

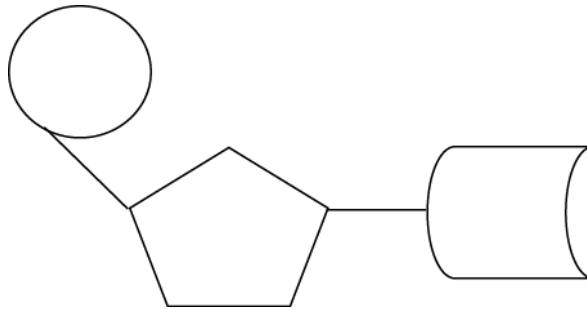
1(a).

(i) DNA is a polymer made of nucleotides.

Each nucleotide is made of three parts:

- A phosphate group
- A base
- A sugar.

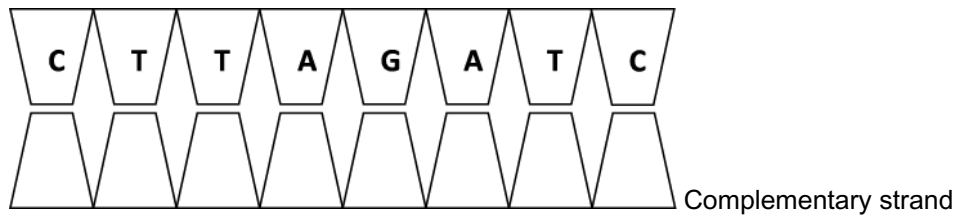
Draw a line and label the phosphate group on the nucleotide below.



[1]

(ii) DNA has four different bases. A, T, C and G.

Use these four bases to complete the base sequence of the complementary strand of DNA.



[1]

(b). The diagram below shows how genetic material is organised.

Choose a word from the list to label each structure.

Write the correct word next to the structure on the diagram.

gene

chromosome

DNA

base pair

cell

nucleus



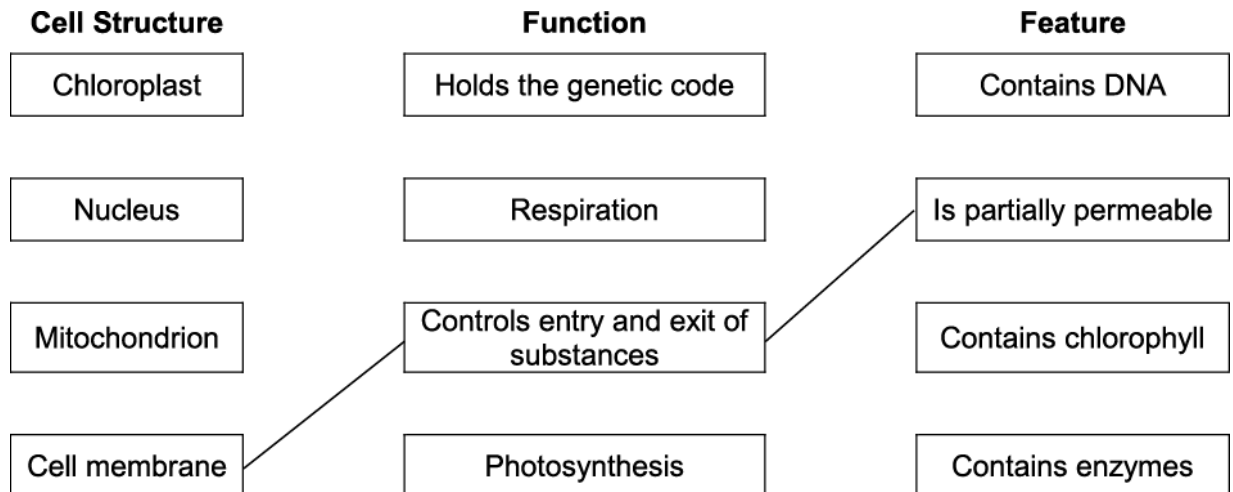
[3]

2(a). Cells are the basic building blocks of life. They need to do many things in order to stay alive.

Structures within cells perform a variety of functions and have features that allow them to do these jobs.

Use straight lines to complete the diagram to show which cell structure links to the function and the feature that allows that structure to do its job.

Two lines have been drawn for you.



[3]

(b). Anna and Jess are identical twins.

Their parents can easily tell the difference between them.

Explain why Anna and Jess are described as genetically identical and suggest why their parents can tell the difference between them.

[4]

3(a). Albinism is an inherited condition where affected people are unable to make a pigment called melanin. Skin, hair and eyes may all be affected and the person will be very pale skinned with white-blonde hair and possibly red eyes.

Esther and Simon's daughter, Livvy, has albinism.

Esther and Simon are both heterozygous (carriers).

Complete the Punnett square below to show how Esther and Simon passed the alleles for albinism to Livvy.

Use **A** to represent the allele for normal melanin production and **a** to represent the allele for albinism.

Livvy's genotype is **aa**.

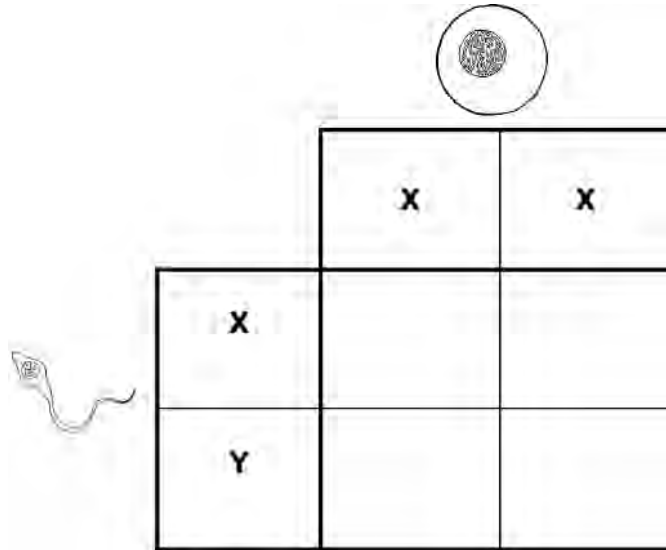
	A	a

[2]

(b). In humans, sex chromosomes determine gender.

Esther and Simon are having another child.

Use the diagram below to show the probability of Esther and Simon's second child being a boy.



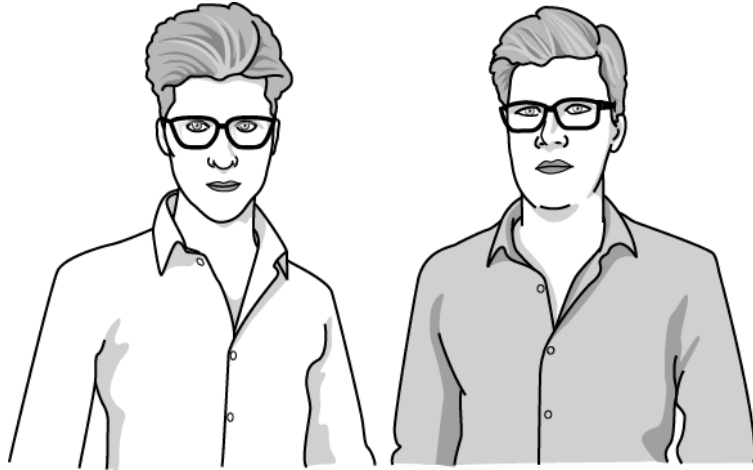
Probability -----

[2]

(c). Use the example of the inheritance of albinism to describe the difference between **homozygous** and **heterozygous**.

[2]

4. Jack and Ted are identical twins.



Explain why Jack and Ted look very similar but will not always look exactly the same.



The quality of written communication will be assessed in your answer.

[6]

5. Our genes control how we develop and function.

Draw a **ring** around the correct word to complete each of the sentences about genes.

Genes are **cells** / **instructions** / **nuclei** that describe how to make proteins.

Genes are sections of DNA molecules that make up **chromosomes** / **enzymes** / **proteins**.

Different versions of the same gene are called **alleles** / **chromosomes** / **proteins**.

[2]

6. Steve and Jane have a baby.
Some features of the baby are like Steve and some are like Jane.
However some features look different to both Steve and Jane.

Use ideas about genes, alleles and the environment to explain these observations.



The quality of written communication will be assessed in your answer.

[6]

7. Chromosomes contain a molecule called DNA.

Describe the structure of DNA and its job in the cell.



The quality of written communication will be assessed in your answer.

[6]

8. Every person has two alleles for a gene.

These alleles can be dominant or recessive.

Draw one straight line from each pair of alleles to the characteristic that the person would have.

Pair of alleles

two dominant alleles

one dominant and one recessive allele

two recessive alleles

Characteristic

the dominant characteristic

the recessive characteristic

[2]

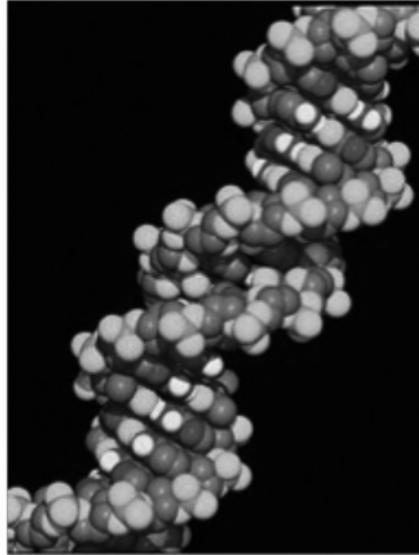
10(a) This question is about DNA and genes.

DNA is a double helix.

The double helix is divided into genes along its length.

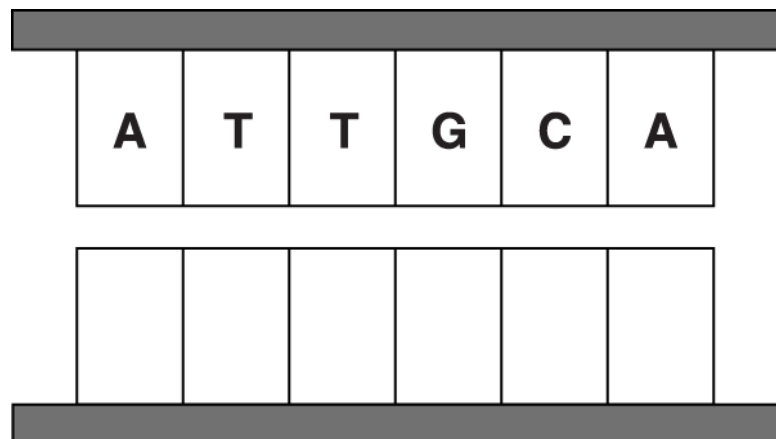
The two strands are held together by bonds between pairs of bases.

The bases always pair up in the same way.



Complete the model of DNA to show the missing bases.

Write **A**, **T**, **C** or **G** in each box.



(b). 36% of the bases found in a particular gene are type G.

(i) What is the percentage of type C bases in this gene?

Explain your answer.

----- [2]

(ii) A second gene has a different percentage of type G bases.

Suggest **why** the percentage of type G bases is different in this gene.

----- [2]

(c). A copy of a gene is produced to carry the genetic code to the cytoplasm.

Complete the sentence to explain why.

Use the correct words from the list.

cell membrane

cell wall

cytoplasm

nucleus

vacuole

Genes are found in the _____ of the cell but protein synthesis takes place in the _____ of the cell.

[1]

11. Humans have different characteristics.

These characteristics have different causes.

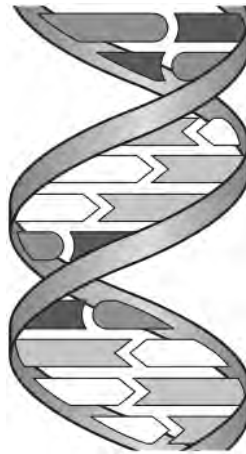
Complete the table by writing each **characteristic** in the correct column to show its **cause**.

Cause		
Genes	Environment	Both genes and environment

[2]

12. DNA is a polymer made of nucleotides. A nucleotide is made of a sugar, a phosphate and a base.

The diagram shows the structure of DNA.



(i) On the diagram label the location of a base.

[1]

(ii) On the diagram label the location of the sugar and phosphate group.

[1]

13. Nina is learning about substances absorbed by plants. She finds out that plants absorb nitrate ions from the soil.

Explain why nitrate ions are essential for plant growth and survival.

[2]

14. DNA has four different bases.

A always pairs with T.

C always pairs with G.

A scientist is analysing a sample of DNA. She works out that 23% of DNA is made up of the base A.

Which **two** statements about the sample are correct?

Tick (✓) **two** boxes.

23% of the sample will be the base T.

23% of the sample will be the base C.

27% of the sample will be the base T.

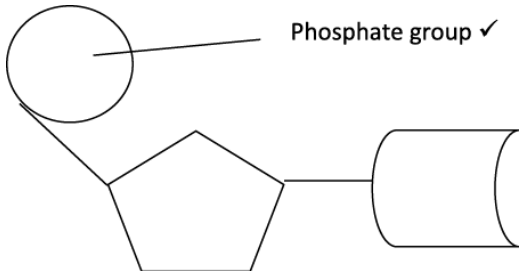

27% of the sample will be the base C.

77% of the sample will be the base T.

[2]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance															
1	a	i	 <p style="text-align: right;">Phosphate group ✓</p>	1																
		ii	GAATCTAG ✓	1	Label is given next to any structure															
	b		 <p style="text-align: right;">chromosome ✓ DNA ✓</p>	3	If more than one label is given next to any structure, do not award the mark even if the correct label is also given															
Total				5																
2	a		<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <thead> <tr> <th style="width: 33%;">Structure</th> <th style="width: 33%;">Function</th> <th style="width: 33%;">Feature</th> </tr> </thead> <tbody> <tr> <td>Chloroplast</td> <td>Holds the genetic code</td> <td>Contains DNA</td> </tr> <tr> <td>Nucleus</td> <td>Respiration</td> <td>Is partially permeable</td> </tr> <tr> <td>Mitochondrion</td> <td>Controls entry and exit of substances</td> <td>Contains chlorophyll</td> </tr> <tr> <td>Cell membrane</td> <td>Photosynthesis</td> <td>Contains enzymes</td> </tr> </tbody> </table>	Structure	Function	Feature	Chloroplast	Holds the genetic code	Contains DNA	Nucleus	Respiration	Is partially permeable	Mitochondrion	Controls entry and exit of substances	Contains chlorophyll	Cell membrane	Photosynthesis	Contains enzymes	3	Mark each structure separately Both lines need to be correct for 1 mark
Structure	Function	Feature																		
Chloroplast	Holds the genetic code	Contains DNA																		
Nucleus	Respiration	Is partially permeable																		
Mitochondrion	Controls entry and exit of substances	Contains chlorophyll																		
Cell membrane	Photosynthesis	Contains enzymes																		
	b		<ol style="list-style-type: none"> 1. Same DNA / genes (1) 2. Resulting from a single fertilised egg / zygote that splits into two (1) 3. Idea of environmental differences (1) 4. One example of an environmental difference (1) 	4	MP4 e.g. scar, piercings, dyed hair, different clothes															
Total				7																
3	a		<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr> <td></td> <td style="width: 50px;">A</td> <td style="width: 50px;">a</td> </tr> <tr> <td style="width: 50px;">A</td> <td>AA</td> <td>Aa</td> </tr> <tr> <td style="width: 50px;">a</td> <td>Aa</td> <td>aa</td> </tr> </table>		A	a	A	AA	Aa	a	Aa	aa	2	<p>One mark for correct gametes for second parent</p> <p>One mark for correct completion of Punnett square</p> <p>ALLOW aA for Aa</p>						
	A	a																		
A	AA	Aa																		
a	Aa	aa																		

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance									
	b	Punnett square correct ✓ <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td></td> <td>X</td> <td>X</td> </tr> <tr> <td>X</td> <td>XX</td> <td>XX</td> </tr> <tr> <td>Y</td> <td>XY</td> <td>XY</td> </tr> </table> Probability is 50% / 0.5 / ½ ✓		X	X	X	XX	XX	Y	XY	XY	2	ALLOW YX for XY
	X	X											
X	XX	XX											
Y	XY	XY											
	c	Homozygous - having the same allele on both chromosomes of a pair e.g. AA or aa Heterozygous - when the alleles on a pair of chromosomes are different e.g. Aa	2	DO NOT ALLOW 'have same gene on both chromosomes' DO NOT ALLOW 'have different genes on both chromosomes'									
		Total	6										

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
4	<p>[Level 3] Answer explains why the twins look very similar AND explains why they look different. Quality of written communication does not impede communication of the science at this level.</p> <p style="text-align: right;">(5 – 6 marks)</p> <p>[Level 2] Answer gives an explanation for difference OR similarity with an example. Quality of written communication partly impedes communication of the science at this level.</p> <p style="text-align: right;">(3 – 4 marks)</p> <p>[Level 1] Answer gives examples of possible differences OR gives examples of possible similarities. Quality of written communication impedes communication of the science at this level.</p> <p style="text-align: right;">(1 – 2 marks)</p> <p>[Level 0] Insufficient or irrelevant science. Answer not worthy of credit.</p> <p style="text-align: right;">(0 marks)</p>	6	<p>This question is targeted at grades up to E</p> <p>Indicative scientific points may include:</p> <p><i>Why they look very similar:</i> <i>examples</i> of similarities in appearance eye colour, nose shape, ear lobes etc</p> <p><i>explanation</i></p> <ul style="list-style-type: none"> • they have identical alleles / genotype / genetic information / DNA / chromosomes / genes • they are clones • they came from the same embryo / zygote / fertilised egg / sperm and egg • the embryo split <p>ignore they are identical twins (given in stem) ignore same genes/chromosomes accept same DNA/alleles</p> <p><i>Why they will not always look exactly the same:</i> <i>examples</i> of possible differences in appearance that could arise physical damage, weight, hairstyle, clothes, tattoos</p> <p><i>explanation</i></p> <ul style="list-style-type: none"> • idea that differences are only due to environment/lifestyle • high level idea that any genetic differences must be due to changes/mutations in body cells (not in original gametes) <p>Use the L1, L2, L3 annotations in Scoris; do not use ticks.</p> <p>Examiner's Comments</p> <p>This was the first of the six-mark extended writing questions. It is pleasing to see that the candidates are now confident in tackling these questions and that many</p>

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					<p>have developed good strategies to ensure that all parts of the question are answered. Candidates were asked to explain why identical twins look similar, but will not always look exactly the same. The majority of candidates scored between 1 and 4 marks on this question, with a large proportion scoring at Level 2. Candidates were able to correctly identify similarities and differences, though similarities were discussed less frequently. Candidates were able to express well that the differences were observed due to the environment and gave a good range of examples.</p> <p>Candidates struggled to explain why the twins looked similar. Many referred to the twins having the same genes rather than the same alleles and unfortunately were therefore unable to score. Centres are asked to ensure that when discussing similarities that the distinction is made between genes and alleles. Some candidates were confused and thought that the twins would have different genes/alleles and discussed the inheritance of dominant and recessive alleles from the parents. Candidates did seem aware that something 'split' and frequently made reference to the egg splitting, fertilised egg or embryo splitting was rarely mentioned. Genetic variation was not well understood by most candidates.</p>
			Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
5			instructions ; chromosomes ; alleles	2	<p>ignore any line in which more than one word is circled three correct lines = 2 marks two correct lines = 1 mark one correct line = 0 marks</p> <p>Examiner's Comments</p> <p>In this question candidates were required to select the correct word to complete three sentences to explain how genes function. The majority of students scored one mark for this question. The most common error being in the first sentence where many candidates thought that genes were cells that describe how to make proteins.</p>
			Total	2	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
6		<p>Level 3 (5–6 marks) Refers to genetic and environmental factors, clearly links the factors to explanation of similarities and differences. Correct technical terms. Quality of written communication does not impede communication of the science at this level.</p> <p>Level 2 (3–4 marks) Refers to both genetic and environmental factors, probably using some technical terms. Less technical terms, ie more description. Incomplete with only some explanation. Quality of written communication partly impedes communication of the science at this level.</p> <p>Level 1 (1–2 marks) Brief vague account, possibly only accounting for either similarities or differences, or give only genetic or only environmental responses. Quality of written communication impedes communication of the science at this level.</p> <p>Level 0 (0 marks) Insufficient or irrelevant science. Answer not worthy of credit.</p>	6	<p>This question is targeted at grades up to E.</p> <p>Relevant points include:</p> <p>general environmental factors mentioned genetic factors mentioned</p> <p>specific examples of environmental variation given eg food eaten examples of genetic variation given eg skin, hair and eye colour some variation is a combination of both with examples such as weight multiple genes can work together to produce different characteristics characteristics are determined by a combination of maternal and paternal genes genes can be inherited in different combinations ignore primary sexual characteristics</p> <p>Use the L1, L2, L3 annotations in SCORIS; do not use ticks.</p> <p>Examiner's Comments</p> <p>Saw most candidates score some marks. Level 1 responses were often limited to references to genetic factors, and a number of candidates limited their marks by making clear their misconception that alleles are not genes. Many responses might have been much improved by giving examples such as genetic variation leading to variation in hair or eye colour.</p>
		Total	6	

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
7	<p>Level 3 (5–6 marks) Good description of the structure of DNA AND describes the job of the DNA in the cell.</p> <p>Quality of written communication does not impede communication of the science at this level</p> <p>Level 2 (3–4 marks) Good description of the structure of DNA AND job Quality of written communication partly impedes communication of the science at this level</p> <p>Level 1 (1–2 marks) Basic description of the structure of DNA OR job Quality of written communication impedes communication of the science at this level</p> <p>Level 0 (0 marks) Insufficient or irrelevant science. Answer not worthy of credit</p>	6	<p>This question is targeted at grades up to C</p> <p>Indicative scientific points may include</p> <p>Job in the cell</p> <ul style="list-style-type: none"> • contains / holds the genetic code / genes • involved in / has instructions for the synthesis of proteins / enzymes / amino acids <p>ignore DNA makes / synthesises protein</p> <ul style="list-style-type: none"> • able to replicate (to produce new chromosomes) • stores information <p>DNA structure</p> <ul style="list-style-type: none"> • double helix (or description) • consists of 2 strands • has (4) bases • (bases are) A, T, C, G • A pairs with T OR C pairs with G <p>NB Base A pairs with T and C pairs with G covers the third, fourth AND fifth bullets.</p> <p><u>Examiner's Comments</u></p> <p>This was a 6 mark, level of response question on the structure and the function of DNA. Most candidates gained some credit for aspects of structure – double helix, bases ATCG and the fact that they pair. The better answers referred to DNA as a store of information, genetic coding for proteins and being able to replicate.</p>
	Total	6	

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance							
8	<table border="0" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 35%; vertical-align: top;">Pair of alleles</td> <td style="width: 65%; vertical-align: top;">Characteristic</td> </tr> <tr> <td style="border: 1px solid black; padding: 5px;">two dominant alleles</td> <td rowspan="2" style="border: 1px solid black; padding: 5px; vertical-align: middle;">the associated dominant characteristic</td> </tr> <tr> <td style="border: 1px solid black; padding: 5px;">one dominant and one recessive allele</td> </tr> <tr> <td style="border: 1px solid black; padding: 5px;">two recessive alleles</td> <td style="border: 1px solid black; padding: 5px;">the associated recessive characteristic</td> </tr> </table>	Pair of alleles	Characteristic	two dominant alleles	the associated dominant characteristic	one dominant and one recessive allele	two recessive alleles	the associated recessive characteristic	2	<p>one mark for two recessive correctly linked to characteristic</p> <p>one mark for both two dominant and one dominant correctly linked to characteristic</p> <p>credit if line is crossed out and no obvious replacement drawn</p> <p>Examiner's Comments</p> <p>This question tested candidates' ability to link the pair of alleles with the characteristic that would result from the combination. The majority of candidates correctly identified that two recessive alleles would result in the recessive characteristic and two dominant alleles would result in the dominant characteristic. However, relatively few candidates indicated that one dominant allele and one recessive allele would result in the dominant characteristic.</p>
Pair of alleles	Characteristic									
two dominant alleles	the associated dominant characteristic									
one dominant and one recessive allele										
two recessive alleles	the associated recessive characteristic									
	Total	2								

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
9	<p>[Level 3] Answer describes the role of genes AND the environment in determining our characteristics AND gives examples of characteristics determined by each. Answer also describes that some characteristics are controlled by both genes and the environment. Quality of written communication does not impede communication of the science at this level.</p> <p style="text-align: right;">(5 – 6 marks)</p> <p>[Level 2] Answer describes the role of genes AND the environment in determining our characteristics AND gives at least one examples of characteristics determined by one of these. Quality of written communication partly impedes communication of the science at this level.</p> <p style="text-align: right;">(3 – 4 marks)</p> <p>[Level 1] Answer describes the role of genes OR the environment in determining our characteristics. Quality of written communication impedes communication of the science at this level.</p> <p style="text-align: right;">(1 – 2 marks)</p> <p>[Level 0] Insufficient or irrelevant science. Answer not worthy of credit.</p> <p style="text-align: right;">(0 marks)</p>	6	<p>This question is targeted at grades up to E</p> <p>Indicative scientific points may include:</p> <p>genetic:</p> <ul style="list-style-type: none"> • some characteristics are determined by genes / chromosomes / DNA / alleles • inherited from our parents • examples include blood group, dimples, eye colour, gender <p>environment:</p> <ul style="list-style-type: none"> • some characteristics are determined by our environment • not inherited • examples include scars, tattoos <p>both:</p> <ul style="list-style-type: none"> • some characteristics are determined by both • examples include height, weight, hair colour <p>ignore general references to 'looks' and 'behaviour' as examples (as given in stem of question)</p> <p>Examiner's Comments</p> <p>This was the first six-mark extended-writing question. A large range of responses at all levels were observed with many candidates achieving Level 2 and Level 3. Candidates provided good, detailed descriptions and examples of both genetic and environmental influences. Unfortunately some candidates did not discuss both elements and in these cases the mark was limited. Fewer candidates identified characteristics that would be influenced by both genes and the environment, which again limited their mark. A common error made by candidates was in the selection of a characteristic determined solely by the environment, many candidates incorrectly identified</p>

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					height and weight. Examiners were pleased to see full and very good answers to this question.
			Total	6	

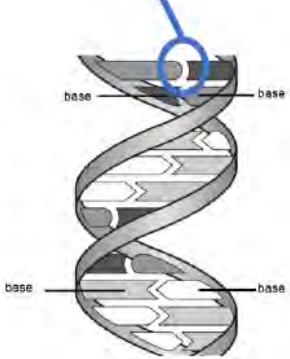
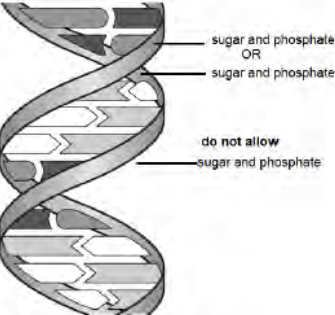
Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
10	a	T, A, A, C, G, T	2	<p>6 correct responses = 2 marks 5 or 4 correct responses = 1 mark 3 or less correct responses = 0 marks</p> <p>Examiner's Comments</p> <p>This question was worth 2 marks and candidates tended to score either 2 or 0 marks. Where candidates scored 0 marks it was evident that they had attempted the question but had copied the original strand information onto the new strand.</p>
	b	i	2	<p>36% (1) C pairs with G / if G is 36%, C must be the same (1)</p> <p>allow bonds / joins / goes together / matches</p> <p>ecf eg C pairs with T or A then C = 14% because $36 \times 2 = 72$, $100 - 72 = 28$, $28/2 = 14\%$</p> <p>Examiner's Comments</p> <p>Some candidates who had understood question 3a knew that the percentage of C bases was 36% as C pairs with G, however many thought that the percentage of type C bases was 64% as the total percentage would be 100%.</p>
		ii	2	<p>different genes code for / make different proteins / this (second) gene codes for a different protein / AW (2)</p> <p>allow genes code for / make proteins = 1 mark</p> <p>Examiner's Comments</p> <p>This was not a particularly well answered question.</p>
	c	nucleus and cytoplasm (1)	1	<p>two correct responses in correct order = 1 mark</p> <p>Examiner's Comments</p> <p>This question required candidates to complete the sentences by choosing words from the list. Most candidates were able to correctly use the word "nucleus" but only half were able to correctly identify both words.</p>

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance						
			Total	7							
11			<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%; text-align: center;">dimples</td> <td style="width: 33%; text-align: center;">scars</td> <td style="width: 33%; text-align: center;">weight</td> </tr> <tr> <td style="text-align: center;">eye colour</td> <td></td> <td></td> </tr> </table>	dimples	scars	weight	eye colour			2	<p>4 correct = 2 marks 3 correct = 1 mark</p> <p>if a feature is placed in more than one column, does not score</p> <p>Examiner's Comments</p> <p>In this question candidates were asked to complete the table by writing each characteristic in the correct column. Many candidates were able to assign 3 characteristics correctly and it was encouraging to see that over half could assign all 4 correctly.</p>
dimples	scars	weight									
eye colour											
			Total	2							

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
12		i	base correctly labelled ✓	1 (AO 1.1)	<p>label lines must clearly touch the relevant part of the molecule only one of the four types of base need to be labelled ALLOW A, T, C or G for the base DO NOT ALLOW</p> 
		ii	sugar and phosphates correctly labelled ✓	1 (AO 1.1)	<p>label lines must clearly touch the relevant part of the molecule</p>  <p>Examiner's Comments</p> <p>On this AO1 question, base was better recognised than the sugar phosphate backbone. Candidates should be encouraged to label using straight lines rather than arrows and take care that their lines touch the diagram. They should also be advised that unless instructed otherwise, only a single line is necessary to identify a feature and that circling large parts of a diagram should be avoided.</p>
Total				2	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
13		(nitrate ions are the plant's only source of) nitrogen ✓ to make amino acids/proteins/nitrogenous compounds ✓	2 (AO 1.1 × 2)	ALLOW examples e.g. enzymes / DNA <u>Examiner's Comments</u> Very few candidates showed understanding that nitrate ions are the plant's source of nitrogen, or that this is necessary for making amino acids and therefore proteins.
		Total	2	
14		23% of the sample will be base T ✓ 27% of the sample will be base C ✓	2 (AO 1.2)	<u>Examiner's Comments</u> Two thirds of candidates obtained one or more marks on this AO1 question. Although many could identify that 23% of the sample would be base T, far fewer were able to use this information to correctly calculate the percentage of C.
		Total	2	