Anglo-Chinese Junior College

JC2 Biology Preliminary Examination
Higher 2

A Methodist Institution
(Founded 1886)

CANDIDATE NAME		FORM CLASS	
TUTORIAL CLASS		INDEX NUMBER	

BIOLOGY **9744/02**
Paper 2 Structured Questions 22 August 2024
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.

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

For Examiners' use only	
1	/ 8
2	/ 10
3	/ 11
4	/ 10
5	/ 11
6	/ 9
7	/ 10
8	/ 10
9	/ 10
10	/ 5
11	/ 6
Total	/ 100

For Examiner Use

Answer **all** questions.

1 Fig. 1.1 is an electron micrograph of a cell found in the human adrenal cortex which secretes the hormone adrenaline into the bloodstream.

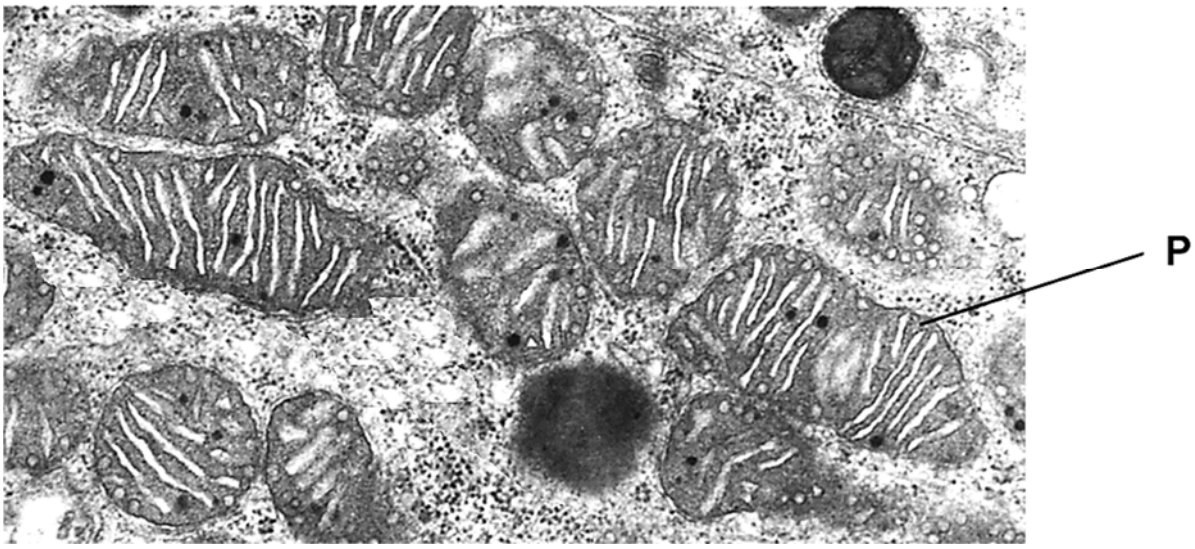

Fig. 1.1

(a) **(i)** Identify organelle **P**.

..... [1]

(ii) Describe how organelle **P** is involved in the secretory process of the cell in Fig. 1.1.

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..... [2]

(b) Cells expressing proteins of interest are allowed to take up radioactively labeled amino acids for a brief interval, during which all newly synthesised proteins will exhibit a certain level of radioactivity.

Fig. 1.2. shows the percentage of radioactivity found in three organelles of the endomembrane system, **X**, **Y** and **Z** within the span of two hours.

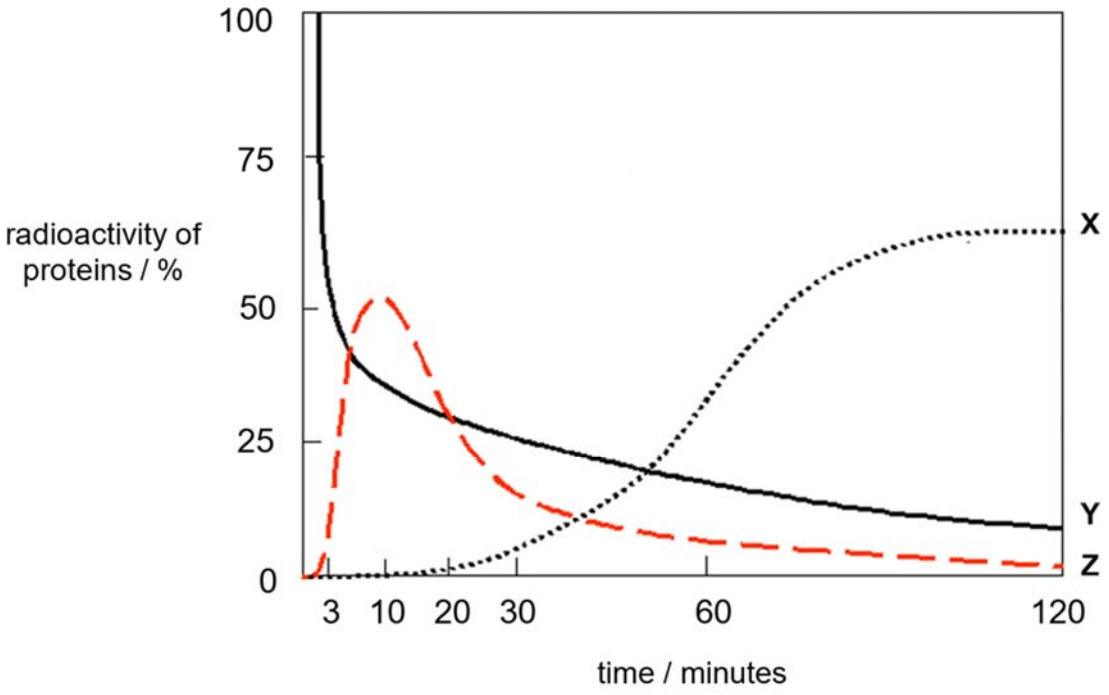

Fig. 1.2

(i) Identify organelle **Y**.

..... [1]

(ii) Using Fig. 1.2, account for the level of radioactivity in organelle **Y**.

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..... [2]

[Turn over

(iii) Bafilomycin A1 is a chemical inhibitor that blocks the process of exocytosis at the cell surface membrane. This causes a change in one of the graphs in Fig 1.2.

On Fig. 1.2, sketch a graph that represents this expected change. [1]

(iv) Explain your answer in **(b)(iii)**.

……..

…….....[1]

[Total: 8]

2 Collagen plays a structural role and contributes to mechanical properties and shape of tissues in the body.

Fig. 2.1 shows the approximate composition of collagen and the molecular structure of four of the amino acids found in it.

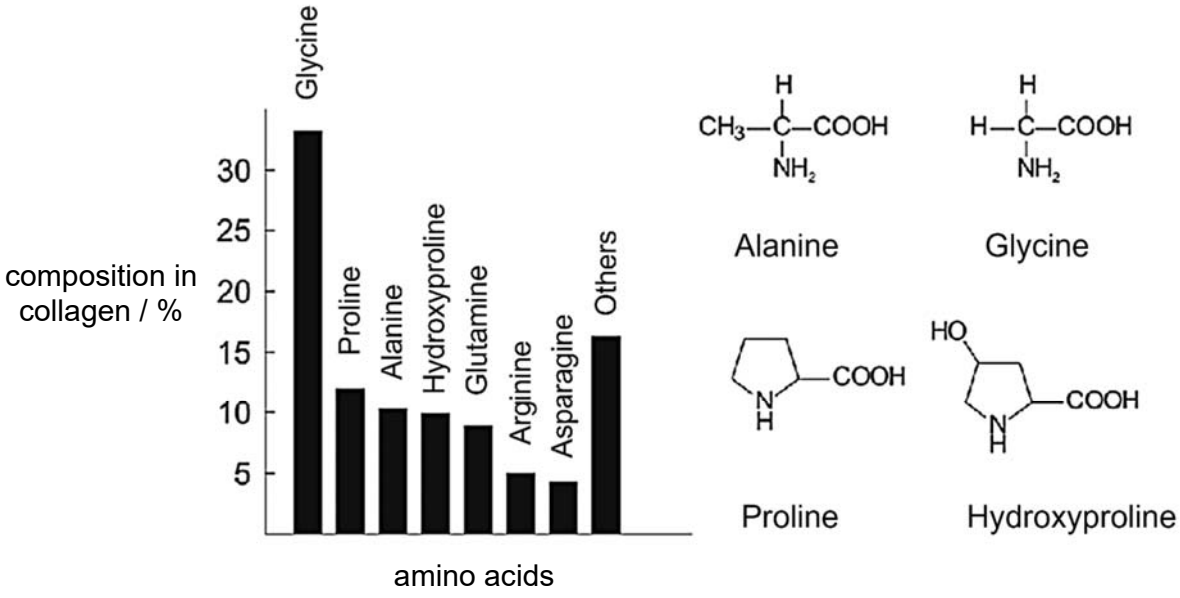

Fig. 2.1

(a) (i) With reference to Fig. 2.1, explain why collagen is an insoluble protein.

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……..[3]

[Turn over

(ii) Explain why the abundance of glycine in collagen is essential for its function.

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……[3]

(b) Fig. 2.2 shows how changes in concentration of oxygen affects its binding to haemoglobin.

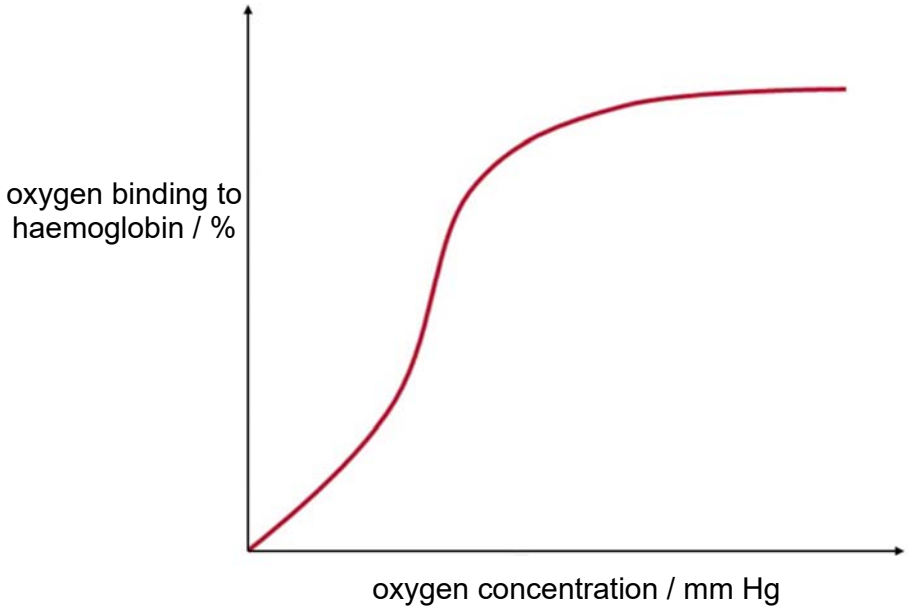

Fig. 2.2

(i) State the property of haemoglobin that is illustrated in Fig. 2.2.

…… [1]

(ii) Using your knowledge of the structure of haemoglobin, explain how the property stated in **(b)(i)** enhances its function.

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…… [3]

[Total: 10]

3 Fig. 3.1 shows the fluid mosaic model of cell surface membrane.

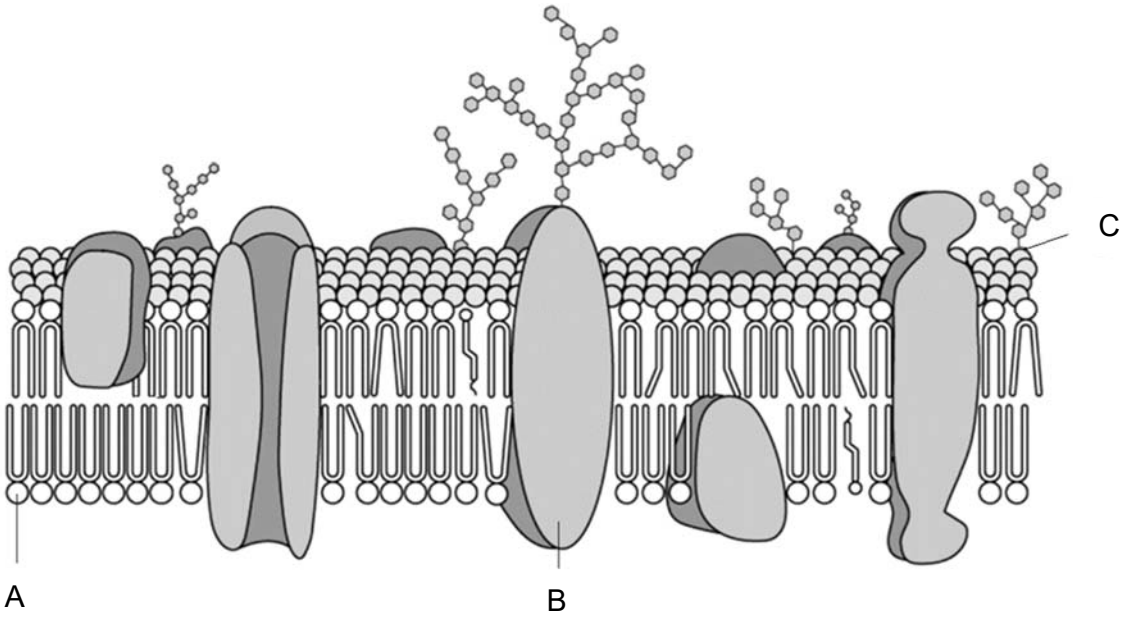

Fig. 3.1

(a) Identify structures labelled **A** and **B** in Fig. 3.1.

A .....

B .....

[2]

(b) Explain why the structure of **C** varies across different membranes in a cell.

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.....[2]

(c) Table 3.1 shows the results from a study on the mean percentage of cholesterol found in the cell surface membrane of epithelial skin cells of different animals.

Table 3.1

animal	mean percentage of cholesterol in cell surface membrane of epithelial skin cell
giraffe	10
rhinoceros	12
eurasian mouse	15
scottish blackface sheep	18
antarctic penguin	28
african elephant	8
arctic fox	30

(i) Suggest why arctic foxes have a greater mean percentage of cholesterol in their cell surface membranes than giraffes.

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……[2]

(ii) Estimate, with a reason, the percentage of cholesterol that would be found in the cell surface membranes of polar bears.

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…… [2]

[Turn over

(iii) Explain why the mass of cholesterol in the cell surface membranes is calculated as a percentage rather than an absolute number.

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…… [2]

(iv) Suggest why the percentage of cholesterol in Table 3.1 is an underestimate of the actual percentage found in the entire cell.

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……[1]

[Total: 11]

4 Fig. 4.1 shows the process of DNA replication.

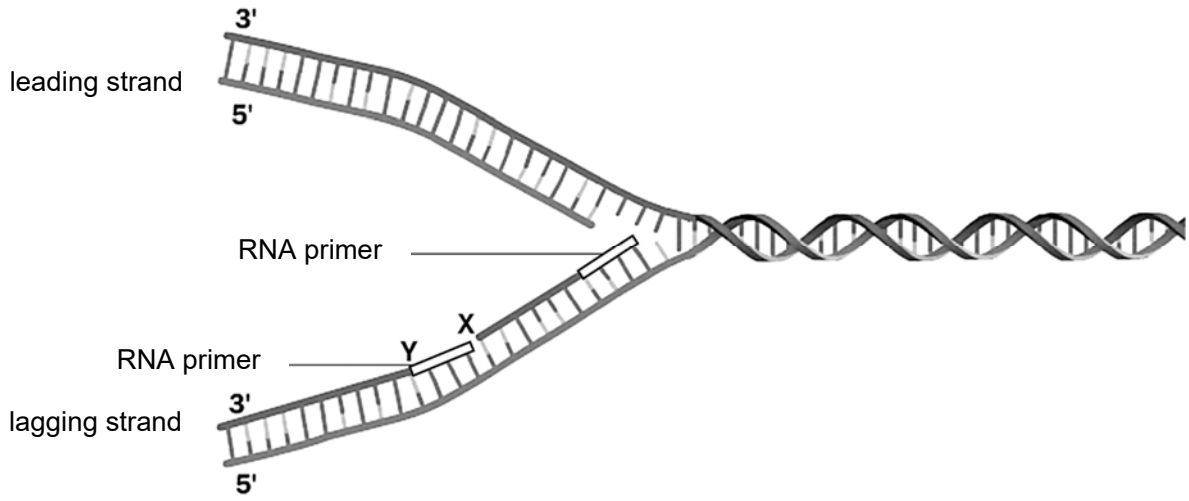

Fig. 4.1

(a) With reference to Fig 4.1,

(i) identify the enzyme that will remove the RNA primers shown,

……..... [1]

(ii) state whether the first deoxyribonucleotide to be added between both Okazaki fragments, after the removal of the RNA primer, will be at X or Y, and

…….....[1]

(iii) justify your answer in **(a)(ii)**.

…….....

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…….....

…….....[2]

[Turn over

(b) Fig. 4.2 shows the action of telomerase enzyme at the end of a linear chromosome after DNA replication. The entire length of the chromosome is not shown in Fig. 4.2.

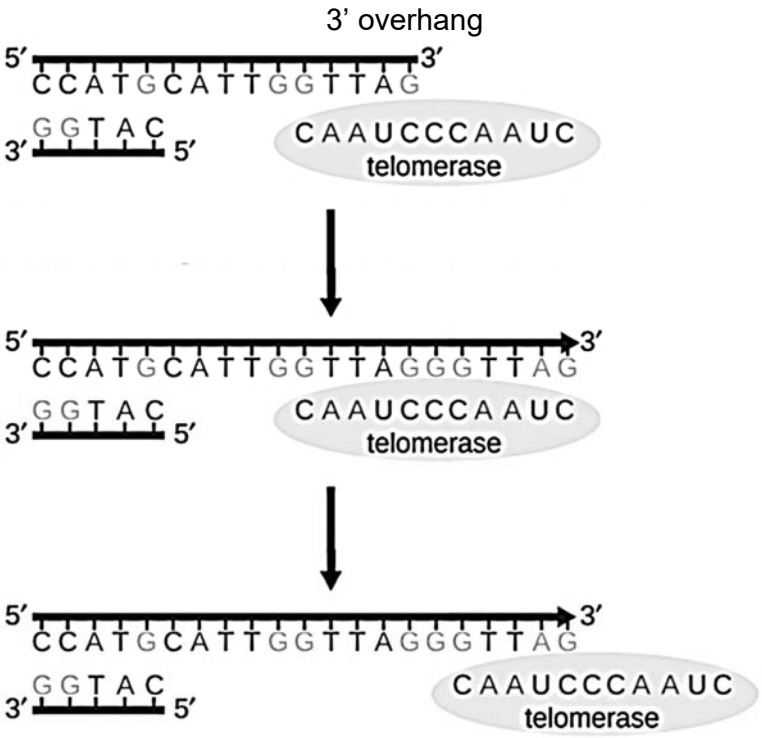

Fig. 4.2

(i) With reference to Fig. 4.2, explain the purpose of the sequence within the telomerase enzyme.

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……[2]

(ii) In Fig. 4.2, after the action of telomerase enzyme, the newly-synthesised DNA strand with the 3' overhang is now extended.

With reference to named enzymes, describe the events that must occur at the shorter complementary DNA strand to extend it to the same length.

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……[2]

(c) When a human is in the newborn phase, white blood cells have telomeres ranging from 8,000 to 13,000 base pairs in length. After this phase, the number of base pairs tends to decline by approximately 20 to 40 per year.

Calculate the range of base pairs a telomeric end could have lost by the time a person reaches the age of 40. Show your working.

range of base pairs lost = ……
[2]

[Total: 10]

[Turn over

5 Fig. 5.1 shows enterobacteria phage T2, a virulent phage in the family *Myoviridae,* which T4 phage also belongs to.

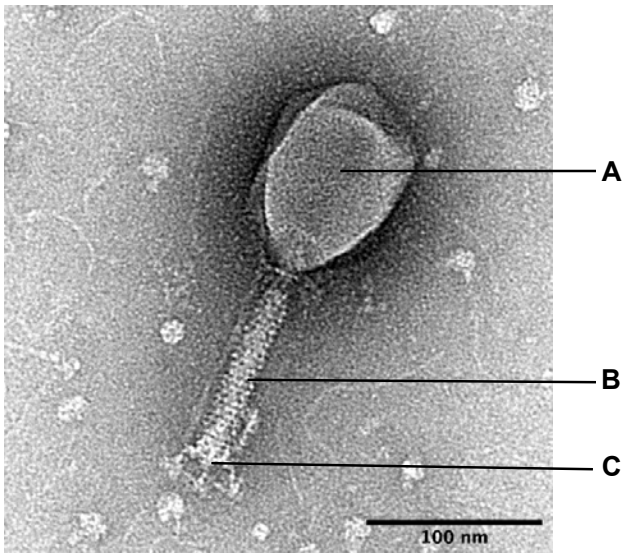

Fig. 5.1

(a) (i) Name the structures labelled **A**, **B** and **C** in Fig. 5.1.

A ……..

B ……..

C ……..... [3]

(ii) With reference to the information provided, suggest the molecular structure of the genetic material of phage T2.

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……..... [2]

(b) (i) As a virulent phage, phage T2 replicates through the lytic cycle.

Describe how newly-synthesised phage T2 are released from the host cell.

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……..... [2]

(ii) Temperate phage replicates through both the lysogenic and lytic cycles.

Suggest why it may be advantageous for a phage to have a lysogenic cycle.

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……..... [4]

[Total: 11]

6 The production of β-galactosidase is controlled by a length of DNA called the *lac* operon.

(a) Fig. 6.1 shows the *lac* operon when lactose is absent.

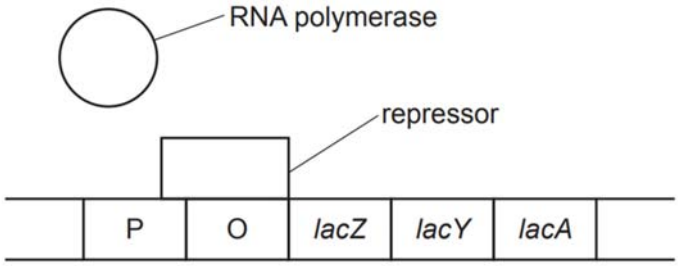

Fig. 6.1

Using the symbols from Fig. 6.1, on Fig. 6.2 draw the positions of RNA polymerase and the repressor molecule when lactose is **present**.

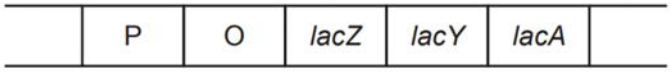

Fig. 6.2

[2]

(b) State the function of the *lacY* gene.

……

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…… [1]

(c) In an investigation into the growth of *E. coli*, a sample of the bacterium was grown in a medium that contained limited concentrations of glucose and lactose. The population size of *E. coli* was measured at regular intervals.

Fig. 6.3 shows the population growth curve from this investigation.

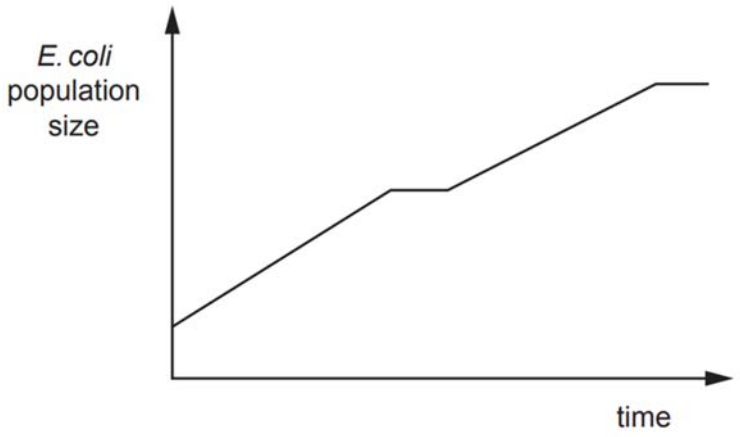

Fig. 6.3

Account for the population growth curve shown in Fig. 6.3.

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…… [4]

[Turn over

(d) The *lac* operon is an example of an inducible system whereas *trp* operon is an example of a repressible system.

Suggest why it is an advantage to prokaryotes to have repressible systems.

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…… [2]

[Total: 9]

For Examiner Use

7 Stem cells are unspecialised cells of the human body capable of self-renewal. In recent years, stem cell therapy has become a very promising research topic.

(a) (i) Using a named example, describe the feature of totipotent stem cells.

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..... [2]

(ii) Describe two ethical challenges of stem cell therapy and research.

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..... [2]

[Turn over

(b) During an ischaemic stroke, many brain cells will die due to the lack of oxygen. Scientists have investigated the use of different types of stem cell to treat damage to the brain after a patient suffers from an ischaemic stroke.

One of the types of stem cells that scientists are working on is the neural stem cell (NSC).

Fig. 7.1 shows the types of cells which NSCs can differentiate into.

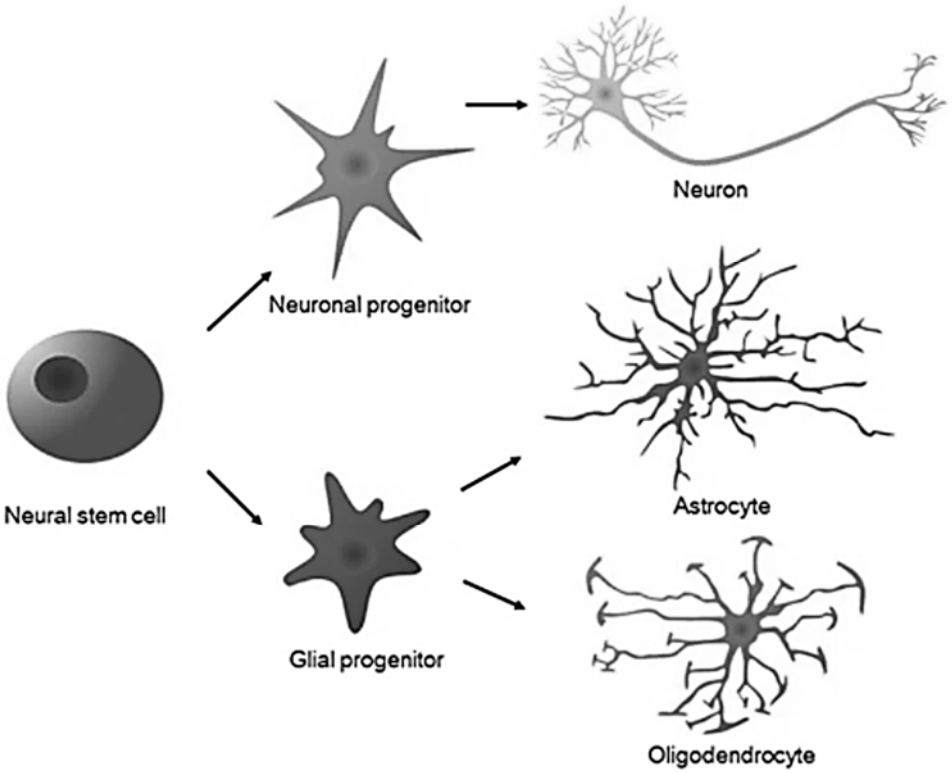

Fig. 7.1

(i) With reference to Fig. 7.1, state the potency of NSCs and explain how they are suitable to treat ischaemic stroke patients.

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..... [2]

(ii) NSCs are capable of undergoing asymmetrical division.

Describe the advantage of asymmetrical division.

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…… [2]

(iii) Suggest how implanting NSCs into a patient's damaged brain could potentially cause additional harm.

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…… [2]

[Total: 10]

8 Fig. 8.1 shows an electron micrograph of structures within a chloroplast.

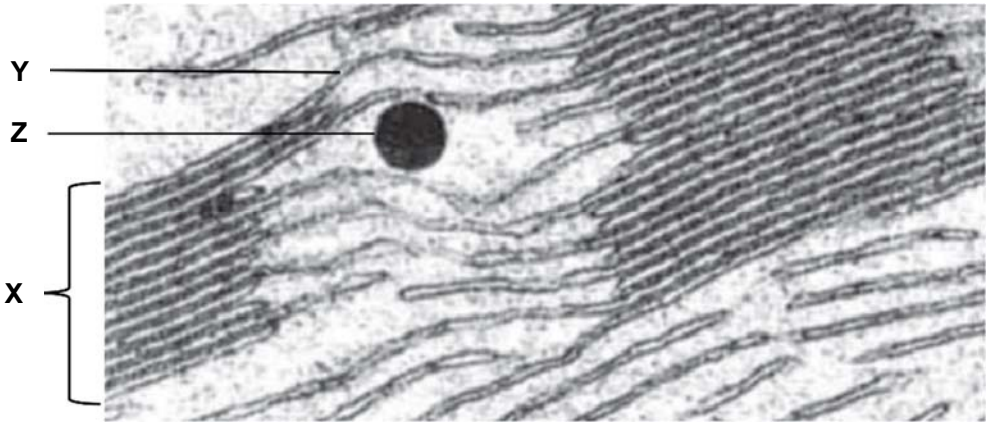

Fig. 8.1

(a) (i) Name the structures labelled **X** and **Y** in Fig. 8.1.

X .....

Y .....
[2]

(ii) **Z** is a lipid droplet that can be formed within chloroplasts.

Suggest how lipids can be synthesised within the chloroplasts even though it lacks smooth endoplasmic reticulum.

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..... [2]

For Examiner Use

(b) Fig. 8.2 shows two graphs relating to photosynthesis overlaid on the same grid.

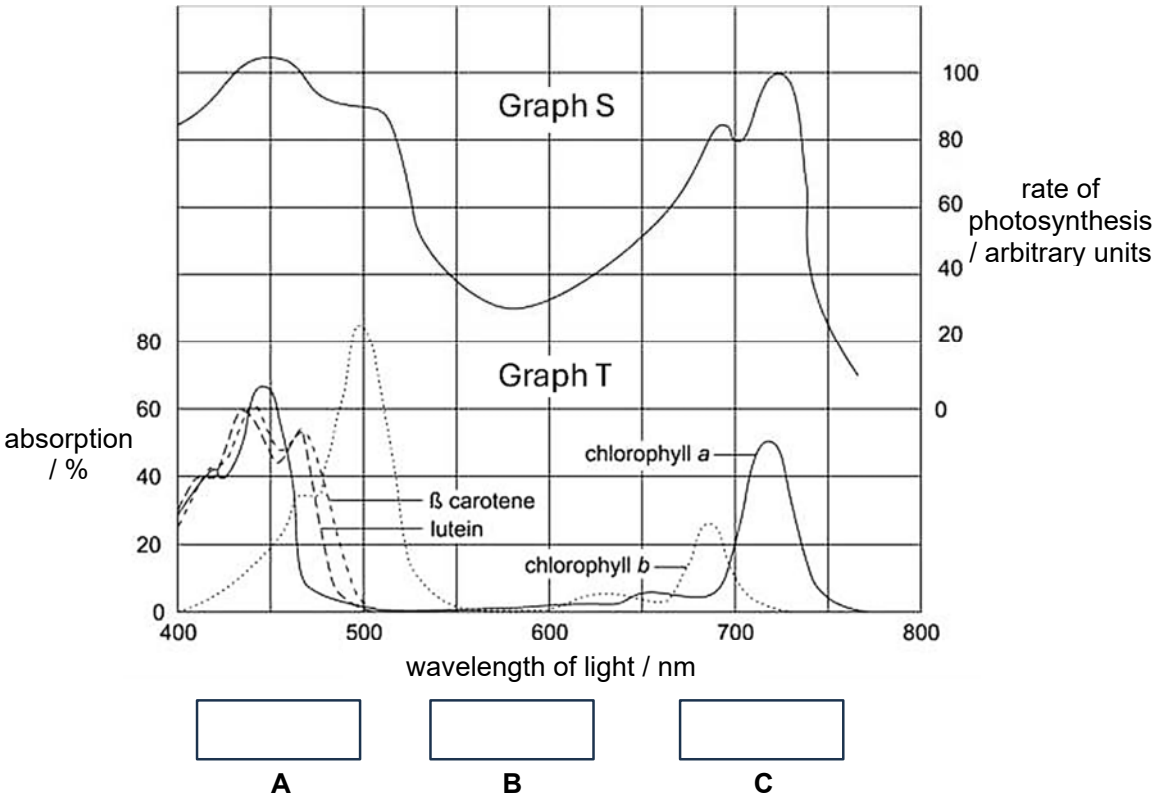

Fig. 8.2

(i) Describe how light is absorbed during photosynthesis.

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…….....[2]

[Turn over

(ii) Compare graphs S and T.

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……..

……..... [2]

(iii) Red, blue and green light coincide with specific wavelengths.
On Fig. 8.2, indicate in the boxes **A**, **B** and **C** at the bottom of the graph, where red, blue and green light is found.

[2]

[Total: 10]

9 **(a)** Explain what is meant by the term phylogeny.

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…… [2]

In the Hawaiian archipelago, there is a group of birds known as the Hawaiian honeycreepers. They do not occur naturally in other parts of the world. Although at least 56 species of Hawaiian honeycreepers have been documented, only 18 of them survive today with the most recent extinction occurring in 2004.

Fig. 9.1 shows the phylogenetic tree of the Hawaiian honeycreeper species. The four grey vertical bars indicate the times when the four Hawaiian islands were formed.

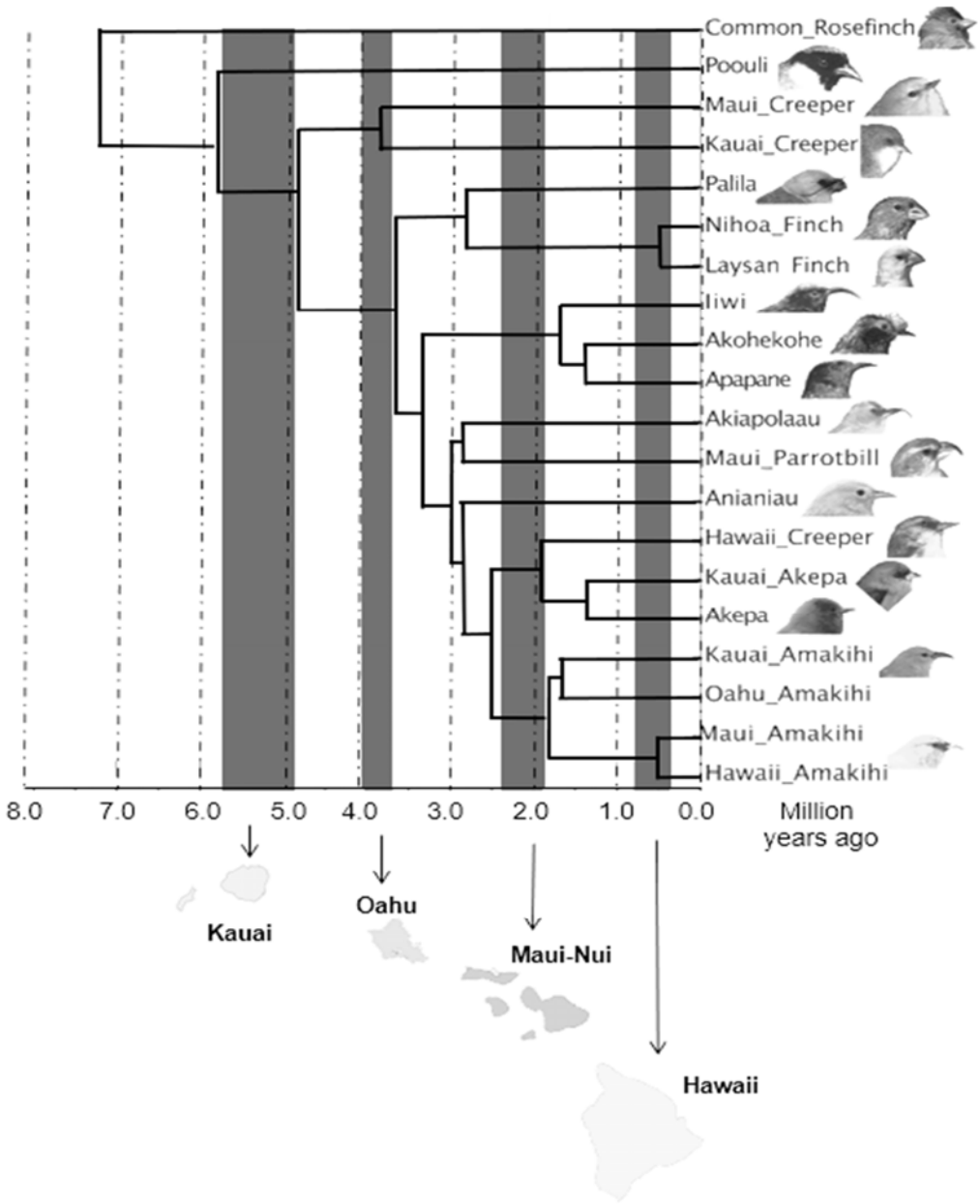

Fig. 9.1

(b) Explain how the common ancestor of Hawaiian honeycreepers evolved into so many different species in just under 6.0 million years.

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…… [5]

(c) With reference to Fig. 9.1, name the island whose emergence corresponds to the greatest number of speciation events.

…… [1]

(d) The Maui Creeper, while endemic to Maui-Nui, did not originate there. Suggest how the Maui Creeper appears in Maui-Nui.

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…… [2]

[Total: 10]

[Turn over

10 When a person received the smallpox vaccine, the number of plasma cells specific for the smallpox pathogen were measured from blood samples taken over a period of 35 days.

Fig. 10.1 shows the changes in the number of smallpox-specific plasma cells over 35 days following vaccination.

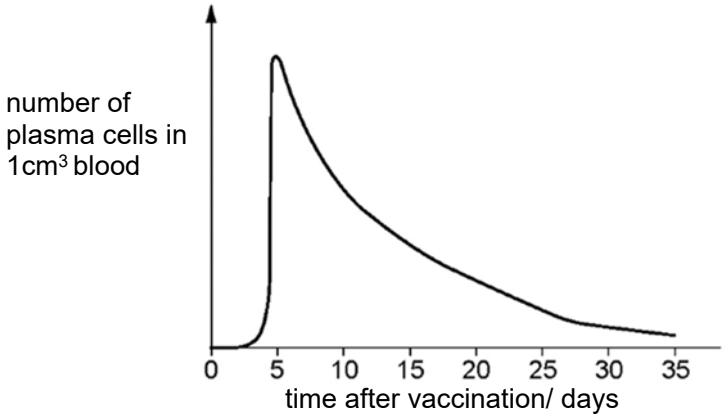

Fig. 10.1

(a) With reference to Fig. 10.1, describe the changes in the number of smallpox-specific plasma cells during the 35 days.

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…….. [2]

(b) Explain how a single dose of this vaccine can provide immunity for up to 10 years even though plasma cells are short-lived.

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……...[3]

[Total: 5]

11 Fig. 11.1 shows the annual change in atmospheric methane concentrations at Baring Head, New Zealand between 1990 and 2022. The dashed line shows the change in atmospheric methane concentration from year to year.

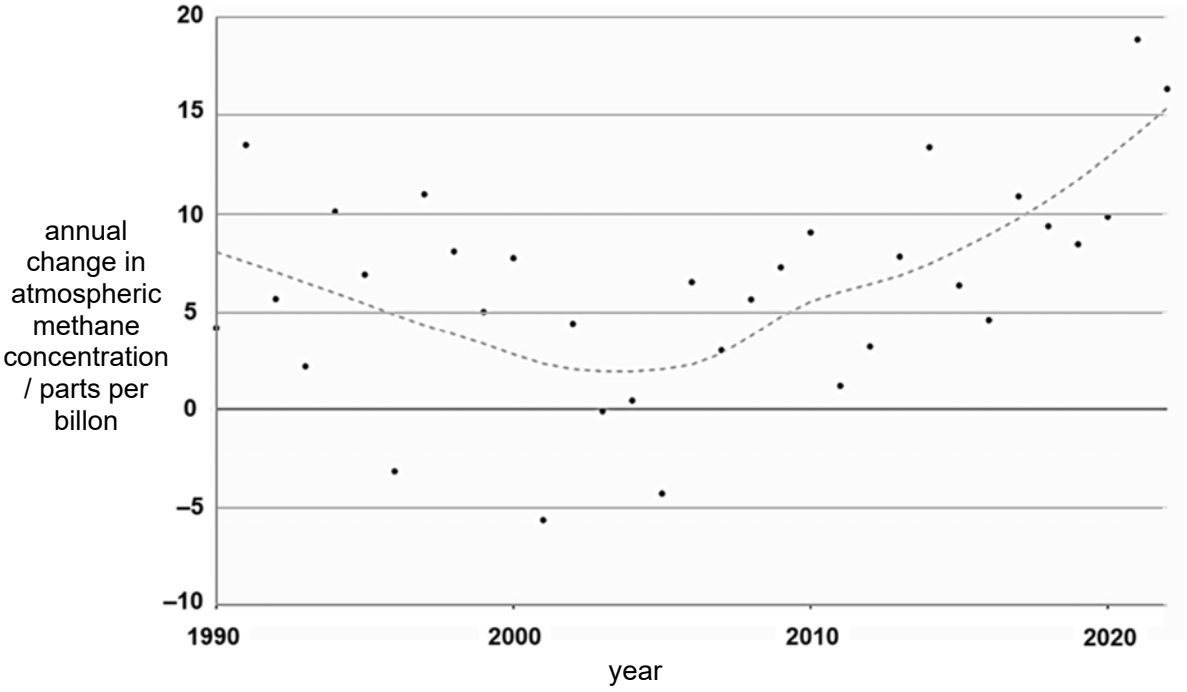

Fig. 11.1

(a) Describe the change in atmospheric methane concentration from 1990 to 2022.

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…… [2]

(b) Suggest what could have resulted in the change in atmospheric methane concentration from 1990 to 2004.

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……[1]

[Turn over

(c) Deduce how the change in atmospheric methane concentration between 2004 to 2022 could affect the temperatures at Baring Head during this period.

……..

……..

……..

……..

……..……[2]

(d) Carbon dioxide is similar to methane with respect to its negative impact in the atmosphere and environment.

Name one other naturally-occurring gas in the atmosphere that could have the same negative impact resulting in climate change.

……..……[1]

[Total: 6]

END OF PAPER