Q1.

Plants transport sucrose from leaves to other tissues for growth and storage. SUT1 is a sucrose co-transporter protein.

Scientists investigated whether the cells of tobacco plant leaves used SUT1 to transport sucrose to other tissues.

(a) The scientists used a radioactively labelled DNA probe to show that the cells of tobacco plant leaves contained the *SUT1* gene.

Describe how they would do this.

Do **not** include PCR in your answer.

(4)

(b) To study the role of SUT1 in tobacco plants, scientists reduced the expression of the *SUT1* gene.

When the *SUT1* gene is transcribed, the SUT1 mRNA produced is called 'sense' SUT1 mRNA. The scientists genetically modified plants by inserting an **extra** gene so that this **also** allowed the production of 'antisense' SUT1 mRNA.

The scientists had two types of tobacco plants:

- type **A** – plants that were genetically modified
- type **B** – plants that were **not** genetically modified.

Suggest how the production of 'antisense' SUT1 mRNA in type **A** plants would reduce the expression of the *SUT1* gene.

(4)

Q2.

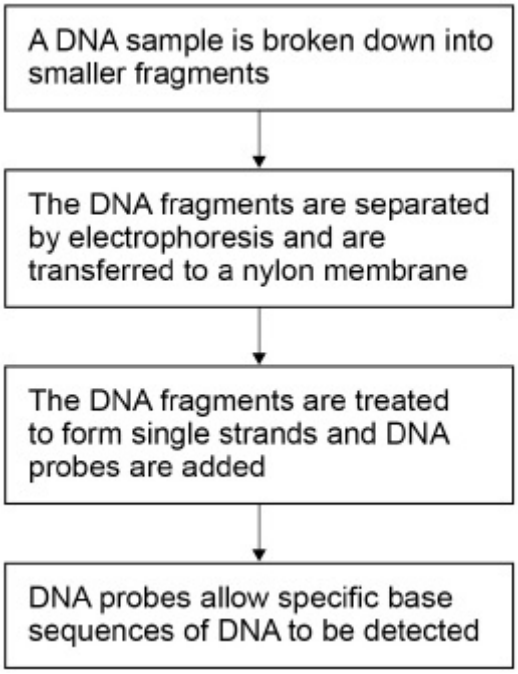
(a) What is a DNA probe?

(2)

DNA probes are used to detect specific base sequences of DNA.

The process is shown in **Figure 1**.

Figure 1



(b) Describe how the DNA is broken down into smaller fragments.

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(2)

(c) The DNA on the nylon membrane is treated to form single strands. Explain why.

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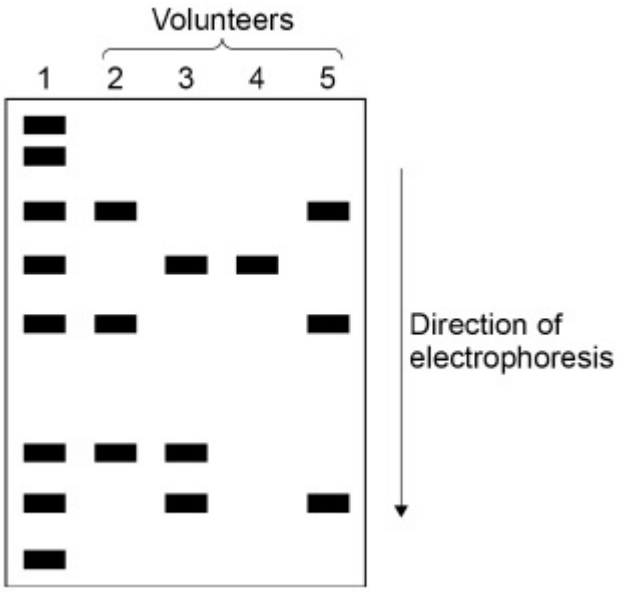
(1)

A scientist used DNA probes and electrophoresis to screen four volunteers for five different viral DNA fragments.

Figure 2 shows the results the scientist obtained. The lanes numbered 2 to 5 represent the four volunteers.

Figure 2



(d) Lane 1 of **Figure 2** enabled the size of the different viral fragments to be determined.

Suggest and explain how.

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(2)

The lengths of the viral DNA fragments were:

- 600 base pairs
- 250 base pairs
- 535 base pairs
- 300 base pairs
- 500 base pairs.

(e) Which volunteers had at least one of the viral DNA fragments with 250 base pairs or 535 base pairs?

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(1)

(Total 8 marks)

Q3.

Mycobacterium tuberculosis causes tuberculosis. The DNA of *M. tuberculosis* contains a direct repeat (DR) region. The DR region consists of 43 different, non-coding base sequences called spacers. Each spacer is found in a specific place in the DR region.
In different strains of *M. tuberculosis*, some of these spacers have been lost.

(a) (i) The DR region consists of non-coding base sequences.

What is meant by a non-coding base sequence?

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(1)

(ii) Name the process by which the base sequence of a spacer is lost from a DR region.

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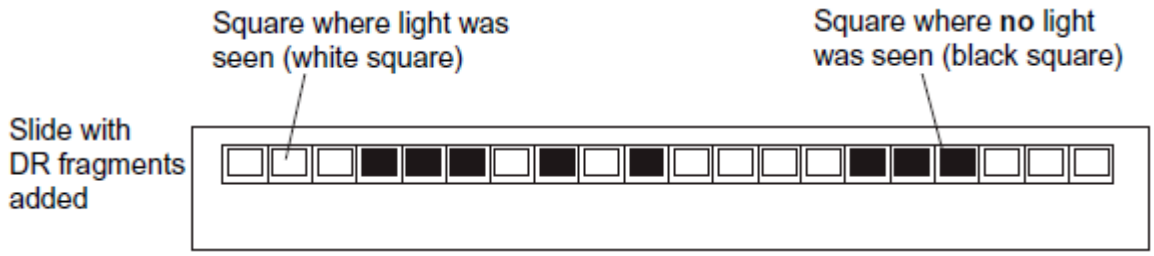
(1)

Scientists investigated the DR regions of different strains of *M. tuberculosis*. They produced a DNA probe for each of the 43 spacer sequences. Each probe was:

- labelled with a fluorescent marker that gave off light if the probe attached to its complementary spacer
- attached to a particular square on a slide.

They obtained samples of the DR region from each strain. These were cut into small single-stranded DNA fragments. The fragments from each strain were added to a slide with the DNA probes attached. The diagram below shows their results for one strain of *M. tuberculosis* with 20 of the probes.



(b) The scientists cloned the DR region DNA *in vitro* before testing for the presence of spacers.

Give the name of the method they used to clone the DNA *in vitro*.

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(1)

(c) Explain how the use of DNA probes produced the results in the diagram.

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(3)

(d) Doctors can use the method with DNA probes to identify the specific strain of *M. tuberculosis* infecting a patient. This is very important when there is an outbreak of a number of cases of tuberculosis in a city.

Suggest and explain why it is important to be able to identify the specific strain of *M. tuberculosis* infecting a patient.

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(2)

(Total 8 marks)