CAMBRIDGE INTERNATIONAL EXAMINATIONS

Pre-U Certificate

MARK SCHEME for the May/June 2013 series

9790 BIOLOGY

9790/02 Paper 2 (Long Answer), maximum raw mark 120

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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CAMBRIDGE
International Examinations

Section A

1 (a) 1 action of statins as enzyme inhibitor ;
2 reduces production of cholesterol ;
3 reduces, LDL / low density lipoprotein, concentration in the blood ;
accept increases uptake of LDLs by liver (cells)
4 prevents / reduces build-up of plaque / atheroma / fatty streaks (on inner walls of arteries) ;
accept ref. to atherosclerosis
5 (build-up of plaque) increases blood pressure / risk of blockage / thrombosis ; **[max 2]**

(b) 1 given to control group (in place of real treatment) ;
2 *idea that* allows a valid comparison ;
e.g. compare active ingredient with taking pill without drug
3 subjects / medical staff, not aware who is taking the drug ;
4 ensures results not distorted by psychological factors / AW ; **[max 3]**

(c) 1 the stain reduces the risk of cardiovascular, events / disease ;
accept stroke / other cardiovascular events
2 the reduction is (statistically) significant (at $p < 0.05$) ;
3 the probability of the reduction being due to chance is less than 0.05 / 5% ;
4 greater decrease in incidence of stroke ;
5 sample size not known ;
6 AVP ;
e.g. fewer people suffer from strokes / ref. gender / ref. ethnicity **[max 3]**

[Total: 8]

2 (a) (i)

	green plumage	purple plumage
observed (O)	7 + 3 = 10	4
expected (E)	10.5	3.5
$O - E$	–0.5	0.5
$(O - E)^2$	0.25	0.25
$\frac{(O-E)^2}{E}$	0.024	0.071
$\sum \frac{(O-E)^2}{E} = \chi^2$	0.095	

1 calculation ;
2 correct answer as 0.095 ;
accept ecf from calculation **[2]**

(ii) 1 not significant ;
2 no difference between observed and expected which cannot be explained by chance ;
3 (observed ratio) is a valid approximation to a 3:1 ratio ;
4 (should be treated with caution since it is) based on a small sample ; **[max 3]**

(b) (i) parental phenotypes: green male × green female

parental genotypes: Z^GZ^g × WZ^G

gametes: Z^G Z^g × W Z^G

Punnett square:

		green male	
		Z^G	Z^g
green female	W	WZ^G	WZ^g
	Z^G	Z^GZ^G	Z^GZ^g

green male = Z^GZ^G and Z^GZ^g
green female = WZ^G
purple female = WZ^g

2 green male: 1 green female: 1 purple female

1 choice of appropriate symbols for the gene for plumage and its alleles **;**
e.g. G / g
accept ecf in later parts of question if inappropriate symbols used, e.g. G and P
2 gametes of both parents correct and offspring genotypes derived correctly **;**
accept X and Y instead of W and Z if used correctly, e.g. male = XX, female = XY
3 correct link between genotype and phenotype indicated **;** **[3]**

(ii) Z^GZ^g × Z^gW green (heterozygous) male × purple female **;**
Z^gZ^g × Z^gW purple male × purple female **;**
accept ecf from **(b)(i)** for symbols of alleles
accept Z^GZ^g green (heterozygous) male, Z^gZ^g purple male, Z^gW purple female if not written out as crosses **[2]**

[Total: 10]

3 **(a)** X = rubisco / ribulose bisphosphate carboxylase (oxygenase) ;
3C = phosphoglyceric acid / phosphoglycerate / glycerate (3) phosphate / PGA / GP ; **[2]**

(b) 1 at both temperatures sugar cane reaches maximum uptake at lower carbon dioxide concentration ;
2 data quote for at least one temperature ;
e.g. maximum for sugar cane at 90–100 ppm + barley at 310–320 ppm at 25 °C
e.g. maximum for sugar cane at 60–70 ppm + barley at 480–500 ppm at 10 °C

3 gradient for uptake of sugar cane is higher than for barley ;
4 data quote for correct calculations ;
5 rate of / gradient, for uptake by sugar cane is higher than for barley at 25 °C (at all carbon concentrations) ;
6 rate of uptake by sugar cane at 10 °C is higher than for barley up to 250 ppm ;
7 rate of uptake by barley at 10 °C is higher than sugar cane above 250 ppm ;
8 AVP ;
e.g. ref. to carbon dioxide compensation point (no net uptake) at different concentrations of carbon dioxide **[max 4]**

(c) 1 competition between oxygen and carbon dioxide for rubisco ;
2 *idea that* rubisco is inefficient because of photorespiration ;
3 this reduces the rate of photosynthesis ;
4 *the idea that* C4 plants are adapted to reduce impact of photorespiration ;
5 by spatial separation within the leaf / mesophyll and bundle sheath cells / Krantz anatomy ;
6 by isolating, the light-independent stage (which produces oxygen) from, rubisco / Calvin cycle ;
7 movement of fixed carbon / malate (from mesophyll to bundle sheath) ;
8 so concentrating carbon dioxide ;
9 this requires ATP ;
10 this is an advantage when carbon dioxide concentration is limiting ; **[max 4]**

(d) 1 more water is absorbed per gram dry mass by C3 plants ;
2 comparative use of figures ;
3 C4 plants make more efficient use of water than C3 ;
4 C4 plants are photosynthetically more efficient ;
5 reference to habitat / climate ;
e.g. arid regions for C4
6 lower rate of transpiration ;
7 greater productivity ;
8 comment on validity of results ;
e.g. only three species of each type **[max 4]**

(e) 1 C4 plants are better adapted to low carbon dioxide concentration than C3 plants ;
2 C4 plants will, have reduced advantage / be at a disadvantage, over C3 plants with respect to carbon dioxide concentration ;
3 C4 plants (already) well adapted to high temperatures ;
4 C4 plants well adapted to, water stress / lack of water ;
5 C4 plants likely to increase in hot dry areas / ora ;
6 C4 plants may spread to higher latitudes ;
7 C4 crop plants will continue to be cultivated in places with high temperatures and low rainfall ;
8 C4 crops will make more efficient use of irrigation ;
9 higher rainfall will benefit C3 plants / ora ;
10 the predicted change in temperature over the next century is only small therefore not going to make a lot of difference ;
11 rising temperatures in some places will be linked to lower rainfall ;
12 ref. to competition between C3 and C4 plants with respect to, water supply / [CO_2] ;
13 AVP ;
e.g. C4 plants thought to have evolved in (current) low carbon dioxide atmosphere and C3 plants when the carbon dioxide levels were higher (further back in the past)
e.g. ref. to photorespiration in appropriate context **[max 6]**

[Total: 20]

4 Planning Task

Sections	Expected answer	Mark
P Defining the problem	**P: Planning** 1 Hypothesis or prediction ; e.g. tolerant variety lower (more negative) solute potential than non-tolerant / incipient plasmolysis brought about in tolerant variety by higher concentration of external solution than in case of cells of the non-tolerant variety 2 Theory to support hypothesis or prediction ; water moves by osmosis from, higher to lower / towards the more negative, solute potential therefore when external solute potential is low (as in a concentrated salt solution) the internal solute potential must be even lower (as in more concentrated internal solution) 3 Outline of strategy and justification ; e.g. determining the external concentration / solute potential which results in incipient plasmolysis / 50% plasmolysis in cells of each variety Key variables: 4 independent: concentration of / solute potential of, external solution ; 5 dependent: number / percentage, of cells plasmolysed ; 6 controlled: immersion time and volume of immersion solution ; 7 Risk Assessment ; must refer to hazard <u>and</u> precaution e.g. care in attaching pipette filler to pipette / care in use of scalpel to remove epidermal tissue from onion / dispose of broken cover slips with care *Some points may be taken from a diagram or a flow sequence diagram.*	**[max 6]**
M Methods	**S: Preparation of solutions** 8 prepare range of sodium chloride concentrations using the 1 mol dm^{-3} solution provided ; 9 suggested range of 0 and at least 5 concentrations, e.g. 0.2, 04, 0.6, 0.8, 1.0 mol dm^{-3} ; 10 how dilution made, e.g. to make 100 cm^3 of 0.2 mol dm^{-3} solution pipette 10 cm^3 1 mol dm^{-3} solution into 100 cm^3 volumetric flask or measuring cylinder and make up to 100 cm^3 with deionised water ; 11 evidence of awareness that it is easier to make accurate dilution using an appropriate sized pipette and reasonably large total volume ;	**[max 4]**

Sections	Expected answer	Mark
M Methods	**O: Obtaining results** 12 remove epidermis from inner surface of onion scale with scalpel ; 13 and immerse in constant volume of solution ; 14 in labelled specimen tubes ; 15 leave for minimum of 15 minutes ; 16 ref. to staggering to allow for sampling ; 17 (after time period) transfer specimen to microscope slide ; 18 in drop of external solution and add coverslip ; 19 may add iodine as a coloured liquid – make plasmolysed cells easier to see ; 20 (for each specimen) count cells and record % plasmolysed ; 21 repeats at each concentration for both varieties of onion ;	**[max 4]**
	Analysis of results **G: Graph** 22 plot graph concentration of external solution (*x*-axis) ; 23 against mean % plasmolysis (*y*-axis) ; 24 draw line of best fit (probably sigmoid) ; 25 plot both varieties of onion separately (could be on same axes) ; 26 read concentration causing 50% plasmolysis for each variety ;	**[max 4]**
	Analysis of results **Stats: Mathematical processing** 27 then the difference could be tested for significance using a *t*-test ; 28 in making the conclusion the solute potential of the cells of each variety of onion is equivalent to that of the solution which causes 50% plasmolysis ; 29 because at this point, wall / turgor, pressure is zero therefore external and internal solute potential are equal ; 30 the solute potential of a given concentration of sodium chloride solution can be found by consulting an appropriate table ; 31 solute potential can be expressed in kPa and is normally a negative value ;	**[max 4]**

[Total: 22]

[Total for Section A: 60]

Section B

5 **(a)** *relatively large flowers:*

1 to attract insects for pollination ;
2 (in case there are) few insects available (as effective pollinators) ;
3 if not pollinated then seeds not produced ;

thick and very hairy:

4 Shetland plant a xerophyte / has xeromorphic features ;
5 reduced surface area to volume ratio ;
6 hairs reduce transpiration / water loss from leaves (to atmosphere) ;
7 thick leaves store water ;

relatively large seeds

8 large food reserves / ref. to endosperm ;
9 seeds remain viable for a long time / AW ;
10 ref. to conditions for germination ; **[max 5]**

(b) 1 ref. to, natural selection / selective pressure(s) ;
2 allopatric speciation ;
3 ref. to environmental conditions being different, on the Keen / in Shetland, to those, elsewhere / in Faeroes ;
4 example of environmental difference mentioned / implied in the passage (relative to Faeroes or other Arctic mouse-ear habitats) ;
e.g. warmer / drier / nutrient poor
5 ref. to mutations ;
6 ref. to recombination ;
7 ref. to genetic isolation / reproductive isolation / lack of gene flow (from Faeroes) ;
8 only genetically determined characteristics passed on to next generation ;
9 AVP ;
e.g. founder effect / genetic drift, in correct contexts **[max 5]**

[Total: 10]

6 (a) (i) 1 gives a view of, the wider area / the area not affected by eutrophication ;
2 objectives / free of bias / to place the permanent plots in a wider perspective ; **[2]**

(ii) *(following, the addition of, nutrients / phosphate, / the eutrophication event)*
1 an increase in (mean total) plant cover ;
2 (since, the addition of nutrients / 1980) the density of Shetland mouse-ear increased and then decreased ;
3 use of figures ;
e.g. (population of) Shetland mouse-ear at a maximum in 1980 and 1985, and then decreased to zero by 2006 ;
4 low nutrients (help to) kept the debris bare / plants on debris are under nutrient stress / nutrients are a limiting factor ;
5 Shetland mouse-ear cannot compete with the other species ; **[max 4]**

(iii) 1 quadrats where the, eutrophication / nutrient addition, did not take place / was prevented ;
2 in similar debris habitat nearby ;
3 to check that the changes shown in Table 6.1 were, really caused by adding nutrients / not caused by a change in another variable / appropriate example of other variable ; **[max 2]**

(b) 1 protect the debris habitat ;
2 prevent eutrophication ;
3 collect seeds and keep in a seed bank / reintroduce from seed bank ;
4 reducing / removing, the closed vegetation ;
5 since Shetland mouse-ear is endemic / is almost entirely confined, to the Keen there cannot be more than one reserve ;
6 make the reserve as large as possible ;
7 reference to SLOSS (single large or several small reserves) ; **[max 3]**

[Total: 11]

7 **(a)** 1 interbreed the two types of plant ;
2 if separate species hybrids would be infertile / ora ;
3 reference to seed viability ;

other methods
4 DNA sequencing / DNA hybridisation / isoenzymes / amino acid sequencing ;
5 detail of any appropriate method ; **[max 3]**

(b) **(i)** 1 (a ring species is) a connected series of neighbouring populations, each of which can interbreed with closely sited related populations ;
2 (but for which) there exist at least two “end” populations in the series, which are too distantly related to interbreed ;
3 even though they are in the same location ;
4 there is a potential gene flow between each neighbouring population ;
5 (in this case) extending around the world / northern latitude ;
6 (in this case) the end populations are (the two similar species) herring gull and lesser black-backed gull in, Shetland / North Atlantic ; **[max 3]**

(ii) 1 (further round the ring in Canada) lesser black-backed and herring gulls may be able to interbreed with intermediate types ;
2 increase in gene flow ;
3 reduces chances of (further) speciation ; **[max 1]**

(iii) 1 plants are non-motile ;
2 therefore mainly pollinated by plants growing close by ;
3 (whereas gulls move / fly and may travel far to find a mate) pollen / seeds, not distributed very far ;
4 less gene flow than for gull ; **[max 2]**

[Total: 9]

[Total for Section B: 30]

Section C

Breadth **[max 3]**

Mark	Descriptors
	Candidate has:
3	given a balanced account including most of the relevant topic areas and selected a wide range of facts, principles, concepts and / or examples pertinent to the title.
2	given a fairly balanced account including some of the relevant topic areas and selected some of the appropriate facts, principles, concepts and / or examples pertinent to the title.
1	given an account including a few of the relevant topic areas and selected a few of the appropriate facts, principles, concepts and / or examples pertinent to the title.
0	given an account that relies on one topic area alone and selected a few of the appropriate facts, principles, concepts and / or examples pertinent to the title.

Argumentation **[max 3]**

Mark	Descriptors
	Candidate has:
3	developed and sustained a coherent argument throughout the essay leading to an appropriate conclusion showing insight.
2	introduced an argument and partially developed it but has not sustained it coherently throughout the essay.
1	shown evidence of an argument, but has not developed it successfully.
0	shown no evidence of argumentation.

Communication **[max 2]**

Mark	Descriptors
	Candidate has:
2	organised and presented information clearly and used correct terminology in appropriate contexts.
1	not organised material very well and not used terminology appropriately so that answer has to be re-read.
0	presented an unstructured answer with poor use of terminology.

Spelling, punctuation and grammar **[max 2]**

Mark	Descriptors
	Candidate has:
2	used spelling, punctuation and grammar accurately.
1	used spelling, punctuation and grammar accurately, but has made significant errors.
0	not used spelling, punctuation and grammar accurately.

Scientific Content **[max 20]**

Mark		Descriptors
		The candidate:
20	a	recalls and consistently uses all facts and principles (relevant to the essay)
	b	shows sound understanding of all principles and concepts
	c	writes accurately with no major errors and very few minor errors
	d	gives detail fully in keeping with that expected of candidates at the end of a programme of study designed to prepare candidates for university.
16	a	recalls and consistently uses most facts and principles (relevant to the essay)
	b	shows sound understanding of most principles and concepts
	c	writes accurately with no major errors and few minor errors
	d	gives detail fully in keeping with that expected of candidates at the end of a programme of study designed to prepare candidates for university.
12	a	recalls and consistently uses some facts and principles (relevant to the essay)
	b	shows sound understanding of some principles and concepts
	c	writes some material accurately with not more than one major error and some minor errors
	d	gives detail fully in keeping with that expected of candidates at the end of a programme of study designed to prepare candidates for university.
8	a	recalls some facts and principles (relevant to the essay)
	b	shows some understanding of some principles and concepts
	c	writes some material accurately with more than one major error or many minor errors
	d	gives some detail appropriate for that expected of candidates at the end of a programme of study designed to prepare candidates for university.

4	a	recalls a few facts and principles (relevant to the essay)
	b	shows limited understanding of a few principles and concepts
	c	writes material including many errors, some of which may be major errors
	d	gives little detail appropriate for that expected of candidates at the end of a programme of study designed to prepare candidates for university.
0	a	recalls no relevant facts and principles
	b	shows no understanding of relevant principles and concepts
	c	writes irrelevant material or includes many major errors
	d	gives no detail appropriate for that expected of candidates at the end of a programme of study designed to prepare candidates for university.

Expected content

For each of the questions, guidance is given as to the kind of content from the syllabus that may be appropriate to answering the question. Some candidates will include all of these areas and others may write in more detail about these or may include other relevant topics, in each case reflecting the candidate's reading-around the subject and personal research and other interests. Some topics, both in the candidate's answers and in the following expected content, may not be directly on the syllabus, but it is important to credit such responses where they are given and thus they are included here.

8 Discuss the problems involved in the transfer of male gametes on land, and the ways in which these problems have been solved in a range of organisms. [30]

The three areas of the syllabus where there is relevant material for this essay are human reproduction (3.6), flowering plant reproduction (4.3) and sexual behaviour in animals e.g. dunnock (5.1). There is also a reference to the difficulties of fertilisation for terrestrial organisms in the extension material in section 3.6 and some students may use examples for a larger range of organisms than those specifically mentioned in the syllabus. A balanced essay on this topic will touch on all of these areas and should at least deal with humans and flowering plants.

The structure, synopsis and argumentation invited by this essay are along the following lines:

- Terrestrial animals and plants are evolved from aquatic ancestral forms in which sperm can swim through the water to reach the ova.
- On land, however, there is, in many cases, no water between the male and female through which the sperm can swim.
- In flowering plants, the free-swimming male gamete has been replaced by an alternative process involving pollen grains which are non-motile and dry, transferred from male to female organs passively by insects or the wind (4.3a, 4.3b).
- Animals retain the motile sperm but fertilisation is internal, within the body of the female.
- The male and female animals come together physically through behavioural adaptations (3.3n, 4.1c).
- The reproductive systems of the male and female provide an aqueous route through which fertilisation takes place (3.6a, 3.6c).

9 DNA molecules are replicated with a high degree of accuracy yet not always perfectly.

Describe how this occurs and describe why the survival of a species depends on DNA molecules being stable, yet not *absolutely* stable. [30]

The structure, synopsis and argumentation invited by this essay are along the following lines:

- How DNA replication takes place accurately during cell division (1.3a, 1.3b, 1.6a).
- Replication not being 'always perfect' refers to mutation (1.6k).
- Describe how mutations may take place during DNA replication (1.6l).
- Recognise why it is important that DNA replication is accurate for the survival of offspring, using examples such as sickle cell anaemia, cystic fibrosis and/or hereditary haemochromatosis (1.6m).
- The role of mutation in evolution by natural selection (2.2c).
- Argue that continuation of a species and its continued evolution relies on a balance between accurate transmission of nucleotide sequences and the need for random change to provide the variation needed to allow continued evolution, thus responding to environmental change.

10 'The function of hormones in both plants and animals is essentially the same but only animals need a nervous system'.

Discuss the extent to which this is a valid statement. **[30]**

The structure, synopsis and argumentation invited by this essay are along the following lines:

- Review the nature and role of hormones in coordination of homeostasis in animals, exemplified by insulin and glucagon (3.4c), ADH (3.4f), and in the coordination in growth and development exemplified by hormones such as oestrogen, progesterone, FSH and LH (3.6b).

- Animal hormones are proteins whereas not all plant 'hormones' are – although there are DELLA proteins which block transcription of genes responsible for cell growth (4.4b).

- The role of auxins and gibberellins, the nearest equivalent to hormones in plants (4.4a).

- Plant and animal hormones both play a part in coordinating growth and responding to internal and external environmental change and may both be involved in gene switching.

- Animals have a nervous system (3.3), unlike plants.

- How nerves transmit impulses (3.3a–f).

- Plant hormones do resemble animal hormones in that they **coordinate growth and responses** to stimuli and they can both work by gene switching.

- However, plants are mostly **non-motile** and an elaborate coordination system is not essential for survival. Plants achieve the same outcomes as animals but in different ways which do not require a nervous system (protection by spines, fertilisation through pollination, surviving the winter). Venus fly trap responds rapidly to stimuli (fly in the trap) but does so without a nervous system.

- Animals like mammals can make a co-ordinated response **rapidly** to external stimuli and for this they need a nervous system. A nervous system allows animals to see, hear or smell 'danger' and to react very quickly using all their limbs in tight coordination to run away. If animals did not do this they would be unable to find food, to escape predators and to find a mate.

- The nervous system of animals can produce flexible responses, learn responses and consciously modify behaviour in the light of experience – no equivalent of this in plants.