

**CAMBRIDGE INTERNATIONAL EXAMINATIONS**

Cambridge International Advanced Subsidiary and Advanced Level

## **MARK SCHEME for the October/November 2015 series**

### **9700 BIOLOGY**

**9700/43**

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

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Mark scheme abbreviations:

<b>;</b>	separates marking points
<b>/</b>	alternative answers for the same point
<b>R</b>	reject
<b>A</b>	accept (for answers correctly cued by the question or by extra guidance)
<b>AW</b>	alternative wording (where responses vary more than usual)
<b><u>underline</u></b>	actual word given must be used by candidate (grammatical variants accepted)
<b>max</b>	indicates the maximum number of marks that can be given
<b>ora</b>	or reverse argument
<b>mp</b>	marking point (with relevant number)
<b>ecf</b>	error carried forward
<b>I</b>	ignore
<b>AVP</b>	alternative valid point (examples given as guidance)

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- 1 (a) (i) **W** = ethanal ; **A** acetaldehyde / C<sub>2</sub>H<sub>4</sub>O  
**X** = carbon dioxide ; **A** CO<sub>2</sub>  
**Y** = reduced NAD ; **A** NADH / NADH<sub>2</sub> / NADH<sup>+</sup> + H<sup>+</sup> [3]
- (ii) *in yeast cells – ora for muscle cells*  
1 ethanol produced as opposed to, lactate / lactic acid ;  
2 irreversible ;  
3 different dehydrogenases involved /  
reduction of ethanal instead of pyruvate / AW ;  
4 two steps / two enzymes involved / decarboxylation /  
*ref. to* (pyruvate) decarboxylase / CO<sub>2</sub> production ; [max 2]
- (b) *fewer ATP molecules produced*  
no / fewer, protons / H<sup>+</sup>, move through, ATP synth(et)ase / stalked particles  
**or**  
less steep, proton / H<sup>+</sup>, gradient ; **I** chemiosmosis  
*more heat energy released*  
H<sup>+</sup> gradient / electron flow / ETC, energy converted to, heat / thermal energy ;  
*constant oxygen uptake*  
ETC still works / oxygen acts as final electron acceptor ;  
**I** oxidative phosphorylation still works [3]
- [Total:8]
- 2 (a) 1 NicVAX / vaccine, recognised as, non-self / foreign ;  
2 *ref. to* antigen presenting cells ;  
3 (recognised / bound, by), specific / particular / certain, B-lymphocytes ;  
**I** correct / right  
4 clonal selection ;  
5 clonal expansion / mitosis / cell division, of B-lymphocytes ;  
6 T-helper cells stimulate B-lymphocytes ;  
7 T-helper cells release cytokine ;  
8 B-lymphocytes, become / mature into, plasma cells ;  
9 plasma cells, secrete / produce, antibody ;  
**A B-cell for B-lymphocyte throughout** [max 5]

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- (b) 1 plasma cells / B-lymphocytes, extracted from (mouse) spleen ; I blood  
2 fused with, myeloma / cancerous / tumour / malignant, cells ; I 'mixed with'  
3 use of, a fusogen / electrofusion ; A EFF–AFF / detergent  
4 formation of hybridoma cells ;  
5 identify hybridoma cells with, specific / anti-nicotine / relevant, antibody ;  
6 large-scale culture / grow in fermenter ;  
7 AVP ; e.g. detail of cell identification [max 4]
- (c) (i) increase from 0 to 30 mins  
**or**  
rapid / steep, increase from 0 to 15 mins ;  
  
(from 30 mins) decrease then, gradual / slow / gentle, increase ; I steady [2]
- (ii) 1 (both) antibodies reduce nicotine (concentration in the fetal circulation) ;  
2 at specified time quote concentration for nicotine  
and **either** Nic-IgG **or** Nic311 plus units  
**or**  
compare maximum concentrations for  
nicotine =  $12.5 \text{ ng cm}^{-3}$   
**and** Nic-IgG =  $2.0 \text{ ng cm}^{-3}$   
**and** Nic311 =  $5.5 \text{ ng cm}^{-3}$  ;  
*units need to be quoted once only*  
3 lower nicotine (concentration) gives fewer adverse side-effects in the fetus ;  
4 Nic-IgG, is more effective /  
reduces the fetal nicotine (concentration) to a lower level, (than Nic311) ;  
5 AVP ; e.g. do not know concentration of nicotine that is harmful to fetus /  
*idea that* nicotine still present in fetal circulation [max 3 ]
- (d) pregnancy testing / diagnosis of disease / treatment of disease / delivery of drugs /  
blood or tissue typing ;  
I monoclonal antibodies kill pathogens [1]

[Total:15]

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- 3 (a) (i) 1 expose salmon to, IPN/virus ;
- 2 (humans) select/choose/identify, unaffected/resistant, individuals ;  
A survivors
- 3 breed them together ;
- 4 repeat for several generations ; [max 3]
- (ii) 1 increase in homozygosity ;
- 2 harmful recessive alleles may be expressed ;
- 3 inbreeding depression/loss of hybrid vigour ;
- 4 limited gene pool/decrease in genetic variation ;
- 5 AVP ; e.g. loss of desirable traits [max 2]
- (b) (i) *accept ora throughout*
- 1 *comparative statement that* group A, have lower percentage mortality ;
- 2 after 30 days no more in group A die  
or  
rise in deaths in group B, throughout/until 45 days ;
- 3 at specified time in days quote mortality for both A and B plus % unit ;  
A 'percentage mortality' for unit
- 4 (more) resistance/less susceptibility, (to IPN) in group A ;
- 5 *ref. to* resistance allele(s) ; A resistance gene R immunity/tolerance
- 6 infection spreads throughout/reservoir of infection in, group B ; [max 4]
- (ii) another, disease/pathogen, could be present ;
- by chance/random event ; e.g. pollution/temperature variation [max 1]
- [Total:10]
- 4 (a) 1 identify females, with the recessive allele/who are carriers ;
- 2 if embryo has allele can choose abortion ;
- 3 select unaffected IVF embryo (to implant) ; A pre-implantation genetic diagnosis
- 4 women can choose not to have children ; [max 2]

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- (b) (i) 1 insert a, functional / normal / dominant / correct, allele ;  
**R** remove / replace, faulty allele I gene
- 2 to obtain, functional / normal / correct, protein / polypeptide ;  
**A** e.g. clotting factor
- 3 reduce the symptoms (of the disorder) ;
- 4 restore / modify / enhance, cellular functions ;  
**A** e.g. enzyme reaction / clotting process / membrane transport
- 5 increase, quality of life / life expectancy / survival ; **A** live normal life
- penalise germ-line therapy once only* [max 2]

- (ii) 1 caused by a recessive allele ;
- 2 serious / common, disorder ; [max 1]

- (c) (i) 1 *F9* gene is shorter ;
- 2 easier to insert into, plasmid / vector / adenovirus ;
- 3 easier to enter nucleus ; I into cell
- 4 easier to integrate into genome ;
- ora** throughout for *F8* gene [max 2]

- (ii) *adenovirus advantage*
- 1 (double-stranded) DNA so no, reverse transcription / making cDNA ;  
I single-stranded to double-stranded step alone
- 2 high gene expression so produce more (therapeutic) protein ;
- adenovirus disadvantage*
- 3 high immune response so adenovirus may be removed before it reaches target cells ;
- 4 high immune response so, allergies / side effects ; [max 3]

[Total:10]

- 5 (a) (i) 1 diversity of, habitats / ecosystems ;
- 2 number of different species ;
- 3 genetic diversity within a species ; [max 2]

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- (ii) 1 maintain, food chains / food webs  
or  
maintain, stability / balance, in ecosystems ; I ecological
- 2 maintain, genetic diversity / genetic variation / gene pool ;
- 3 resources (for humans) ; e.g. biofuel / food / medicine / wood
- 4 aesthetic reasons / (eco)tourism ;
- 5 maintain, nutrient cycle / soil structure / climate stability ; [max 3]

(b) (i) *between 1970 and 1990*

- 1 in terrestrial, as protected areas increase, biodiversity decreases  
**A** negative correlation / inversely proportional
- 2 in marine (general trend) as protected areas increase, biodiversity increases ;  
**A** positive correlation
- 3 exceptions ; e.g. dip, from 1980 / till 1985 (in marine) /  
rise, from 1970 / till 1975 (in terrestrial) ;

*between 1990 and 2005*

- 4 **in both habitats** as total area protected increases, biodiversity decreases ; [max 3]

- (ii) 1 marine environments are difficult to, patrol / monitor ;
- 2 lack of public, awareness / interest ;
- 3 international ownership issues ; **A** example
- 4 difficult to, set / mark / recognise, boundaries ;
- 5 AVP ; e.g. problem of mobile populations [max 2]

[Total:10]

6 (a) G ;

C ;

J ;

B ; [4]

(b) (i) 515 (%) ;;

*allow one mark for working*

e.g.  $\frac{14.76 - 2.40}{2.40} (\times 100)$  or  $\frac{12.36}{2.40} (\times 100)$  [2]

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(ii) *high protein diet*

- 1 hydrolysed / digested, to amino acids (in gut) ; **A** broken down
- 2 excess amino acids cannot be stored ;
- 3 deaminated (in liver) / ornithine cycle, to produce urea ;
- 4 more urea in blood filtered into nephron(s) ;

[max 2]

**[Total:8]**

7 (a) (i) 1 more light absorbed by chlorophyll ;

- 2 short / blue, wavelengths have more energy ; **ora**  
**A** suitable figures for **X** (in range 400–500nm)  
**or** for **Y** (in range 600–700nm)

- 3 (so) greater rate of photosynthesis ;

[max 2]

(ii) 1 contain chlorophyll ;

- 2 reflects / does not absorb, green light ; **A** reflects / does not absorb,  
500–600 nm

[2]

(iii) 1 absorbs light, wavelengths / colours, not absorbed by, primary pigment /  
reaction centre / P680 / P700 ;

- 2 passes (light) energy to, primary pigment / reaction centre / P680 / P700 ;

[2]

(b) 1 decrease in rate of photosynthesis ; **A** photosynthesis stops

- 2 rubisco / enzyme, denatured ;

- 3 less / no, carbon dioxide, fixed / binds to RuBP ;

- 4 (initial) increase in transpiration ; **A** high transpiration

- 5 loss of turgor / wilting ;

- 6 ABA production ;

- 7 (eventually) stomata close ;

- 8 reduction in carbon dioxide uptake ;

- 9 photorespiration / rubisco binds to oxygen instead of carbon dioxide ;

[max 5]



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(c) rubisco / RuBP carboxylase-oxygenase ;

thylakoids ; I membranes

DNA ;

ribosomes ; **A** 70S **R** 80S

[4]

[Total:15]

8 (a) **NNGG**  
**NNGg**  
**NnGG**  
**NnGg** ;;

4 correct = 2 marks

2/3 correct = 1 mark

[2]

(b) 1 test cross ;

2 cross fly with, vestigial wing and ebony body fly

**or**

double / homozygous, recessive fly / nngg fly ;

3 if some offspring have vestigial wing and/or ebony body genotype is heterozygous ; **A** if, some offspring have recessive trait / not all offspring have dominant trait, genotype is heterozygous

4 if offspring all have normal wing and/or grey body genotype is homozygous ;  
**A** if offspring all have dominant trait genotype is homozygous

**A** short for vestigial *and* black for ebony *throughout*

[max 3]

(c)

parental genotypes	(white male) $X^wY$	×	(red female) $X^R X^o$ ;	
gametes	$X^w$	$Y$	$X^R$	$X^o$ ;
offspring genotypes	$X^R X^w$	$X^o X^w$	$X^R Y$	$X^o Y$ ;
offspring phenotypes	red-eyed female	orange-eyed female	red-eyed male	orange-eyed male ;

wrong symbols = 0

superscript R on Y chromosome = 0

superscripts w/o on Y chromosome = 1 (for correct line 4)

no X and Y = max 2 (for correct lines 3 and 4)

**ecf** alleles written as subscripts not superscripts = max 3

**ecf** superscript R written as small r = max 3

[4]

[Total:9]

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- 9 (a) 1 germinal epithelial cells form oogonia ; **A** primordial germ cells form oogonia  
2 by mitosis ; **A** mitosis increases number of oogonia  
3 *ref. to* germinal epithelial cells/oogonia, are, diploid/2n ;  
4 oogonia , grow/mature ;  
5 (oogonia) start meiosis to form primary oocytes ;  
6 meiosis stops at prophase 1 ;  
7 stage, 1/2/3/4/5/6, occurs in, embryo/fetus ;  
8 many primary oocytes in baby girl at birth ;  
9 primary oocyte completes meiosis I ;  
10 at/after, puberty ; **A** correct *ref. to* each menstrual cycle/before ovulation  
11 produces secondary oocyte and (first) polar body ;  
12 products (of meiosis I) are two haploid cells ;  
13 secondary oocyte undergoes meiosis II at fertilisation ;  
14 produces ovum and (second) polar body ;  
15 AVP ; e.g. *ref. to* events occur in follicles

*correct names required for all mp except mp6, mp7, mp10, mp12 and mp15*

[max 9]

- (b) 1 fall in concentration of progesterone ;  
2 endometrium (uterine lining) breaks down ; **I** 'thins'  
3 menstruation/period, occurs ;  
4 follicular/granulosa, cells secrete oestrogen ; **I** oestrogen produced  
5 oestrogen concentration rises ;  
6 (oestrogen) stimulates, proliferation/thickening/increase in blood vessels, of endometrium ;  
7 corpus luteum secretes progesterone ; **I** progesterone produced  
8 progesterone concentration increases ;  
9 (progesterone) maintains endometrium ; **I** 'thickens'

[max 6]

**[Total:15]**

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- 10 (a) 1 hybrids/offspring from cross between two species, infertile/sterile ;  
**A** AA × BB gives, sterile/infertile, AB
- 2 (normal) meiosis cannot occur ;
- 3 chromosomes do not pair up ;  
**A** set A chromosomes, not homologous to/do not pair with, set B
- 4 (spontaneous) doubling of chromosome number/formation of, tetraploid/AABB (emmer wheat) ; **A** chromosome doubling  
**I** doubling idea for mp 4 if context **not** chance occurrence but **ecf** for mp 6
- 5 non-disjunction (in mitosis) ; **A** in meiosis (unreduced gametes)
- 6 restores fertility/(AB) gametes can now form ; *must be linked to mp 4*
- 7 second hybridisation **and** polyploidy gives, hexaploid ;  
**A** 4n (emmer wheat) × 2n (wild goat grass) **and** chromosome number doubling → 6n  
**A** AABB × CC → ABC **and** doubling to AABBCC
- benefits*
- 8 hybrid vigour ;
- 9 large grains ;
- 10 high yield ;
- 11 beneficial characteristic/named example, introduced by parent of hybrid ;  
**A** example e.g. shorter stems plus benefit/  
grain remains attached to ear more strongly plus benefit

[max 8]

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**(b)** *environmental*

- 1 GM/genetically modified, rape may itself be, a weed/invasive ;
- 2 pollen transfer to/hybridisation with, wild relatives ;
- 3 resistant gene transfer to, non-GM crops/wild relatives ; I other plants
- 4 (resulting) hybrid offspring invasive ;
- 5 (intensive) use of herbicide selects for herbicide-resistant weeds ;
- 6 (intensive use of herbicide) reduces biodiversity ;

*economic*

- 7 problem with competition between crops and herbicide-resistant weeds ;
- 8 *idea of*, contamination of organic farming/  
accidental mixing of GM crops with non-GM, financial consequences ;
- 9 high cost of/poor farmers cannot afford, GM, seeds/plants ;
- 10 cost of herbicide ;
- 11 cost of problems with pollution ;
- 12 cost of human health problems ;

[max 7]

**[Total:15]**