



CANDIDATE
NAME

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CIVICS
GROUP

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REGISTRATION
NUMBER

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H2 Biology

9744/02

Paper 2 Structured & Free Response Questions

15 March 2019

2 hours

Candidates answer **Section A** on the Question Paper and **Section B** on separate writing paper.
Additional Materials: Answer Paper.

READ THESE INSTRUCTIONS FIRST

Write your name, civics group and registration number on all the work you hand in.
Tie your answers for Section B together using the string provided.
Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use paper clips, highlighters, glue or correction fluid.

Section A

Answer **all** questions.

Section B

Answer **all** questions.

Write your answer to each part of the question on a fresh sheet of paper.

The use of an approved scientific calculator is expected, where appropriate.

At the end of the examination, submit section A and B 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	
2	
3	
4	
5	
6	
Section B	
7	
8	
Total	80

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Section A

Answer **all** the questions in this section.

- 1 (a) Explain what is meant by the fluidity of the cell surface membrane and how it is regulated.

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- (b) Gramicidin is an antibiotic that kill bacteria by forming ion channels in bacterial cell membranes. It acts by disrupting the carefully maintained differences in ion concentration across the bacterial membranes.

- (i) With reference to the structural properties of cell membranes, explain how differences in ion concentrations are maintained across the membrane.

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- (ii) Gramicidin has hydrophilic and hydrophobic properties. Explain how these affect the 3D structure of Gramicidin and allows it to form the ion channel in the cell membrane and perform its function.

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- (iii) Explain what will happen to ion concentrations on either side of the bacterial membrane as a result of the use of Gramicidin.

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.....[2]

[Total: 9]

- 2 Fig. 2.1 shows the double helix structure of DNA discovered by Watson & Crick in 1953.

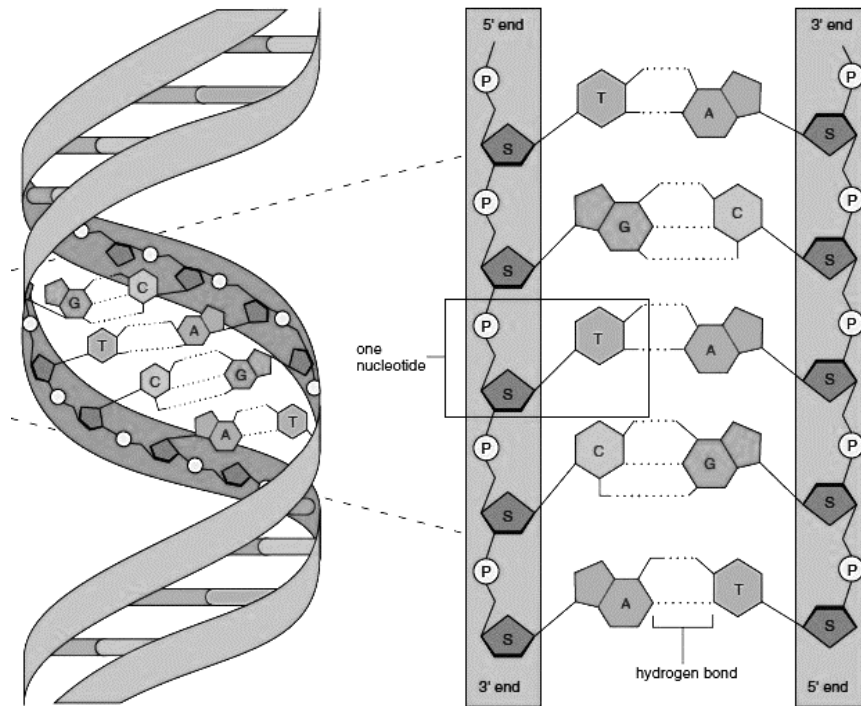


Fig. 2.1

- (a) Explain how the stability of the DNA structure is maintained.

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The central dogma of molecular biology describes the flow of genetic information from DNA to messenger RNA (mRNA) to protein.

- (b) A molecule involved in the flow of genetic information from mRNA to protein is transfer RNA (tRNA). Outline the role of tRNA in the production of a polypeptide.

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Each step in the flow of information from DNA to mRNA to protein provides the eukaryotic cell with a potential control point for regulating its functions by adjusting the amount and type of proteins synthesised.

Fig. 2.2 shows the regulation of gene expression of the albumin gene during transcription in eukaryotes. The albumin gene is associated with two control elements and a promoter.

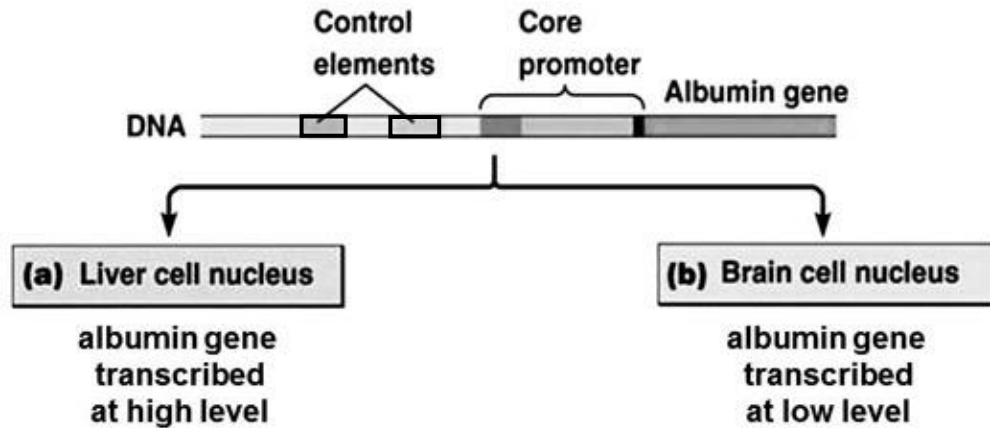


Fig. 2.2

- (c) A molecule involved in the flow of genetic information from mRNA to protein is transfer RNA (tRNA). Outline the role of tRNA in the production of a polypeptide.

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.....[3]

In a normal person, the Fragile X Mental Retardation Protein (FMRP), regulates the synthesis of neuron (nerve cell) proteins by stopping ribosomal translocation on target mRNAs. Fig. 2.3 shows how patients with fragile X syndrome (FXS) have non-functional FMRP, resulting in accelerated synaptic protein synthesis that leads to abnormal synaptic function and intellectual disability.

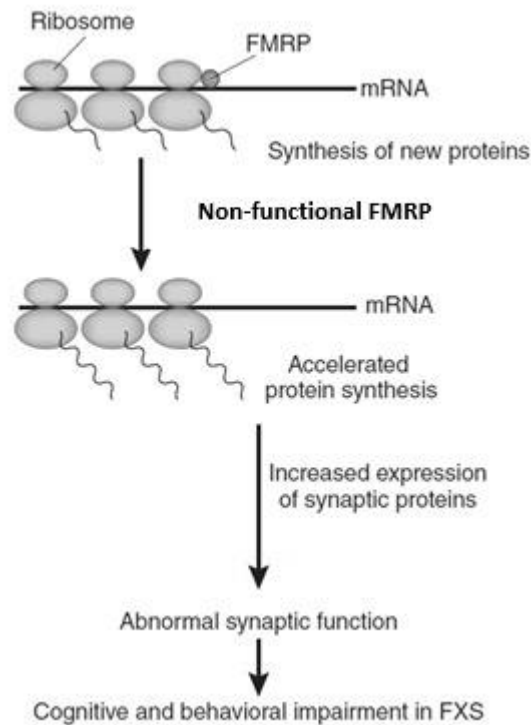


Fig. 2.3

(d) (i) State the level of control by FMRP on synaptic protein gene expression.

.....[1]

(ii) State one other control mechanism of gene expression of a similar level as **(d)(i)**.

.....[1]

[Total: 9]

- 3 A series of experiments on the respiration of an amoeba, a single-celled organism found in freshwater and marine environments (Fig 3.1), was carried out.

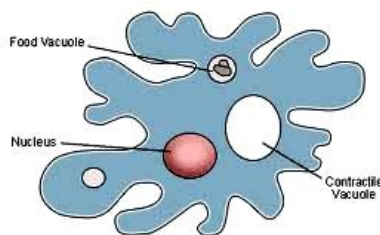


Fig 3.1 Amoeba

Table 3.1 lists the intact whole cell and two cellular components (mitochondria only and residual cytoplasm) of the amoeba and shows their ability to produce carbon dioxide and lactate when incubated with glucose in the presence of oxygen.

	Product	
	CO ₂	Lactate
Whole cell	✓	X
Mitochondria only	X	X
Residual cytoplasm (without mitochondria)	X	✓

Table 3.1

- (i) With reference to Table 3.1, give reasons for the product(s) detected between the whole cell and the cellular component consisting of mitochondria only.

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.....[4]

- (ii) Explain why the cellular component, residual cytoplasm (without mitochondria), produces lactate but not carbon dioxide.

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- (iii) Explain why the pathway leading to the formation of lactate is regarded as energetically inefficient oxidation of glucose.

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.....[1]

- (b) Discuss the significance of NAD in cellular respiration.

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.....[4]

[Total 11]

- 4 The rabies virus is classified in the same group as the influenza virus. Fig. 4.1 shows a simplified rabies virus life cycle in an infected cell.

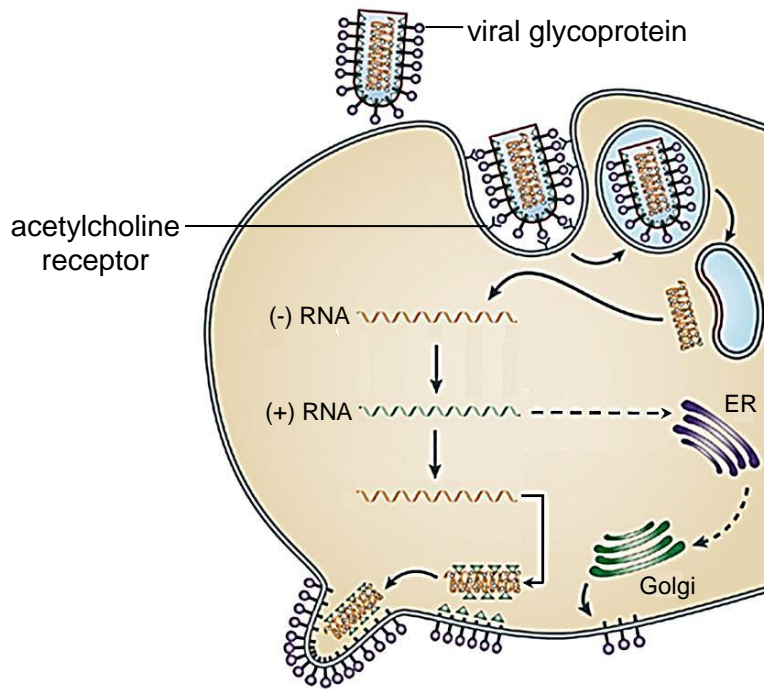


Fig. 4.1

- (a) (i) With reference to Fig. 4.1, identify the type of host cell that the rabies virus infects. Explain your choice.

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[2]

- (ii) Using the information given in Fig 4.1, explain the role of a named viral enzyme in the rabies reproductive cycle.

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 [3]

- (b) Using Fig. 4.1, distinguish between the reproductive cycles of lambda phage and rabies virus. [3]

stage	lambda phage	rabies virus
penetration		
integration		
release		

- (c) Oncoviruses refer to viruses which can cause cancer in their hosts. The Rous Sarcoma Virus (RSV) is a retrovirus which can cause tumour growths in the connective tissues of its host.

Using your knowledge of retroviral replication, suggest how the RSV causes cancer.

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..... [3]

[Total 11]

- 5 A study of the bacteria chromosome showed that it possesses a *lac* operon to allow the bacterium to metabolise lactose. The structure of the *lac* operon is shown below in Fig. 5.1.

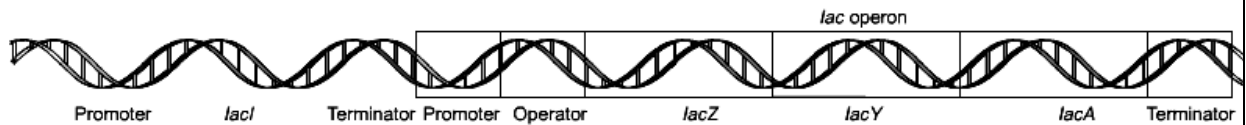


Fig. 5.1

A group of Eunoians conducted some research involving chemotaxis in bacteria. Chemotaxis is a phenomenon in which a bacterium moves towards a chemoattractant (e.g. glucose) or moves away from a certain chemical (e.g. poison). A bacterium moves by propelling its flagellum and the energy required for this is obtained from bacterial respiration.

In the experiment, they suspended 2 different strains of the bacteria in strips of semi-solid agar that are soft enough to allow bacterial motility. The semi-solid agar contains lactose. The students used a species of bacteria that moves linearly.

Subsequently, they were able to observe the tracks made by the moving bacteria. Fig 5.2 shows the results observed (top view) on Day 1 and Day 2.

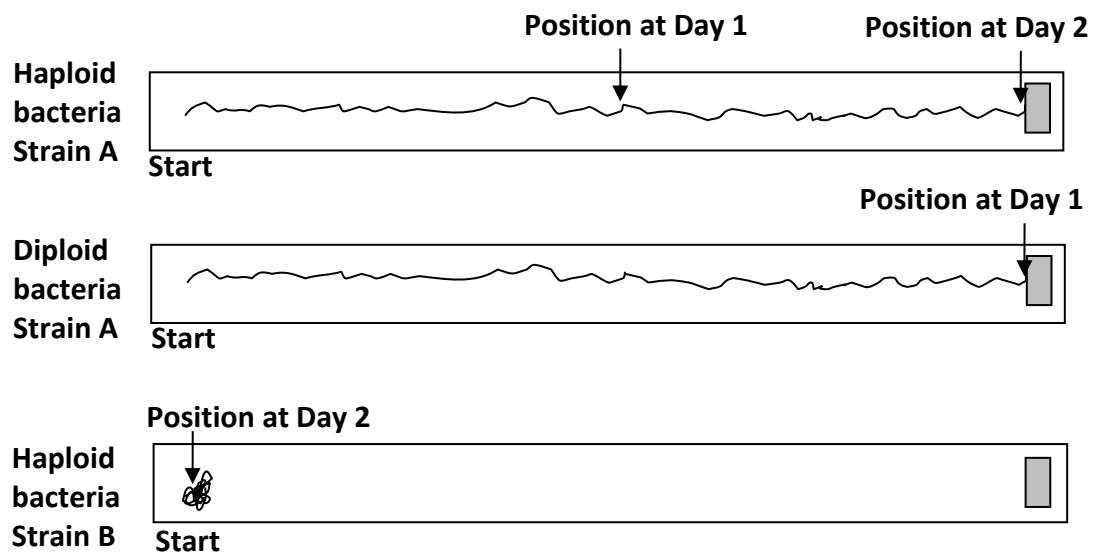


Fig 5.2

 Track made by bacteria strain
  A patch in the agar containing glucose as chemoattractant

- (a) Using your knowledge of the *lac* operon, explain why the bacteria is able to propel themselves through the semi-solid agar.

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- (b) Explain the difference in the results obtained for haploid bacteria strain A and diploid bacteria strain A.

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..... [2]

As shown in Fig 5.2, haploid bacteria strain B did not show any chemotactic movement after 2 days and the student deduced that strain B has a mutation at the *lac I* gene.

- (c) Explain how the mutation at the *lac I* gene results in no movement of the haploid bacteria strain B.

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.....[3]

[Total: 10]

- 6 A new breed of dogs were discovered recently and canine researchers have been studying them closely.



Fig. 6.1

Hair type in these dogs is controlled by two genes, which are found on different chromosomes. Dogs with the H allele have wiry hair and dogs with the genotype hh have non-wiry hair.

The length of wiry hair is always the same. Dogs with non-wiry hair have either long or short hair. The length of non-wiry hair is controlled by another gene. Dogs with the D allele have short hair and those with the genotype dd have long hair.

- (a) (i) State all the possible genotypes for dogs with non-wiry, short hair.

.....[1]

- (ii) State the type of genetic interaction occurring between two genes. Explain your answer.

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.....[2]

- (b) A wiry-haired male with the genotype **HhDd** was mated with a non-wiry, long-haired female with the genotype **hhdd**. Draw the genetic diagram to show the ratio of offspring phenotypes expected in this cross. [4]

A group of dog breeders bred dogs with the parental genotypes, as found in (b). The results of their breeding experiments yielded the following results, as shown in Table 3.

Table 3

Offspring Phenotype	Observed Number
Wiry haired	9
Non-wiry, short haired	6
Non-wiry, long haired	5

Table 4

Percentage Points of the Chi-Square Distribution

Degrees of Freedom	Probability of a larger value of χ^2								
	0.99	0.95	0.90	0.75	0.50	0.25	0.10	0.05	0.01
1	0.000	0.004	0.016	0.102	0.455	1.32	2.71	3.84	6.63
2	0.020	0.103	0.211	0.575	1.386	2.77	4.61	5.99	9.21
3	0.115	0.352	0.584	1.212	2.366	4.11	6.25	7.81	11.34
4	0.297	0.711	1.064	1.923	3.357	5.39	7.78	9.49	13.28

- (c) Using the information from (b) and Table 3, calculate the chi-square value to test the significance of the differences between the observed and expected results. [1]

- (d) Using Table 4 and your answer in (c), explain if the observed results differ significantly from the expected results of the cross.

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[2]

[Total 10]

Section B

Answer **all** questions.

Write your answers for **7** and **8** in separate pieces of the answer paper provided.

Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.

Your answers must be in continuous prose, where appropriate.

7. Discuss the functional significance of membranes in photosynthesis and respiration in a eukaryotic cell. [10]
8. Insulin is a peptide hormone that is secreted out of the pancreatic cell into the blood. Describe the route taken by insulin and the processes it undergoes from the site of its synthesis until it leaves the cell. [10]

[Total: 20]

END OF PAPER