

PEARSON EDEXCEL A-LEVEL BIOLOGY B • 9B10

BIOLOGY



EXAM QUESTION PACK

TOPIC 7: MODERN GENETICS
STEM CELLS

SCORE

/35

PERCENTAGE

%

STEMUP

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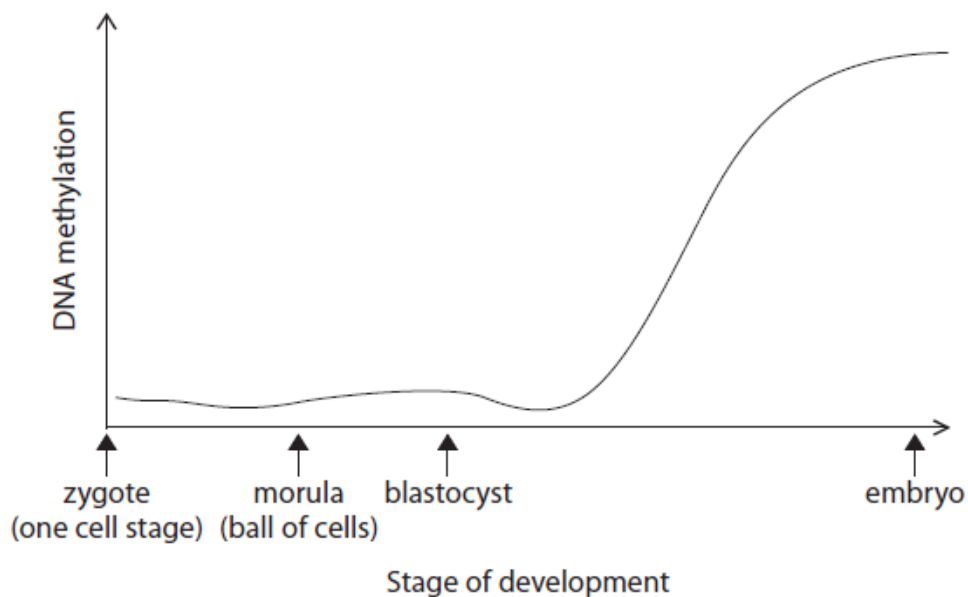
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Q1.

Epigenetic modifications are involved in the development of an embryo.

The graph shows the changes in DNA methylation during the development of an embryo from a zygote.



(i) State the meaning of the term DNA methylation.

(1)

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(ii) Describe the differences between totipotent, pluripotent and multipotent stem cells during the development of an embryo.

(3)

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(iii) Analyse the graph to explain why DNA methylation is involved in the development of an embryo.

(2)

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(Total for question = 6 marks)

Q2.

Mouse embryonic fibroblasts can be converted into F-class ('fuzzy') pluripotent cells. Scientists have shown that DNA demethylation may be involved in this conversion. Explain how demethylation of DNA might cause this conversion.

(2)

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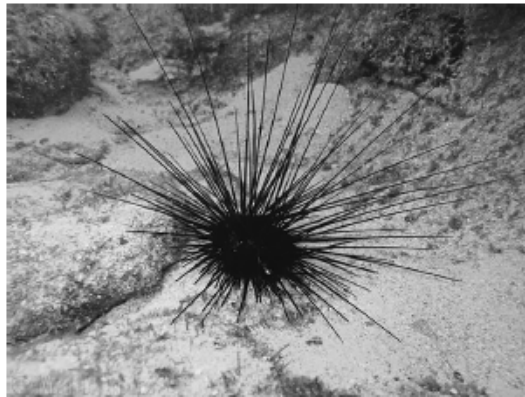
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Q3.

A sea urchin is an invertebrate animal that lives on the seabed.

The photograph shows a sea urchin.



Sea urchin embryos are often used to study embryonic development.
In the early stages of embryonic development, a sea urchin embryo is similar to a mammalian embryo.

Explain why the use of sea urchin embryos was approved by an ethics committee.

(2)

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Q4.

Explain why some cells are not able to become other cell types.

(2)

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(Total for question = 2 marks)

Q5.

Retinitis pigmentosa is a genetic eye disease that affects rod cells. The disease results in night blindness and sight defects.

Induced pluripotent stem cells (iPS cells) are being used by scientists studying this disease.

(a) Which of the following is correct for a pluripotent cell?

(1)

	Is obtained from	Can differentiate into
☐ A	early embryo	any cell type
☐ B	early embryo	limited cell types
☐ C	late embryo	any cell type
☐ D	late embryo	limited cell types

(b) Describe how iPS cells can be produced.

(3)

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(c) Describe how iPS cells could be used to cure retinitis pigmentosa.

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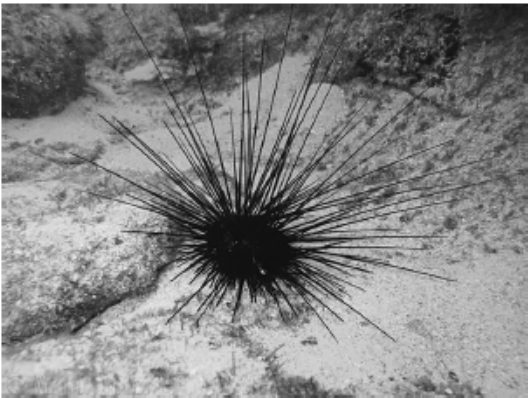
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(Total for question = 6 marks)

Q6.

A sea urchin is an invertebrate animal that lives on the seabed.

The photograph shows a sea urchin.



Sea urchin embryos are often used to study embryonic development. In the early stages of embryonic development, a sea urchin embryo is similar to a mammalian embryo.

A scientist carefully removed one of the 128 cells from the hollow structure and injected fluorescent dye into its cytoplasm

She replaced this cell in a new position on the opposite side of the hollow structure.

The embryo then developed normally. The repositioned cell formed healthy tissue, appropriate to its new position.

The tissue formed by an embryonic cell is called the 'fate' of the cell.

(i) Explain how the scientist could identify the fate of the repositioned cell.

(2)

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(ii) The scientist found that repositioning this cell changed its fate.

Explain the scientist's finding.

(4)

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Q7.

The photograph shows the hand of a person with the inherited condition 'WHIM'.



This condition results in a defective immune system, warts on the skin surface and an increased risk of cancer.

A woman had WHIM but her symptoms disappeared. However, she was worried that she had passed the condition on to her children.

Bone marrow is responsible for making white blood cells.

Scientists found that the woman had a single mutation in a bone marrow stem cell. This caused 'chromosome shattering' with the loss of 164 genes, including the defective gene.

(i) Explain how this mutation in a bone marrow stem cell had cured her of WHIM.

(2)

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(ii) Some people have complained about the use of stem cells from fetal cell lines in the development of Ebola vaccines.

Explain why these stem cells are being used to produce vaccines rather than bone marrow cells.

(2)

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Q8.

Scientists are developing ways of using stem cells to replace heart cells that have been damaged as a result of heart disease.

Both embryonic stem cells and induced pluripotent stem cells (iPS cells) can be used to create new heart cells.

Compare and contrast the properties and uses of embryonic stem cells with those of iPS cells.

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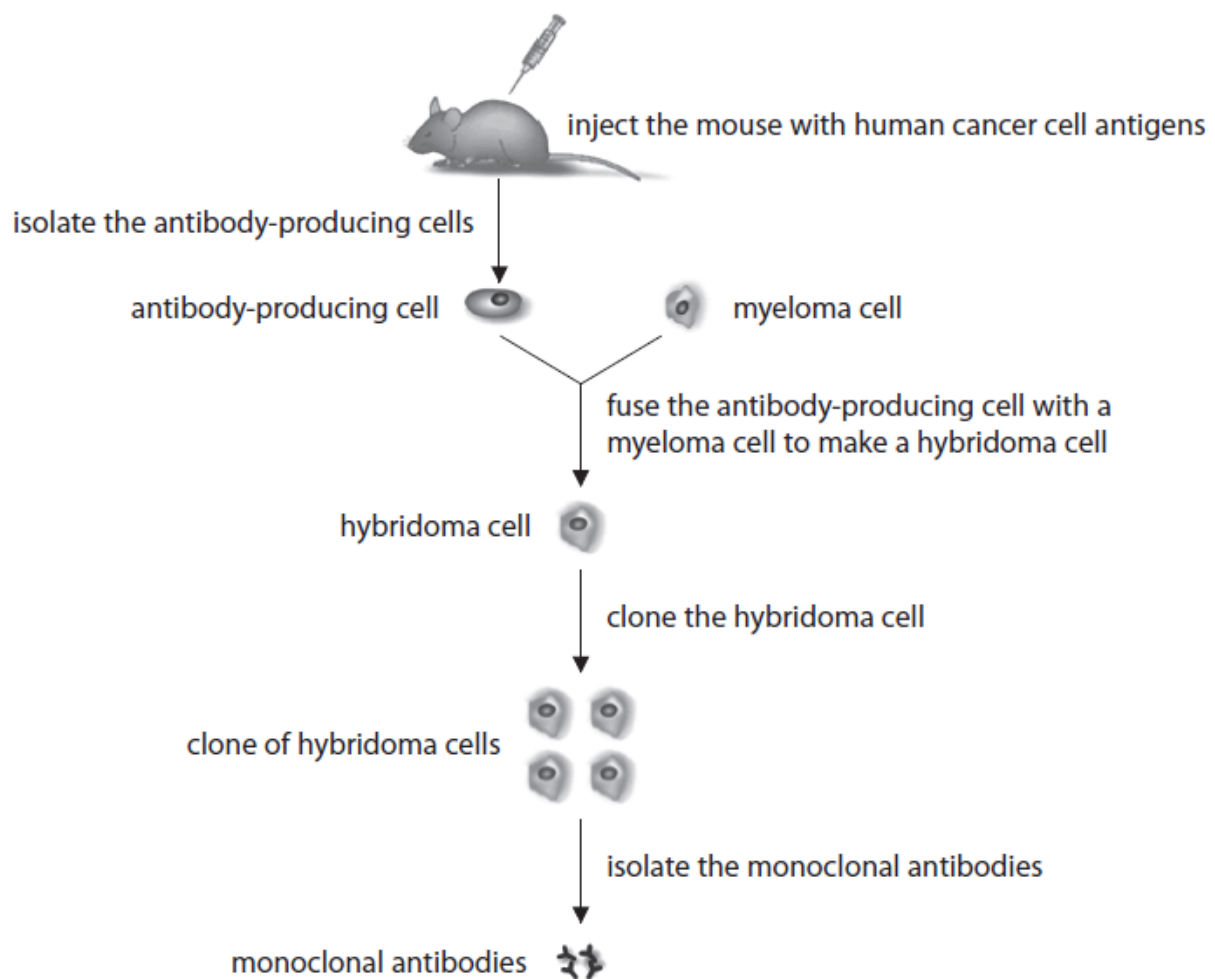
(Total for question = 5 marks)

Q9.

Monoclonal antibodies can be made against a wide range of different antigens. They are used in research and medicine.

Monoclonal antibodies are made by fusing an antibody-producing cell with a myeloma cell.

The diagram shows some of the steps involved in making monoclonal antibodies against human cancer cell antigens.



Myeloma cells have the potential to divide indefinitely.

Explain why myeloma cells are used in the production of monoclonal antibodies.

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(Total for question = 2 marks)

Mark Scheme

Q1.

Question Number	Answer	Additional Guidance	Mark
(i)	{methyl group / CH ₃ } added to a {base (cytosine or adenine) / cytosine / adenine / CpG site}	DO NOT ACCEPT between cytosine and guanine ACCEPT A for adenine, C for cytosine, G for guanine	

Question Number	Answer	Additional Guidance	Mark
(ii)	A description that makes reference to the following: • {zygote / morula} are totipotent stem cells as they give rise to all cell types (1) • {blastocyst / inner cell mass} contains pluripotent cells that give rise to the cells of the embryo (and not the extra embryonic tissue) / most cell types (1) • cells in the developing embryo are multipotent as they become only some cell types (1)	ACCEPT references to early and late stages of development if clear from description which stages are being referred to ACCEPT cleavage cells ACCEPT {trophoblastic cells / cells around the outside of the blastocyst} as they become extra embryonic tissue N.B. If correct description given for 2 or more types of stem cell but no reference to embryo, award 1 mark	

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to two of the following: • level of DNA methylation increases after the blastocyst stage} (1) • because genes {switched off / silenced / inactivated / cannot be transcribed / cannot be expressed} (1) • causing cells to become {specialised / differentiated} (1)		

Q2.

Question Number	Acceptable Answer	Additional guidance	Mark
	An explanation that makes reference to the following: • demethylation might result in a gene being activated (1) • therefore transcription of the gene takes place, producing protein that causes change in the fibroblast cells (1)		(2)

Q3.

Question Number	Acceptable Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: • great potential importance or medical implications of the research (1) • this outweighs concerns around the use of { invertebrates due to less developed nervous system / embryos have no nervous system } (1)		(2)

Q4.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to two of the following: - because they are (fully) differentiated cells (1) - therefore genes needed (for other cell types) are (permanently) {switched off / silenced} (1) - therefore proteins needed by other cell types cannot be produced (1)	ACCEPT specialised ACCEPT not able to express certain genes	

Q5.

Question Number	Answer	Additional guidance	Mark
(a)	D		(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
(b)	A description that makes reference to the following: {fibroblasts / non-pluripotent cells / somatic cells} are used (1) {specific / reprogramming } {genes / transcription factors / miRNAs} are put into the cells (1) Plus one of the following: - credit named gene, e.g. Oct4 (Pou5f1), Sox2, cMyc, or Klf4 (1) - using a {vector / virus} (1) - cells are cultured (1)		(3)

Question Number	Acceptable Answer	Additional guidance	Mark
(c)	A description that makes reference to the following: - replace the dysfunctional cells with functional cells derived from iPS cells (1) - iPS cells are injected into the retina and then develop into normal retinal cells (1)		(2)

Q6.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to the following points: - examine cells from different tissues in the mature sea urchin, under a microscope (1) - cells descended from the repositioned cell are fluorescent due to traces of the dye injected (1)		(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: - the cell was (still) pluripotent (1) - therefore cell signalling in the new position could determine the fate of the cell (1) - causing activation of transcription factors for transcription of genes relevant to the new position (1) - leading to synthesis of proteins for development into different tissue (1)	Allow totipotent	(4)

Q7.

Question Number	Acceptable Answer	Additional guidance	Mark
(i)	An explanation that makes reference to the following: • mutation had removed defective gene but the cell continued to multiply (1) • therefore functioning white blood cells produced and immune system was restored to normal functioning (1)		(2)

Question Number	Acceptable Answer	Additional guidance	Mark
(ii)	An explanation that makes reference to the following: • fetal stem cells will be pluripotent (1) • therefore they are able to develop into a wider range of cell types (1)		(2)

Q8.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to five of the following, including at least one similarity or one difference : <u>Similarities:</u> - both have the potential to divide indefinitely (1) - both have the potential to differentiate into a number of cell types (1) <u>Differences:</u> - iPS cells were {adult cells / named example of adult cell} but embryonic stem cells are cells taken from the {morula / inner cell mass} (1) - iPS have a {gene / named gene} added but embryonic cells do not (1) - there are {no / less / different} ethical issues surrounding the use of iPS cells (1) - iPS cells can form adult cells whereas embryonic cells form younger cells (1) - iPS cells will produce patient-matched cells but embryonic stem cells will be antigenic (1)	NB do not piece together Accept have no Hayflick limit Accept to specialise e.g. fibroblasts, keratinocytes, kidney epithelium, blood cells Accept blastomeres / early embryo (up to 14 days) e.g. Oct4, Sox2, cMyc, Klf4 Accept there will be rejection issues using embryonic stem cells but not using iPS cells	(5)

Q9.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to two of the following: - to produce lots of {genetically identical / hybridoma} cells (1) - so that lots of antibodies (of one type) can be produced (by hybridoma cells) (1) - so that the hybridoma cells can divide (1)	Accept because a {fully-differentiated / antibody-producing / plasma} cell cannot divide	(2)