

PEARSON EDEXCEL A-LEVEL BIOLOGY B • 9B10

BIOLOGY



EXAM QUESTION PACK

TOPIC 7: MODERN GENETICS
FACTORS AFFECTING GENE EXPRESSION

SCORE

/63

PERCENTAGE

%

STEMUP

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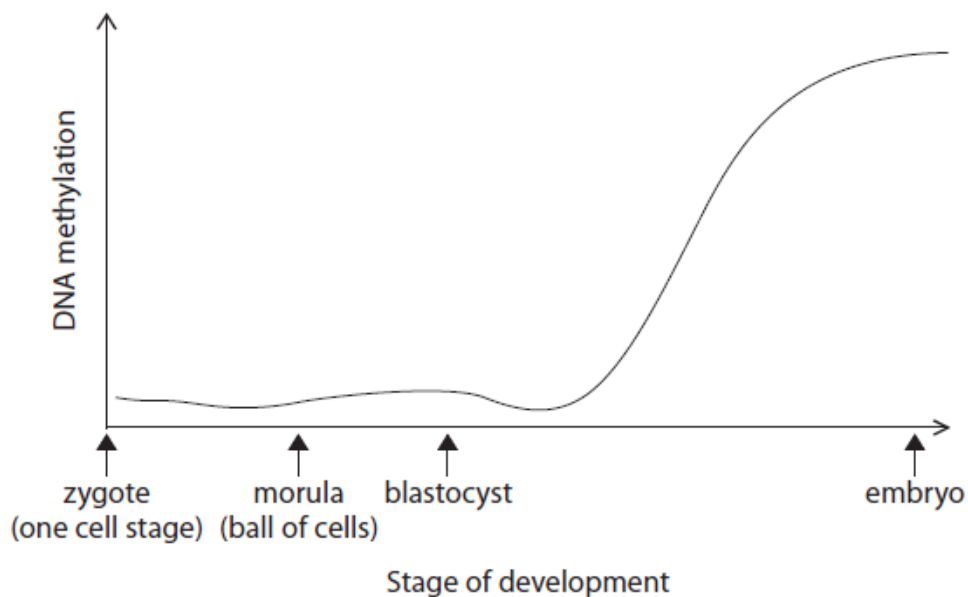
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Q1.

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.

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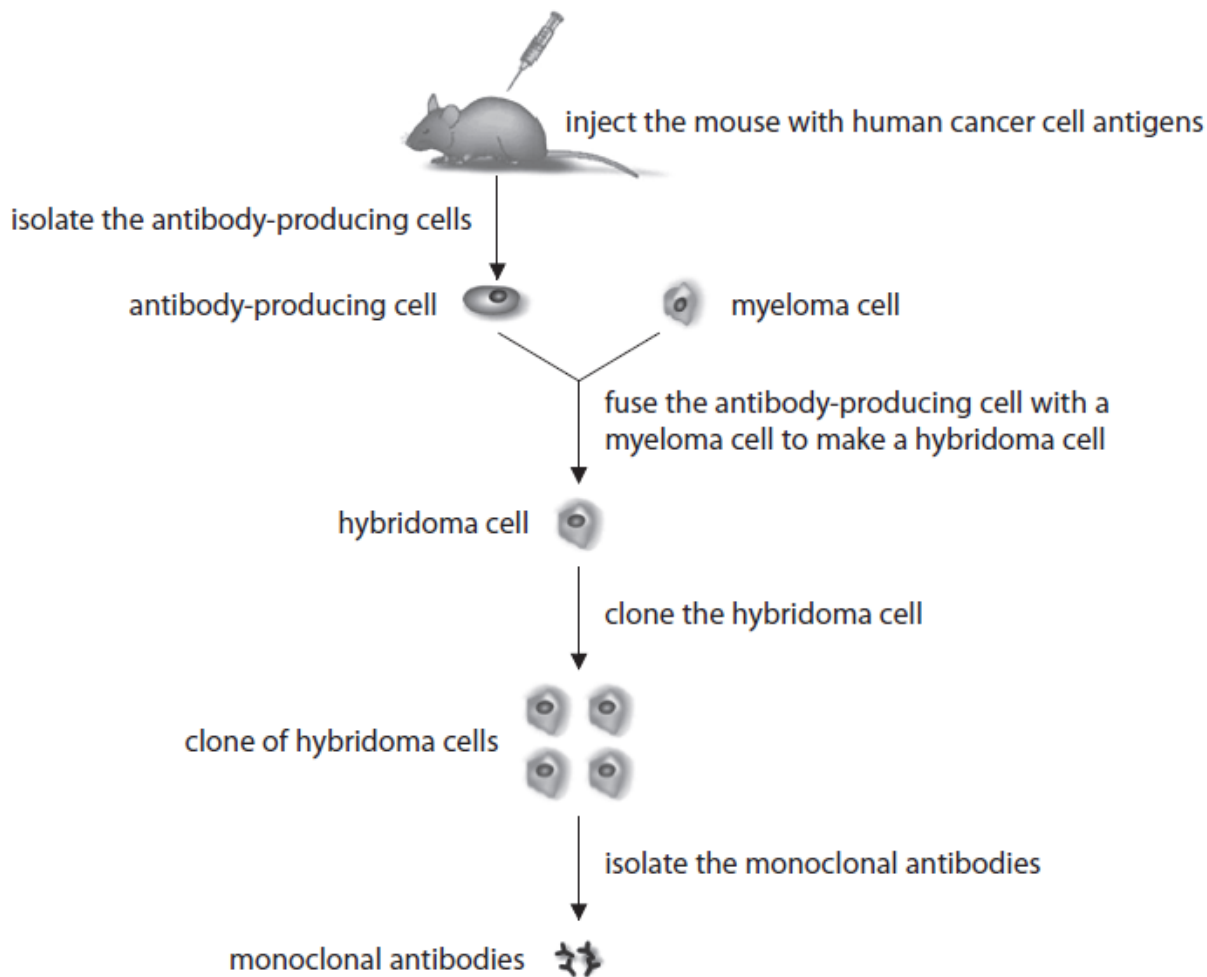
(Total for question = 6 marks)

Q2.

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.



Epigenetic modification is involved in the formation of the antibody-producing cells.
Describe epigenetic modification.

(3)

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(Total for question = 3 marks)

Q3.

Hypoxia is an inadequate supply of oxygen to tissues and cells that restricts their function.

The body responds to hypoxia by releasing hypoxia-inducible transcription factors (HIF).

Investigations have shown that one effect of HIF is an increase in the rate of glycolysis in the affected cells.

(i) Explain how HIF could result in an increase in the rate of glycolysis.

(2)

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(ii) Explain why cells need to respond to hypoxia with an increase in the rate of glycolysis.

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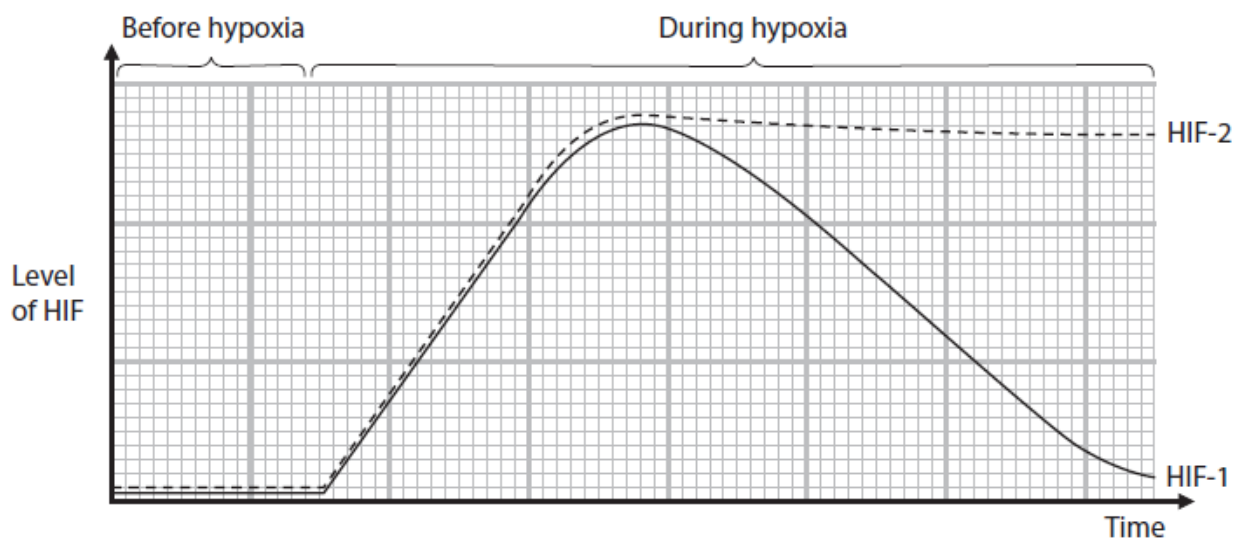
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(iii) The graph shows the changes in levels of two HIFs, HIF-1 and HIF-2, before and during hypoxia.



Compare and contrast the changes in the levels of HIF-1 and HIF-2 during hypoxia.

(2)

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(iv) Explain the changes in levels of HIF-1 and HIF-2 during hypoxia.

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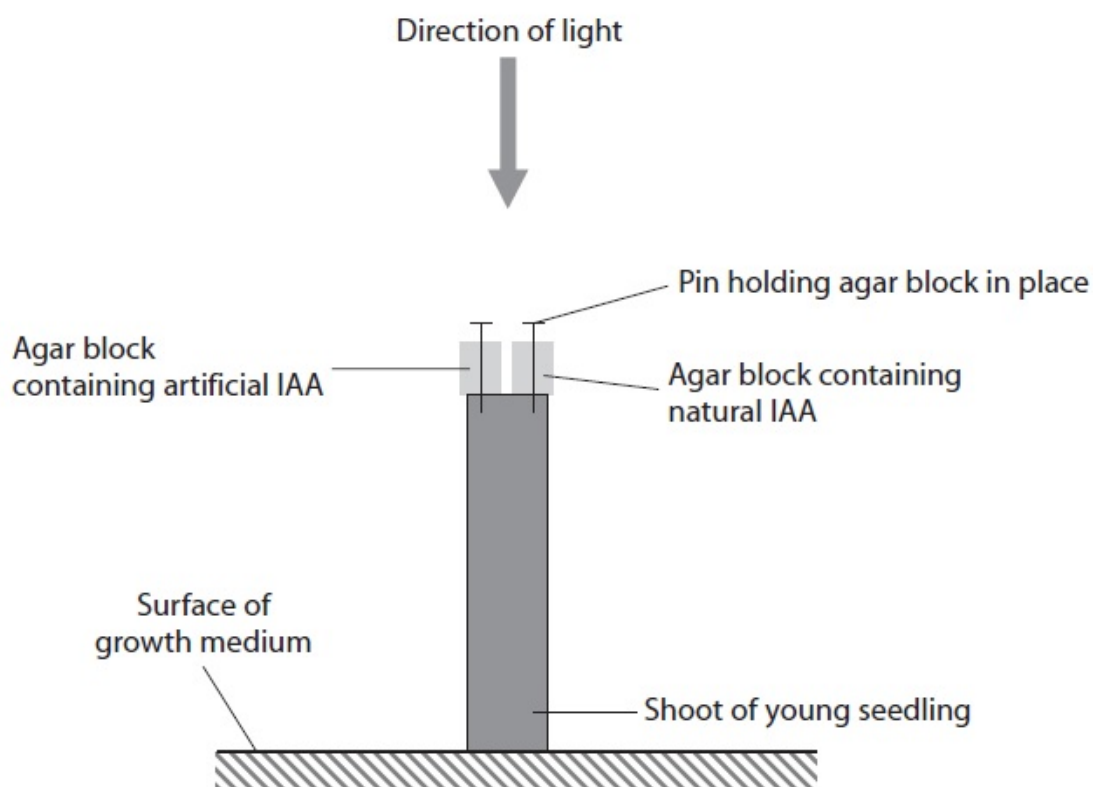
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(Total for question = 10 marks)

Q4. IAA (auxin) is a plant growth substance.

(a) A student investigated the effect of natural IAA and artificial IAA on shoot growth.

The diagram below shows how she set up her investigation.



(i) The student also set up a control.

Describe a suitable control for this investigation.

(1)

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(ii) After 48 hours, the student recorded her observations of the growth of the shoots. From her observations, she concluded that both natural and artificial IAA affected growth. She also concluded that the artificial IAA had a greater effect than the natural IAA.

Suggest what she recorded and explain how the IAA in the agar affected the growth of the shoot.

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(b) IAA is known to bind to transcription factors.

Suggest how IAA can stimulate cells to synthesise proteins.

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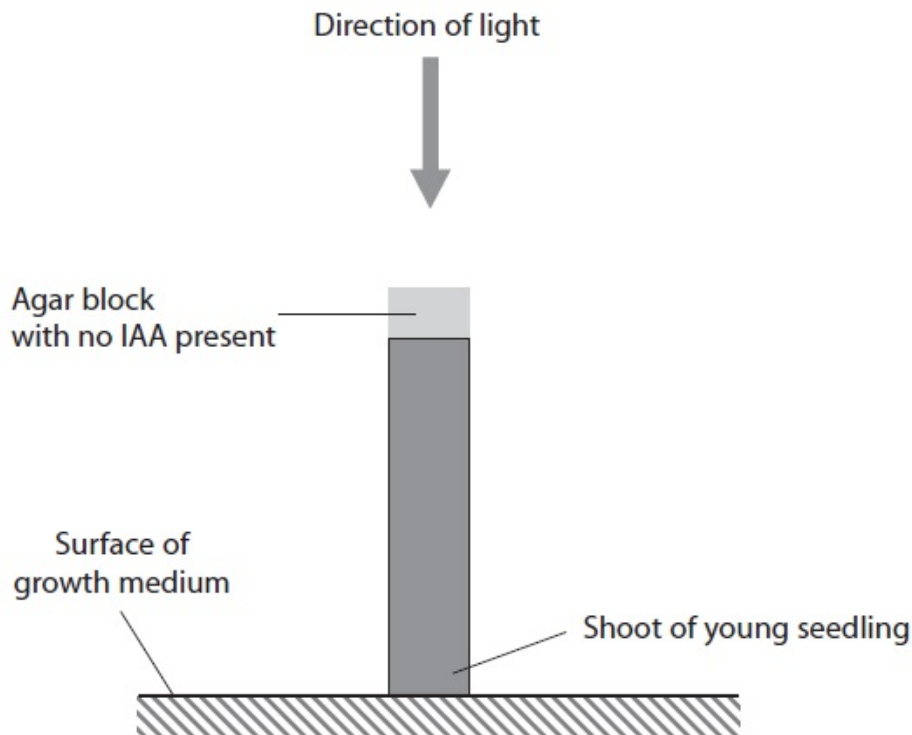
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(Total for Question = 10 marks)

Q5. IAA (auxin) is a plant growth substance.

(a) A student investigated the effect of different concentrations of IAA on shoot growth.

The diagram below shows how she set up her control.



(i) Describe the role of the control in this investigation.

(1)

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(ii) After 48 hours, the student recorded her observations of the growth of the shoots.

From her observations, she concluded that IAA affected growth. She also concluded that a higher concentration of IAA had a greater effect.

Suggest what she recorded and explain how the IAA in the agar affected the growth of the shoots.

(5)

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(b) IAA can interact with transcription factors to stimulate cells to produce proteins.

Suggest how the presence of IAA can cause cells to produce proteins.

(4)

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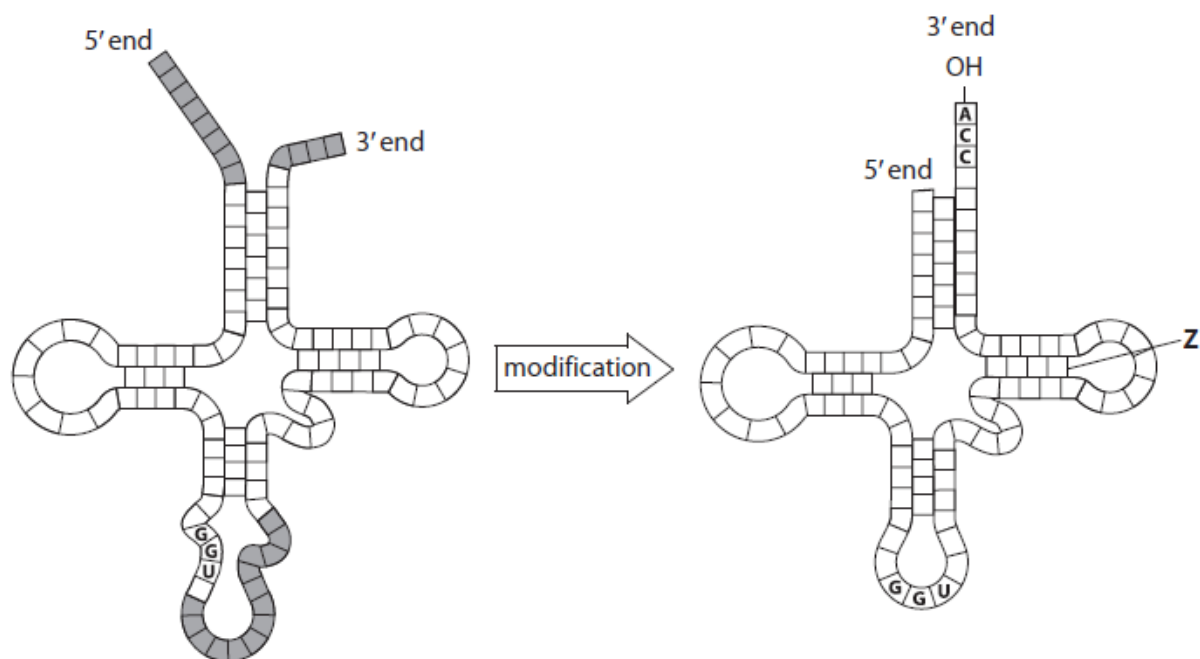
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(Total for Question = 10 marks)

Q6.

A molecule of tRNA is made from a precursor molecule that is modified. Modification includes splicing, trimming and attachment of new nucleotides.

The diagram shows a precursor molecule for a tRNA specific for the amino acid proline, and a tRNA molecule specific for the amino acid proline. Some of the bases are shown in each diagram.



precursor molecule

tRNA molecule specific for the amino acid proline

Describe how this precursor molecule is modified to produce a tRNA molecule specific for the amino acid proline.

(3)

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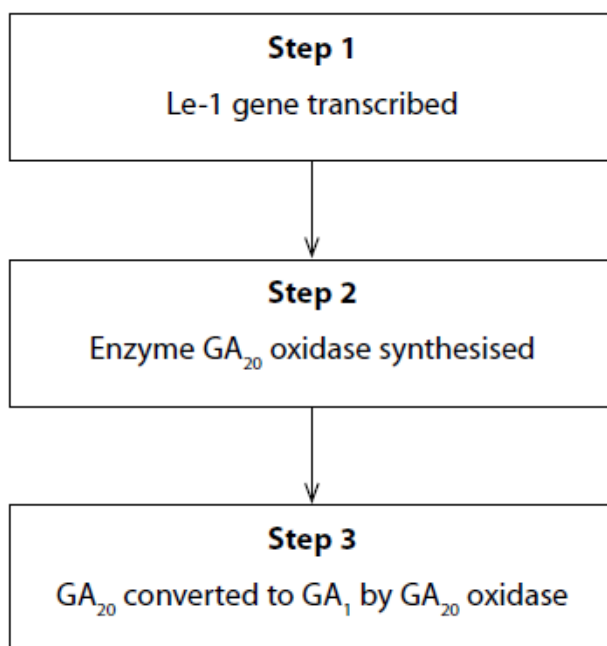
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(Total for question = 3 marks)

Q7.

The diagram shows some stages in the production of blood cells from bone marrow stem cells.

The diagram below shows part of the biochemical pathway leading to the synthesis of an active plant growth substance called gibberellin (GA_1). GA_1 reduces the effect of 'DELLA' proteins.



(a) The Le-1 gene codes for the enzyme GA_{20} oxidase. A mutation of this gene forms a recessive allele which, when translated, leads to a single amino acid change in this enzyme. This change significantly reduces the activity of GA_{20} oxidase.

Explain how a single amino acid change can bring about a change in the structure and activity of GA_{20} oxidase.

(4)

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(b) (i) Explain why homozygous recessive plants will have short stems.

(4)

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(ii) An ecological survey of a stable population of one species of plant found that 36% had short stems.

Calculate the percentage of heterozygous individuals in this population.
Assume that there are only two alleles for this gene.

(4)

Answer

(Total for question = 12 marks)

Q9.

The scientific article you have studied is adapted from articles in *Nature* and *Scientific American*.

Use the information from the article and your own knowledge to answer the question.

'While the manipulated individual may look like an ant, it represents a fungal genome expressing fungal behaviour through the body of an ant' (paragraph 33).

Suggest how fungal genes may be expressed and affect the behaviour of these ants.

(5)

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)		

Question Number	Answer	Additional Guidance	Mark
	A description that makes reference to the following: - changes that affect gene {expression / activation} (1) - credit an example of epigenetic modification (1) - involved in {differentiation / change in function / change in proteins synthesised } (1)	Do not accept altering the DNA / base sequence / genetic code e.g. DNA methylation, histone {modification / methylation / acetylation} / chromatin remodelling / non-coding RNA / transcription factors Accept when a B cell becomes a plasma cell	(3)

Q3.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to two of the following: - because HIF can switch on gene (expression) (1) - bind to a promotor region / stimulate transcription / stimulate protein synthesis} (1) - for {enzymes / proteins} involved in glycolysis (1)	ACCEPT increased gene expression ACCEPT increase rate of transcription IGNORE enzymes ACCEPT named {enzyme / protein} involved in glycolysis e.g. enzyme that makes NAD IGNORE NAD otherwise	(2) EXP
Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: (because if conditions are hypoxic) there is not much oxygen available to act as a terminal electron acceptor (1) - therefore the electron transport chain will not operate (1) - therefore ATP production by oxidative phosphorylation will be reduced (1)	ACCEPT no oxygen IGNORE numbers of ATP molecules produced	(4) EXP

	ATP is produced (directly / SLP) during glycolysis (during these anaerobic conditions) (1)		
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Question Number	Answer	Additional Guidance	Mark
(iii)	An answer that makes reference to the following: - both HIF-1 and HIF-2 increase (during hypoxia) (1) - levels of HIF-2 remain high (after a small decrease) but levels of HIF-1 fall (1)	DO NOT PIECE TOGETHER IGNORE any explanations given	(2) EXP

Question Number	Answer	Additional Guidance	Mark
(iv)	An explanation that makes reference to two of the following: - HIF-1 and HIF-2 switch on different genes (1) {products / transcription of genes} resulting from the presence of both HIF-1 and HIF-2 are needed in the early stages of hypoxia (1) {products / transcription of gene} resulting from the presence of HIF-2 are needed {for longer periods of hypoxia / to sustain glycolysis} (1)	ACCEPT bind to different promotor regions ACCEPT converse for HIF-1	(2) EXP

Q4.

Question Number	Answer	Additional guidance	Mark
(a) (i)	(cut shoot) without IAA present / without agar blocks ;	ACCEPT - agar block with no IAA, empty agar block, agar block with water ACCEPT - auxin(s) as alternative to IAA	(1)

Question Number	Answer	Additional guidance	Mark
(a) (ii)	1. (both sides of) shoot taller / eq ; 2. than the control / eq ; 3. both IAA's diffuse {down / out of agar / to zone of elongation} / eq ; 4. reference to cell elongation / eq ; 5. details of cell elongation / eq ; 6. shoot bends to the right / eq ; 7. (due to) more growth on {left side of shoot / side with artificial IAA} / eq ;	ACCEPT - auxin as alternative to IAA throughout ACCEPT 1 – grow {taller/higher/up/ towards the light} ACCEPT 3 – away from the light/agar block ACCEPT 6 - bends away from side with artificial IAA	(5)

Question Number	Answer	Additional guidance	Mark
(b)	1. idea that IAA enters the cell ; 2. reference to movement within cell / IAA in cytoplasm to nucleus ; 3. effect when binds to transcription factor e.g. forms a transcription initiation complex or countering an inhibitor ; 4. reference to switching on gene ; 5. activity at promoter region / eq ; 6. allows formation of (m)RNA / eq ; 7. idea of translation produces protein ;	ACCEPT - auxin as alternative to IAA throughout ACCEPT 3 - joins to promoter region or activates transcription factor ACCEPT 5 – ref to RNA polymerase activity	(4)

Q5.

Question Number	Answer	Additional Comments	Mark
(a) (i)	As a comparison / to show that IAA required for growth ;		(1)

Question Number	Answer	Additional Comments	Mark
(a) (ii)	1. recorded {height / eq} of the shoots / eq ; 2. calculated difference in heights / eq ; 3. shoots with IAA are taller than control / eq ; 4. because IAA diffuse {down / out of agar / to zone of elongation} ; 5. causing cell elongation ; 6. details of cell elongation ; 7. idea of higher IAA concentration causes more growth ; 8. (due to) more cell elongation ;	ACCEPT auxin as alternative to IAA throughout 1. Accept length 4. Accept away from the light/agar block or goes into shoot 6. Accept change in pH, H ions, H bonds, plasticity	(5)

Question Number	Answer	Additional Comments	Mark
(b)	1. Idea of IAA at cell surface membrane e.g. binds to receptors ; 2. idea of movement within cell e.g. secondary messengers, IAA moves to the nucleus ; 3. detail of interaction with transcription factor ; 4. idea of switching on gene ; 5. Activity at promoter region / eq ; 6. Allows formation of (m)RNA ; 7. Idea of translation produces protein ;	Accept auxin as alternative to IAA throughout 1. Accept IAA enters the cell 3. Accept e.g. binds to a TF, activates TF, forms transcription initiation complex, binds to or counters an inhibitor 4. Accept binds to promoter region 5. Accept RNA polymerase activity 6. Accept preRNA, rRNA Ignore ref to tRNA 7. Ignore translation of protein	(4)

Q6.

Question Number	Answer	Additional Guidance	Mark
	A description that makes reference to the following: - removal of the {shaded nucleotides / introns} (1) - attachment of ACC (and OH) (1) - joining with phosphodiester bonds (1)	ACCEPT shaded {parts / areas} ACCEPT adding {acceptor stem / amino acid binding site}	(3)

Q7.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to four of the following: - by epigenetic modification (1) - for example by {DNA methylation / histone methylation / histone acetylation} (1) {house-keeping genes / genes needed in both cell types} remain switched on (1) - genes needed in {common lymphoid progenitor / lymphoid} cells become (permanently) switched off (1) - causing {proteins / named protein} to be made that are specific to the {cell type / named cell} (1)	ACCEPT descriptions / post-transcriptional modification transcription of genes switched on / no transcription of genes switched off ACCEPT converse ACCEPT converse credit a named example of a gene which may be switched {on / off} e.g. gene coding for cytokines in T lymphocytes NB genes become switched on or off = 1 mark, if no other marks awarded	(4)

Q8.

Question Number	Correct Answer	Additional guidance	Mark
(a)	An explanation that makes reference to the following: • {Active site changes shape / not correctly formed} and no longer an efficient 'fit' to substrate (1) • because if one amino acid is changed then these bonds cannot form (1) • because only certain amino acids (e.g. cysteine needed for S –S bonding) can form disulphide bridges/hydrogen bonds/ionic bonds (1) • and these bonds are important in the formation of a tertiary/3D protein structure (1)		(4)

Question Number	Correct Answer	Additional guidance	Mark
(b)(i)	An explanation that makes reference to the following: • (reduced activity of GA₂₀ oxidase means) less active GA₂₀ is produced (1) • therefore less GA₂₀ means more DELLA proteins present (1) • hence more DELLA proteins means fewer transcription factors binding to growth regulator genes (1) • therefore resulting in growth regulator genes not expressed / growth less because transcription factors needed for expression of genes (1)	Less DELLA protein broken down	(4)

Question Number	Correct Answer	Additional guidance	Mark
(b)(ii)	• equation $p^2 + 2pq + q^2 = 1$ (1) • $p^2 = 0.36$ so $p = 0.6$ (1) • $q = 0.4$ so $2pq = 2 \times 0.6 \times 0.4$ (1) • correct answer 48% (1)		(4)

Q9.

Question Number	Answer	Additional guidance	Mark
	- reference to transcription factors ; - bind to promoter region / form a transcription initiation complex / eq ; - RNA polymerase can bind /eq ; - mRNA made ; - idea of translation occurring ; - at ribosomes / on the RER / in the cytoplasm ; - idea of function of product e.g. inhibits normal ant behaviour / stimulates abnormal ant behaviour / description of abnormal behaviour given ; - idea of product affecting nervous system ;	ACCEPT gene switched on ACCEPT protein/poly peptide produced	(5)