H

RAFFLES INSTITUTION
2017 Year 6 Preliminary Examination

Higher 2

BIOLOGY 9744/01

Paper 1 Multiple Choice **26th September 2017**

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

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

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

Read the instructions on the Answer Sheet very carefully.

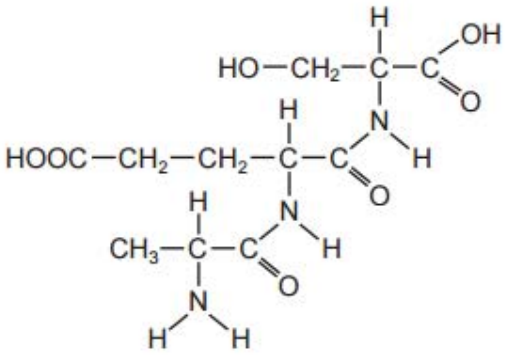
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **20** printed pages.

Raffles Institution
Internal Examination

1. Sample A contains a mixture of biological molecules. It was tested using Benedict's reagent, biuret solution and ethanol. After testing, the solutions were blue with the Benedict's test, purple with the biuret test and cloudy with ethanol emulsion test.

1



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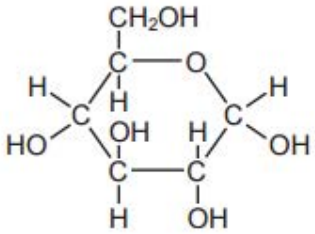

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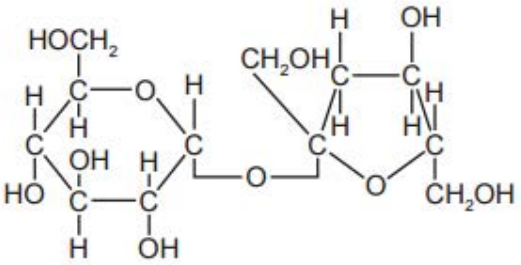

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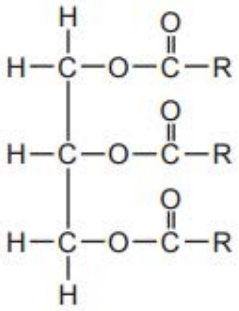


Which molecules could the mixture contain?

A **1** only

B **3** and **4** only

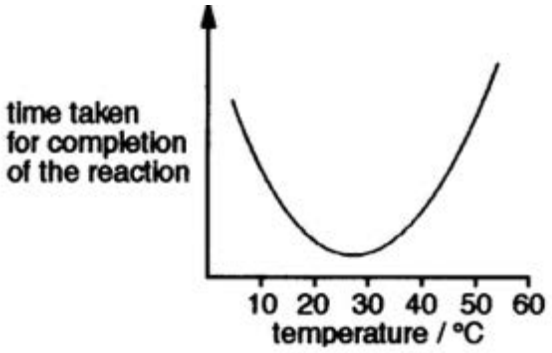
C **1**, **3** and **4** only

D **2**, **3** and **4** only

2. A fixed concentration of this enzyme was added to a fixed concentration of its substrate. The time taken for completion of the reaction was measured at different temperatures from 5°C to 55°C. An enzyme was found to be completely denatured at 50°C.

Which of the following is true?

I The graph below represents the above reaction.



II As the temperature increases, the activity of the enzymes increases.

III The optimum temperature of the enzyme is less than 50°C.

IV The kinetic energy of the molecules was highest at 50°C.

A **I** and **III** only

B **I** and **II** only

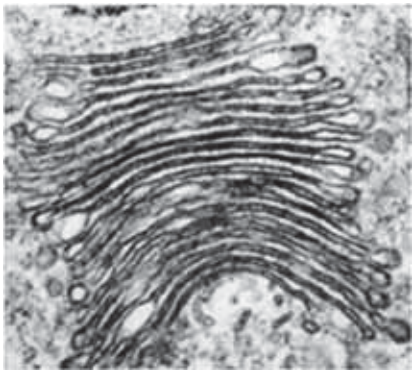
C **II** and **IV** only

D **III** only

3. As part of a medical check-up, a doctor decided to conduct a liver biopsy for his patient who is a chronic alcoholic. After the patient's liver cells had been extracted and examined. It was compared to a normal cell.

Which of the following organelles could he expect to see in higher quantities?

A



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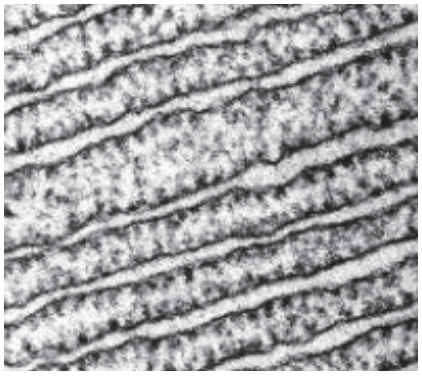
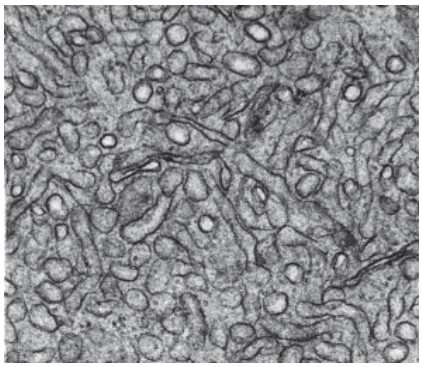
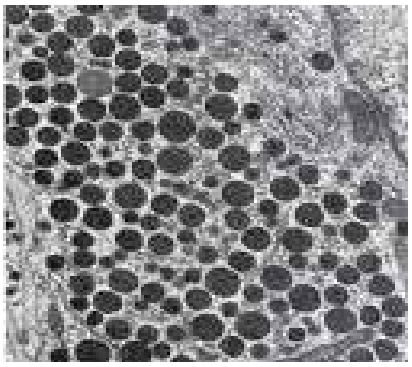


C



D



4. Beetroot cells contain a water-soluble red pigment. Two test tubes were set up as described in the table.

tube 1	Pieces of washed raw beetroot in water
tube 2	Pieces of washed raw beetroot in water containing 3 drops of cyanide, a respiratory inhibitor.

After 30 minutes, the water in tube 2 contained a red pigment but the water in tube 1 did not.

Which of the following statements are false for tube 2?

I Pigment molecules passed out and were replaced by cyanide.

II The cell membrane was unable to retain the red pigment.

III Water entered the tissue by osmosis and caused the cells to burst.

IV Water passed out of the cells by osmosis and carried the soluble pigment with it.

V The same result will occur if ethanol was used instead of cyanide.

A **I** and **III** only

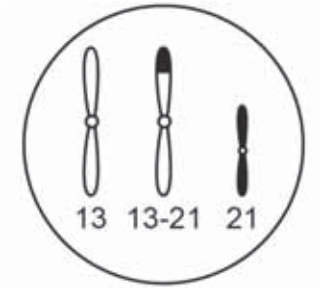
B **III** and **IV** only

C **II** and **V** only

D **I**, **III** and **IV** only

5. Down's syndrome can be caused by a trisomy of chromosome 21, but can also result from translocation of chromosome 21 onto chromosome 13, forming a single chromosome 13-21.

The diagram below shows chromosomes 13 and 21 in the nucleus of a diploid (2n) testis cell from a phenotypically normal male carrier of a 13-21 translocation. This cell has a chromosome number of 45.



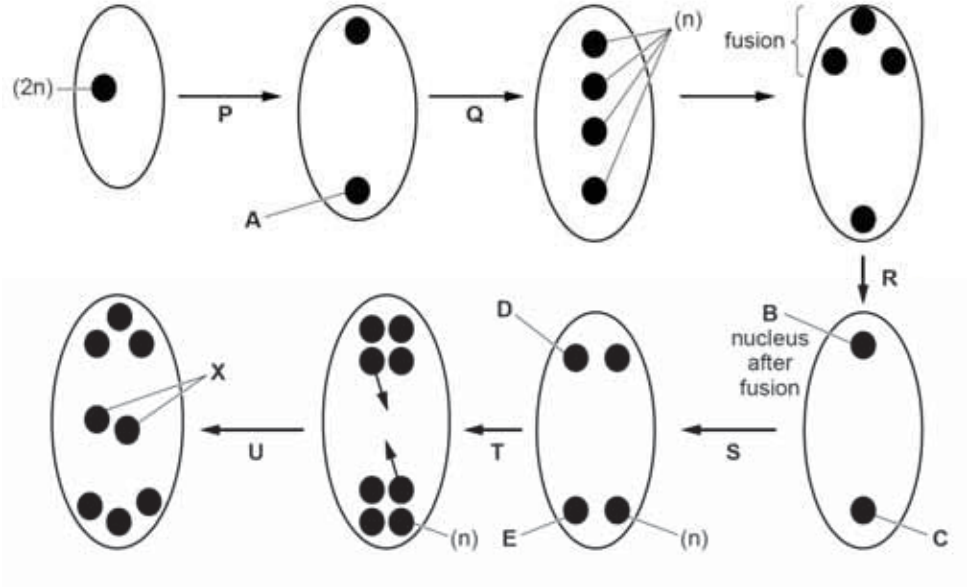
Which is not a likely outcome of fertilisation of normal oocytes by sperm from this male?

	chromosomes in sperm	**embryo**
A	13 and 21	2n = 46 normal phenotype
B	13-21	2n = 45 normal phenotype
C	13-21 and 21	2n = 46 Down's syndrome
D	13-21 and 21	2n = 47 Down's syndrome

6. The development of the embryo sac in flowering plants involves both mitosis and meiosis. Details of this development can vary in different plants.

The diagrams summarise the development of the egg cell within the embryo sac of *Lilium* sp.

Some of the nuclei have been labelled to indicate the ploidy: n = haploid; 2n = diploid.

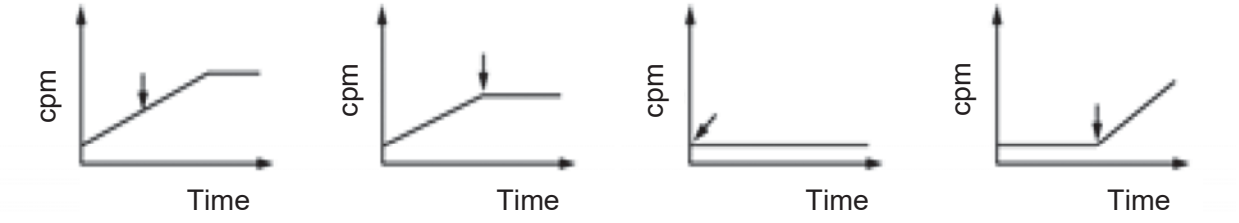


Choose the option that correctly matches mitosis and meiosis to P, Q, S and T.

	P	Q	S	T
A	mitosis	meiosis 1	meiosis 2	mitosis
B	meiosis 1	meiosis 2	mitosis	mitosis
C	mitosis	meiosis 2	mitosis	meiosis 1
D	meiosis 1	meiosis 2	mitosis	meiosis 1

7. The graphs below represent the various curves obtained in a project to study the effect of antibiotics on bacteria.

Radioactively-labelled amino acids were added to bacterial cultures. Various antibiotics, represented by arrows, were added at different times. The peptide products obtained were analysed as counts per minute (cpm).



I **II** **III** **IV**

Which of graph(s) represent the addition of an antibiotic that binds irreversibly to the A site of the ribosome?

A **III** only

B **IV** only

C **I** and **IV** only

D **II** and **III** only

8. Use the table to answer the following question.

Three-letter codons of messenger RNA and the amino acids specified by the codons

AAU, AAC – Asparagine	CAU, CAC – Histidine	GAU, GAC – Asparatic acid	UAU, UAC – Tyrosine
AAA, AAG – Lysine	CAA, CAG – Glutamine	GAA, GAG – Glutamate	UAA, UAG – Stop
ACU, ACC, ACA, ACG – Threonine	CCU, CCC, CCA, CCG – Proline	GCU, GCC, GCA, GCG – Alanine	UCU, UCC, UCA, UCG – Serine
AGU, AGC – Serine AGA, AGG – Arginine	CGU, CGC, CGA, CGG – Arginine	GGU, GGC, GGA, GGG – Glycine	UGU, UGC – Cysteine UGA – Stop UGG – Tryptophan
AUU, AUC, AUA – Isoleucine AUG – Methionine	CUU, CUC, CUA, CUG – Leucine	GUU, GUC, GUA, GUG – Valine	UUU, UUC – Phenylalanine UUA, UUG – Leucine

A cell grown in the presence of radioactively-labelled uracil is actively producing a protein containing lysine.

Which of the following would be radioactive?

A The amino acid lysine.

B The codons for lysine.

C The anticodons for lysine.

D The DNA code for lysine.

9. The following table shows the genome size, number of genes and chromosome number for a variety of organisms.

organism	genome size (kilo bp)	number of genes	chromosome number
E. coli	4,000	4,000	n = 1
Yeast	12,000	6,000	2n = 12
Amoeba	290,000,000	No data	500-1000 (possibly polyploid)
Mouse	3,000,000	No data	2n = 64
Rhesus monkey	3,000,000	No data	2n = 42
Fruit fly	137,000	14,000	2n = 8
Humans	3,000,000	30,000	2n = 46

From this data it is possible to conclude that

A there is more non-coding DNA in humans than in the bacterium.

B as chromosome number increases, so do the number of genes.

C the mouse and the rhesus monkey will have the same number of genes.

D the genome size relates to the complexity of an organism.

10. Transcription factors in eukaryotes must be able to perform the following functions except

A transcribe different classes of RNA.

B enter and leave the nucleus.

C interact with RNA polymerase.

D bind to DNA.

11. Which of the following statement(s) regarding viruses is/are incorrect?

I When viruses go through antigenic drift, two different viruses may have infected a single host cell and recombined into a new virus.

II The DNA-dependent RNA polymerases that are required for the replication of influenza viral genome in the host cell are of viral origin.

III Cytotoxic T cells can kill virus-infected target cells by releasing perforins that create pores in the infected cell and lysozymes that activate enzymes that trigger apoptosis of the cell respectively.

IV The enzyme integrase is involved in the integration of viral DNA into the host cell genome in both the lambda phage and human immunodeficiency virus life cycles.

V For the influenza virus to enter the host cell, haemagglutinin on the host cell membrane binds to a sialic acid receptor of the virus.

A **IV** only

B **I**, **II** and **IV** only

C **I**, **II, III** and **V** only

D All of the above

12. Which of the following statement(s) is/are true?

I A mutation that inactivates the regulatory gene of a repressible operon in *E.coli* would result in the continuous transcription of the structural genes that are controlled by that regulator.

II During generalised transduction, the prophage may be improperly excised to include the adjacent segment of bacterial DNA during an induction event.

III A mutation in the regulatory gene that resulted in the permanent repression of the *lac* operon could be due to the inability of the mutant repressor to bind to the inducer.

IV The F factor on the F plasmid, codes for proteins necessary for the formation of sex pili and subsequent cytoplasmic mating bridge, allowing for conjugation to occur between bacteria.

A **III** only

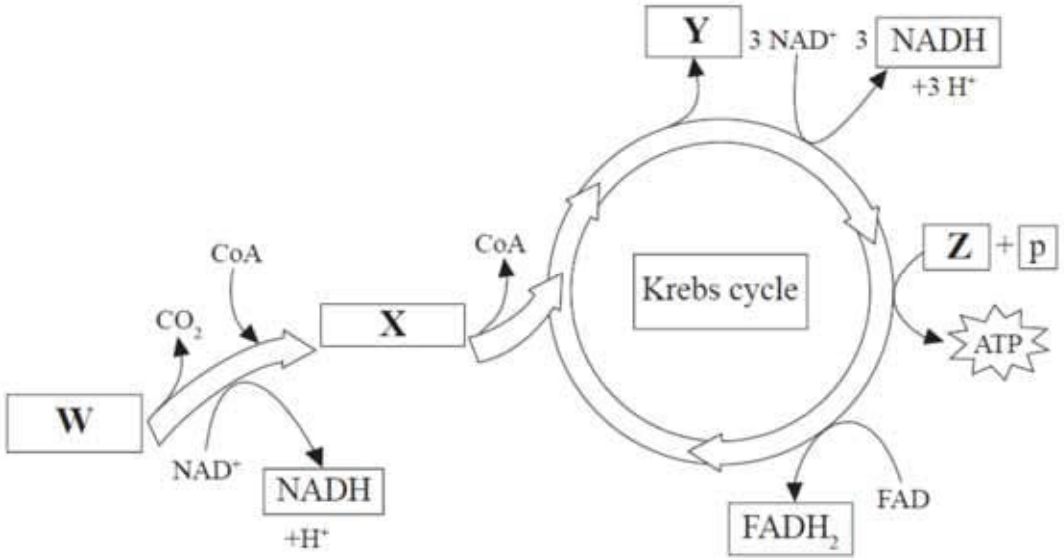
B **I** and **II** only

C **I**, **III** and **IV** only

D All of the above

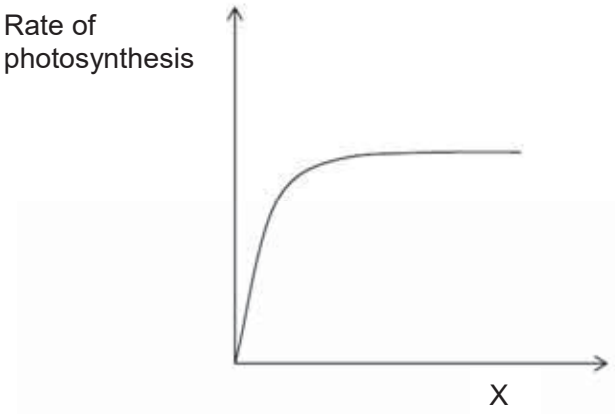
13. The diagram below shows the link reaction and stages of the Krebs cycle.

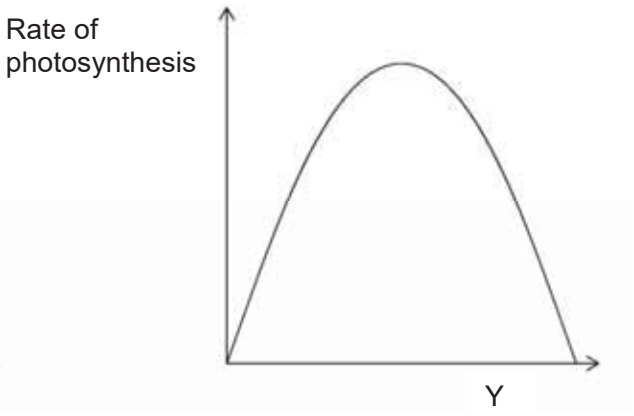
Which molecules are represented by the letters W, X, Y and Z?



	W	X	Y	Z
A	acetyl CoA	carbon dioxide	ADP	pyruvate
B	pyruvate	acetyl CoA	carbon dioxide	ADP
C	pyruvate	acetyl CoA	citrate	ATP synthase
D	acetyl CoA	pyruvate	carbon dioxide	ADP

14. Which limiting factors of photosynthesis are represented by X and Y?





	X	Y
A	carbon dioxide concentration	temperature
B	temperature	carbon dioxide concentration
C	light intensity	carbon dioxide concentration
D	temperature	light intensity

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

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

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

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

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

	blue-flowered plant	purple-flowered plant
A	AABB	AaBb
B	AaBb	Aabb
C	aaBB	AaBB
D	aaBb	aaBb

16. A cross between a round-leafed, tall plant and round-leafed dwarf plant produced the following offspring:

	Key
121 round-leafed, tall plant	**R** – round leaf
124 round-leafed, dwarf plant	**r** – oval leaf
42 oval-leafed, tall plant	**T** – tall
37 oval-leafed, dwarf plant	**t** – dwarf

Which of the following statements are correct?

I The parental genotypes are **RrTt** x **Rrtt**.

II **R/r** and **T/t** loci are found on the same chromosome.

III The progeny are results of a test cross.

IV Crossing over occurred between the **R/r** and **T/t** loci during the formation of gametes in the parents.

A **I** only

B **II** and **IV** only

C **II** and **III** only

D **II**, **III** and **IV** only

17. When a polymerase chain reaction amplification was performed on a sample of human genomic DNA, multiple products of varying sizes were obtained, including one of the expected size.

Which of the following modifications to the protocol is the most likely to eliminate the extra PCR products?

A raising the annealing temperature from 52°C to 58°C

B raising the elongation temperature from 70°C to 76°C

C decreasing the number of cycles from 30 to 20

D decreasing the amount of template DNA from 1.0 μg to 0.5 μg

18. A restriction enzyme recognises specific DNA nucleotide sequences and cleaves the DNA at those positions. This can be used to detect DNA polymorphisms that are found within these sites.

Why is it not always possible to use restriction fragment length polymorphism (RFLP) to detect a mutation involving a disease-causing allele?

A Not all disease-causing alleles have an associated RFLP.

B Point mutations can never be distinguished using RFLP.

C Use of RFLP is restricted to genetic diseases that are heritable.

D The temperature required in Southern hybridisation is unknown.

19. Which is a correct statement about obtaining human embryonic stem cells for research?

A Removal of these cells is considered to be ethically acceptable as normal development of the embryo is not inhibited.

B The cells must be removed at an early stage of development from a region of the blastocyst known as the inner cell mass.

C The cells must be removed within a day following the successful fertilisation of the ovum by the sperm, and after checking for normal mitotic division.

D The region of the blastocyst from where the cells are removed is an area that develops at a later stage into the placenta.

20. Which of the following statements about the control of enzyme activity by phosphorylation is correct?

A Phosphorylation of an enzyme is not a reversible process since it is a covalent modification.

B Phosphorylation of an enzyme occurs by protein phosphatases.

C Phosphorylation of an enzyme is an intracellular process and cannot occur in response to external signals.

D Phosphorylation of an enzyme results in a conformational change.

21. Which of the following statements about the integration of fat and carbohydrate metabolism control is correct?

A Low insulin/glucagon ratio inhibits lipolysis in liver cell.

B High insulin/glucagon ratio increases the number of GLUT4 at the plasma membrane of pancreatic cell.

C Low insulin/glucagon ratio activates conversion of glycogen to glucose in liver cell.

D High insulin/glucagon ratio stimulates conversion amino acids to glucose in muscle cell.

22. *Porphyrio hochstetteri*, is a flightless bird that is restricted to a small area of the South Island of New Zealand. It is one of only two remaining species of large, flightless, herbivorous birds from New Zealand. All the other species are extinct. *Porphyrio hochstetteri* was thought to be extinct, but a small population was discovered in 1948 in remote mountains of the South Island.

Which of the following statement(s) about the flightless bird population is/are incorrect?

	reasons for birds to evolve to become flightless in New Zealand	**threats to remaining species of flightless birds in New Zealand**
I	There were available niches.	A change in the environment.
II	There were no/few predators.	No change in the environment.
III	Suitable food on the ground was abundant.	The emergence of a disease.
IV	Flight requires considerable energy.	The introduction of predators by humans.

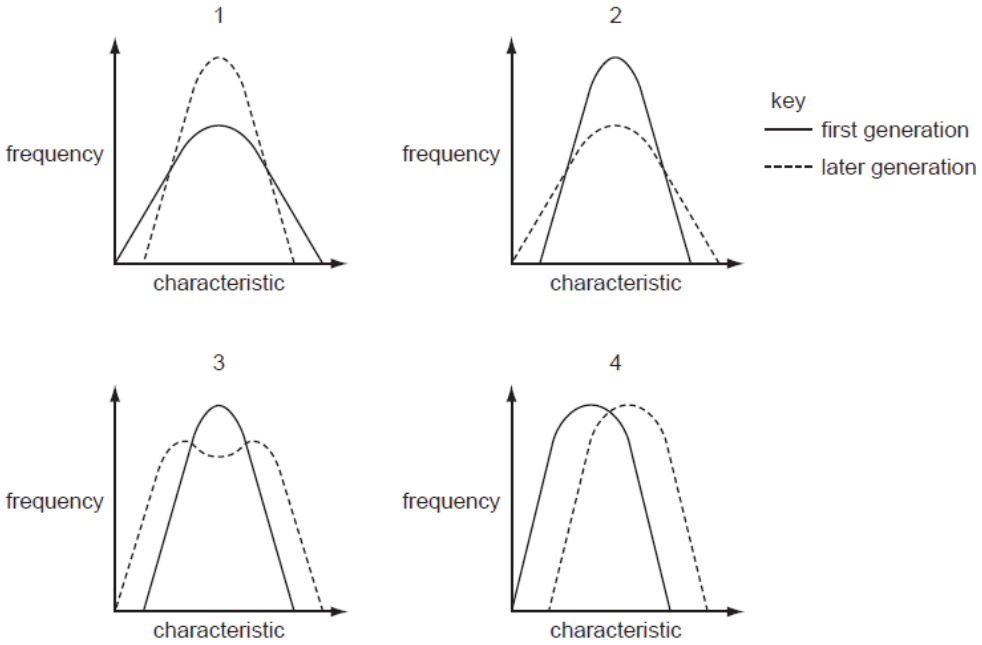
A **II** only

B **I** and **III** only

C **II** and **III** only

D All of the above

23. The graphs show frequency against a measured characteristic in the first and a later generation of a species.



Which graph represents each type of natural selection?

	directional	disruptive	stabilising
A	4	3	2
B	2	3	4
C	3	1	2
D	4	3	1

24. Phenylketonuria (PKU) is an autosomal recessive genetic disorder characterised by a deficiency in the enzyme phenylalanine hydroxylase. This enzyme is necessary to metabolise the amino acid phenylalanine to the amino acid tyrosine. When phenylalanine hydroxylase is deficient, phenylalanine accumulates and is converted into a toxic substance. Left untreated, this condition causes problems with brain development, leading to progressive mental retardation and seizures.

Which of the following maintains the presence of this harmful allele in a population's gene pool?

A heterozygote advantage

B heterozygote protection

C frequency-dependent selection

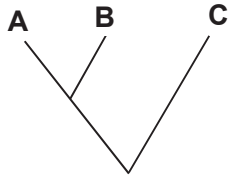
D natural selction

25. Cytochrome c is a protein found in most organisms. The amino acid sequence of this protein varies between species. The number of differences in the amino acid sequences in cytochrome c between three species of chordates, A, B and C are shown in the table below.

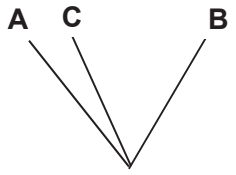
	species B	**species C**
species A	11	3
species B		10

Based on this evidence, the phylogenetic tree that best represents the possible evolutionary relationships between the three species is:

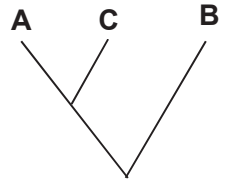
A



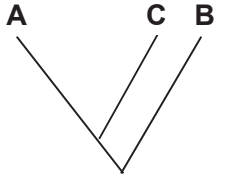
B



C



D



26. What is/are the function(s) of macrophages during an immune response?

1 engulf pathogens and apoptotic cells

2 present antigens to naïve B cells

3 secrete signal molecules to recruit other immune cells

A **1** only

B **1** and **3** only

C **2** and **3** only

D All of the above

27. The heavy and light chains of an immunoglobulin are encoded by _____ that is/are rearranged during B cell development. This gives rise to a great diversity of immunoglobulins in an individual, where each immunoglobulin has a specific _____complementary to an _____on a pathogen.

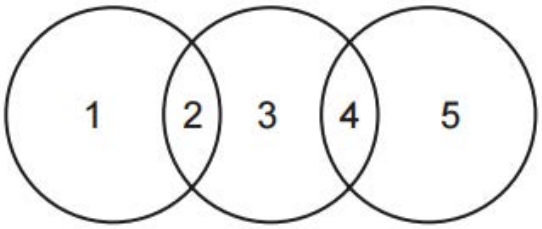
A a single continuous RNA sequence ; epitope ; antigen

B a single continuous DNA sequence ; antigen-binding site ; antigenic determinant

C sets of gene segments ; epitope ; antigen

D sets of gene segments ; antigen binding site ; antigen

28. The diagram shows the relationship between influenza, tuberculosis and dengue.



Which of the following options is correct?

	1	2	3	4	5
A	dengue	bacteria	tuberculosis	airborne	influenza
B	influenza	waterborne	dengue	bacteria	tuberculosis
C	influenza	virus	tuberculosis	waterborne	dengue
D	tuberculosis	airborne	influenza	virus	dengue

29. Which effect of temperature increase on arctic ecosystems, will increase carbon dioxide in the atmosphere?

A Greater production of plants due to warmer temperatures and changing vegetation.

B Greater decomposition of organic matter currently stored in permafrost.

C Less ice and snow will cause incoming radiation to be absorbed more readily.

D Melting ice from glaciers and icebergs will cause sea levels to rise.

30. Which statement is likely to be false?

A Due to global warming, in the Northwest Atlantic, some of the commercial fish stocks will show significant range shifts due to warming sea temperatures.

B With increasing global temperatures, more radiation from sun will be reflected from the Earth's surface.

C Due to global warming, seedling survival of a few tree species will decrease due to lower rainfall in the Southern Appalachians mountains.

D Due to global warming, coastal mudflats and estuaries can disappear affecting the survival of migratory birds.

End of Paper

ANSWERS

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

H

RAFFLES INSTITUTION
2017 Year 6 Preliminary Examination

Higher 2

CANDIDATE NAME

CIVICS GROUP | 1 | 7 | S | 0 | 3 |

INDEX NUMBER

BIOLOGY

9744/02

Paper 2 Structured Questions

19th September 2017

2 hours

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

READ THESE INSTRUCTIONS FIRST

Write your index number, CT group & name in the spaces at the top of this page.
Write in dark blue or black pen.
You may use a HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES

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

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
1	/ 7
2	/ 11
3	/ 10
4	/ 12
5	/ 11
6	/ 13
7	/ 15
8	/ 10
9	/ 11
Total	/ 100

This document consists of **25** printed pages.

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Internal Examination

Answer **all** the questions.

1 Collagen is the main structural protein in the human body. It strengthens the tendons and supports the skin and internal organs. Fig. 1.1 shows the organisation of collagen fibres.

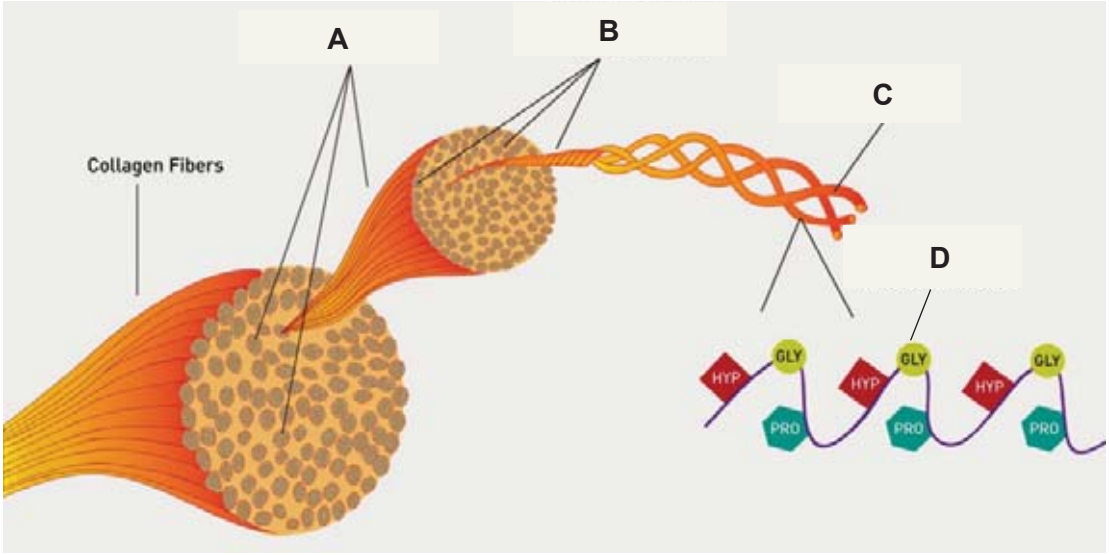

Fig. 1.1

(a) Label structures **A**, **B**, **C** and **D** in Fig. 1.1.

A .....

B .....

C .....

D .....[2]

(b) With reference to Fig. 1.1, describe the bonds involved in the formation of collagen which contribute to its high tensile strength.

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.....[2]

(c) Certain pathogenic bacteria such as *Clostridium histolyticum*, have collagenases which digests collagen tissue of their hosts, causing a form of tissue death known as gangrene.

The action of collagenase can be seen in Fig.1.2, illustrating the specificity of the active site in binding to a segment of collagen and eventually cleaving it into 2 segments.

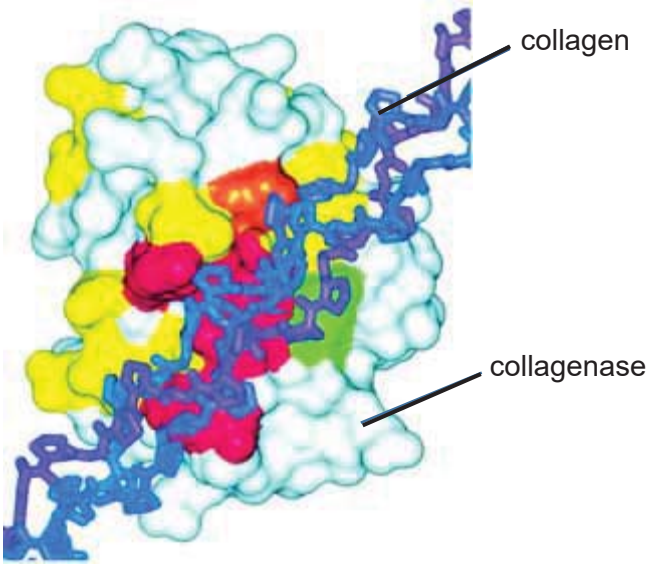

Fig. 1.2

(i) Explain the functions of amino acids residues situated at the active site of collagenase.

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.....[2]

(ii) Santyl® Ointment is an enzymatic ointment which contains collagenase. The enzyme collagenase is derived from *Clostridium histolyticum*.

Suggest a therapeutic use of collagenase.

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……...[1]

[Total : 7]

For Examiner's Use

2 Plant cells may be grown in culture and examined using the technique of immunofluorescence in which antibodies are used to attach fluorescent dyes to specific molecules within the cells.

Fig. 2.1 is an immunofluorescent light micrograph of a plant cell at metaphase of mitosis.

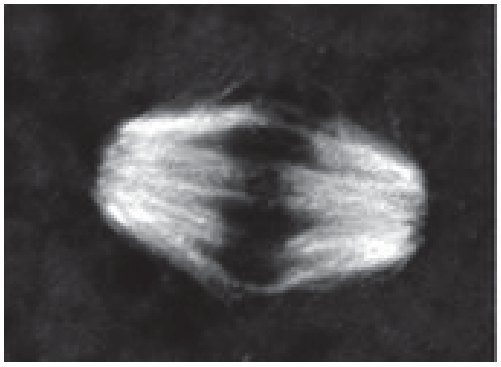

Fig. 2.1

(a) The cell in Fig. 2.1 has two areas that are brightly stained.

(i) Name the brightly stained structures in the two areas and outline their functions.

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…….....[3]

(ii) If a mutation occurred on the centromere of one copy of chromosome 5, suggest how this will affect mitosis.

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.....[3]

For Examiner's Use

(b) A variety of watermelon with small, sweet, seedless fruit has been produced by selective breeding. The melons also have thin skin and a uniform flavour throughout the fruit.

The selective breeding programme followed the sequence shown in Fig. 2.2.

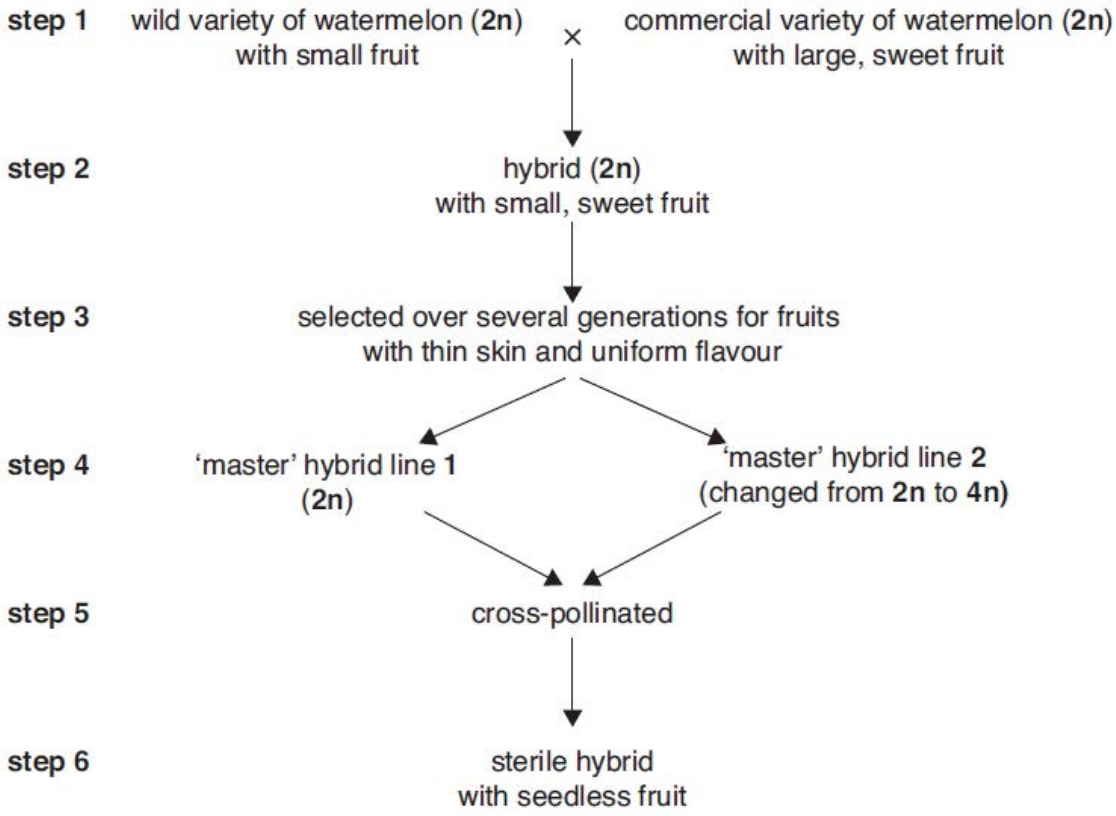

Fig. 2.2

With reference to Fig. 2.2,

(i) explain why several generations were needed in step 3,

.....

.....[1]

(ii) state what could have been used in step 4, so that the 'master' hybrid line 2 was changed from 2n to 4n and

…….....[1]

For Examiner's Use

(iii) explain why the hybrid produced in step 6 is sterile and seedless.

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……[3]

[Total: 11]

3 Fig. 3.1 shows the process of amino acid activation by an enzyme.

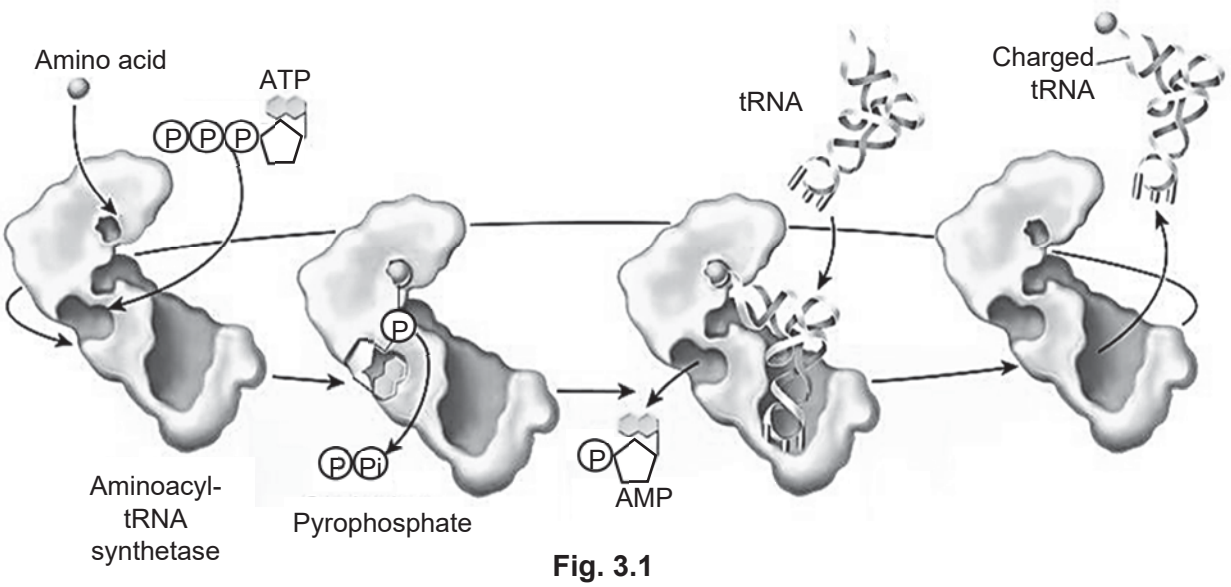

Fig. 3.1

(a) Explain how the enzyme shown in the Fig. 3.1 is specific.

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……

……

……[2]

(b) Explain why an amino acid needs to be activated.

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……[3]

(c) The enzyme in Fig. 3.1 exhibits the induced fit mechanism.

Explain the induced fit mechanism.

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……

……[2]

The amino acid sequence of the enzyme glucose isomerase has been determined. The first five amino acids of this sequence are shown in Fig. 3.2.

Amino acid sequence :	Met – Tyr – Glu – Pro – Lys
Nucleotide sequence :	AUG UAU GAA CCU AAA

Fig. 3.2

(d) Explain why an mRNA different from the one shown in Fig. 3.2 can result in the same amino acid sequence of Met – Tyr – Glu – Pro – Lys.

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……

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……[3]

[Total: 10]

For Examiner's Use

4 In eukaryotic cells, gene expression is regulated in a highly coordinated way.

The Ras protein stimulates the cell cycle through a series of reactions. Fig. 4.1 shows a simple description of the pathway in which the Ras protein acts.

A growth factor binds to receptor

↓

This helps Ras protein to bind to GTP instead of GDP, activating Ras protein

↓

Active Ras protein activates MAPK protein

↓

Active MAPK protein phosphorylates a transcription factor

↓

Active transcription factor switches on target genes

Fig. 4.1

(a) With reference to Fig. 4.1, state the level at which the expression of these genes are regulated:

(i) *Ras* gene, and

……..……..[1]

(ii) the target genes.

……..……..[1]

(b) Fig. 4.2 shows part of the process of RNA splicing. The snRNA (small nuclear RNA) is part of the spliceosome.

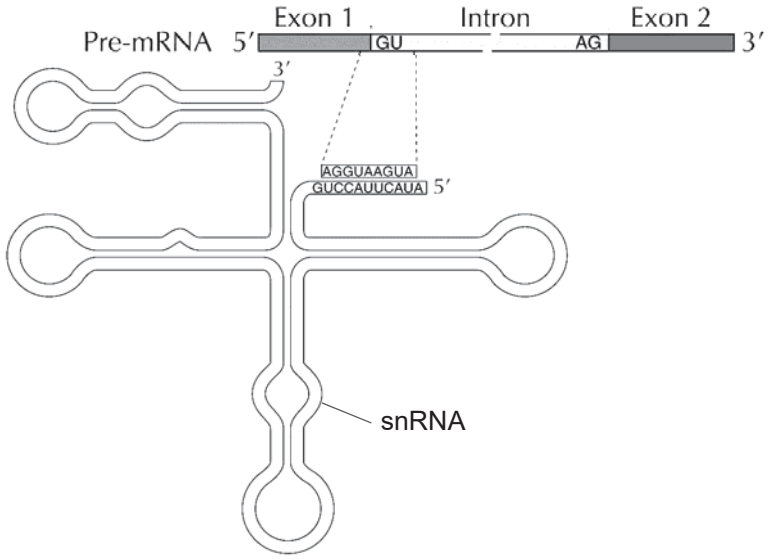

Fig. 4.2

(i) With reference to Fig. 4.2, describe the role of snRNA.

……

……

……

……[2]

(ii) Describe how regulation at the post-transcriptional level can be carried out via alternative splicing.

……

……

……

…… [2]

(iii) In the study of particular tissues, different mRNAs were produced from a single gene. However only a particular mRNA was detected at high levels.

Suggest how the structure of the mRNA accounts for this.

……

…… [1]

(c) Regulation of gene expression can also be carried out at the post-translational level.

Fig. 4.3 below shows the control gene expression using ubiquitin and proteasome.

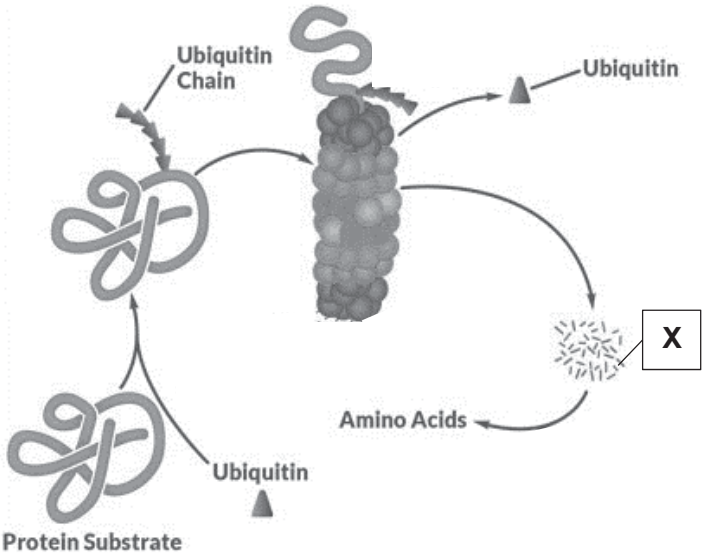

Fig. 4.3

(i) Name molecule **X**.

…… [1]

(ii) With reference to Fig. 4.3, explain how cellular proteins are degraded using this system.

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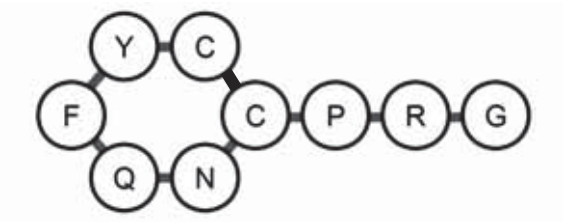
……..

…… [3]

Fig. 4.4. represents vasopressin, a small peptide hormone, with the following structure.



Key: C = cysteine, F = phenylalanine, G = glutamic acid, P = proline, Q = glutamine, R = arginine, Y = tyrosine, N = asparagine

Fig. 4.4

(iii) Describe one post-translational modification that must have occurred to form vasopressin.

……..……..[1]

[Total: 12]

For Examiner's Use

5 Cystic fibrosis is a human disorder related to abnormally thick and sticky mucus which can lead to damage in various body organs. Fig. 5.1 shows the inheritance of cystic fibrosis in a Norwegian family. Those individuals with the condition are shaded.

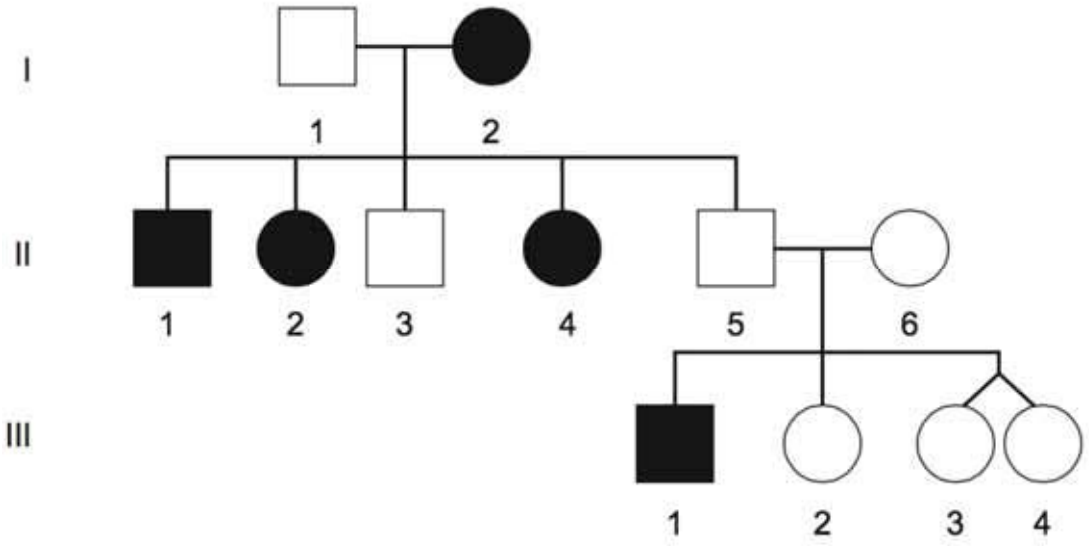


Fig. 5.1

(a) (i) State the mode of inheritance of cystic fibrosis and give two reasons to support your answer.

Mode of inheritance

……..[1]

Reason 1

……...……..……..……..

……...……..……..……..…

……...……..……..……..….[1]

Reason 2

……...……..……..……...

……...……..……..……..……

...……..……..……..……[1]

For Examiner's Use

(ii) Individuals III-3 and III-4 are identical twins. They were recruited for a study, looking for trait differences expressed by the two individuals. Of the 10 traits studied, they showed a difference in two of the traits.

Explain what the findings of such a study revealed.

……...……...……..

……..……...……[1]

(b) In the primula plant, the pigment malvidin creates blue-coloured flowers. Synthesis of malvidin is controlled by gene **A**. However, the production of this pigment is under the influence of another gene, gene **D**, which is found on a different chromosome. In the presence of gene product **D**, the primula plant will produce white flowers.

(i) White flowers were observed in plants that carried both the dominant alleles A and D.

Explain the interaction between gene A and gene D in influencing the colour of the primula flower.

……...……...……..

……...……...……...

……...……...……...…

……...……...……...…

……...……...……

……..……..……[3]

A cross between two primula plants with white flowers, heterozygous at both gene loci, yielded the following offspring:

Primula plants bearing blue flowers: 37
Primula plants bearing white flowers: 155

(ii) Draw a genetic diagram in the space provided, to explain the above cross.

[4]

[Total: 11]

6 Pyruvate, a product of glycolysis, needs to move from the cytosol into the mitochondrion. After some processing, pyruvate will be converted to acetyl Co A which then enters the Kreb cycle.

Fig. 6.1 is an electron micrograph of a mitochondrion.

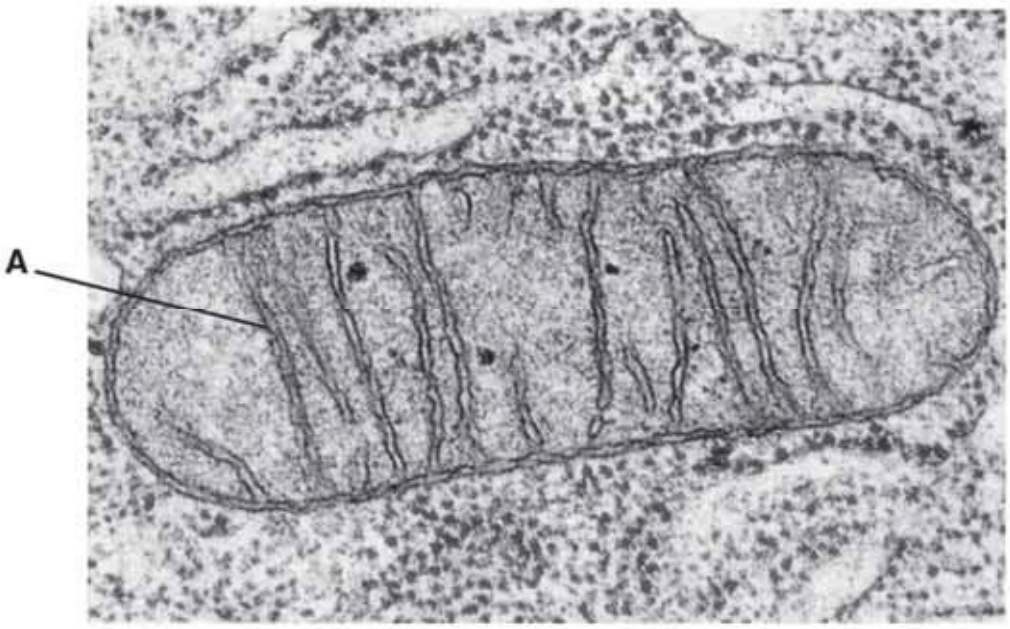


Fig. 6.1

(a) Name the region within the mitochondrion where the Krebs cycle occurs and using the symbol **X**, indicate this region on Fig. 6.1.

region **X**:…..……..……[1]

(b) Pyruvate requires the help of pyruvate translocase to enter the mitochondrion. The structure of pyruvate is shown in Fig. 6.2.

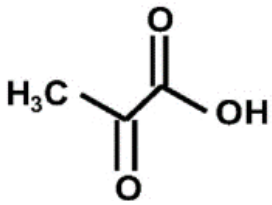


Fig. 6.2

Pyruvate translocase is located on the membrane labelled 'A' in Fig. 6.1.

Fig. 6.3 shows how pyruvate is transported across the membrane A.

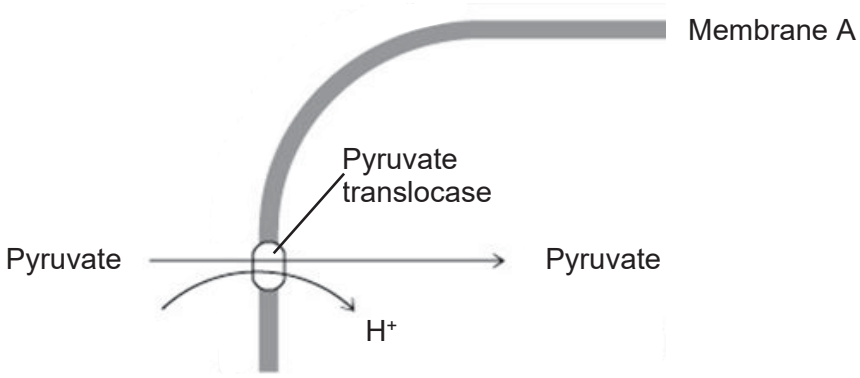


Fig. 6.3

(i) Explain why pyruvate requires the help of pyruvate translocase to cross membrane A.

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…… [2]

(ii) With reference to Fig. 6.3, describe the transport of pyruvate across membrane A.

……

…… [1]

(c) Other than pyruvate translocase, the electron transport chain and ATP synthase can also be found on membrane A.

(i) Explain how pyruvate translocase, the electron transport chain and ATP synthase are held in membrane A.

……

……

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…… [2]

(ii) Explain how mitochondria are adapted to contain many structures such as pyruvate translocase, the electron transport chain and ATP synthase.

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…… [1]

(d) Fig. 6.4 shows a section of membrane A.

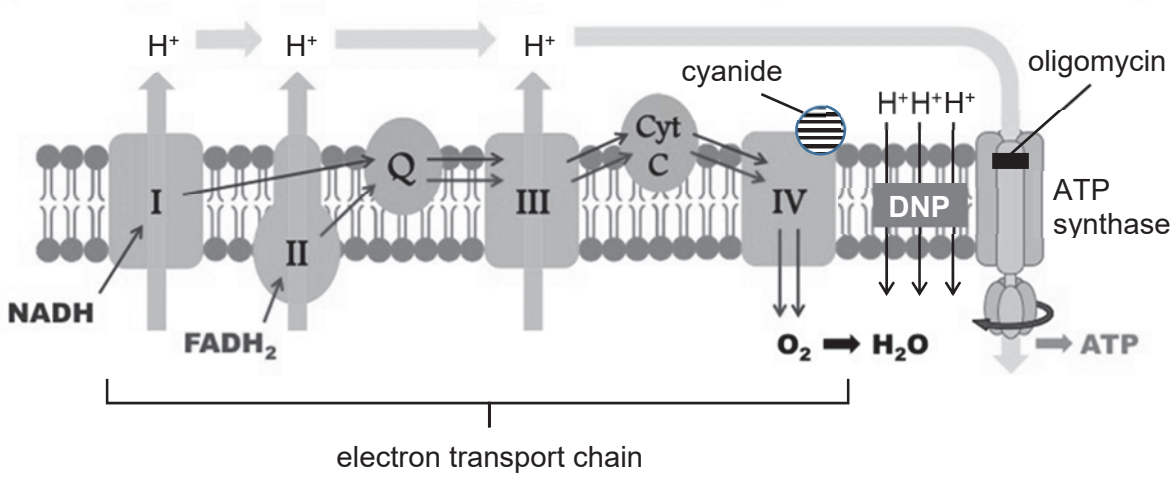

Fig. 6.4

Dinitrophenol (DNP), cyanide and oligomycin are chemicals that interfere with the normal functioning of the components shown in membrane A.

(i) DNP can shuttle H^+ across biological membranes.

With reference to Fig. 6.4, explain why fewer ATP molecules were produced when DNP was added to mitochondria.

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…… [1]

(ii) Cyanide inhibits complex IV shown in Fig. 6.4.

Explain why in the presence of cyanide, oxygen consumption decreases and lactate production increases.

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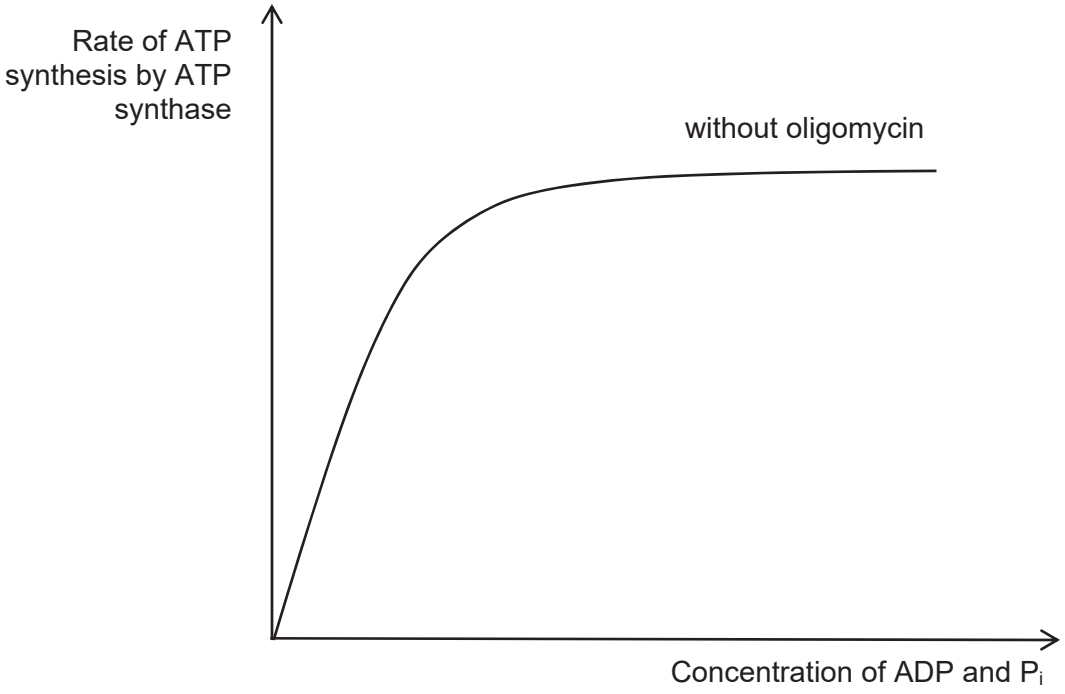
…… [4]

(iii) Oligomycin inhibits ATP synthase by blocking the proton channel, as seen in Fig. 6.4.

Indicate in the graph below, the effect of administering a fixed amount of oligomycin on the rate of ATP synthesis. [1]



[Total: 13]

For Examiner's Use

7 *Streptococcus pyogenes* bacteria causes a range of diseases including skin infections and respiratory illnesses. Treatment of the diseases is carried out using antibiotics such as penicillin and erythromycin.

In 1988, a nation-wide movement to reduce the use of the antibiotic erythromycin to treat patients infected with *S. pyogenes* was started in Finland.

Fig. 7.1 shows the number of doses of erythromycin used per thousand people per month, over a period of eleven years from 1984 to 1994. The figure also shows the percentage of infections each year caused by erythromycin-resistant strains of *S. pyogenes*.

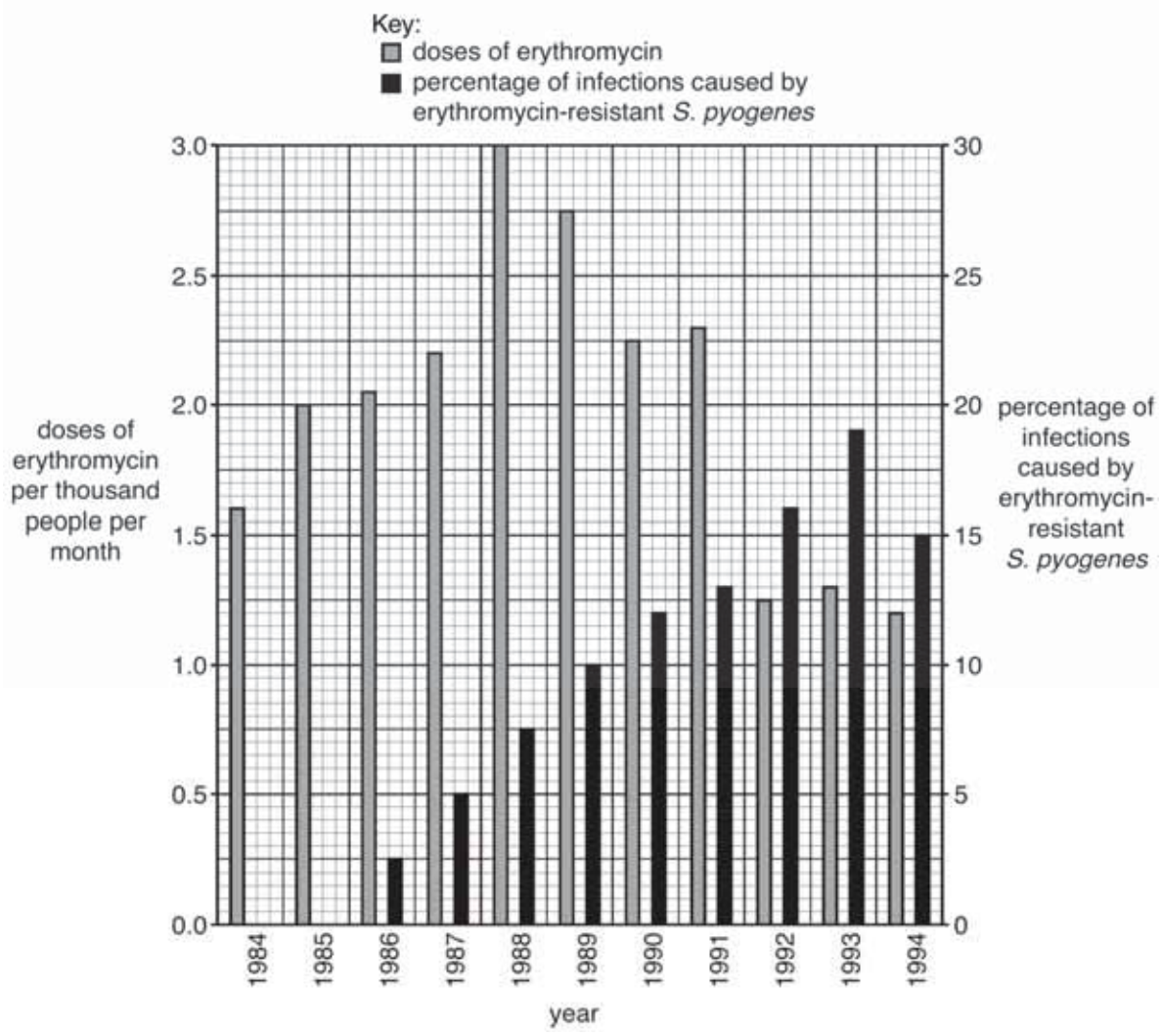


Fig. 7.1

(a) **(i)** Describe two structural features that are typical of bacteria, including *S. pyogenes*.

……

……

……

……[2]

(ii) Explain the advantages to scientists of giving the bacterium *Streptococcus pyogenes* a binomial Latin name.

……..

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……..

…….[2]

(b) **(i)** With reference to Fig. 7.1, describe the trend in the use of erythromycin between 1984 and 1994.

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……..[3]

(ii) Apart from mutation, suggest how the erythromycin-resistant *S. pyogenes* may have originated in Finland in 1986.

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……..[1]

(iii) Explain why the percentage of erythromycin-resistant bacterial infections increased between 1986 and 1993.

……..

……..

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……..

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……..

……..[4]

(iv) Suggest why the percentage of erythromycin-resistant bacterial infections fell between 1993 and 1994.

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……[2]

(c) In 2014, the World Health Organisation highlighted the prevalence of antibiotic resistance in bacteria as a global health threat. This prompted the urgent development of alternative methods to the use of antibiotics to treat bacterial infections.

Phage therapy, which is the use of bacterial viruses to defend against pathogenic bacteria is a strategy to address this issue.

Suggest an advantage of using phage therapy.

……

……[1]

[Total: 15]

8 Sea slugs are marine molluscs and two are shown in Figs. 8.1 and 8.2. Sea slugs live in shallow coastal waters where they graze on animals that form colonies on rocks, like sponges and corals. Sea slugs are preyed upon by fish.

Fig. 8.1

Fig. 8.2

Many sea slugs collect poisonous chemicals or defenses such as stinging cells from their prey. They then make use of these in their own bodies. Sea slugs containing poisonous chemicals or other defenses are generally brightly-coloured.

Sea slugs evolved from sea snails by the loss of the shell. It is thought that being brightly coloured is an advantage to poisonous animals.

For Examiner's Use

(a) Suggest why being poisonous and brightly-coloured is more common in sea slugs than in sea snails.

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……[2]

(b) The waters of South-Eastern Australia are home to a group of sea slugs found nowhere else in the world.

Three species of the genus *Chromodoris* all share a pattern of bright red spots on a white background. This is an example of mimicry. One of the *Chromodoris* species is shown in Fig. 8.1.

(i) Explain why one type of warning pattern shared by three species gives a greater selective advantage to the slugs than if each had its own distinctive warning pattern.

……

……

……

……[2]

(ii) Describe how a South-Eastern Australian sea slug population that was originally white might have developed the red-spotted pattern over a period of time.

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……[4]

For Examiner's Use

(iii) Explain how environmental factors can act as stabilising forces of natural selection in the waters of South-Eastern Australia, after the initial evolution of the three species of sea slugs of genus *Chromodoris*.

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……[2]

[Total: 10]

9 The Calvin cycle is a stage of photosynthesis during which carbon dioxide is fixed.

(a) **(i)** State the products of the light dependent stage that are used in the Calvin cycle.

……[1]

(ii) Describe the fate of the triose sugar produced in the Calvin cycle.

……

……

……

……[2]

(b) The conditions in which young plants of wheat and maize are grown affects their ability to photosynthesise at high and low temperatures when they mature.

Young maize plants were grown to maturity at high and low temperatures. When they were mature, their rate of photosynthesis was measured at different temperatures. The results are shown in Fig. 9.1.

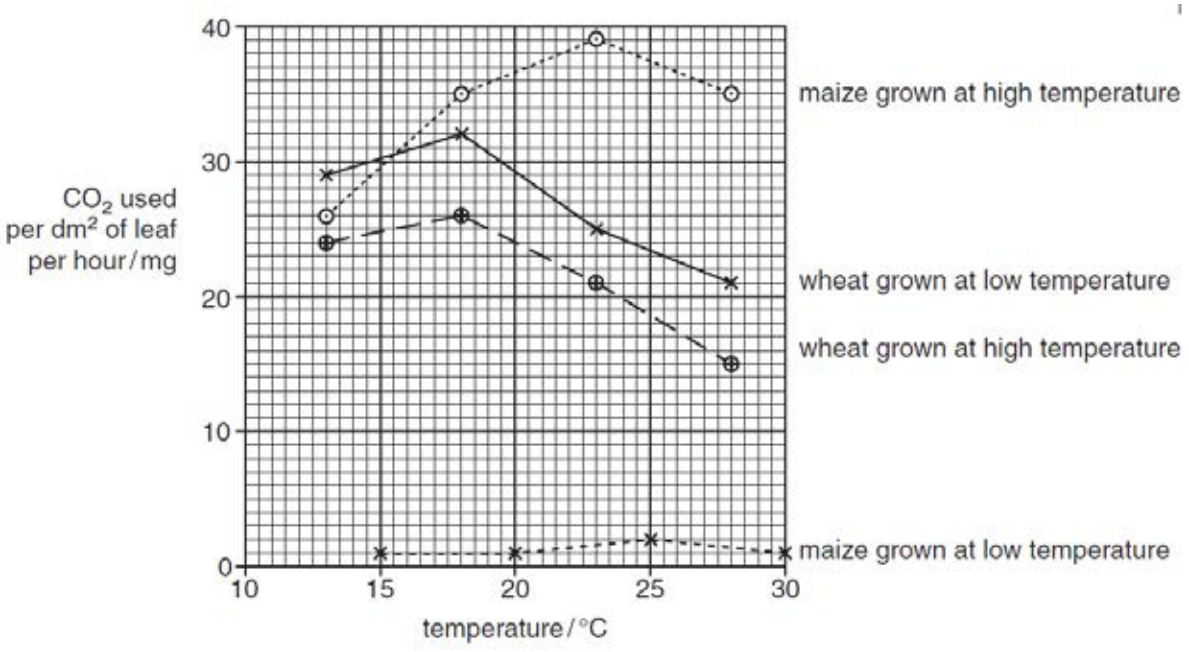

Fig. 9.1

(i) With reference to Fig. 9.1, compare the effect of temperature on the rate of photosynthesis of the maize plants and wheat plants that were grown at high temperature when they were young.

……..

……..

……..

……[2]

(ii) Low temperatures slow down the formation of membranes inside the chloroplasts in maize leaves but not in wheat leaves.

Use this information to explain the differences between the results for maize and wheat grown at low temperatures in Fig. 9.1.

……..

……..

……..

……[2]

(iii) In view of this information, suggest how maize farmers in temperate countries should adapt their practices to ensure higher yield in the field.

……..

……..……[1]

(c) Table 9.1 shows the yield in plot tests of the same variety of wheat grown at 18°C and 20°C.

No.	Wheat grown at 18°C	Wheat grown at 20°C
1	22.9	13.7
2	19.8	18.2
3	24.4	17.5
4	27.9	15.1
5	23.1	21.6
6	25.7	19.2
7	28.2	21.6
8	25.6	24.8
9	28.7	25.2
10	31.5	27.8
11	26.2	25.2
12	37.0	34.0
	Mean = 26.75	Mean = 21.99

Table 9.1

(i) Given that the t-test value is 2.26, examine the data and use the information given on the next page to decide whether or not the wheat grown at the 2 temperatures are different in yielding ability.

……..

……..

……..

……..……[2]

(ii) In view of global warming, suggest an implication of the finding in **c(i)**.

……..

……..……[1]

Degrees of freedom	Significance level					
	20% (0.20)	10% (0.10)	5% (0.05)	2% (0.02)	1% (0.01)	0.1% (0.001)
1	3.078	6.314	12.706	31.821	63.657	636.619
2	1.886	2.920	4.303	6.965	9.925	31.598
3	1.638	2.353	3.182	4.541	5.841	12.941
4	1.533	2.132	2.776	3.747	4.604	8.610
5	1.476	2.015	2.571	3.365	4.032	6.859
6	1.440	1.943	2.447	3.143	3.707	5.959
7	1.415	1.895	2.365	2.998	3.499	5.405
8	1.397	1.860	2.306	2.896	3.355	5.041
9	1.383	1.833	2.262	2.821	3.250	4.781
10	1.372	1.812	2.228	2.764	3.169	4.587
11	1.363	1.796	2.201	2.718	3.106	4.437
12	1.356	1.782	2.179	2.681	3.055	4.318
13	1.350	1.771	2.160	2.650	3.012	4.221
14	1.345	1.761	2.145	2.624	2.977	4.140
15	1.341	1.753	2.131	2.602	2.947	4.073
16	1.337	1.746	2.120	2.583	2.921	4.015
17	1.333	1.740	2.110	2.567	2.898	3.965
18	1.330	1.734	2.101	2.552	2.878	3.922
19	1.328	1.729	2.093	2.539	2.861	3.883
20	1.325	1.725	2.086	2.528	2.845	3.850
21	1.323	1.721	2.080	2.518	2.831	3.819
22	1.321	1.717	2.074	2.508	2.819	3.792
23	1.319	1.714	2.069	2.500	2.807	3.767
24	1.318	1.711	2.064	2.492	2.797	3.745
25	1.316	1.708	2.060	2.485	2.787	3.725
26	1.315	1.706	2.056	2.479	2.779	3.707
27	1.314	1.703	2.052	2.473	2.771	3.690
28	1.313	1.701	2.048	2.467	2.763	3.674
29	1.311	1.699	2.043	2.462	2.756	3.659
30	1.310	1.697	2.042	2.457	2.750	3.646
40	1.303	1.684	2.021	2.423	2.704	3.551
60	1.296	1.671	2.000	2.390	2.660	3.460
120	1.289	1.658	1.980	2.158	2.617	3.373
∞	1.282	1.645	1.960	2.326	2.576	3.291

$v = n_1 + n_2 - 2$

where v = degrees of freedom
n = sample size (number of observations)

[Total:11]

End of Paper

H

RAFFLES INSTITUTION
2017 Year 6 Preliminary Examination

Higher 2

CANDIDATE NAME

CIVICS GROUP | 1 | 7 | S | 0 | 3 | | INDEX NUMBER | | | | | | |

BIOLOGY

9744/03

Paper 3 Long Structured and Free-response Questions

14th September 2017

2 hours

Candidates answer on the Question Paper.
Additional Materials: Writing paper.

READ THESE INSTRUCTIONS FIRST

Write your index number, CT group & name in the spaces at the top of this page.
Write in dark blue or black pen.
You may use a HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES

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

Section B
Answer any **one** question in the writing paper provided.

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, **hand in your essay question SEPARATELY.**

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

For Examiner's Use	
Section A	
1	**/ 23**
2	**/ 27**
Section B	
3 or 4	**/ 25**
Total	**/ 75**

This document consists of **13** printed pages.

Raffles Institution
Internal Examination

[Turn over

1 **(a)** Epidermal growth factor (EGF) stimulates cell division and differentiation. Fig. 1.1 shows a cell signaling pathway triggered by EGF.

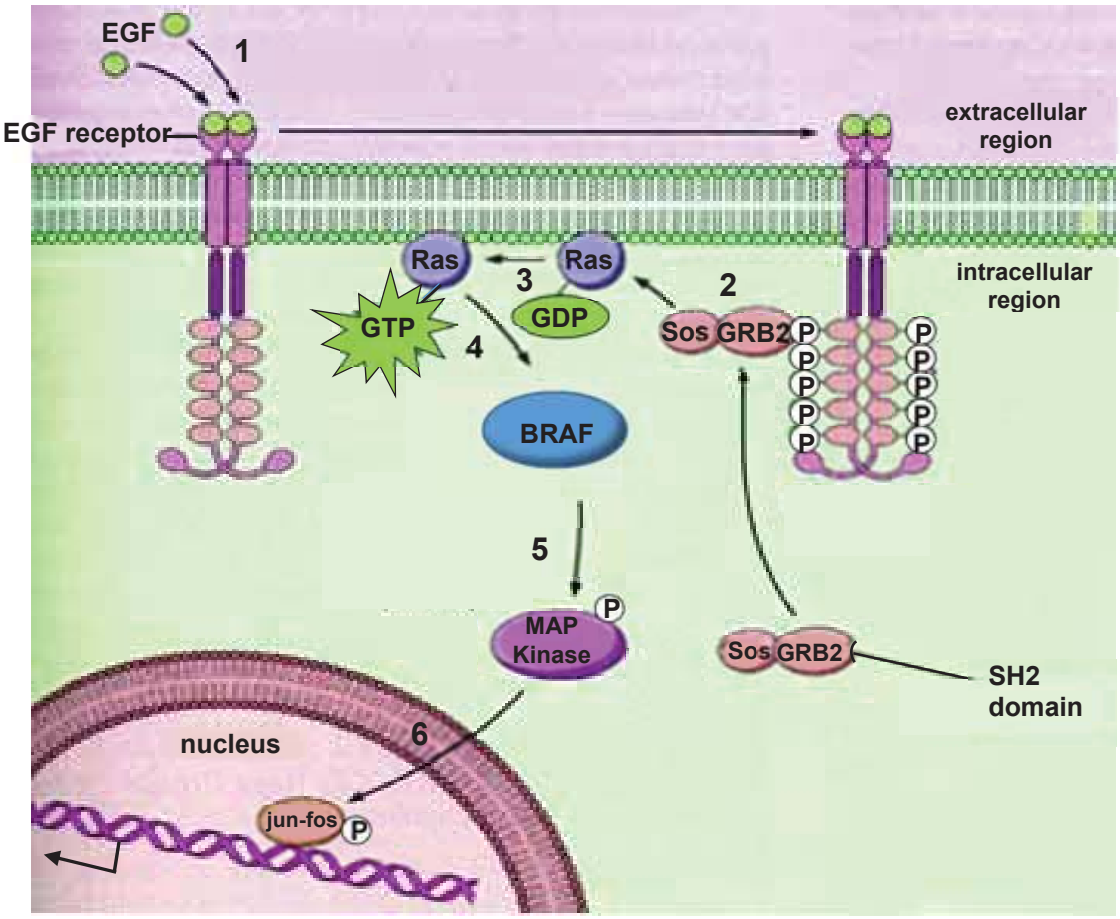

Fig. 1.1

(i) With reference to Fig.1.1, describe stages 1 to 5.

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.....[5]

(ii) With reference to Fig. 1.1, describe the cellular response caused by EGF.

.....

.....

.....

.....[2]

(iii) Cell signaling pathways are advantageous to multicellular organisms.

Describe two advantages of such a signalling pathway.

.....

.....

.....

.....[2]

(b) Lung cancer remains as one of the most aggressive cancer types with nearly 1.6 million new cases reported worldwide each year. Chronic exposure to carcinogens results in gene damage in lung epithelial cells causing them to become tumour cells.

Presence of EGF leads to apoptosis inhibition and cell proliferation. Mutations in at least 1 of the genes coding for the proteins shown in Fig. 1.2 have been found in tumour cells of lung cancer patients.

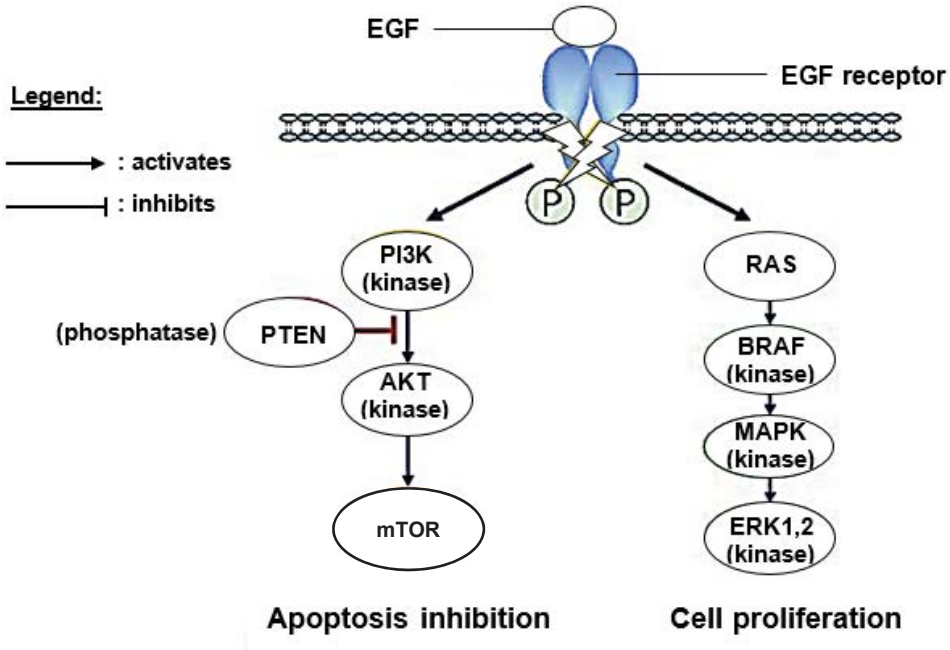

Fig. 1.2

(i) Name a carcinogen that can increase the chances of cancerous growth in the lungs.

.....[1]

(ii) Assuming the nucleotide sequence of the *Ras* gene was unchanged, suggest and explain one way in which a gain-in-function mutation of the *Ras* gene can occur.

.....

.....

.....

.....[2]

(iii) With reference to Fig. 1.2, suggest how *PTEN* functions as a tumour suppressor gene.

.....

.....

.....

.....[2]

(c) In stem and cancer cells, telomerase is activated to prevent the shortening of telomeres to a critical length.

The Hayflick Limit is the number of times a somatic cell will divide until cell division stops. Telomeres associated with each cell's DNA will shorten with each cell division until they shorten to a critical length.

(i) Describe the role of telomerase in cancer and stem cells.

.....

.....

.....

.....

.....

.....[3]

(ii) Telomerase activity is reactivated in tumour cells.

Suggest and explain how telomerase can be inhibited as a form of cancer therapy.

.....

.....

.....

.....[2]

(d) Fig. 1.3 shows the development of an embryonic stem cell into a somatic cell, and a somatic cell being reprogrammed into an induced pluripotent stem cell (iPSC).

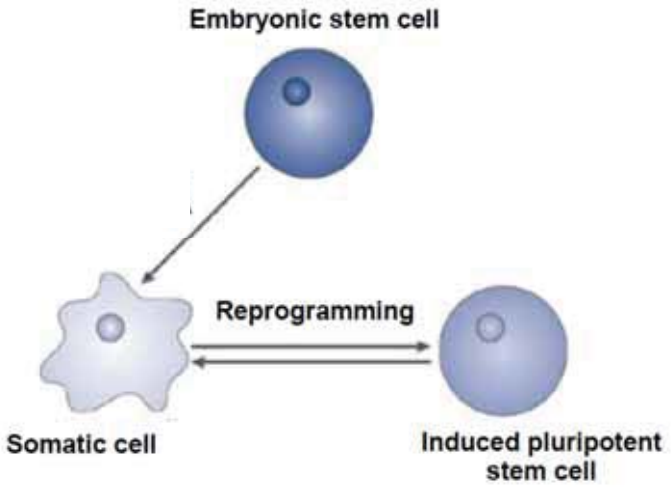

Fig. 1.3

Embryonic stem cells have been known to express a specific set of genes that enable them to behave like stem cells, but these genes are turned off in normal somatic cells. Researchers have discovered that they can convert human fibroblast cells into embryonic stem cells by switching on the specific set of genes. These cells have been cultured in labs all over the world, and they are termed induced pluripotent stem cells (iPSCs).

(i) Describe the characteristics of an induced pluripotent stem cell (iPSCs).

.....

.....

.....

.....[2]

(ii) Traditionally, the only source of embryonic stem cells is from the inner cell mass of an embryo, thus raising many ethical issues with the use of stem cells from embryos. The discovery of iPSC is exciting for scientists, as it enables research to be carried out on cells that behave like embryonic stem cells, without obtaining them from embryos.

Suggest two ethical concerns regarding the use of embryonic stem cells which are no longer relevant with the development of iPSCs.

.....

.....

.....

.....[2]

[Total: 23]

2 Dengue fever is a disease spread by a particular species of mosquito, *Aedes aegypti*. The incidence of dengue has dramatically increased in recent years. This has heightened the need to understand the vector, as well as the virus.

(a) Fig. 2.1 shows the distribution of dengue fever in 1990, as well as the estimated distribution of dengue fever in 2085.

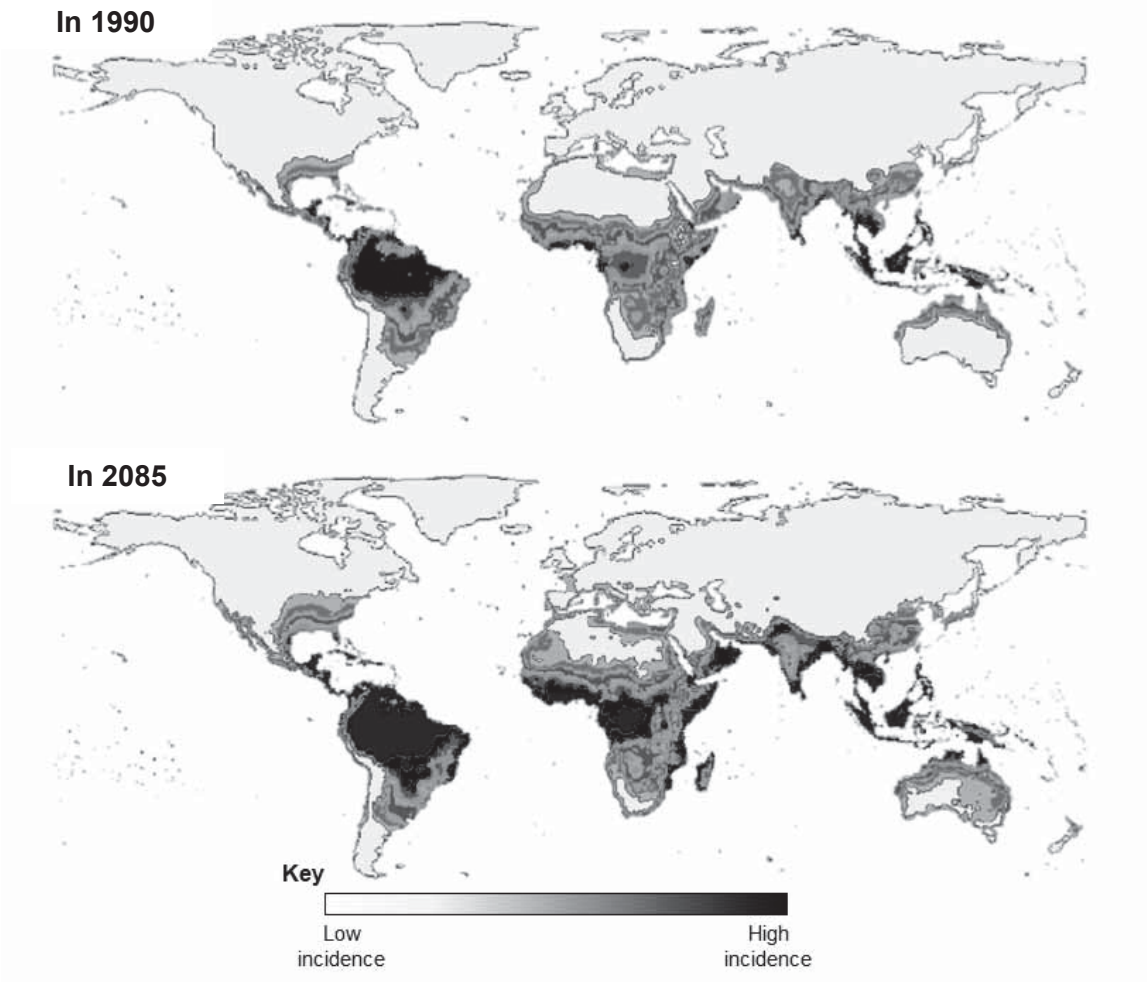

Fig. 2.1

(i) With reference to Fig. 2.1, describe and explain how climate change may influence the distribution of dengue fever.

……

……

……

……

……

…… [3]

In order to arrive at the 2085 prediction in Fig. 2.1, scientists have looked into the factors affecting the mosquito's physiology and fitness in transmitting the disease. Fig. 2.2 shows the summary of their findings.

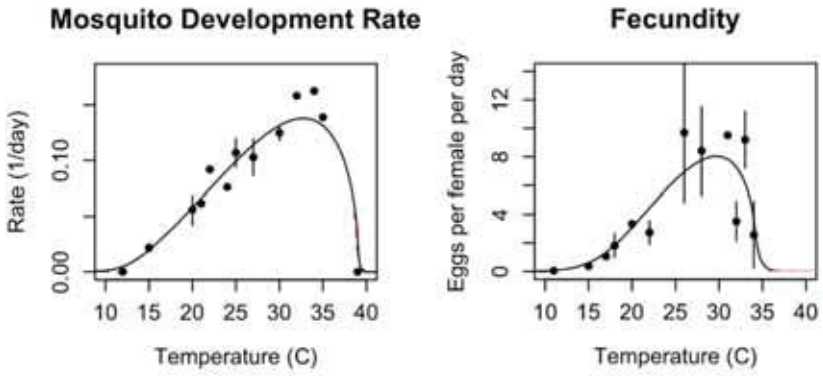

Fig. 2.2

With reference to Fig. 2.2,

(ii) describe how the change in temperature from 20˚C to 30˚C may affect the transmission of dengue.

……

……

……

…… [2]

(iii) predict and explain the transmission of dengue at 40˚C.

……

……

……

…… [2]

(b) The dengue virus spends part of its life cycle living in mosquitoes and another part of its life cycle living in humans where it causes the disease, dengue fever.

(i) State the name of the type of interaction between dengue virus and its human host.

…… [1]

(ii) Explain the difference between an infectious and a non-infectious disease.

……

……

……

…… [2]

In order to design a treatment for dengue fever, the reproductive cycle of the dengue virus was and is being studied. The dengue virus is found to be in the family of *Flavivirus*, which has characteristics similar to both the influenza virus and HIV.

Fig. 2.3 shows the structure of a dengue virus which contains a positive stranded RNA.

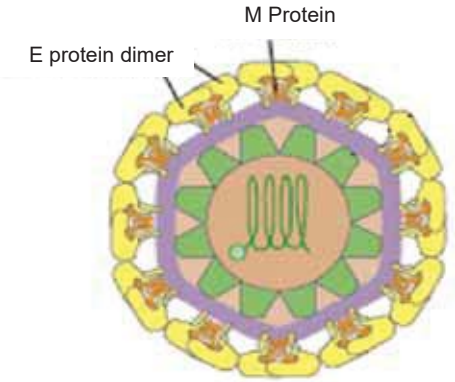

Fig. 2.3

(iii) State one similarity that the dengue virus shares with both influenza virus and HIV.

……..[1]

(c) Fig. 2.4 shows the reproductive cycle of the dengue virus in a human host cell after an individual was bitten by an *Aedes* mosquito carrying the virus.

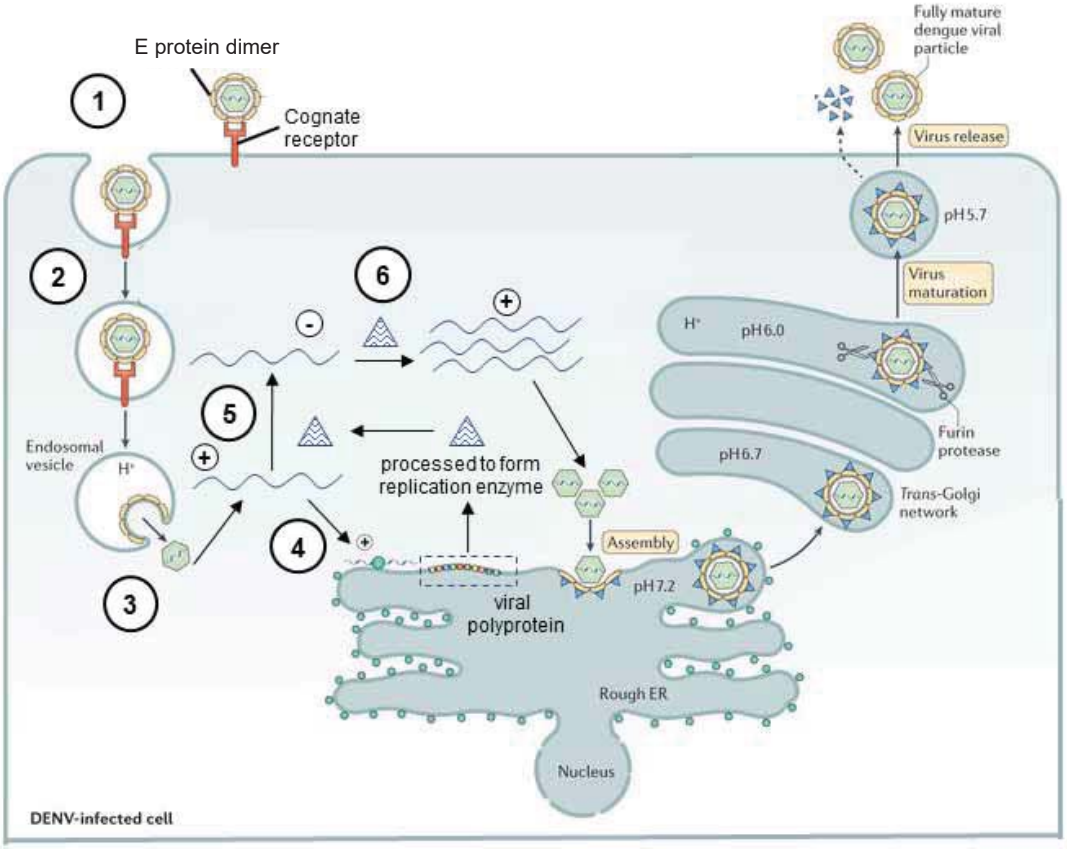

Fig. 2.4

Adapted from Nature Immunology

With reference to Fig. 2.4, describe the following stages in the life cycle of the dengue virus.

(i) stages 1 to 3

.....

.....

.....

.....

.....

..... [3]

(ii) stages 4 to 6

……

……

……

……

……

…… [3]

(iii) With reference to Fig 2.4, suggest how researchers may design a drug to prevent the replication of dengue virus within a human host cell.

……

…… [1]

(d) A patient is required to go for a blood test to find out if he has been infected by the dengue virus. The blood test will determine the viral load in a person's blood stream.

Currently, there are no known medical treatments for dengue. Patients are recommended to rest and let the body's immune system eliminate the virus.

(i) Describe how the patient's specific immune system is able to remove cells infected by the dengue virus.

……

……

……

…… [2]

(ii) Dengvaxia® is a vaccine that is currently being administered as a measure of dengue prevention in various countries stricken by dengue epidemics.

Explain how the vaccine confers an individual protection against the dengue virus.

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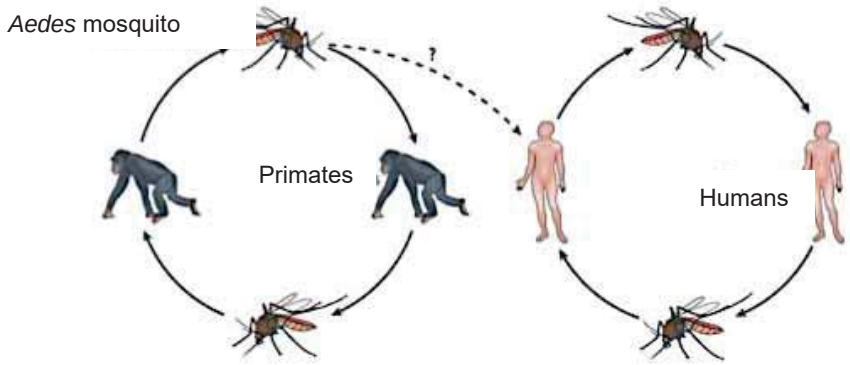
……

…… [5]

(e) The abstract in Fig. 2.5 was taken from an article in Nature Immunology.



"Scientists hypothesize that the dengue viruses evolved in nonhuman primates and jumped from these primates to humans in Africa or Southeast Asia between 500 and 1,000 years ago."

Fig. 2.5

Using your knowledge of viruses, explain the changes in the dengue virus that could have led to the phenomenon in the statement above.

……

……

……

……[2]

[Total: 27]

Section B

Answer **one** question in this section.

Write your answers on the separate answer paper provided.
Your answers should be illustrated by large, clearly labeled diagrams, where appropriate.
Your answers must be in continuous prose, where appropriate.
Your answers must be set out in sections **(a)**, **(b)** etc., as indicated in the question.

3 **(a)** Describe how variation arises and how recessive alleles are preserved in a population. [13]

(b) Compare and contrast the techniques of polymerase chain reaction and Southern hybridisation. [12]

[Total: 25]

4 **(a)** Describe how anatomical and molecular homology support Darwin's theory of descent with modification. [13]

(b) Describe the effects of different types of mutations on the proteins of eukaryotes. [12]

[Total: 25]

End of Paper

H

RAFFLES INSTITUTION
2017 Year 6 Preliminary Examination

Higher 2

CANDIDATE NAME															
CIVICS GROUP	1	7	S	0	3		INDEX NUMBER								

BIOLOGY

9744/04

Paper 4 Practical

25th August 2017

2 hours 30 minutes

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions.

READ THESE INSTRUCTIONS FIRST

Write your index number, CT group & name 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 a HB pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Shift
Laboratory

Answer **questions 1 and 2** in the **spaces** provided on the **Question Paper**.

Answer **question 3** in the **foolscap paper** provided.

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

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

For Examiner's Use	
1	
2	
3	
Total	

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

Raffles Institution
Internal Examination

Answer **all** the questions.

1 Many plant cells contain a water soluble molecule called ascorbic acid, which has many functions to help the plant survive.

You are provided with an extract from plant cells, **P**, which contains ascorbic acid.

Visking tubing, **V**, is selectively permeable, similar to a cell surface membrane, so that some biological molecules will diffuse through the wall of the tubing.

You are required to investigate the diffusion of ascorbic acid from **P** into the water surrounding the Visking tubing over a period of 15 minutes.

Fig. 1.1 shows the apparatus before the water was added.

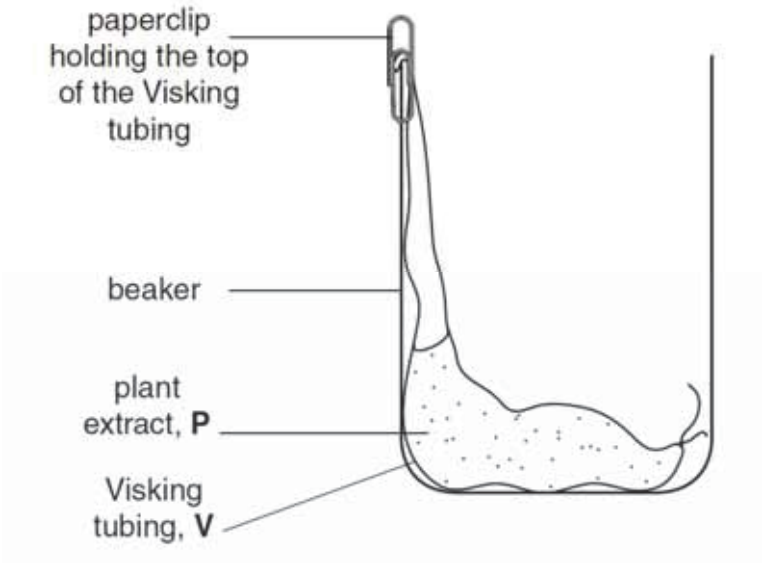


Fig. 1.1

(a) (i) Water is added to the beaker in Fig. 1.1.

Describe the expected trend in the concentration of ascorbic acid in the water over a period of 15 minutes.

……

…….. [1]

You are provided with:

labelled	contents	hazard	volume / cm^3
A	sample of water removed after 15 minutes	irritant	15
P	plant extract containing ascorbic acid	irritant	15
W	distilled water	none	100
I	iodine in potassium iodide solution	irritant	20
S	starch	none	20

labelled	details
V	15 cm length of Visking tubing in a beaker containing water

You must now read up to the end of step 23 before proceeding.

To compare the concentration of ascorbic acid in the samples, you are required to find the **volume** of iodine solution, **I**, added to each sample until the end-point is reached.
The drops of **I** will be added one at a time using a small syringe.

To practice releasing drops from a small syringe:

1. Fill the syringe with 2 cm^3 of **I**.

2. Hold the syringe over an **empty** test-tube and push the plunger **gently** to release one drop at a time, as shown in Fig. 1.2.

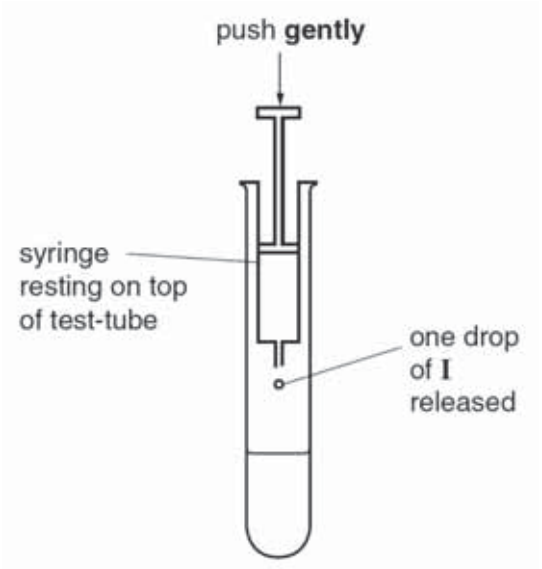


Fig. 1.2

To compare the concentration of ascorbic acid in the samples you will need to add drops of **I** until a blue colour appears. When this blue colour lasts for more than 10 seconds, this is the end-point and the **volume of I** that has been added should be recorded.

The apparatus in Fig. 1.1 was set-up and water was added and left for 15 minutes.

Sample **A** was removed from the water in the beaker.

You are required to find the volume of **I** needed to reach the end-point for sample **A**.

Proceed as follows:

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

4. Put 3 cm^3 of the sample (e.g. **A**) into the same test-tube.

5. Shake the test-tube gently to mix the contents.

6. Fill the syringe, labelled **I**, with 2 cm^3 of **I**.

7. Wipe off any drops of **I** from the outside of the syringe with a paper towel.

8. Add **one** drop of **I** to the mixture in the test-tube as shown in Fig. 1.2.

9. Mix gently and if there is no colour change add another drop.

10. Continue adding drops, one at a time, until the blue colour appears.

    Wait 10 seconds to see if the end-point has been reached. If the blue colour disappears then add another drop.

11. Repeat step 10 until the mixture stays blue for at least 10 seconds

(ii) Record the **volume of I** needed to reach the end-point.

volume .....[1]

You are required to:

- set up Visking tubing containing **P** as in Fig. 1.3
- decide the level of water to put into the beaker
- remove samples of the water surrounding the Visking tubing at **5 minute intervals** for 15 minutes
- compare the ascorbic acid concentrations in the samples.

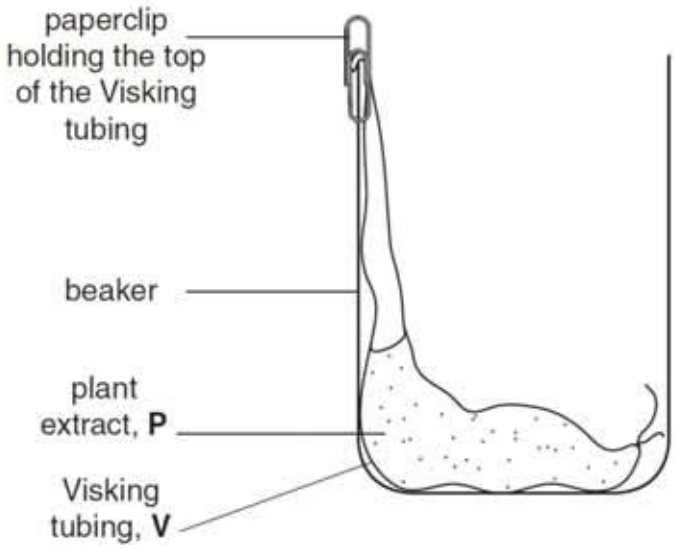


Fig. 1.3

Samples of water surrounding the Visking tubing will be removed for testing, so you need to take this into account when you decide the level of water to put into the beaker.

(iii) Draw **on** Fig. 1.3 the level of the water

- before you remove any samples (label 'before'),
- after the total volume of water needed for all the tests has been removed (label 'after'). [2]

(iv) In order to compare the ascorbic acid concentrations,

state **one** variable which you will need to standardise when finding the volume of **I** added to each sample and describe how you will standardise this variable.

variable .....

description.....

…….....[1]

Proceed as follows:

12. Put **S**, as in **step 3**, into the four test-tubes you will require in order to test the samples of water.

13. Tie a knot in the Visking tubing as close as possible to one end so that it seals the end.

14. To open the other end, wet the Visking tubing and rub the tubing gently between your fingers.

15. Put 6 cm^3 of **P** into the open end of the Visking tubing.

16. Rinse the outside of the Visking tubing by dipping it into a beaker of water.

17. Then put the Visking tubing into an empty beaker as shown in Fig. 1.3.

18. Make sure the open end of the Visking tubing is held in place by a paperclip.

You will start timing as soon as you add **W** (**steps 19 and 20**).

*You should read **steps 19 to 23** before proceeding.*

19. Put **W** into the beaker to the level you decided in **(iii)**.

20. Immediately start timing and remove the first sample of water (as in **step 4**) and put into a prepared test-tube (as in **step 12**).

21. Test the sample as in **steps 5 to 11**.

22. After 5 minutes, gently mix the water surrounding the Visking tubing and then remove the next sample, put it into a different (prepared) test-tube and repeat **steps 5 to 11**.

23. Repeat **step 22** for two more samples.

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

[3]

(vi) Describe how the results support your expected trend as stated in **(a)(i)**.

……

……

…….. [1]

This investigation provides results to compare the concentration of ascorbic acid in the samples.

(vii) The actual concentration of ascorbic acid cannot be quantified in (v).

If you had been provided with 1.0% ascorbic acid solution, suggest how you would modify this investigation to find the **percentage concentration** of ascorbic acid in the water after 15 minutes.

……

……

……

……

……

……

……

…….. [3]

(viii) A systematic error occurs when apparatus with scales are used, since the scales may be slightly different.

For example, when measuring the same line, two rulers may give different lengths.

However, as long as the same ruler is used for all the measurements, the trend is **not** affected because the error is consistent.

State **one** piece of apparatus used in this investigation that may have a systematic error. Suggest whether this affected your results and give a reason for your answer.

apparatus .....

reason.....

…….....[1]

(b) Iodine solution (iodine in potassium iodide solution) turns blue-black when starch is present in plant tissues.

However, as ascorbic acid is also found in plant tissues, some scientists investigated the effect of testing for starch with iodine solution when there was ascorbic acid present.

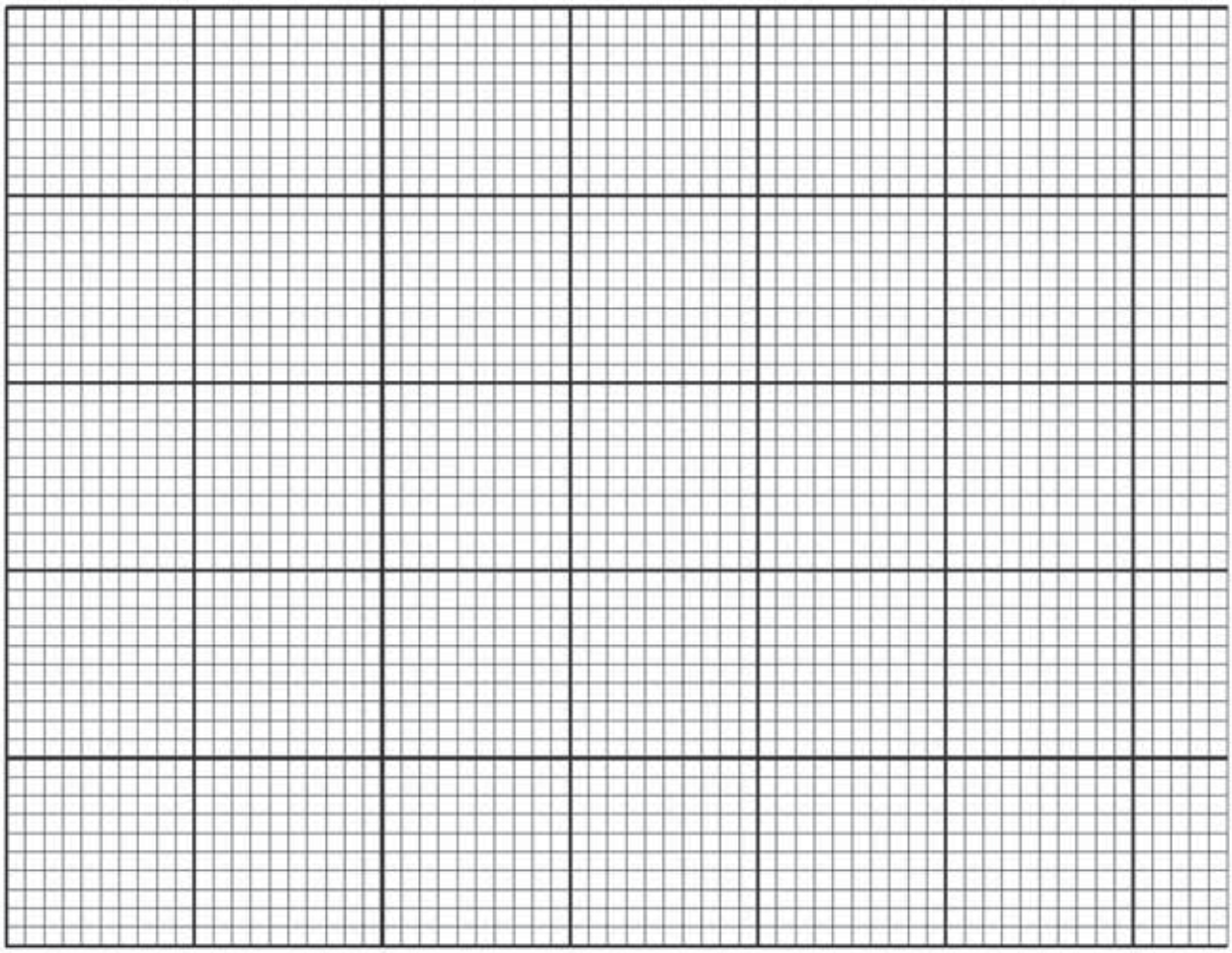
The concentration of ascorbic acid was 0.0001 mol dm^{-3} and the concentration of starch solution was standardised.

The percentage of starch which reacted with the iodine solution was measured.
The results are shown in Table 1.1.

Table 1.1

volume of iodine solution/ cm^3	percentage of starch which reacted with iodine solution/ %
0.0	0.0
0.5	2.0
1.5	5.0
2.0	36.0
2.5	68.0

(i) Plot a graph of the data shown in Table 1.1.
*You will need to consider the answer to **(b)(ii)** before you plot your graph.*



[4]

(ii) Estimate the volume of iodine solution needed for 100% of the starch to be reacted.

Show on your graph how you obtained the volume of iodine solution.

Volume of iodine solution ..... cm^3 [1]

(iii) Explain how the presence of ascorbic acid may affect the use of iodine solution as a test for the presence of starch in different plant tissues.

……

……

……

……...[2]

(iv) A plant tissue contains starch and 0.0001 mol dm^{-3} ascorbic acid.

Suggest how you would make sure that the iodine test showed the presence of all the starch (100%).

……

……[1]

(c) In a separate experiment, starch and amylase were placed into a Visking tubing. The glucose that diffused out of the Visking tubing was tested with Benedict's solution.

(i) A student wants to study the effect of temperature on the rate of diffusion of glucose through the Visking tubing.

Describe **two** ways to make this experiment valid.

……

……

……

…….. [2]

(ii) Explain the effects of increased temperature on the rate of diffusion of glucose through the Visking tubing.

……

……

……

…….. [2]

[Total: 25]

2 Methylene blue stains dead cells blue. Living cells are **not** stained blue so they will appear white or clear.

You are provided with:

- methylene blue solution, **M**, (handle it carefully as it will stain your skin) and
- suspensions of yeast cells, labelled **S1**, **S2** and **S3**.

Each suspension, **S1**, **S2** and **S3** has been heated for ten minutes at 45 °C or 80 °C or 100 °C.

You are required to:

- use the microscope to observe the colour of the yeast cells from **S1**, **S2** and **S3**, after **M** has been added,
- record your observations by using annotated drawings of three yeast cells from each of **S1**, **S2** and **S3** and
- identify the temperature at which each of **S1**, **S2** and **S3** was heated.

1. Label three microscope slides **S1**, **S2** and **S3**.

2. Place **one drop** of **S1** onto slide **S1** and add **one drop** of **M**. Mix carefully using a glass rod. (If **M** comes into contact with your skin rinse with cold water.)

3. Repeat step 2 with **S2** and **S3**.

4. Leave for five minutes.

5. Add a coverslip to each slide.

6. Use the paper towel to dry off any excess liquid around the coverslip.

7. Use the microscope to observe the yeast cells on each slide, then select cells which you can draw and annotate to describe the effect of **M**.

(a) **(i)** Prepare the space below and record your observations:

S1

S2

S3

[3]

(ii) Use your observations to identify the temperature that was used to heat each of the suspensions **S1**, **S2** and **S3**.

Complete the table below.

suspension	temperature/ °C
S1	
S2	
S3	

[1]

(iii) Besides conducting repeats and replicates, describe how you could modify this investigation to obtain more accurate quantitative measurements.

……

……

…….. [1]

Fig. 2.1 shows a diagram of a stage micrometer scale that is being used to calibrate an eyepiece graticule.

One division, on either the stage micrometer scale or the eyepiece graticule, is the distance between two adjacent lines.

The length of one division on this stage micrometer is **0.1 mm.**

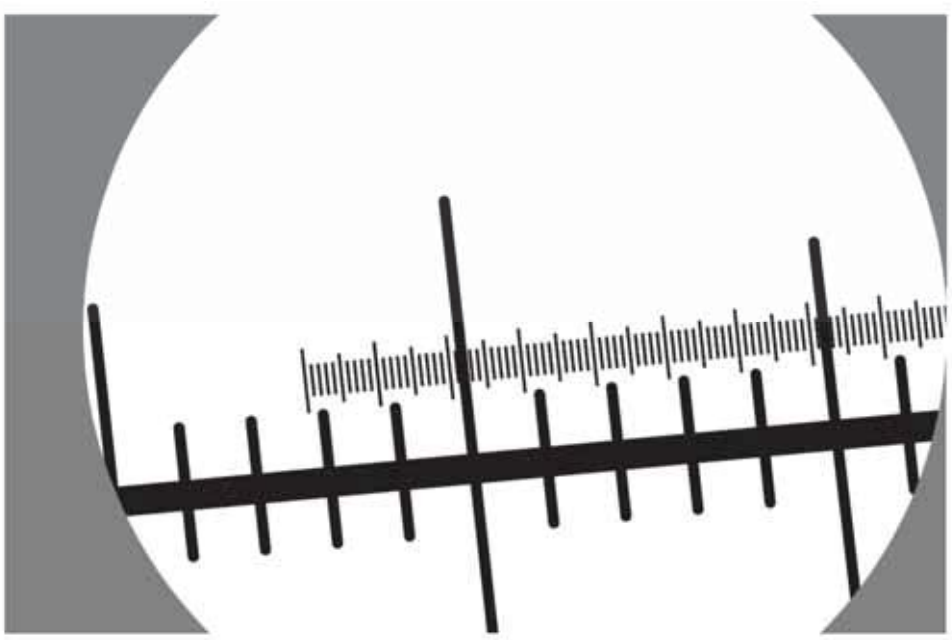


Fig. 2.1

(b) (i) Using this stage micrometer, where one division is **0.1 mm**, calculate the actual length of one eyepiece graticule unit using Fig. 2.1 by completing the steps below:

Step 1

1 eyepiece graticule unit = …….. divided by …… = …….. mm

Step 2

Convert the answer to a measurement with the unit most suitable for use in light microscopy.

……multiplied by ……= ……

[2]

Fig. 2.2 is a photomicrograph of yeast cells.

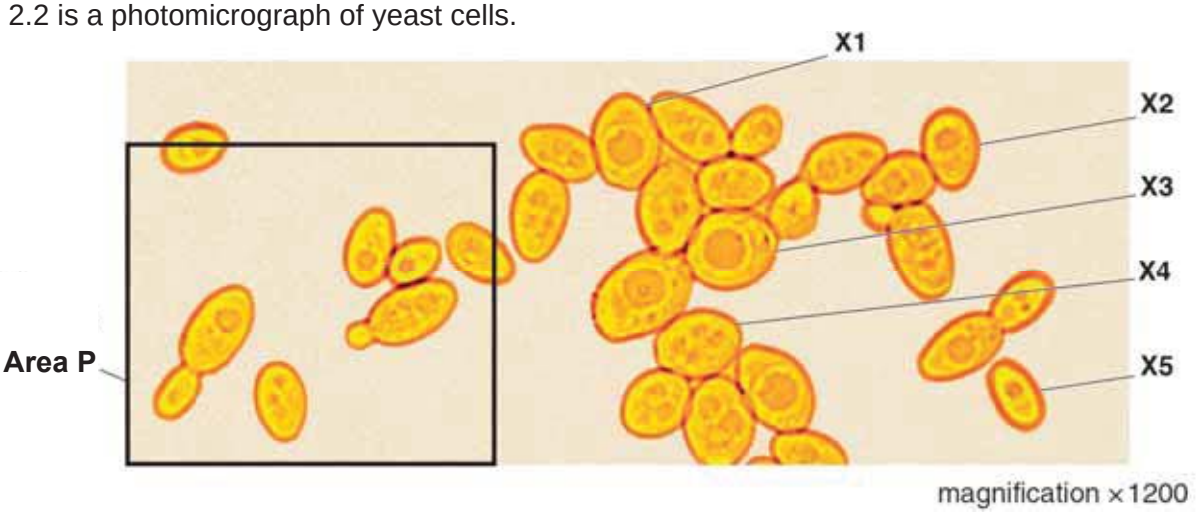


Fig. 2.2

(c) (i) Use the magnification to calculate the mean maximum actual length, in µm, of yeast cells, **X1**, **X2**, **X3**, **X4** and **X5**.

You may lose marks if you do not show your working or if you do not use the appropriate units.

..... µm

[4]

(ii) Make a large drawing of the whole cells in area P shown in Fig. 2.2.

[5]

[Total:16]

3 Obesity-related diseases such as high blood pressure, heart disease, diabetes and some cancers have been on the rise. High incidence of obesity has been attributed to an unhealthy diet that is high in lipids and sugars.

To combat the issue of a high-fat diet, scientists have been trying to develop drugs that will prevent the absorption of lipids in people's diet. Gastric and pancreatic lipases are enzymes that play a pivotal role in the digestion of dietary lipids.

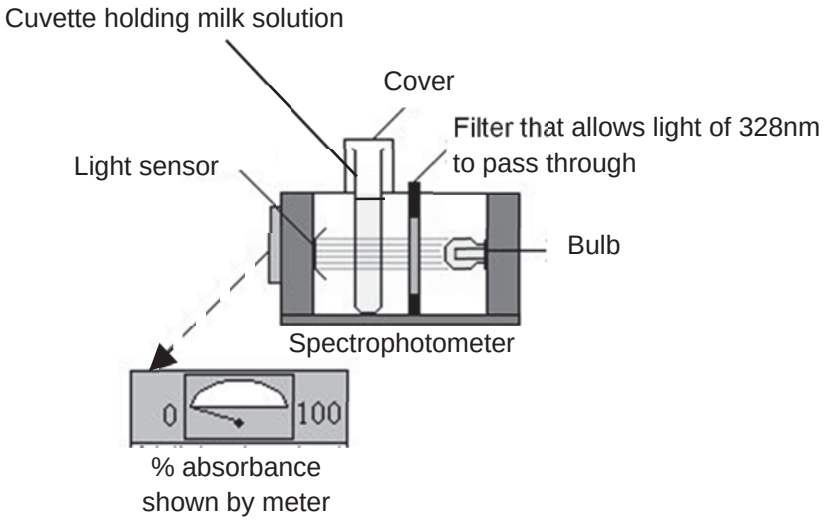
Scientists have recently developed a new drug, Lipobuster, which is a competitive inhibitor of these lipases. In tests performed by the scientists, Lipobuster has been found to have no activity against amylase, trypsin, chymotrypsin and phospholipases.

However, when Lipobuster is administered with lipid-containing foods, it successfully inhibits the hydrolysis of triglycerides. While Lipobuster can help to prevent the absorption of triglycerides, initial studies in mice have shown that high dosages of Lipobuster administered over a long duration resulted in development of tumours.

To ascertain the effectiveness of Lipobuster, scientists have been using full-fat milk in their experiments. Milk is opaque due to the proteins and fats contained within the milk. Thus the effect of Lipobuster on lipase can be investigated by observing its effect on milk opacity.

Opacity of any liquid can be measured using a spectrophotometer, where the reading of absorbance on the spectrophotometer is measured in percent (%). Absorbance is the amount of light that passes through the solution. When all the light passes through the solution, absorbance is zero. In contrast, when no light is able to pass through the solution, absorbance reading would be at 100%.

Note: Lipobuster and lipase are clear colourless solutions.



Using the information given and your own knowledge, design an experiment to determine the minimum concentration of Lipobuster that is needed for lipase to be fully inhibited.

You must use the following:

- full-fat milk
- 5% lipase solution
- 10% Lipobuster solution
- distilled water
- spectrophotometer
- cuvette

You may select from the following apparatus and use appropriate additional apparatus range of common laboratory apparatus:

- normal laboratory glassware e.g. test-tubes, beakers, measuring cylinders, graduated pipettes, glass rods, etc.
- stopwatch
- thermometer
- syringes
- water trough

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 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 reliable as possible;
- include layout of results table and graphs with clear headings and labels;
- use the correct technical and scientific terms;
- include reference to safety measures to minimise any risks associate with the proposed experiment.

[Total: 14]

End of Paper