CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2013 series

9700 BIOLOGY

9700/41 Paper 4 (A2 Structured Questions), maximum raw mark 100

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AW	alternative wording (where responses vary more than usual)
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max	indicates the maximum number of marks that can be given
ora	or reverse argument
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I	ignore
AVP	Alternative valid point (examples given as guidance)

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1 **(a)** allele – variation / different form, of a gene **;**

dominant – (allele) always expresses itself (in the phenotype when present) **;** [2]

(b) the greater the number of (CAG) repeats the earlier the symptoms first appear / inversely proportional / negative correlation **;**

paired figures **;** [2]

(c) 1. fear of needles **;**

2. fear of positive result **;**

3. fear of effect of result on other members of family **;**

4. no desire to have children **;**

5. financial / insurance, concerns / AW **;**

6. possibility of false results **;**

7. cost of test **;**

8. not worth having test because of no treatment **;** [max 3]

[Total: 7]

2 **(a)** *in context of woolly mammoth*

1. individuals varied (in their phenotypes) **;**

2. (phenotypic variation) caused by, genetic variation / mutation **;**

3. change in, selection pressure / environmental conditions **;**

4. *idea that* variation increases the chance of some individuals surviving / AW **;**

5. named adaptation explained **;** e.g. better insulation / smaller surface area to volume

6. survivors breed **;**

7. passed on <u>alleles</u> to offspring **;**

8. changed <u>allele</u> frequency (in population) **;** [max 5]

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(b) 1. differences in, primary structure / sequence of amino acids / polypeptide **;**

2. provides different, side chains / R groups **;**

3. change in, tertiary structure / 3D shape **;**

4. effect on quaternary structure **;**

5. greater effect on β chain **;**

6. change in properties **;** **A** function [max 3]

(c) **(i)** 1. still able to offload oxygen (in cold temperatures) **;**

2. surface tissues colder than, core / body, temperature **;**

3. so can maintain oxygen supply to surface tissues **;** [max 2]

(ii) 1. no / tiny, difference in effect of temperature on haemoglobin alone **;**

2. so no evidence (woolly mammoth haemoglobin) better adapted **;**

3. greater reduction in effect of temperature on haemoglobin with red cell effector in woolly mammoth **; ora**

4. (so) woolly mammoth haemoglobin (with red cell effector) better adapted to cold **;**

5. ref. change to oxygen binding sites **;**

6. so can offload oxygen at low temperatures **;** [max 4]

[Total: 14]

3 **(a)** adenine / nitrogen(ous) base / purine **;** **R** adenosine

ribose / pentose **;** [2]

(b) 1. (cell uses) ATP as source of energy **;**

2. ATP broken down **;**

3. (so) cell must regenerate ATP **;**

4. from ADP and Pi **;**

5. ref. ADP / AMP, must be synthesised in the cell **;** [max 2]

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(c) (i) 1. palmitic acid has **more**, hydrogens / C-H bonds **;**

2. per mole **;**

3. hydrogens needed for, ATP production / chemiosmosis / oxidative phosphorylation **;**
[max 2]

(ii) *alanine* – starvation / lack of fat or carbohydrate **;**

lactate – after anaerobic respiration **;** [2]

[Total: 8]

4 (a) (i) working **;** e.g. 1st oestrogen peak at day 13, 2nd peak at day 41 / looked at two peaks and calculated number of days in between

28 **;** [2]

(ii) began: day 13 or14 **;**

ended: day 29 or 30 **;** [2]

(iii) (anterior) pituitary (gland) **; R** posterior pituitary [1]

(iv) 1. stimulates follicle **;**

2. to secrete oestrogen **;**

3. surge in LH secretion**;**

4. stimulates ovulation **;**

5. ref. development of corpus luteum / stimulates corpus luteum **;**

6. to secrete progesterone **;** [max 3]

(b) (i) 1. ref. reliability **;**

2. ref. to irregularity of cycles **;**

3. *idea that* cannot be sure about menstrual phase on day 22 **;**

4. *idea that* using hormones alone might not identify day of cycle precisely enough **;**
[max 2]

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(ii) 1. (yes because) oestrogen concentration high on day 22 and low on day 2 ;

2. (but) shows correlation but not necessarily, linked / causal effect ;

3. concentration of progesterone could be affecting performance ;

4. (progesterone concentration) high at 22 days and low on day 2 ;

5. not LH as concentration low on both days ;

6. ref. to small numbers in investigation / more evidence needed ;

7. ref. to use of statistics to determine if difference in results is significant ; [max 4]

[Total: 14]

5 **(a)** 1. no change between 1860 and 1930 ;

2. ref. to increases from 1930 to 2010 ;

3. use of figures including <u>units</u> ; [3]

(b) 1. single-cross hybrids have homozygous parents ;

2. each has inherited the same alleles ;

3. (so) they are uniformly heterozygous ;

4. double-cross hybrids have heterozygous parents ;

5. each has inherited different combinations of alleles
or
(mixture of) homozygous dominant, homozygous recessive and heterozygous hybrids ;
[max 3]

(c) **(i)** 1. the greater the inbreeding coefficient, the lower the yield ;

2. in each site in each year ;

3. use of figures ; [max 2]

(ii) 1. the yield differs, at different sites / in different years ;

2. for the same inbreeding coefficient ;

3. use of figures ;

4. named environmental factor ; e.g. rainfall / temperature / mineral content of soil
[max 2]

[Total: 10]

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6 (a) (i) greater speed (if myelinated) **;**

comparative figures with units **;** [2]

(ii) larger diameter greater speed / ora **;**

comparative figures with units **;** [2]

(b) 1**.** myelin insulates axon **;**

2. no myelin at nodes **;**

3. action potentials / depolarisation, only at nodes (of Ranvier) **;**

4. local circuits set up between nodes **;**

5. action potentials 'jump' from node to node / saltatory conduction **;**

6. myelination prevents leakage of ions **; ora** [max 3]

(c) (i) 1. (sheath) treated as, 'foreign' / non-self **;**

2. ref. role of, antibodies / phagocytes / lymphocytes **;** [2]

(ii) 1. less insulation of axon **;**

2. action potentials, slow down / stop **;** [2]

[Total: 11]

7 (a) (i) 1. (blue) light is absorbed and used for photosynthesis **;**

2. CO_2 , used / concentration decreased **;**

3. leads to, rise in pH / decrease in acidity **;** [max 2]

(ii) 1. respiration **but no** photosynthesis **;**

2. CO_2, produced / released **;**

3. leads to, decrease in pH / increase in acidity **;** [max 2]

(b) (i) absorb light (energy) **;**

pass (light) energy onto, primary pigment / chlorophyll a / reaction centre **;** [2]

(ii) $H_2O \longrightarrow 2H^+ + 2e^- + ½\ O_2$ **;**

A $2H_2O \longrightarrow 4H^+ + 4e^- + O_2$ [1]

(iii) grana / thylakoid, membrane **;** [1]

[Total: 8]

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8 **(a)** any number between 873 – 882 inclusive **;;**

allow one mark for correct working or for number not rounded up [max 2]

(b) *named species (no mark)*

*four **relevant** reasons for a named species* **; ; ; ;**
e.g. animal species
direct human effect e.g. hunting / fishing / collection / skins
habitat destruction
climate change qualified
increase in pollution
spread / increase, in disease or new disease
lack of food
increased predation

e.g. plant species
direct human effect e.g. specimen collection / logging
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spread / increase, in disease or new disease
loss of pollinators
increased competition from introduced plants [4]

[Total: 6]

9 dormancy **;**

embryo **;**

aleurone **;**

endosperm **;**

maltose **;**

ATP / energy **;**

transcription / expression **;** [7]

[Total: 7]

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10 (a) 1. chance / random / spontaneous **;**

2. change in, base / nucleotide, sequence (in DNA) **;**

3. during DNA replication **;**

4. base substitution **;**

5. often no effect **/** silent mutation / may code for same amino acid **;**

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9. alters whole sequence of bases after mutation **;**

10. may lead to stop codon **;**

11. different / new, allele **;**

12. protein, different shape / different function / not made **;** [max 9]

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2. Cl^- ions do not move out **;**

3. less water leaves cell **;**

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mucus not moved effectively by cilia / mucus accumulates **;**

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9. lungs are scarred **;**

10. blocked sperm ducts **;**

11. blocked pancreatic duct **;** [max.6]

[Total: 15]

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11 (a) 1. multicellular ;

2. (cells are) differentiated into tissues ;

3. autotrophic / photosynthetic ;

4. eukaryotic (cells);

5. starch is storage compound ;

6. (some have) chloroplasts / chlorophyll ;

7. cell wall ;

8. made of cellulose ;

9. plasmodesmata ;

10. large (central) vacuole ; [max 7]

(b) 1. 0.5–1.0 μm, diameter / width ;

2. double membrane ;

3. inner membrane folded / cristae ;

4. hold, stalked particles / ATP synthase / ATP synthetase ;

5. site of ETC ;

6. ref. H^+ and intermembrane space ;

7. ATP production ;

8. oxidative phosphorylation / chemiosmosis ;

9. matrix is site of, link reaction / Krebs cycle ;

10. enzymes in matrix ;

11. 70S ribosomes ;

12. (mitochondrial) DNA ; [max 8]

[Total: 15]

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9700/42 Paper 4 (A2 Structured Questions), maximum raw mark 100

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climate change qualified
increase in pollution
spread / increase, in disease or new disease
lack of food
increased predation

e.g. plant species
direct human effect e.g. specimen collection / logging
habitat destruction
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spread / increase, in disease or new disease
loss of pollinators
increased competition from introduced plants [4]

[Total: 6]

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embryo **;**

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2. (cells are) differentiated into tissues ;

3. autotrophic / photosynthetic ;

4. eukaryotic (cells);

5. starch is storage compound ;

6. (some have) chloroplasts / chlorophyll ;

7. cell wall ;

8. made of cellulose ;

9. plasmodesmata ;

10. large (central) vacuole ; [max 7]

(b) 1. 0.5–1.0 μm, diameter / width ;

2. double membrane ;

3. inner membrane folded / cristae ;

4. hold, stalked particles / ATP synthase / ATP synthetase ;

5. site of ETC ;

6. ref. H^+ and intermembrane space ;

7. ATP production ;

8. oxidative phosphorylation / chemiosmosis ;

9. matrix is site of, link reaction / Krebs cycle ;

10. enzymes in matrix ;

11. 70S ribosomes ;

12. (mitochondrial) DNA ; [max 8]

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1 (a) X^RY and X^rX^r ;

X^R **Y** X^r **(**X^r**)** ; *allow ecf from incorrect parental genotypes*

X^RX^r and X^rY ; [3]

(b) (i)

phenotype of fly	O	E	O–E	$(O–E)^2$	$\frac{(O–E)^2}{E}$
red-eyed female	54	50	(+)4	16	0.32 ;
white-eyed male	46	50	(-)4	16	0.32 ;

0.64 ;
allow ecf [3]

(ii) probability is greater than 0.05 ; **A** chi squared smaller than 3.84

no significant difference ;

due to chance ; [max 2]

[Total: 8]

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2 (a) (i) 1. coelacanth α chain has higher percentage of matches ;

2. with both adult and larval amphibians ;

3. coelacanth β chain has higher percentage of matches with larval amphibians (rather than adults) ;

4. figures to support mp1 or mp3 or mp6 (comparing coelacanth with lungfish);

5. supports closer relationship of coelacanth and amphibia ;

6. (but) lungfish β chain has higher percentage of matches with adult amphibian (than coelacanths) ;

7. does not support suggestion / supports closer relationship lungfish and amphibia ;

[max 4]

(ii) 1. larvae aquatic **and** adults (partly) terrestrial / AW ;

2. different oxygen concentration available ;

3. need haemoglobins with different oxygen affinities ; [max 2]

(b) (i) 1. idea of, unchanging / constant, environment ;

2. oxygen concentration acts as a selective agent ;

3. organisms best adapted to these conditions survive ; ora

4. extreme (phenotypes) selected against ;

5. ref. narrow range of genetic variation / allele frequency maintained ;

6. sketch graph ;

7. ref. mutation ; [max 3]

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(ii) 1. ref. change in oxygen concentration ;

2. (low) oxygen concentration acts as selective agent ;

3. some individuals (in population) are better adapted ;

4. these are more likely to survive ; ora

5. <u>directional selection</u> ;

6. sketch graph ;

7. populations develop in different concentrations of oxygen ;

8. <u>disruptive selection</u> ;

9. sketch graph ;

allow either mp6 or mp9 but not both [max 3]

(c) 1. (same) species separated into separate populations ;

2. (by) geographical isolation / named example ;

3. prevents interbreeding between populations / no gene flow ;

4. ref. to different selection pressures ;

5. change in allele frequencies ;

6. eventually do not successfully interbreed ;

7. <u>allopatric speciation</u> ;

8. ref. to genetic drift / founder effect / different mutations / (different) new alleles ; [max 3]

[Total: 15]

3 **(a)** 1. <u>oxidative phosphorylation</u> ;

2. oxygen is **final** electron acceptor ;

3. reduced to water / accepts hydrogen ion to form water ; **A** equation

4. so electron transport chain can continue ; ora

5. increases ATP production ; ora

6. in absence of oxygen only glycolysis continues ; [max 3]

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(b) (i) 1. lipid releases most energy ;

2. because it has more, hydrogens / C-H bonds ;

3. per unit mass ;

4. hydrogens needed for, ATP production / chemiosmosis ; [max 3]

(ii) many more hydrogens available to, reduce / convert, oxygen to water ; [1]

[Total: 7]

4 (a) idea that sperm can survive for several days ;

so fertilisation can occur, at / after, ovulation ; [2]

(b) (i) low until around day 13 then one peak returning to low at around day 28 ;

peak around day 22 ; [2]

(ii) began: day 1 *and* ended: day 14 ; [1]

(c) (i) 1. ref. to irregularity of cycle ;

2. example of factor affecting cycle ; e.g. illness / travel / stress / synchronicity [2]

(ii) 1. avoid sexual intercourse when LH level high ;

2. can predict next LH surge ; [2]

(iii) 1. change in basal temperature (at ovulation) is only small ;

2. *idea of* continuous monitoring **/** avoids, misreading values / inaccuracy / missing temperature change ; ora for thermometer [2]

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(d) 1. there is a possibility of becoming pregnant on most days of the cycle ;

2. guidelines should include more days before and after ovulation ;

3. not possible to become pregnant on days 1–3 and days 27–29 ;

4. *idea of* days 10 to 17 are centred around the highest probability ;

5. ref. to day 18 having same probability as day 10 ;

6. comparative figures ; e.g. probability on two different days

7. idea of women with irregular cycles have more variation (in fertile window) ; [max 4]

[Total:15]

5 (a) (i) 1. greater in teosinte (than in maize) ;

2. greater at 9 loci / less at 1 locus / except at locus 7 ;

3. greatest difference at locus 10 ;

4. use of comparative figures ; [max 2]

(ii) 1. artificial selection / selective breeding ;

2. humans carry out selection ;

3. of plants with desirable traits ;

4. not all <u>alleles</u> selected (in cultivated varieties) ;

5. increased homozygosity ;

6. *idea that* greater variety of alleles are needed to survive in the wild environment ; [max 3]

(iii) 1. wild plants have greater variety of, alleles / base sequences ;

2. could be useful for future breeding ;

3. example of use ; e.g. to cope with climate change / drought [max 2]

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(b) 1. to avoid inbreeding depression ;

2. hybrids have, higher yields / hybrid vigour ;

3. avoids expression of harmful recessive alleles ;

4. ref. to genetic uniformity ;

5. (which) results in easier, cultivation / harvest / etc ; [max 3]

[Total: 10]

6 (a) (i) **B** ;

(ii) **E** ;

(iii) **D** ;

(iv) **A + F** ; *both required* [4]

(b) (i) Protoctista ; [1]

(ii) 1. ref. to voltage-gated sodium ion channels / ref. ligand gated channels ;

2. channels change shape (when, pd / voltage, changes) ;

3. open when, membrane depolarises / action potential arrives / neurotransmitter binds to receptors ;

4. sodium ions flood in ;

5. diffuses / down concentration gradient ;

6. channels close when membrane, repolarises / potential reaches +30mV ;

7. ref. to sodium-potassium pump ; [max 3]

(iii) 1. no, depolarisation / action potentials ;

2. *idea of* life-threatening paralysis **/** named consequence ;
e.g. cannot breathe / heart stops [2]

[Total: 10]

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7 **(a)** **A** – photosystem II / P680 / PS II ;

B – photosystem I / P700 / PS I ; [2]
if photosystem given for both but wrong way round give one mark

(b) **(i)** 1. carbon dioxide fixation ;

2. production of GP ;

3. ref. to rubisco ; [max 2]

(ii) 1. reduction (of GP) / donates hydrogen ;

2. GP to TP ; [2]

(iii) 1. supplies, energy / phosphate ;

2. (to convert) GP to TP ;

3. (to) regenerate of RuBP ; [max 2]

[Total: 8]

8 **(a)** 7 500 ;;

allow one mark for correct working
allow one mark for 7.5 tonnes [2]

(b) 1. stop / reduce, fishing ; **A** correct ref. to quotas / moratorium

2. ref. to size of nets ;

3. ref. to methods of fishing ;

4. control pollution ;

5. education ;

6. captive breeding and release / restocking from fish farms ;

7. ref. to marine reserves ; [max 3]

[Total: 5]

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9 active transport **/** diffusion ;

mass ;

phloem ;

dominance ;

decrease / reduce / lower ;

division / mitosis / elongation ;

elongation / division / mitosis ; [7]

[Total: 7]

10 (a) 1. (CF caused by) mutation ;

2. of CFTR gene ;

3. (CFTR) protein defective ;

4. (so) insert, normal / dominant, (CFTR) allele ;

5. into DNA ; **A** chromosome

6. in cells of respiratory system ; **A** named part of airway **Ignore** alveoli

7. ref. to vector ;

8. taken as spray / inhaled ;

9. use liposomes ;

10. use harmless virus ;

11. not all cells take up virus ;

12. may have unpleasant side-effects ;

13. effects are short-lived / treatment needs repeating ; [max 8]

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(b) *counsellor:*

1. ref. to pedigree analysis ;

2. ref. to genetic screening / DNA analysis ;

3. detail of genetic screening ; e.g. tissue samples from adults / IVF and test embryos/ amniocentesis

4. explains results of tests **/** estimates chances of having affected child ;

5. (may discuss) termination ;

6. (may discuss) alternative, therapies **/** treatments ;

7. (may discuss) financial implications (of having affected child) ;

8. (may discuss) the effect of having affected child on existing siblings ;

9. (may discuss) ethical issues ; *max 6*

couple referred if:

10. either has genetic disease (in family) or are carriers ;

11. history of recurrent miscarriages ;

12. older woman ; [max 7]

[Total: 15]

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11 (a) 1. rise in blood glucose concentration detected by β cells ;

2. (β cells) in, islets of Langerhans / pancreas ;

3. insulin released into blood ;

4. binds to receptors in cell surface membrane ;

5. ref. to liver / muscle, cells ;

6. increase in uptake of glucose (by cells) /
(cell surface) membrane more permeable to glucose ;

7. increase in use of glucose in respiration ;

8. (increase in) conversion of glucose to glycogen ;

9. blood glucose <u>concentration</u> falls ;

10. inhibits, glycogen / lipid / amino acid, breakdown ; [max 6]

(b) 1. (stick / kit) dipped in (early morning) urine sample ;

2. hCG / urine, moves up strip ;

3. idea that hCG acts as <u>antigen</u> ;

4. (mobile) antibody also bound to, indicator / gold ;

5. (mobile) antibody in stick binds to hCG ;

6. ref. to variable region (of antibody) ;

7. ref. to specificity (of antibody) ;

8. ref. to monoclonal (antibody) ;

first window or region
9. second antibody is, immobilised / fixed ;

10. first antibody and hCG complex binds to second antibody ;

11. coloured band indicates pregnancy ;

second window or region
12. immobile antibody binds to mobile antibody-gold complex ;

13. second coloured band shows strip is working ; [max 9]

[Total: 15]

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