Marking Schemes

This document was prepared for markers' reference. It should not be regarded as a set of model answers. Candidates and teachers who were not involved in the marking process are advised to interpret its contents with care.

SECTION A

Question No.	Key		Question No.	Key	
1.	C	(48%)	21.	A	(78%)
2.	A	(28%)	22.	A	(45%)
3.	A	(57%)	23.	A	(15%)
4.	B	(41%)	24.	D	(46%)
5.	A	(25%)	25.	A	(41%)
6.	C	(41%)	26.	C	(46%)
7.	D	(78%)	27.	A	(64%)
8.	D	(28%)	28.	B	(61%)
9.	B	(71%)	29.	B	(62%)
10.	D	(38%)	30.	C	(36%)
11.	C	(63%)	31.	D	(19%)
12.	A	(81%)	32.	B	(58%)
13.	D	(49%)	33.	D	(50%)
14.	D	(66%)	34.	B	(44%)
15.	B	(76%)	35.	C	(36%)
16.	C	(64%)	36.	D	(43%)
17.	B	(56%)			
18.	C	(63%)			
19.	A	(39%)			
20.	C	(52%)			

Note: Figures in brackets indicate the percentages of candidates choosing the correct answers.

General Marking Instructions

1. In order to maintain a uniform standard in marking, markers should adhere to the marking scheme agreed at the markers' meeting.

2. The marking scheme may not exhaust all possible answers for each question. Markers should exercise their professional discretion and judgment in accepting alternative answers that are not in the marking scheme but are correct and well-reasoned.

3. The following symbols are used:

/	A single slash indicates an acceptable alternative within an answer.
*	Correct spelling required

4. In questions asking for a specified number of reasons or examples, if a candidate gives more than the required number, the extra answers should not be marked. For instance, in a question asking candidates to provide two examples, if a candidate gives three, only the first two should be marked.

5. In cases where a candidate answers more questions than required, the answers to all questions should be marked. However, the excess answer(s) receiving the lowest score(s) will be disregarded in the calculation of the final mark.

6. Award zero marks for answers which are contradictory.

Paper 1 Section B

	Concept for mark award	Example	Marks
1(a)	correct signalling molecules	nervous control: neurotransmitter hormonal control: hormone	(1)
1(b)	correct transmission pathways	nervous control: neurones / nerves / nerve fibres hormonal control: blood / blood vessel	(1)
1(c)	correct comparison	nervous control is faster than hormonal control	(1)

3 marks

	Concept for mark award	Example	Marks
2(a)	correct complementary base pairing	TTGA	(1)
2(b)	Some triplet codes encode the same amino acids / conformation of protein	any ***one*** of the following: • the new triplet code encodes the same amino acid as the original amino acid / different triplet codes may code for the same amino acid • the new amino acid is located in a region which does not affect the functional part of the protein / the active site of the enzyme	(1)
2(c)	cellular activities related cancer formation	any ***one*** of the following: • control of cell division / mitotic cell division • control of cell growth • control of cell death • control of cell cycle • control of cell differentiation • DNA repair	(1)

3 marks

	Concept for mark award	Example	Marks
3(a)	correct labelling	* matrix	(1)
3(b)	correct description of the feature	the inner membrane forms infolding / folds / invagination	(1)
	significance of the feature to the functioning of mitochondria	increased surface area to hold more enzymes / electron carriers / membrane proteins for aerobic respiration / oxidative phosphorylation / synthesis of ATP	(1)
3(c)(i)	correct process	inhibition of the conversion of pyruvate to acetyl co-A / inhibition of Krebs cycle	(1)

	Concept for mark award	Example	Marks
3(c)(ii)	consequences for the respiratory pathway	Any ***three*** of the following points: • glycolysis proceeds as usual to produce pyruvate • pyruvate cannot be metabolised through Krebs cycle / no co-enzyme A is regenerated for the conversion of pyruvate to acetyl co-A • ATP synthesis was inhibited / NADH and $FADH_2$ formation was inhibited / oxidative phosphorylation was inhibited • pyruvate will be converted to alcohol and carbon dioxide in the anaerobic pathway of plant cells / alcoholic fermentation	(3)

7 marks

	Concept for mark award	Example	Marks
4(a)	correct identification of the two factors	black arrow: difference between the water potential of the blood and tissue fluid / the water potential gradient between blood and tissue fluid	(1)
		white arrow: difference between the hydrostatic pressure of blood and tissue fluid	(1)
4(b)	change in the hydrostatic pressure	the factor represented by white arrow / hydrostatic pressure decreases	(1)
	fluid movement	as fluid / water is forced out of the blood at the end near P	(1)
	consequence for blood volume	the blood volume in the capillaries decreases, leading to the decrease in hydrostatic pressure / blood pressure	(1)
4(c)(i)	correct organ	pancreas	(1)
4(c)(ii)	correct organ	liver	(1)
	explanation in relation to the function of the organ	excess amino acids are deaminated / metabolised to form urea in this organ and transported away	(1)

8 marks

	Concept for mark award	Example	Marks
5(a)	translation process	the mRNA α is translated at rough endoplasmic reticulum / ribosome to form a polypeptide chain	(1)
	folding of polypeptide to form protein	the polypeptide chain will fold into protein α / a protein with a specific shape	(1)
	transport to membrane	protein α / the protein formed will be transported to the membrane	(1)

	Concept for mark award	Example	Marks
5(b)(i)	comparison between cell sap and bathing solution in water potential	pure water has a higher water potential than that of the cytoplasm / cell sap in the frog egg cell	(1)
	correct description of water movement	there is a net movement of water into the frog egg cell by osmosis / water moves from a region of higher water potential to a region of lower water potential, i.e. from water into the frog egg cell	(1)
5(b)(ii)	comparison of the results from normal frog egg cell and frog egg cell injected with mRNA α	the relative volume of the frog egg cell injected with mRNA α increases much faster than that injected with water only / at the time point X, the relative volume of the frog egg with mRNA α is much higher than that injected with water only	(1)
	inference from the difference	this shows that the presence of protein α has increased the permeability of the membrane to water	(1)
	deduction	therefore, protein α is probably a channel protein for the passage of water	(1)
5(b)(iii)	correct explanation	the frog egg cells injected with mRNA α have burst	(1)

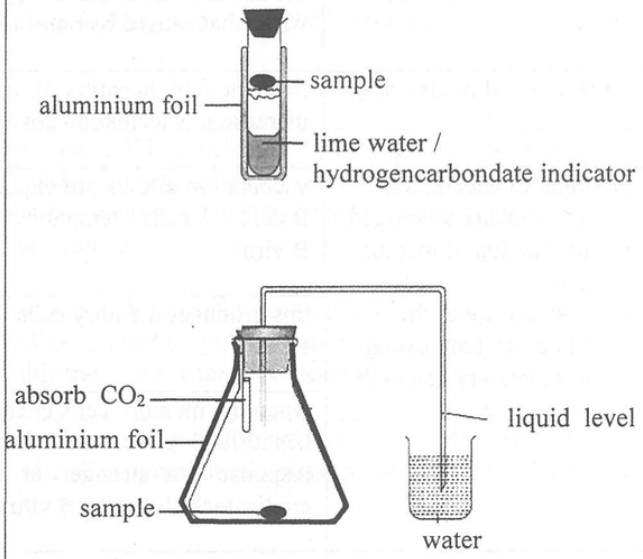
9 marks

	Concept for mark award	Example	Marks
6(a)	correct choice	pancreatic amylase	(1)
	explanation	most of the starch digestion takes place in the small intestine / small intestine is long which allows more time for starch digestion	(1)
		while pancreatic amylase is responsible for the digestion of starch in the small intestine	(1)
6(b)(i)	concept of control variables	to ensure the volume of the reaction mixture in the two set-ups is the same	(1)
		to ensure that the concentration of substrate / enzyme in the two set-ups is the same because it will affect the rate of digestion	(1)
6(b)(ii)	correct reagent / test for detecting the substrate / product + valid measurement of the change in substrate / product over time	either ***one*** of the following sets: • use iodine test / iodine solution • add a drop of the reacting mixture to iodine solution at fixed time intervals, then measure the time taken for blue-black colour to disappear / for a negative result from the test Or • use Benedict's test / Benedict's solution • at a fixed time interval, take a fixed amount of the reacting mixture and heat with Benedict's solution, measure the amount of brick-red precipitate formed / measure the absorbance / transmittance / optical density of the supernatant	(2)

	Concept for mark award	Example	Marks
6(c)	effect of inhibitor on enzyme activity	same curve before time t, after that the curve is lower than the original curve	(1)
6(d)(i)	validity of the results	any one of the following: • the conditions in the human body / animal's body (in vivo) are a lot more complicated than reaction in a test tube (in vitro) • there are multiple factors affecting the reaction in the body • reaction in a test tube cannot simulate the conditions in a body	(1)
6(d)(ii)	correct blood composition	blood glucose level	(1)
	correct results related to starch digestion	a slower rise in blood glucose level in the experimental group than the control group / lower blood glucose level in the experimental group than the control group	(1)
6(e)	inhibition of starch digestion alters the food preference of insects	insects cannot digest the starch / cannot obtain nutrients from the beans with the amylase inhibitor, in the long run, insects will feed other plants for food / insects will not eat the beans with amylase inhibitor	(1)

12 marks

	Concept for mark award	Example	Marks
7(a)(i)	point out the missing equipment	line transect and quadrat	(1)
7(a)(ii)	how to use the missing equipment	lay a transect from backshore to waterfront and place a quadrat next to the transect	(1)
		count the number of species and their abundance within the quadrat	(1)

	Concept for mark award	Example	Marks
7(b)	the set-up should show • a closed system / an air pump system • blockage of light • valid method to show the change in carbon dioxide		(3)
7(c)	prediction based on the information	the level of free radicals should increase continuously from 0 to 4 hours	(1)
7(d)	inhibitory action of antioxidants	antioxidants counteract the action of free radicals / reduce the level of free radicals	(1)
	supporting evidence from the graph	from 0 to 1 hour, the level of antioxidants increases to suppress the level of free radicals in the algal tissue	(1)
		from 1 hour onwards, the level of antioxidants remains unchanged, as a result, the level of free radicals rises to a level higher than normal	(1)

10 marks

	Concept for mark award	Example	Marks
8(a)	description of the trends shown	the disease burden caused by infectious diseases decreases while that caused by non-infectious diseases increases	(1)
8(b)	correct causal relationship	incidence of hepatitis B infections decreases with the increase in vaccination coverage	(1)
	principle of vaccination • 1st exposure to antigen • production of memory cell • re-exposure to the same antigen leading to secondary response	vaccination allows pre-exposure of the immune system / B cells / T cells / lymphocytes to antigens of the hepatitis B virus	(1)
		this produces memory cells for the antigens of hepatitis B virus	(1)
		when the memory cells encounter the antigens of the real hepatitis B virus, the memory cells elicit a secondary response / a stronger or faster immune response to eradicate the hepatitis B virus before it can invade the cells	(1)
8(c)	relate the decrease in disease burden to decrease in incidence	vaccination programmes can reduce the incidence of infectious diseases / reduce the number of susceptible hosts to break the chain of infection, thereby decreasing the disease burden caused by infectious diseases in country X	(1)
8(d)	correct description of data with reference to all age groups	the incidence of liver cancer is higher in the unvaccinated group than the vaccinated group in all age groups	(1)
	relate the data trend to concept of risk factor	hepatitis B is a risk factor for liver cancer / having hepatitis B increases the risk of getting liver cancer	(1)

8 marks

	Concept for mark award	Example	Marks
9(a)	observations from the photographs	the photomicrographs show that the stoma has become smaller / was closed in the presence of plant hormone X	(1)
	inference	a smaller stoma size / closure of stoma will reduce water loss through transpiration, which may help the plant to survive during drought stress / when water supply is inadequate	(1)
9(b)	correct choice	A	(1)
	comparison of data	the leaf of A has lost less water than that of B	(1)
	inference (1)	the leaf of A should have been influenced by hormone X leading to a reduction in size of stomata	(1)

5 marks

	Concept for mark award	Example	Marks
10(a)	recognise that pollen grains are formed after meiotic cell division / haploid	pollen grains are formed after meiotic cell division / haploid, they carry one set of chromosomes only	(1)
	deduction from phenotypes to genotypes	structure X is developed in pollen grain A, thus the allele carried by pollen grain A should be responsible for this trait / character / characteristic / the development of structure X	(1)
		structure X failed to develop in pollen grain B, thus the allele carried by pollen grain B should be responsible for this trait / character / characteristic	(1)
	deduction about the genotype of parent plant	therefore, the parent plant that produced these two types of pollen grain should have possessed both alleles, i.e. heterozygous	(1)
10(b)	function of pollen tube	pollen tube / structure X transfers / carries / delivers the male gametes to the female gametes / egg / ovum inside the ovule	(1)
	fertilisation	the male gametes fertilise / fuse with the female gametes / eggs / ova in the ovule	(1)
	correct type of pollen grains	therefore, only type A pollen grains result in fertilisation that leads to the formation of seeds	(1)
10(c)	correct percentage	homozygous dominant: 50%; heterozygous: 50%; homozygous recessive: 0% or homozygous dominant: 0%; heterozygous: 50%; homozygous recessive: 50%	(1)

8 marks

	Concept for mark award	Example	Marks
11	why vegetarian diet can reduce carbon footprint:		max. 6
	<u>food chain</u> comparison of the length of food chains	• food chain involved in a vegetarian diet is shorter than that in a diet with meat / eating vegetables involves fewer trophic levels in the food chain than eating meat	(1)
	carbon footprint of the additional trophic level	• animals in the additional trophic level release carbon dioxide through respiration / decomposition of waste / excretory products / faeces / uneaten parts from each trophic release carbon dioxide	(1)
	inference	• therefore, carbon dioxide released from animals / carbon footprint from meat will not be counted if we adopt a vegetarian diet	(1)
	relating methane emissions to plant-eating mammals in the mixed diet	• in addition, plant-eating mammals such as cows emit a large amount of methane during digestion of plant materials, which contributes to the carbon footprint of a mixed diet	(1)
	relating the practice to change in land use	• more people adopting a vegetarian diet would reduce the demand for meat, so land use for rearing plant-eating mammals or cows will decrease, and the carbon footprint from methane emissions from rearing plant-eating mammals will also be reduced	(1)
	<u>gas exchange</u> crops undergo photosynthesis, which absorbs carbon dioxide	• during cultivation of crops, they undergo photosynthesis during daytime, which absorbs carbon dioxide and releases oxygen	(1)
	growing crops reduces carbon dioxide from atmosphere	• therefore, adopting a vegetarian diet would lead to a reduction in carbon dioxide in the atmosphere	(1)
	relating the practice to change in land use	• more people adopting a vegetarian diet would increase the demand for crops, and more land used for growing crops means that more carbon dioxide would be removed from the atmosphere	(1)

	Concept for mark award	Example	Marks
	other personal actions (should be from other perspectives)	any ***two*** of the following points: • take public transport instead of private transport to reduce carbon dioxide release through transportation • buy local products instead of imported products to reduce the carbon dioxide from transportation • use electrical appliances with high energy efficiency to save electricity, which reduces emission of carbon dioxide from combustion of fossil fuels • use energy saving lighting such as LED to reduce energy use, which reduces emission of carbon dioxide from combustion of fossil fuels • turn off electrical appliances when not in use to reduce electricity use, which reduces emission of carbon dioxide from combustion of fossil fuels	max. 2 (1) (1) (1) (1) (1)
	effective communication		(0-3)

11 marks

Mark award for communication:

Mark	Clarity of expression and relevance to the question	Logical and systematic presentation
3	• Answers are easy to understand. They are fluent, showing good command of language. • There is no or little irrelevant material.	• Answers are well structured, showing coherence of thought and organisation of ideas.
2	• Language used is understandable but there is some inappropriate use of words. • A little irrelevant material is included but does not mar the overall answer.	• Answers are organised, but there is some repetition of ideas.
1	• Markers have to use some time and effort in understanding the answer(s). • Irrelevant material obscures some minor ideas.	• Answers are a bit disorganised, but paragraphing is evident. Repetition is noticeable.
0	• Language used is incomprehensible. • Irrelevant material buries the major ideas required by the question.	• Ideas are not coherent or systematic. Candidates show no attempt to organise thoughts.

Paper 2 Section A

	Concept for mark award	Example	Marks
1(a)(i)	comparison of data about FSH level	when she is taking the contraceptive pill daily, her FSH is maintained at a lower level that in the normal cycle	(1)
	inherence from this difference	the low FSH level fails to stimulate the development of the follicles in the ovary, so there will be no mature follicles	(1)
	comparison of data LH level	when she is taking the contraceptive pill daily, her LH is lower than in the normal cycle	(1)
	inherence from this difference	the LH surge is absent and there will be no ovulation	(1)
1(a)(ii)	correct identification	progesterone	(1)
	mark reference to the negative feedback of progesterone as evidence	a high level of progesterone will inhibit the secretion of FSH and LH from the pituitary	(1)
1(a)(iii)	relate the given condition to the function of uterine lining	if the uterine lining is too thin, implantation of the embryo is impossible	(1)
1(a)(iv)	comparison of data about oestrogen levels	when she is taking the contraceptive pill daily, her level of oestrogen is lower than in the normal cycle	(1)
	inherence from this difference	a low level of oestrogen fails to stimulate the thickening of the uterine lining	(1)
1(b)(i)	correct formula	fluid retention = amount of fluid drunk – amount of urine collected	(1)
1(b)(ii)	comparison of fluid retention of the two groups	the group that consumed the sports drink with salt had a greater retention of fluid than that which consumed water	(1)
	comparison of the water potential of the blood after consumption of the two drinks	after consuming the drinks, the water potential of the blood in the group consuming the sports drink with salt would be lower than that of the group drinking water / would drop to a greater extent than the group drinking water	(1)
	effect on secretion of ADH	the hypothalamus stimulated the pituitary gland to release more ADH in the group drinking the sports drink with salt	(1)
	effect on permeability of collecting duct	the wall of the collecting duct in the group drinking salt solution became more permeable to water, so a larger proportion of water was reabsorbed from the glomerular filtrate to retain fluid in the body	(1)
1(b)(iii)	heat production during a marathon	heat is continuously produced by muscle contraction during running	(1)
	advantage of fluid retention in terms of sweating	more fluid is available for sweating	(1)
		when sweat evaporates, this facilitates heat loss	(1)

	Concept for mark award	Example	Marks
1(b)(iv)	manipulation of independent variable	instead of sitting down quietly, request the participants to run on a treadmill set at a constant speed	(1)
	measurement of dependent variable	in addition to the original measurements, measure the body temperature / amount of sweat produced by the participants	(1)
1(b)(v)	use of glycerol for energy provision	glycerol can be a source of energy during the marathon	(1)

20 marks

Paper 2 Section B

	Concept for mark award	Example	Marks
2(a)(i)	explain how human activity affects the number of yellow-breasted buntings	any ***one*** of the following: • massive hunting of yellow-breasted buntings for food • reclamation of wetlands leads to loss of stopovers used by yellow-breasted buntings to fuel up during the long journeys • change in land use leads to destruction of habitats / loss of breeding grounds for yellow-breasted buntings	(1)
2(a)(ii)(1)	description of trend in number of birds	increasing trend shown in number of birds recorded	(1)
	description of trend for number of bird species	increasing trend shown in the number of bird species recorded	(1)
	inference from the comparison	more birds were attracted to stay in / visit Long Valley since the implementation of habitat management	(1)
		this includes new bird species that were not found in Long Valley before	(1)
2(a)(ii)(2)	effect of habitat management	habitat management provides / restores different habitats in Long Valley	(1)
	relate increasing food resources to population size / size of community	different habitats provide more food resources to support a larger community / larger populations of different species, which accounts for the increase in the number of birds	(1)
	relate different habitats to the provision of different conditions for bird species with different ecological niches	different habitats provide various food sources / hiding places / breeding grounds	(1)
		for attracting bird species with different ecological niches / to suit the needs of certain bird species, which accounts for the increase in the number of bird species	(1)

	Concept for mark award	Example	Marks
2(b)(i)	relate the identifying source of MP pollution to mobility of the indicator organisms	any ***one*** of the following sets: • sessile organisms obtain MPs from water surrounding their habitats • making source of MPs identifiable or • movable organisms can move around and obtain MPs from other aquatic environments • making it difficult to identify the source of MPs	(2)
2(b)(ii)	correct choice of species	species C	(1)
	comparison of data	species C is found in all / different habitats while other species can only be found in restricted habitats / only species C is found in all three habitats	(1)
	inference from the comparison	therefore the same species can be used to monitor MP pollution in all three habitats for a fair comparison of the MP pollution in these habitats	(1)
2(b)(iii)	correct choice of species	species R	(1)
	comparison of data	different sizes of MPs are found in species R while other species show a preference for ingesting / rejecting / egesting a certain size of MPs species / species R is the only species in which all sizes of MPs are found inside its body	(1)
	inference from the comparison	therefore, species R can be a full representation of different sizes of MPs in the aquatic environment / be used to monitor all different sizes of MPs in the aquatic environment	(1)
2(b)(iv)(1)	quote relevant data to support the argument	any ***one*** of the following: • yes, because majority / over 70% of the larvae can survive for 28 days, showing that they can obtain nutrients to support themselves for a substantial period of time • yes, because majority / over 70% of the larvae can form pupae / transform into adult moths, showing that they have obtained nutrients to support this transformation	(1)

	Concept for mark award	Example	Marks
2(b)(iv)(2)	valid parameter + justification	any ***one*** of the following sets: • check the faeces / gut content of the larvae to see if the plastics are chemically or physically digested, if plastics are broken down into MPs which would not solve the problem of plastic pollution • check if the plastic lowers the reproductive power of the moth to ensure that the method is a sustainable practice • check the amount of plastic the larvae consume to see if plastic consumption reduces the appetite of the larvae • check changes in body weight / fresh mass / length of the larvae to see if plastic consumption decreases their growth	(2)

20 marks

Paper 2 Section C

	Concept for mark award	Example		Marks
3(a)(i)	comparison of results + deduction	Comparison of results	Deduction	(4)
		I vs II number and types of colonies found on the plates in I (without phage treatment) and II (with phage treatment) were more or less the same / similar	this shows that phages did not kill the non-targeted bacteria found on the leaf surface	
		III vs IV colonies of bacterial pathogen Y were absent from the plate in III (without phage treatment) but present on the plate in IV (with phage treatment)	this shows that phages successfully killed the bacterial pathogen Y	
3(a)(ii)	concept host specificity	phages act on specific hosts only		(1)
	advantage of being host-specific	any ***one*** of the following: • they will not affect other beneficial bacteria / nontargeted bacteria / non-pathogenic bacteria • less likely to cause the development of antibiotic resistance in bacteria		(1)
3(a)(iii)	how to collect samples from a flat surface	rub the leaf surface with a wet sterile swab		(1)
		transfer the sample to a culture medium by putting the swab in the medium		(1)
3(a)(iv)	aseptic technique related to plate spreading	any ***two*** of the following: • perform plate spreading in a biological safety cabin • perform the spreading near a Bunsen flame • the lid of the petri dish should be slightly open during spreading		(2)

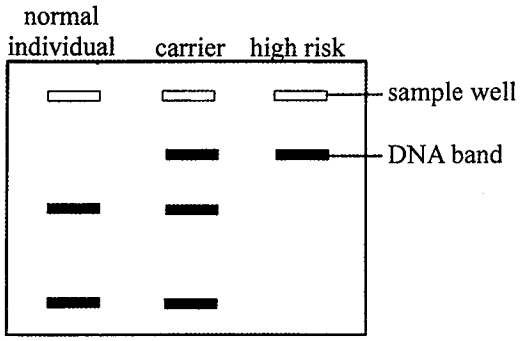
	Concept for mark award	Example	Marks
3(b)(i)(1)	correct explanation	mouse siblings have a similar genetic composition to minimise the effect of genetic factors on the results of the experiment	(1)
3(b)(i)(2)	concept of aseptic techniques	any ***two*** of the following: • feed the mice with antibiotics to kill the gut bacteria • all food and drink should be sterilised / autoclaved to ensure that no bacteria are ingested • the mice should be kept in sterilised and isolated incubators / chambers to make sure that they have no contact with bacteria from the environment	(2)
3(b)(ii)(1)	correct choice	experimental group	(1)
3(b)(ii)(2)	correct description of data trends	any ***two*** of the following: • the proportion of Q has increased / takes up the major portion of the community • the proportion of P has reduced • the proportion of R has reduced	(2)
3(b)(ii)(3)	correct identification	Q	(1)
	supporting evidence from data	Q has the greatest increase in the proportion in the gut bacterial community after adopting the 'high-fat high-sugar' diet	(1)
3(b)(iii)	correct conclusion	the gut bacterial community induced by 'high-fat and high-sugar' diet has the ability to increase the digestion and absorption of food in their host	(1)
	supporting evidence from results	even though the same diet was given to the two groups, i.e. same intake, the experimental group still had a greater increase in body mass and body fat %	(1)

20 marks

Paper 2 Section D

	Concept for mark award	Example	Marks
4(a)(i)	correct name	plasmid	(1)
	functional role as a vector	as a vector for carrying the foreign genes and transferring them to the plant cells	(1)

	Concept for mark award	Example	Marks
4(a)(ii)(1)	handling of data to reach a standardised base for comparison	• GM-A – each plant produces 75 A.U. of PUFAs per month / 900 A.U. of PUFAs per year • GM-B – each plant produces 150 A.U. of PUFAs per month / 1800 A.U. of PUFAs per year • GM-C – each plant produces 50 A.U. of PUFAs per month / 600 A.U. of PUFAs per year	(1)
	correct choice	GM-B will be selected	(1)
	supporting evidence from data	because GM-B produces the highest amount of PUFAs per plant within the same period of time	(1)
4(a)(ii)(2)	the seed extract does not contain foreign genes	PUFAs extracted from GM seeds are free of DNA / genes	(1)
	the seed extract contains the same PUFAs as those from fish	PUFAs extracted are structurally the same as PUFAs from wild fish species	(1)
4(a)(iii)(1)	transfer of foreign genes to wild species	the foreign gene in the GM crops may be transferred to the wild species by cross-pollination	(1)
4(a)(iii)(2)	manipulation of independent variable	growing the GM seed crop and the wild species together in a controlled environment	(1)
	collection of data	any ***one*** of the following sets: • after some time, collect seeds from the wild species, and then analyse them for the presence of the foreign gene / enzyme responsible for production of PUFAs / PUFAs • collect individuals from the next generation of the wild species and then analyse them for the presence of the foreign gene	(2)
4(b)(i)	PCR and its purpose	use PCR to amplify the gene fragments	(1)
	restriction enzymes cutting and its purpose	and then cut with the restriction enzyme to produce DNA fragments	(1)
	gel electrophoresis and its purpose	use gel electrophoresis to separate the DNA fragments according to size	(1)
4(b)(ii)	correct choice and explanation	primer Q, because it is too close to the restriction site, the DNA fragments produced will be too short and will then run out of the gel during electrophoresis	(1)

	Concept for mark award	Example	Marks
4(b)(iii)	correct representation of the three genotypes		(3)
4(b)(iv)	correct choice	on the side with cathode / negative pole / on the right-hand side	(1)
	correct explanation	negatively charged DNA fragments will migrate towards the anode / positive pole from the sample wells	(1)

20 marks