

**CAMBRIDGE INTERNATIONAL EXAMINATIONS**

Cambridge International Advanced Subsidiary and Advanced Level

## **MARK SCHEME for the May/June 2015 series**

### **9700 BIOLOGY**

**9700/41**

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

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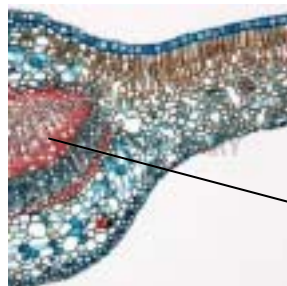
<b>Page 2</b>	<b>Mark Scheme</b>	<b>Syllabus</b>	<b>Paper</b>
	<b>Cambridge International AS/A Level – May/June 2015</b>	<b>9700</b>	<b>41</b>

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)

Page 3	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2015	9700	41

1 (a)



**P** / palisade mesophyll (tissue) ;

**X** / xylem (tissue) ;

[2]

(b) *large surface area*  
(to get) more, light / carbon dioxide ; **A** gas exchange **I** oxygen

*thinness*

small(er) / short(er) / reduced, diffusion distance for gases **OR**  
fast(er) diffusion of gases ; **A** named gas, either CO<sub>2</sub> or O<sub>2</sub>

*1 mark only if both points made but not related to features in italics*

[2]

(c) (i) have chloroplasts / varying thickness of (cell) walls / no plasmodesmata ;

[1]

(ii) water potential /  $\Psi$ , of (guard) cell(s), increases / becomes less negative ;

water leaves cell(s) ;

(by) osmosis / down a water potential gradient ; **I** diffuses

(guard cell) becomes, flaccid / less turgid / AW ;

[max 3]

**[Total: 8]**

2 (a) has more than one polypeptide ; **A** FSH has 2 /  $\alpha$  and  $\beta$ , polypeptides **R** has four

has, prosthetic group / non-protein part / carbohydrate / sugar ;

[max 1]

(b) 1 produce / make, monoclonal antibodies specific to (u-h)FSH / anti(u-h)FSH monoclonal antibodies ;

2 ref. to column / framework, for, attachment / immobilisation ; **R** test strip

3 urine, added to / flows past / passed over, antibodies ;

4 (so) allowing, hormone / (h)FSH, to bind (to monoclonal antibodies) ;

5 treatment needed to release, hormone / (h)FSH (from monoclonal antibodies) ; **I** filtering

[max 3]

Page 4	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2015	9700	41

- (c) 1 sugars need to be added / glycosylation ; **A** bacteria cannot modify protein
- 2 needs, Golgi body / rough endoplasmic reticulum ; **A** bacteria lack, Golgi / rough endoplasmic reticulum
- 3 ref. to problems in bacteria with, introns / wrong promoter / secretion / **ora** ; [max 1]

(d) *labels to correct recognisable structures*

(secondary) oocyte ; **R** ovum

zona pellucida ;

corona radiata / cumulus oophorus ;

fluid-(filled space) / antrum ;

granulosa / follicle / follicular, cells ;

theca ;

[max 3]

(e) (i)

*comparison*

- 1 more mature follicles with r-hFSH ; **ora**
- 2 oestrogen (concentration), higher with r-hFSH ; **ora**
- 3 comparative data quote ; e.g. 13 v 8 mature follicles  
**OR** 6.55 v 3.95 nmol dm<sup>-3</sup> oestrogen concentration  
**OR** manipulated figures  
e.g. difference of 5 / 2.6 nmol dm<sup>-3</sup> /  
62.5% increase (r) follicles / 65.8% (r) oestrogen

*explanation*

- 4 (because) r-hFSH, purer / more concentrated / **ora**  
**OR**  
(some) u-hFSH, damaged by extraction technique / degraded ; [max 4]

(ii)

- 1 difference / difference described, is significant ;
- 2 not due to chance ; **A** due to something other than chance
- 3 smaller than, critical value / value for significance of, 0.05 / 5% ; [max 2]

**[Total: 14]**

Page 5	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2015	9700	41

- 3 (a) *self-pollination ora for cross-pollination*
- 1 gametes / alleles / genes / DNA, come(s) from one parent ;
  - 2 gives, less genetic variation / more genetic uniformity ;
  - 3 results in inbreeding ;
  - 4 increases homozygosity / decreases heterozygosity ; [max 3]
- (b) anthers and stigma / stamens and carpels, closer together ; [1]
- (c)
- 1 range of flower size in original population ;
  - 2 genetic variation (affecting flower size) in original population ; I mutation
  - 3 change in environment / selection pressure,  
is absence of, bees / insect pollination (in greenhouse) ;
  - 4 plants with small, flowers / petals, are,  
selected for / reproduce / at a selective advantage ; **ora**
  - 5 alleles for small size passed to offspring ; **ora** I gene
  - 6 frequency of, advantageous / smallness, allele increases ; **ora**
  - 7 directional selection ;
  - 8 temperature / irrigation / space / competition, different in field and glasshouse ;
  - 9 small size explanation linked to factor in mp8 ; [max 5]
- [Total: 9]**
- 4 (a) (i)
- 1 habitat loss / urbanisation / roads / agriculture ; **R** deforestation
  - 2 human damage (to plants) ; e.g. trampling / camping / picking
  - 3 climate change ; e.g. drought / storms
  - 4 soil erosion ;
  - 5 loss of pollinators ;
  - 6 use of herbicides ;
  - 7 competition with / eaten by, introduced species ;
  - 8 pollution ; [max 2]

Page 6	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2015	9700	41

- (ii)
- 1 to maintain biodiversity ;
  - 2 to maintain, food chains / food webs / stability of ecosystems ;
  - 3 to maintain, genetic diversity / genetic variation / gene pool ;
  - 4 resources (for humans) ; e.g. biofuel / food / medicines / wood
  - 5 aesthetic reasons / (eco)tourism ;
  - 6 to maintain, nutrient cycle / soil structure / climate stability ;
  - 7 *idea of ethical duty* ;
- [max 3]

- (b)
- 1 gibberellin moves (from embryo) to aleurone layer ;
  - 2 gene, switched on / transcribed / used to make mRNA ;
  - 3 amylase produced ; I released / stimulated
  - 4 (amylase), hydrolyses / digests, starch to maltose ; I breaks down / converts / glucose
  - 5 for, respiration / ATP / energy ;
  - 6 for, growth / development / cell division / mitosis, in embryo ;
  - 7 AVP ; e.g. role of, DELLA / PIF
- [max 4]

- (c) (i)
- survival:*
- 1 less risk of extinction (for high seed survival compared with low survival) ;
- germination percentage:*
- for low survival:*
- 2 as % germination increases, risk of extinction decreases ;
- for high survival:*
- 3 as % germination increases risk of extinction decreases until, 30–36 % germination, then risk of extinction increases ;
  - 4 use of paired figures ; e.g. quote % germination and risk of extinction for each of:  
high v low [mp1]  
2 points on low survival line [mp2]  
2 points on high survival line [mp3]  
*allow ± one grid square for figures*
- [max 3]

Page 7	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2015	9700	41

- (ii)
- 1 *yes*  
(scraping) increases germination ;
- 2 more germination lowers risk of extinction ; **ora**
- 3 if seeds don't survive long/for low survival value seeds, scraping is good ;
- 4 *no*  
if seeds do survive long-term/for high survival value seeds, a store of seeds remains in soil ;
- 5 (avoid risk of) all germinating at once and perhaps all dying ; [max 3]

[Total:15]

- 5 (a) 1 two (complete) sets of chromosomes /diploid /2n ;
- 2 one of each chromosome, from each parent/maternal and paternal ;
- 3 to allow (homologous) pairs to form during, meiosis/prophase 1/reduction division ; [max 2]

- (b) most/high %/more than 70%,  
of females in **three** populations prefer calls from their own population ;
- less than half/44%, of females in, **one** population/population 60,  
prefer calls from their own population ; **ora** [2]

- (c) *yes*
- 1 different chromosome numbers ;
- 2 cannot interbreed to form fertile offspring /hybrids infertile ;
- 3 (because) not all chromosomes will be able to pair in meiosis ;
- 4 live in different, habitats /climatic regions  
**OR**  
geographical isolation ;
- 5 (so) unlikely to interbreed/reproductively isolated ;
- 6 most females prefer males from their own population ; **ora**
- 7 differences in mating, call/behaviour ;
- no*
- 8 some females, willing to mate with/prefer, males from other populations ;
- 9 phenotypically/morphologically, similar ; [max 4]

[Total: 8]

Page 8	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2015	9700	41

- 6 (a) *toxin may*
- 1 bind to receptors on postsynaptic (membrane) ;
  - 2 (so) stops ACh binding / inhibits depolarisation /  
no action potentials / Na<sup>+</sup> ion channels stay shut ;
  - 3 (so) stimulates ACh receptors / causes (continuous) depolarisation /  
causes action potentials / opens Na<sup>+</sup> ion channels ;
  - 4 reduces / stops, release / recycling, of ACh (by presynaptic neurone) ;
  - 5 inhibits acetyl cholinesterase / AW ; **R** denatures [max 3]
- (b)
- 1 enter, presynaptic neurone / AW ;
  - 2 causes vesicles (containing ACh) ;
  - 3 to, move to / fuse with, (presynaptic) membrane ;
  - 4 (so) ACh released (into synaptic cleft) / exocytosis ; [max 3]
- (c)
- 1 ensure one-way transmission ;
  - 2 filter out infrequent impulses / temporal summation ; **I** weak
  - 3 allow, interconnection / integration, of, nerve (cell) pathways / many neurones ;  
**OR**  
spatial summation / convergence of impulses / divergence of impulses ;
  - 4 ref. memory / learning ;
  - 5 idea of inhibitory effect ; [max 2]
- [Total:8]**



Page 9	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2015	9700	41

- 7 (a)
- 1 glucose phosphorylated by ATP ;
  - 2 (forms) hexose / fructose, bisphosphate ;
  - 3 raises energy level of / activates, glucose / sugar  
**OR**  
lowers activation energy of reaction ;
  - 4 breaks down to **two** TP ;
  - 5  $6C \rightarrow 2 \times 3C$  ;
  - 6 hydrogen (atoms) removed / dehydrogenated / oxidised ;
  - 7 2 reduced NAD formed ; **A** NADH / NADH<sub>2</sub>
  - 8 ref. to 4 ATP produced / net gain of 2 ATP ;
  - 9 pyruvate produced ;
  - 10 AVP ; e.g. ref. to substrate level phosphorylation / dehydrogenase / phosphofructokinase / hexokinase

[max 6]

(b)

	substrate level phosphorylation	oxidative phosphorylation	
enzymes are involved	✓	✓	
occurs in cytoplasm	✓	x	;
occurs in mitochondria	✓	✓	;
channel proteins are involved	x	✓	;

[3]

<b>Page 10</b>	<b>Mark Scheme</b>	<b>Syllabus</b>	<b>Paper</b>
	<b>Cambridge International AS/A Level – May/June 2015</b>	<b>9700</b>	<b>41</b>

- (c) *seeds soaked in water*
- 1 little / no, oxygen (in water) ;
  - 2 (mostly) anaerobic respiration ;
- seeds after 12 hours in the soil*
- 3 (more) aerobic respiration / less anaerobic respiration ;
  - 4 mixture of substrates ; e.g. 2 of carbohydrates, proteins and lipids
- seedlings after 21 days*
- 5 aerobic respiration ;
  - 6 substrate is, glucose / carbohydrate ;
  - 7 ref. to presence of leaves / photosynthesis ;

[max 6]

**[Total:15]**

8 (a) gene mutation ;

a change in the, base(s)/ nucleotide(s) ;  
 e.g. base, substitution/ deletion/ addition

[2]

(b) *parental genotypes*  
**CC<sup>a</sup>Bb x C<sup>h</sup>C<sup>a</sup>Bb ;**

*gametes*

**CB Cb C<sup>a</sup>B C<sup>a</sup>b      x      C<sup>h</sup>B C<sup>h</sup>b C<sup>a</sup>B C<sup>a</sup>b ;** *allow on Punnett square*

offspring genotypes ; ; *deduct one mark for each error*  
*max 1 ecf for offspring genotypes if only 4 given*

offspring phenotypes ;

phenotypes linked to genotypes ;

	<b>C<sup>h</sup>B</b>	<b>C<sup>a</sup>B</b>	<b>C<sup>h</sup>b</b>	<b>C<sup>a</sup>b</b>
<b>CB</b>	<b>CC<sup>h</sup>BB</b> full black	<b>CC<sup>a</sup>BB</b> full black	<b>CC<sup>h</sup>Bb</b> full black	<b>CC<sup>a</sup>Bb</b> full black
<b>Cb</b>	<b>CC<sup>h</sup>Bb</b> full black	<b>CC<sup>a</sup>Bb</b> full black	<b>CC<sup>h</sup>bb</b> full red	<b>CC<sup>a</sup>bb</b> full red
<b>C<sup>a</sup>B</b>	<b>C<sup>a</sup>C<sup>h</sup>BB</b> Him black	<b>C<sup>a</sup>C<sup>a</sup>BB</b> albino black	<b>C<sup>a</sup>C<sup>h</sup>Bb</b> Him black	<b>C<sup>a</sup>C<sup>a</sup>Bb</b> albino black
<b>C<sup>a</sup>b</b>	<b>C<sup>a</sup>C<sup>h</sup>Bb</b> Him black	<b>C<sup>a</sup>C<sup>a</sup>Bb</b> albino black	<b>C<sup>a</sup>C<sup>h</sup>bb</b> Him red	<b>C<sup>a</sup>C<sup>a</sup>bb</b> albino red

[6]

[Total:8]

Page 12	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2015	9700	41

- 9 (a) 1 obtain mRNA from  $\beta$  cells (of islets of Langerhans of pancreas) ;  
2 reverse transcriptase ;  
3 make (single-stranded) cDNA ;  
4 DNA polymerase used to make cDNA double stranded ;  
5 sticky ends created ; **A** description  
6 (obtain) plasmids ;  
7 cut with restriction, endonuclease/enzyme ; **A** named e.g. EcoR1  
8 ref. complementary sticky ends ;  
9 cDNA/insulin gene, mixed with plasmid ;  
10 DNA ligase ;  
11 seals nicks in sugar-phosphate backbone ; **R** anneals [max 8]
- (b) 1 (recombinant) plasmids mixed with bacteria ;  
2 (some) bacteria, take up plasmids/transformed ;  
3 heat shock/calcium chloride solution/ $\text{Ca}^{2+}$  ions/electroporation ;  
*to identify bacteria containing plasmids*  
4 grow on, agar/medium, containing antibiotic (A) ; **A** ampicillin  
5 plasmid contains, antibiotic (A)/ampicillin, resistance gene(s) ;  
6 bacteria with plasmid survive ; **ora**  
*to identify recombinant bacteria*  
7 replica plate ; **A** description e.g. sponge/velvet pad/absorbent paper  
8 (onto) agar/medium, containing second antibiotic (B) ; **A** tetracycline  
9 ( $\text{tet}^R$ /B/2<sup>nd</sup>) resistance gene inactivated (by insertion of new, DNA/gene)/AW ;  
10 (ID) colonies from, 1<sup>st</sup>/ampicillin, plate that do not grow on, 2<sup>nd</sup>/tetracycline, plate ; [max 7]

[Total:15]

Page 13	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2015	9700	41

- 10 (a) *batch/penicillin*
- 1 nutrients, decrease / run out ;
  - 2 so, secondary metabolite / penicillin, made ;
  - 3 fermenters can be used (after cleaning) for different process ;
  - 4 if problem occurs only one batch affected ;
  - 5 needs little, monitoring / attention (once set up) ;
- continuous/mycoprotein*
- 6 (fungus) kept in, exponential / log, phase (of growth) ;
  - 7 (so) high, biomass / yield / production rate ;
  - 8 little / no, downtime ;
  - 9 small, vessels / space, required;
  - 10 cost-effective ;
- [max 8]
- (b)
- 1 mouse is injected with an antigen ;
  - 2 wait for immune response to occur ;
  - 3 clonal selection ; **A** description e.g. antigen binds to, specific / virgin, B cell
  - 4 clonal expansion ; **A** description e.g. mitosis / division / cloning of B cells
  - 5 B-lymphocytes / plasma cells, are extracted ;
  - 6 from the mouse's spleen ;
  - 7 fused with, cancer / myeloma / tumour, cells ;
  - 8 hybridoma cells formed ;
  - 9 hybridoma cells producing antibodies are identified ;
  - 10 cultured on a large scale (to secrete monoclonal antibodies) ;
- [max 7]

**[Total:15]**