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# BIOLOGY

## THE CONTROL OF GENE EXPRESSION

Level & Board	AQA (A-LEVEL)
TOPIC:	STEM CELLS
PAPER TYPE:	QUESTION PAPER - 2
TOTAL QUESTIONS	6
TOTAL MARKS	31

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## Stem Cells - 2

1.

Go over the passage that follows.

One type of complete color blindness is called complete achromatopsia. It results from merely having rods and non-functioning cone cells. Individuals who suffer from full achromatopsia have trouble seeing details. An autosomal recessive allele causes complete achromatopsia, which typically affects just one person out of every 40,000. On the island of Pingelap in the Pacific, however, 10% of the populace is impacted.

More males than women are affected with a sex-linked recessive gene that causes one type of red-green color blindness. Individuals who suffer from this red-green color blindness are unable to discriminate between other colors as well as between red and green. Although they have photoreceptive pigments, their green-sensitive cones are inactive.

Researchers looked at using gene therapy to treat monkeys who were red-green color blind. The monkeys' eyes were immediately injected with viruses that carried the gene for the pigment that is sensitive to green. Even though the monkeys were able to see color for two years, there is disagreement over whether this type of gene therapy is beneficial. No human clinical studies have been conducted for this treatment. Induced pluripotent stem cells (iPS cells) are being used in studies to treat red-green color blindness. Gene therapy may not always be superior to the usage of iPS cells.

Answer the following questions using the facts in the passage and your own understanding.

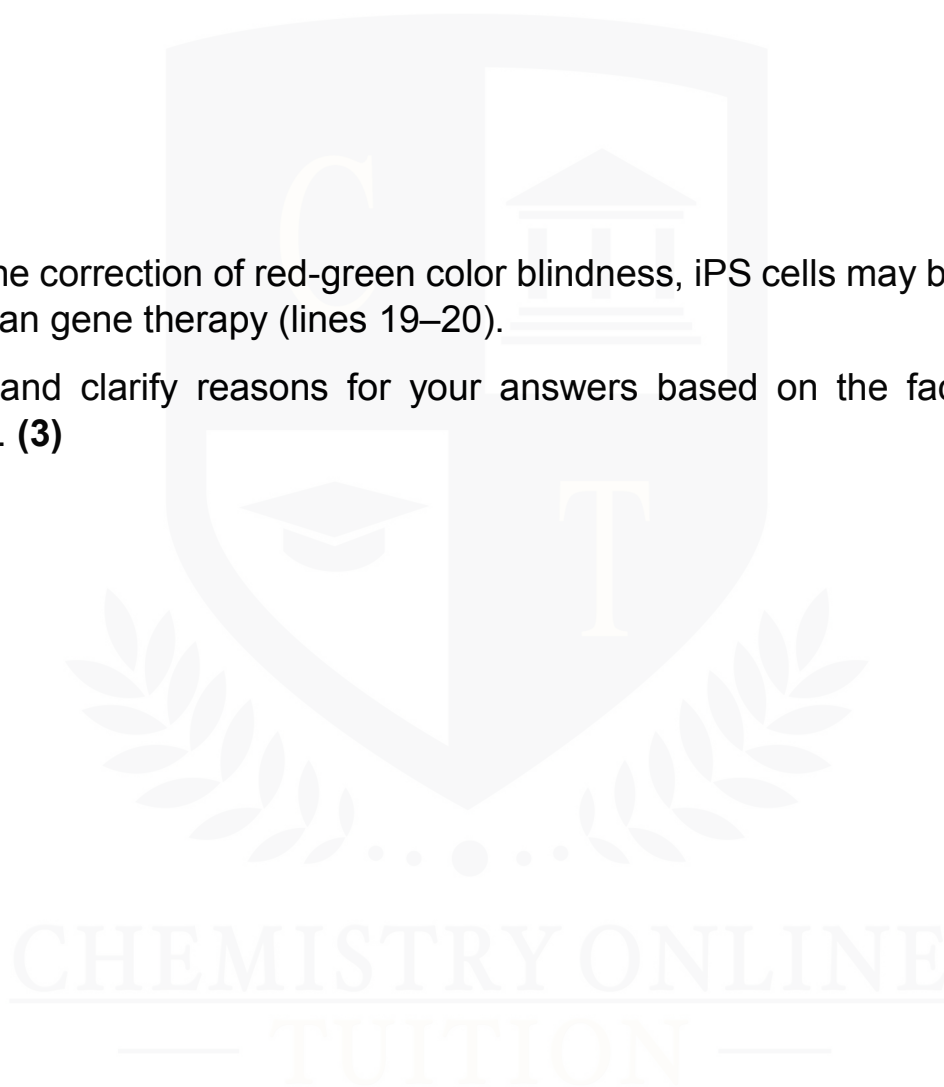
**(a)** Induced pluripotent stem cells, or iPS cells, are being used in research to correct red-green color blindness (lines 17–19).

Describe a potential treatment for red-green color blindness using iPS cells.

**(2)**

**(b)** For the correction of red-green color blindness, iPS cells may be a better option than gene therapy (lines 19–20).

Provide and clarify reasons for your answers based on the facts in the passage. **(3)**



## 2.

Researchers looked into treating mice with type I diabetes with induced pluripotent stem cells (iPS cells). The researchers reprogrammed skin cells to create iPS cells using four transcription factors. Next, the researchers induced pluripotent stem cells to differentiate into pancreatic cells in vitro.

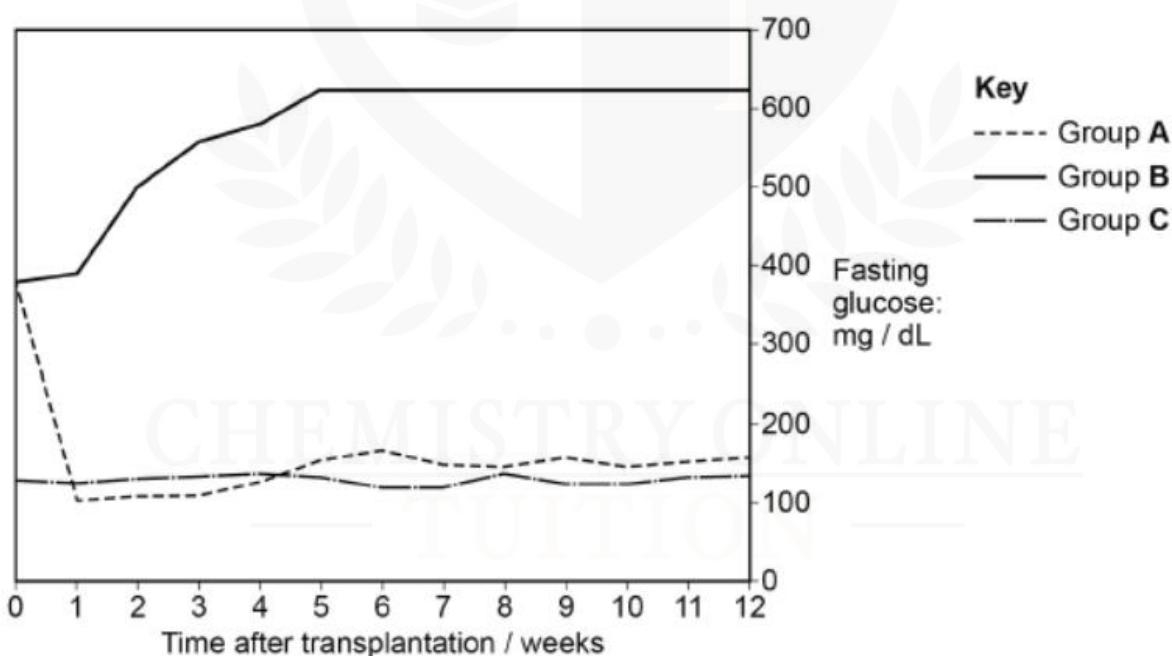
Three experimental groups were formed by the scientists:

- Group A: iPS cell-derived pancreatic cell transplants were given to 30 mice suffering from type I diabetes.

Thirty mice without diabetes were left untreated in Group C, while thirty mice with type I diabetes were left untreated in Group B.

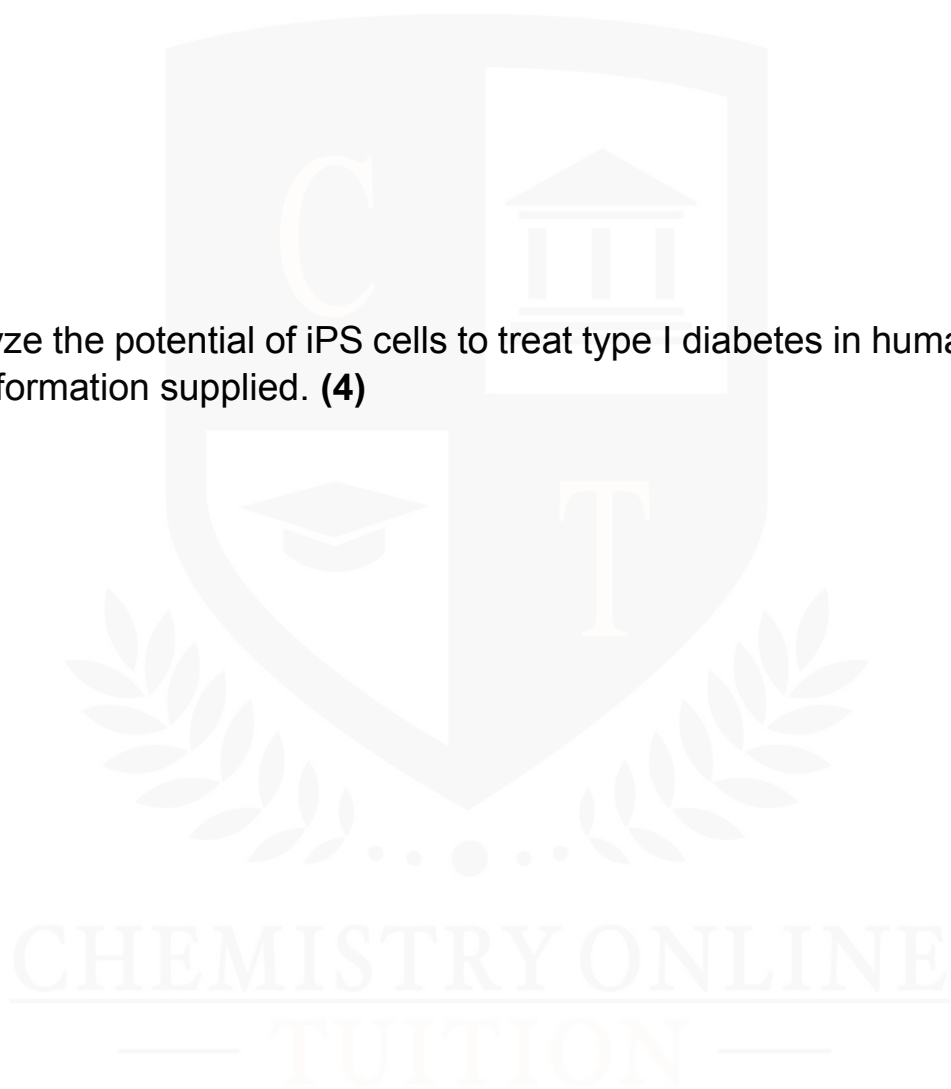
For a duration of 12 weeks, the blood glucose concentration of every mouse was monitored by the scientists once a week.

The graph displays the findings that the scientists were able to collect.



**(a)** Explain how reprogramming cells to become iPS cells is possible with transcription factors. **(2)**

**(b)** Analyze the potential of iPS cells to treat type I diabetes in humans using all the information supplied. **(4)**



**3.**

Researchers have looked into using various kinds of stem cells to heal heart damage resulting from myocardial infarction. A myocardial infarction results in the death of several different types of cardiac cells. Cardiomyocytes are cells found in the heart muscle.

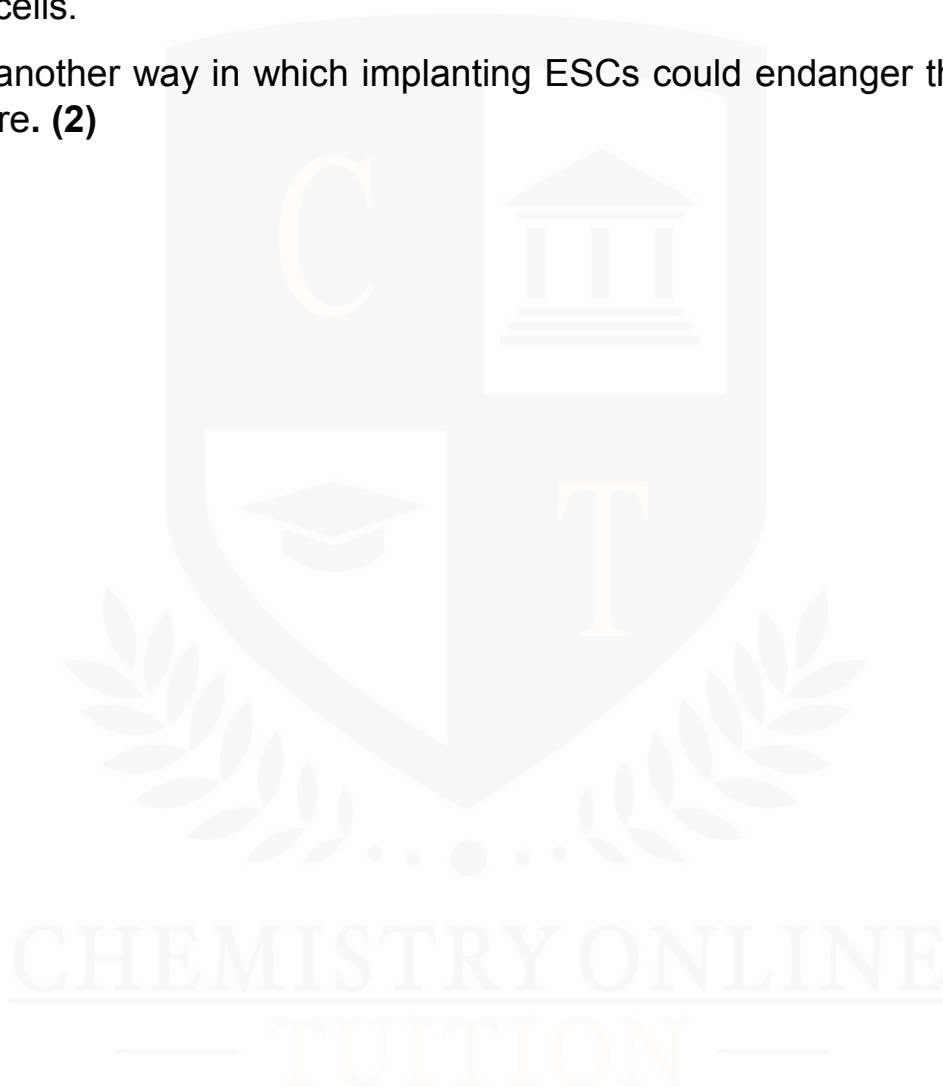
The ability of embryonic pluripotent stem cells (ESCs) to proliferate and differentiate into a diverse array of cell types is remarkable.

**(a)** Provide one explanation for why cardiac injury might be treated using ESCs based on the facts provided. **(2)**

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**(b)** ESCs have not yet been utilized in the treatment of myocardial infarction patients. This is due to worries that using ESCs could cause the user further injury. ESCs may cause additional harm by developing into the incorrect kinds of cells.

Provide another way in which implanting ESCs could endanger the patient even more. **(2)**



**(c)** It has been demonstrated that transplanting cardiomyocytes can speed up the healing of myocardial infarction-damaged cardiac tissue.

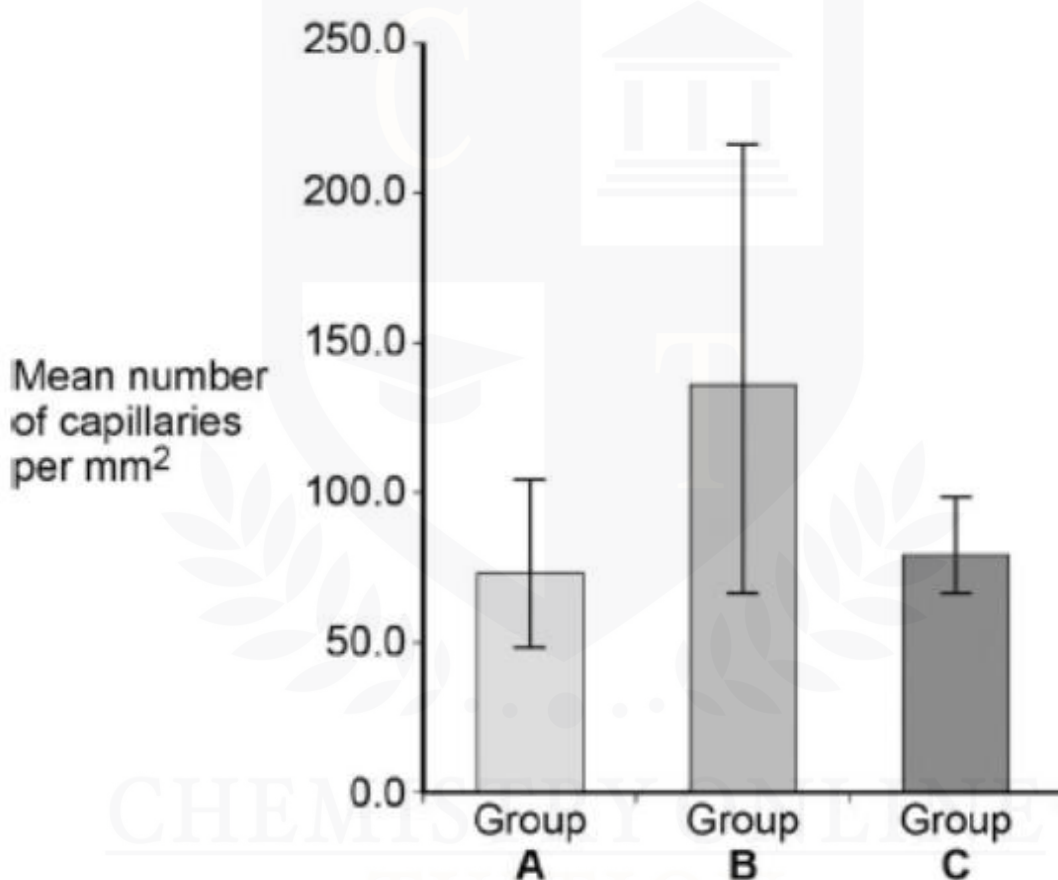
A team of researchers looked into the theory that the injured cardiac tissues are stimulated to generate new blood arteries by these transplants. Three sets of mice (A, B, and C) with myocardial infarctions were obtained.

- Group A underwent surgery, but no graft was administered.

Group C received transplants containing the two other types of heart cells but not cardiomyocytes, while Group B had surgery and received transplants comprising cardiomyocytes and two other types of heart cells.

The researchers took pieces of the mice's hearts that had suffered myocardial infarction, and after a reasonable amount of time, they counted the mean number of capillaries per millimeter.

The graph below displays their findings. 95.4% of the data is represented by the bars, which display  $\pm 2$  standard deviations.

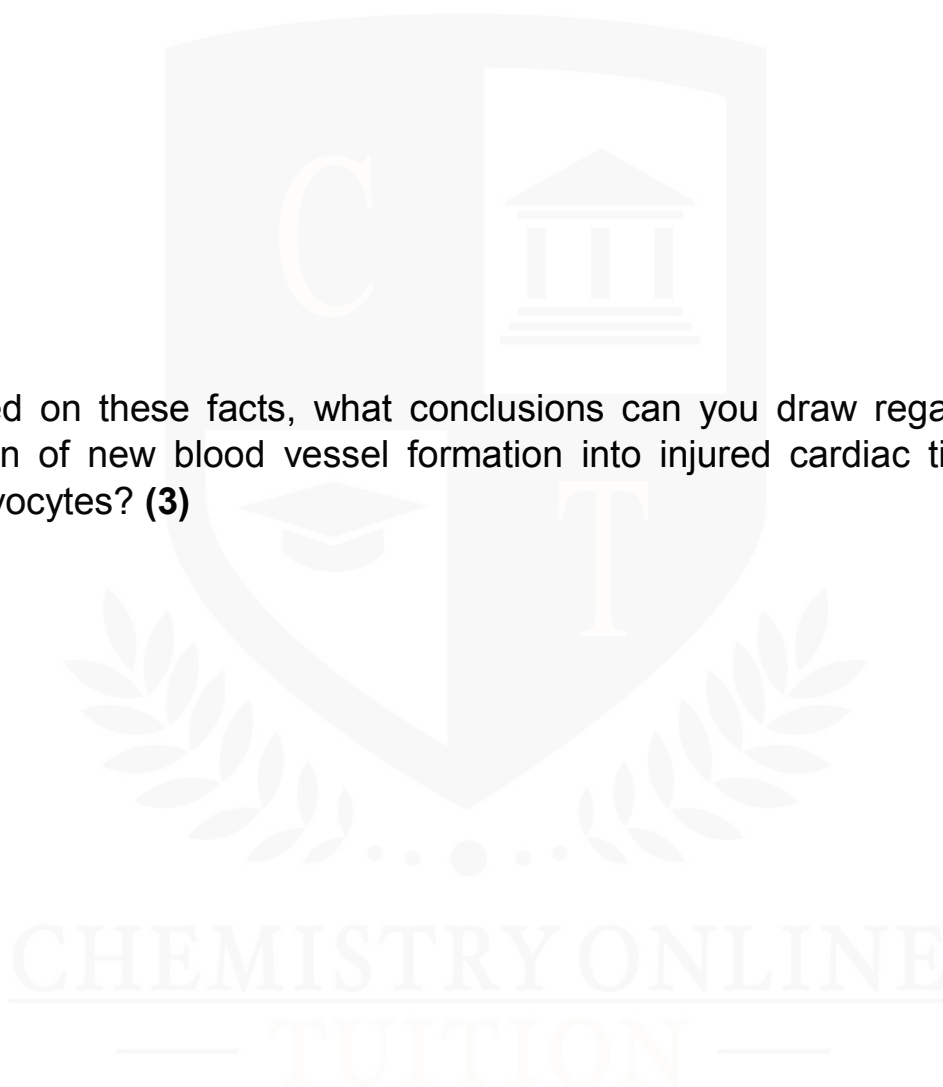


One control group was Group A. Describe the two ways that Group A controls the situation. (2)



**4.**

**(a)** Based on these facts, what conclusions can you draw regarding the promotion of new blood vessel formation into injured cardiac tissues by cardiomyocytes? **(3)**



**(b)** Explain how the formation of new blood vessels within injured cardiac tissues may accelerate tissue healing. **(3)**



**5.**

Using tissue culture, plant physiologists tried to grow papaya plants. They looked at how two plant growth hormones affected tiny segments of a papaya plant's stem tip at various concentrations. The table displays their outcomes.

Concentration of auxin / $\mu\text{mol dm}^{-3}$	Concentration of cytokinin / $\mu\text{mol dm}^{-3}$		
	5	25	50
0	No effect	No effect	Leaves produced
1	No effect	Leaves produced	Leaves produced
5	No effect	Leaves produced	Leaves and some plantlets produced
10	Callus produced	Leaves and some plantlets produced	Plantlets produced
15	Callus produced	Callus and some leaves produced	Callus and some leaves produced

A mass of undifferentiated plant cells is called a callus. Little plants are called plantlets.

**(a)** Describe how the table's evidence demonstrates the totipotency of stem tip cells. **(2)**

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**(b)** Determine the cytokinin to auxin ratio that you would suggest using to develop papaya plants using this technique. **(2)**

**6.**

**(a)** Papaya trees use seeds for sexual reproduction. The yield of papaya plants cultivated from seeds varies greatly. Describe your reasoning. **(2)**

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**(b)** Describe the benefits of using tissue culture to develop papaya plants as opposed to seeds. **(2)**





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