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**ADVANCED**  
 General Certificate of Education  
 2018

Centre Number

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Candidate Number

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# Life and Health Sciences

Assessment Unit A2 5

*assessing*

Genetics, Stem Cell Research and Cloning



AZ051

**[AZ051]**

**WEDNESDAY 6 JUNE, AFTERNOON**

## TIME

1 hour 45 minutes.

## INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

Write your answers in the spaces provided in this question paper.

Answer **all nine** questions.

## INFORMATION FOR CANDIDATES

The total mark for this paper is **100**.

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

You may use an electronic calculator.

Quality of written communication will be assessed in question **9**.

For Examiner's use only	
Question Number	Marks
1	
2	
3	
4	
5	
6	
7	
8	
9	

<b>Total Marks</b>	
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1 (a) The following account is about the genetic code.

Write the most appropriate word(s) in the blank spaces to complete the account.

A length of DNA coding for a particular polypeptide is called

a \_\_\_\_\_.

It occupies a fixed position on a particular strand of DNA called

a \_\_\_\_\_.

A sequence of three bases, called a triplet, codes for a

specific \_\_\_\_\_.

A \_\_\_\_\_ is a change in the base sequence to the

DNA of an organism.

[4]

(b) Describe **two** ways meiosis produces genetically different cells.

1. \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

2. \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ [4]

Examiner Only	
Marks	Remark

2 (a) Fig. 2.1 below represents the structure of a DNA nucleotide.

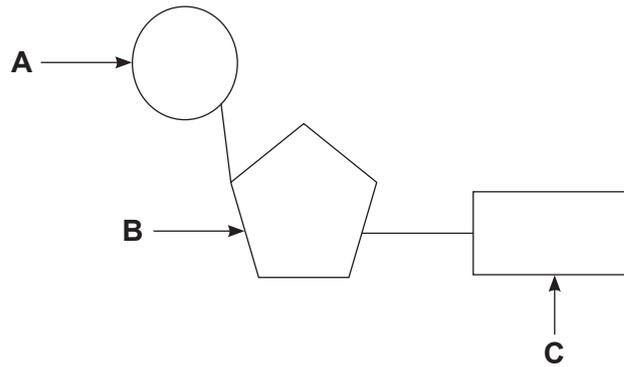


Fig. 2.1

(i) Name the components labelled **A**, **B** and **C**.

**A** \_\_\_\_\_

**B** \_\_\_\_\_

**C** \_\_\_\_\_

[3]

There are three types of RNA.

(ii) Complete **Table 2.1** below to identify the **type** of RNA described.

Table 2.1

Type of RNA	Description
	Single chain folded into a 'clover leaf' shape.
	Long single strand.
	Forms over half the mass of each ribosome.

[3]

- (b) Scientists James Watson and Francis Crick described a model for the structure of DNA as a three-dimensional double helix.

They used evidence from another scientist Edwin Chargaff who had analysed the nitrogenous base composition of DNA from several species.

- (i) How did Watson and Crick's three-dimensional double helix model illustrate Chargaff's rule for nitrogenous bases?

\_\_\_\_\_ [1]

- (ii) Complete **Table 2.2** below to summarise Chargaff's results for the base composition of human DNA and rat DNA.

Chargaff found that the same rules of base pairing applied to DNA of both human and rat.

**Table 2.2**

Name of base	Type of base	Percentage of base found in human DNA	Percentage of base found in rat DNA
Adenine	Purine	30	
Cytosine	Pyrimidine		
Thymine	Pyrimidine		29
Guanine	Purine	20	21

[4]

- (iii) Scientists analysed the base composition of DNA from a virus and found that 24% was cytosine, 33% was thymine, 20% was guanine and 23% was adenine.

What does this suggest about this viral DNA?

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_ [1]

Examiner Only

Marks Remark

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- 3 (a) Fig. 3.1 below shows two different stem cells and the cells that they can form.

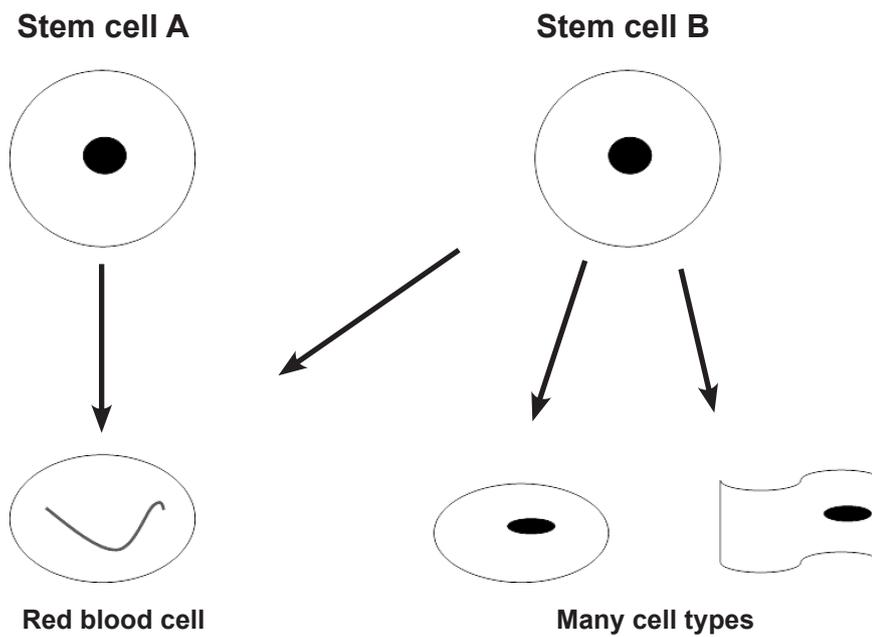


Fig. 3.1

- (i) Identify each type of stem cell.

**Stem cell A** \_\_\_\_\_

**Stem cell B** \_\_\_\_\_ [2]

- (ii) Suggest **one** site where **Stem cell A** may be found in a human.

\_\_\_\_\_ [1]

The differentiated cells derived from **Stem cell B** have the same DNA but have different structures and functions.

- (iii) Describe how cells which have the same genetic material can develop different structures and functions.

\_\_\_\_\_

\_\_\_\_\_ [1]

Examiner Only	
Marks	Remark

(b) (i) Explain **two** unique properties of stem cells in medicine.

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[2]

(ii) Some people may object to human stem cell research for ethical reasons. Suggest **one** reason why.

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[1]

Examiner Only	
Marks	Remark



- (iv) Before the production of humulin, insulin was extracted from animals such as cattle and pigs.

Give **two** advantages of using insulin from genetically modified organisms rather than from animals.

1. \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

2. \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ [2]

- (v) The sequence of amino acids in insulin varies slightly between species. Insulin obtained from cattle differs from human insulin by three amino acids.

Using the information about the difference in amino acid sequence between human insulin and cattle insulin, suggest why scientists preferred to extract insulin from pigs rather than cattle.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ [1]

Examiner Only

Marks

Remark

Diabetes mellitus is a condition where sufferers cannot properly regulate blood glucose levels.

- (b) (i) Explain how insulin is involved in the regulation of glucose levels in humans.

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[2]

**Table 4.1** below shows the number of people in two European countries with diabetes mellitus from 2012 to 2016.

**Table 4.1**

Year	Number of people with diabetes mellitus	
	Country A	Country B
2012	70 125	174 201
2013	74 071	179 114
2014	79 997	183 210
2015	82 236	188 017
2016	88 646	192 111

Source: Principal Examiner

Examiner Only	
Marks	Remark

- (ii) Calculate the **percentage increase** in people suffering with diabetes mellitus in Country **B** from **2013 to 2014**.

Give your answer to **two decimal places**.

**You are advised to show your working.**

\_\_\_\_\_ % [2]

- (iii) Suggest **one** reason why there is a difference in the number of people with diabetes mellitus in Country **A** compared to Country **B**.

\_\_\_\_\_

\_\_\_\_\_ [1]

Examiner Only	
Marks	Remark

5 (a) The principle of DNA fingerprinting is based on the uniqueness of each person's genotype.

(i) Describe how DNA differs from one person to another making each of them unique.

\_\_\_\_\_  
\_\_\_\_\_ [1]

The process of genetic fingerprinting requires several stages.

**Stage 1.** DNA is extracted from the sample.

**Stage 2.** PCR is carried out on this sample to make many copies of the DNA.

**Stage 3.** An enzyme is then used to cut the DNA into fragments.

(ii) Name the type of enzyme used to cut DNA into fragments.

\_\_\_\_\_ [1]

(iii) Explain why different sized fragments are produced when this type of enzyme cuts the DNA in **Stage 3**.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [2]

Examiner Only

Marks Remark

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- (b) Genetic fingerprinting must be carried out in a specialist laboratory under strict conditions. The results of a genetic fingerprint can be used as evidence to link a suspect to a crime.

The genetic fingerprint in **Fig. 5.1** below shows the bands obtained from saliva at a crime scene and the bands obtained from three different suspects.

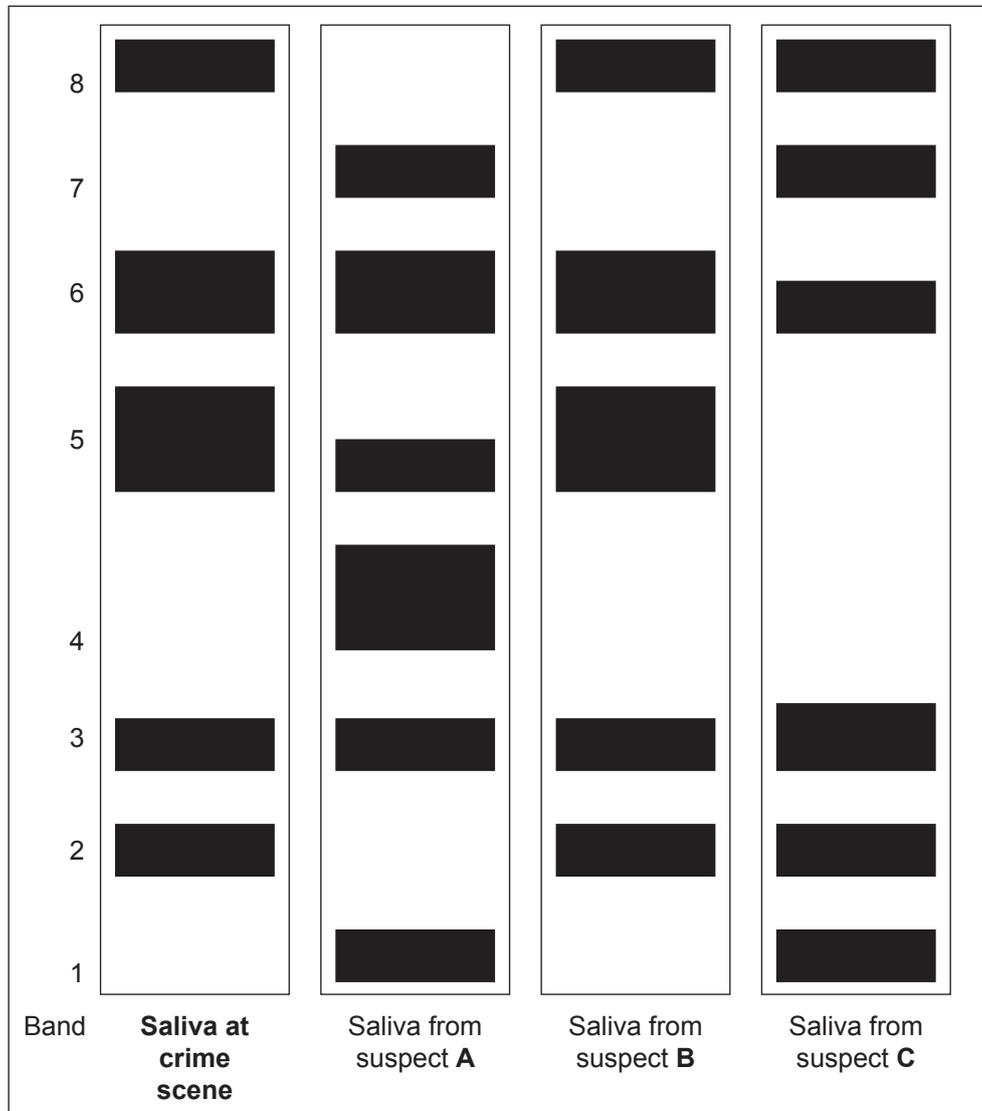


Fig. 5.1



- 6 (a) Haemophilia is a sex-linked condition that affects the blood's ability to clot.

The gene for this condition is located on the X chromosome.

The allele (**H**) for normal blood clotting is dominant to the recessive allele (**h**) that causes haemophilia.

- (i) Jessica is a carrier for haemophilia and has the genotype  $X^H X^h$ . Jessica's husband Paul does not suffer from haemophilia.

Give Paul's genotype.

Paul \_\_\_\_\_ [1]

- (ii) Determine the **probability** of Jessica and Paul having a child who suffers from haemophilia.

Show your working in a Punnett square in the space below.

Probability of having a child with haemophilia \_\_\_\_\_ [4]

Examiner Only	
Marks	Remark



- 7 Cystic fibrosis is caused by a mutation of the gene producing the protein CFTR.

This mutation leads to the production of defective CFTR which will not transport chloride ions out of cells.

- (a) (i) Explain how this leads to the production of thick, sticky mucus.

\_\_\_\_\_ [1]

- (ii) The respiratory system is one of the body systems affected by production of thick, sticky mucus.

Provide an explanation for each symptom shown in **Table 7.1**.

**Table 7.1**

Symptom	Explanation
Shortness of breath	
Chest infections	

[2]

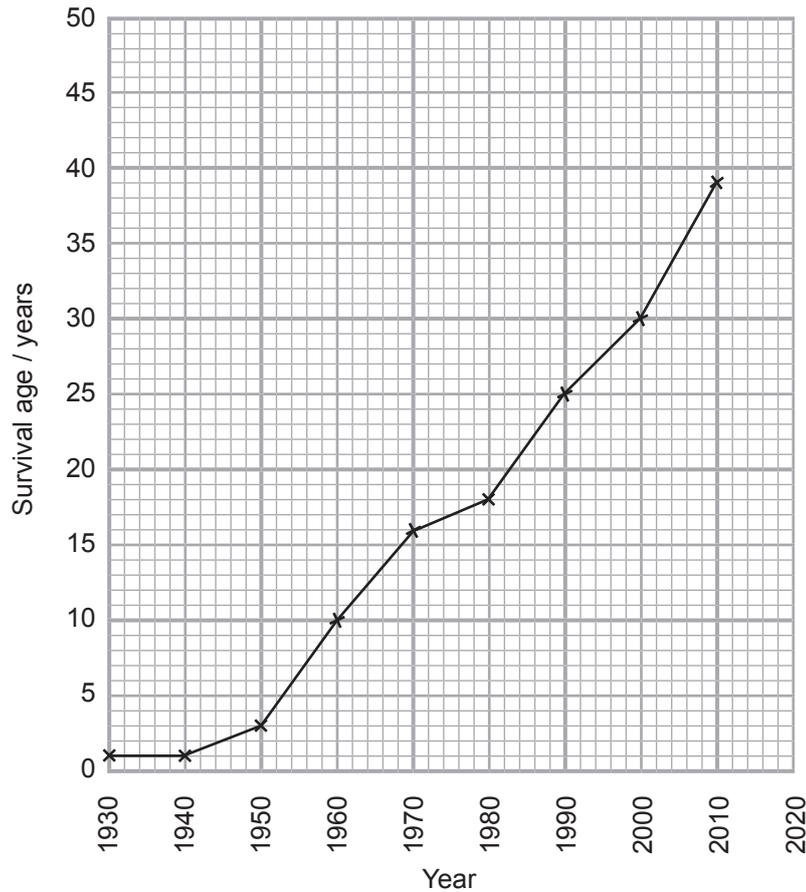
- (iii) Name **one** other body system affected by this condition and state how it is affected.

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_ [2]

Examiner Only	
Marks	Remark



- (c) The graph below shows the survival age of patients with cystic fibrosis from 1930 to 2010.



Source: <http://err.ersjournals.com/content/22/127/3>  
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- (i) In which 10-year period was there the biggest increase in survival age?

\_\_\_\_\_ to \_\_\_\_\_ [1]

- (ii) Suggest **one** reason for this increase in survival age.

\_\_\_\_\_  
\_\_\_\_\_ [1]

Assume that the trend in the survival age of people with cystic fibrosis continues at the same rate as it was from 2000 to 2010.

- (iii) Use the graph to find the age in years a person with cystic fibrosis would be expected to survive to in 2020.

Age \_\_\_\_\_ [2]

Examiner Only	
Marks	Remark

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- 8 Scientists carried out an experiment with fruit flies to investigate the inheritance of wing shape and eye size.

The genes for these characteristics are located on separate chromosomes and are independently inherited. They are not sex-linked.

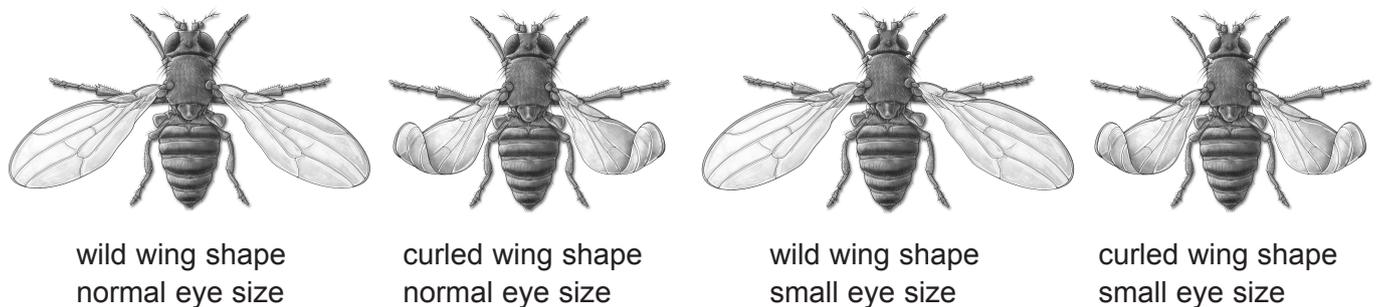
The allele (**W**) for wild wing shape is dominant.

The allele (**w**) for curled wing shape is recessive.

The allele (**E**) for small eye size is dominant.

The allele (**e**) for normal eye size is recessive.

**Fig. 8.1** shows the four types of fruit flies with these characteristics.



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**Fig. 8.1**

- (a) (i) State the genotype of a fly with curled wing shape and normal eye size.

\_\_\_\_\_

[1]

- (ii) State the genotype of a fly heterozygous for wing shape and heterozygous for eye size.

\_\_\_\_\_

[1]

Examiner Only	
Marks	Remark

(b) Two flies of the following genotypes were crossed.

**WwEe x WwEe**

(i) Complete the Punnett square to show the parental gametes and the genotypes of the offspring.


[4]

(ii) Give the numbers of each of the phenotypes produced in this Punnett square.

wild wing shape, small eye size \_\_\_\_\_

wild wing shape, normal eye size \_\_\_\_\_

curled wing shape, small eye size \_\_\_\_\_

curled wing shape, normal eye size \_\_\_\_\_

[2]

Examiner Only	
Marks	Remark

(c) The numbers of offspring produced from **another** cross using fruit flies were recorded.

- Wild wing shape, small eye size 236
- Curled wing shape, small eye size 257
- Wild wing shape, normal eye size 239
- Curled wing shape, normal eye size 268

A total of **1000** flies was recorded.

The Chi-squared test ( $\chi^2$ ) can be used to check if these results statistically fit an expected ratio of **1:1:1:1**.

The formula for the Chi-squared test is:

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

where O = observed frequency  
E = expected frequency  
 $\Sigma$  = sum of.

(i) Complete **Table 8.1** below and then calculate the  $\chi^2$  value for these results.

**Table 8.1**

Category	Observed (O)	Expected (E)	(O-E)	(O-E) <sup>2</sup>	$\frac{(O-E)^2}{E}$
Wild wing shape, small eye size	236	250	-14	196	0.784
Curled wing shape, small eye size	257				
Wild wing shape, normal eye size	239				
Curled wing shape, normal eye size	268				

Calculated  $\chi^2$  value \_\_\_\_\_ [5]

Examiner Only

Marks Remark

**Table 8.2** below gives probability values for use in  $\chi^2$  test with  $n-1$  degrees of freedom (d.f.) where  $n$  is the number of categories.

**Table 8.2:**  $\chi^2$  values

d.f.	probability = 0.900	0.500	0.100	0.050	0.010	0.001
1	0.016	0.455	2.71	3.84	6.63	10.83
2	0.211	1.39	4.61	5.99	9.21	13.82
3	0.584	2.37	6.25	7.81	11.34	16.27
4	1.06	3.36	7.78	9.49	13.28	18.47
5	1.61	4.35	9.24	11.07	15.09	20.52
6	2.20	5.35	10.64	12.59	16.81	22.46
7	2.83	6.35	12.02	14.07	18.48	24.32
8	3.49	7.34	13.36	15.51	20.09	26.13
9	4.17	8.34	14.68	16.92	21.67	27.88

Source: CCEA

(ii) What is the number of degrees of freedom (d.f.) for this test?

\_\_\_\_\_ [1]

(iii) Between what **range of probabilities** does your  $\chi^2$  value fit?  
Use **Table 8.2** to assist you.

between \_\_\_\_\_ and \_\_\_\_\_ [1]

(iv) Explain fully the outcome of your statistical test.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [2]

Examiner Only

Marks Remark



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**THIS IS THE END OF THE QUESTION PAPER**

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