2013 Biology

Advanced Higher

Finalised Marking Instructions

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Part One: General Marking Principles for Biology 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 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 spractice 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

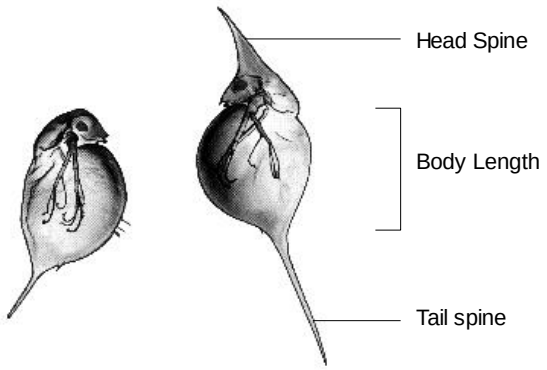
Part Two: Marking Instructions for each Question

Section A

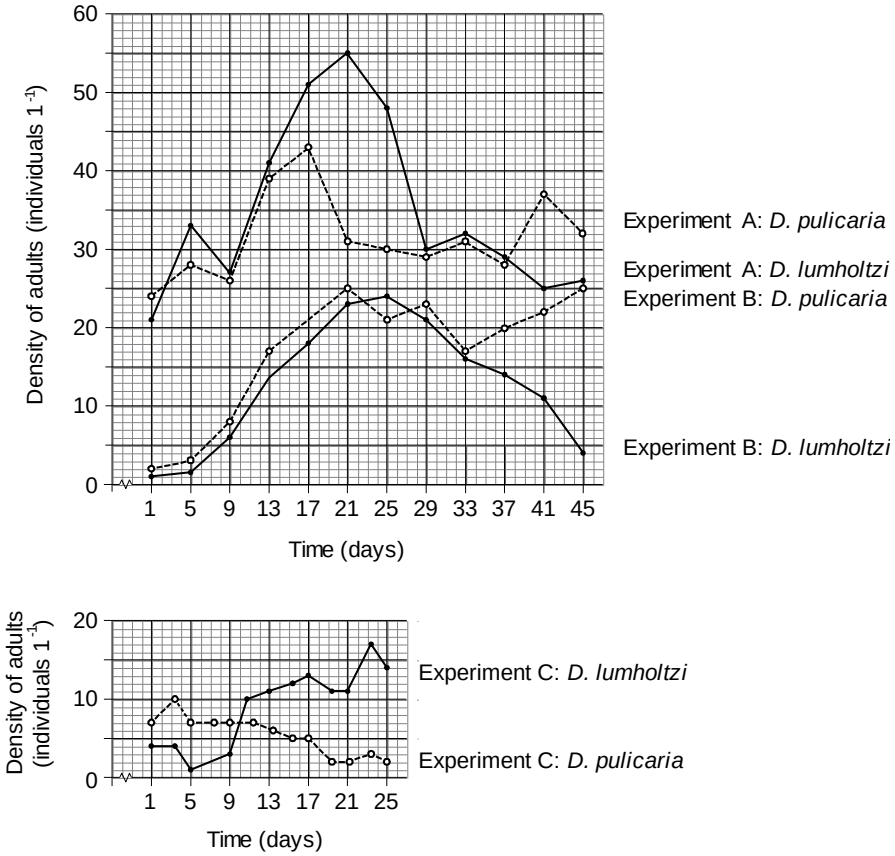
Question			Expected Answer/s	Max Mark	Notes	Negates
1			A			
2			C			
3			D			
4			B			
5			B			
6			A			
7			B			
8			A			
9			C			
10			C			
11			C			
12			D			
13			D			
14			A			
15			B			

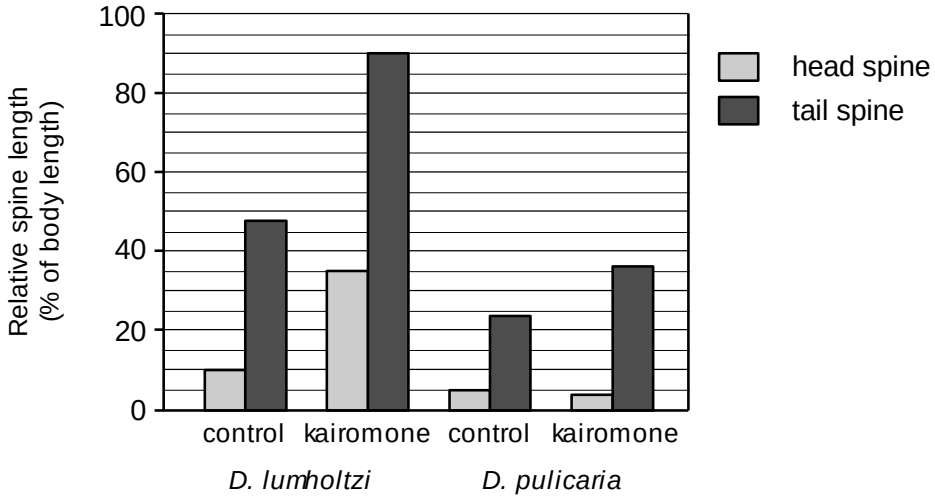
Question			Expected Answer/s	Max Mark	Notes	Negates
16			**D**			
17			**A**			
18			**C**			
19			**A**			
20			**D**			
21			**C**			
22			**D**			
23			**B**			
24			**B**			
25			**D**			

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 (20 ºC) 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**  		
1	**a**	**i**	Explain why *D. lumholtzi* can be described as an exotic species. Introduced (by human activity / artificially) Alien / foreign / not native / not naturally in N America	**1**	
1	**a**	**ii**	State **one** damaging effect of an exotic species on an ecosystem. Reduces (populations of) other species **OR** can cause extinction of other species **OR** lowers diversity	**1**	

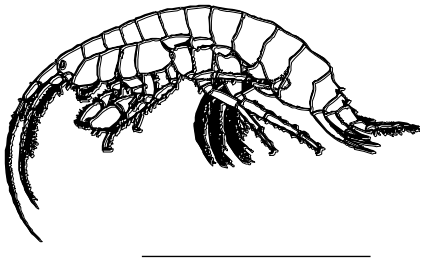
Question			Expected Answer/s	Max Mark	Notes
1	b	i	Refer to Figure 2. Use the data at Day 41 to demonstrate that competition is a negative interaction for both species. Population of both species higher when separate / in Exp A **OR** equivalent for Exp B **1** D lum 25 vs 11 OR D pul 37 vs 22. **1**	**2**	Comparison of Experiment A with B Units not needed
1	b	ii	What term could be used to describe the fate of *D. lumholtzi* in experiment B, if the trend observed from Day 33 to Day 45 continues? competitive exclusion (principle) **OR** (local) extinction	**1**	
1	b	iii	What evidence is there that spine formation may be affecting predator behaviour? In Exp C / predators present *D. lumholtzi > D pulicaria* *D lum* decreases in Exp B / no predators but increases in Exp C / predators present *D. pulicaria* decreased in the presence of predators but not in their absence **Any 1**	**1**	Comparison of Experiment B with C - the population trends are reversed when predators are present

Question			Expected Answer/s	Max Mark	Notes
1	**c**	**i**	Refer to Figure 3. What appears to be the defence of *D. pulicaria* against fish predation? Increase in **length** of tail spine	**1**	***D pulicaria*** *data comparing control and kairomone*
1	**c**	**ii**	Suggest why relative spine lengths were used in Figure 3. To allow comparison (of fleas with) different **body** size.	**1**	
1	**c**	**iii**	For *D. lumholtzi* with a mean body length of 1·6mm, what was the difference in length between the head spines in the control and kairomones cultures? 0·4 mm	**1**	Units required
1	**c**	**iv**	Compare the response of the two species to the presence of kairomones. In both species tail spines increase *D.lum* tail spines increase more than *D.pul* (tail) spines Head spines only increase in *D.lum* (decrease in D pul) **Any 2**	**2**	Comparison essential
1	**d**		Spine formation is a structural defence against predators. Give **two** defences against predators in which the mechanisms depend on coloration. crypsis / camouflage / masquerade / disruptive coloration / warning (aposematic) coloration / mimicry **Any 2**	**2**	Types of Mimicry only count once

Question			Expected Answer/s	Max Mark	Notes
2			Discuss the flow of energy through ecosystems. 1. Autotrophs fix light (energy) into chemicals / biomass / GPP 2. Heterotrophs obtain energy from food / from NPP **OR** Energy is transferred from one trophic level to another by feeding 3. Energy losses occur at a trophic level / at transfers 4. Ecological efficiency as percentage transferred 5. Energy lost in excreted / egested / uneaten material 6. Energy flow to detritivores / decomposers / saprotrophs 7. **All** energy ultimately lost as heat **OR** Heat energy lost from respiration **Any 5**	**5**	1.not solar Producer = autotroph Consumer = hetrotroph 3. Can include producer R loss as = to 'Not all energy passed on at each trophic level' 3. **Not** energy **decreases** = energy loss 5. Not 'waste'
3	**a**		Much of the heather moorland in Scotland is an unstable, man-made ecosystem. Heather moorland is maintained by sheep grazing and by burning to promote the growth of new heather. If these activities ceased, succession would result in stable woodland communities. What term is used to describe a stable woodland community? Climax (community)	**1**	
3	**b**		Give one reason why stability increases as succession proceeds from heather moorland to woodland. Increased + one from below: food web complexity species diversity / biodiversity / plant diversity nutrient levels in soil / humus variety of habitats variety / number of niches	**1**	Not biomass

Question			Expected Answer/s	Max Mark	Notes
3	**c**		Large areas of heather moorland are under threat from bracken, a type of fern that spreads vigorously by means of underground storage organs called rhizomes. Bracken can shade out neighbouring plants and it produces toxic compounds, some of which can reduce the germination and growth of other plant species. The spread of bracken on many moorland sites has been limited by mechanical control measures (cutting and rolling) and the use of the herbicide *asulam*. **Figure: Heather (*Calluna vulgaris*) being invaded by bracken (*Pteridium aquilinum*)**		
		i	What aspect of bracken's success can be attributed to interference competition? Production of toxic compounds **OR** shading (neighbouring) plants / heather	**1**	
3	**c**	**ii**	Why are mechanical control measures by themselves unlikely to be successful? **Underground** stems allow bracken to grow back / re-establish	**1**	Underground stems = rhizomes = storage organs Not 'roots'/'seeds'/cost Not 'spread'
3	**c**	**iii**	An EU ban on the use of *asulam* came into effect at the end of 2011. Suggest **one** reason why such a ban would be imposed. low specificity / kills other species / reduces diversity persistence leads to (unexpected) toxic effects	**1**	Acceptable answers can be **consequences** of low specificity, eg **toxic** to other species **OR** persistence, eg accumulation to **toxic** levels, run-off into pond is **toxic** **Not** 'damaging' / harmful'

Question	Expected Answer/s	Max Mark	Notes
4	Animals that live under polar sea-ice benefit from adaptations that allow them to survive changes in the salinity of their immediate environment as the ice freezes and thaws. The crustacean *Gammarus wilkitzkii* is a dominant species of the Arctic ice community.		



3 cm

During the summer, as sea-ice melts, this species experiences low salinity and during sea-ice growth in the winter it is exposed to high salinity.

Figure 1 shows the rate of oxygen consumption of this animal when transferred to water of varying salinity. Figure 2 shows ion concentrations in its body fluids at the higher salinities.

Figure 1

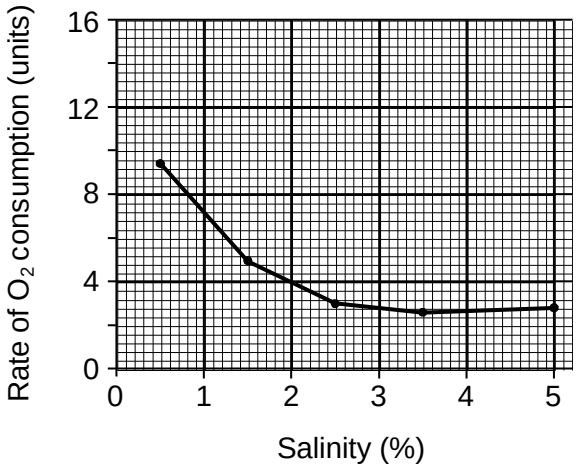
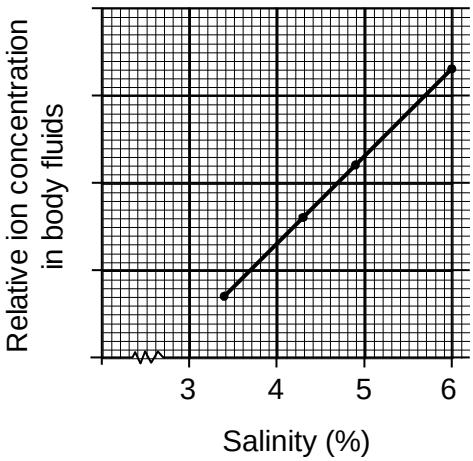
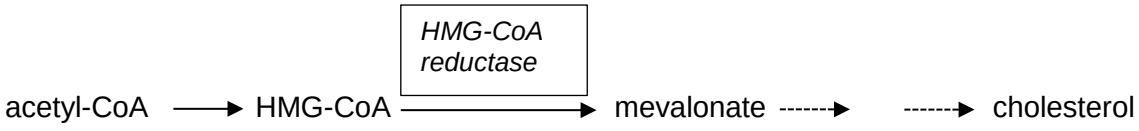
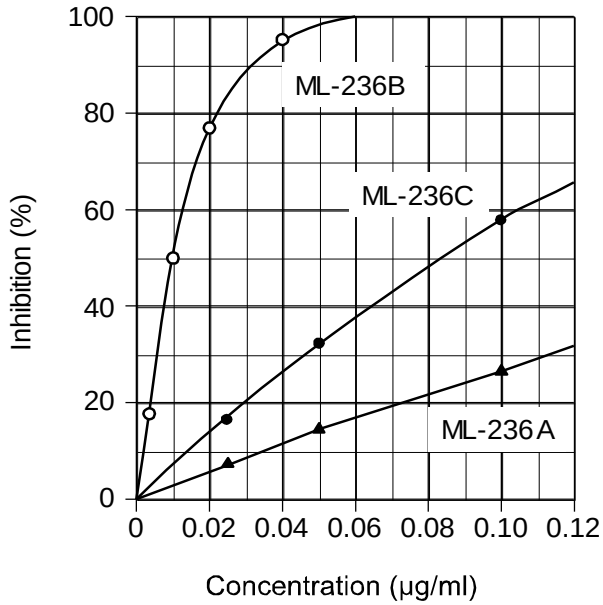


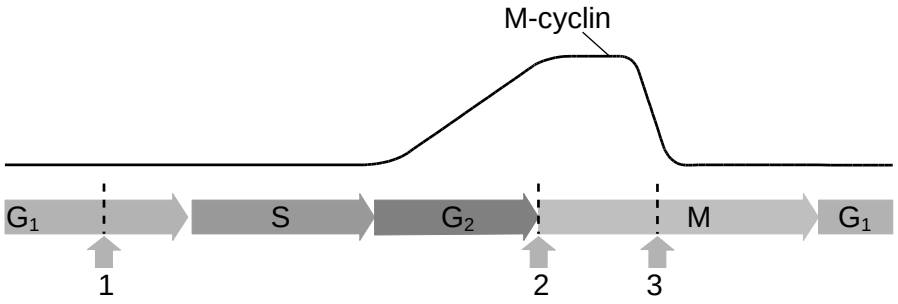
Figure 2



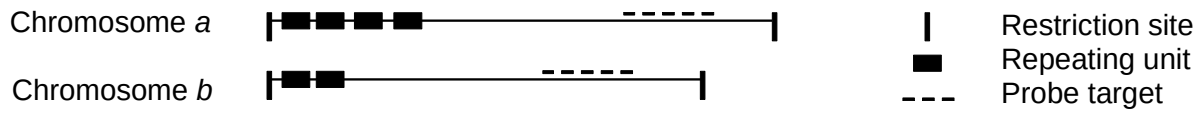
Question			Expected Answer/s	Max Mark	Notes
4	**a**		Refer to Figure 1. Explain how the data suggest that *Gammarus wilkitzkii* is a regulator in salinities up to 2·5%. Regulation has energy costs Oxygen consumption is higher at lower salinities / as salinity increases oxygen consumption decreases (to 2.5%) Greater oxygen use reflects greater energy demand / ATP production (to maintain internal conditions) **Any 2**	**2**	
4	**b**	**i**	Refer to Figure 2. What term is used to describe an organism that shows this type of physiological response? <u>Osmoconformer</u>	**1**	
4	**b**	**ii**	Increasing concentrations of ions in body fluids lower the temperature at which these fluids will freeze. Suggest how the response shown in Figure 2 would aid the survival of *G.wilkitzkii* during winter. as (sea) salinity rises, internal ion levels increase and body fluids / tissues / the animal can resist freezing	**1**	
4	**c**		Another crustacean, *Parathemisto libellula*, is unable to tolerate or resist salinity variations. How would this affect the habitat range that it could occupy? Restricted / limited / narrower (range)	**1**	
5	**a**		Cholesterol is an important component of cell membranes and a starter molecule in the formation of steroid hormones. Give **one** role of cholesterol in cell membranes. Reference to (membrane) fluidity Reference to permeability stabilises (membranes) Prevents crystallisation (of membrane)	**1**	Control fluidity OK, **not** regulate

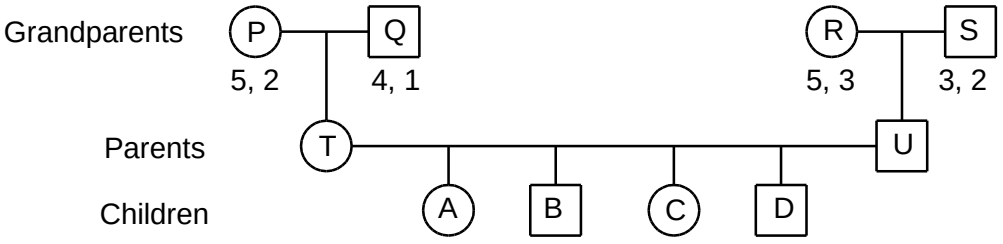
Question			Expected Answer/s	Max Mark	Notes
5	**b**		When cholesterol accumulates in the wall of an artery, the plaque that forms reduces the internal diameter of the vessel. Plaque formation (atherosclerosis) is a major cause of heart disease. *Statins* are taken to reduce blood cholesterol and are one of the most commonly prescribed medications. Cholesterol is synthesised by cells in a sequence of steps starting with acetyl-CoA from the 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.		
					
		i	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 would occupy site away from active site / bind to second binding site / bind to allosteric site **OR** enzyme would not be destroyed / enzyme would be modulated **OR** Cholesterol / end product would interact with 1st enzyme in the sequence **1**	**2**	'Inhibitor' = cholesterol
			change in conformation / shape <u>and</u> **reduced** affinity for / binding of substrate (at active site) **1**		**Not** substrate 'cannot fit' 'Reactant' = substrate
5	**b**	**ii**	Statins are *competitive* inhibitors of HMG-CoA reductase. Explain how they would reduce cholesterol formation. sits in active site <u>and</u> one from list below:	**1**	
			prevents substrate / HMG-CoA entering reduces available enzyme reduces mevalonate (for next stages)		Prevents binding OK

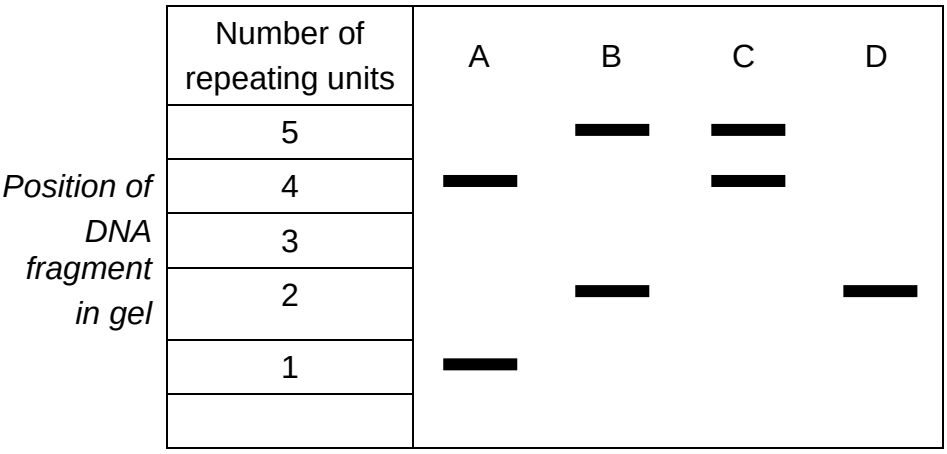
Question			Expected Answer/s	Max Mark	Notes
5	**b**	**iii**	The graph below shows results of an experiment done in 1976 on three forms of a substance, ML-236, extracted from a fungal culture. The experiment was assessing how well these substances inhibit cholesterol formation, the key requirement for 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**	Units not essential

Question			Expected Answer/s	Max Mark	Notes
6			During the cell cycle, proteins called *cyclins* are made and destroyed in a fixed sequence. As their concentrations change, they activate enzymes that cause the dynamic events of the next stage to proceed. The diagram below shows how cell cycle phases and checkpoints (1, 2 and 3) relate to changes in the level of one type of cyclin, *M-cyclin*.  		
	a		M-cyclin is part of the protein complex MPF. What is the role of MPF? (role of MPF is) to control entry into mitosis	**1**	Controls entry into = Promotes / triggers / induces
6	**b**		What is controlled at checkpoint 3 on the diagram? Exit from mitosis / Entry to anaphase Ensures equal distribution of DNA / chromosomes	**1**	**Not** trigger cytokinesis **Not** monitoring chromosome alignment
6	**c**		Use the diagram to suggest how M-cyclin contributes to the progress of the cell cycle. M cyclin increase, (enough) **enzymes** have been activated to pass checkpoint 2 / to enter mitosis **OR** Decrease in M cyclin activates **enzymes** for passing checkpoint 3 / to enter anaphase / to exit mitosis	**1**	

Question			Expected Answer/s	Max Mark	Notes
7			Fragments of DNA between restriction sites can vary in length depending on the number of repeating units present. DNA profiling identifies the number of repeating units between the restriction sites on each chromosome. The diagram below shows fragments from a pair of homologous chromosomes for an individual with four repeating units on one chromosome and two on the other chromosome. The genotype for this individual is described as 4, 2.		
	a		Orphans (A, B, C, D) from a war zone, believed to be from the same family, were being relocated back to grandparents. DNA profiling was used to check the family tree. The results are shown below.		





Question			Expected Answer/s	Max Mark	Notes
7	a		**(cont)**  		
		i	Explain the result for child D. has two copies of fragment with 2 units **OR** inherits fragment size 2 from both parents / both sets of grandparents	**1**	Acceptable alternatives: both alleles/genes have 2 has genotype 2,2 has two chromosomes of *chromosome b*
7	a	ii	Which child is **not** related to both sets of grandparents? Use the results to justify your answer. **A and** Grandparents R and S do not have 4 or 1 / either of A's alleles **OR** A does not have 5,3 or 2 so not related to R and S	**1**	
7	b		Explain the role of probing in the production of a DNA profile. probe **identifies** / **labels / tags** the DNA **fragments** (in the gel)	**1**	Q is not about how probes are designed

Question			Expected Answer/s	Max Mark	Notes
8			Answer **either** A **or** B		
	A	a	Give an account of the procedures involved in producing transgenic plants. Use the following headings: plant production by tissue culture 1. aseptic techniques / conditions 2. named suitable medium eg (M+S) **OR** two components: sugar, mineral (salts) / salts, N source, vitamins, amino acid, 'hormones' 3. explant or protoplasts needed **OR** description of source 4. callus forms **OR** mass of undifferentiated cells form 5. growth regulators cause differentiation / formation of roots / shoots 6. (plant growth regulators are) auxin **and** cytokinin 7. plantlets from callus 8. plant cells are totipotent / capable of differentiation into any cell type **max 5**	**5**	Hormone = plant growth regulator
		b	the use of *Agrobacterium* 9. (transgenic defined) organism with genetic material of another organism 10. (*Agrobacterium*) causes tumours / causes crown gall in plants 11. disease is caused by (Ti) plasmid 12. plasmids are (additional) circular DNA in bacteria	**4**	
		c	13. the bacterium / its plasmid can be used to transfer DNA / can be a vector 14. (*Agrobacterium* / Ti) plasmid inserts into (plant) DNA **max 4**		
			modification of plasmids 15. desirable gene removed / cut from source DNA 16. (Agro / Ti) plasmid cut using endonuclease / restriction enzyme 17. use same endonuclease / restriction enzyme **OR** ref to same sticky ends 18. foreign DNA / gene joined to (Ti) plasmid DNA by ligase 19. modified plasmid returned to (Agro)bacterium 20. plasmid has marker gene / antibiotic resistance gene / **or** other eg 21. that allows only modified *Agrobacterium* / <u>bacteria</u> to grow 22. plant cells are 'infected' with bacterium containing engineered plasmid 23. **plant cells** (grown) in selective medium 24. medium only allows growth of plant cells with foreign DNA 25. role of Bt toxin as insecticide **max 6**	**6**	'Source' can be a plasmid

Question			Expected Answer/s	Max Mark	Notes
8	**B**	**a**	Give an account of proteins in the following contexts: membranes 1. (membrane) proteins are integral / intrinsic and peripheral / extrinsic 2. Integral / intrinsic = in membrane / (phospholipid) bilayer **OR** peripheral = on membrane 3. join cells **OR** form junctions 4. attach to cytoskeleton / extracellular matrix 5. transport of (hydrophilic) substances across membranes 6. **two** from carriers / channels / pumps 7. some membrane proteins are enzymes 8. glycoproteins / proteins with carbohydrate portion are for cell-cell recognition / are antigenic markers	**5**	**Not** 'in phospholipid'
		b	cell signalling 9. some signalling molecules / hormones are proteins / peptides 10. hydrophilic signals cannot cross the membrane 11. protein / receptor for hydrophilic signal is in the membrane 12. receptors cause transduction / trigger cell response 13. hydrophobic signals / steroid hormones can pass through the membrane 14. protein / receptor for hydrophobic signals / steroid hormones is in the cell or in nucleus 15. protein / receptor is gene regulatory **OR** receptor-signal complex regulates transcription	**5**	Hydrophilic = water soluble = polar Hydrophobic = lipid soluble / not water soluble = non polar 13.Testosterone = steroid 15.Complex = hormone-protein
		c	cytoskeleton 16. cytoskeleton is made of (protein) fibres (of different types) 17. **microtubules** are made of tubulin / dimers / globular proteins 18. **microtubules** are straight / hollow rods 19. **microtubules** radiate from MTOC / centrosome 20. spindle fibres are microtubules 21. microtubules / cytoskeleton role in location / movement of (membrane-bound) organelles 22. cytoskeleton role in support / shape / movement of cells 23. other protein filaments in cytoskeleton + eg. keratin / intermediate or actin / microfilament 24. function of other component, eg actin in cytokinesis, keratin as fixed structure	**5**	

Section C

Biotechnology

<table>
<tr><th colspan="3">Question</th><th>Expected Answer/s</th><th>Max Mark</th><th>Notes</th></tr>
<tr><td>1</td><td></td><td></td><td>A study was carried out to investigate the growth rate of the bacterium Escherichia coli (E.coli) in different growth media. A single colony of bacteria was used to inoculate either complex broth or minimal medium to which was added one of a variety of carbon sources. Cell numbers were estimated using a colorimeter to measure the turbidity of the culture during growth. The generation time for each culture is shown in the table.

<table>
<tr><th>Growth medium</th><th>Generation time (minutes)</th></tr>
<tr><td>complex broth</td><td>22</td></tr>
<tr><td>minimal medium + glucose</td><td>40</td></tr>
<tr><td>minimal medium + succinate</td><td>67</td></tr>
<tr><td>minimal medium + ethanoate</td><td>120</td></tr>
</table>
</td><td></td><td></td></tr>
<tr><td></td><td>a</td><td>i</td><td>What is meant by the term generation time?

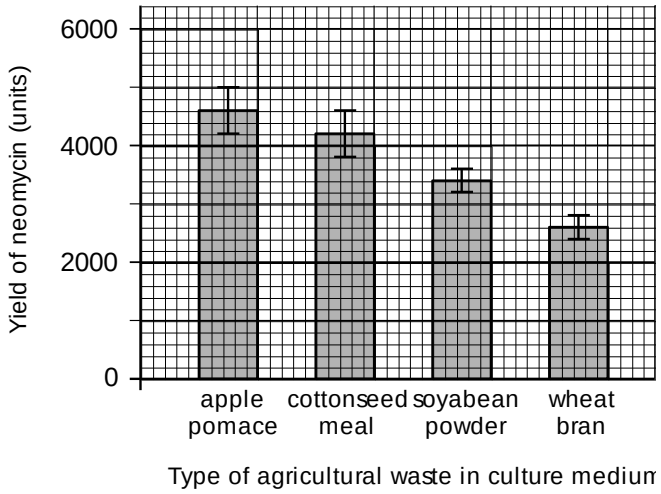
time for the cell number to double</td><td>1</td><td>Cell number = population</td></tr>
<tr><td>1</td><td>a</td><td>ii</td><td>Give two general conclusions about the effects of growth medium on the generation time of E.coli.

generation time is shortest in broth
OR
growth in broth is fastest / minimal media gives slower growth 1

carbon sources differ in their effects on growth rate / generation) time 1</td><td>2</td><td></td></tr>
<tr><td>1</td><td>b</td><td></td><td>Calculate the growth rate constant for E.coli growing in minimal medium containing ethanoate. (In2 = 0·693)

$0{\cdot}35h^{-1}$ (0.3465) OR $0.0058min^{-1}$ (0.006)</td><td>1</td><td>Units required</td></tr>
</table>

Question			Expected Answer/s	Max Mark	Notes
1	**c**	**i**	State **one** disadvantage of the method used to estimate cell numbers. (turbidity measurement) counts dead cells as well as live not a viable count cells of different shape / size scatter light differently instrument has to be calibrated for each microbial species **Any 1**	**1**	**Not** 'total count' alone
1	**c**	**ii**	Name an alternative method for obtaining cell number in bacterial cultures. dilution **plating** haemocytometer / direct counting	**1**	
2			Silage is an important winter feed for cattle. Give an account of the production of silage. 1. grass put in silos / wrapped in polythene **OR** storage prevents air entry 2. (cut grass / silage) inoculated with *Enterococcus* and *Lactobacillus* 3. (and) cellulases / pectinases 4. enzymes (partially) break down cells / release nutrients 5. bacteria create anaerobic conditions 6. bacteria produce lactic acid which lowers pH 7. anaerobic conditions and low pH prevents growth of spoilage organisms 8. nutritional quality preserved	**5**	

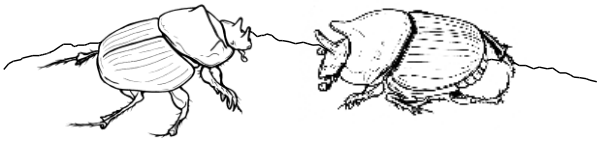
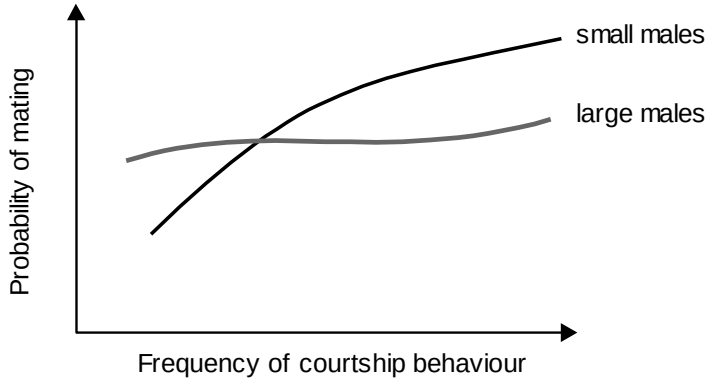
Question			Expected Answer/s	Max Mark	Notes
3			Antibiotics can be produced by growing micro-organisms in culture media made from waste materials. For example, apple *pomace* is a waste left over after juice extraction and it contains peel, seeds and other solid parts. Waste materials are dried and ground into a powder that can be added to culture medium in a fermenter.		
	a		The graph below shows the yield of the antibiotic *neomycin* produced using media containing a variety of agricultural waste products.  		
		i	It was concluded that medium containing apple pomace gave a higher yield of neomycin than media containing the other waste products. Comment on the validity of this conclusion. true for apple v soyabean *and* apple v wheat bran **1** no difference between apple pomace and cottonseed **OR** **no significant difference** between apple pomace and cottonseed **1**	**2**	

Question			Expected Answer/s	Max Mark	Notes
3	**a**	**ii**	This study was carried out in India where it is estimated that one million tonnes of apple pomace is produced each year. Suggest **two** reasons why it is desirable to use this material in the production of antibiotics. reduces cost **OR** gives high yield (of antibiotic) **1** gets rid of / upgrades waste **1**	**2**	
3	**b**		Neomycin is a bactericidal antibiotic. Describe how its action would differ from a bacteriostatic antibiotic. bactericidal kill bacteria <u>and</u> bacteriostatic inhibit their growth / block their metabolism	**1**	
4	**a**		Many enzymes used in biotechnology are produced industrially by fermentation using naturally occurring micro-organisms. Name **one** industrially produced enzyme and the micro-organism used in the fermentation. **enzyme** **organism** cellulase *Penicillium* / *Aspergillus* pectinase *Erwinia* amylase *Bacillus subtilis* / *Aspergillus*	**1**	
4	**b**	**i**	Describe **two** conditions that need to be controlled during the fermentation process used to produce enzymes. Any **two** from: sterility nutrient supply / concentration oxygen supply / aeration pH temperature addition of anti-foaming agents	**1**	

Question			Expected Answer/s	Max Mark	Notes
4	**b**	**ii**	Give **one** method used in the recovery of enzymes from the fermentation culture. Any **one** from: flocculation filtration centrifugation ultrafiltration vacuum evaporation chromatography	**1**	
4	**c**		Explain what is meant when an industrial enzyme is described as a *secondary metabolite.* substances produced in stationary phase (of population growth) substances not required for the growth of the organism	**1**	

Section C

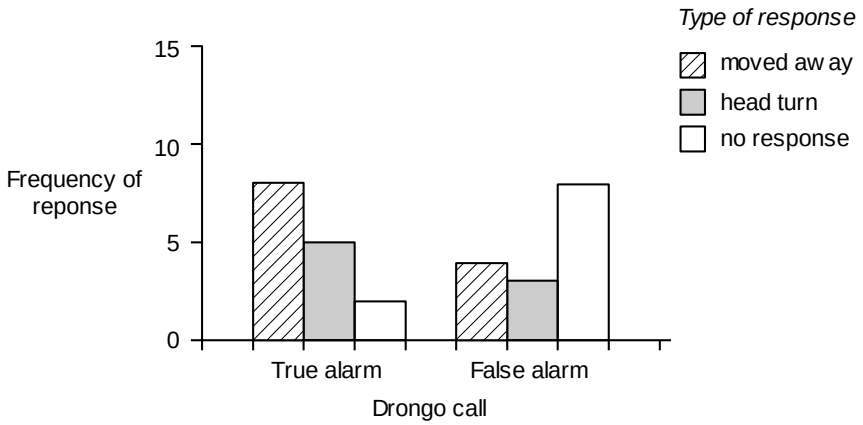
Animal Behaviour

Question			Expected Answer/s	Max Mark	Notes
1			Sexual selection in the dung beetle *Onthophagus sagittarius* was investigated in the laboratory. Male (left) and female dung beetles.  Beetles were paired by randomly selecting males and females, and the pairs were placed in breeding chambers. Mating success in relation to the frequency of courtship behaviour was recorded for large and small males. 		
	a		From the results, describe how female choice changes in relation to male size. at low courtship frequencies large males are chosen more often / have a higher probability of mating but this reverses at higher frequencies **OR** It changes from large males to small males as courtship rates increase	**1**	

Question			Expected Answer/s	Max Mark	Notes
1	**b**		What terms apply to the following measurements during the experiment:		
		i	time from introduction until first courtship latency	**1**	
1	**b**	**ii**	total time of courtship duration	**1**	
	c		Male and female dung beetles can be distinguished by their horns. What term can be used to describe this difference in appearance? sexual dimorphism	**1**	
	d		Females in many species are relatively inconspicuous. Explain why this is beneficial to them. less easy for predators to see them may be nesting / laying eggs **1** **OR** survival chances of the young increase **1**	**2**	**Not** less predation

Question			Expected Answer/s	Max Mark	Notes
2	**a**		Most of the behaviour of the fruitfly *Drosophila melanogaster* is determined by "nature" rather than "nurture". Explain why nurture has little influence on the behaviour of an invertebrate such as *Drosophila*. short lifespan so **no time** for learning **OR** little or no parental care of offspring	**1**	**Not** explanation based on nature / innate behaviour
2	**b**		The *Drosophila* period (*per*) gene is an example of a single gene affecting behaviour. Describe the effects of this gene. (*per* gene in Drosophila) controls 24 hour cycle / circadian rhythm **1** affects the amount of PER protein that is produced in the fly **OR** different alleles / forms / mutations of the gene produce protein that alters the cycle **1**	**2**	

Question			Expected Answer/s	Max Mark	Notes
3			Discuss behaviour that maximises net energy intake by predators. For max net energy gain, need 1. energy gain is from food intake 2. energy loss is from searching / handling 3. behaviour that maximises gain and minimises losses 4. behaviour / prey selection that reduces / optimises handling time 5. behaviour that increases encounter rate **OR** decreases search time 6. optimal foraging is maximising <u>net</u> energy gain 7. predation strategies affect energy intake 8. (benefit of) solitary hunting, predator gets all energy 9. (benefit of) cooperative hunting – one from: individuals expend less energy foraging can take bigger prey have higher success rate **Any 5**	**5**	Intake = gain Foraging = searching for food
4	**a**		Many birds that feed together in mixed-species flocks produce distinctive alarm calls which alert other flock members to the presence of predators. However, some of the flocks may contain birds that produce calls that sound similar to the alarm calls. These calls are emitted when there are no predators present and are referred to as “false alarm” calls. Explain why true alarm calling may be regarded as altruistic behaviour. improves survival chances of others **1** cost to self in drawing attention of predator **1**	**2**	
4	**b**		State why the evolution of true alarm calls **cannot** be the result of kin selection alone. mixed species / individuals are not related	**1**	

Question			Expected Answer/s	Max Mark	Notes
4	**c**		Suggest a benefit to the caller of using false alarm calls. The caller distracts other birds and will steal food **OR** more food for caller if other birds move away	**1**	'It can steal the food left by the other birds' is acceptable
4	**d**		A study investigated true and false alarm calls of the racket-tailed drongo (*Dicrurus paradiseus*). The calls were recorded and played to the orange-billed babbler (*Turdoides rufescens*), a species that regularly feeds in the same flocks. The graph shows the responses of the babblers to both types of call.  From the graph select information to show that babblers are able to distinguish between the false and true calls of the drongos. <u>comparison</u> needed, for example: fewer babblers responded to the false alarm (than to the true alarm) fewer babblers moved away when false calls were used	**1**	Correct comparison of any response type of True v False

Question			Expected Answer/s	Max Mark	Notes
4	**e**		The study involved wild babblers in their natural habitat. Suggest why the researchers used a method that involved selecting a different individual babbler for each measurement. to remove the possibility that learning or habituation might arise **OR** to make the data independent of each other **OR** (good sampling technique) to assess range of variation between individuals in the population	**1**	

Physiology Health and Exercise

Question			Expected Answer/s	Max Mark	Notes
1	a		Coronary heart disease (CHD) is caused by restriction of blood flow in vessels that supply oxygenated blood to heart muscle. Describe the changes in blood vessel walls that lead to CHD. Formation of atheroma / plaque **in** walls of <u>coronary</u> arteries **OR** atherosclerosis **in** <u>coronary</u> arteries Rough surface of wall allows clot formation Narrow lumen + leads to angina **OR** Clot/embolus causes MI **Any 2**	**2**	Atherosclerosis = hardening / loss of elasticity Heart attack = MI
1	b		Give **two** modifiable risk factors for the development of CHD. smoking physical activity / exercise diet obesity **Any 2 for 1 mark**	**1**	Reference to the risk factors via advice on how to reduce risk, still needs the terms.

<table>
<tr><th colspan="3">Question</th><th>Expected Answer/s</th><th>Max Mark</th><th>Notes</th></tr>
<tr><td>1</td><td>c</td><td></td><td>The table shows the incidence of CHD in two categories of male employees in the 1950s.

<table><tr><td></td><td colspan="2">CHD rate per 1000</td></tr><tr><td>Age (years)</td><td>Postmen</td><td>Office workers</td></tr><tr><td>35-44</td><td>0·3</td><td>0·4</td></tr><tr><td>45-54</td><td>2·7</td><td>2·9</td></tr><tr><td>55-65</td><td>4·6</td><td>6·5</td></tr></table>
Give two general conclusions about CHD that can be drawn from the data.

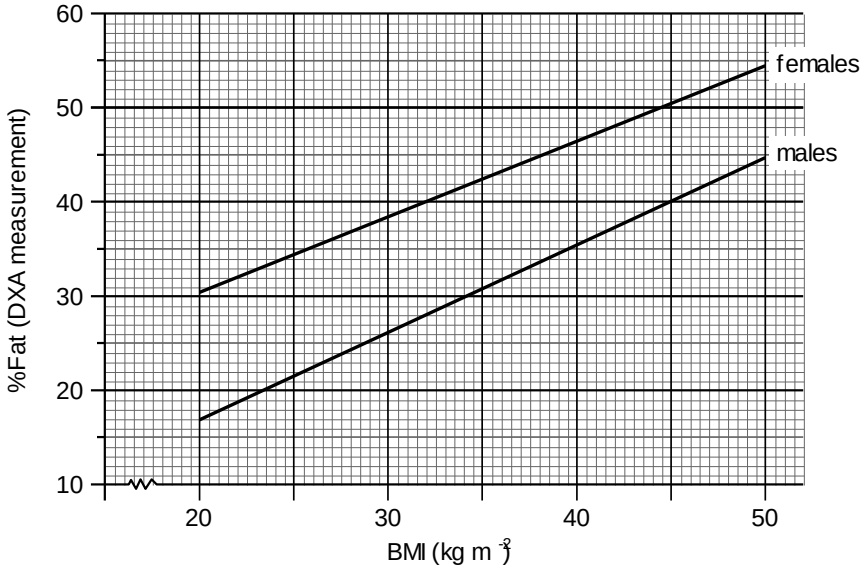
Physical activity decreases CHD
OR
Postmen are more active than office workers <u>and</u> have lower CHD rate 1

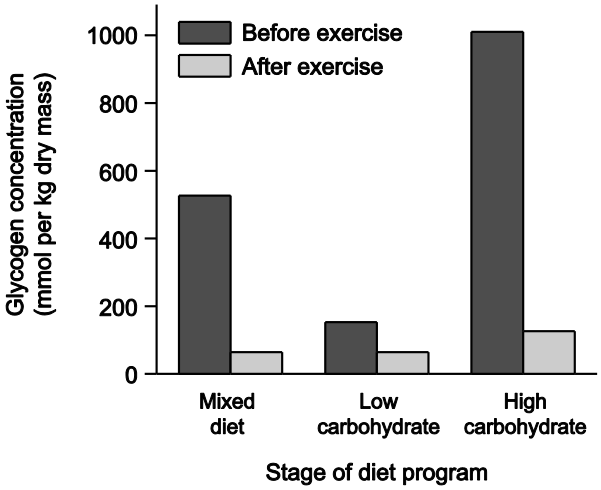
Age increases incidence (regardless of physical activity) 1</td><td>2</td><td>If comparing postmen and office workers, the answer must point out the difference in activity level.</td></tr>
<tr><td>2</td><td></td><td></td><td>Discuss the effects of exercise on the development of osteoporosis.

1. (In osteoporosis) bone density / mass decreases
2. weight bearing exercise increases bone density / mass
3. example of weight bearing exercise
4. maximum bone density is reached by mid 20s to 30
5. exercise beyond 30 / by older people maintains bone density / delays decline
6. exercise intensity needs to be moderate / should not be extreme
OR
osteoporosis in young women associated with extreme levels of training

Any 4</td><td>4</td><td>'Extreme' as in endurance training</td></tr>
</table>

Question			Expected Answer/s	Max Mark	Notes
3	**a**	**i**	Give **one** reason for assessing body composition. to assess health **risk** to measure **proportion** of body fat to assess effect of dietary modification to assess effect of exercise training **Any 1**	**1**	
3	**a**	**ii**	What **two** measurements are required to estimate body composition using densitometry? mass and volume	**1**	weight is acceptable
3	**b**		The BMI value is used routinely in the assessment of an individual's body composition. State **one** limitation of using BMI for this purpose. can misclassify individuals with a high muscle mass / lean tissue mass (as obese) **OR** does not distinguish between muscle and fat mass (ie. does not assess composition)	**1**	

Question			Expected Answer/s	Max Mark	Notes
3	**c**		Percentage body fat can be measured accurately using a method called *dual X-ray absorption* (DXA). The graph shows "best fit" lines when BMI values are correlated with measured % body fat.  		
		i	What are the BMI values of a man and a women who both have 40% body fat? Male = 45; Female = 32	**1**	Units not needed
3	**c**	**ii**	Recently an improved way of estimating % body fat has been developed. It involves calculating the body adiposity index (BAI) using the formula below. The calculated BAI equals the % body fat. $$BAI = \left(\frac{\text{Hip circumference (cm)}}{\text{Height (m)} \times \sqrt{\text{Height (m)}}} \right) - 18$$ A woman with a BMI value of 27 (kg m^{-2}) has a hip circumference 105 cm and height 1·69 m. Compare the predicted value of % body fat obtained using her BMI with that obtained using the more accurate BAI. BMI of 27 (correlates to) 36 % **1** BAI gives 29.79, 29.8, 30% **1**	**2**	

Question			Expected Answer/s	Max Mark	Notes
4	a		Elite athletes are interested in ways to improve performance in endurance events. Give **two** changes in the performance of an athlete's heart arising from endurance training. Increased stroke volume Increased cardiac output Increased maximum heart rate Lower resting heart rate / HR during exercise	**2**	**Not** anatomy changes **Not** shorter recovery time
4	b		In a study, volunteers ate a mixed diet for three days and then measured endurance by exercising to exhaustion. Over the next three days they ate a low carbohydrate diet and again measured endurance. Over a further three days they ate a high carbohydrate diet and exercised to exhaustion for a third time. The Figure shows glycogen concentration in skeletal muscle before and after the endurance testing for each stage of the diet programme. The Table shows the time to exhaustion as *exercise duration.*  *Stage of diet programme* / *Exercise duration (*mins*)* Mixed diet — 126 Low carbohydrate — 59 High carbohydrate — 189		

Question			Expected Answer/s	Max Mark	Notes
4	**b**		**(cont)**		
		i	What evidence supports the conclusion that increased muscle glycogen improved endurance? Increased / high **pre-exercise** muscle glycogen concentration gives increased endurance / exercising time to exhaustion	**1**	
4	**b**	**ii**	What term is used for exercise testing that takes athletes to exhaustion? <u>Maximal</u>	**1**	
4	**b**	**iii**	Give an example of a situation where it would **not** be appropriate for an individual to exercise to exhaustion. cardiac patient rehabilitation assessment of heart disease elderly / unfit / untrained	**1**	

[END OF MARKING INSTRUCTIONS]