Question	Answers	Extra information	Mark	AO / Specification reference
01.1	23 46 alleles dominant recessive		1 1 1 1 1	AO1 4.6.1.6
01.2	BB – homozygous dominant Bb – heterozygous bb – homozygous recessive	all three correct for 2 marks one or two correct for 1 mark	2	AO1 4.6.1.6
01.3	BB – Brown eyes Bb – Brown eyes bb – Blue eyes		1 1 1	AO1 4.6.1.6
01.4	the baby may be born with brown eyes, or may be born with blue eyes		1	AO2 4.6.1.6
01.5	as the mother may be heterozygous for the eye colour gene		1	AO2 4.6.1.6
02.1	image B as the chromosomes are identical / XX		1 1	AO2 4.6.1.8
02.2	mother XX, father XY resulting allele combinations XX, XY, XX, XY half offspring boys, half offspring girls 50% chance of offspring being a girl		1 1 1 1	AO1 4.6.1.8
02.3	12.5%	allow ecf from 02.2 allow 50% chance for each child for 1 mark allow (0.5^3) x 100 for 2 marks	3	AO2 4.6.1.8 MS1c

02.4	Manchester 1:1 ratio a statistical probability the larger the sample size the more likely the sample will show the statistical likelihood		1 1 1	AO2 4.6.1.8
03.1	additional finger(s) / toe(s)		1	AO1 4.6.1.7
03.2	caused by dominant allele so if either parent passes on the dominant / faulty/ polydactylyl allele the child will have the condition		1 1	AO1 4.6.1.7
03.3	father – D d mother – d d	accept any letter providing the correct uppercase/lowercase combination is used	1 1	AO2 4.6.1.7
03.4	diagram correctly showing father and mothers alleles possible alleles of offspring Dd, dd, Dd, dd	allow ecf from 3.3	1 1	AO2 4.6.1.7
03.5	1:1	accept 2:2	1	AO2 4.6.1.7
03.6	genetic cross diagram/calculated value shows expected statistical outcome combination of alleles random so actual offspring will not necessarily follow statistical likelihood		1 1 1	AO2 4.6.1.7

03.7	Any **six** from: • polydcatyly is caused by a dominant allele • only one allele is required to inherit condition • higher likelihood of inheriting condition • relevant figure quoted e.g. 75% chance of polydactyly from heterozygous parents • polydactyly does not reduce life expectancy • so allele for polydactyly likely to be passed on to offspring • CF is caused by a recessive allele • two recessive alleles need to be inherited to inherit condition • so likelihood of inheriting condition relatively low • relevant figure quoted e.g. 25% chance of CF from heterozygous parents • CF reduces life expectancy / can cause infertility so allele for CF less likely to be passed on to offspring		6	AO3 4.6.1.7
04.1	the allele which will always be expressed if present		1	AO1 4.6.1.6
04.2	DD, Dd	both required for 1 mark	1	AO2 4.6.1.6
04.3	offspring alleles DD, Dd, DD, Dd		1 1	AO2 4.6.1.6
04.4	100% likelihood of dimples being present as all allele combinations contain the dominant allele		1 1	AO2 4.6.1.6 MS1c

04.5	gametes contain half the parents chromosomes/ Alleles present in each gamete cell are random / different		1	AO2 4.6.1.6
	gametes fuse / join/ combine randomly		1	
	so each offspring will inherit different combinations of alleles so look different		1	
	overall alleles from which offspring are produced are the same so they look similar		1	
05.1	any **two** from: • regular lung infection • persistent coughing • shortness of breath • poor growth rate / weight gain infertility	accept any other correct symptom	2	AO1 4.6.1.7
05.2	cystic fibrosis caused by recessive allele		1	AO2 4.6.1.7
	carrier will have the allele combination C c		1	
	disorder only expressed if both alleles are recessive		1	
05.3	fathers alleles Cc, mothers alleles Cc		1	AO2 4.6.1.7
	offspring alleles CC, Cc, Cc, cc		1	
05.4	25%		2	AO2 4.6.1.7 MS 1c
05.5	280	1 mark: chance of couple meeting who are both carriers = $(1/25)^2$ / 0.0016 1 mark: Chance of offspring from two carrier having CF = 0.25 3 marks: Probability of a couple being carriers and having a child with CF = 0.0004 4 marks: Number with CF = 700000×0.0004	5	AO2 4.6.1.7 MS1c
06.1	mitosis		1	A01 4.6.1.1

06.2	any **four** from: • DNA replicates / 2 copies of the chromosomes are formed • one set of chromosomes is pulled to each end of the cell • The nucleus divides • cytoplasm and cell membrane divides to form 2 identical cells		3	A01 4.1.2.2
07.1	24		1	AO2 4.6.1.6
07.2	12		1	AO2 4.6.1.6
07.3	two parents are required gametes fuse together		1 1	AO1 4.6.1.6
07.4	any **four** from: • copies of the DNA / genetic information is made • cell divides twice • to form four gametes / pollen cells • each with a single set of chromosomes each pollen cell is genetically different / non identical		4	A02 4.6.1.2
08.1	polymer / chain of nucleotides two strands arranged as a double helix		1 1 1	A01 4.6.1.4
08.2	specific sequence of amino acids create a specific protein (which carries out a particular function)		1 1	A01 4.6.1.4
08.3	the complete set of genes / genetic material present in a cell / organism		1	AO1 4.6.1.4
08.4	find genes linked to disease understand / design treatments for inherited disorders trace ancestry /human migration		1 1 1	A01 4.6.1.4

09.1	ovaries		1	A01 4.6.1.2
09.2	testis		1	A01 4.6.1.2
09.3	any **four** from: **Similarities:** • starts with one parent cell • genetic material is copied **Differences:** • mitosis produces 2 cells / meiosis produces 4 cells • mitosis produces diploid cells (2 sets of chromosomes)/ meiosis produces haploid cells (1 set of chromosomes) • in mitosis the cell divides once / in meiosis the cell divides twice mitosis produces clones (genetically identical cells) / meiosis produces genetically different cells	to achieve full marks students must mention at least one similarity and one difference	4	A01 4.6.1.2 4.1.2.2
09.4	any **three** from: • each gamete is (genetically) different • random combination of half of the parents chromosomes • meeting of sperm and egg is random unique combination of parental chromosomes/alleles combined		3	A01 4.6.1.2
09.5	gamete cells are produced by meiosis contain half the number of chromosomes / haploid cell when egg and sperm join chromosome number if returned to normal / a full set / diploid cell cells in early embryo / fertilised egg divide by mitosis to grow into a foetus / baby		1 1 1 1	A01 4.6.1.2 4.1.2.2

10.1	pancreas releases digestive enzymes for fats / starches / proteins		1	AO2 4.6.1.7
	if these are blocked large insoluble molecules will not be digested / broken down		1	
	villi provide large surface area for digestion		1	
	if surface area reduced fewer soluble / digested molecules will be able to pass into bloodstream		1	
10.2	any **two** from: • pathogens enter lungs and are trapped in mucus • cilia are unable to move mucus out of the lungs pathogens remain and cause infection		2	AO2 4.6.1.7
10.3	**Social:** • allows a couple a choice about whether or not to being a child into the world with a genetic disorder • screening enables health service / support services to plan extent of support networks **Economic:** • cost of procedure small compared with cost of lifetime care • enables couple to make pragmatic choice about whether they will be able to financially support child effectively **Ethical:** • risk of parents 'choosing' characteristics of their child • right to life of unborn foetus enables implication that some conditions are not 'desirable' – may increase prejudice could prevent a child being born who may suffer from pain / constant medical intervention	to award 6 marks, answers should include at least one relevant point for each of social, economic and ethical considerations allow other valid arguments	6	AO3 4.6.1.7

11.1	male and brown hair		2	AO2
11.2	recessive allele as neither parent shows this characteristic but the offspring does show the characteristic		1 1 1	AO2
11.3	heterozygous		1	AO2
11.4	mother genotype Bb, father genotype bb parents gametes– B b b b offspring Bb, bb, Bb, bb 50% will have red hair	accept a different letter used to represent the alleles but capitalisation must be correct	1 1 1 1	AO2
12.1	shortness of breath / tiredness / anaemia		1	A02 4.6.1.7
12.2	bind to / carry oxygen		1	AO1 4.2.2.3
12.3	(cells clump together) and block blood vessels can stop blood reaching the brain oxygen cannot reach the brain resulting in a stroke		1 1 1	AO2 4.2.2.2
12.4	oxygen		1	AO1 4.4.1.1
13.1	0.020		2	AO2 4.4.1.2
13.2	the data does follow $light\ intensity\ \alpha\ \frac{1}{distance^2}$. $k = I\ d^2$ $k \approx 2500$ all values fall within approx. 5% of mean value / are very similar therefore rule is correct / valid		1 1 1 1	AO2 4.4.1.2

13.3	x-axis: light intensity (arbitrary units), with linear scale 0– 40 au		1	AO2 4.4.1.2
	plots to tolerance ±1 mm		1	
	linear best fit line		1	
13.4	rate of photosynthesis directly proportional to light intensity		1	AO2 4.4.1.2
	therefore light intensity is the limiting factor		1	
	other limiting factors (temperature / carbon dioxide concentration) would have caused the rate to fall below a directly proportional relationship / gradient of the line to decrease		1	
13.5	shortness of breath / tiredness / anaemia		1	A02 4.6.1.7
14.1	differences in the characteristics within a species		1	AO1 4.6.2.1

| 14.2 | place seeds of plant A <u>and</u> plant B
in different environmental conditions
condition suggested e.g. different temperatures / access to different volumes of water / different light intensity
allow time for plants to grow
suggestion of monitoring growth e.g. change in mass, change in height, number of leaves

Discussion of how to deduce whether effect is caused by genes or the environment:
• compare growth (rate) of plants grown from seeds from sunflowers A and B
• plants of sunflower A in all conditions will have grown more or less (rapidly) than sunflower B in the same conditions, as they have different genes
• the plants in different conditions will grow to different heights, as they have different environmental factors supplied or removed | award one mark per marking point

award up to four marks for an appropriate method

award up to two marks for a discussion of genetic and environmental effects on growth rate | 6 | AO3
4.6.2.1 |