H

NATIONAL JUNIOR COLLEGE, SINGAPORE
Senior High 2
Preliminary Examination
Higher 2

CANDIDATE NAME			
BIOLOGY CLASS	2bi2_____	REGISTRATION NUMBER	

Biology

9744/02

Paper 2 Structured Questions

27 August 2024

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, Biology class and registration number on all the work you hand in.
Write in dark blue or black pen.
You may use an HB 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 workings or if you do not use appropriate units.

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

For Examiner's Use	
Section A	
1	**/10**
2	**/10**
3	**/10**
4	**/10**
5	**/10**
6	**/10**
7	**/10**
8	**/10**
9	**/10**
10	**/5**
11	**/5**

Total	/100

This document consists of **26** printed pages and **2** blank pages.

Answer **all** the questions.

1 Fig. 1.1 is an electronmicrograph of part of a human liver cell that contains many glycogen granules.

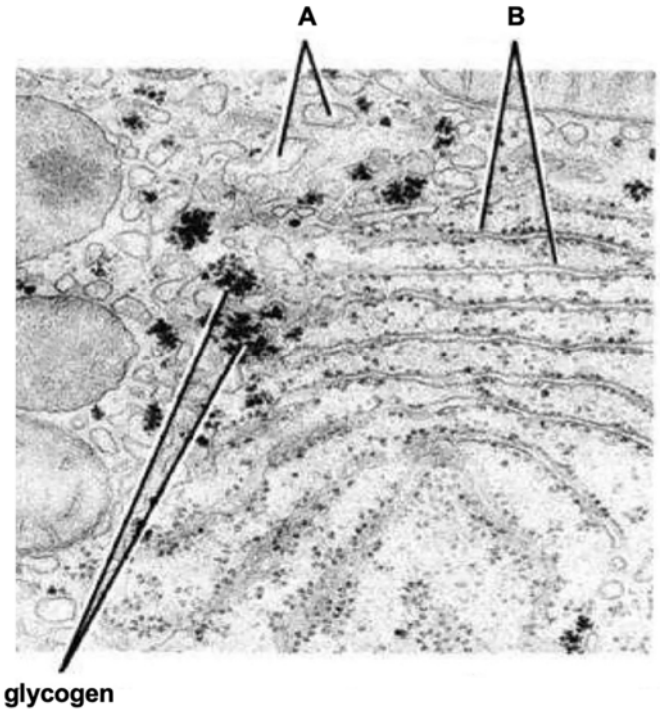

Fig. 1.1

(a) Structures **A** and **B** are interconnected compartments.

Name and state the role of structures **A** and **B**.

	name	role
A		
B		

[4]

(b) Explain why it is important for a human liver cell to contain many glycogen granules.

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..... [2]

Isolation membranes derived from structure **A** play important role in degradation of unwanted cytoplasm components.

Fig. 1.2 shows the steps involved in the degradation of unwanted cytoplasm components.

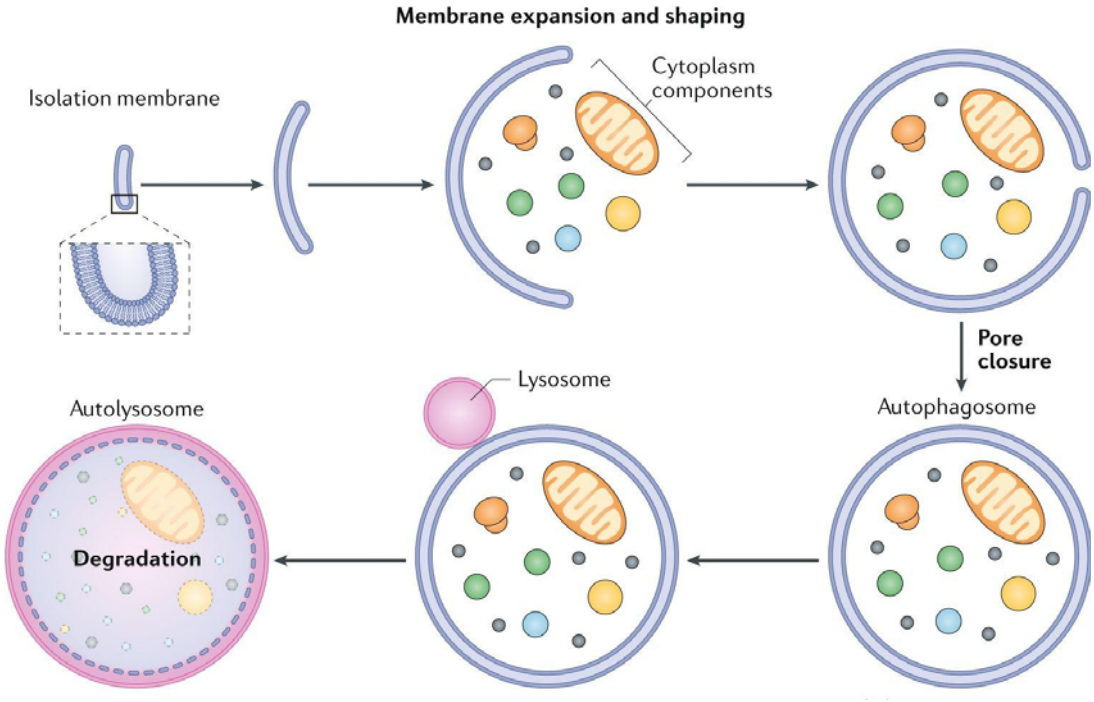

Fig. 1.2

(c) With reference to Fig. 1.2, describe how the unwanted cytoplasm components are degraded.

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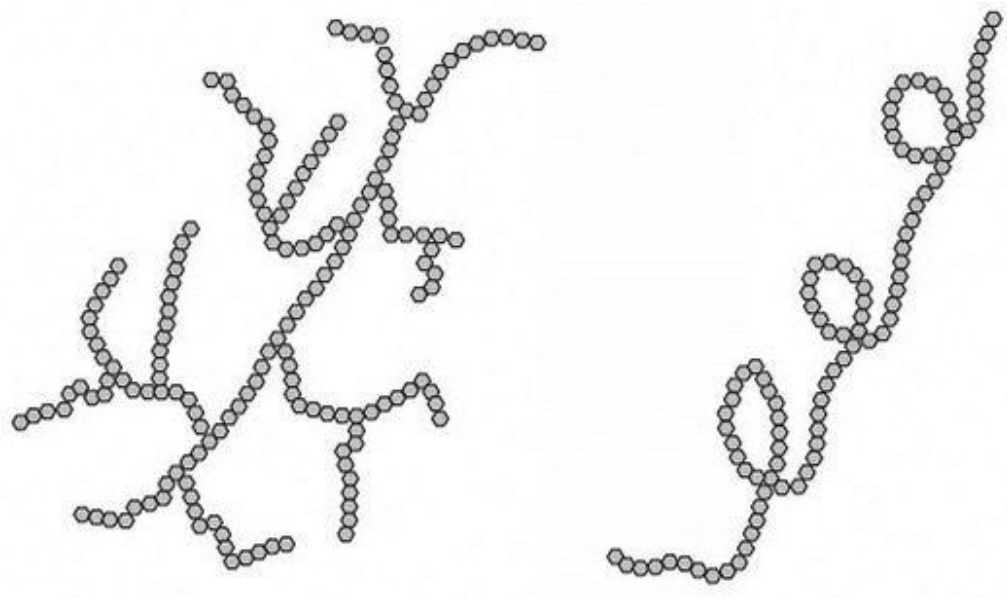
..... [4]

[Total: 10]

2 Fig. 2.1 shows the components of a storage molecule that is widely distributed in plants.



A **B**

Fig. 2.1

(a) Identify the components **A** and **B**.

A .....

B .....

[2]

(b) The presence of branches is a key structural feature of component **A**.

Explain how this structural feature enables the function of component **A**.

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..... [2]

Fig. 2.2 shows two types of glucose found in plants.

Fig. 2.2

(c) With reference to Fig. 2.2, draw a labelled diagram in the space provided to show how **two** glucose molecules react to form a branch point in component **A**.

[3]

(d) Glycolipids are generally found on the extracellular face of eukaryotic cell surface membrane.

Describe the roles of glycolipids in eukaryotic cell surface membrane.

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[Total: 10]

3 **(a)** Fig. 3.1 shows the process of DNA replication.

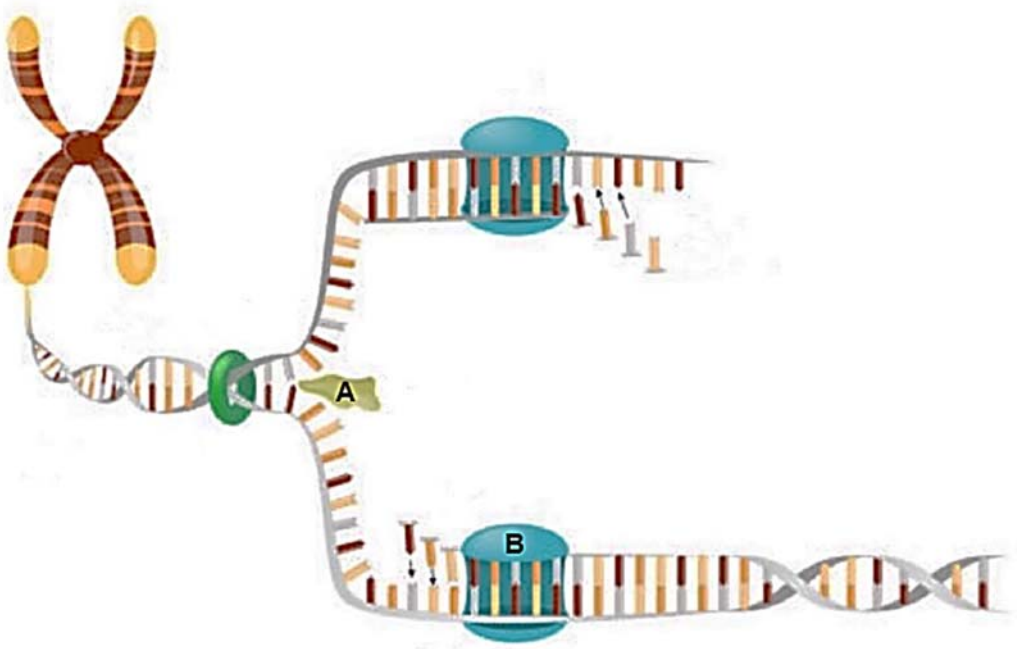

Fig. 3.1

(i) On Fig. 3.1,

- label a leading strand and a lagging strand
- draw an arrow to show the direction of movement of the replication fork.

[3]

(ii) Name the molecules **A** and **B**.

A .....

B .....

[2]

(iii) Describe how a mutation in the gene coding for molecule **B** can affect its function in DNA replication.

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..... [3]

(b) Dideoxycytosine triphosphate (ddCTP) can bind to the active site of molecule **B**, in a similar way to deoxycytosine triphosphate (dCTP).

Fig. 3.2 shows the structure of dCTP and ddCTP.

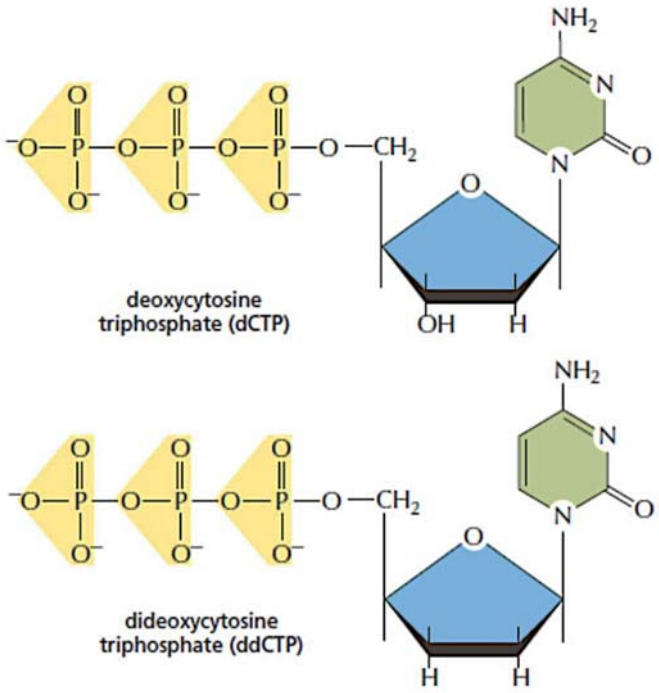

Fig. 3.2

In an *in vitro* DNA replication reaction mixture, ddCTP was added together with deoxyribonucleotides.

Suggest how the addition of ddCTP would affect DNA replication.

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..... [2]

[Total: 10]

4 Epstein-Barr virus (EBV) was the first virus known to cause human cancer. Human B lymphocytes are the host cells of EBV infection.

Fig. 4.1 shows the structure of EBV.

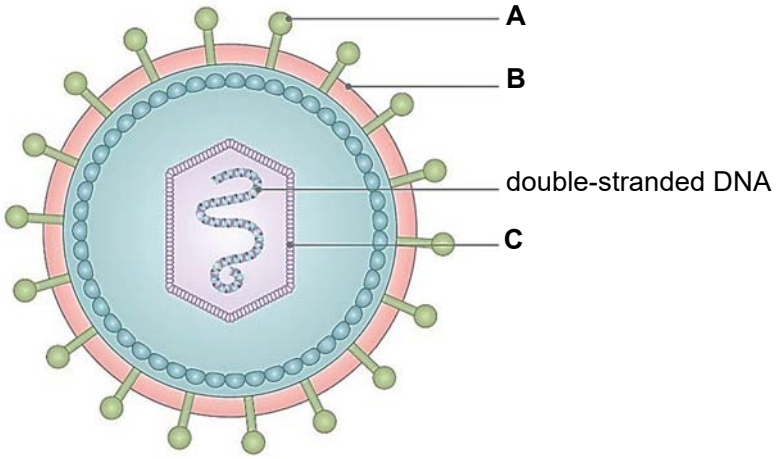

Fig. 4.1

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

A .....

B .....

[2]

(ii) List **two** differences between the EBV and influenza virus genomes.

1 .....

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2 .....

..... [2]

Fig. 4.2 shows part of the reproductive cycle of EBV starting from its attachment to a B lymphocyte.

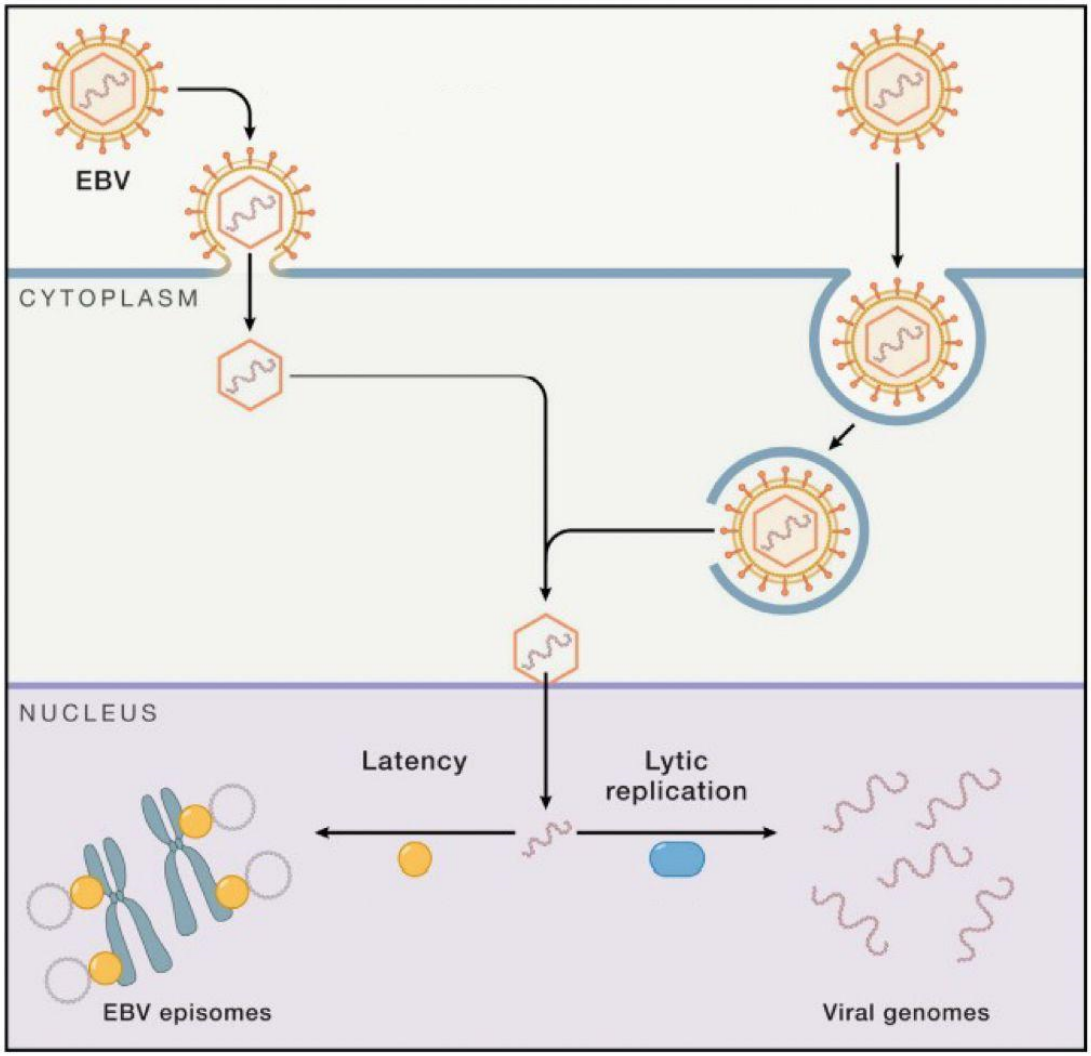

Fig. 4.2

(b) (i) With reference to Fig. 4.2, describe **two** ways how EBV enters the B lymphocyte.

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..... [2]

(ii) Besides replicating the viral genome, the synthesis of structure **C** is necessary before new EBV particles can be produced.

Describe how structure **C** is synthesised in the infected B lymphocyte.

[3]

(iii) Depending on the environmental cues, EBV may enter latency where the viral genome is retained as an extrachromosomal episome as shown in Fig. 4.2. New EBV particles are not produced.

Suggest **one** advantage of EBV entering latency.

[1]

[Total: 10]

Question 5 starts on page 12.

5 Increased methylation of the promoter region of a tumour suppressor gene causes a type of human lung cancer. The methylation is caused by an enzyme called DNA methyltransferase (DNMT).

Scientists have found a potential anti-cancer drug in green tea, called EGCG. EGCG is a competitive inhibitor of DNMT and enables daughter cells to produce mRNA from the tumour suppressor gene.

(a) Explain how EGCG can serve as an anti-cancer drug.

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..... [4]

(b) The scientists investigated the effect of EGCG concentration on the viability of lung cancer cells grown *in vitro*.

Fig. 5.1 shows their results. The asterisk (*) indicates significant difference ($p<0.05$) compared to the control group treatment with EGCG.

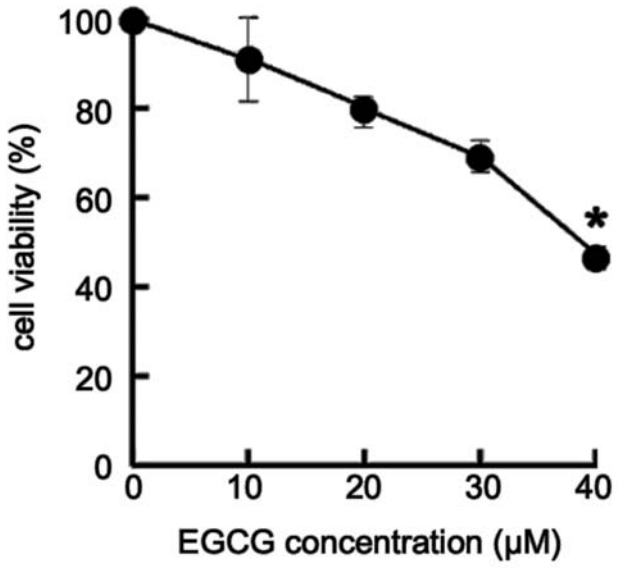

Fig. 5.1

(i) With reference to Fig. 5.1, describe the effect of increasing EGCG concentration on the viability of lung cancer cells.

[3]

(ii) A reporter reviewed the results of the investigation and concluded that drinking green tea could be a cure for cancer.

Suggest **three** reasons why his conclusion might **not** be valid.

[3]

[Total: 10]

6 The fruit fly, *Drosophila melanogaster*, has autosomal genes for body colour and wing shape.

A dihybrid cross was carried out between flies with brown body and straight wings which are heterozygous for both body colour and wing shape, and flies with black body and curved wings.

Table 6.1 shows the number of offspring of each phenotype obtained in the cross.

Table 6.1

phenotype	observed (O)	expected (E)	$(O - E)^2 / E$
brown body colour, straight wings	1695		
brown body colour, curved wings	1903		
black body colour, straight wings	1918		
black body colour, curved wings	1692		
		χ^2 =	

A chi-squared (χ^2) test was carried out to compare the observed results with the results that would be expected from a cross involving genes on different autosomal chromosomes.

The formula for chi-squared test is:

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

Table 6.2 shows the critical values for the χ^2 distribution.

Table 6.2

degrees of freedom	*p* value		
	0.05	0.01	0.001
1	3.84	6.64	10.83
2	5.99	9.21	13.82
3	7.82	11.35	16.27
4	9.49	13.28	18.47

(a) Complete Table 6.1 to

(i) show the expected number of each phenotype if the two genes are on different autosomes [1]

(ii) calculate the value of χ^2 to **two** decimal places. [1]

(iii) State and explain what can be concluded about inheritance of body colour and wing shape in fruit fly from the χ^2 value.

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..... [3]

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

Use the symbols **B** and **b** to represent the alleles for body colour and **D** and **d** to represent the alleles for wing shape.

[5]

[Total: 10]

7 In the 1950s, Melvin Calvin studied the series of reactions that we now know as the Calvin cycle. Calvin's 'lollipop' experiment was so called because it used a lollipop-shaped glass flask containing single-celled photosynthetic algae growing in culture.

Fig. 7.1 shows the setup of Calvin's 'lollipop' experiment.

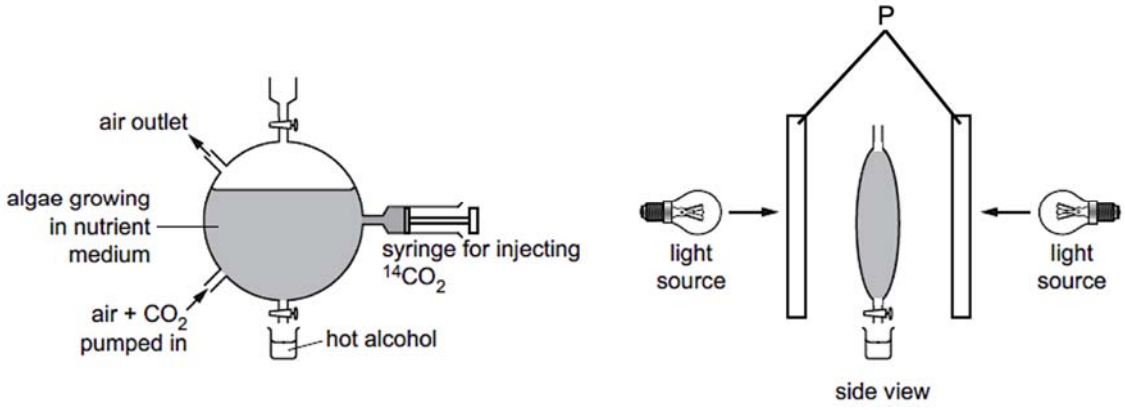

Fig. 7.1

The algae were illuminated for 30 minutes before the start of the experiment. Air containing non-radioactive carbon dioxide was pumped into the suspension throughout the 30 minutes.

At time zero, a small amount of radioactively-labelled carbon dioxide ($^{14}CO_2$) was introduced. At intervals after addition of $^{14}CO_2$, samples of the suspension were killed in hot alcohol before being analysed.

(a) **P** is placed between each lamp and the lollipop-shaped glass flask as shown in Fig. 7.1.

Suggest the purpose of **P**.

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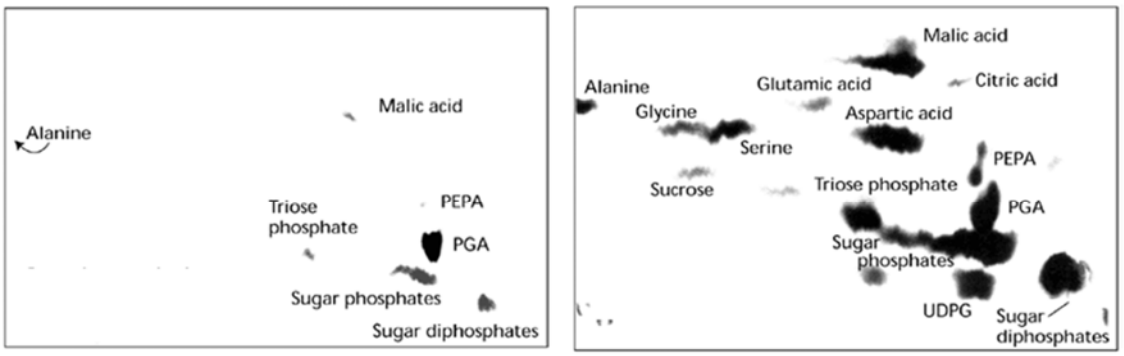
..... [1]

The samples were analysed using chromatography and autoradiography.

Fig. 7.2 shows the results of Calvin's 'lollipop' experiment. Dark spots showed the presence of radioactive organic compounds at 5 seconds and 30 seconds after the addition of $^{14}CO_2$.



5 seconds after addition of $^{14}CO_2$

30 seconds after addition of $^{14}CO_2$

Fig. 7.2

(b) With reference to Fig. 7.2,

(i) explain how PGA was determined to be the first intermediate in carbon fixation.

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..... [1]

(ii) explain the results at 30 seconds after addition of $^{14}CO_2$.

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..... [5]

(c) Calvin cycle requires the products of light dependent reactions.

Compare non-cyclic and cyclic photophosphorylation.

[3]

[Total: 10]

Question 8 starts on page 20.

8 The insulin receptor comprises two α–chains (L1, CR, L2, F1, F2 and α-CT) and two β–chains (F3, TM and TK). The extracellular portion of the receptor consists of the α–chain and F3 of β–chain. The remainder of the β–chain includes a transmembrane helix (TM) and the intracellular tyrosine kinase (TK) domain.

Fig. 8.1 shows the steps involved in the activation of the insulin receptor.

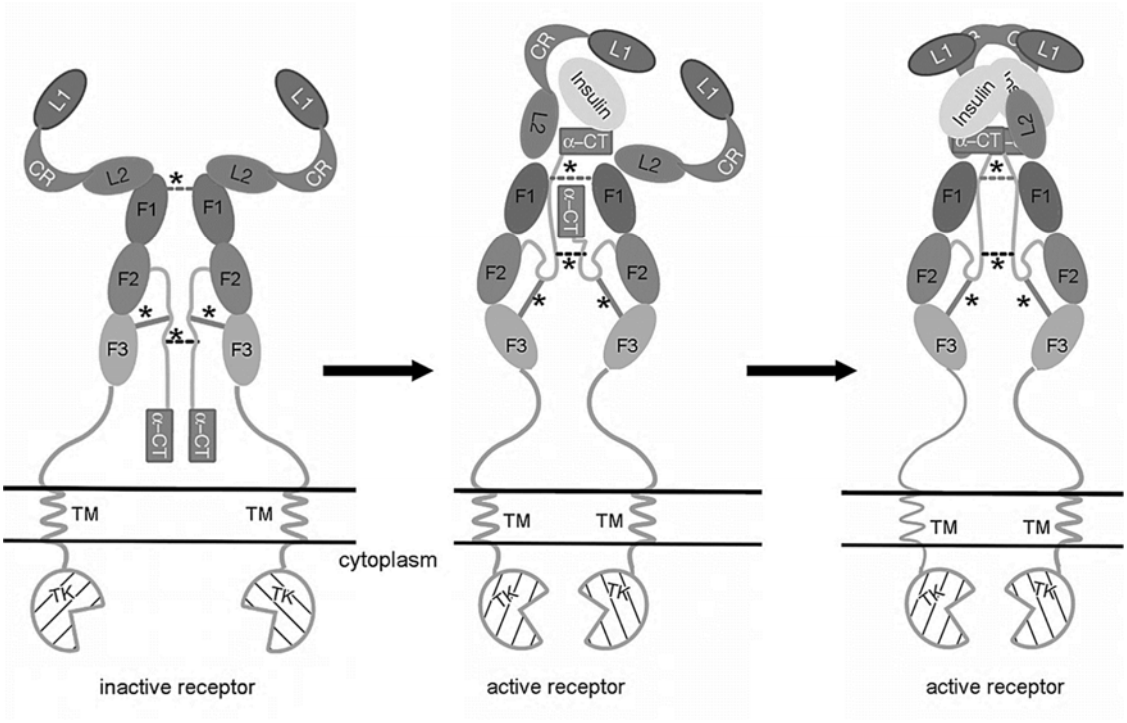

Fig. 8.1

(a) With reference to Fig. 8.1, explain how the binding of insulin leads to the activation of the insulin receptor.

[5]

(b) The lines marked by asterisks (*) represent a type of strong bond holding the polypeptide chains together.

(i) Name the bond.

.....[1]

(ii) With reference to Fig. 8.1, describe the significance of these bonds.

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.....[1]

(c) Suggest why the active receptor with two insulin molecules bound may be more effective in triggering downstream signal propagation.

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.....[1]

(d) Describe **two** cellular responses when insulin binds to the receptors in muscle cells.

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.....[2]

[Total: 10]

9 Green lacewings of the genus *Chrysoperla* are insects commonly used for biological pest control as their larvae are predatory and feed on aphids.

Different *Chrysoperla* species may be identical in terms of morphology but can be readily separated based on their courtship songs, which are vibration signals used to attract mates.

Fig. 9.1 shows the characteristics of courtship songs of four *Chrysoperla* species, namely, North American *C. calocedrii* and European *C. carnea*, *C. mediterranea* and *C. pallida*.

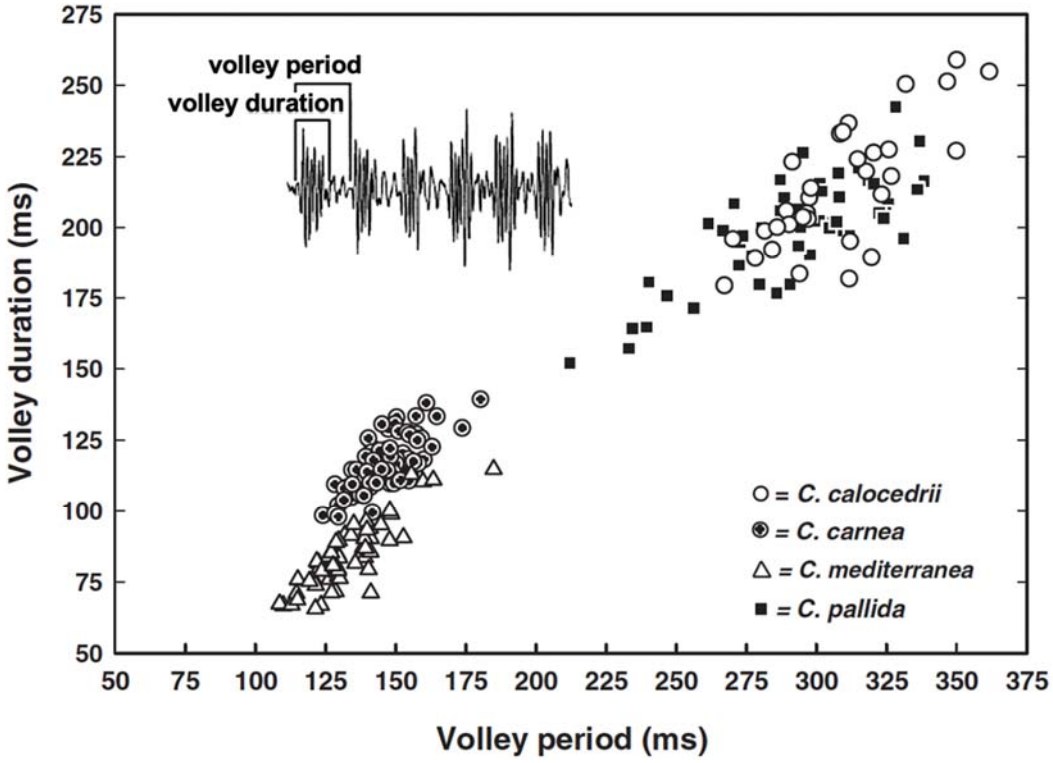

Fig. 9.1

(a) Explain how the European *C. carnea*, *C. mediterranea* and *C. pallida* may have evolved from a common ancestor.

[5]

(b) Different *Chrysoperla* species that are isolated from each other on different continents are not constrained to sing differently, so there may be occasional instances where nearly identical songs have evolved independently.

(i) With reference to Fig. 9.1, identify the European *Chrysoperla* species which has similar courtship song as the North American *C. calocedrii*.

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[1]

(ii) Suggest how the introduction of the North American *C. calocedrii* to Europe will affect the gene pool of the European *Chrysoperla* species.

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[1]

(c) Fig. 9.2 shows the phylogeny based on DNA sequence data for the four *Chrysoperla* species.

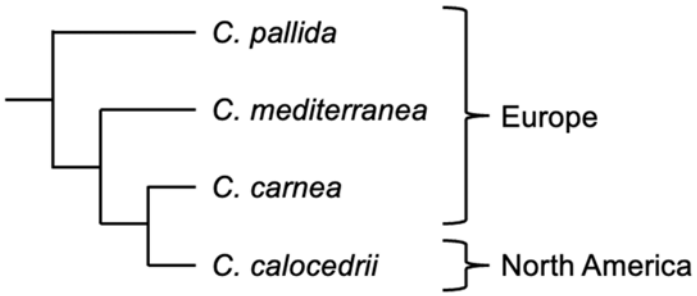

Fig. 9.2

With reference to Fig. 9.1 and Fig. 9.2 and the information provided, explain the importance of using DNA sequences, in addition to morphology and courtship songs, in reconstructing phylogenetic relationships of *Chrysoperla* species.

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[3]

[Total: 10]

10 Palm oil is a vegetable oil that is used very widely in food products. The oil is extracted from the fruit of the oil palm tree.

Oil palm trees have a higher oil yield than that of other oil-producing plants.

Fig. 10.1 shows the oil yield of four crop plants.

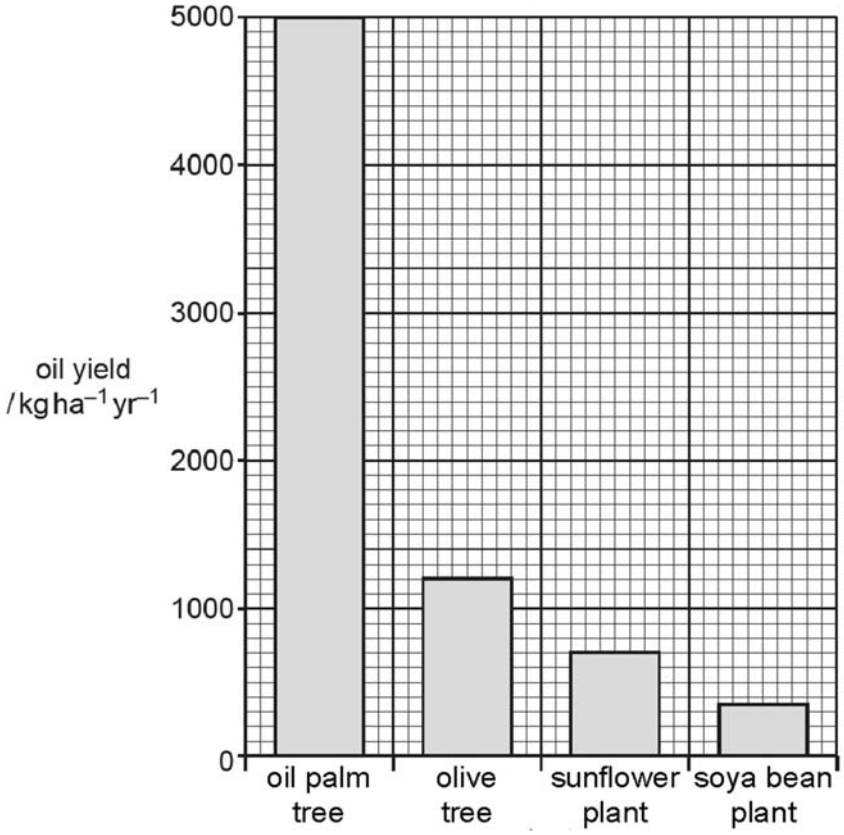

Fig. 10.1

(a) Calculate how many hectares (ha) of soya bean plants would be needed to produce the **same** yield of oil as one hectare of oil palm trees per year.

Show your working and write your answer to **one** decimal place.

..... ha [2]

(b) Oil palm plantations in Malaysia and Indonesia have been created by cutting down rainforests. This reduces biodiversity.

State three reasons why it is important to maintain biodiversity.

[3]

[Total: 5]

11 Infectious diseases can be controlled by different methods including vaccines and antibiotics.

Describe how vaccines and antibiotics can be used to control infectious diseases.

[5]

[Total: 5]

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