1 **(a)**	**1** antennae **;** **2** elongated bodies **;** **3** <u>segmented</u> body / many <u>segments</u> **;** **4** many (⩾10) legs **;** **5** (one or two pairs of) legs on each segment **;** **6** exoskeleton **;** **7** <u>jointed</u> legs **;**	max [3]	
(b)	**1** length of antennae **;** **2** number of sections on antennae **;** **3** presence / absence, of tail pieces / AW **;** **4** length of tail pieces **;** **5** length of legs **;** **6** number of leg joints **;** **7** total number of legs **;** **8** position of legs on body **;** **9** number of legs per segment **;** **10** size / shape of segments **;** **11** number of body segments **;** **12** length of body **;** **13** head shape **;** **14** presence / absence ‘spots / markings’ **;**	max [3]	

1 (c) (i)	nucleus ;	[1]	**Ignore** chromosomes
(ii)	**1** *idea that* animals are identified accurately ; **R** identify unqualified **2** barcoding is, cheap / easy / quick / efficient ; **3** barcoding is useful if distinguishing characteristics / dichotomous key are difficult ; **4** identify previously unknown species ; **5** helps to identify, threatened / endangered species ;	max [2]	
(iii)	**1** ref to genes ; **2** codes for (specific) proteins ; **3** stores genetic information ; **4** can be copied to pass on information to new cells ;	max [2]	
(d) (i)	**1** all arrows point from food to feeder ; **2** millipedes eat dead leaves <u>and</u> fungi ; **3** food chain : bacteria → nematodes → springtails → centipedes ; **4** centipedes eat millipedes, springtails and earthworms ;	[4]	
(ii)	**1** ref to, respiration / decomposition ; **2** release <u>carbon dioxide</u> ; **3** carbon dioxide is taken in by, plants / photosynthesis ;	max [2]	
		[Total:17]	

Question		Marks	Additional Guidance
2 (a (i)	**1** concentration of PCBs increases up the food chain / **ora**; **2** concentration is much higher in larger organisms / **ora**; **3** big(gest) increase between herring and porpoise; **4** (only) herring / porpoise / animals at top of food chain, have a range of concentrations; **5** use of figures (arbitrary units) to make a comparison between two, trophic levels / organisms;	**max 3**	**MP4** must be a qualitative statement, not just statement of figures **MP5** – must be a comparison not just figures unqualified, e.g. use of 'but', 'and', 'only', etc. and accept $\times1.8/2$, $\times4$, $\times30$, $\times384$, $\times1900$
(ii)	animals at higher trophic levels live longer; eat many of the animals below them in the food chain; PCBs cannot be, excreted / eliminated / removed / broken down; so build up in the body (tissues); <u>bioaccumulation</u> / <u>biomagnification</u>;	**max 3**	
(b) (i)	<u>mutation</u> / change in DNA; any mutagen; gene(s) code for, AHR / protein; any sensible suggestions about change to protein molecule; fish susceptible to PCB poisoning died; fish with changed protein survived and reproduced; passing on mutant <u>allele</u>; reference to (natural) selection;	**max 5**	**A** ref to genetic variation **R** AHR / protein, mutates e.g. radiati e.g. different amino acid sequen
(ii)	fish with mutant allele not at an advantage / no selection for PCB resistance; PCB resistant fish may not compete well with others / **ora**; so less successful at breeding / **ora**; leave fewer offspring / **ora**; idea that mutant allele is diluted as fish interbreed;	**max 2**	**A** 'the altered AHR protein is of less / no use'

Question		Marks	Additional Guidance
2 (c)	**1** persistent / does not breakdown / accumulates; **2** fill up / takes up space in, landfill sites / rubbish dumps; **3** suffocate / choke, animals; **4** kills animals that get trapped in it; **5** release, toxins / poisons; **6** AVP;	max 3	**MP1 A** 'can't get rid of them' / takes a long time to breakdown **MP3** and **MP4** do not allow kill unqualified **MP5** maybe in context of leaching out, burning or eating **I** references to recycling **I** pollution unqualified • (fill with water to become) breeding grounds for mosquitoes • blocks light for, photosynthesis • negative effect on tourism / visual pollutant • blocks drains • blocks flow of water in, rivers / streams • reduces soil, drainage / aeration • interferes with water treatment allows spread of alien species in the oceans
		[Total: 16]	

Question	answers	Mark	Additional Guidance
3 **(a)**	there are different forms of one, feature / characteristic **;** example of a feature shown by Soay sheep **;** coat / fur, colours patterns of coat / AW with and without horns lengths of horns ear, length / width / size / shape face, length / width / size / shape body mass body shape / body size / AW	[2]	look for a general explanation of 'variation in their phenotype' and an example the example chosen does not have to be visible in Fig. 6.1
(b) (i) **1** **2** **3**	*in years with high populations of sheep* more deaths in total **; A** low survival rate *for all sizes of lambs* more lambs died than survived **;** any comparative data quote using same body mass in high and low population years – units (kg) are not necessary **A** tolerance given in table for bars between gridlines	[max 2]	*looking at sum total of the bars in each graph* *looking at bars for each body mass* e.g. lambs 13-14 (kg), 106 died in hi population year against 12 that died in low population year see page 18 for table of data

Question	answers	Mark	Additional Guidance
3 (ii)	*in high population – ora for low population* *one mark for competition and two marks for marking points 2-11*		**ignore** explanations about why the population is high in some years and low in others – not relevant
1	competition for, shelter / food / grass / resources **;**	[1]	
2	as a result of competition there is shortage of food for each lamb **;**		
	as a result of competition for food		**R** competition for mates
3 4 5	lambs do not store enough fat **;** ref insulation **;** cannot survive the winter **;**		
6 7 8 9 10	ewes / females, produce less milk **;** ref to number of lambs per female **;** ref to, more likely to die of disease / AW **;** **A** disease more likely to spread more small lambs die **;** (pregnant) ewes / females, are short of food	[max 2]	

Question	answers	Mark	Additional Guidance
3 (c)	*note that this is **not** a question about artificial selection*		*points need to be in correct sequence and in the context of selection*
1	variation / AW, among the sheep in the population **;**		
2	some are better, adapted / suited / AW, than others **; A** 'best adapted'		**R** better animals survive unqualified by adaptation or some example
3	any example of an adaptive feature for survival in the extreme conditions **;**		'some sheep have thicker coats' = **MP1** and **MP3** **MP3** must be a feature related to survival in extreme conditions, not 'strength', 'fitness' 'healthiness' etc
4	any example of an appropriate selective agent **;** **ignore** 'extreme conditions / weather'		to survive the cold = **MP4**
5	survive and, breed / have offspring **; A ora**		
6	pass on their <u>alleles</u> **;**		
8	*idea that* over time better adapted, features / traits, become more common **;**	[max 4]	

body mass / kg	low population years		high population years	
	died	surv	died	surv
3 – 4	0	0	6 (5 – 7)	0
5 – 6	0	2 (1 – 3)	15 (14 – 16)	0
7 – 8	0	7 (6 – 8)	20	(2 – 4)
9 – 10	5 (4 – 6)	16 (15 – 17)	56	(5 – 7)
11 – 12	12 (11 – 12)	48	(93 – 95)	25 (24 – 26)
13 – 14	12 (11 – 12)	57 (56 – 58)	106 (105 – 107)	30 (29 – 31)
15 - 16	12 (11 – 12)	52		34 (33 – 35)
17 – 18	6 (5 – 7)	22 (21 – 23)	16	(17 – 19)
19 – 20	2 (1 – 3)	12	(5 – 7)	2 (1 – 3)
21 - 22	0	0	2 (1 – 3)	0