1 **(a)**	*gene* a length of DNA that codes for a protein **;** *gene mutation* a change in base sequence of DNA **;**	[2]	**R** chromosome / molecule of / genome
(b) (i)	1 **Bb ;** 2 **bb ;** 3 **Bb ;**	[3]	

Question		**Mark**	**Guidance**
(ii)	(Bb x bb) **B** , **b** + **b** , (**b**) **;** *offspring genotypes* **Bb** and **bb** **;** **A** heterozygous and homozygous recessive *offspring phenotypes* normal / carrier and acatalasia **;**	[3]	<table><tr><td colspan="2"></td><td colspan="2">male gametes</td></tr><tr><td colspan="2"></td><td>B</td><td></td></tr><tr><td rowspan="2">female gametes</td><td>b</td><td>Bb</td><td></td></tr><tr><td>(b)</td><td>Bb)</td><td>(bb)</td></tr></table>
(iii)	test (cross) **;**	[1]	
		[Total: 9]	

Question		Marks	Guidance Notes
2 **(a) (i)**	1 cros / breed, (parent) plants with <u>desired</u> feature **;** 2 (grow seeds and) chose offspring for (desired) feature(s) **;** 3 cross (offspring) plants showing features with, original variety / self / each other **;** 4 kee / many generations of, crossing and selecting **;** 5 any detail **;** e.g. bagging flowers / transfer of pollen (with paintbrush) / detail of seed collection	[max 3]	
(ii)	1 two parents / gametes, are required **;** 2 variation in offspring / offspring might not all be red **;** 3 time consuming **;** 4 AV **;** e.g. harvesting seeds / finding pollinators, can be difficult / limited number of seeds / wasteful in context of unused pollen	[max 2]	**I** cost / energy
(b)	1 <u>reductio / nuclear, division</u> **;** 2 chromosome <u>number</u> is halved **;** 3 (diploid to) haploid **;** 4 results in <u>genetically</u> different, cells / gametes / AW **;**	[max 2]	
(c) (i)	F^A F^N **;**	[1]	
(ii)	pink (flowers) **;**	[1]	ecf from **(c)(i)**
(iii)	*gametes:* F^A , F^N , F^A , F^A **;** *offspring genotype:* F^AF^A, F^AF^N **;** *offspring phenotype:* red, pink **;** *proportion of pure breeding carnation plants*: 50% / 1:1 / 0.5 / half **;**	[4]	
		[Total:13]	

Question		Mark	Guidance
3 (a)	<table><tr><th>gametes</th><th>(X)</th><th>X</th></tr><tr><td>(X)</td><td>XX</td><td></td></tr><tr><td>(Y ;)</td><td>XY</td><td>XY ;</td></tr></table> offspring ratio = 1:1 / 50:50 / 50% male, 50% female / 2:2 ;	[3]	
(b) (i)	**cat 1** X^bY ; **cat 4** X^BY ; **cat 5** X^BX^B ;	[3]	
(ii)	distinct, phenotypes / coat colours / categories ; no (continuous) range of colour / AW ; controlled by genes ; not affected by the, environment / AW / named example ;	[3]	**A** only orange, black and calico **A** inherited
		[Total: 9]	

4 **(a) (i)**	*Caenorhabditis* ;	[1]	
(ii)	thread-like bodies / filamentous / filament-like ; unsegmented body ; hydrostatic skeleton ; body, tapers / is pointed, at, one / both, ends ; through gut / mouth and anus ; relatively large pharynx / sucking mouthparts ;	max [2]	
(b)	prevents accumulation of dead matter / removes (organic) waste ; recycles nutrients / named nutrient(s) ; releases (carbon as) carbon dioxide ; (carbon dioxide) for photosynthesis ; decreases particle size of food for decomposers ; ref to energy flow in, food chain / food web / ecosystem ;	max [3]	**R** energy cycling / recycling
(c) (i)	gametes from same individual ; self-fertilisation / described ; only new source of variation is mutation ; variation produced by meiosis ;	max [2]	
(ii)	6 ;	[1]	

(iii)	***P*** *meiosis* reduction division / chromosome number is halved **;** prevents doubling of chromosome number, with each generation / when gametes fuse together / at fertilisation **;** ref to haploid (cells / gametes / sex cells) **;** gamete / sex cell, production **;** ***Q*** *mitosis* growth is taking place **;** producing (genetically) identical cells **;** more diploid cells **;**	max [3]	producing haploid gametes = 2
(d)	in chromosomes **;** in the nucleus **;** in mitochondria **;**	max [2]	**A** in plasmids **;**