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Biological Sciences review

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Volume 29, Number 3, February 2017

Activity

Cell potency and stem cells

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This exercise is based on Angela McCahill's article, 'Stem cells and regenerative medicine', on pages 2–7 of the February 2017 issue.

The topic of stem cells is relatively new to most GCE biology specifications.

- It includes some relatively straightforward biological content, which many students seem to find confusing. Some of the following questions test recall of this content.
- Stem cells also offer opportunities in medicine, as outlined in Dr McCahill's article. Questions covering these opportunities enable examiners to link this aspect of biology with others, i.e. make synoptic links between different topics. Some of the following questions do this.
- Finally, the use of stem cells raises ethical issues, which could be exploited in examination questions.

Read the first page of the article and answer the following questions testing recall with understanding.

1 Give **three** features of a stem cell. [3 marks]

2 Naturally occurring adult stem cells are either unipotent or multipotent.

(a) Describe the difference between a unipotent cell and a multipotent cell. [1 mark]

(b) Give **one** location of an adult multipotent stem cell. [1 mark]

(c) Use your knowledge of biology to suggest **one** location of an adult unipotent stem cell. [1 mark]

(d) Suggest why the term 'adult stem cell' might be inappropriate. [1 mark]

On this first page of her article, Dr McCahill describes the use of bone marrow transplants as the first stem cell therapy carried out.

3 What is the potency of the haematopoietic cells used in bone marrow transplants? [1 mark}

4 Figure 2 in the article shows that stem cells are removed from a healthy donor, i.e. this is an allogeneic transplant.

(a) Why must this transplant be allogeneic? [1 mark]

(b) The bone marrow to be used in the transplant must be from a matched donor. Explain why the donor must be matched. [4 marks]

(c) Suggest **one** treatment that could be used to destroy the recipient's blood stem cells. [1 mark]

Now turn to Figure 5 in the article and answer the following questions.

5 The 3–5 day post-fertilisation embryo (the **blastocyst**) contains an inner mass of cells, called blastomeres, surrounded by a single layer of cells, called trophoblasts.

(a) Each blastomere is pluripotent. Give the evidence in Figure 5 that supports this statement. [2 marks]

(b) Suggest the function of the trophoblasts. [1 mark]

6 The zygote is the only human cell that is totipotent. Use evidence from Figure 5 to justify this statement. [2 marks]

The following questions relate to the content of the section of the article entitled 'Different types of stem cell'.

7 Give **two** advantages that embryonic stem cells have over adult stem cells in regenerative medicine. [2 marks]

8 The use of human embryonic stem cells raises ethical issues.

In the UK, the use of human embryonic stem cells is tightly regulated by law (The Human Fertilisation and Embryology Act of 1990) and is licensed by a body called the Human Fertilisation and Embryology Authority (HFEA)

Give **three** of the restrictions on the use of human embryonic stem cells given in Dr McCahills' article. [3 marks]

9 Blood from a vein in the umbilical cord is also a source of haematopoietic cells. Collected at birth, this blood can be stored in a cord blood bank and, if necessary, used in regenerative medicine later in the same person's life. In the UK, the NHS cord blood bank is a public service but other, commercial, cord blood banks are also licensed.

(a) Are there any advantages in storing a child's umbilical cord blood from birth? Is so, what are they? [2 marks]

(b) The use of human embryonic stem cells raises ethical issues. Does the use of human cord stem cells also raise ethical issues? Justify your answer. [2 marks]

The final questions relate to the section of Dr McCahill's article entitled 'Induced pluripotent stem cells'

10 In 2006, Shinya Yamanaka's laboratory in Kyoto, Japan, showed how adult cells could be reprogrammed to become iPS cells. The technique involved treating mouse skin cells called fibroblasts with transcription factors.

(a) Describe the effect that a transcription factor has in a cell. [3 marks]

(b) Suggest the working hypothesis of Shinya Yamanaka's team. [1 mark]

(c) Without giving any experimental procedures, suggest how the team might have set about discovering the transcription factors that resulted in iPS cells. [2 marks]

11 As with many procedures, the used of iPS cells raises potential dangers. Use a search engine to find a potential danger in the use of one of the transcription factors given in Figure 5. [1 mark]