

Name of the Student: _____

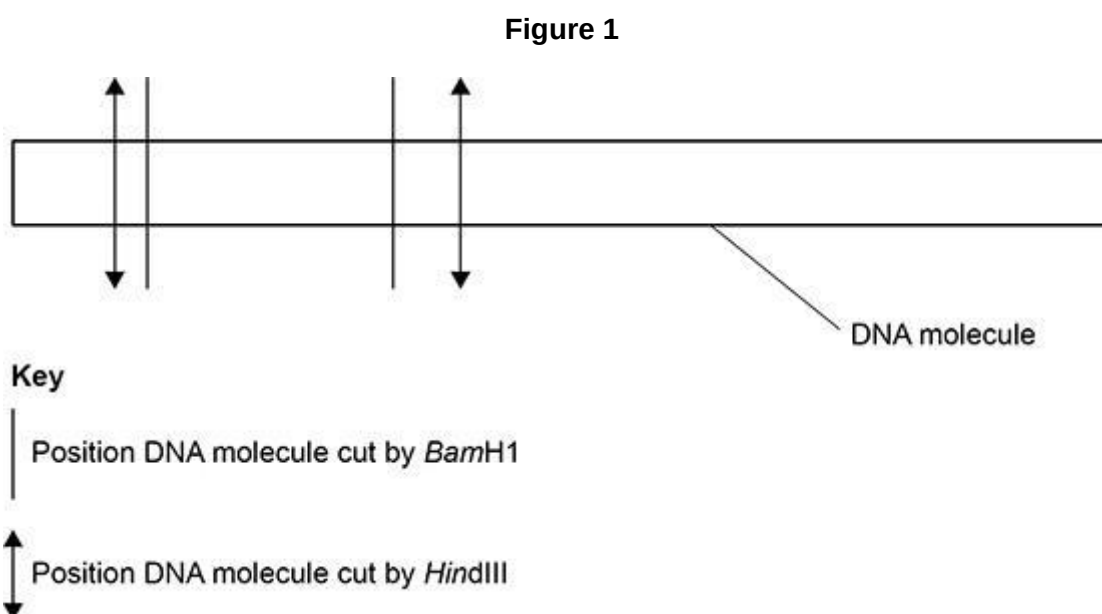
Max. Marks : 25 Marks

Time : 25 Minutes

Q1.

- (a) *Bam*H1 and *Hind*III are both restriction endonucleases.

Figure 1 shows the positions where these enzymes cut a linear molecule of DNA.



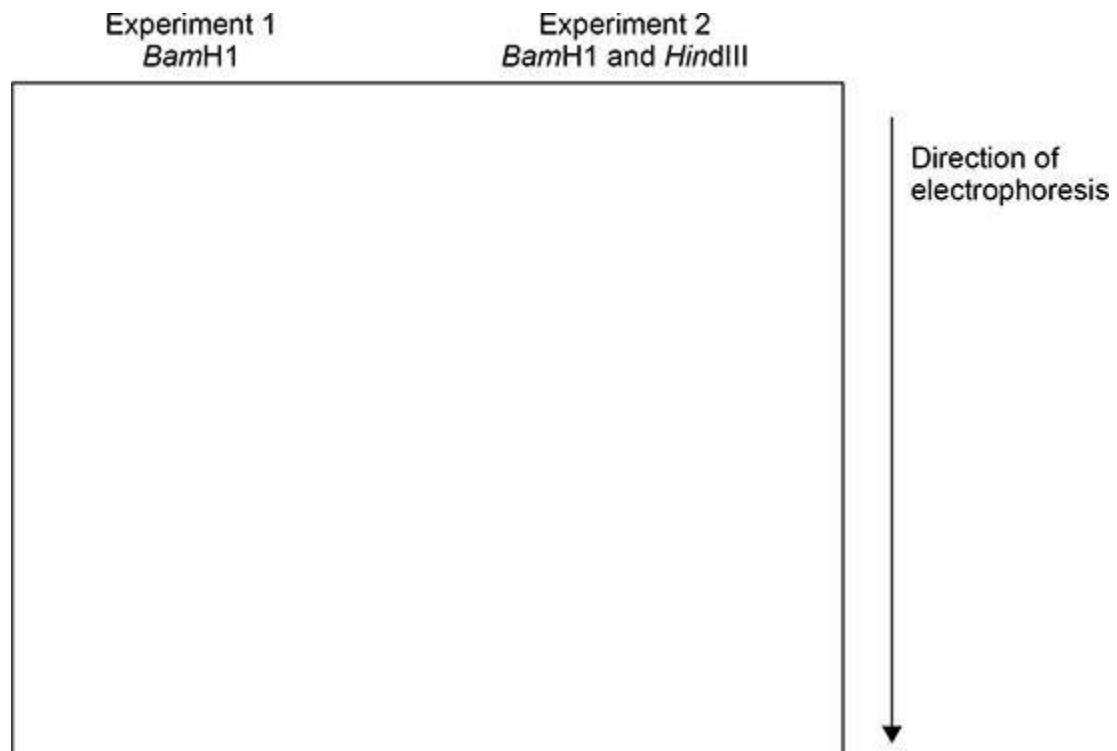
In two experiments, multiple copies of the DNA molecule shown in **Figure 1** were all completely cut into fragments using these restriction enzymes. The DNA fragments produced were then separated by electrophoresis.

Experiment 1 – DNA cut into fragments using *Bam*H1.

Experiment 2 – DNA cut into fragments using *Bam*H1 and *Hind*III.

Complete **Figure 2** to show the relative positions of the bands following electrophoresis in experiments 1 and 2.

Figure 2



(2)

- (b) Suggest how you could determine the size of the different DNA fragments produced in these experiments.

(2)

- (c) How many DNA fragments would be produced in experiment 2 if the original DNA molecule was a plasmid?

(1)

- (d) Describe how restriction endonuclease and DNA ligase are used to insert a gene into a plasmid.

(2)
(Total 7 marks)

Q2.

Leigh syndrome (LS) is a rare, recessive, inherited condition.

LS is caused by a mutation in any one of more than 75 different genes coding for proteins involved in oxidative phosphorylation.

In 80% of people with LS, these mutations occur in nuclear DNA. In 20% of people with LS, these mutations occur in mitochondrial DNA (mtDNA).

15% of the nuclear DNA mutations that cause LS occur in the *SURF1* gene. A mutated *SURF1* gene codes for a shorter polypeptide than a non-mutated *SURF1* gene.

- (a) Name **one** type of *SURF1* gene mutation and explain how this mutation could lead to production of a shorter polypeptide.

Type of mutation _____

Explanation _____

(2)

Globally, the frequency of LS is 1 in 40 000

In the Faroe Islands, which are 18 isolated islands, the frequency of LS is 1 in 1700

- (b) The population of the Faroe Islands is 49 053

Estimate the number of people in the Faroe Islands with LS caused by a mutation in the *SURF1* gene.

Use information in this question.

Give your answer to the nearest whole number.

Show your working.

Answer _____ people

(3)

- (c) The frequency of LS is higher in the Faroe Islands than globally.

Suggest and explain **one** reason why.

(2)

- (d) LS usually causes death within the first three years of life.

Using all the information in this question, evaluate whether all people should be genetically screened for LS.

(3)

(Total 10 marks)

Q3.

- (a) The *KRAS* gene codes for a protein called K-Ras. The protein relays signals from outside a cell to a cell's nucleus, stimulating cell division. An alteration in the *KRAS* gene produces an oncogene which can cause a tumour to develop.

Suggest and explain how an alteration in the *KRAS* gene can cause a tumour to develop.

(3)

- (b) Alterations in the *KRAS* gene can cause colorectal cancer (CRC). Scientists investigated the survival time of the following three groups of CRC patients who had type II diabetes.

Group **A** – received no drug to treat type II diabetes

Group **B** – received the drug metformin to treat type II diabetes

Group **C** – received a combination of drugs (including metformin) to treat type II diabetes

The scientists used a statistical test to compare the survival time of these patients with CRC patients with no history of type II diabetes.

The table below shows some of the results obtained by the scientists.

Group	Mean survival time of CRC patients / months	Probability value (P)
No history of type II diabetes	32.2	–
A	21.3	0.007
B	49.7	0.022
C	38.3	0.636

Using the information provided, what can you conclude about the effects of type II diabetes and the different drug treatments on the survival time of CRC patients?

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(5)

(Total 8 marks)