2018 Stem Cells STQ

2018 / H2 / EJC PRELIM / P2 Q3

1 Bone marrow contains stem cells that divide by mitosis to form blood cells. The fate of a stem cell was trac
and it was recorded that during the observed duration the stem cell divided asymmetrically each time.

Fig. 3.1 shows changes in the mass of DNA in a human stem cell from bone marrow during three cell cycles

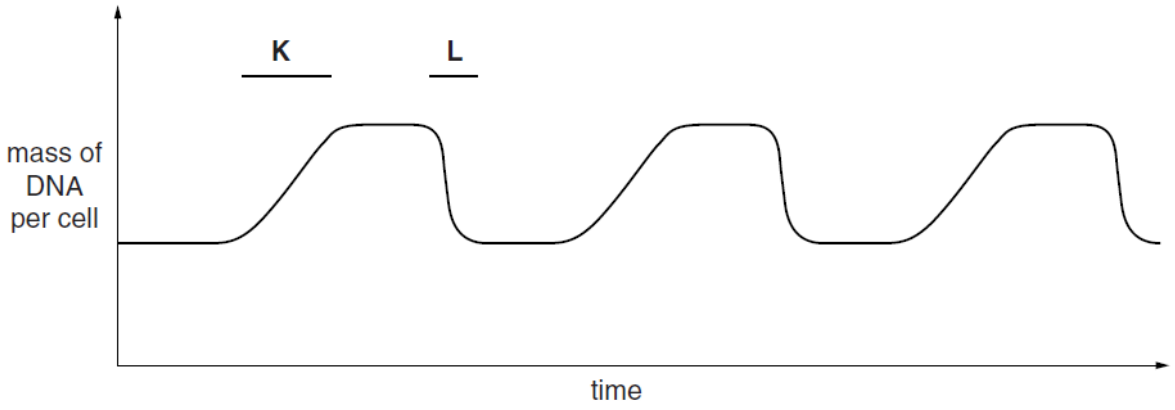

Fig. 3.1

(a) With reference to the information provided above,

(i) Describe what happens to bring about the changes in the mass of DNA per cell at time period **K** an
at time period **L**.

K ……

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L ……

……..[2]

(ii) State one function of these stem cells undergoing the above type of cell division.

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……..[1]

(iii) The process of meiosis is significant to natural selection in evolution.

Explain this significance.

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……..[2]

A bone marrow cell was extracted and observed under the electron micrograph shown in Fig. 3.2. The stud
focused on an organelle which he described as having “an envelope surrounding genetic material contain
both darker and lighter stained patches, distinct from the site where ribosomal subunits were assembled”.

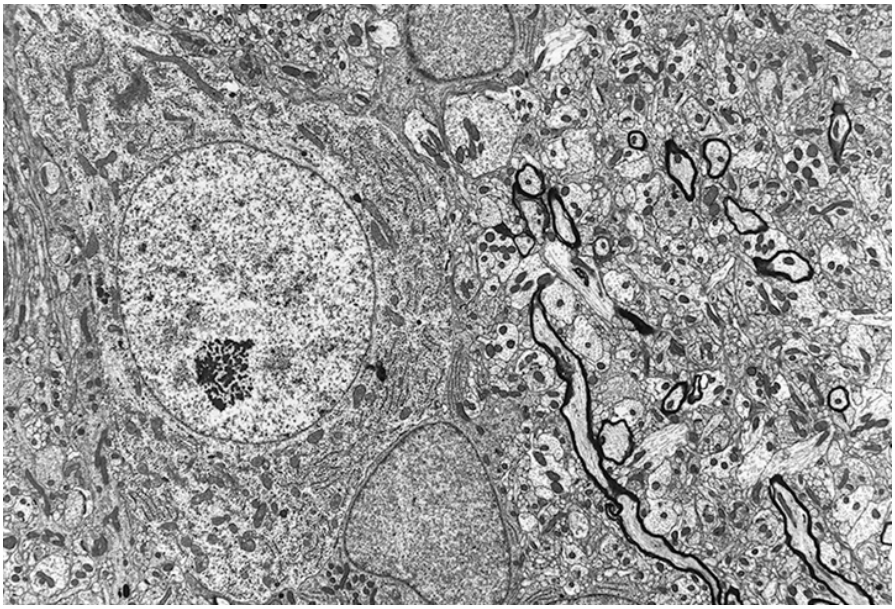

Fig. 3.2

(b) Explain the significance of the “darker and lighter stained patches” that the student referred to, in a
undergoing differentiation.

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……..[3]

The use of embryonic stem cells (ESCs) for stem cell therapy and research is controversial and considered
many people as unethical. Scientists have circumvented this issue through the use of induced pluripotent
stem cells (iPSCs) as an alternative to ESCs.

Fig. 3.3 summarises the procedure for obtaining iPSCs and its use.

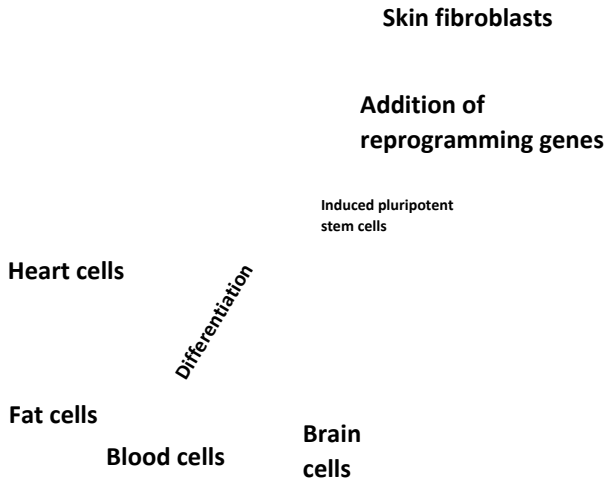

Fig. 3.3

(c) Explain why the use of iPSCs is preferred over ESCs.

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……..[2]

2018 / H2 / NJC PRELIM / P2 Q7

2 **(a)** Define and state an example of a multipotent stem cell.

[2]

(b) **(i)** One unique feature of stem cells is their ability to differentiate into different cell types, where some genes are silenced and some genes are expressed.

Explain how stem cells achieve this.

[4]

(ii) During the process of differentiation, specific proteins are produced.

Account for the roles of **three** types of RNA in producing these proteins.

[3]

(c) A recent advancement in stem cell gene therapy is the use of CRISPR/Cas9

system to edit genes. This stem cell gene therapy can help to cure genetic diseases by removing the undesired gene and adding the corrected version in the stem cells.

The CRISPR/Cas9 system works by delivering a Cas9 nuclease complexed with a single-stranded RNA (artificial guide) into a cell.

Fig. 7.1 and Fig. 7.2 explain how gene editing is achieved using CRISPR/Cas9 system.

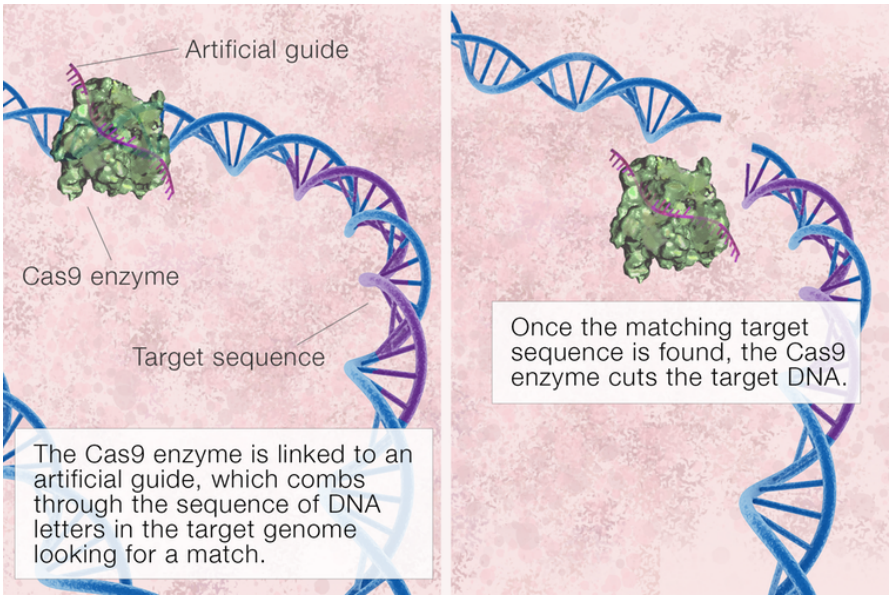

Fig. 7.1

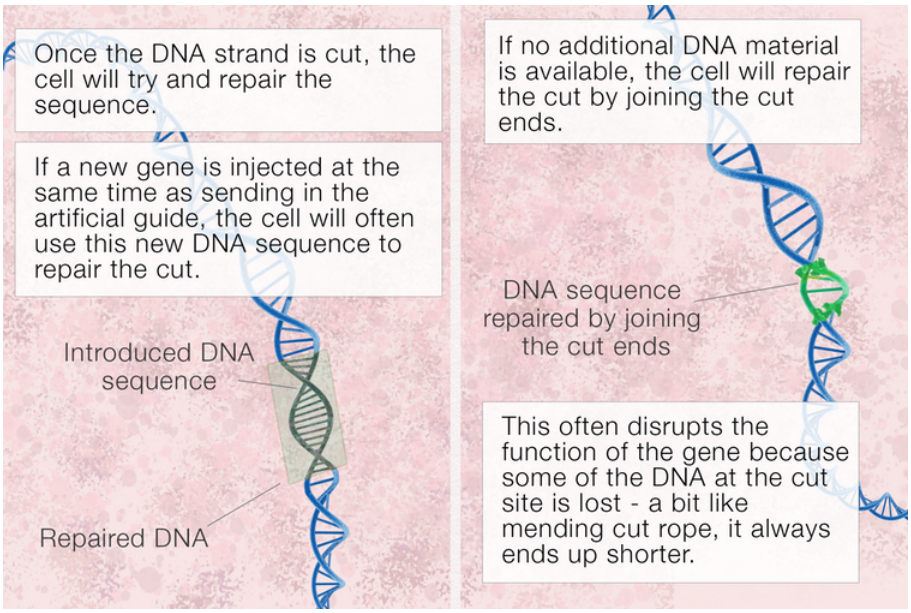

Fig. 7.2

(i) With reference to Fig. 7.1 and Fig. 7.2, explain why CRISPR/Cas9 is believed to have potential applications for treating **many** genetic diseases in humans.

[2]

(ii) Despite the potential of CRISPR/Cas9 in treating many genetic diseases, some scientists are worried about the use of such technology in humans.

Suggest **one** possible consideration.

[1]

[Total: 12]