2013 Biology (Revised)

Advanced Higher

Finalised Marking Instructions

Part One: General Marking Principles for Biology (Revised) Advanced Higher

This information is provided to help you understand the general principles you must apply when marking candidate responses to questions in this Paper. These principles must be read in conjunction with the specific Marking Instructions for each question.

(a) Marks for each candidate response must always be assigned in line with these general marking principles and the specific Marking Instructions for the relevant question. If a specific candidate response does not seem to be covered by either the principles or detailed Marking Instructions, and you are uncertain how to assess it, you must seek guidance from your Team Leader/Principal Assessor.

(b) Marking should always be positive ie, marks should be awarded for what is correct and not deducted for errors or omissions.

GENERAL MARKING ADVICE: Biology (Revised) Advanced Higher

The marking schemes are written to assist in determining the "minimal acceptable answer" rather than listing every possible correct and incorrect answer. The following notes are offered to support Markers in making judgements on candidates' evidence, and apply to marking both end of unit assessments and course assessments.

1. There are no **half marks**. Where three answers are needed for two marks, normally one or two correct answers gain one mark.

2. In the mark scheme, if a word is **underlined** then it is essential; if a word is **(bracketed)** then it is not essential.

3. In the mark scheme, words separated by/are **alternatives**.

4. If two answers are given which contradict one another the first answer should be taken. However, there are occasions where the second answer negates the first and no marks are given. There is no hard and fast rule here, and professional judgement must be applied. Good marking schemes should cover these eventualities.

5. Where questions in data are in two parts, if the second part of the question is correct in relation to an incorrect answer given in the first part, then the mark can often be given. The general rule is that candidates should not be penalised repeatedly.

6. If a numerical answer is required and units are not given in the stem of the question or in the answer space, candidates must supply the units to gain the mark. If units are required on more than one occasion, candidates should not be penalised repeatedly.

7. Clear indication of understanding is what is required, so:

- if a description or explanation is asked for, a one word answer is not acceptable
- if the question asks for **letters** and the candidate gives words and they are correct, then give the mark
- if the question asks for a word to be **underlined** and the candidate circles the word, then give the mark
- if the result of a calculation is in the space provided and not entered into a table and is clearly the answer, then give the mark
- **chemical formulae** are acceptable eg CO_2, H_2O
- contractions used in the Arrangements document eg DNA, ATP are acceptable
- words not required in the syllabus can still be given credit if used appropriately eg metaphase of meiosis

8. Incorrect **spelling** is given. Sound out the word(s),

- if the correct item is recognisable then give the mark
- if the word can easily be confused with another biological term then **do not** give the mark eg ureter and urethra
- if the word is a mixture of other biological words then **do not** give the mark, eg mellum, melebrum, amniosynthesis

9. **Presentation of data:**

- if a candidate provides two graphs or bar charts (eg one in the question and another at the end of the booklet), mark both and give the higher score
- if question asks for a line graph and a histogram or bar chart is given, then do not give the mark(s). Credit can be given for labelling the axes correctly, plotting the points, joining the points either with straight lines or curves (best fit rarely used)
- if the *x* and *y* data are transposed, then do not give the mark
- if the graph used less than 50% of the axes, then do not give the mark
- if 0 is plotted when no data is given, then do not give the mark (ie candidates should only plot the data given)
- no distinction is made between bar charts and histograms for marking purposes. (For information: bar charts should be used to show discontinuous features, have descriptions on the *x* axis and have separate columns; histograms should be used to show continuous features; have ranges of numbers on the *x* axis and have contiguous columns)
- where data is read off a graph it is often good practice to allow for acceptable minor errors. An answer may be given $7{\cdot}3 \pm 0{\cdot}1$

10. **Extended response questions:** if candidates give two answers where this is a choice, mark both and give the higher score.

11. **Annotating scripts:**

- put a 0 in the box if no marks awarded – a mark is required in each box
- indicate on the scripts why marks were given for part of a question worth 3 or 2 marks. A ✓ or **x** near answers will do

12. **Totalling scripts:** errors in totalling can be more significant than errors in marking:

- enter a correct and carefully checked total for each candidate
- do not use running totals as these have repeatedly been shown to lead to more errors

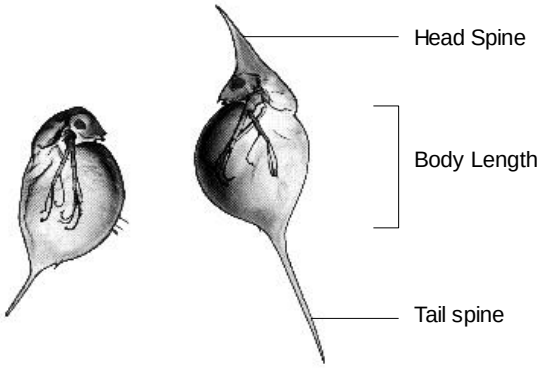
Part Two: Marking Instructions for each Question

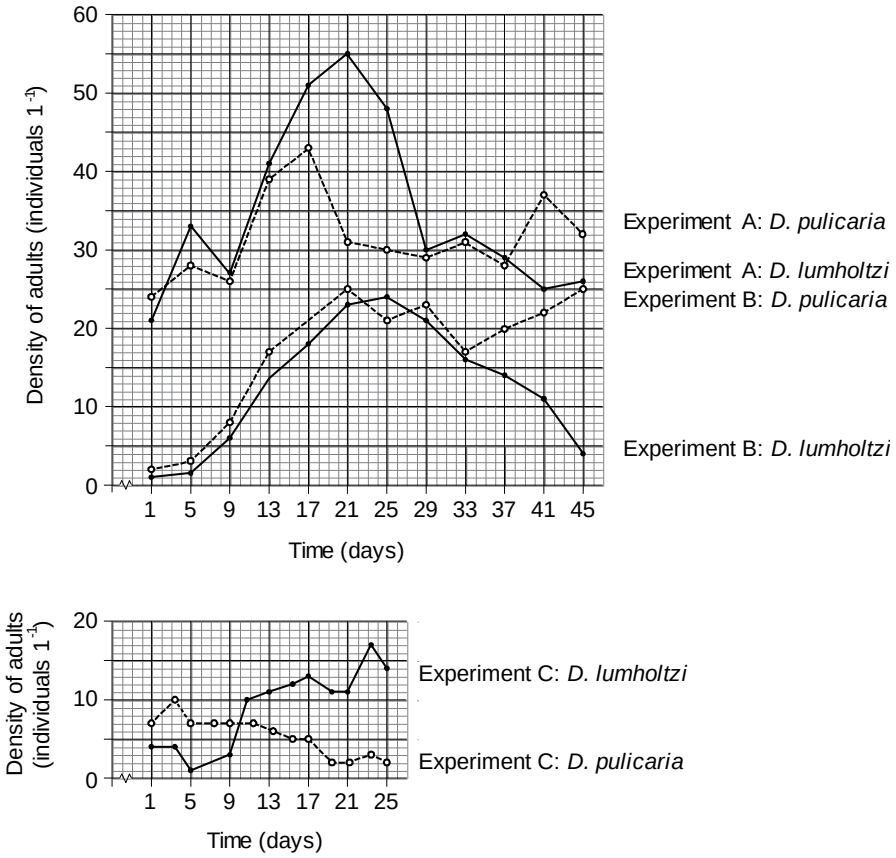
Section A

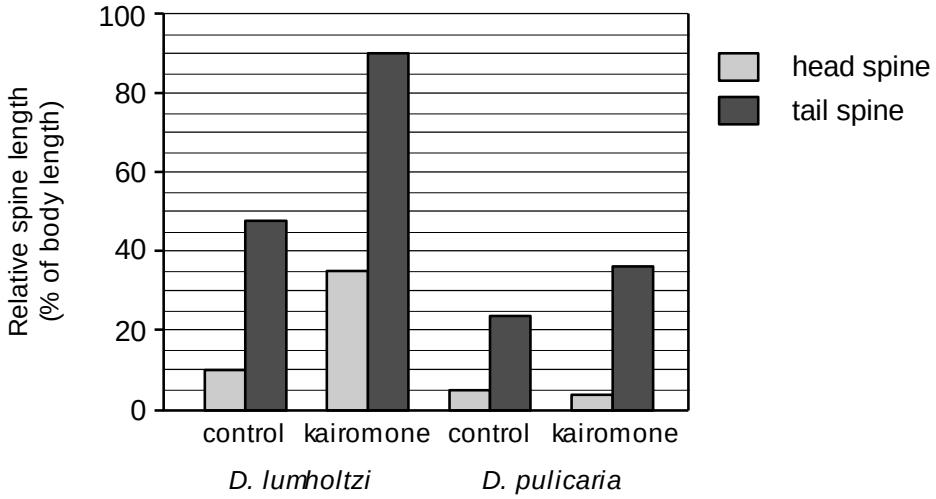
Question			Expected Answer/s	Max Mark	Notes	Negates
1			D	1		
2			A	1		
3			A	1		
4			C	1		
5			C	1		
6			A	1		
7			D	1		
8			B	1		
9			A	1		
10			B	1		
11			D	1		
12			B	1		
13			D	1		
14			D	1		
15			B	1		

Question			Expected Answer/s	Max Mark	Notes	Negates
16			A	1		
17			C	1		
18			C	1		
19			C	1		
20			A	1		
21			C	1		
22			B	1		
23			D	1		
24			C	1		
25			A	1		

Section B

Question			Expected Answer/s	Max Mark	Notes
1			Some species of *Daphnia* (water fleas) are able to develop their head spines and tail spines as structural defences against predators such as fish. These structures can increase in length in response to kairomones, chemicals in water where the fish occur. One species, *Daphnia lumholtzi*, occurs naturally in freshwater habitats in Africa, Asia and Australia. It has now spread throughout North America, first appearing in lakes in the south in 1990 and reaching more northern and western lakes within four years. It is thought to have been introduced when lakes were stocked with African fish species. **Figure 1: Illustration of *Daphnia lumholtzi* before and after exposure to kairomones**  The successful spread of *D. lumholtzi* has been attributed to its ability to develop defensive spines. To investigate the relevance of this feature to *Daphnia* survival, laboratory experiments were carried out to compare the population dynamics of *D. lumholtzi* with *Daphnia pulicaria*, the most widely distributed American species. All the experiments were conducted under standard conditions of temperature (20ºC) and light in identical plastic tanks. The culture medium was based on minerals and phosphate buffer made up in water of a very high purity. *Daphnia* were fed with green algae in quantities that maintained constant food availability. The density of each species was the same at the start and populations were left for several days before sampling began.		

Question			Expected Answer/s	Max Mark	Notes
1			(cont) Figure 2 shows the population changes observed from the first day of sampling in experiments set up as below: Experiment A: Single species alone without predators Experiment B: Two species together without predators Experiment C: Two species together with fish predators. Figure 3 shows the results of measuring the lengths of head spines and tail spines for the two species in culture medium either containing or lacking kairomones. **Figure 2: Population changes in Experiments A, B and C**  		

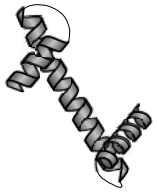
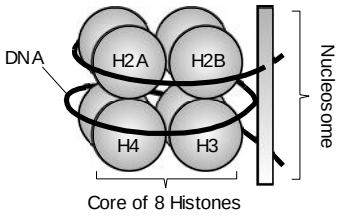
Question			Expected Answer/s	Max Mark	Notes
1			**(cont)** **Figure 3: Relative lengths of spines before and after exposure to kairomones**  		
	a		Refer to Figure 2.		
		i	Use the data at Day 41 to demonstrate that competition is a negative interaction for both species. Population of both species higher when separate/in Exp A **OR** equivalent for Exp B **1** D lum 25 vs 11 **OR** D pul 37 vs 22. **1**	**2**	Comparison of Experiment A with B
1	**a**	**ii**	Suggest how long it takes for spine formation to affect predator behaviour. Justify your answer. 9-13 days <u>and</u> (density of) *D lum* > *D. pul* **OR** *D lum* increasing *D. pul decreasing*	**1**	Any day in range 9-13 Comparison of the population change in **both** species

Question			Expected Answer/s	Max Mark	Notes
1	**b**	**i**	Refer to Figure 3. What appears to be *D. pulicaria's* defence against fish predation? Increase in length of tail spine	**1**	
1	**b**	**ii**	For *D. lumholtzi*, with a mean body length of 1·6 mm, what was the difference in length between the head spines in the control and kairomone cultures? 0·40 mm	**1**	
1	**c**		Explain why the researchers believed the formation of head spines to be critical in the survival of *D. lumholtzi* in competition with *D. pulicaria*. (When both are competing) in presence of fish / predators / kairomones / Exp C **1** Both species increase tail spines **and** *D lum* also increases head spine / *D pul* does not increase head spine **1**	**2**	Dl increases head spine as well as tail spine Increase = grow, produce, make

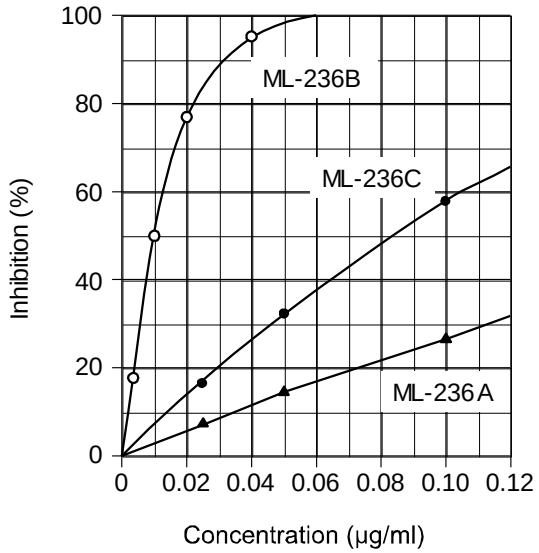
Question			Expected Answer/s	Max Mark	Notes
2			The table below shows data comparing some stages in the purification of an enzyme from a tissue sample. Total protein and enzyme activity are measured at the end of each stage.		

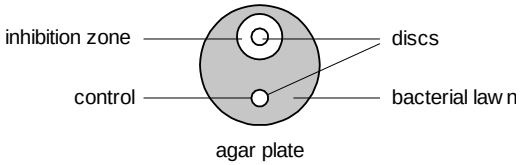
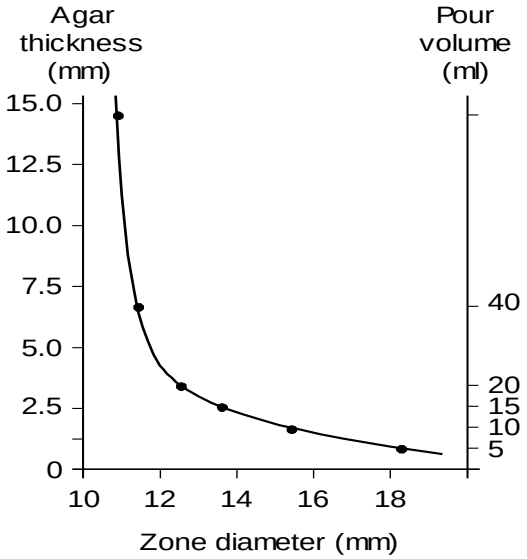
	Stage	*Total protein* (mg)	*Enzyme activity* (units)
1	Liquidised tissue	10 000	2 000 000
2	Precipitation by salts	3000	1 500 000
3	Iso-electric separation	500	500 000
4	Affinity chromatography	30	42 000

	a	**i**	By the end of the purification process, what percentage of the original protein has been removed? 99·7%	**1**	
2	**a**	**ii**	Enzyme purity can be calculated from these values as the *activity per mg of protein*. By how many times has the enzyme purity increased by the end of stage 4? 7 times **1 mark** for one correct specific activity difference is 1200 units	**2**	Specific activities Stage 1: 200 Stage 4: 1400
2	**b**		Explain the principle of iso-electric separation. Isoelectric point is pH where a protein has no net/overall charge **1** In a buffer, proteins at their isoelectric point will + not move in an electric field **OR** (become insoluble and) settle out / precipitate **1**	**2**	Amino acid OK instead of protein Electrophoresis = electric field
2	**c**		In affinity chromatography, a ligand specific to the enzyme was bonded to beads in a burette. Explain how this method can improve purity. the ligand binds the enzyme the enzyme is held in the burette while the other proteins pass through / wash out	**2**	

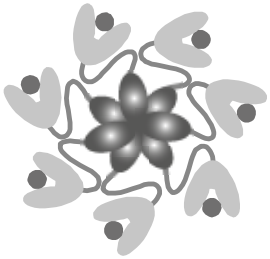
Question			Expected Answer/s	Max Mark	Notes
3			Figure 1 below shows the structure of a histone protein molecule, histone 4 (H4). Figure 2 represents a nucleosome showing the arrangement of the histones that make up its core. **Figure 1**  **Figure 2**  		
	a		Name the type of bonding that maintains the shape of an alpha helix in a protein. hydrogen	**1**	
3	**b**		What level of protein structure is shown in Figure 1? tertiary	**1**	
3	**c**		What is the importance of DNA being bound in nucleosomes? Packing / condensation of DNA (into chromosomes) / nucleosomes can further fold up	**1**	
3	**d**		Over 20% of the amino acids in histones are lysine and arginine. Explain why the high abundance of these positively charged amino acids is significant in the formation of a nucleosome. DNA has negative charges and histone binds DNA to produce compact shape	**1**	

Question			Expected Answer/s	Max Mark	Notes
4			When cholesterol accumulates in the wall of an artery, the plaque that forms reduces the internal diameter of the vessel. Plaque formation (atherosclerosis) is a major cause of heart disease. *Statins* are taken to reduce blood cholesterol and are among the most commonly prescribed medications. Cholesterol is synthesised by cells in a sequence of steps starting with acetyl-CoA from the citric acid (Krebs) cycle. The step that limits the rate of production is near the start and is catalysed by the enzyme *HMG-CoA reductase*, as illustrated below. acetyl-CoA ⟶ HMG-CoA (*HMG-CoA reductase*) ⟶ mevalonate ⇢ ⇢ cholesterol		
	a		In this pathway, a form of end-product inhibition occurs in which increasing cholesterol promotes the destruction of HMG-CoA reductase. Describe how end-product inhibition would be achieved if the enzyme was allosteric. Cholesterol / end product would occupy site away from active site / bind to second binding site / bind to allosteric site (on the reductase) change in conformation / shape <u>and</u> **reduced** affinity for / binding of substrate (at active site) less / no mevalonate for making more cholesterol / end product **Any 2**	**2**	
4	**b**		Statins inhibit HMG-CoA reductase by competing for the active site of the enzyme. Explain why this would reduce cholesterol formation. sits in active site <u>and</u> one from list below: prevents substrate / HMG-CoA entering reduces available enzyme reduces mevalonate (for next stages)	**1**	

Question			Expected Answer/s	Max Mark	Notes
4	**c**		The graph below shows results of an experiment carried out in 1976 on three forms of a substance, ML-236, extracted from a fungal culture. The experiment was assessing how well these substances inhibit cholesterol formation, the key requirement for a potential statin.  Use data for 50% inhibition to compare the effectiveness of the three molecules as potential statins. ML-236B is most effective inhibitor **OR** Rank order in terms of effectiveness **1** Quantify ML-236A does not reach on scale shown ML-236C at about 0.085 (+/- 0.005) ML-236B at 0.01 **1**	**2**	

Question			Expected Answer/s	Max Mark	Notes
5			Substances can be screened for antibiotic effects using the *diffusion plate* method. In this method, filter paper discs soaked in the test substance are laid on a "lawn" of bacterial culture freshly spread on a nutrient agar plate. A clear zone in the lawn around the disc occurs where the diffusing antibiotic stops growth.  The distance any substance travels in the agar depends on a range of factors that affect its rate of diffusion: these factors are confounding variables. In an experiment to evaluate one of these confounding variables, plates were made up by pouring different volumes of nutrient agar, creating different agar thicknesses. The results graph from the research paper is shown below.  		

Question			Expected Answer/s	Max Mark	Notes
5	**a**		What is meant by the term *confounding variable*? Any factor affecting the dependent variable that is not the independent variable factor affecting results / dependent variable <u>and</u> should be kept constant / monitored	**1**	
5	**b**		In this experiment identify the independent variable. pour volume / depth / thickness of agar	**1**	
5	**c**		Describe the results of the experiment. as the volume / depth of agar decreases the zone diameter increases	**1**	
5	**d**		Plates poured and stored for use at a later date gradually lose water by evaporation. Explain why results of experiments involving the diffusion plate method may be invalid when using stored plates. concentration of substance is higher so zone will be wider volume of water below disc is less so the concentration of substance is greater	**1**	

Question			Expected Answer/s	Max Mark	Notes
6			*Apoptosomes* are large protein structures formed inside cells during the process of apoptosis. Apoptosomes are formed in response to cell death signals. Diagram of apoptosome  cell death signals → formation of apoptosome → activation of proteinases involved in apoptosis		
	a		Name the type of proteinase activated by apoptosomes. caspase	**1**	
6	**b**		Give **one** reason why cell death must be carefully controlled in a multicellular organism. Link to organ / tissue formation (during development) **OR** degenerative conditions **OR** tumour formation	**1**	

Question			Expected Answer/s	Max Mark	Notes
6	c		Cell death signals can originate within the cell (intrinsic) or outwith the cell (extrinsic).		
		i	Give **one** example of an event that would trigger an intrinsic cell death signal. DNA damage	**1**	
6	c	ii	Describe how an extrinsic cell death signal initiates apoptosis. signal binds to surface receptor (protein) **1** (binding) triggers the events inside cells **1**	**2**	
6	d		Bcl-2 is a protein that regulates apoptosis by binding to apoptosomes, preventing them from activating proteinase. Some mutations cause an increase in the level of bcl-2 protein. Suggest why these mutations are associated with tumour growth. More bcl-2 so less apoptosome activity so possible tumour cells not destroyed / not undergoing apoptosis	**2**	

<table>
<tr><th colspan="3">Question</th><th>Expected Answer/s</th><th>Max Mark</th><th>Notes</th></tr>
<tr><td>7</td><td>a</td><td></td><td>Describe how insulin stimulates the uptake of glucose into cells.

insulin binding triggers recruitment of glucose transporters / GLUT 4 1

to (plasma) membrane of fat / muscle / target cells 1</td><td>2</td><td></td></tr>
<tr><td>7</td><td>b</td><td></td><td>Research has shown that fatty (adipose) tissue secretes a number of signalling molecules that regulate a variety of metabolic processes. One of these molecules, adiponectin, is thought to increase the sensitivity of cells to the hormone insulin.

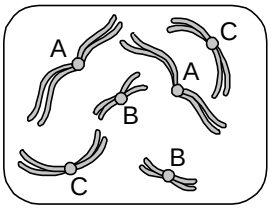
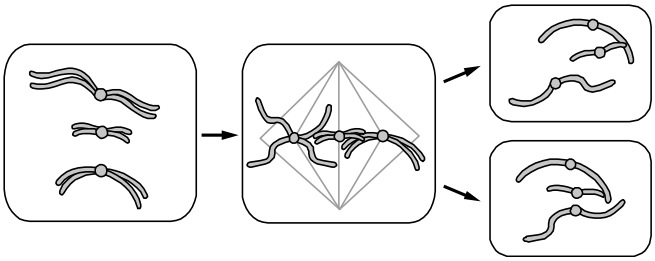
Table 1 shows the results of a study that compared the concentration of adiponectin in patients having type 2 diabetes with non-diabetic subjects.

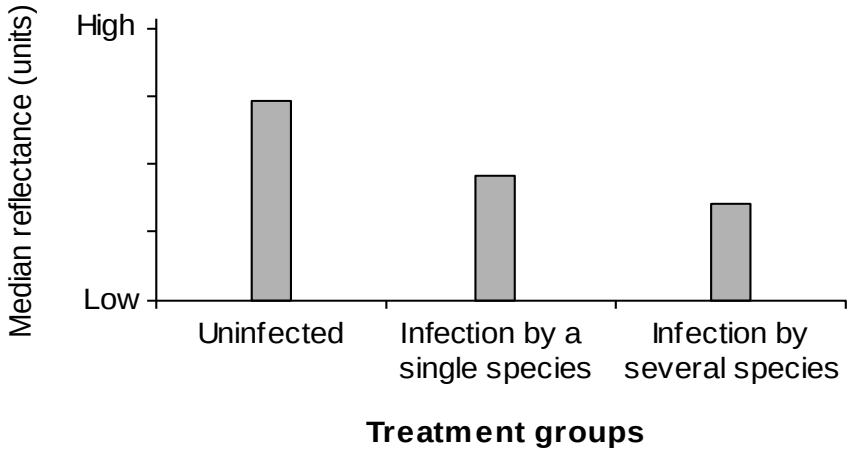
Table 1
<table>
<tr><th>Subjects</th><th>Average plasma adiponectin concentration (µg cm^{-3} ± SE)</th></tr>
<tr><td>type 2 diabetes</td><td>6·6 ± 0·4</td></tr>
<tr><td>non-diabetics</td><td>7·9 ± 0·5</td></tr>
</table>
Use the information to explain the relationship between type 2 diabetes and the average plasma concentration of adiponectin.

adiponectin levels are lower in type 2 diabetics / higher in non-diabetics

type 2 diabetes is associated with decreased sensitivity to insulin / loss of receptor function</td><td>2</td><td></td></tr>
</table>

Question			Expected Answer/s	Max Mark	Notes
7	c		Table 2 below shows the results of a second study that measured changes in adiponectin following treatment of individuals at risk of developing type 2 diabetes. **Table 2** *Treatment* | *Average increase in adiponectin concentration* ($\mu g\ cm^{-3} \pm SE$) drug treatment | 0·83 ± 0·05 lifestyle changes | 0·23 ± 0·05 none | 0·10 ± 0·05 How do the data in Table 2 **confirm** that both treatments were effective in increasing adiponectin concentration? Increases are (statistically) significant **OR** use error data to show the ranges do not overlap	**1**	
7	d	i	Both studies used human subjects. For this type of research: give **one** important ethical consideration informed consent / right to withdraw data / confidentiality	**1**	
7	d	ii	explain why a large sample size is required to produce valid conclusions it captures / represents the variation in the population large number of confounding variables other factors (such as body weight) may have an effect	**1**	

Question			Expected Answer/s	Max Mark	Notes
8			Figure 1 shows chromosomes of a gamete mother cell at the start of meiosis. The cell has three pairs of chromosomes, labelled A, B and C. Figure 1  Figure 2 		
	a		The chromosomes of each pair are described as homologous. Apart from being the same size, give **two** other features that are characteristic of homologous chromosomes. same position of centromere; same genes banding pattern; same genes at same loci **Any 2**	**2**	
8	**b**		Explain how members of a homologous pair may differ genetically. (genes correspond but) alleles differ **OR** maternal and parental origin of DNA	**1**	
8	**c**		Select **two** features from Figure 2 that show meiosis II is taking place. Cells have one of each chromosome / cells are haploid Chromosome line up singly on spindle Single chromatids in new cells / being separated **Any 2**	**2**	

Question			Expected Answer/s	Max Mark	Notes
9			The North American wild turkey (*Meleagris gallopavo*) shows distinct differences between males and females. The males have vividly-coloured, iridescent plumage. An experiment was carried out to investigate the effect of parasite infections on the amount of light reflected by the males' plumage. Results are shown in the chart below: lower reflectance scores indicate duller plumage.  		
	a		What term is used to describe the differences between males and females? Sexual dimorphism	**1**	
9	**b**		Describe the relationship between parasitic infection and the male birds' plumage. As the number of <u>species</u> (of parasites in the infection) increases the reflectance decreases	**1**	
9	**c**		The researchers have suggested that iridescent coloration in wild turkeys serves as an honest signal to females. How will this influence mating success? Coloration is correlated with male health Females choose healthier males <u>and</u> increase their own fitness / reproductive success	**2**	The question is **not** about the reproductive advantage to males of bright plumage. It is about the signals females use to improve the survival of their offspring.

Question	Expected Answer/s	Max Mark	Notes
10	The parasitic wasp, *Nasonia vitripennis*, lays its eggs inside the pupa stage of the housefly, *Musca domestica* (Figure 1). Wasp eggs hatch into larvae that consume the housefly pupae. Figure 2 shows a cage set up with populations of the wasp and the housefly.		

Figure 1

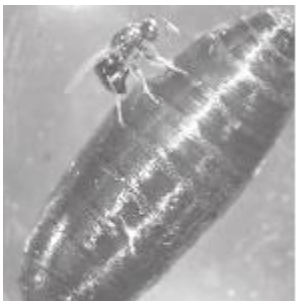
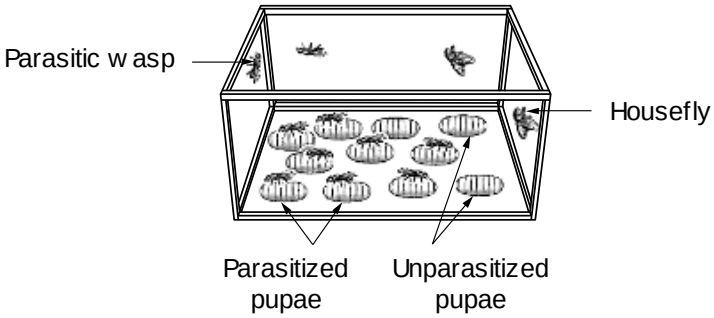
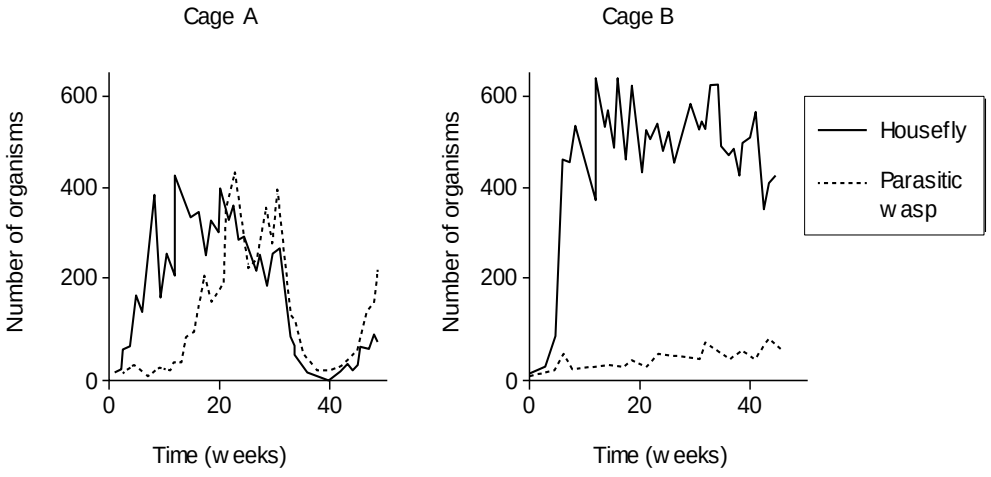


Figure 2



In a study to test the host's evolutionary response to the parasite, two cages were set up. In Cage A the housefly population had no previous exposure to wasps; in Cage B the housefly population had already been exposed to wasp parasitism for three years.

The graphs below show population changes in both species in the two cages over a 40 week time period.



Question			Expected Answer/s	Max Mark	Notes
10	**a**	**i**	How do the results support the general conclusion that the houseflies had developed resistance to wasp parasitism? In B, parasitoid numbers remain low whereas in A they were fluctuating (in relation to host population changes) **OR** Fly / host numbers high in B but fluctuate in A (in relation to parasitoid population)	**1**	Following an increase in host population in A, the parasite numbers increase. But not in B: when host population is high the parasite numbers remain low.
10	**a**	**ii**	Explain how the resistance would have evolved. mutation (produces resistance) **1** resistant individuals more likely to reproduce **OR** resistance increases in frequency / in subsequent generations **1**	**2**	
10	**b**	**i**	The response of the housefly is an example of co-evolution. What is meant by the term co-evolution? (in two interacting species) change in a trait / adaptation in one species acts as a selection pressure on the other	**1**	Adaptation in one species **results in** adaptation in another
10	**b**	**ii**	According to the Red Queen hypothesis, what population change would be expected in Cage B if it is now left undisturbed? Parasitoid / wasp population would increase **OR** flies decrease	**1**	

Question			Expected Answer/s	Max Mark	Notes
11	**A**		Answer either A or B. Discuss factors that maximise the transmission of parasites. 1. Transmission is spread of **parasites to host** 2. Virulent parasites have high transmission rate 3. High host density 4. Vector in life-cycle can nullify the need for a healthy host **OR** eg of vector transmission 5. Transmission can be water-borne (even though host is incapacitated) **OR** eg. 6. Host behaviour is exploited 7. eg STD, ingestion during grazing, etc **OR** named example 8. Host behaviour can be modified 9. eg risk taking/habitat choice/anti-predator behaviour, etc **OR** named example 10. So (host behaviour) is extended phenotype of parasite 11. Suppression of host immune system 12. Modification of host size (infected hosts larger and so more spores) 13. Host reproductive rate modified (infected hosts breed less) 14. Rapid rate of evolution (ie overcoming host immunity improvements) 15. Asexual life-cycle phase allows rapid build-up of adapted parasites	**10**	

Question			Expected Answer/s	Max Mark	Notes
11	**B**		Discuss how host immune responses minimise the impact of parasites in mammals. 1. Defences can be non-specific / natural **and** specific / adaptive 2. Physical barriers / secretions prevent entry of parasites **OR** examples 3. Inflammatory response **and** purpose 4. Destruction of **abnormal** cells by phagocytes / natural killer cells 5. Phagocytosis description as ingestion **and** digestion 6. White cells do 'surveillance' 7. A different lymphocyte is produced for each antigen 8. Lymphocytes amplified by clonal selection 9. T cells / T lymphocytes target infected or damaged cells 10. T cells induce apoptosis 11. Phagocytes display antigens 12. B cells make antibodies to specific antigens 13. Some lymphocytes act as memory cells	**10**	Abnormal = infected, stressed

[END OF MARKING INSTRUCTIONS]