



Rewarding Learning
ADVANCED
 General Certificate of Education
 2022 Reserve Series

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]

FRIDAY 01 JULY, 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(b)**.

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

Total Marks	
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1 This question is about cell division.

(a) Name the type of cell division which produces haploid cells.

_____ [1]

(b) Write the most appropriate word(s) in the blank spaces to complete the passage below.

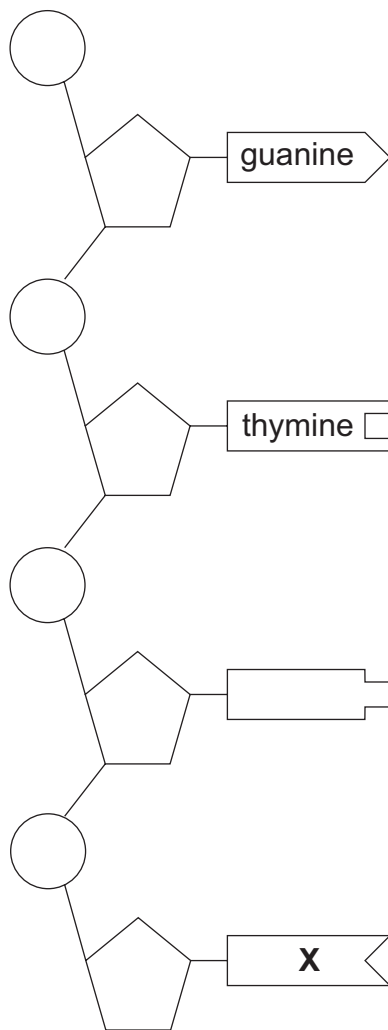
The only haploid cells in the human body are the _____.

It is important that these cells are haploid, as when they combine in fertilisation, the normal number of _____ is restored.

As well as producing haploid cells, this type of cell division produces cells which are _____ different. [3]

Examiner Only	
Marks	Remark

3 (a) The diagram below shows part of a DNA strand.



Source: Principal Examiner

(i) On the diagram, circle one nucleotide. [1]

(ii) Identify the base labelled X. [1]

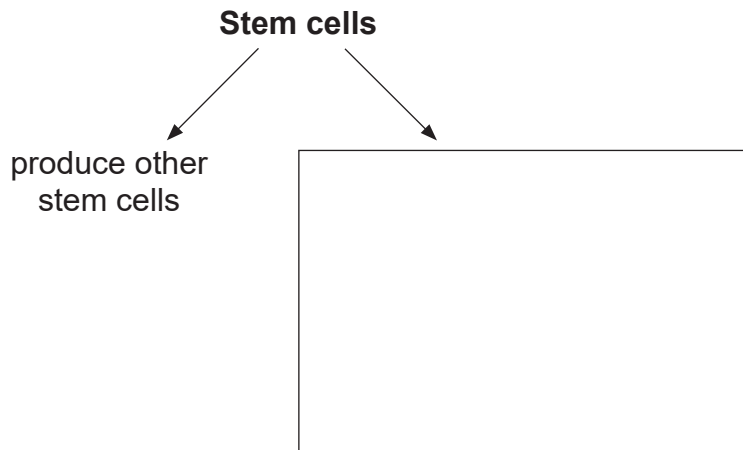
(iii) State the evidence which shows that the diagram represents part of a DNA strand and not RNA. [1]

(iv) State one other way in which RNA differs from DNA. [1]

Examiner Only	
Marks	Remark

4 Stem cells are cells which divide to produce other cells.

(a) Complete the diagram below which summarises the properties of stem cells.



[1]

Stem cells are important in repairing damaged tissue in the body. For example, stem cells in the skin produce new skin cells following skin damage.

During this process, some genes in the stem cells are switched on so that the types of cells required can be produced in the quantities required.

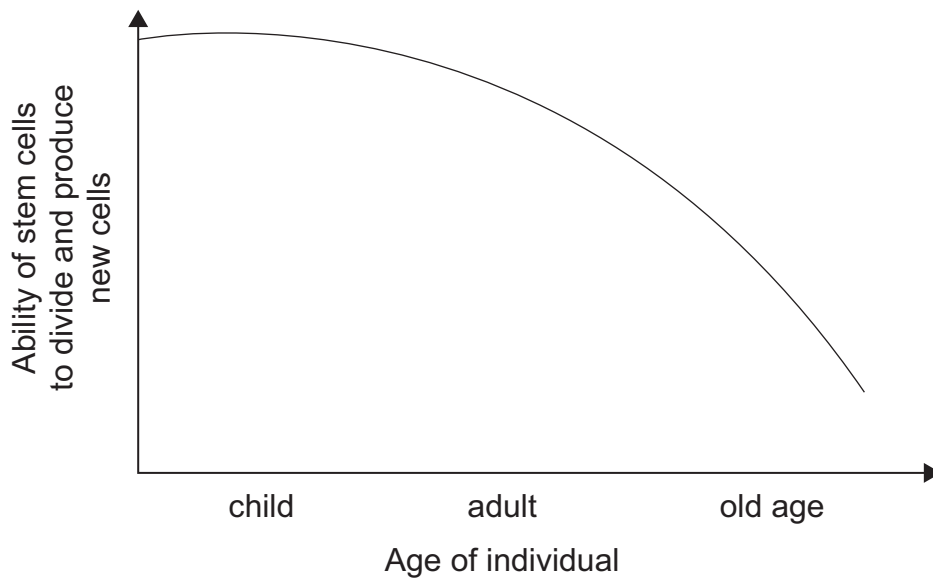
Stem cells are also used by scientists to produce large sheets of skin (grafts) which are used to treat patients with severe burns.

(b) Using the information provided, suggest how scientists produce skin grafts.

[2]

Examiner Only	
Marks	Remark

The graph below shows how the ability of stem cells to divide and produce new cells over time changes as people age.



Source: Principal Examiner

Hospital records show that elderly people take much longer to recover from broken bones and other injuries than children and young adults.

(c) Using the information provided, explain the reason for this.

[2]

Examiner Only	
Marks	Remark

- 5 Domestic chickens have red-coloured flaps of skin on the top of their head called combs.

The size and shape of these combs is under genetic control.

Two separate genes (**A** and **R**) are involved in comb development, with each having one dominant and one recessive allele, making **A**, **a**, **R** and **r** the alleles involved.

The development of four types of combs is controlled by the interaction of these genes as outlined in the table below.

Comb type (phenotype)	Explanation
Walnut	One (or more) dominant A allele(s) and one (or more) dominant R allele(s)
Pea	One (or more) dominant A allele(s), but no dominant R alleles
Rose	No dominant A alleles, but one (or more) dominant R allele(s)
Single	No dominant alleles present

- (a) (i) State the phenotype produced by the genotype **Aarr**.

_____ [1]

- (ii) State the **two** genotypes which give a Rose comb.

_____ and _____ [1]

Examiner Only	
Marks	Remark

(b) Two chickens with the following genotypes were crossed.

AaRr × AARr

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

[4]

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

Walnut _____ Pea _____ [2]

(iii) In terms of parental gametes, explain why there were **no** offspring chickens with a Single comb.

 _____ [1]

(iv) A breeder wished to produce chickens with Rose combs only. There are two possible crosses which give this outcome. State the genotypes of the parental chickens the breeder would have to use to get chickens with Rose combs only.

_____ × _____

and

_____ × _____ [2]

(c) State the term given to a situation where two genes interact to produce a phenotype different to that produced by either gene acting individually.

_____ [1]

Examiner Only	
Marks	Remark

(b) Using transgenic organisms has two major advantages over traditional breeding.

These are:

- organisms with desirable characteristics are developed in a shorter time using genetic modification than with traditional breeding;
- new and original features can be developed in transgenic organisms, unlike in traditional breeding.

Explain how these benefits are brought about:

in a **shorter time**

with **new and original features**

[4]

(c) Despite the advantages of using transgenic organisms, many people are opposed to their use and favour traditional methods.

Give two reasons for the opposition to transgenic organisms.

1. _____

2. _____

[2]

Examiner Only	
Marks	Remark

- 7 (a) Cystic fibrosis (CF) is a condition caused by a mutation in the CFTR gene, which results in a faulty CFTR protein.

As a result, passageways in the lungs and digestive system become clogged with mucus.

- (i) Using the information provided, suggest why individuals with CF suffer from regular chest infections.

_____ [1]

- (ii) Most people with CF have a particular mutation which produces a CFTR protein missing one amino acid.

State the number of bases missing from the CFTR gene to produce this outcome.

_____ bases [1]

- (iii) About one in every 25 people are carriers for the mutated CF gene.

If two carriers have a child, there is a one in four chance that this child will inherit CF.

Using this information, estimate the frequency of CF in the population.

You are advised to show your working.

_____ [3]

Examiner Only	
Marks	Remark

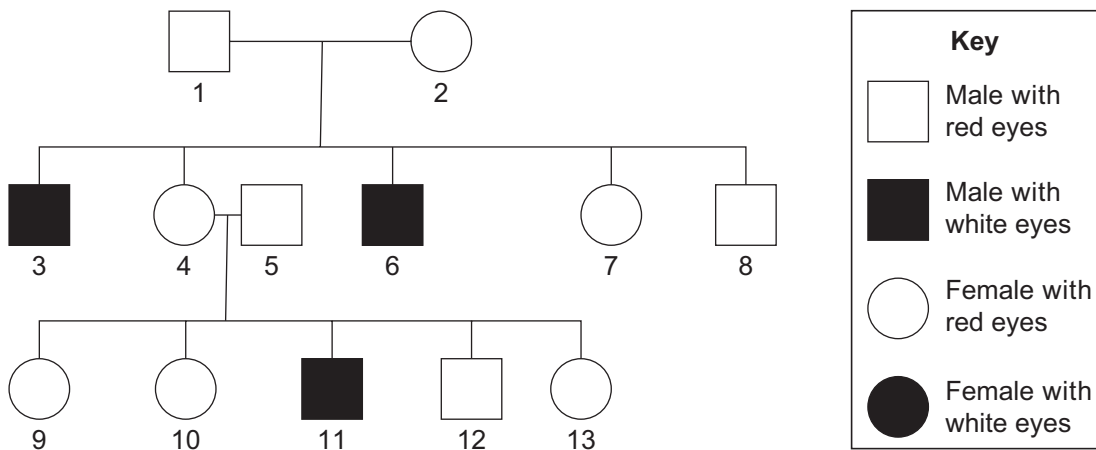
- 8 (a) The normal eye colour in fruit flies is red but some fruit flies have white eyes.

Eye colour in fruit flies is **sex-linked**.

Sex-linked inheritance in fruit flies is the same as in humans.

Pedigree diagrams can be used to show inheritance of a trait through several generations.

The pedigree diagram below shows the inheritance of eye colour in some fruit flies.



Source: Principal Examiner

- (i) The allele for white eyes is recessive.

Explain how you can work this out from the pedigree diagram.

_____ [1]

- (ii) Using the symbols **r** to represent the allele for white eyes and **R** for red eyes, give the complete genotype for each of the following:

Individual 1: _____

Individual 2: _____

Individual 6: _____

[3]

Examiner Only	
Marks	Remark

- (b) In fruit flies, body colour is controlled by a gene with two alleles. Normal body colour (**B**) is dominant to darkened body colour (**b**).

The body colour gene is **not** sex linked.

- (i) In the space below, draw a Punnett square to show the outcome of a cross between a male of genotype **Bb** and a female of the same genotype.

Ratio of offspring:

normal body colour _____ : darkened body colour _____ [2]

- (ii) If there were 120 offspring produced in the cross above, calculate the number of flies which would be expected to have darkened body colour.

_____ [1]

Examiner Only

Marks Remark

However, in a cross between two parents each with the genotypes **Bb** as described on the previous page, out of 120 offspring, 37 flies had darkened body colour.

The chi-squared test can be used to determine if the observed offspring ratio matches the expected ratio.

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

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

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

Category	Observed (O)	Expected (E)	(O-E)	(O-E) ²	$\frac{(O-E)^2}{E}$
normal body colour	83				
darkened body colour	37				

Calculated χ^2 value _____ [3]

Examiner Only

Marks Remark

The table below gives probability values for use in χ^2 test.

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

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

_____ [1]

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

between _____ and _____ [1]

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

 _____ [2]

Examiner Only	
Marks	Remark

(c) The mosquito, an insect like fruit flies, is responsible for spreading the parasite that causes malaria.

Mosquitos breed in lakes and ponds.

Malaria kills many people in Africa each year.

(i) Explain why many lakes and ponds in many parts of Africa are drained or covered over.

[2]

Examiner Only	
Marks	Remark

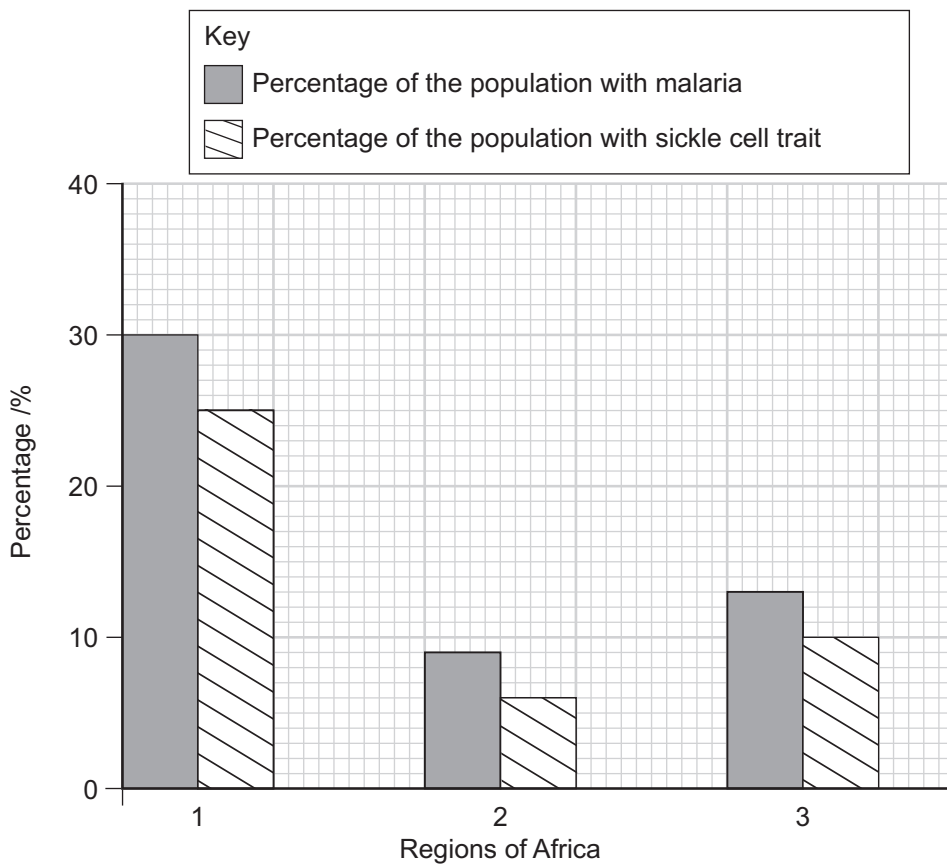
Many Africans have sickle cell trait.

This is a genetic condition in which haemoglobin in the blood cells is slightly damaged and does not carry oxygen as efficiently as in individuals without the trait.

Although short of energy, affected individuals can often live reasonably normal lives.

However, individuals with sickle cell trait have a good degree of resistance to malaria.

The graph below shows the percentage of the population with malaria in three different regions of Africa and the percentage of the population who have sickle cell trait in these areas.



Source: Principal Examiner

(ii) Describe and explain the information provided by the graph.

[2]

(iii) Suggest how the percentage of the population with sickle cell trait will change in parts of Africa where there are no mosquitos.

[1]

Examiner Only	
Marks	Remark

- 9 The huntingtin gene is one of the largest genes found in humans, which if defective can lead to Huntington's disease.

For part of this gene, the base sequence CAG is repeated many times along **one strand** of the DNA (i.e. the base sequence in this part of the gene is CAGCAGCAG and so on).

- (a) For an individual where the sequence CAG is repeated 20 times, calculate the number of deoxyribose sugar molecules this section of DNA will contain.

You are advised to show your working.

_____ deoxyribose sugar molecules [2]

- (b) Huntington's disease is a genetic disease which causes breakdown in brain function and eventual death.

Whether individuals will develop Huntington's disease or not depends on their number of CAG repeat sequences.

The table below shows data on 12 individuals from families in which there was a history of Huntington's disease.

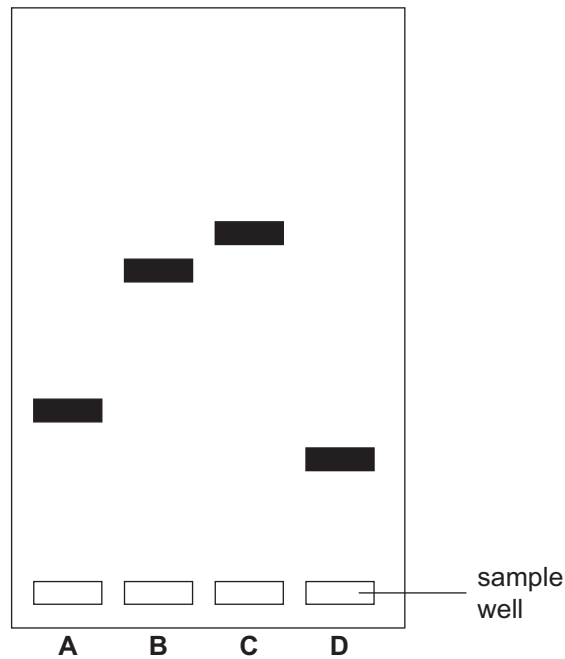
Each of the individuals tested was aged 50 years, by which age they would have developed Huntington's disease had they been going to.

Individual	Number of CAG repeats	Male (M) or female (F)	Developed Huntington's disease (Yes or No)
1	18	M	No
2	42	F	Yes
3	47	M	Yes
4	84	M	Yes
5	25	F	No
6	22	M	No
7	28	F	No
8	88	F	Yes
9	66	M	Yes
10	18	F	No
11	43	F	Yes
12	29	M	No

Examiner Only

Marks Remark

The diagram below shows the genetic fingerprints of four individuals, two of whom have Huntington's disease (**A** and **D**) and two who do not (**B** and **C**).



Source: Principal Examiner

(iii) Using your understanding of gel electrophoresis and the data in the table in **part (b)**, outline the process of gel electrophoresis and explain the genetic fingerprints shown above.

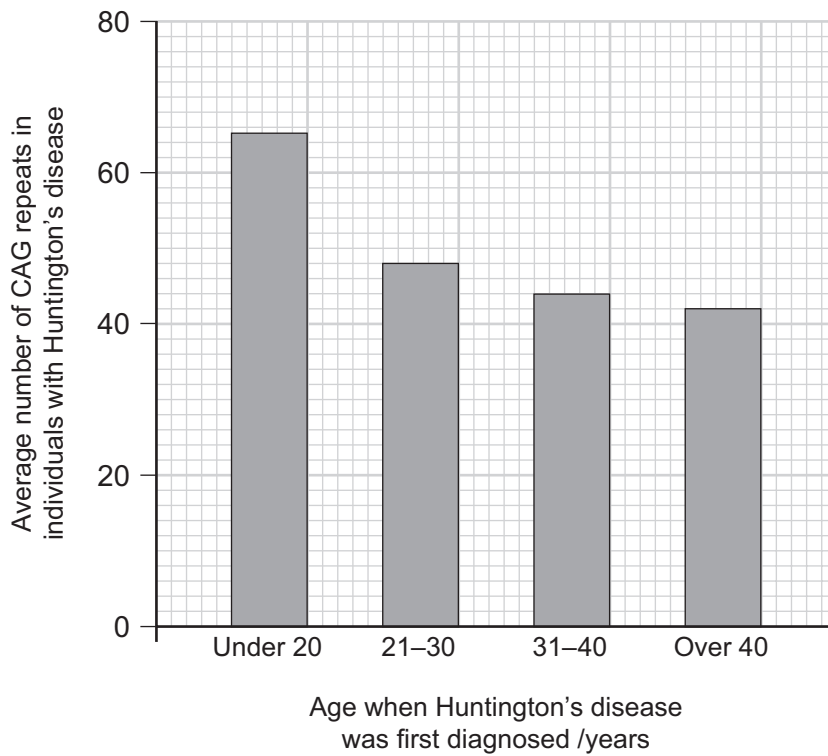
Process of gel electrophoresis _____

Explanation of genetic fingerprint shown _____

[5]

Examiner Only	
Marks	Remark

(d) The link between the number of CAG repeats and the age at which Huntington’s disease was first diagnosed was investigated in a further study.



Source: Principal Examiner

(i) State the average number of CAG repeats in those who were first diagnosed when under 20 years of age.

_____ [1]

(ii) Summarise the results shown in the graph above.

 _____ [3]

Examiner Only	
Marks	Remark

(e) As Huntington's disease is genetically inherited, individuals in families affected can be screened to determine if they will develop the disease in later life.

Suggest **one** advantage and **one** disadvantage to an individual of being screened for the condition.

Advantage _____

Disadvantage _____

_____ [2]

THIS IS THE END OF THE QUESTION PAPER

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