



Rewarding Learning
ADVANCED
 General Certificate of Education
 2022

Centre Number

--	--	--	--	--

Candidate Number

--	--	--	--

Life and Health Sciences

Assessment Unit A2 5

assessing

Genetics, Stem Cell Research and Cloning



AZ051

[AZ051]

MONDAY 27 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 **7(c)**.

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

Total Marks	
--------------------	--

The following account describes the importance of meiosis in producing cells that are genetically different.

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

The process of meiosis results in the formation of a cell that has half the amount of genetic material present in the parent cell.

The term used to describe a cell with this amount of DNA is _____.

Chromosome pairs line up in the middle of the cell at the _____ in metaphase 1.

When chromosomes line up in metaphase 1, each pair lines up independently of any other pair of chromosomes.

This is called independent _____.

During prophase 1, genetic variation occurs when two non-sister chromatids exchange sections with each other.

This is called _____.

[4]

Examiner Only	
Marks	Remark

- 4 Severe combined immunodeficiency (SCID) is a rare inherited disorder which leads to a greatly increased risk of infections that are life-threatening.

One of the most common causes of SCID is the absence of the functional gene to make the enzyme ADA.

- (a) The absence of this enzyme means that white blood cells are not produced or do not function properly.

Some children with SCID are treated with stem cells.
The treatment is shown in the diagram below.

Image removed due to copyright

- (i) Suggest **one** site where the stem cells could be obtained from the child.

_____ [1]

- (ii) Explain how the child makes the enzyme ADA after the corrected stem cells are injected.

_____ [3]

(b) Two Labrador dogs of the following genotypes were crossed.

BbEe x BbEe

(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.

Black coat colour _____

Brown coat colour _____

Yellow coat colour _____

[3]

Examiner Only	
Marks	Remark

BLANK PAGE

(Questions continue overleaf)

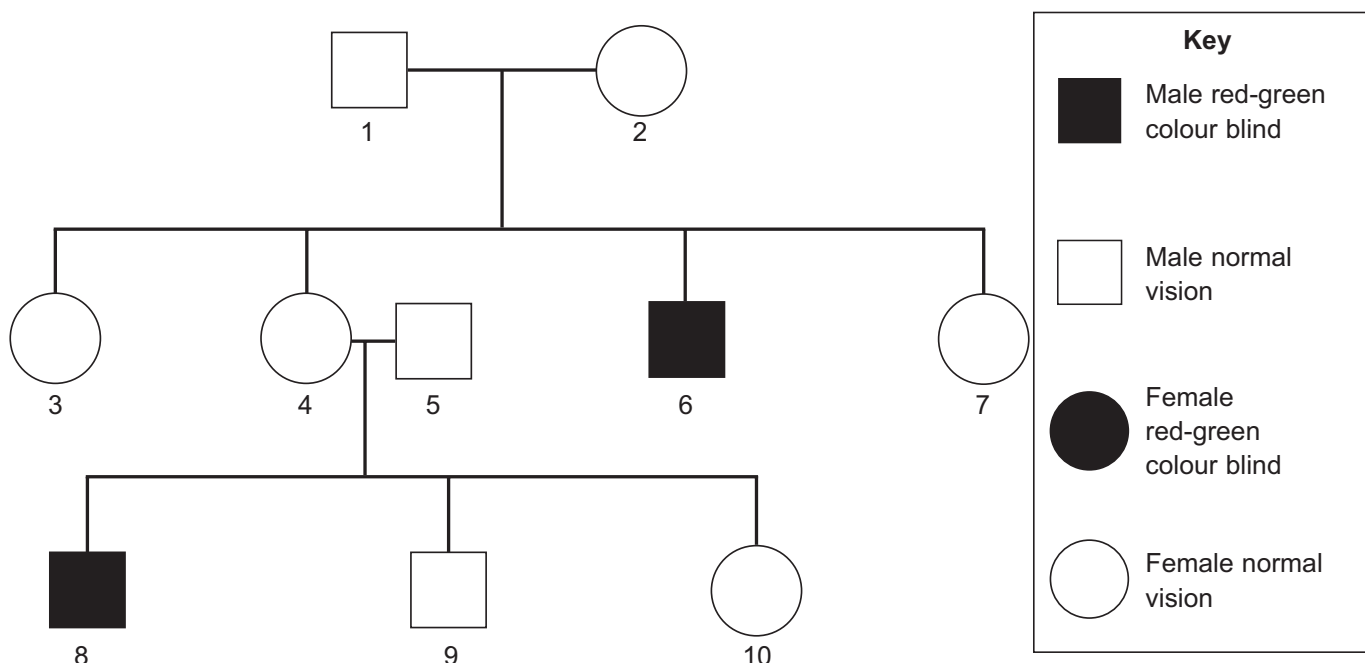
6 Pedigree diagrams can be used to show the inheritance of a condition through several generations.

The pedigree diagram below shows the inheritance of red-green colour blindness in a family.

The individual members of the family have been numbered 1–10.

Males are represented by squares and females by circles.

Those who have red-green colour blindness are shown by solid symbols and those with normal colour vision are shown by clear symbols.



(a) Use the information in the pedigree chart and your knowledge to determine if inheritance of red-green colour blindness is:

(i) Sex-linked or autosomal? _____

Explain your answer.

_____ [2]

Examiner Only	
Marks	Remark

8 PTC is a chemical substance that has a bitter taste.

Some people can taste this bitter substance but others cannot.

The ability to taste PTC as bitter is linked to the presence of a protein that is encoded by the *TAS2R38* gene.

The *TAS2R38* gene contains 333 amino acids.

(a) Calculate the number of **bases** that code for the *TAS2R38* gene.

You are advised to show your working.

_____ bases [2]

TAS2R38 has two alleles, the dominant allele (**T**) which confers the ability to taste PTC, and a recessive non-taster allele (**t**).

The table below shows the ability to taste PTC according to genotype.

Genotype	Ability to taste PTC
TT	Extremely bitter
Tt	Somewhat bitter
tt	Not bitter at all

Students carried out an investigation to determine their genotype for *TAS2R38*.

The students extracted DNA from cheek cells obtained from the inside of their mouths.

Following the extraction of DNA, it is necessary to make many copies of the DNA.

(b) Name the process that is used to produce many copies of DNA for genetic fingerprinting.

[1]

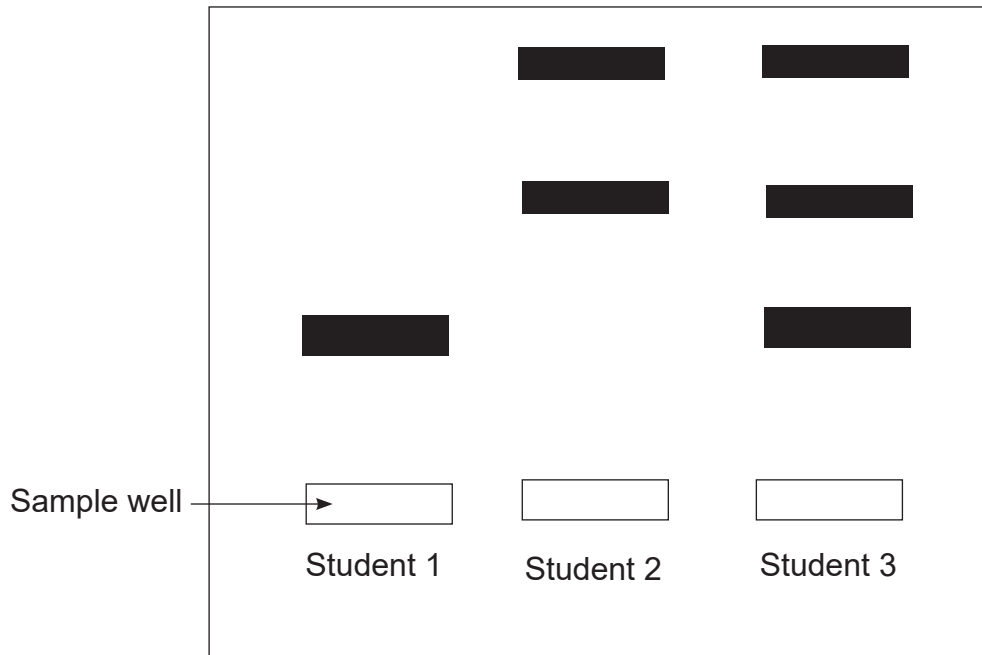
Examiner Only	
Marks	Remark

After many copies of the DNA are produced, a restriction enzyme is used to cut the DNA.

The taster allele (**T**) contains a restriction site for the restriction enzyme.

The non-taster allele (**t**) does not and remains uncut.

The genetic fingerprint below shows the bands obtained from 3 students.



(c) (i) Based on the information provided and your knowledge, give the **genotype** of Student 3.

Explain your answer.

Genotype _____

Explanation _____

_____ [3]

(ii) Give the **phenotype** of Student 1.

_____ [1]

Examiner Only	
Marks	Remark

(d) A number of people were tested to determine if they could taste PTC.

During this investigation PTC taste tester strips were used.

The PTC taste tester strip contains PTC.

(i) Before testing with the PTC strip, a taste paper with no PTC on it was used. Suggest why.

_____ [1]

It is estimated that **70%** of people can taste PTC (somewhat bitter plus extremely bitter), whereas the other **30%** cannot (not bitter at all).

In the investigation, the results from 200 people were recorded.

- Somewhat bitter plus extremely bitter **122**
- Not bitter at all **78**

The formula for the chi-squared test is:

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

Where O = observed frequency

E = expected frequency

Σ = sum of.

(ii) Complete the table below and then calculate the χ^2 value for these results.

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

Category	Observed (O)	Expected (E)	(O-E)	(O-E) ²	$\frac{(O-E)^2}{E}$
somewhat bitter plus extremely bitter	122				
not bitter at all	78				

Calculated χ^2 value _____ [5]

Examiner Only

Marks

Remark

The table below gives probability values for use in χ^2 test with $n-1$ degrees of freedom (d.f.) where n is the number of categories.

χ^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

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

_____ [1]

(iv) Between what **range of probabilities** does your χ^2 value fit?

Between _____ and _____ [1]

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

 _____ [2]

Examiner Only	
Marks	Remark

- 9 Scientists believe that the inheritance of certain genes can increase the risk of developing certain types of cancer.

These genes can cause the production of abnormal cells when activated by an environmental factor.

These abnormal cells can multiply and spread, causing cancer.

- (a) Explain why screening of people for the presence of these cancer-causing genes is recommended.

[2]

- (b) Cells contain tumour suppressor genes, which code for proteins that **inhibit** cell division.

A mutation of a tumour suppressor gene can result in the formation of a cancerous tumour.

- (i) Suggest how.

[2]

Not all mutations result in a change to the amino acid sequence of the protein.

- (ii) Suggest why.

[1]

- (iii) Suggest **one** environmental factor that could lead to a mutation in a tumour suppressor gene.

[1]

Examiner Only

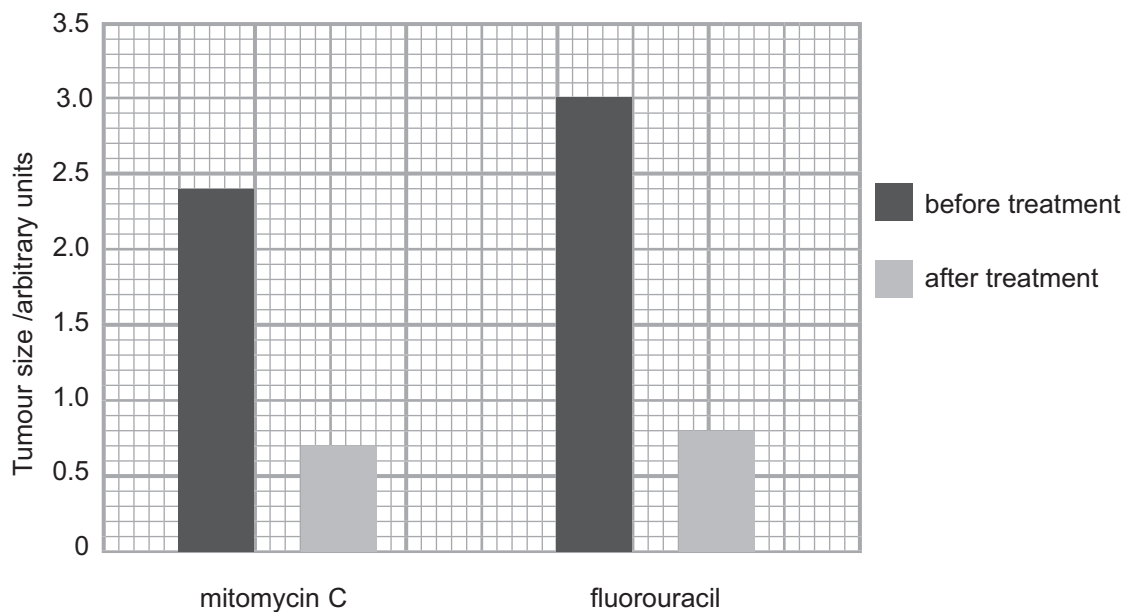
Marks Remark

- (c) One type of treatment for cancer is chemotherapy, which involves the use of drugs that interfere with DNA replication in cells.

Scientists investigated the effect of mitomycin C and fluorouracil on tumour size in cancer patients.

They recorded the tumour size at the start of the investigation and at the end of the investigation.

The graph below shows the results of this investigation.



Source Adapted from: © www.researchgate.net
Licenced under: <https://creativecommons.org/licenses/by/2.0/>

- (i) Calculate the percentage decrease in tumour size for the drug **mitomycin C**.

You are advised to show your working.

Give your answer to **one decimal place**.

_____ % [2]

Examiner Only

Marks Remark

The drug mitomycin C forms strong cross-links between the two strands in a DNA molecule.

The drug fluorouracil inhibits an enzyme involved in making nucleotides that contain the base thymine.

Adapted from: www.discover.nci.nih.gov

(ii) Suggest how these drugs affect the DNA in cancer cells.

mitomycin C:

[2]

fluorouracil:

[2]

For the treatment of certain types of cancer, a combination of **mitomycin C and fluorouracil** may be administered to patients.

(iii) Suggest why doctors would administer both drugs to treat patients with cancer.

[1]

Examiner Only	
Marks	Remark

THIS IS THE END OF THE QUESTION PAPER

Permission to reproduce all copyright material has been applied for.
In some cases, efforts to contact copyright holders may have been unsuccessful and CCEA
will be happy to rectify any omissions of acknowledgement in future if notified.