

Name of the Student: _____

Max. Marks : 24 Marks

Time : 24 Minutes

Q1.

Scientists have investigated the use of different types of stem cell to treat damage to the heart after a myocardial infarction. During a myocardial infarction, a number of different cell types in the heart die. This includes cardiomyocytes which are heart-muscle cells.

Embryonic pluripotent stem cells (ESCs) can divide and differentiate into a wide range of different cell types.

- (a) Using the information given, suggest **one** reason why ESCs might be suitable to treat damage to the heart.

(1)

- (b) ESCs have not yet been used to treat people who have had a myocardial infarction. This is because of concern that the use of ESCs might lead to more harm to the person. One way that ESCs might lead to more harm is by differentiating into the wrong types of cells.

Suggest **one** other way that putting ESCs into a person's heart might lead to more harm to the person.

(2)

- (c) Transplants of cardiomyocytes have been shown to increase the repair of heart tissue damaged by myocardial infarction.

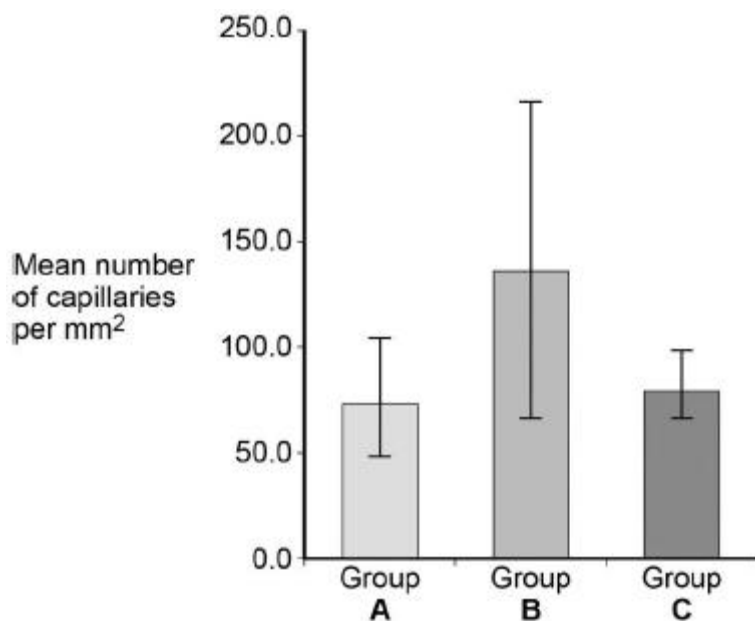
One group of scientists investigated the hypothesis that these transplants work by stimulating growth of new blood vessels into damaged heart tissues. They obtained three groups of mice, **A**, **B** and **C** that had suffered myocardial infarctions.

- **Group A** were operated on but no transplant was given.
- **Group B** were operated on and given transplants containing cardiomyocytes and two other types of heart cell.
- **Group C** were operated on and given transplants containing the two other types of heart

cells but no cardiomyocytes.

After a suitable time, the scientists measured the mean number of capillaries per mm² in sections taken from areas of the hearts of the mice affected by myocardial infarction.

Their results are shown in the graph below. The bars show ± 2 standard deviations, which includes 95.4% of the data.



Group **A** was a control group. Explain **two** ways in which Group **A** acts as a control.

1. _____

2. _____

(2)

- (d) What can you conclude from these data about the stimulation by cardiomyocytes on growth of new blood vessels into damaged heart tissues?

(3)

- (e) Suggest how the growth of new blood vessels into damaged heart tissues could increase the rate of repair of tissues.

(3)

- (f) The scientists used an optical microscope to measure the number of capillaries in thin sections cut from samples of heart muscle.

Describe the method they would have used to find the mean number of capillaries per mm².

(4)

(Total 15 marks)

Q2.

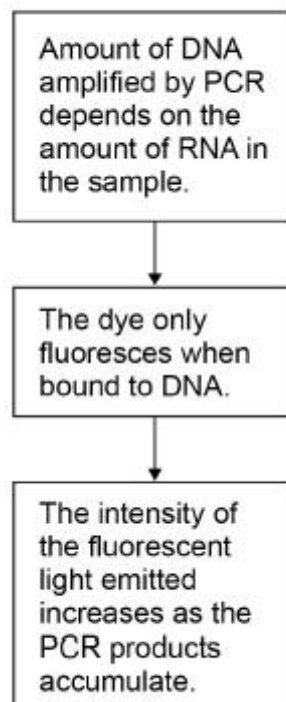
One way to detect and measure accurately the amount of RNA in a tissue sample is by RT-PCR (reverse transcriptase-polymerase chain reaction).

RT-PCR uses a reaction mixture containing:

- the sample for testing
- reverse transcriptase
- DNA nucleotides
- primers
- DNA polymerase
- fluorescent dye.

The principle behind this method is shown in **Figure 1**.

Figure 1



(a) Explain the role of reverse transcriptase in RT-PCR.

(1)

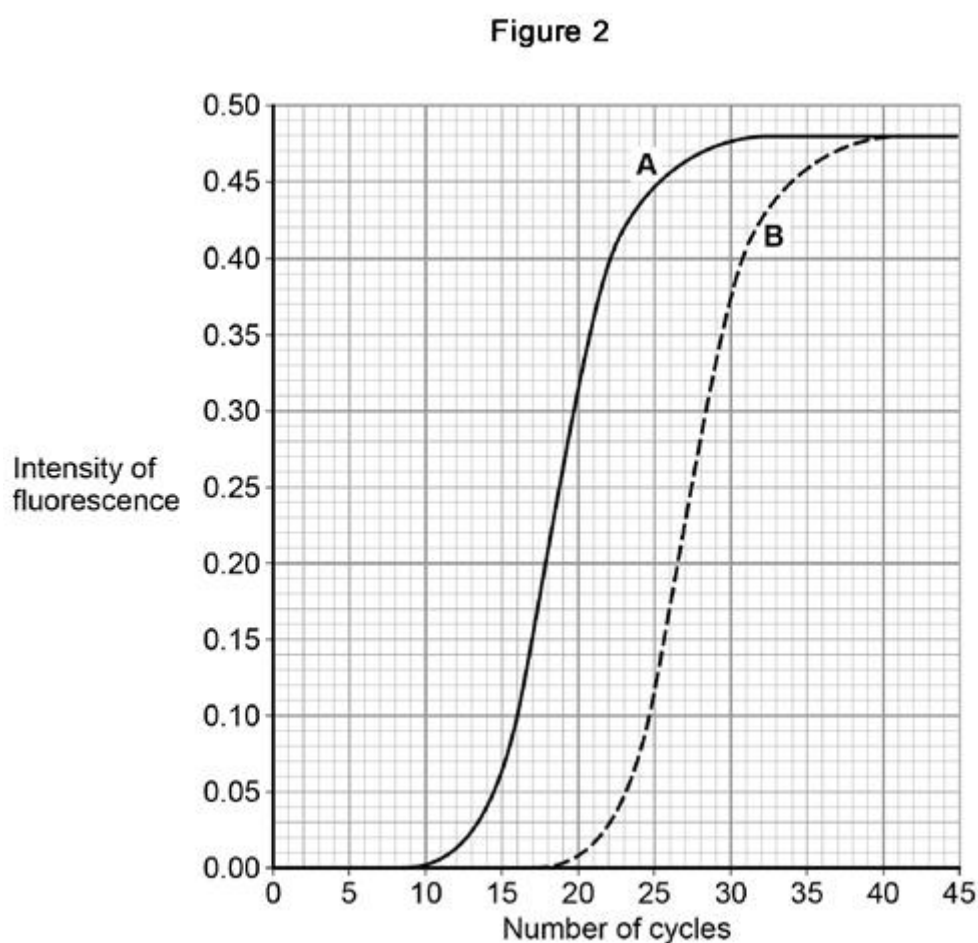
(b) Explain the role of DNA polymerase in RT-PCR.

- (c) Any DNA in the sample is hydrolysed by enzymes before the sample is added to the reaction mixture.

Explain why.

(2)

- (d) **Figure 2** shows the results from using RT-PCR to detect RNA in two different samples, **A** and **B**.



A quantitative comparison can be made of the amount of RNA in samples **A** and **B**. This involves determining the number of cycles required to reach 50% maximum concentration of DNA (**C**).

The amount of RNA in a sample can be measured as: $\frac{1}{C}$

Use this information to calculate the ratio for RNA content in sample **A** : RNA content in sample **B**.

- (e) Suggest **one** reason why DNA replication stops in the polymerase chain reaction.

(1)

- (f) Scientists have used the RT-PCR method to detect the presence of different RNA viruses in patients suffering from respiratory diseases.

The scientists produced a variety of primers for this procedure.

Explain why.

(2)

(Total 9 marks)