑ ES complex formation per unit time ➡ ↑ products formed (i.e. 3PGA) per unit time

↑ rate of carbon fixation;; [2]

Studies were carried out on soil-dwelling aerobic and anaerobic bacteria. Samples were taken from different depths at intervals of one month and six months after the soil was put into a large heap for storage.

Table 2.4 shows the numbers of aerobic and anaerobic bacteria at different depths in the stored soil.

Table 2.4

depth in soil store / m	mean number of bacteria per gram of stored soil $\times 10^7$			
	aerobic bacteria		anaerobic bacteria	
	after one month	after six months	after one month	after six months
0.0	12.4	12.5	0.4	0.6
0.5	10.1	8.3	0.6	1.0
1.0	9.8	5.9	0.8	3.8
1.5	9.7	3.1	0.8	7.6
2.0	10.5	0.8	0.7	8.1
2.5	10.8	0.7	0.8	8.5
3.0	10.2	0.9	0.6	8.8

(e) **(i)** Account for the trends shown by the distribution of the two types of bacteria after six months.

1. aerobic bacteria decrease with depth from mean number of bacteria per gram of stored soil of 12.5 x 10^7 to 0.9 x 10^7

anaerobic bacteria increase with depth from mean number of bacteria per gram of stored soil of 0.6 x 10^7 to 8.8 x 10^7;;

2. aerobic bacteria requires oxygen for respiration

oxygen content of soil decreases with depth;;

3. less oxygen available as the final electron acceptor in ETC

decrease in ATP synthesis for use in cellular functions;; [3]

(ii) Suggest how aerobic bacteria are structurally adapted for cellular respiration.

1. presence of cytoplasmic membranes in aerobic bacteria

increase surface area;;

2. for more embedding of electron transport chain and ATP synthase

to allow electron transfer / to drive oxidative phosphorylation;; [2]

In a further study, soil samples were taken at two depths, **A** and **B**, in the soil store. The samples were taken at intervals over six years. Soil samples of equal mass were used to determine the activity of dehydrogenases in aerobic bacteria.

Fig. 2.5 shows the mean dehydrogenase activity of the bacteria in these samples.

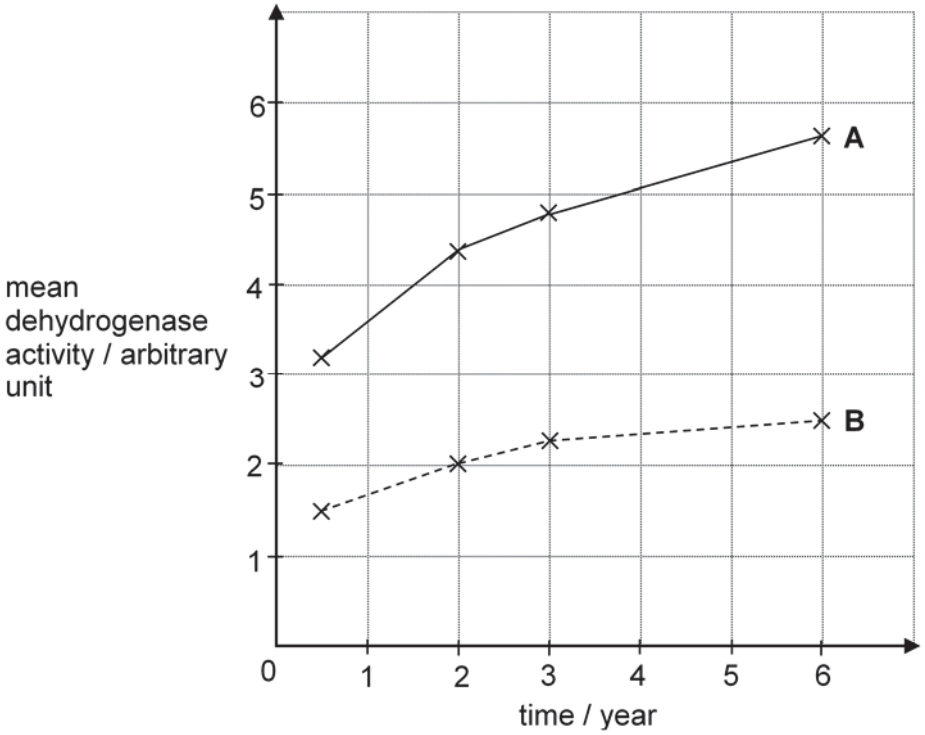


Fig. 2.5

(f) **(i)** State with evidence from Fig. 2.5 which depth, **A** or **B**, were samples taken from a greater depth.

1. depth B;;

2. bacteria in samples taken from depth B shows a lowered mean dehydrogenase activity with 1.5 to 2.4 au

compared to 3.2 to 5.7 au in samples taken from depth A;;

[2]

(ii) Explain the roles of dehydrogenase in Krebs cycle of the aerobic bacteria.

1. catalyze oxidation reactions in Krebs cycle;

loss of protons and electrons;

2. reduction of NAD and FAD;

to form reduced NAD and reduced FAD;

[2]

[Total: 25]

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), (b), etc., as indicated in the question.

3 **(a)** Greenhouse gases are key contributors to climate change affecting animals and plants in the environment they live in.

Discuss the effects of climate change in the global environment. [13]

1. ***due to increase in global ave temp as GHGs trap heat from sun's radiation causing accumulation of heat in atm;;***
2. ***results in melting of polar ice caps causing faster water surface run-off on land towards the sea (reduction of water infiltrating into aquifers as freshwater supplies & contribute to rise in sea levels);;***
3. ***results in rising sea levels due to warming of ocean waters leading to vol. expansion;;***
4. ***due to melting of ice (ice sheets & sea ice) resulting in loss of habitat & food source for animals such as polar bears;;***
5. ***results in reduction of freshwater supplies due to saltwater intrusion where salt water mixes with freshwater stores;;***
6. ***due to increased demand from humans as popn increases & increased freq & duration of droughts;;***
7. ***results in more freq. extreme unpredictable weather events such as heat waves & heavy rains/ higher evaporation rate in water cycle resulting in faster cloud formation (major fluctuations in precipitation – rain, snow);;***
8. ***causing flash floods on land surface leading to large vol of water surface run-off towards large bodies of water/ sea causing effects to residential areas, loss of crops, cattle;;***
9. ***results in death of coral reefs due to coral bleaching (corals lose their colours back to their white/brown original state);;***
10. ***loss of symbiotic algae (zooxanthallae) from coral tissue & dissolving of coral skeleton;;***
11. ***due to ocean acidification by absorption of carbon dioxide by ocean waters to form carbonic acid;;***
12. ***results in habitat migration of fish & insects to higher latitudes & altitudes with cooler temp to survive & thrive;;***
13. ***loss of biodiversity in current location, affecting food web (loss of prey for predators), change in plant distribution & adaptations;;***
14. ***increase in competition for resources with natives, increase in species variety in new habitat;;***
15. ***results in release of carbon dioxide & methane;;***

16. ***from melting frozen organic matter (permafrost) in soil due to decomposition by microbes;;***
17. ***increase in metabolic rate among insects such as mosquitoes due to higher kinetic energy b/w enzymes & substrates;;***
18. ***shorter life cycle, faster devt (mature faster) & reproduction of mosquitoes, higher population, more transmission of dengue virus as Aedes aegypti are vectors, spread of dengue;;***
19. ***spread to temperate regions (now exposed) not only tropical regions due to migration of mosquitoes;;***

(b) After viruses infect host organisms, they are able to make use of host cell machinery to replicate and reproduce thereby causing diseases in the host organism.

Describe how dengue causes viral disease in humans. [12]

<u>Infection of host cell (reproductive cycle of DENV)</u>

1. ***infected mosquito injects DENV into bloodstream infecting keratinocytes & dendritic cells;;***
2. ***E glycoprot of DENV binds to receptors on host cell & enters host cell via receptor-mediated endocytosis (RME);;***
3. ***acidification of endosome ➡ conformational △ where fusion of viral env with endosomal memb ➡ release of nucleocapsid into host cytoplasm;;***
4. ***viral RNA translated by host ribosomes on rough ER ➡ produce viral polypeptides which are cleaved by host & cellular protease to pdc 10 prots;;***
5. ***viral RNA is transcribed to form –ve sense RNA which acts as templates for synthesis of more viral genome;;***
6. ***viral RNA associate with capsid prots forming nucleocapsid at surface of rER, nucleocapsid buds into ER forming an env containing E & M glycoprots on surface;;***
7. ***immature viruses travel through Golgi body & undergoes maturation where furin cleaves b/w pr & M prots;;***
8. ***fusion of vesicle memb with host cell memb releasing mature virions to infect other cells;;***

<u>Pathogenesis (devt of disease)</u>

9. ***infected dendritic cells travel to lymph node & present viral Ag ➡ activate monocytes ➡ monocytes infected;;***
10. ***monocytes travel to site of infection via lymphatic system infecting more cells ➡ viremia (presence of viruses in blood) causing fever;;***
11. ***infection & apoptosis of monocytes & macrophages causes low WBC count/ leukopenia;;***
12. ***infection & apoptosis of endothelial cells resulting in thinning/ weakening of endothelium lining blood vessels ➡ haemorrhage (escape of blood from ruptured blood vessel);;***

[Total: 25]

4 (a) Effector molecules are responsible for the regulation of transcriptional units in prokaryotes.

Using named examples, explain the roles of these effector molecules in the negative feedback regulation of transcriptional unit in a prokaryote such as *Escherichia coli.*

[12]

<u>lac operon: allolactose</u>

1. ***effector molecule: allolactose (an inducer) for lac operon, formed from isomerization of lactose by β-galactosidase;;***
2. ***lactose from env bacteria tpted into bacteria via lactose permease;;***
3. ***allolactose binds to active lac repressor prot bound to operator of lac operon → changes 3D config of lac repressor, no more complementary to operator site;;***
4. ***lac repressor dissociates from operator site, RNA pol binds to promoter site;;***
5. ***initiates transcription of structural genes, lacZ, lacY & lacA, lac operon is switched on;;***
6. ***in absence of allolactose, lac repressor remains bound to operator site, RNA pol cannot access promoter site/ blocked from initiating transcription, lac operon is switched off;;***

<u>trp operon: tryptophan</u>

7. ***effector molecule: tryptophan (a co-repressor) for trp operon, synthesised when trp operon is switched on;;***
8. ***tryptophan present in bacteria env will bind to trp repressor, → changes 3D config of trp repressor becoming active;;***
9. ***trp repressor DNA binding site complementary to operator site, binds to operator site preventing RNA pol binding;;***
10. ***no initiation of transcription of structural genes trpE, trpD, trpC, trpB & trpA, trp operon is switched off;;***
11. ***in absence of tryptophan, trp repressor is inactive, trp repressor does not bind to operator site, RNA pol can bind to promoter site,***
12. ***initiates transcription of structural genes to form mRNA to synthesise enzymes for biosynthesis of tryptophan, trp operon is switched on;;***

(b) Protein production in eukaryotes is controlled at all stages of the process.

Explain how protein production is controlled in eukaryotes and the advantages of regulating protein production at different stages. [13]

Stages of Protein Production Control (max 9m)

chromatin remodelling/ chromatin level regulation (max 2m)

1. ***DNA methylation → covalent addition of a methyl grp to DNA catalysed by DNA methyltransferase decreases transcription rates;;***
2. ***histone acetylation → adding an acetyl grp to lysine residues at N-terminal of histone tails, catalyzed by HATs increases transcription rate;;***

   OR histone deacetylation of histone involves removal of an acetyl grp from lysine residues at N-terminal of histone tails catalysed by HDACs decreases transcription rate;;

transcription control (max 2m)

3. ***core promoters (TATA box) → found upstream of gene bound by general TFs (trans-acting element) & RNA pol forming transcription initiation complex to initiate transcription;;***

   proximal promoters (CAAT/ GC box) → found further upstream of core promoters bound by various TFs to promote transcription;;
4. ***enhancers (distal acting element) → regulatory DNA seq bound by activators (specific TF) → enhance transcription initiation;;***

   silencers (distal acting element) → regulatory DNA seq bound by repressors (specific TF) → inhibit activators & reduce transcription initiation;;
5. ***trans-acting elements located on diff chromosome as gene they regulate → code for specific TFs (activators & repressors);;***

post-transcription control (max 2m)

6. ***5' capping → methylated guanine added to 5'end pre-mRNA forming a 5' cap;;***

   3' polyadenylation → multiple adenine residues added to 3'end of pre-mRNA forming a poly(A) tail at AAUAAA seq (polyadenylation signal);;
7. ***RNA splicing (constitutive & alternative) → introns removed & exons joined by spliceosomes at splice sites;;***

translational control (max 2m)

8. ***mRNA stability → mRNA stability depends on length of poly(A) tail → 5' cap of mature mRNA poly(A) tail shortened by exonucleases in cytoplasm resulting in mRNA degradation, length of poly(A) tail can be lengthened by cytoplasmic enz to increase its lifespan;;***
9. ***initiation of translation → blocked by regulatory prots that bind to 5' or 3' UTR) prevents attachment of small subunit of ribosomes to initiate translation initiation complex;;***
10. ***miRNA regulates gene expression in cytoplasm by repressing translation of mRNAs and/or degrading mRNAs → miRNA complexes with RISC → binds***

to target mRNA & degrades it/ binds to 3' UTR leading to an inhibition of translation;;

post translational control (max 1m)

11. ***protein stability → prots undergoing proteolytic degradation conjugated with ubiquitin → recognised & degraded by proteasome → lower conc of prot needed;;***
12. ***protein processing → prots become functional via cleaving of prots (e.g. cleaving of preproinsulin to form insulin, biochemical modification (e.g. phosphorylation/ glycosylation of prots);;***

Advantages of Regulating Protein Production (max 4m)

chromatin remodelling/ chromatin level regulation

13. ***switching genes on & off to restrict active genes to those only req'd by specific cells, more efficient/ less wasteful of resources;;***

transcriptional level

14. ***allows regulation of rate of prot pdtn, match short term requirements/allow flexibility;;***

post-transcriptional level (max 1m)

15. ***allows for pdtn of diff prot variants from same pre-mRNA via alternative splicing/ increases coding capacity of genome;;***
16. ***facilitate export of mRNA to cytoplasm → prevent enzymatic degradation of mRNAs by exonucleases → controls mRNA stability;;***
17. ***removal of introns prevents extra aas from being incorporated during translation;;***

translational level

18. ***affecting timeliness of prots to be translated from mature mRNA depending on conc of prots present in cell;;***

post-translational level

19. ***allows rapid pdtn of active prot from inactive form via phosphorylation & glycosylation where it is needed, safe transport/ storage of produced prots when not needed immediately;;***

QWC

scientific argumentation exemplified by two or more advantages of regulating protein production linked coherently to the correct stage of the process

[Total: 25]

INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
in preparation for General Certificate of Education Advanced Level
Higher 2

CANDIDATE NAME **ANSWER SCHEME**

CLASS _____ INDEX NUMBER _____

BIOLOGY

9744/04

Paper 4 Practical

17 August 2017

2 hours 30 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name and class 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 on both sides of the paper.
You may use an HB pencil for any diagrams, graphs.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions in the spaces provided in the Question Paper.

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

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

Shift
Laboratory

For Examiner's Use	
1	/24
2	/17
3	/14
Total	/55

Answer **all** questions

1 The enzyme **E** catalyses the hydrolysis of sucrose to produce fructose and glucose.

The products of the hydrolysis of sucrose will reduce potassium permanganate from purple to colourless as follows:

purple ⟶ colourless

You are required to investigate the effect of sucrose concentration on the progress of this enzyme-catalysed reaction by finding the time taken for the decolourization of potassium permanganate.

You are provided with

- 1% enzyme solution, labelled **E**
- 10% sucrose solution, labelled **S1**
- 2%, 4%, 6%, 8%, 10% glucose solution, labelled **G1 – G5**
- 1 mol dm^{-3} sulfuric acid, labelled **A**
- 0.01% potassium permanganate solution, labelled **P**
- distilled water labelled, **W**

☠**Sulfuric acid and potassium permanganate are harmful.**
If any comes into contact with your skin wash immediately under cold water.
It is recommended that you wear safety goggles.

Proceed as follows:

1 Prepare an appropriate volume of 5% sucrose and label it **S2**.

2 Put 1 cm^3 of **A** into a test-tube.

3 Add 1 drop of **P** into the same test-tube. Gently shake to mix.

4 Add 1 cm^3 of **G1** to the test-tube. Start the stopwatch.

5 Record the time taken for **P** to decolourise in step **12**.

6 Repeat step **2** to **5** for **G2** to **G5**. You may perform the test simultaneously.

7 Put 5 cm^3 of **S1** into a small beaker.

8 Add 1 cm^3 of **E** into the small beaker containing **S1**.

9 Stir to mix the solutions. Allow the reaction to take place for 2 minutes.

10 Perform step **2** to **5** for reaction mixture of **E** and **S1**.

11 Repeat step **7** to **10** for **S2** you have prepared in step **1**.

12 Record your data in a suitable format in the space provided below. If **P** does not decolourise, record 'more than 600'.

1. *[L] layout ®if rate is calculated*
2. *[H] headings with units*
3. *[G] time taken for P to decolourise for glucose standards in seconds*
4. *[T] with correct trend (decreasing timing with increasing conc.)*
5. *[S] time taken for P to decolourise for S1 and S2 in seconds, S1 < S2*
   ®if S1 > S2

Solution	*Reducing sugar conc. / %*	*Time taken for P to decolourise / s*		
		CBL	*GAR*	*WMY*
G1	*2*	*180*	*120*	*210*
G2	*4*	*130*	*150*	*120*
G3	*6*	*110*	*120*	*105*
G4	*8*	*95*	*120*	*80*
G5	*10*	*90*	*75*	*60*
S1	*unknown*	*16*	*15*	*20*
S2	*unknown*	*20*	*18*	*30*

-1 for table in pencil. Table must be in black or blue ink.
® time taken

[5]

(a) **(i)** Using your results in step **12**, estimate the concentration of reducing sugar in the reaction mixture with

S1 *corresponding range* [1]

S2 *in %* [1]
@ ranges between 2 – 10%
® value between 2 – 10%
® values smaller than 2 and greater than 10
® if missing units (%)

(ii) With reference to enzyme action, explain your observations for **S1** and **S2**.

1. *S1 with higher [S]*

thus more ES cplx formed

2. *higher rate of sucrose hydrolysed to monosacc / RS / glucose & fructose*

thus faster rate of reduction of $KMnO_4$, lesser time taken for colour change [2]

(b) Describe a suitable control for this investigation.

1. replace E with 1 cm^3 of boiled and cooled E / distilled water
@ replace S with 5cm^3 of distilled water

2. keeping the rest of the conditions the same as experimental set up
®point 2 not awarded if point 1 is incorrect [2]

(c) **(i)** Identify **two** significant sources of error in this investigation.

1. determination of end-point is subjective

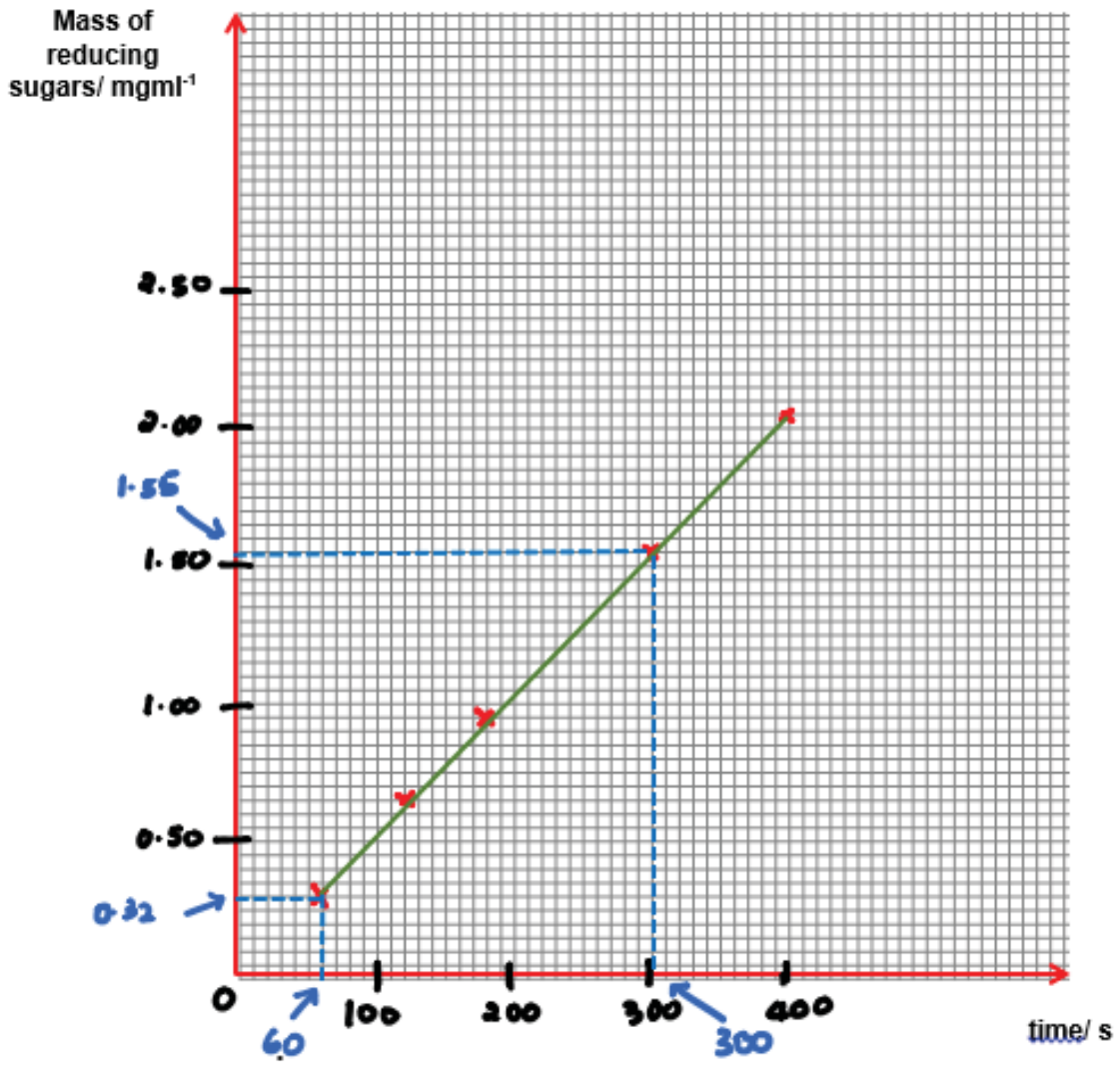
2. temp of enzyme reaction not kept constant [2]

(d) Table 1.1 shows the results for a similar investigation which measured the mass of reducing sugars produced over a period of 400 seconds.

Table 1.1

time / s	mass of reducing sugars / mg ml^{-1}
60	0.32
120	0.64
180	0.95
300	1.55
400	2.05

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



1. *[A] correct axes (y-axis: mass of reducing sugars, x-axis: time*
2. *[U] correct axes labels with units (y-axis: mg ml^{-1}, x-axis: s)*
3. *[S] appropriate scale (> ½ total no. of grids provided) AND correct data points plotted Also, need to show regular intervals on both x-axis & y-axis*
4. *[L] best fit line or dot-to-dot plot AND no extrapolation (no extension of line graph beyond 1st & last point)* [4]

(ii) Using your graph, find the rate of hydrolysis of the sucrose.

Need to show on graph how gradient is obtained from 2 points on the line graph (with dotted lines extended to scale on y-axis & x-axis shown)

Show on your graph where you took the readings to calculate the rate. [1]
Show all working in your calculation.

1. ***calculates gradient (advisable to use 2 points on line graph)(show working)***
2. ***state rate in mgml^{-1} s^{-1} to 3 s.f.***

rate of enzyme activity ..... [1]

(iii) Describe how results shown in Table 1.1 can be obtained if you are provided with Benedict's solution, 3 mg ml^{-1} reducing sugar solution and a colorimeter.

1. dilute 3 mg ml^{-1} reducing sugar (RS) solution with water

to obtain RS solutions of 1, 1.5, 2, 2.5 mg ml^{-1} as colour glucose standards;;

2. conduct Benedict's test using 2 cm^3 of 1, 1.5, 2, 2.5 and 3 mg ml^{-1} RS

with equal vol of Benedict's soln, place in boiling water bath for 2 min;;

3. record absorbance by ppt formed using a colorimeter

plot a graph of absorbance agst RS conc.;;

4. conduct Benedict's test on2 cm^3 of reaction mixture at 60, 120, 180, 300, 400s

using 2 cm^3 of Benedict's soln;;

5. record absorbance using colorimeter

locate RS conc. corresponding to absorbance at each sampling times;; [5]

[Total: 24]

2 **K1** is a stained, longitudinal section of a young root tip.

Use your microscope to examine carefully the regions labelled **X** and **Y** in Fig. 2.1.

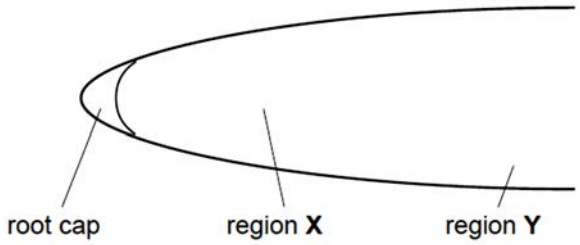


Fig 2.1

(a) Make a large, labelled, high-power drawing of a single cell at

(i) metaphase

1. [N] draws correct no. of cell with clean, continuous lines

2. [S] of appropriate shape

3. [CW] with thin (proportional) cell wall

4. [C] appropriate chromosomal arrangement

(any 2 MP1-4 for 1m)

5. [L1][L2] with at least 2 labels
cell wall, cytoplasm, cell surface memb

Magnification =

[3]

(ii) anaphase

1. ***[N] draws correct no. of cell with clean, continuous lines***
2. ***[S] of appropriate shape***
3. ***[CW] with thin (proportional) cell wall***
4. ***[C] appropriate chromosomal arrangement***

(any 2 MP1-4 for 1m)

5. ***[L1][L2] with at least 2 labels***
   cell wall, cytoplasm, cell surface memb

Magnification =

[3]

(b) **(i)** Using the eyepiece graticule fitted in the eyepiece lens of your microscope, state the objective lens you are using and the number of eye piece divisions equivalent to length of the cell you have drawn in **(a)(i)** and **(ii)**.

objective lens	***x40***	***x60***	
number of eyepiece graticule divisions for **(a)(i)** =	***5 to***	***8 to***	[1]
number of eyepiece graticule divisions for **(a)(ii)** =	***12***	***20***	[1]

(ii) Using the stage micrometer, determine the length of one division on your eyepiece graticule at the objective stated in **(b)(i)**.

Show the measurements you have made and your working.

1. ***100 eyepiece graticule div = 17 stage micrometer div***
2. ***.: 1 eyepiece graticule div = 0.17 stage micrometer div***
   = 0.17 x 0.01 mm
   = 0.0017 mm
   = 1.7 μm

[2]

(iii) Using your results in **(b)(i)** and **(ii)**, find the actual length, in **μm**, of the length of the cells that you have drawn in **(a)(i)** and **(ii)**.

Show your working in the space provided.

no. of eye piece graticule div x length of 1 eyepiece graticule division

1. ***for (a)(i)***
2. ***for (a)(ii)***

(A) ECF from (b)(i) and (ii)

NB: 10 μm < cell size < 50 μm

[2]

(iv) Indicate the actual length of the cells in an appropriate manner on your diagram in **(a)**. [1]

@ ECF from (b)(iii) i.e. label the wrong actual size but in a correct manner

(v) Calculate and state the magnification of your drawing in **(a)**. Show your working.[2]

@ ECF from (b)(iii) i.e. correct calculation using wrong actual size

® drawing size measurement of > ± 0.2 cm diff

(c) Describe **two** differences observed between cells at region **X** and **Y**.

1. *many cells in region X are undergoing cell division / mitosis*

   but few / no cells in region Y are dividing

2. *cells in region X are small*

   cells in region Y are larger

3. *cells in region X are squarish in shape*

   cells in region Y are elongated [2]

® cells in region X has no nucleus, cells in region Y has nucleus

[Total: 17]

3 Respiratory quotient (RQ) is a measurement of the ratio of carbon dioxide given out to oxygen taken in. The RQ value act as an indication of the respiratory substrate used.

$$RQ = \frac{CO_2 \text{ given out}}{O_2 \text{ taken in}}$$

Carbohydrates often give a RQ of 1.0, while protein and fats give 0.8 and 0.7, respectively.

Yeast are unicellular eukaryotic organisms that respire using a range of substrate

You are required to plan, but not carry out, an experiment to investigate the RQ when yeast is metabolising different carbohydrates in respiration.

You must use:

- active yeast suspension in small conical flask
- 5% glucose
- 5% sucrose
- rubber bung with delivery tube
- soda lime in syringe
- T-shaped connecting tube
- capillary tube
- blue ink

Fig. 3.1 shows part of the experimental setup.

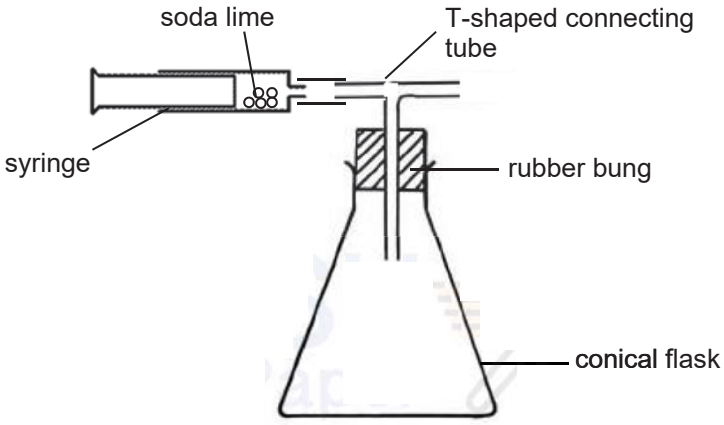


Fig. 3.1

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

- normal laboratory glassware, e.g. test-tubes, boiling tubes, beakers, measuring cylinders, graduated pipettes, glass rods, etc.
- syringes
- timer, e.g. stopwatch
- thermostatically regulated electrical water bath

Your plan should:

- have a clear and helpful structure such that the method you use is able to be repeated by anyone reading it
- be illustrated by relevant diagram(s), if necessary, to show, for example, the arrangement of the apparatus used
- identify the independent and dependent variables
- describe the method with the scientific reasoning used to decide the method so that the results are as accurate and repeatable as possible
- include layout of results tables and graphs with clear headings and labels
- use the correct technical and scientific terms
- include reference to safety measures to minimise any risks associated with the proposed experiment

[Total: 14]

[T]	*1.*	***explains that O_2 is taken in as final e- acceptor in ETC***
		CO_2 is given out in link rxn & Krebs cycle
[IV]	*2.*	***states indep var is type of carbohydrate***
[DV]	*3.*	***states dep var is RQ***
		measured by O_2 uptake and CO_2 given out
	4.	***describes how O_2 uptake is measured e.g. distance moved by ink droplet in presence of soda lime***
		explain CO_2 given out is absorbed by soda lime thus $\triangle$ in air vol is solely due to O_2 taken in
	5.	***describes how CO_2 given out is measured e.g. distance moved by ink droplet in absence of soda lime***
		explain CO_2 given out is no longer absorbed thus ink movement is due to net diff in O_2 taken in & CO_2 given out
	6.	***calculate CO_2 given out as difference in distance travelled by ink droplet with & without soda lime***
[CV]	*7.*	***identify controlled var e.g. vol of yeast & resp substrate***
		describes how to control it e.g. using 5 cm^3 and 10 cm^3
	8.	***identify controlled var e.g. temp***

		describes how to control it e.g. 35^{o}C in thermostatically-regulated electrical water bath
[CS]	***9.***	***describe control e.g. replace active yeast with boiled and cooled yeast of same vol, all other conditions same as experimental setup***
		state purpose of control
[P]	***10.***	***equilibration at desired temp***
		acclimatisation after adding resp substrate to yeast
	11.	***logical, coherent seq of steps***
		reasonable duration of rxn e.g. 2 min
	12.	***diagram of setup e.g. fitting of capillary tube, water bath etc.***
[R+R]	***13.***	***3 replicates***
		2 repeats
[R]	***14.***	***results table with appropriate layout***
		headings and units
[S]	***15.***	***identify hazard, its corresponding risk and describes safety precaution***
		e.g. HCO_3 is skin irritant, wear gloves when handling

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