The Cell

Question Paper 1

Level	Pre U
Subject	Biology
Exam Board	Cambridge International Examinations
Topic	The Cell
Booklet	Question Paper 1

Time Allowed: **66 minutes**

Score: **/55**

Percentage: **/100**

1 You should read through the whole of this question carefully and then plan your use of the time to make sure that you finish all the work that you would like to do.

R1 is a transverse section of the spinal cord of a small mammal.

(a) **(i)** Make a low-power plan drawing of **R1**.

Label your plan drawing.

[6]

(ii) Use a ruler to measure the actual size of the specimen on slide **R1** and the size of your drawing between the same points. Put a line on your drawing to show the size that you have measured. Calculate the magnification of your drawing.

Show your working.

magnification .... [2]

(b) Use the high-power lens of your microscope to locate a cell body of a motor neurone in **R1**.

Make a labelled drawing to show the cell body.
Annotate your drawing to indicate the functions of the structures you have drawn.

Use the eyepiece graticule and stage micrometer to measure the diameter of the cell body.
Indicate the actual diameter on your drawing and show how you have derived your answer.

[8]

(c) Slide **R2** is a transverse section of part of the brain of a small mammal.

Compare, using a hand lens and your microscope, the structure and appearance of **R1** and **R2**.

Present your comparison as a table in the space below.

[5]

(d) Fig. 2.1 is an electron micrograph that shows a cross section of a neurone.

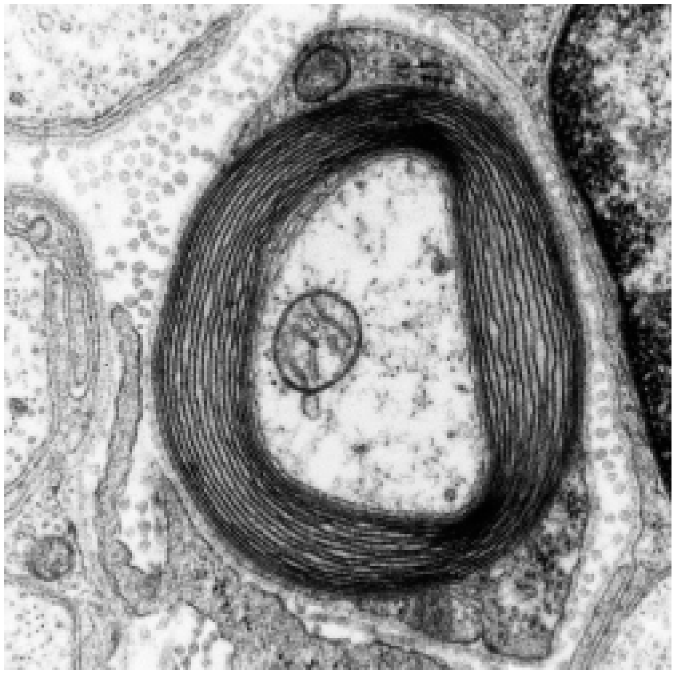

Fig 2.1

(i) Describe the appearance of the section of the neurone. You may use drawings or diagrams to illustrate your answer.

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(ii) Explain how the structural features you describe in **(i)** are related to the function of the neurone.

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(e) Fig. 2.2 is an electron micrograph that shows a junction between two neurones in the brain.

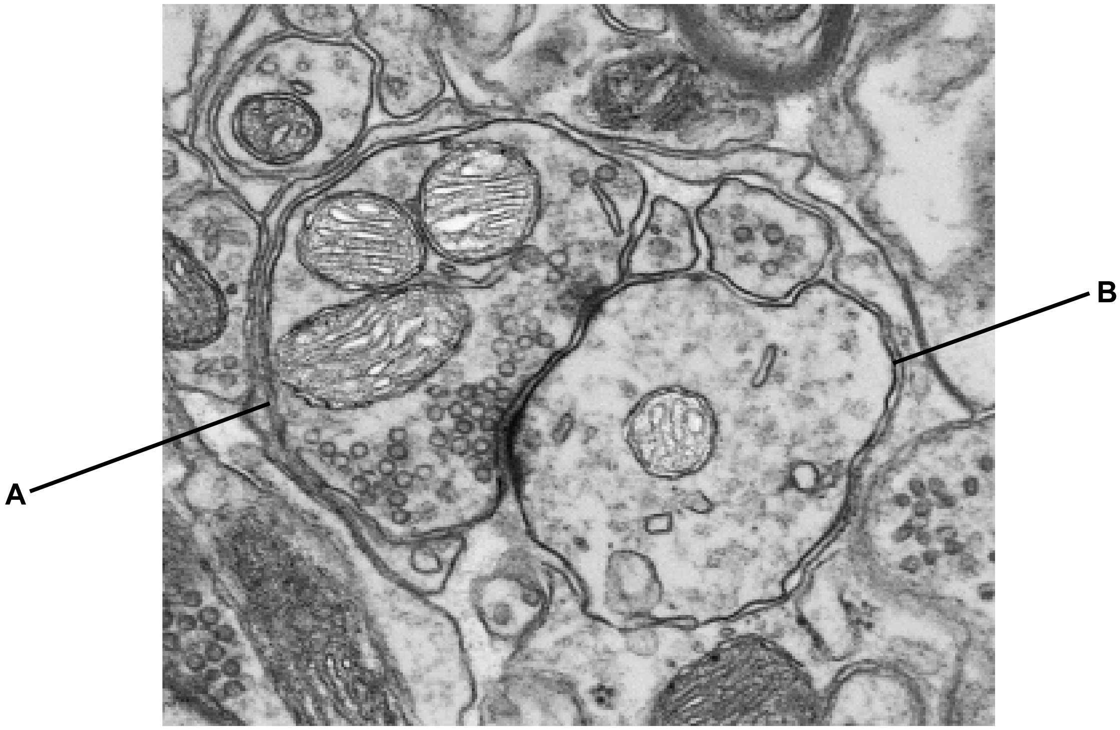

Fig 2.2

Identify neurones **A** and **B** and relate the appearance of these structures to their function. You may use the space opposite for any diagrams you may wish to draw to illustrate your answer.

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[5]

[Total: 35]

2 Some types of bacteria can grow on a medium containing only glucose and some mineral ions. This medium is known as minimal medium. Bacteria that are able to do this are known as wild type bacteria. Unlike wild type bacteria, nutritional mutants are bacteria that lack an active enzyme for the synthesis of a certain essential compound required for growth and therefore cannot grow on a minimal medium. For example, the *trp* mutant is not able to make the enzyme to synthesise the amino acid tryptophan and the *his* mutant cannot synthesise the amino acid histidine.

Wild type bacteria and five different mutant types of bacteria, **A** to **E**, were grown on five different media as shown in Table 5.1. The growth of bacterial colonies on each of the media is indicated by a plus (+) sign and lack of growth by a minus (–) sign.

Ampicillin is an antibiotic.

Table 5.1

bacteria	medium used				
	1 minimal medium	**2** minimal medium and ampicillin antibiotic	**3** minimal medium and histidine	**4** minimal medium and tryptophan	**5** lactose and mineral ions
wild type	+	–	+	+	+
type **A**	–	–	+		
type **B**	–	–		+	+
type **C**	–	–	+	–	–
type **D**	–	–			
type **E**	+	+			

(a) **(i)** Suggest why mutant type **C** cannot grow on minimal medium.

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(ii) Suggest why type **E** can grow on all the media.

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Transformation occurs when bacteria take up DNA from their surroundings. Gene transfer also occurs during conjugation when the bacterial chromosome of the donor bacterium is replicated and then transferred through a conjugation tube to the recipient bacterium as shown in Fig. 5.1.

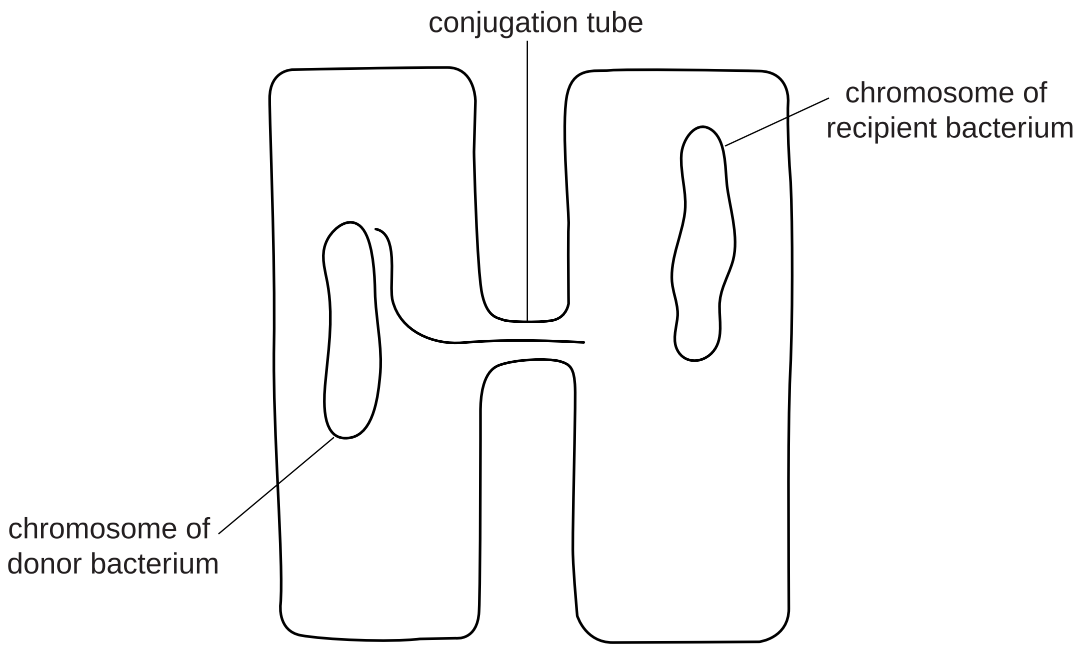

Fig. 5.1

The transfer of the whole chromosome to the recipient takes 60 minutes.

The order of genes on the chromosome and the distance between them can be determined by interrupting the transfer of the chromosome through the conjugation tube.

In an investigation of gene transfer, type **E** bacteria were used as the donor and type **D** as the recipient bacteria.

Samples were taken from the culture of the two types of bacteria at 10 minute intervals and shaken vigorously to break the conjugation tubes.

Small quantities of each sample were placed on media **2** to **5** as identified in Table 5.1.

The numbers of colonies of the recipient type **D** bacteria that developed from each sample are shown in Table 5.2. The time at which colonies begin to grow on a particular medium shows the time at which the appropriate gene was transferred from the wild type to the type **D** bacteria.

Table 5.2

sampling time / minutes	numbers of colonies of recipient type **D** bacteria on the media			
	2	**3**		
0	0	0	0	0
10	0	32	0	0
20	0	287	38	0
30	34	339	182	0
40	156	341	226	28
50	179	338	229	89
60	180	340	227	95

(b) **(i)** Plot the results from Table 5.2 on the graph paper provided. [3]

(ii) The time at which the genes are transferred is found by extrapolating the steepest parts of the lines to the x axis.

Use your graph to find the time when each gene is transferred and use Table 5.1 to identify the function of each gene.

Complete Table 5.3 by stating the function of each gene and giving the time when each gene is transferred.

Table 5.3

medium	function of each gene	time of gene transfer to recipient type **D** cells / minutes
2		
3		
4		
5		

[2]

(c) Use the information from Table 5.3 to indicate the positions of the genes on the bacterial chromosome shown in Fig. 5.2.

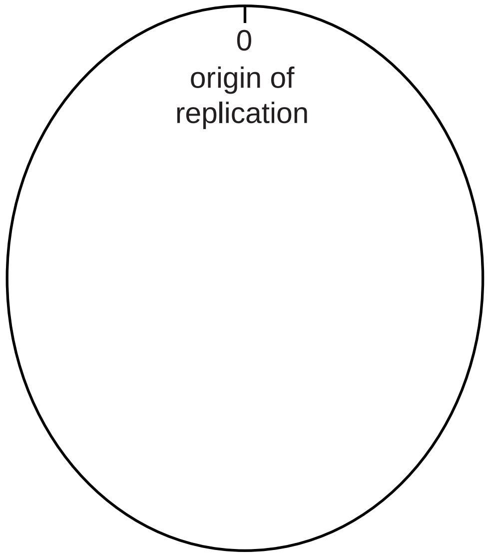

Fig. 5.2

[1]

[Total: 10]

3 Fig. 4.1 shows a female hedge sparrow or dunnock, *Prunella modularis*, feeding its

Fig. 4.1

Dunnocks have several reproductive strategies and associated nestling feeding strategies:

- monogamy – one female with one male so that each female receives the help of one male all of the time (full time) in feeding the nestlings – category **1** in Table 4.1 (although the male may die before being able to help feed the nestlings – category **2**)
- polygyny – two or more females with one male so that each female receives a male's help in feeding the nestlings part of the time (part time) (category **3**)
- polyandry – one female is shared by two or more males so that each female receives the help of at least two males full time (category **4**)
- polygynandry – two or more females share two or more males so that each female receives the help of at least two males part time (category **5**)

The strategy employed in any one area depends on the way in which the territories of males and females overlap.

A study of the breeding success of these different strategies was carried out in the Botanic Gardens in Cambridge. Two of the ways used to measure breeding success were:

- the mass of each nestling six days after hatching
- the proportion of nestlings that died within six days of hatching

Table 4.1 shows the effects on reproductive success of the different reproductive strategies and includes the sex and number of adults feeding the nestlings.

Table 4.1

reproductive strategy	number of females feeding the nestlings	number of full time and part time males feeding the nestlings	reproductive and feeding strategy category	mean mass of nestlings at day 6 / g ± 1 standard deviation	proportion of nestlings that died within six days of hatching	number of nests studied
monogamy	1	1 full time	**1**	12.30 ± 1.76	0.30	45
monogamy (male died)	1	none	**2**	8.33 ± 3.21	0.86	7
polygyny	1	1 part time	**3**	10.96 ± 3.03	0.57	14
polyandry	1	at least 2 full time	**4**	14.06 ± 1.28	0.31	31
polygynandry	1	at least 2 part time	**5**	11.80 ± 2.45	0.39	33

(a) Summarise the data shown in Table 4.1. You may refer to each reproductive and feeding strategy by its number (**1** to **5**).

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A statistical analysis showed that the variables that had a significant effect on the **mass of nestlings** were the reproductive and feeding strategy and the number of adults feeding the nestlings.

Table 4.2 shows the comparisons made between the different types of reproductive and feeding strategies (**1** to **5**) analysed using *t*-tests.

Table 4.2

reproductive and feeding strategies	value for *t*	degrees of freedom	significance, *p*
1 v **2**	2.222	50	< 0.05
1 v **3**	1.529	....	....
1 v **4**	5.042	74	<0.001
1 v **5**	0.990	76	not significant
4 v **5**	2.793	....	....

Table 4.3 shows critical values of *t* at different levels of significance and degrees of freedom.

Table 4.3

degrees of freedom	significance, *p*		
	0.05	**0.01**	**0.001**
30	2.04	2.75	3.03
35	2.03	2.72	3.00
40	2.02	2.70	2.97
45	2.01	2.69	2.95
50	2.01	2.68	2.94
55	2.00	2.67	2.92
60	2.00	2.66	2.91
65	2.00	2.65	2.91
70	1.99	2.65	2.90
75	1.99	2.64	2.89
80	1.99	2.64	2.89

(b) Complete Table 4.2 by stating, for strategies **1** v **3** and **4** v **5**,

- the degrees of freedom
- the significance

Write your answers in the spaces in Table 4.2. [2]

(c) Explain why the *t*-test was used to assess the effects of the strategies on the mass of the nestlings.

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(d) Suggest and explain the limitations of using the data shown in Table 4.1 as the basis for assessing the overall success of the different reproductive and nestling feeding strategies.

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[Total: 10]