

## Stem Cells and Epigenetics - Questions by Topic

Q1.

Fibrosis of the liver is a chronic condition that can lead to cirrhosis of the liver and liver failure.

In fibrosis of the liver, liver cells secrete excess collagen.

There is an association between fibrosis of the liver and alcohol consumption in humans.

Scientists have investigated the effects of alcohol intake on collagen synthesis in rats.

The results are shown in the table.

Alcohol intake / week	Synthesis of collagen in the liver / au
none	14
small volume each day	16
one large volume on day one	19
one large volume on day one and a small volume from day two and day seven	27

(i) Deduce the effect of alcohol intake on fibrosis of the liver in rats.

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(ii) The scientists have suggested that epigenetic events are involved in regulating collagen synthesis in rats given alcohol.

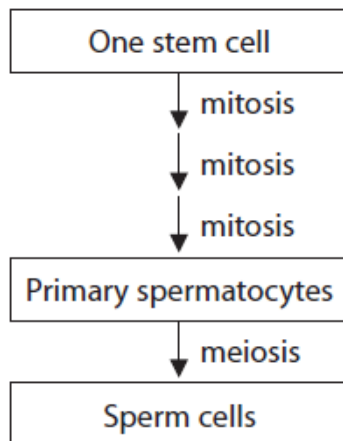
Explain how epigenetic events might be involved in regulating collagen synthesis in rats given alcohol.

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Q2.

Sperm are produced from stem cells in a process that involves several cycles of mitosis and a single cycle of meiosis, as shown in the diagram.



(i) State what is meant by the term stem cell.

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(ii) Compare and contrast the results of mitosis and meiosis in the production of sperm cells from stem cells.

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**(Total for question = 6 marks)**

Q3.

Type 1 diabetes occurs when beta cells in the pancreas do not produce insulin.

Stem cells produced from skin cells can be used to replace these beta cells in mice. The skin cells can be stimulated to become pluripotent stem cells.

The pluripotent stem cells were injected into the mice. After eight weeks, these cells had developed into insulin-secreting beta cells.

Describe how these pluripotent stem cells became specialised beta cells.

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Q4.

Type 1 diabetes occurs when beta cells in the pancreas do not produce insulin.

Stem cells produced from skin cells can be used to replace these beta cells in mice. The skin cells can be stimulated to become pluripotent stem cells.

Place a cross  in the box next to the correct definition to complete the following statement.

Pluripotent stem cells are

(1)

- A** specialised cells that can differentiate to give rise to almost any type of cell in the body, including totipotent cells
- B** specialised cells that can differentiate to give rise to any type of cell in the body, excluding totipotent cells

- C** unspecialised cells that can differentiate to give rise to almost any type of cell in the body, excluding totipotent cells
- D** unspecialised cells that can differentiate to give rise to any type of cell in the body, including totipotent cells

Q5.

The phenotype of an organism can be influenced by a variety of factors.

Phenotypic plasticity is the mechanism that many organisms use to phenotypically alter due to a change in environmental conditions.

An investigation to study phenotypic plasticity was carried out using a species of freshwater snail.

Newly hatched freshwater snails were used. These snails were divided into three groups and each group was placed in a tank with a different set of conditions.

Three different conditions were used. One was a control and the other two are described in the table.

Condition	Description
A	In water taken from a tank containing predator fish that had eaten some of the snails
B	In water in a tank exposed to ultraviolet light (UV)

(a) Describe a suitable control to be used with the third group of snail

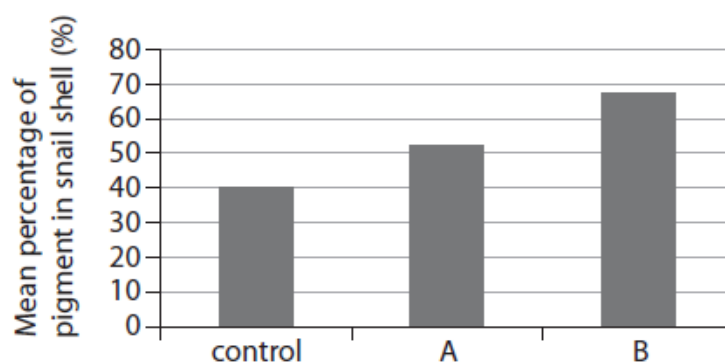
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(b) The snails were allowed to grow for eight weeks and then the mean percentage of pigment in the snail shells was assessed for each group. The results are shown in the graph.





(i) Scientists predicted that the snails exposed to both UV light and water from a tank of predator fish would have 80% shell pigmentation.

Explain how this prediction was made.

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(ii) It is thought that an increase in shell pigmentation levels provides protection against UV light. UV is a form of radiation that can damage DNA.

Explain how the DNA of the snail could be damaged.

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Q6.

Some fish live in very cold parts of the sea where ice can form.

Many of these fish produce anti-freeze proteins, which help to stop ice forming inside the fish.

Some fish produce another anti-freeze protein, called AFP II.

The tissues of these fish were tested for the presence of AFP II and the mRNA coding for AFP II.

The results are shown in the table.

Molecule	Present in
AFP II protein	all tissues
AFP II mRNA	liver tissue only

Explain the distribution of the AFP II protein and AFP II mRNA.

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**(Total for question = 4 marks)**

Q7. Recently, scientists have shown an interest in using plant tissue culture techniques to produce large numbers of genetically identical cotton plants. Cotton plants provide fibres used for clothing.

Plant tissue culture techniques depend on the totipotent properties of the cells used.

(a) Describe how you could use a plant tissue culture technique to show totipotency in cotton plant seedlings.

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(b) Scientists used similar plant tissue culture techniques to investigate the effect of the age of the seedlings on totipotency.

Seedlings were divided into four groups, each consisting of 25 seedlings. One group was grown for 7 days before the plant tissue culture technique was carried out. The number of seedlings that showed totipotency was recorded as a percentage.

This procedure was repeated for the other three groups of seedlings, which were grown for 14, 21 and 28 days respectively before the plant tissue culture technique was carried out.

The results are shown in the table below.

<b>Age of seedlings before plant tissue culture technique carried out / days</b>	<b>Percentage of seedlings showing totipotency (%)</b>
7	76
14	56
21	40
28	60

(i) Describe the effect of age on the percentage of seedlings showing totipotency.

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(ii) The scientists were concerned about the reliability of the data.

Suggest how the data could have been made more reliable.

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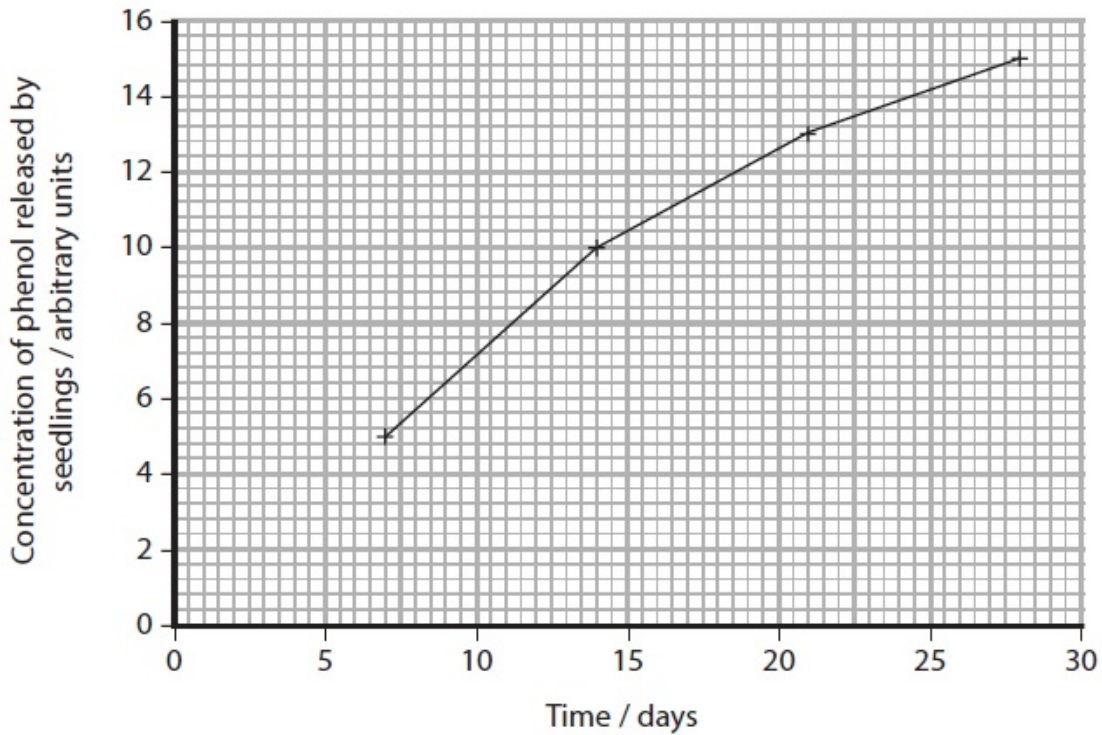
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(c) As cotton plants grow, they release a substance called phenol.

In another investigation, the scientists measured the concentration of phenol released by seedlings.

The results are shown in the graph below.



(i) Using the information in the table in part (b) and the graph, give evidence to support the hypothesis that phenol reduces totipotency.

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(ii) Using the information in the table in part (b) and the graph, give evidence that d **not** support the hypothesis that phenol reduces totipotency.

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(d) Human stem cell research involves the use of both totipotent and pluripotent stem cells. Describe the differences between a totipotent stem cell and a pluripotent stem cell.

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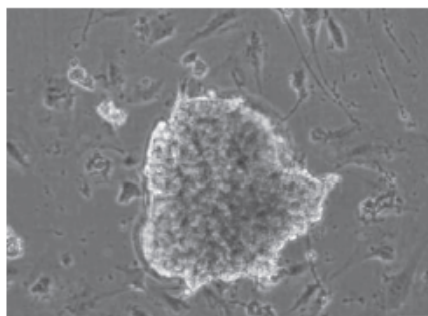
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**(Total for Question = 12 marks)**

Q8.

Scientists have used stem cells collected from a patient's own heart tissue to heal tissue damaged by heart attacks.

The photograph below shows a stem cell extracted from heart tissue.



Magnification  $\times 200$

After collection, the stem cells were grown in a laboratory to increase their numbers. These stem cells were then put into the coronary arteries surrounding the heart of the patient.

The stem cells developed into heart muscle cells, which repaired the damaged heart tissue.

(a) (i) Place a cross (☒) in the box that best identifies the name of the property that would enable these stem cells to give rise to heart muscle cells.

(1)

- A** cardiopotency
- B** omnipotency
- C** pluripotency
- D** totipotency

(ii) Explain how these stem cells become specialised and develop into heart muscle cells.

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(b) Explain the advantages of using stem cells from the patient instead of using stem cells from a donor.

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(c) Suggest why this form of stem cell therapy is less controversial than embryonic stem cell therapy.

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**(Total for question = 9 marks)**