

Questions

Q1.

Haemophilia is a condition that results in excessive bleeding due to a lack of blood clotting factors such as factor 8.

It is an X-linked recessive condition and one cause is a mutation to the F8 gene.

There are 2931 mutations to the F8 gene that have been identified.

Haemophilia can also be caused by a mutation to the F9 gene.

There are 1133 mutations to the F9 gene that have been identified.

Haemophilia is not classed as a polygenic disorder.

(i) Give the meaning of the term polygenic.

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(ii) There are 575 identified mutations to the F9 gene that cause severe symptoms of haemophilia.

The same percentage of these types of mutation is found in the F8 gene.

Calculate the number of mutations to the F8 gene that produce severe symptoms.

(2)

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(Total for question = 4 marks)

Edexcel Biology A-level - Stem Cells and Epigenetics

Q2.

Fertilisation in humans involves the fusion of a sperm cell with an egg cell.

Factors such as the diet of the mother during pregnancy can cause epigenetic changes in the embryo.

Explain how epigenetic changes affect the development of tissues in the embryo.

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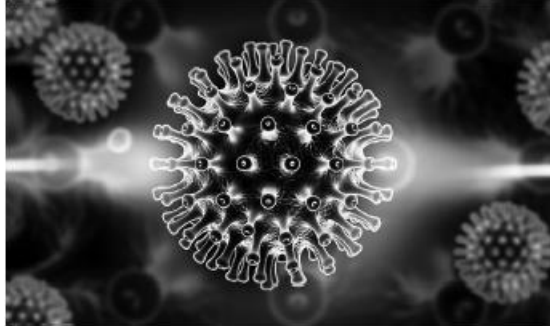
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(Total for question = 3 marks)

Edexcel Biology A-level - Stem Cells and Epigenetics

Q3.

The human immunodeficiency virus (HIV), shown in the image, causes acquired immunodeficiency syndrome (AIDS).



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A small number of people have been identified who are resistant to HIV.

They have a mutation in a gene coding for a protein in the cell membrane.

(i) Deduce why this mutation makes these people resistant to HIV infection.

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(ii) Stem cell therapy can be used to treat patients infected with HIV.

The bone marrow of these patients can be destroyed using radiotherapy.

The patients can then be given stem cells from the bone marrow of a donor who has this mutation.

Explain why these stem cells may prevent HIV causing AIDS.

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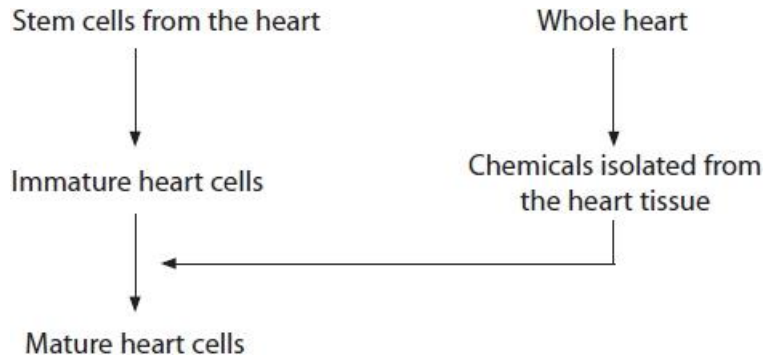
Edexcel Biology A-level - Stem Cells and Epigenetics

Q4.

Stem cells can be used to repair damaged organs.

Stem cells from the heart can be used to produce mature heart cells.

The diagram below shows one method used to produce mature heart cells.



The whole heart contains cardiac muscle tissue. The whole heart is an organ.

Give one difference between a tissue and an organ.

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(Total for question = 1 mark)

Edexcel Biology A-level - Stem Cells and Epigenetics

Q5.

Stem cells can be used to repair damaged organs.

Human embryos are another source of stem cells used in medical therapies.

Describe the decisions that society has to make about the use of these embryonic stem cells.

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(Total for question = 3 marks)

Edexcel Biology A-level - Stem Cells and Epigenetics

Q6.

Fertilisation in humans involves the fusion of a sperm cell with an egg cell.

Cell division of the fertilised cell produces a ball of totipotent cells.

(i) Give the meaning of the term totipotent cell.

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(ii) This ball of cells continues to divide to form the embryo. The cells of the embryo become specialised to form tissues and organs.

Describe how cells become specialised.

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(Total for question = 5 marks)

Edexcel Biology A-level - Stem Cells and Epigenetics

Q7.

Stem cells can be used to repair damaged organs.

Part of the eye contains stem cells. These cells can be used to repair damaged corneas in the eye.

(i) Explain why stem cells from the heart cannot be used to grow cells to repair the cornea.

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(ii) Explain why chemicals from the eye are needed to produce corneal cells from a suitable source of stem cells.

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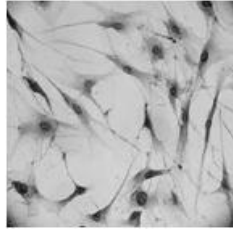
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Edexcel Biology A-level - Stem Cells and Epigenetics

Q8.

In humans, different types of stem cell are found in the bone marrow.

The photograph shows some mesenchymal stem cells from bone marrow.



Mesenchymal stem cells can differentiate to give rise to a variety of cell types, including bone cells, cartilage cells, muscle cells and fat cells.

The skeletal system consists of bone tissue, muscle tissue and cartilage tissue.

Deduce why age affects the time taken to recover from injuries.

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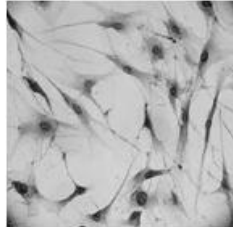
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Edexcel Biology A-level - Stem Cells and Epigenetics

Q9.

In humans, different types of stem cell are found in the bone marrow.

The photograph shows some mesenchymal stem cells from bone marrow.

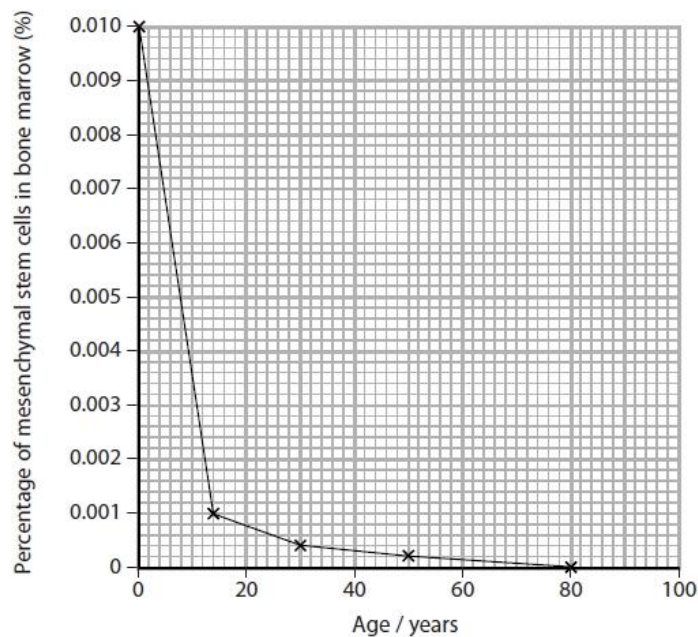


Mesenchymal stem cells can differentiate to give rise to a variety of cell types, including bone cells, cartilage cells, muscle cells and fat cells.

The skeletal system consists of bone tissue, muscle tissue and cartilage tissue.

The proportion of mesenchymal stem cells to other cells in the bone marrow changes with age.

The graph shows the relationship between age and the percentage of mesenchymal stem cells in bone marrow.



Calculate the rate at which the percentage of mesenchymal stem cells in the bone marrow changes between the ages of 14 and 30.

(2)

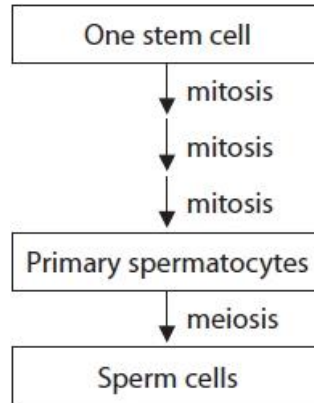
Answer % y^{-1}

(Total for question = 2 marks)

Edexcel Biology A-level - Stem Cells and Epigenetics

Q10.

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)

Edexcel Biology A-level - Stem Cells and Epigenetics

Q11.

Duchenne muscular dystrophy (DMD) is a sex-linked disorder.

(i) Explain what is meant by the term sex-linked disorder.

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(ii) Explain why the genotype frequency for males with DMD cannot be calculated using this Hardy-Weinberg equation.

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(iii) Dystrophin is a protein needed to maintain the structure of muscle cells.

In DMD the affected allele prevents the production of this protein, leading to symptoms that include a progressive effect on muscle tissue.

Stem cells are a potential treatment for DMD.

Explain why stem cells from a healthy donor may provide a treatment for this disorder.

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(Total for question = 7 marks)

Edexcel Biology A-level - Stem Cells and Epigenetics

Q12.

Epigenetic changes can cause monozygotic twins to have different body masses.

Explain how epigenetic changes can cause differences in a characteristic.

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(Total for question = 3 marks)

Edexcel Biology A-level - Stem Cells and Epigenetics

Q13.

As pluripotent stem cells divide, epigenetic changes are passed on.

Explain how epigenetic changes affect the activation of genes in daughter cells.

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(Total for question = 3 marks)

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Q14.

Explain why an individual may have a greater adult height than their biological parents.

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(Total for question = 4 marks)

Edexcel Biology A-level - Stem Cells and Epigenetics

Q15.

The body mass of a group of monozygotic (MZ) twins was studied for 19 years. The correlation between the body masses of each set of twins was calculated. This was repeated for a group of dizygotic (DZ) twins.

If a set of twins had the same body mass, they would have a correlation of 100%.

The results are shown in the graph.



Comment on the effect of genetic and environmental factors in determining the body mass of the twins shown in the graph.

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(Total for question = 4 marks)

Edexcel Biology A-level - Stem Cells and Epigenetics

Q16.

A study was carried out to determine the incidence of VTE in people of different ages. Those who developed VTE were then tested for the factor V gene mutation.

The results of this study are shown in the table.

Age range	Percentage incidence of VTE in the study group (%)	Percentage of VTE patients with factor V mutation in the study group (%)
less than 20 years of age	1.3	49.3
over 70 years of age	34.0	20.9

Deduce the relative impact of the genotype and environmental factors on the development of VTE.

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(Total for question = 4 marks)

Edexcel Biology A-level - Stem Cells and Epigenetics

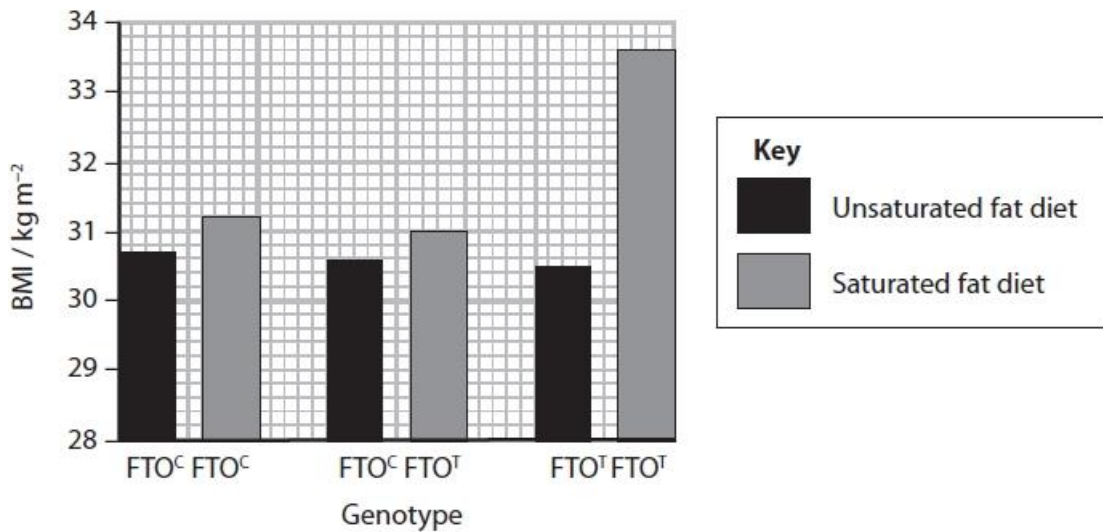
Q17.

Obesity can be affected by both genetic and environmental factors. An indicator of obesity is the body mass index (BMI).

The effects of a gene called FTO, saturated fats and physical exercise on BMI were investigated.

There are two alleles (FTO^T and FTO^C) at the FTO locus.

The effects of saturated fats in the diet on the BMI in individuals with different FTO genotypes are shown in the graph.



Deduce the effect of environmental and genetic factors on BMI.

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(Total for question = 3 marks)

Edexcel Biology A-level - Stem Cells and Epigenetics

Q18.

Answer the question with a cross in the box you think is correct . If you change your mind about an answer, put a line through the box and then mark your new answer with a cross .

Body mass in humans is a polygenic characteristic.

The best definition of a polygenic characteristic is one that involves

- A** a single allele at a single locus
- B** a single allele at multiple loci
- C** multiple alleles at a single locus
- D** multiple alleles at multiple loci

(1)

(Total for question = 1 mark)

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Q19.

Lupus is a genetic condition that has various symptoms.

There are several different genes involved in the development of the disease. The symptoms that develop vary depending on genetic and environmental factors.

Stress and exposure to chemicals in the environment can influence the development of lupus.

(i) What is the term that refers to the pattern of inheritance where a single characteristic is determined by more than one gene?

(1)

- A epigenetic
- B monogenic
- C polygenic
- D sex-linked

(ii) Which of the following is another environmental factor that could affect the development of lupus?

(1)

- A age
- B diet
- C gender
- D height

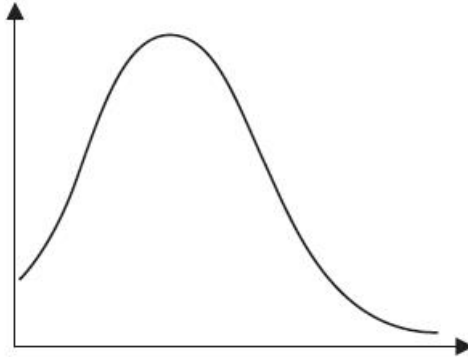
(Total for question = 2 marks)

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Q20.

Answer the questions with a cross in the boxes you think are correct . If you change your mind about an answer, put a line through the box and then mark your new answer with a cross .

Many characteristics within a population show a pattern of variation, similar to the one shown in the graph.



(i) The peak of the curve in the graph is the

(1)

- A mean
- B median
- C mode
- D standard deviation

(ii) Which one of these phenotypes shows a pattern of continuous variation?

(1)

- A blood group
- B body mass
- C eye colour
- D gender

(Total for question = 2 marks)

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Q21.

The saiga antelope is found in the grasslands of Eurasia. In the 1970s its population was 1 250 000. The population has decreased due to loss of habitat and a disease outbreak in 2015.

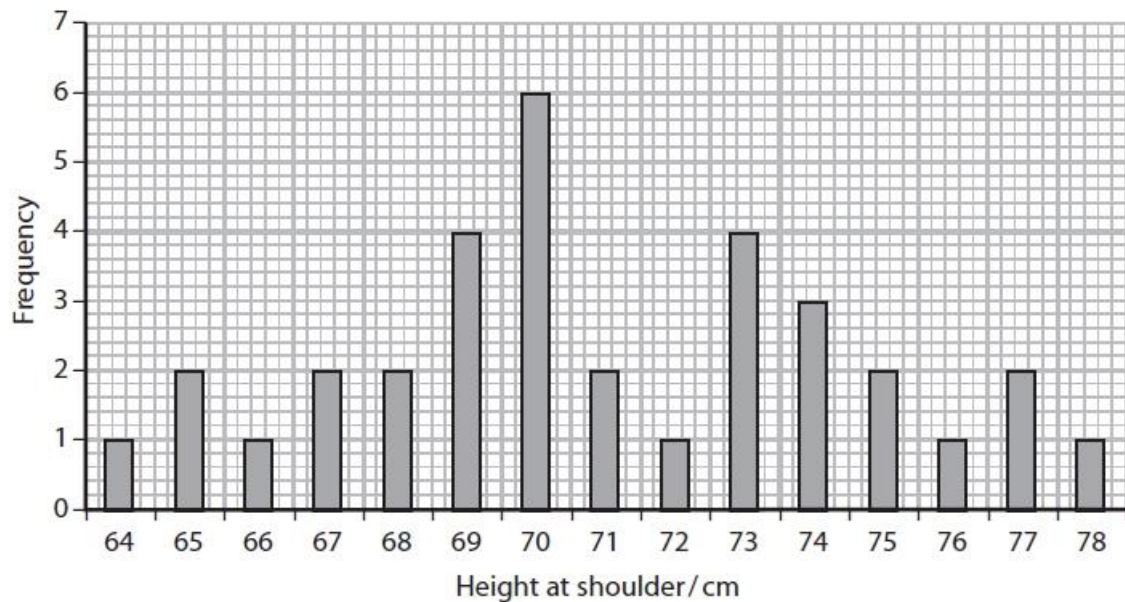
Population estimates suggest as few as 50 000 individuals remain.

Conservation efforts aim to ensure that the population recovers to previous levels.



Endangered animals are monitored to determine the diversity and viability of the population.

The height of 34 saiga antelopes is shown in the graph.



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(i) State how the graph provides evidence that this characteristic shows polygenic inheritance.

(1)

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(ii) Height in animals is determined by polygenic inheritance.

Which is a description of polygenic inheritance of height?

(1)

- A** controlled by a large number of alleles of one gene
- B** controlled by more than one gene
- C** controlled by one gene from each parent
- D** controlled by one gene and the environment

(iii) State and justify the mode for height of the saiga antelope.

(2)

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(Total for question = 4 marks)

Edexcel Biology A-level - Stem Cells and Epigenetics

Q22.

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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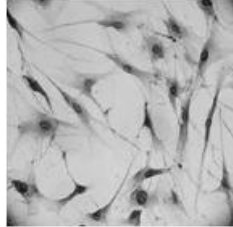
(Total for question = 4 marks)

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Q23.

In humans, different types of stem cell are found in the bone marrow.

The photograph shows some mesenchymal stem cells from bone marrow.



Mesenchymal stem cells can differentiate to give rise to a variety of cell types, including bone cells, cartilage cells, muscle cells and fat cells.

The skeletal system consists of bone tissue, muscle tissue and cartilage tissue.

(i) Describe how a tissue differs in structure from a system.

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(ii) Describe how mesenchymal stem cells can give rise to different types of cell.

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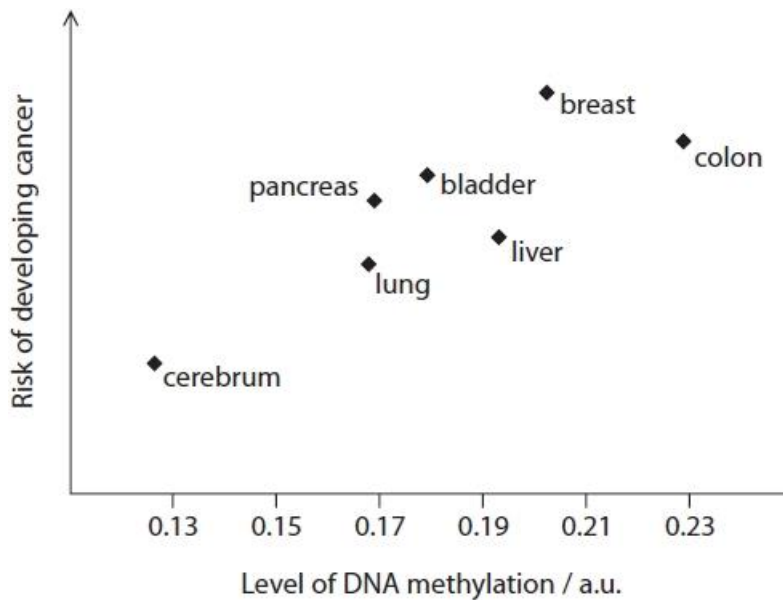
(Total for question = 6 marks)

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Q24.

There is a link between the methylation of certain regions of DNA and the risk of developing cancer.

The graph shows the relationship between the level of methylation of these regions of DNA and the risk of developing cancer in different parts of the body by the age of 70.



(i) Draw a line of best fit on the graph to identify any correlation between the independent variable and the dependent variable.

(1)

(ii) An investigation studied the effect of age on the mean level of DNA methylation. In this investigation, the null hypothesis was rejected at the 5% significance level. Explain what is meant by the phrase: the null hypothesis was rejected at the 5% significance level for this investigation.

(2)

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Edexcel Biology A-level - Stem Cells and Epigenetics

*(iii) Scientists have found that a high level of succinate leads to the inhibition of an enzyme called TET.

The function of TET is to remove methyl groups from DNA.

Explain how a mutation in the gene for succinate dehydrogenase can increase the risk of developing cancer.

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(Total for question = 9 marks)

Edexcel Biology A-level - Stem Cells and Epigenetics

Mark Scheme

Q1.

Question Number	Answer	Additional guidance	Mark
(i)	<p>A description that makes reference to the following:</p> <ul style="list-style-type: none"> • a characteristic showing continuous variation (1) • caused by multiple genes at different loci (1) 		(2)
Question Number	Answer	Additional guidance	Mark
(ii)	<ul style="list-style-type: none"> • calculation of percentage of F9 mutations that cause severe symptoms (1) • same percentage used to calculate number of F8 mutations causing severe symptoms (1) 	<p>Example of calculation</p> $575 \div 1133 = 0.5075 / 0.51$ <p>51% ALLOW 50.75%</p> 2931×0.51 <p>= 1495 ALLOW 1487 or 1488</p> <p>Correct answer with no working gains full marks</p>	(2)

Q2.

Question Number	Answer	Additional guidance	Mark
	<p>An explanation that makes reference to three of the following</p> <ul style="list-style-type: none"> • DNA (in a chromosome) is wrapped around histones (1) • {acetylation / modification} of the histone affects {binding of RNA polymerase / chromosome unwinding} (1) • methylation of DNA affects {transcription of genes / production of mRNA} (1) • therefore gene expression is altered (1) 	<p>ALLOW different proteins are synthesised</p>	(3)

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Q3.

Question Number	Answer	Additional guidance	Mark
(i)	<p>An answer that makes reference to two of the following:</p> <ul style="list-style-type: none"> the protein is a receptor in the cell surface membrane of T helper cells (1) { glycoprotein / GP120 } is unable to bind with the (CD4)receptor (on the host cell) (1) viral RNA cannot enter the cell (1) 	<p>ALLOW the receptor that HIV binds to</p> <p>ALLOW HIV cannot enter the cell</p>	(2)

Question Number	Answer	Additional guidance	Mark
(ii)	<p>An explanation that makes reference to four of the following:</p> <ul style="list-style-type: none"> stem cells (from the bone marrow) can differentiate into specialised cells (1) the stem cells will differentiate into T helper cells that { are resistant to HIV / have the mutated protein } (1) T helper cells are destroyed by HIV so the patient cannot produce an immune response (1) mutated (CD4) receptor prevents HIV entering the (replacement) T helper cells (1) T helper cells are not destroyed therefore { HIV is not present in the blood / AIDS does not develop } (1) 		(4)

Q4.

Question Number	Answer	Additional guidance	Mark
	<ul style="list-style-type: none"> a tissue is made of one type of cell and an organ is made of different tissues 	ALLOW descriptions of tissue and organ	(1)

Edexcel Biology A-level - Stem Cells and Epigenetics

Q5.

Question Number	Answer	Additional guidance	Mark
	<p>A description that makes reference to three of the following:</p> <ul style="list-style-type: none"> embryonic stem cells are totipotent and can be used in a wider range of therapies (1) source of embryonic stem cells has to be {considered / regulated} (1) {moral / ethical} issues as the use of embryonic stem cells destroys embryos (1) need for research establishments to be {regulated / licensed} (1) 		(3)

Q6.

Question number	Answer	Additional guidance	Mark
(i)	<p>An answer that makes reference to the following</p> <ul style="list-style-type: none"> a cell that has the ability to differentiate (1) into all cell types (1) 	ALLOW specialise/give rise to	(2)

Question Number	Answer	Additional guidance	Mark
(ii)	<p>A description that makes reference to the following</p> <ul style="list-style-type: none"> {chemical} signals cause some genes to be {activated/switched on} (1) only activated genes {are transcribed / produce mRNA} (1) {mRNA leads to} synthesis of specific proteins which cause cell modification (1) 	<p>ALLOW reference to {activators/transcription factors} and genes</p> <p>ALLOW proteins determine the structure of the cell</p>	(3)

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Q7.

Question Number	Answer	Additional guidance	Mark
(i)	<p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> • cells are not totipotent (1) • therefore some genes have already been activated and deactivated (1) • therefore, will not be able to specialize into cornea cells (1) 	<p>ALLOW cells are only pluripotent</p> <p>ALLOW some genes have already been switched on or off</p> <p>ALLOW will only be able to become a specific selection of cells</p>	(3)

Question Number	Answer	Additional guidance	Mark
(ii)	<p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> • chemicals cause some genes (related to the cornea) to be {activated/switched on} (1) • these genes are transcribed producing specific mRNA (1) • specific mRNA is translated into specific proteins (1) • these proteins cause the cell to develop into a corneal cell (1) 	<p>Allow reference to genes being deactivated/switched off</p>	(4)

Q8.

Question Number	Answer	Additional Guidance	Mark
	<p>An answer that makes reference to the following:</p> <ul style="list-style-type: none"> • time will increase (with age) (1) • due to fewer (mesenchymal) stem cells (in bone marrow) with age (1) • (fewer mesenchymal stem cells) to replace cells in {bone / muscle / cartilage} tissues (1) 		(3)

Edexcel Biology A-level - Stem Cells and Epigenetics

Q9.

Question Number	Answer	Additional Guidance	Mark
	<ul style="list-style-type: none"> correct figures from the graph correct answer 	<p><u>Example of calculation</u></p> <p>0.001 and 0.0004</p> <p>$0.0006 \div 16$ $= 0.0000375 / 3.75 \times 10^{-5} (\% \text{ y}^{-1})$</p> <p>IGNORE minus sign in answer</p> <p>Correct answer with no working gains full marks</p>	(2)

Q10.

Question Number	Answer	Additional Guidance	Mark
(i)	<p>An answer that makes reference to two of the following:</p> <ul style="list-style-type: none"> a cell that is undifferentiated that can give rise to specialised cells that can divide to produce more stem cells 	<p>ALLOW unspecialised cell</p> <p>ALLOW differentiated cells</p> <p>ALLOW can divide continuously / have no Hayflick limit</p>	(2)

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Question Number	Answer	Additional Guidance	Mark
(ii)	<p>An answer that makes reference to the following:</p> <p><u>Similarity</u></p> <ul style="list-style-type: none"> both increase the number of cells (1) <p><u>Differences</u></p> <ul style="list-style-type: none"> mitosis produces diploid cells and meiosis produces haploid cells meiosis produces cells that are genetically different to each other whereas mitosis produces genetically identical cells mitosis results in 8 spermatocytes from each stem cell whereas meiosis results in 4 sperm cells from each spermatocyte 	<p>ALLOW cells contain { 23 pairs of / 46 } chromosomes after mitosis and 23 chromosomes after meiosis</p> <p>ALLOW mitosis results in 2 daughter cells whereas meiosis results in 4 daughter cells</p>	(4)

Q11.

Question Number	Answer	Additional Guidance	Mark
(i)	<p>An answer that makes reference to two of the following:</p> <ul style="list-style-type: none"> (a disorder caused by) a {mutated / faulty } gene (1) located on the { X / Y } chromosome (1) therefore (the disorder) is more likely in one gender than another (1) 	<p>ALLOW allele for gene</p> <p>ALLOW located on sex chromosome</p>	(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	<p>An explanation that makes reference to two of the following:</p> <ul style="list-style-type: none"> males only have one allele for this gene (1) males cannot be heterozygous (1) the Hardy-Weinberg equation assumes all individuals have two alleles for the gene (1) 	<p>ALLOW males do not have two alleles for the gene</p> <p>ALLOW males cannot be carriers</p> <p>ALLOW 2pq cannot be calculated</p>	(2)

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Question Number	Answer	Additional Guidance	Mark
(iii)	<p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> stem cells can differentiate into muscle cells (1) these cells will not have the affected allele (1) {the protein / dystrophin} will be produced (1) 	<p>ALLOW 'specialise' instead of 'differentiate'</p> <p>ALLOW will have normal allele for dystrophin</p>	(3)

Q12.

Question Number	Answer	Additional guidance	Mark
	<p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> histone modification / DNA methylation (1) {affects activation of / activates / deactivates} genes (1) affecting {enzyme production / metabolism} (1) 	<p>ALLOW acetylation of histones</p> <p>ALLOW genes being switched on or off</p>	(3)

Q13.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> genes {activated/ deactivated} (in stem cells) (1) (because of) {methylation of DNA / histone binding} (1) (therefore) the same genes will be activated in the daughter cells (1) 	<p>ALLOW genes switched on or off</p> <p>ALLOW acetylation of histones</p>	(3)

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Q14.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that makes reference to the following</p> <ul style="list-style-type: none"> height is affected by the environment as well as genotype (1) height is an example of polygenic inheritance (1) (therefore) offspring can inherit a mixture of alleles from both parents (that increase height) (1) description of a named environmental factor that can affect height (1) 	<p>e.g. higher protein diet, more calcium in diet, better healthcare</p> <p>ALLOW parents did not fulfil genetic potential due to a named environmental factor</p>	(4)

Q15.

Question Number	Answer	Additional guidance	Mark
	<p>An explanation that makes reference to four of the following:</p> <ul style="list-style-type: none"> monozygotic twins show higher correlation (than dizygotic twins at all ages) (1) therefore genetic factors have a greater effect (1) because monozygotic twins have identical alleles (for body mass) (1) monozygotic twins show less than 100% correlation (1) therefore environmental factors affect body mass (1) 	<p>ALLOW monozygotic twins have more alleles in common than dizygotic twins OR dizygotic twins have fewer alleles in common ALLOW monozygotic twins are genetically identical</p>	(4)

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Q16.

Question Number	Answer	Additional guidance	Mark
	<p>An answer that makes reference to the following:</p> <ul style="list-style-type: none"> percentage incidence (of VTE) higher in {older people /people older than 70 } (1) in younger people larger percentage (of VTE patients) have the factor V mutation (1) (therefore) genotype has a greater influence on incidence (of VTE) in younger people (1) (therefore) greater incidence (of VTE) in older people probably a result of environmental factors (1) 	<p>ALLOW converse – incidence of VTE lower in {younger people/ people under 20}</p> <p>ALLOW converse - lower percentage of older people have the factor V mutation</p> <p>ALLOW converse – genotype has less influence on incidence of VTE in older people</p>	(4)

Q17.

Question Number	Answer	Additional Guidance	Mark
	<p>An answer that makes reference to the following:</p> <ul style="list-style-type: none"> { FTO^T / saturated fat diet } is associated with increased BMI FTO^T (allele) is recessive / FTO^C (allele) is dominant (1) highest increase in BMI was for individuals homozygous for FTO^T on a saturated fat diet 	<p>ALLOW $FTO^T FTOT$ genotype</p>	(3)

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Q18.

Question Number	Answer	Mark
	<p>The only correct answer is - D multiple alleles at multiple loci</p> <p>B is incorrect because polygenic traits involve more than one allele</p> <p>A is incorrect because polygenic traits involve more than one locus</p> <p>C is incorrect because polygenic traits involve more than one locus</p>	(1)

Q19.

Question Number	Answer	Mark
(i)	<p>The only correct answer is C - polygenic</p> <p><i>A is not correct because epigenetic does not refer to characteristics determined by more than one gene</i></p> <p><i>B is not correct because monogenic would only involve one gene</i></p> <p><i>D is not correct because sex-linked refers to inheritance of genes on the sex chromosomes</i></p>	(1)

Question Number	Answer	Mark
(ii)	<p>The only correct answer is B - diet</p> <p><i>A is not correct because age is not an environmental factor</i></p> <p><i>B is not correct because gender is not an environmental factor</i></p> <p><i>D is not correct because height is not an environmental factor</i></p>	(1)

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Q20.

Question Number	Answer	Mark
(i)	<p>C – the mode</p> <p><i>The only correct answer is C</i></p> <p><i>A is not correct because the mean is a calculated value</i></p> <p><i>B is not correct because the median is the middle value on the x axis</i></p> <p><i>D is not correct because the standard deviation is a calculated value</i></p>	(1)
Question Number	Answer	Mark
(ii)	<p>B – body mass</p> <p><i>The only correct answer is B</i></p> <p><i>A is not correct because blood group is categoric</i></p> <p><i>C is not correct because eye colour is categoric</i></p> <p><i>D is not correct because gender is categoric</i></p>	(1)

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Q21.

Question Number	Answer	Additional Guidance	Mark
(i)	<ul style="list-style-type: none"> (range of heights) show continuous variation (1) 	ALLOW continuous data	(1)
Question Number	Answer	Additional Guidance	Mark
(ii)	<p>B - controlled by more than one gene</p> <p><i>The only correct answer is B</i></p> <p><i>A is not correct because a polygenic trait is not controlled by a large number of alleles of one gene</i></p> <p><i>C is not correct because a polygenic trait is not controlled by one gene from each parent</i></p> <p><i>D is not correct because a polygenic trait is not controlled by one gene and the environment</i></p>		(1)
Question Number	Answer	Additional Guidance	Mark
(iii)	<p>An answer which makes reference to the following:</p> <ul style="list-style-type: none"> 70 cm (1) the highest frequency (of antelopes) (1) 	ALLOW 'most common' height	(2)

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Q22.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that makes reference to four of the following:</p> <ul style="list-style-type: none"> • (AFP II) { gene / allele } { activated only in liver cells / deactivated in cells other than liver cells } (1) • transcription (of AFP II) occurs only in liver cells (1) • { translation / protein synthesis } (of AFP II) takes place only in liver cells (1) • the protein is { secreted from liver cells / transported around the body } (1) • (presence of protein in all tissues) prevents { freezing / ice } in all parts of the body (1) 	<p>ALLOW "switched on/off" This deactivation could be due to DNA methylation / histone modification</p> <p>Ref to liver cells required only once if context / chain of argument is clear.</p>	(4)

Q23.

Question Number	Answer	Additional Guidance	Mark
(i)	<p>A description that makes reference to the following:</p> <ul style="list-style-type: none"> • tissue contains one type of cell (1) • a system contains (many) {different tissues /organs} (1) 	ALLOW similar cells	(2)

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Question Number	Answer	Additional Guidance	Mark
(ii)	<p>A description that makes reference to the following:</p> <ul style="list-style-type: none"> different stimuli activate different genes (1) genes activated are transcribed / mRNA produced from active genes (1) mRNA translated to produce proteins (1) proteins determine {structure / function} of cells (1) different {genes activated / proteins produced} result in different types of cell being produced (1) 	ALLOW switch on	(4)

Q24.

Question Number	Answer	Additional Guidance	Mark
(i)	<p>An answer that includes:</p> <ul style="list-style-type: none"> a line that shows a positive correlation with lung, liver and colon points below the line and breast, bladder and pancreas above the line 		(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	<p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> there is a correlation between age and level of DNA methylation (1) as there is only a 5% likelihood of these results being produced by chance (1) 	<p>ALLOW converse, e.g. 95% probability that DNA methylation increases with age ALLOW as the calculated value is greater than the critical value at $p=0.05$</p>	(2)

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Question Number	Indicative content
*(iii)	<p>Answers will be credited according to candidates' deployment of knowledge and understanding of material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is relevant. Additional content included in the response must be scientific and relevant.</p> <p>Give examples of relevant biological knowledge and understanding:</p> <ul style="list-style-type: none"> • mutation is a change in the { base sequence in DNA / gene } / different amino acid sequence / primary structure of the enzyme succinate dehydrogenase • succinate dehydrogenase { less / non- } functional • succinate therefore accumulates • accumulation of succinate inhibits TET • therefore methyl groups not removed / increased methylation of DNA • affects transcription of a gene / therefore alters amount of product formed • greater methylation of DNA is associated with increased risk of cancer

			Additional Guidance
Level 0	Marks	No awardable content	
Level 1	1-2	<p>An explanation may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one piece of scientific information.</p> <p>The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.</p>	<p>Only one point of basic information referred to: e.g. mutation results in more succinate, or high succinate and inhibition of TET, or less TET and more methylation of DNA</p>
Level 2	3-4	<p>An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information.</p> <p>The explanation shows some linkages and lines of scientific reasoning with some structure.</p>	<p>Link between high levels of succinate and inhibition of TET</p>
Level 3	5-6	<p>An explanation is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information.</p> <p>The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.</p>	<p>Links made to include all of these points: mutation leads to higher levels of succinate, which inhibits TET, therefore increasing DNA methylation, which increases risk of cancer</p> <p>Logical explanation of the reasons why a mutation in the enzyme succinate dehydrogenase can increase risk of developing cancer</p>