TAMPINES MERIDIAN JUNIOR COLLEGE

JC2 PRELIMINARY EXAMINATION

CANDIDATE NAME	
CIVICS GROUP	

H2 BIOLOGY

9744/02

Paper 2 Structured Questions

14 September 2023
2 hours

Candidates answer on the Question Paper.
No additional materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name and Civics Group in the spaces at the top of the 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 examiner's Use	
1	/ 11
2	/ 11
3	/ 11
4	/ 12
5	/ 15
6	/ 9
7	/ 12
8	/ 10
9	/ 9
Total	**/ 100**

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

1 The table below compares the features of typical eukaryotic and prokaryotic cells.

(a) Complete the table below by placing either a tick (✓), a cross (✗) or the words 'sometimes present' as appropriate in each empty box. [3]

Features	Eukaryotic cell	Prokaryotic cell
nuclear envelope	✓	
cell wall	sometimes present	✓
chloroplast	sometimes present	
ribosomes	✓	✓
Golgi apparatus	✓	✗
flagellum	sometimes present	
carries out respiration	✓	✓

Active transport and facilitated diffusion are two ways by which substances cross the cell surface membranes.

(b) State one similarity and one difference between active transport and facilitated diffusion. [2]

similarity……

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difference……

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(c) Vitamins C and D are essential illness-fighting nutrients, which safeguard our health and boost immunity. They are therefore, taken into cells but take different routes across the cell surface membrane. Vitamin C is water-soluble while Vitamin D is lipid soluble.

Explain how Vitamin C and D is transported across the cell surface membrane. [3]

Vitamin C

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Vitamin D

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(d) A vitamin C drink is thought to contain glucose. Excess glucose consumed is stored as glycogen in muscles.

Explain how the structure of glycogen is related to its role in living organisms. [3]

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[Total:11]

2 **(a)** Enzymes speed up the rate of reaction by lowering the activation energy of the reaction. Most enzymes are specific to one reaction.

Outline how enzymes lower the activation energy of a reaction. [2]

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A tyrosine kinase receptor (TKR) is a protein complex found in the cell surface membrane of mammalian cells.

TKR has two components involved in the process of cell signaling:

- a receptor for the signalling molecule (ligand)
- an enzyme that catalyses the transfer of a phosphate group from ATP to an intracellular protein.

Fig. 2.1 is a diagram to show how TKR is involved in cell signalling.

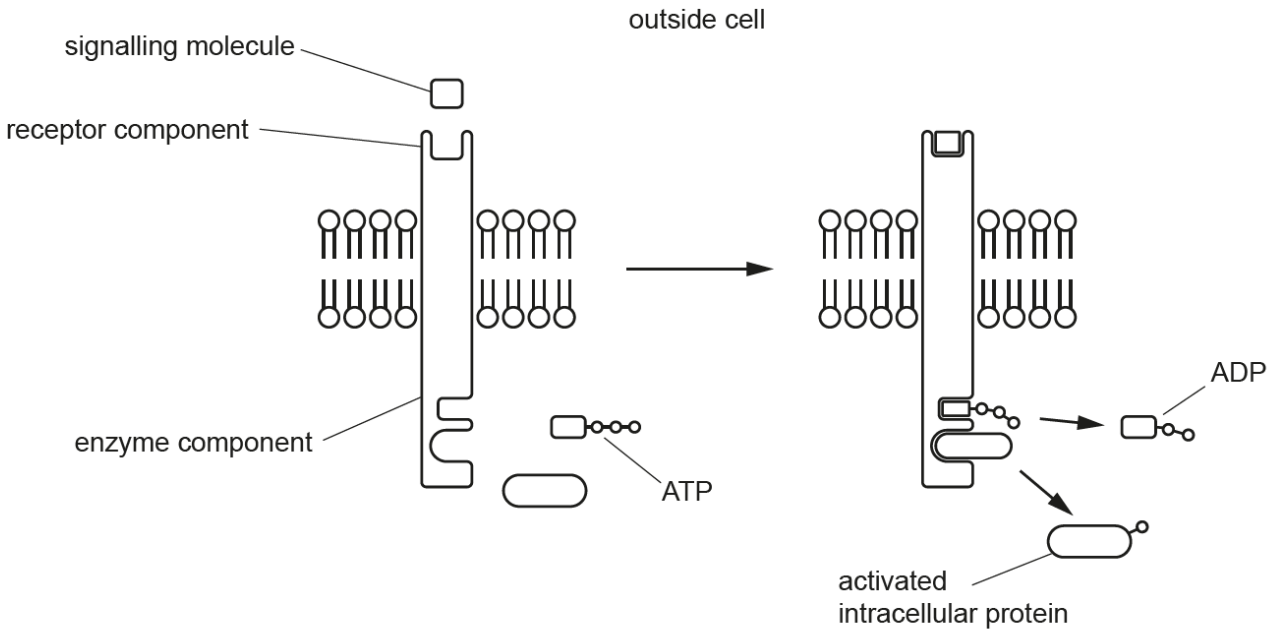

Fig. 2.1

(b) Describe how the signalling molecule shown in Fig. 2.1 is able to trigger a response inside the target cell. [3]

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(c) The drug GNF-5 is used in the treatment of some cancers. GNF-5 affects the activity of TKR by binding to the enzyme component of the complex.

Researchers investigated the effect of GNF-5 on the activity of TKR using different concentrations of ATP solution. In an experiment the activity of TKR was measured with no GNF-5 **and** with GNF-5.

The results are shown in Fig. 2.2.

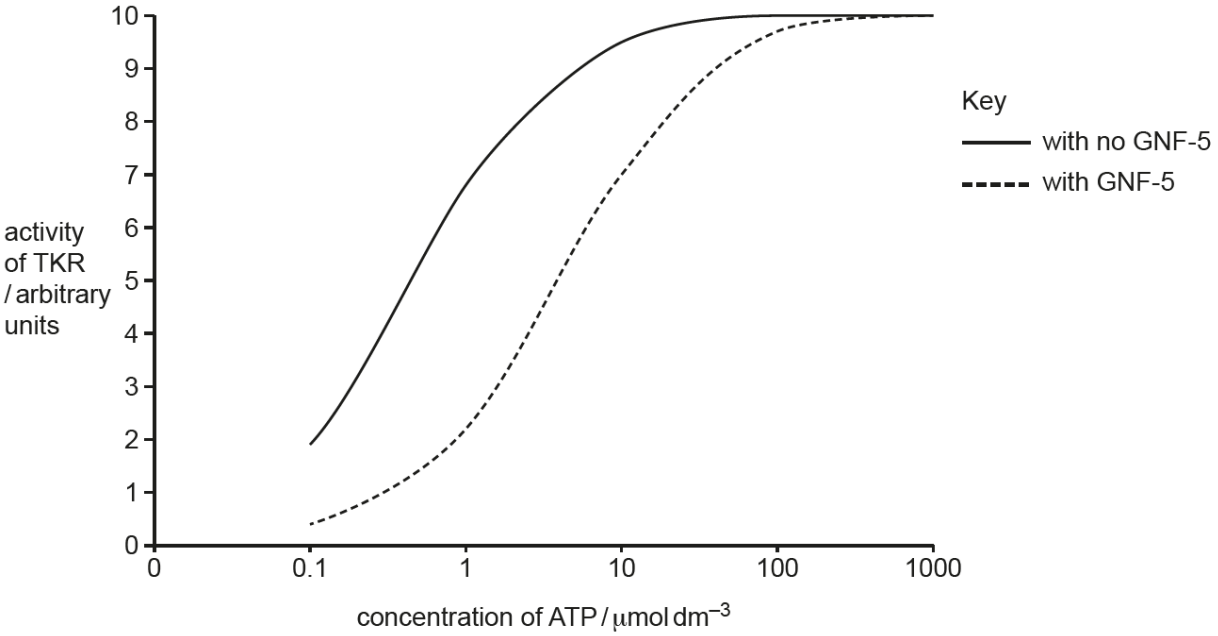

Fig. 2.2

Use Fig. 2.2 to provide evidence that GNF-5 acts as a competitive inhibitor. [3]

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(d) A mutation of the gene coding for TKR results in the change to the enzyme component of TKR. This altered form of TKR is known as T315L.

The effect of GNF-5 on the activity of T315L was also investigated.

The results of this investigation are shown in Fig. 2.3.

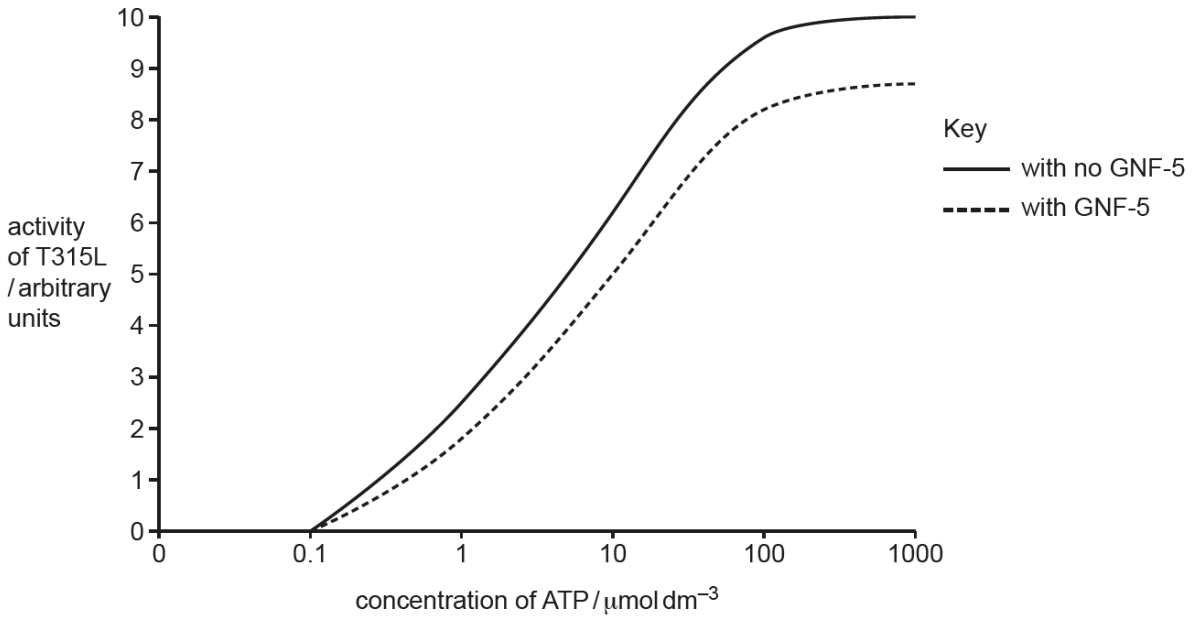

Fig. 2.3

Use Fig. 2.2 **and** Fig. 2.3 to

(i) state how the activity of T315L differs from TKR when **no** GNF-5 was present. [1]

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(ii) explain why the effect of GNF-5 on T315L differs from the effect of GNF-5 on TKR. [2]

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[Total: 11]

3 Fig. 3.1 shows a pair of homologous chromosomes during one of the stages of meiosis.

The letters **G** to **M** represent the dominant alleles of seven genes and the letters **g** to **m** represent the recessive alleles of the same seven genes.

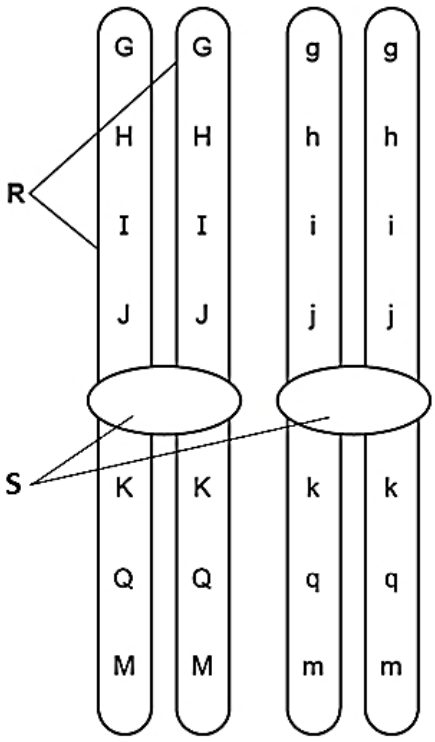

Fig. 3.1

(a) (i) Name the structures labelled **R** and **S** on Fig. 3.1. [2]

R .....

S .....

(ii) State **three** features visible on Fig. 3.1 that identify the chromosomes as a homologous pair. [3]

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(iii) Fig. 3.2 shows the same two chromosomes a little later in the same stage of meiosis. Crossing over is starting to occur at point **T**.

Fig. 3.3 shows an outline of the same two chromosomes after crossing over has occurred.

Complete Fig. 3.3 by writing in the letters of the alleles along both chromosomes. Take care to clearly show the difference between letters representing dominant alleles and letters representing recessive alleles. [2]

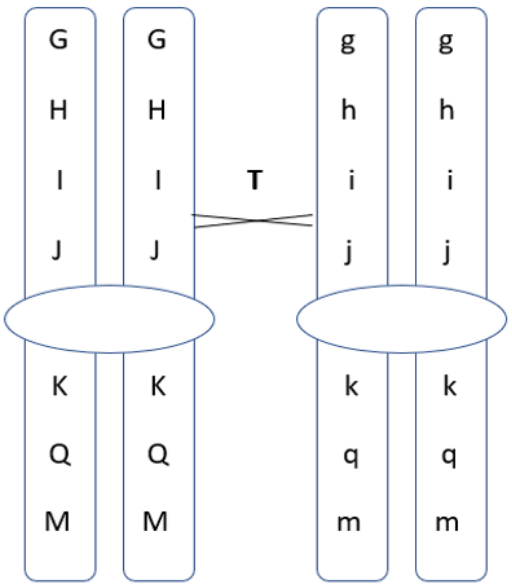

Fig. 3.2

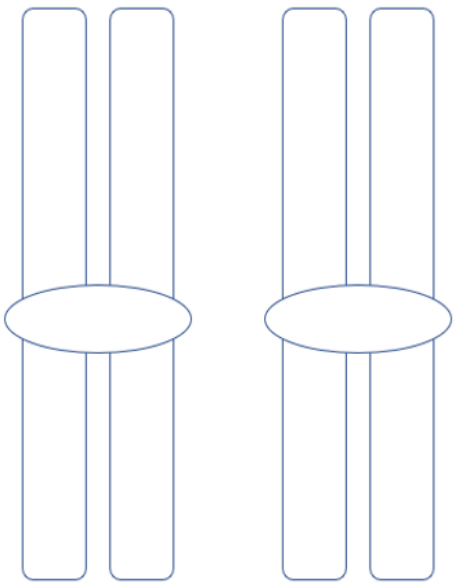

Fig. 3.3

(b) State the stage in meiosis in which crossing over occurs. [1]

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(c) Crossing over results in genetic variation.

Explain how random assortment of homologous chromosomes also results in genetic variation. [2]

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(d) The diploid number of chromosomes of this organism is ten.

In the absence of crossing over or mutation, state the number of genetically unique kinds of gametes that might be formed by one individual. [1]

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[Total: 11]

4 Fig. 4.1 is an electron micrograph of part of a chloroplast.

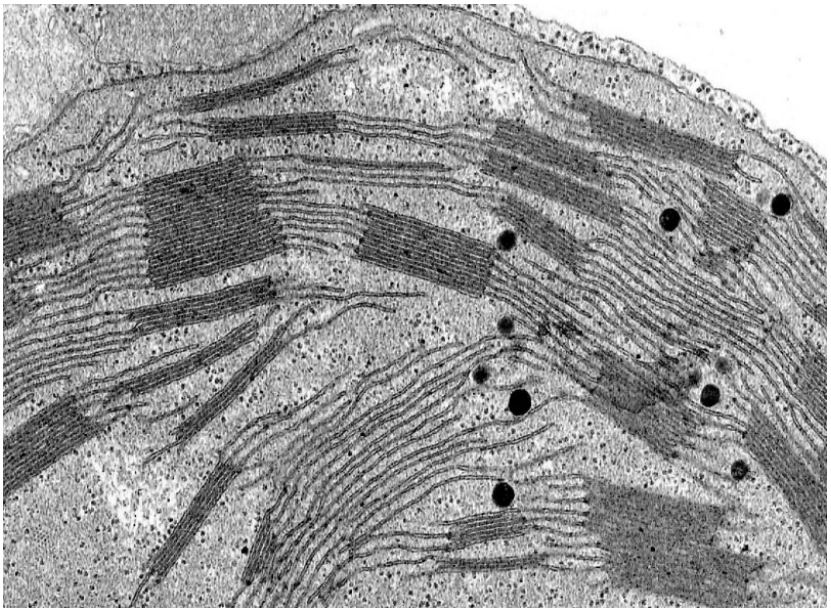

Fig. 4.1

(a) Using ruled label lines and the letters **X** and **Y**, identify a structure in Fig. 4.1:

(i) that contains Rubisco – **X**
(ii) where photoactivation takes place – **Y** [2]

(b) State where in a chloroplast circular DNA may be located. [1]

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(c) Describe the similarities between ATP production in mitochondria and chloroplasts **and** suggest why these similarities exist. [4]

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Fig. 4.2 shows a raccoon.

Fig. 4.2

In the winter, the raccoon curls into a spherical shape underground and sleeps for long periods. During this time, the raccoon switches between two states:

- torpor, when the body temperature is maintained at 10°C
- euthermia, when the body temperature is maintained at 37 °C.

Scientists used the activity of succinate dehydrogenase to investigate the rate of respiration in the mitochondria of raccoons. Mitochondria were extracted from liver and muscle samples of raccoons. The rate of respiration was measured at different concentrations of succinate and at temperatures that corresponded to torpor (10°C) and euthermia (37°C).

The results are shown in Fig. 4.3.

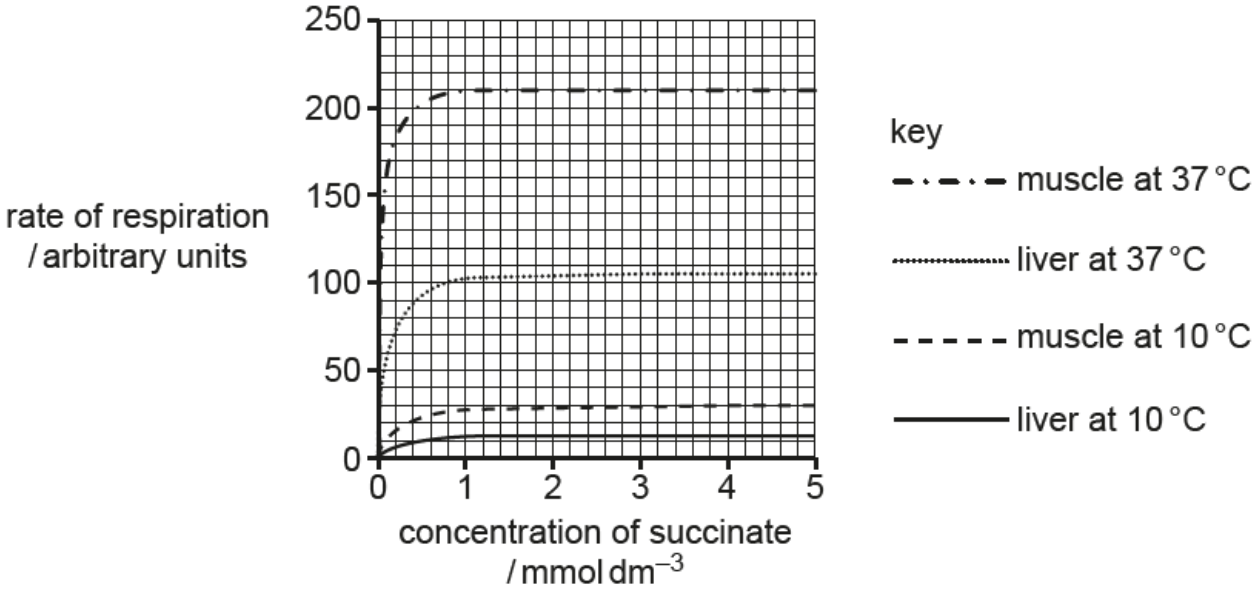

Fig. 4.3

(d) (i) Compare the effect of temperature **and** cell type on rate of respiration. [3]

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(ii) Suggest reasons for the difference in the rates of respiration between liver and muscle cells. [2]

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[Total: 12]

5 A piebald fur dog is one that has white spotted pattern and is often associated with deafness.

Pure bred brown fur dogs with normal hearing were crossed with pure bred piebald, deaf dogs. All F1 generation were brown fur dogs with normal hearing. The F1 generation were then inbred and gave offspring with the following observed numbers and phenotypes as shown in Table 5.1 below.

(a) In Table 5.1,

- indicate the expected number of progeny of the F2 phenotypes if the genes assorted independently.
- complete the rest of Table 5.1 to calculate the chi-squared value. [4]

Table 5.1

Phenotypes	Number of F2 progeny		$(O - E)^2$	$\frac{(O - E)^2}{E}$ (2 d.p.)
	Observed (O)	Expected (E)		
Brown fur, normal hearing	30			
Piebald fur, deaf	24			
Brown fur, deaf	7			
Piebald fur, normal hearing	3			

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

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(b) The critical chi-squared value for these results at a probability of $p = 0.05$ is 7.81.

State what can be concluded about the inheritance from the chi-squared value you have calculated in **(a)**. [3]

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(c) Explain the difference between the expected and observed number in the F2 progeny. [4]

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(d) Draw a genetic diagram to show the results of a cross between the F1 generation.

Use the symbols **B** and **b** to represent alleles for fur colour and **D** and **d** to represent the alleles for hearing. [4]

[Total: 15]

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6 The *lac* operon is a section of DNA present in the genome of *Escherichia coli*. The structural genes of the *lac* operon are only fully expressed when the bacteria is exposed to high lactose concentrations.

Fig. 6.1 is a diagram showing the *lac* operon and a nearby region of the *E. coli* genome.

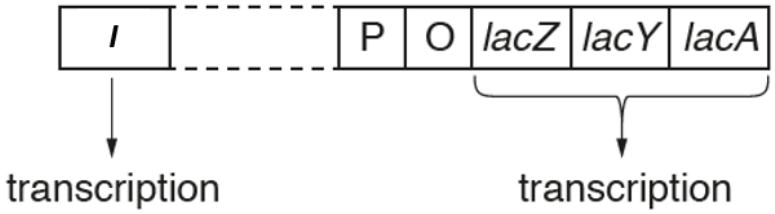

Fig. 6.1

(a) With reference to Fig. 6.1, complete Table 6.1 to identify two structural genes and its products. [2]

Table 6.1

structural gene	name of the gene product

(b) Gene *I* is transcribed all the time to produce its protein. This is known as constitutive expression.

Explain why Gene *I* is constitutively expressed. [3]

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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. 6.2 shows the population growth curve obtained for this investigation.

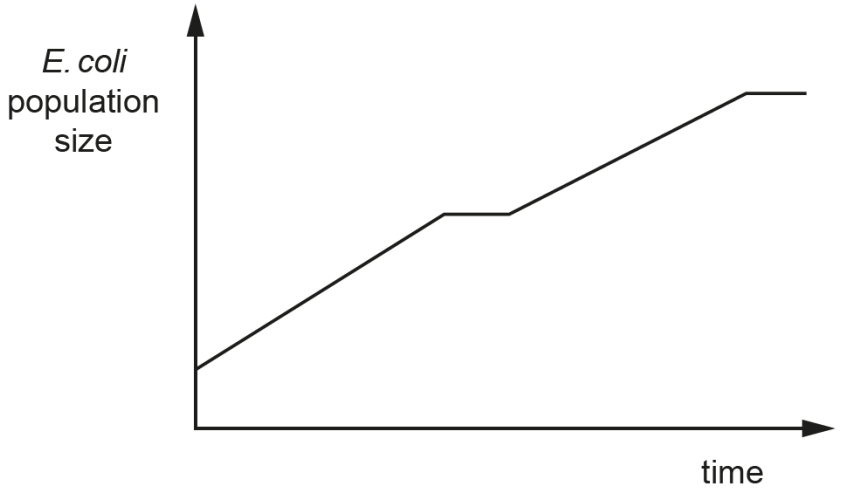

Fig. 6.2

(c) Describe **and** suggest explanations for the population growth curve shown in Fig. 6. [4]

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[Total: 9]

7 Fig. 7.1 shows the evolutionary relationship, constructed based on the DNA sequence data, of three species of *Urena* plants and the corresponding timescale.

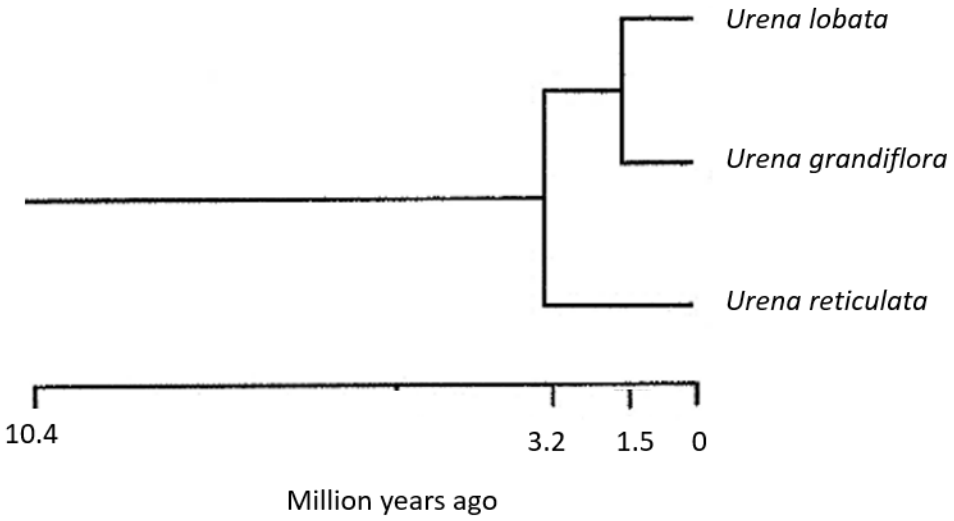

Fig. 7.1

(a) (i) Name the type of diagram used to represent the above evolutionary relationship. [1]

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(ii) Describe the evolutionary relationship between the three species above. [2]

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(b) Table 7.1 shows the Linnaean taxonomy of *Urena lobata*.

Complete Table 7.1 to show the classification of *Urena lobata*. [2]

Table 7.1

Kingdom	
Phylum	Tracheophytes
Class	Magnoliopsida
Order	Malvales
	Malvacea
Genus	
Species	

(c) Describe one advantage of using DNA sequence data in determining evolutionary relationships. [1]

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(d) *Urena lobata is a* wind-pollinated plant species which is an iron tolerant form abundant on land near an iron ore mine. Fig. 7.2 is a profile of the area around the iron mine showing where samples were taken for a study.

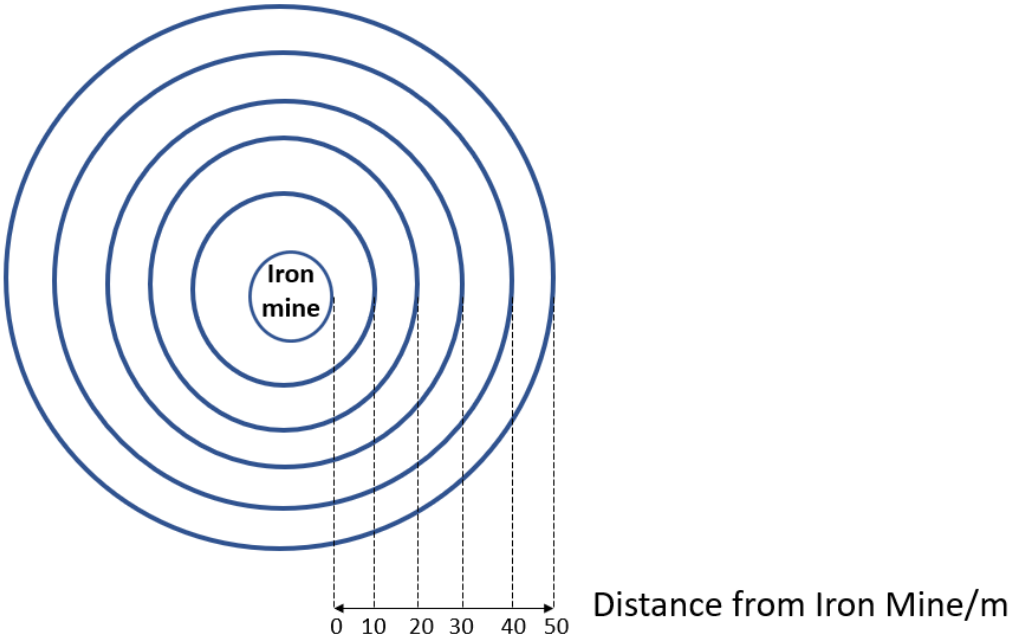

Fig. 7.2

Seeds were collected from plants at 10 metre intervals from the iron mine and germinated in laboratory. The seedlings were planted in a medium containing all the minerals required for healthy growth.

Batch **A** was watered with solution containing diluted concentrations of iron while Batch **B** was watered with distilled water. After two weeks, the mean height of each batch of seedlings were recorded. Table 7.2 shows the results.

Table 7.2

Distance from mine where seeds were collected/ m	Mean height of seedlings/cm	
	Batch **A**	Batch **B**
10	3.9	4.0
20	3.8	4.1
30	3.7	4.8
40	3.8	4.9
50	3.7	4.9

(i) Describe the results shown in Table 7.2.
[3]

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In Batch **A**, it is observed that seedlings collected closer to the mine has greater survival rates after two weeks while those taken further away from the mine died.

(ii) Explain why seedlings collected closer to the mine grow more successfully.
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(iii) Suggest why some iron tolerant plants can be found 50m or more away from the mine area.
[1]

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[Total: 12]

8 AIDS is caused by a virus that infects and kills helper T cells.

(a) State the name of the virus that causes AIDS. [1]

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(b) Describe the consequences of the lack of helper T cells on the functioning of the immune system. [4]

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(c) State **one** way in which this virus can be transmitted from person to person. [1]

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(d) Suggest why antibiotics are prescribed to patients with AIDS, even though antibiotics have no effect on viruses. [2]

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(e) Currently, there is no drug that effectively eliminates the virus that causes AIDS.

Explain why this is so. [2]

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[Total: 10]

9 A large number of different mammal species living in North America were weighed and the mean mass of each mammal species was calculated.

Fig. 9.1 shows the relationship between the mean mass of different mammal species and the mean annual temperature of the habitat in which they normally live.

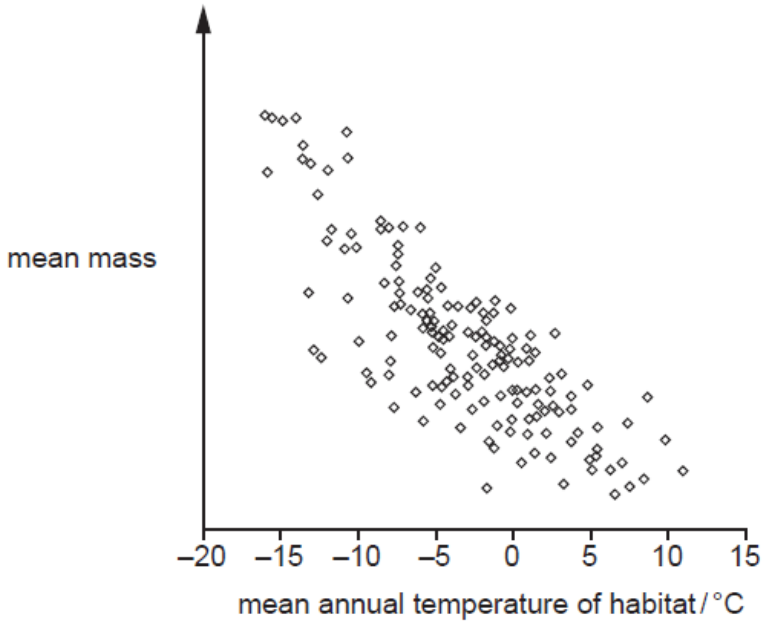

Fig. 9.1

(a) Account for the relationship between the mean mass of mammal species and the mean annual temperature of their habitat shown in Fig. 9.1. [3]

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The mean annual temperature across the world is increasing. The global average surface temperature rose by 0.6 to 0.9°C. Global warming is the term used to describe the rapid increase in Earth's average surface temperature over the past century primarily due to the release of greenhouse gases, such as carbon dioxide.

Fig. 9.2 shows the average concentration of carbon dioxide in the atmosphere every 10 years from 1965 to 2015.

The concentration is in parts per million (ppm).

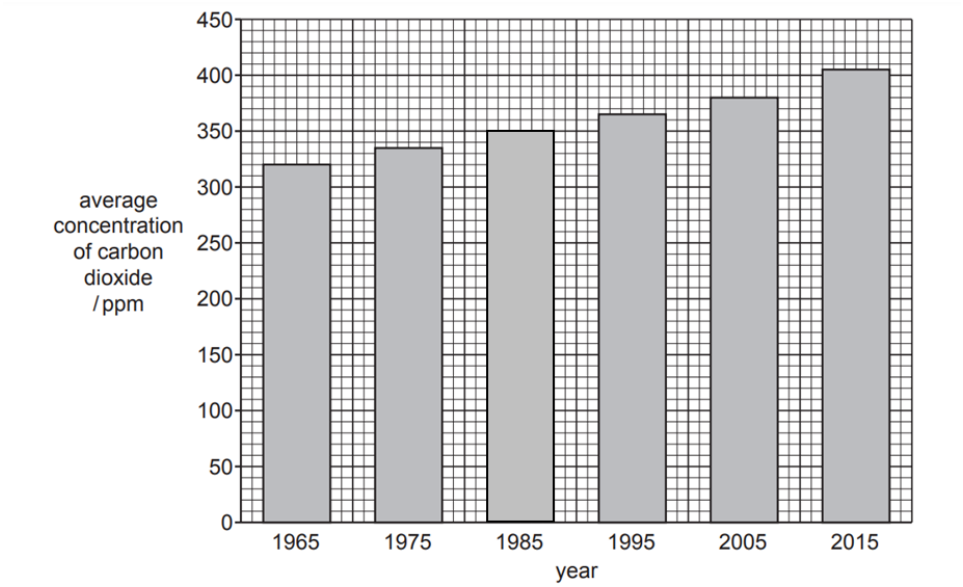

Fig. 9.2

(b) State which 10-year period experienced the greatest increase in concentration of carbon dioxide. [1]

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(c) State a reason for the increase in average concentration of carbon dioxide over the years.[1]

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Scientists study many biotic and abiotic factors that may have been influenced by global warming. Global warming is putting pressure on the different mammal species both on land and in the ocean. Warmer temperatures have already shifted the growing season in many parts of the globe. Spring is arriving earlier in both hemispheres, causing the growing season in parts of the Northern Hemisphere becoming two weeks longer in the second half of the 20th century.

Therefore, migrating animals have to start seeking food sources earlier. Furthermore, the shift in seasons may already be causing the life cycles of pollinators, like bees, to be out of sync with flowering plants and trees. This mismatch can limit the ability of both pollinators and plants to survive and reproduce, which would reduce food availability throughout the food chain.

(d) Define biotic factor. [1]

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(e) Describe how global warming has impacted **other** biotic factors. [3]

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[Total: 9]

☺ **END OF PAPER 2** ☺