AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 4.1.2.1

Chromosomes

Mark schemes and examiner comments

Tier	**Foundation**
Question groups	**7**
Available paper years	**2018–2025**

Using this booklet

1. Booklet answer numbers match the question booklet.
2. Use the original question number within marking tables.
3. Examiner comments are included where available.

Name: _____ **Date:** _____

Where a precise marking extract is unavailable, the full source document is included in an appendix. Any missing mark scheme is explicitly identified.

4.1.2.1 Chromosomes

Answer 01 · Mark scheme

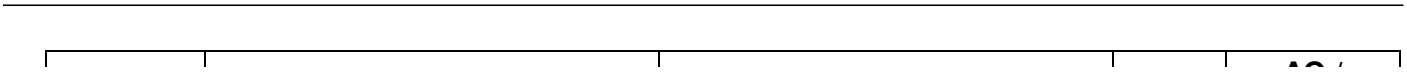
June 2018 | 8464/B/2F | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	a double helix a polymer		1 1	AO1 4.6.1.3
02.2	gene genome	in this order only	1 1	AO1 4.6.1.3
02.3	sperm **and** egg(s) / ova / ovum	in either order	1	AO1 4.6.1.1
02.4	fertilisation		1	AO1 4.6.1.2
02.5	the cell divides twice the new cells have half the number of chromosomes		1 1	AO2 4.6.1.2
Total			**8**	

4.1.2.1 Chromosomes

Answer 01 · Mark scheme

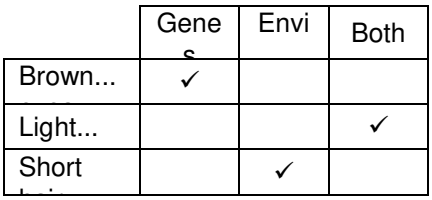
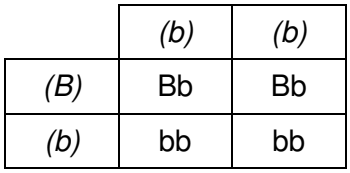
June 2018 | 8464/B/2F | Original Q2



4.1.2.1 Chromosomes

Answer 02 · Mark scheme

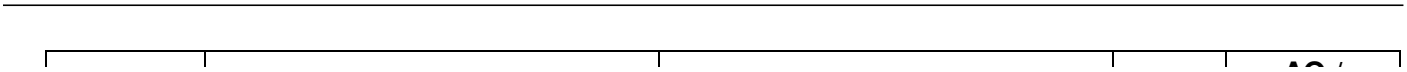
June 2018 | 8464/B/2F | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1			1 1 1	AO2 4.6.2.1
05.2	bb		1	AO2 4.6.1.4
05.3	brown	allow light brown **or** dark brown	1	AO2 4.6.1.4
05.4	(using bb for mother's gametes) correct combination in all four boxes, eg 	allow any combination of mother's gametes as mark is for filling in boxes correctly	1	AO2 4.6.1.4
05.5	50%, 0.5, ½	the award of this mark is consequential to the answer in question **05.4** ignore ratios	1	AO2 4.6.1.4
05.6	phenotype		1	AO2 4.6.1.4
05.7	almost certainly have no effect		1	AO1 4.6.2.1
Total			**9**	

4.1.2.1 Chromosomes

Answer 02 · Mark scheme

June 2018 | 8464/B/2F | Original Q5



4.1.2.1 Chromosomes

Answer 03 · Mark scheme

November 2020 | 8464/B/2F | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1			1	AO2 4.6.1.3
06.2	any **one** from: • 2 strands / chains that are twisted / coiled / spiralled • double helix • (long) polymer	allow cross links between 2 strands / chains allow reference to nucleotides or sugars, phosphates and bases	1	AO1 4.6.1.3
06.3	amino acids protein	in this order only allow polypeptide	1 1	AO1 4.6.1.3
06.4	all the genetic material (of an organism)	allow DNA / genes for genetic material ignore chromosomes	1	AO1 4.6.1.3
06.5	tracing how aboriginal people spread across Australia		1	AO2 4.6.1.3
06.6	variation	ignore genetic/environmental	1	AO1 4.6.2.1

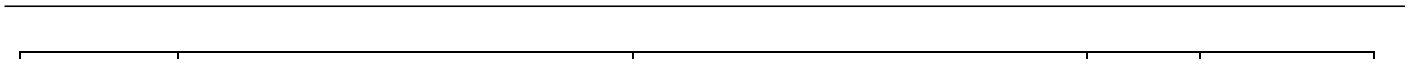
4.1.2.1 Chromosomes

06.7	stronger / larger (shell) (so) more likely to (survive and) breed **or** (so) more likely to (survive and) pass on genes **OR** (better) camouflaged (1) (so) less likely to be eaten and will breed more (1)		1 1	AO2 4.6.2.2
Total			**9**	

4.1.2.1 Chromosomes

Answer 03 · Mark scheme

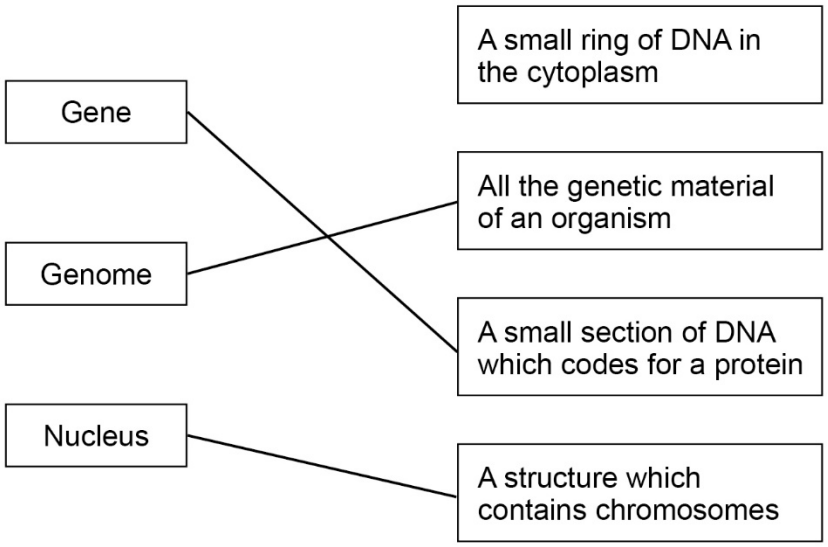
November 2020 | 8464/B/2F | Original Q6



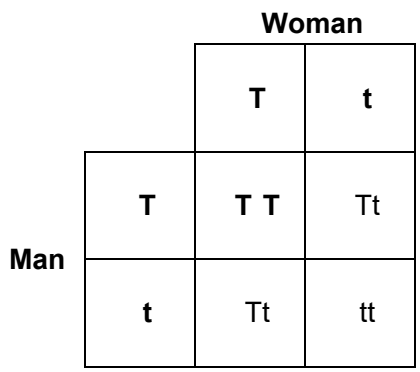
4.1.2.1 Chromosomes

Answer 04 · Mark scheme

November 2021 | 8464/B/2F | Original Q1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	23		1	AO1 4.6.1.2
01.2	**Word** / **Meaning**  additional line from a box on the left negates the mark for that box		1 1 1	AO1 4.6.1.4 4.6.1.3
01.3	any **one** from: • to survive • so you do not eat the plants • to stop you being harmed / poisoned	allow to protect them allow stop you getting ill / dying	1	AO2 4.7.1.4
01.4	heterozygous		1	AO2 4.6.1.4
01.5	tt	allow homozygous recessive	1	AO2 4.6.1.4

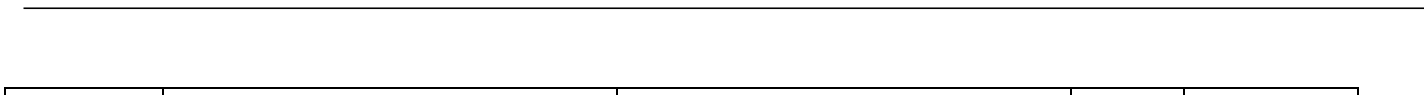
4.1.2.1 Chromosomes

01.6		allow 1 or 2 genotypes correct for **1** mark	2	AO2 4.6.1.4
01.7	75%	allow **only** a probability consistent with student's derivation if no answer to question **01.6** allow 75%	1	AO3 4.6.1.4
Total			**10**	

4.1.2.1 Chromosomes

Answer 04 · Mark scheme

November 2021 | 8464/B/2F | Original Q1



4.1.2.1 Chromosomes

Answer 05 · Mark scheme

November 2021 | 8464/B/2F | Original Q3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	nut(s) → bird(s) → cat(s)	allow **1** mark for organisms in correct order (left to right) but arrows incorrect or missing allow **2** marks for cat(s) ← bird(s) ← nut(s) do **not** accept cat(s)bird(s) nut(s) do **not** accept cat(s) →bird(s) →nut(s)	2	AO2 4.7.2.1
03.2	answer must be consistent with food chain given in question **03.1**	if no answer to question **03.1** allow bird(s)	1	AO2 4.7.2.1
03.3	food pathogens		1 1	AO1 4.7.1.3
03.4	13.60 (mm)	allow 13.6 (mm)	1	AO2 4.6.2.2
03.5	structural		1	AO2 4.7.1.4
03.6	variation mutation reproduction generation	must be in this order	1 1 1 1	AO2 4.6.2.2

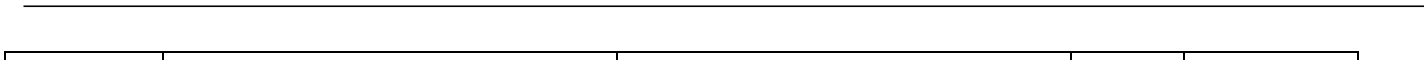
4.1.2.1 Chromosomes

03.7	birds have a shorter life cycle than humans		1	AO3 4.6.3.1 4.6.3.4
03.8	bacteria can become resistant to antibiotics		1	AO1 4.6.3.1 4.6.3.4
Total			**13**	

4.1.2.1 Chromosomes

Answer 05 · Mark scheme

November 2021 | 8464/B/2F | Original Q3



4.1.2.1 Chromosomes

Answer 06 · Mark scheme

June 2022 | 8464/B/1F | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	gene chromosome nucleus cell	must be in this order	1	AO1 4.1.1.1 4.1.1.2 4.1.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	differentiation	ignore specialisation	1	AO1 4.1.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	4	allow 15	1	AO2 4.1.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	46	allow 23 pairs (of chromosomes)	1	AO2 4.1.2.1 4.1.2.2

4.1.2.1 Chromosomes

Answer 06 · Mark scheme

June 2022 | 8464/B/1F | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	**Stage 1** any **one** from: • (cell) growth • increase in number of sub-cellular structures • DNA replicates • chromosomes double / duplicate / replicate	allow increase in number of organelles / ribosomes / mitochondria allow genetic material for DNA allow DNA doubles / duplicates	1	AO1 4.1.2.2
	Stage 2 any **one** from: • (one set of) chromosomes pulled to each end of cell • two nuclei form	ignore mitosis occurs allow chromosomes line up across the centre of the cell allow chromosomes move to opposite ends of the cell allow nucleus divides / splits (into two)	1	
	Stage 3 any **one** from: • cytoplasm / membrane divides • two identical cells formed	allow cytokinesis	1	

4.1.2.1 Chromosomes

Answer 06 · Mark scheme

June 2022 | 8464/B/1F | Original Q6

Question	Answers	Mark	AO / Spec. Ref.
06.6	**Level 2:** Scientifically relevant features are identified; the way(s) in which they are similar / different is made clear and (where appropriate) the magnitude of the similarity / difference is noted.	4–6	AO3
	Level 1: Relevant features are identified and differences noted.	1–3	AO2
	No relevant content	0	

4.1.2.1 Chromosomes

Answer 06 · Mark scheme

June 2022 | 8464/B/1F | Original Q6

	Indicative content General comparisons: • boys height at birth (slightly) greater than girls height • boys are (slightly) taller than girls up to age 11 • correct height comparisons eg boys are approximately 4 / 5 cm taller than girls up to age 11 • girls and boys are the same height at age 11 • girls are taller than boys between age 11 and age 14 • girls and boys are the same height at age 14 • boys are taller than girls above age 14 • correct height comparisons eg boys are 5 to 18 cm taller than girls above age 14 • boys (eventually) grow taller than girls • boys carry on growing for a longer time than girls • girls stop growing age 13 / 14 / 15 **and** boys stop growing age 17 / 18 Rate comparisons: • rate of growth similar up to age 10 / 11 • girls grow faster than boys between 10 / 11 and 14 allow girls have a greater increase in height between 11 and 14 • growth spurt occurs at a younger age in girls • growth spurt starts age 10 / 11 in girls **and** age 13 / 14 in boys • increased rate of growth in girls aged 10 to 13 /14 **and** in boys aged 13 to 17 / 18 Key points for Level 2 are correct reference to 0-11 year period, 11-14 period and after age 14, with at least one correct reference to rate of growth or use of correct values of height and age to illustrate rate.		4.1.2.2

4.1.2.1 Chromosomes

Answer 06 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.7	repair of tissues **or** replacement of cells	ignore growth allow repair of organs ignore repair of cells allow replacement of tissues ignore replacement of organs	1	AO1 4.1.1.4

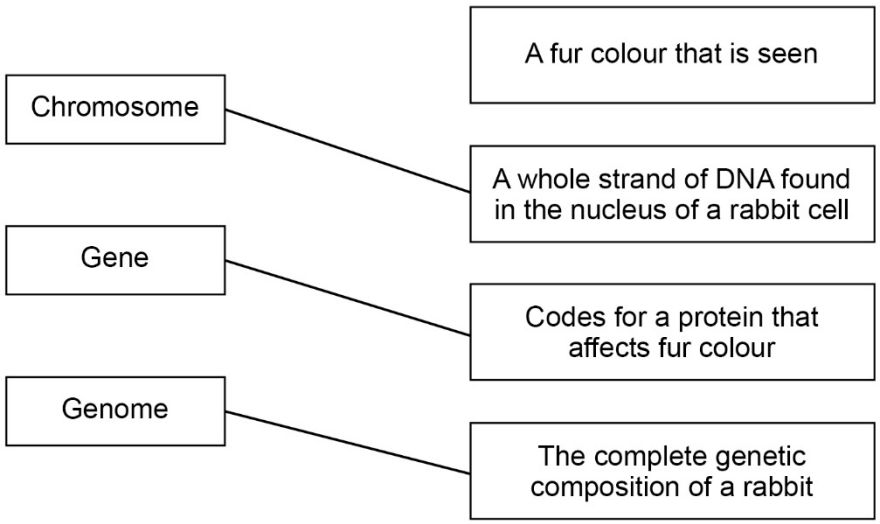
Total Question 6		**14**

4.1.2.1 Chromosomes

Answer 07 · Mark scheme

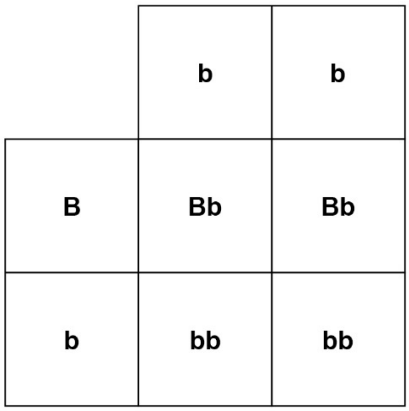
June 2025 | 8464/B/2F | Original Q5

Question 5

Question	Answers	Mark	AO / Spec. Ref.
05.1	Term / Meaning of the term  do **not** accept more than one line from a box on the left	1 1 1	AO1 4.6.1.3 4.6.1.4

4.1.2.1 Chromosomes

Answer 07 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2				
	gametes correct	allow in either position in Punnett square	1	AO2
	offspring genotypes correctly derived	allow correct derivation of offspring genotypes from incorrect gametes allow 3 correctly derived offspring genotypes for **1** mark	2	AO2
	any **bb** offspring identified as having white fur		1	AO2
	0.5	probability must match offspring genotypes if given allow 50% **or** 1 in 2 **or** 1:1 **or** $\frac{1}{2}$ do **not** accept 1:2	1	AO3 4.6.1.4

4.1.2.1 Chromosomes

Answer 07 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3		allow gamete(s) **or** sex cells for sperm throughout		
	sperm have one of each chromosome (pair)	allow sperm have one **set** of chromosomes / genes allow sperm (only) have one allele for each gene allow sperm are haploid allow sperm have half the (number / amount of) chromosomes (compared with a body cell) allow sperm have 23 / 22 chromosomes ignore sperm have one allele ignore sperm have half the DNA / genes	1	AO2
	sperm are produced by meiosis **or** body cells have two of each chromosome	allow body cells have pairs of chromosomes allow body cells are diploid allow body cells have 46 / 44 chromosomes allow **B** and **b** are (alleles) on 2 chromosomes (of the same pair)	1	AO1 4.6.1.1 4.6.1.2 4.6.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	44	allow 22 pairs	1	AO2 4.6.1.6

4.1.2.1 Chromosomes

Answer 07 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	has two X (chromosomes)	allow XX allow the rabbit is not XY allow the rabbit does not have a Y (chromosome) allow the rabbit only has X (chromosomes) allow both (X) sex chromosomes are the same size	1	AO1 4.6.1.6

Total Question 5	**12**

4.1.2.1 Chromosomes

Answer 04 · Examiner comments November 2021 | 8464/B/2F | Original Q1

Question 1 (low demand)

This question assessed the genetics section of the specification. Nearly all students could recall or calculate the number of chromosomes in a sperm cell when told the number of chromosomes in a human body cell. **01.2** was more challenging with few students being able to correctly link the words ‘gene’, ‘genome’ and ‘nucleus’ with the meaning of that word. Of these, nucleus was the most common correct response.

Most students knew the term heterozygous, but few could give the genotype in **01.5**. Many students correctly completed the Punnett square, however interpreting this to give the correct probability was more difficult, with an answer of 50% frequently seen.

Answer 05 · Examiner comments November 2021 | 8464/B/2F | Original Q3

Question 3 (low demand)

Many students could not give the food chain. Some students obtained one mark out of two for having the organisms in the correct order, but used dashes or commas instead of arrows. More students could give the primary consumer in the food chain. Reading from the graph was generally answered well. Fewer students could complete the sentences about evolution.

4.1.2.1 Chromosomes

Answer 06 · Examiner comments

June 2022 | 8464/B/1F | Original Q6

Question 6 (standard demand)

06.1 A quarter of the students put gene, chromosome, nucleus and cell in order of increasing size.

06.2 Fewer than a tenth of students gave the correct answer, differentiation. Some said specialisation, whilst most students thought the process was mitosis or cell division.

06.3 19% of students correctly calculated the number of cell divisions to form a 16-cell embryo.

06.4 41% of students knew that the cells of a human embryo have 46 chromosomes.

06.5 23% of the students scored any marks for this question. Most of these students scored a mark for Stage 1 by saying that the cell grows or that there is an increase in the number of sub-cellular structures. Some students thought Stage 1 was fertilisation, and they went on to describe the development of an embryo.

A mark for Stage 2 was less often awarded. Many students said mitosis happens, but as this was written on the cell cycle diagram it did not gain credit.

For Stage 3 many students only referred to two daughter cells forming, when reference to two identical cells was required. Reference to specialised cells being formed was seen quite a lot.

4.1.2.1 Chromosomes

Answer 06 · Examiner comments

June 2022 | 8464/B/1F | Original Q6

06.6 The question asked students to compare the growth of boys with the growth of girls, using data from growth curves.

There are three main sections in the graph:

- a section from birth to age 10 or 11, where the height and growth rate of boys and girls is very similar
- a section from age 10 or 11 up to age 14, where girls grow faster than boys
- the section from 14 to 18 years, where boys continue to grow rapidly whilst girls have stopped growing.

Within each section there were several comparisons that could be made.

To score the highest marks reference to all three sections of the graph was required, in addition to at least one comparison of the rate of growth. This was rarely seen, where a quarter of students scored three marks. Similar proportions scored two marks and one mark, amounting to 81% scoring at least a single mark.

As the command word was 'Compare' it was important that comparative statements about boys and girls were made. All the statements given in the indicative content are comparisons.

Many responses gave descriptions of what they had learnt about puberty and growth spurts, but if they did not match the data given in the graph they were not credited. Any data given had to be correct.

Common errors in interpreting the graph included:

- boys grow faster than girls up to age 11
- boys grow shorter, or stop growing, at age 11
- girls stop growing at age 18.

06.7 8% of students scored this mark. The question asked for one way that mitosis is important in fully grown animals; so saying 'to grow' was not credited. Some students said for growth and repair, which was insufficient.

Replacement of cells or tissues was required. Repair of tissues, organs or wounds all gained credit. Repair of damaged cells is incorrect.

Many students said mitosis is needed for reproduction, or development of an embryo, both of which were ignored.

4.1.2.1 Chromosomes

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

Answer 07 · Examiner comments

June 2025 | 8464/B/2F | Original Q5

Question 5 (Standard demand)

05.1 The most common incorrect answer was a gene linked to 'a fur colour that is seen'. Students seemed to have a better understanding of the meaning of the term genome.

05.2 45% of students on Foundation tier gained 4 or more marks.

Those students who were able to put the gametes given in the question stem correctly into the Punnet square generally also achieved 2 marks for the correct derivations. Many students failed to identify the offspring that would have white fur and consequently could not be awarded marking point 4. However, the probability mark was often seen and was awarded if it was correct for the student's derivations.

Some students used the Punnet square incorrectly, with gametes given on the outside of the square and more than four derivations.
The most common error was students using both parent genotypes as Bb.

A number of 50/50 answers were seen despite this being highlighted in previous examiner reports as not being an equivalent probability to 0.5 or 50:50. Some students incorrectly gave the probability as 50, rather than 50% and therefore could not be awarded marking point 5.

05.3 This proved a very challenging question with relatively few students gaining a mark. Commonly, students tried to answer in terms of dominant and recessive alleles or genotypes, described the inheritance of alleles from parents, or described the different roles of sperm cells and body cells. Very few made any reference to chromosomes, and even fewer mentioned meiosis.

A frequently seen misconception was that 'sperm contain half a chromosome', illustrating that some students struggle with the abstract concepts relating to this part of the specification. Incorrect use of terminology was frequent, such as 'body cells are heterozygous, but sperm cells are homozygous'. Another frequent misconception was the idea that body cells contain maternal and paternal genes or chromosomes, but that sperm cells only contain paternal genes or chromosomes.

0 5 . 3 A male rabbit is heterozygous for fur colour.

The rabbit's body cells have the genotype **Bb**.

One of the sperm cells from the rabbit has the allele **b**.

Explain why the alleles in the rabbit's body cells and the allele in the sperm cell are different.

[2 marks]

The sperm cell has half of the rabbits DNA and when combines with the other half that is in a female rabbits eggs it creats a whole cell

This student has given a common response that could not be awarded either mark. 'Half of the rabbits DNA' is insufficiently clear as to which 'half' is in the sperm cell, therefore is not equivalent to marking point 1.

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4.1.2.1 Chromosomes

Answer 07 · Examiner comments June 2025 | 8464/B/2F | Original Q5

05.4 A small proportion of students correctly gave an answer of 44, and very few gave the correct equivalent answer of 22 pairs. The most common incorrect answers were 21, 22 and 42, although those also frequently seen included 1, 2, 11, 23 and 46.

05.5 This question asked for evidence from the figure that the rabbit was female. This was answered well with many students stating that there were 2 X chromosomes. A few students did not gain the mark because they stated '2 X genes' or '2 X alleles'. Some students recognised the absence of the Y chromosome which also gained the mark.