

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

**MARK SCHEME for the May/June 2009 question paper
for the guidance of teachers**

9700 BIOLOGY

9700/04

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

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1 (a) (i) 18 ; [1]

(ii) 0.72 ;

allow ecf from (i) [1]

(b) 1 RQ value falls steeply, initially / 40–80 min ;

2 then, very little change / AW ;

3 sugar / carbohydrate, metabolised at start ; **A** named carbohydrate

4 then fat metabolised ;

5 (due to) fasting / carbohydrate running out ; [4 max]

(c) 1 increase in rate of respiration ;

2 kinetic energy increases / more enzyme-substrate complexes / enzyme activity increases ;

3 effects of too high a rise in temperature ; e.g. denaturation of enzymes

4 AVP ; e.g. $Q_{10} = 2$ [2 max]

[Total: 8]

2 (a) *oestrogen*
follicle (cells) / granulosa (cells) / theca ;

progesterone
corpus luteum ; **A** follicle (cells) [2]

(b) 1 (oestrogen / progesterone affect) hypothalamus / anterior pituitary ;

2 inhibit secretion of, FSH / LH / GnRH ;

3 follicles do not develop ;

4 no ovulation ; **R** ref to eggs

5 ref. negative feedback ;

6 alters cervical mucus to stop sperm ;

7 prevents implantation / effect on endometrium ; **R** endometrium thickens [4 max]

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(c) *any two from*

- 1 (advantage of smaller population), less poverty / less starvation / less disease ;
- 2 greater care for children that are born ;
- 3 (benefit to adult women), fitter women / more women working ;
- 4 more promiscuity ;
- 5 more, STD / breast cancer / cervical cancer ;
- 6 population decrease ;

[2 max]

[Total: 8]

3 (a) 1 loss of habitat ; **A** deforestation

- 2 building / industry / farming / localised use of wood ; *ignore logging / timber production*
- 3 difficulty in finding food ; **A** increased competition **R** no food
- 4 poaching / hunting ;
- 5 ref. ivory trade ;

[3 max]

(b) 1 of no use to humans ;

- 2 protected in burrows ;
- 3 variety of food ;
- 4 small quantity of food required ;
- 5 short gestation ;
- 6 large number of offspring ;
- 7 camouflaged ;
- 8 (sophisticated) early warning system ;

[3 max]

[Total: 6]

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- 4 (a) (i) A pericarp / fruit coat
- B scutellum / cotyledon
- C plumule / embryo shoot
- D radicle / embryo root
- 0 or 1 = 0 marks, 2 or 3 = 1 mark, 4 = 2 marks ; ; [2]
- (ii) 1 food / starch / nutrients ;
- 2 for use, during germination / before photosynthesis / before leaves emerge above ground ;
- 3 to provide glucose for, respiration / ATP production ; *ignore energy*
- 4 to produce cellulose for cell wall production ;
- 5 to produce protein for, cell division / growth (of plant) ; **R** growth of cells [3 max]
- (b) (i) 1 permanently ;
- 2 binds with / blocks, active site ;
- 3 binds with, another part of enzyme / allosteric site ;
- 4 change (shape) of active site ; [2 max]
- (ii) *when acetylcholinesterase is inhibited*
- 1 acetylcholine remains attached to receptors (on post-synaptic membrane) ;
- 2 sodium channels on post-synaptic (membrane) remain open ;
- 3 membrane remains depolarised ;
- 4 action potentials / nerve impulses, continue to be produced ; [2 max]
- (c) 1 different sequence of, bases / nucleotides, causes different, sequence of amino acids / primary structure ;
- 2 acetylcholinesterase has a different, shape / tertiary structure ;
- 3 acetylcholine can still bind with, active site / acetylcholinesterase / enzyme **or** active site remains functional ;
- 4 (but) pyrethrum / inhibitor, cannot bind with, acetylcholinesterase / enzyme ;
- 5 inhibition is allosteric / AW ; [3 max]

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- (d) (i) 1 below 0.5 μg no insects killed in either group ;
2 at 0.5 μg hybrid insects killed but resistant insects survived ;
3 at 10 μg all insects killed in hybrid group but only 80% killed in resistant group ;
4 at 30 μg all insects killed in both groups ;
penalise lack of units once [3 max]
- (ii) 1 resistant and susceptible insects are homozygous ;
2 hybrid insect is heterozygous ;
3 hybrid insect shows codominance / mutant allele and normal allele both have an effect ;

allow ref to gene here [2 max]

[Total: 17]

5 (a) *marking points refer to batch culture*

- 1 (penicillin) is a secondary, metabolite / product ; **R** *Penicillium*
2 more penicillin is produced (per unit time) ; **A** higher yield *comparative statement*
3 in the later stages of growth (of the culture) / after main growth phase is over ;
4 (penicillin produced when, fungus / *Penicillium*,) is short of nutrients ; **R** no nutrients left
alternative points for 2 and 3 for continuous culture (ora)
2a less penicillin is produced (per unit time) ; *comparative statement*
3a continuous culture remains in, exponential / active growth, phase ; [3 max]

(b) *description*

when pH is controlled (blue unbroken line)

- 1 penicillin is produced throughout the time period ;

when pH not controlled (blue dotted line)

- 2 penicillin production increases to a maximum and then decreases ;
3 2 penicillin figs plus 2 time figs (to support 1 or 2) ; *ignore pH figs*

explanation

- 4 (pH affects) enzymes (involved in penicillin production) ;

when pH is controlled

- 5 optimum pH for enzymes is at approx pH 7 ;

when pH not controlled

- 6 pH, high / above 7, decreases / stops, penicillin production ;

- 7 (pH, high / above 7), causes change in active site of enzymes / AW ; [4 max]

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- (c) 1 penicillin affects (bacterial) cell wall production ; **A** affects cross-linkages
 2 inhibits, glycoprotein peptidases / enzymes involved with constructing (bacterial) cell wall ;
 3 viruses do not have cell walls ; [2 max]

[Total: 9]

- 6 (a) 1 increases, cellular uptake of glucose (from blood) / membrane permeability to glucose ;
 2 (by), liver / muscle / adipose, cells ;
 3 increased, respiration / metabolism, of glucose ; **A** increased glycolysis
 4 causes conversion of glucose to, glycogen / fat ; **A** inhibits glycogenolysis
 5 (blood glucose concentration maintained between) 80–120 mg per 100 cm³ ;
A single value between 80–120 [3 max]

- (b) 1 it is identical to human insulin / ora ;
 2 (more) rapid response ;
 3 no / fewer, rejection problems / side effects / allergic reactions ;
 4 ref. to ethical / moral / religious, issues ;
 5 cheaper to produce in large volume / unlimited availability ; **R** cheap to produce
 6 less risk of, transmitting disease / infection ;
 7 good for people who have developed tolerance to animal insulin ; [2 max]

- (c) (i) 1 single target site will be in correct resistance gene ;
 2 (gene to be inserted has) complementary sticky ends to target site sticky ends ;
 3 more cuts would fragment plasmid ; [2 max]

(ii)

circle of DNA taken up by bacteria	bacteria resistant to ampicillin	bacteria resistant to tetracycline
unaltered plasmids	✓	✓ ;
recombinant plasmids that have taken up the wanted gene	✓	✗ ;
circles of the wanted gene	✗	✗ ;

[3]

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- (d) (i) 1 risk spread of resistance to other bacteria ;
 2 spread of resistance makes the use of antibiotics less effective / AW ;
 3 via, conjugation / transformation / uptake of plasmids ; **A** description
 4 via, 'phage / transduction ; **A** description
 5 ref. R plasmid multiple resistance (MDR) / extreme resistance (XDR) ; [3 max]

- (ii) 1 gene for fluorescent substance ;
 2 source of gene ; e.g. from jellyfish
 3 substance fluoresces when exposed to appropriate light ;
 or
 4 lacZ gene / gene for β -galactosidase ;
 5 splits non-blue substrate ;
 6 product is blue ; [2 max]

[Total: 15]

7 (a) key ; *black upper case, chestnut lower case*

gametes ;

offspring genotypes **and** chestnut identified ;

25% / 0.25 / $\frac{1}{4}$ / 1 in 4, (probability) ; *ignore ratios* [4]

(b)

<i>parental genotype</i>	aaCC ^{CR}	AaCC
<i>parental phenotype</i>	palomino / cream	black ;
<i>gametes</i>	aC aC^{CR}	AC aC ;
<i>offspring genotypes</i>	AaCC aaCC	AaCC^{CR} aaCC^{CR} ; <i>any order</i>
<i>offspring phenotypes</i>	black chestnut	black palomino / cream ; <i>order linked to genotype order</i>

ecf can be applied to offspring genotypes and phenotypes [4]

[Total: 8]

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- 8 (a) M – palisade ;
N – vascular bundle / phloem and xylem / vein ; [2]
- (b) 1 ref. ABA absence ;
2 H^+ transported out of guard cells, actively / using ATP ;
3 low H^+ conc / negative charge, inside cell ;
4 K^+ channels open / K^+ diffuses into cell ;
5 water potential of cell falls ; A decrease in solute potential
6 water moves into cell by osmosis ;
7 volume of guard cells increase / turgor increases ;
guard cells:
8 have hoops of cellulose microfibrils which ensure increase in length rather than diameter ;
9 have ends that are joined together ;
10 have, thicker inner walls / thinner outer walls ;
11 curve apart / bend, (to open stoma) ; [6 max]
- (c) (i) cyclic photophosphorylation ; [1]
(ii) photolysis ;
(water splits into) $2e^-$, $2H^+$ and $(\frac{1}{2})O_2$;
enzyme is involved ; [2 max]
(iii) ATP ; [1]
(iv) hydrogen carrier ;
GP, reduced / hydrogen added ; R H_2
to, TP / 3 carbon sugar ;
uses ATP ; [2 max]
- [Total: 14]

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- 9 (a) 1 code is three, bases / nucleotides ; **A** triplet code
2 (gene) mutation ; **R** chromosome mutation
3 base, substitution / addition / deletion ;
4 addition / deletion, large effect (on amino acid sequence) ;
5 frame shift ;
6 completely new code after mutation / alters every 3 base sequence which follows ;
7 (substitution) often has no effect / silent mutation ;
8 different triplet but same amino acid / new amino acid in non-functional part of protein ;
9 (substitution) may have big effect (on amino acid sequence) ;
10 could produce 'stop' codon ;
11 sickle cell anaemia / PKU / cystic fibrosis ;
12 reference to transcription or translation in correct context ; **A** description
12a AVP ; e.g. protein produced, is non-functional / not produced / incomplete [7 max]
- (b) 13 individuals in population have great reproductive potential / AW ;
14 numbers in population remain roughly constant ;
15 variation in members of population ;
16 environmental factors / named factor (biotic or abiotic) ; *linked to 17 and 18*
17 (cause) many, fail to survive / die / do not reproduce ;
18 those best adapted survive / survival of the fittest ;
19 (reproduce to) pass on alleles ; **R** genes
20 genetic variation leads to change in phenotype ;
21 ref: changes in, gene pool / allele frequency ;
22 over time produces evolutionary change ;
23 new species arise from existing ones / speciation ;
24 directional / stabilising, selection ; [8 max]

[Total: 15]

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- 10 (a) 1 selective reabsorption ;
- 2 (pct cells have) villi / microvilli / large surface area ;
- 3 (pct cells have) many mitochondria ;
- 4 Na⁺ leave pct cells ;
- 5 by active transport ;
- 6 Na⁺ concentration falls in (pct) cells / Na⁺ concentration gradient ;
- 7 Na⁺ (diffuse) from lumen into (pct) cells ;
- 8 through, transporter / carrier, proteins ; *ignore channel proteins*
- 9 cotransport ;
- 10 of, glucose / amino acids / vitamins / chloride ions ;
- 11 (from pct cells) into intercellular fluid ; *linked to 10*
- 12 (then) diffusion into blood ; *linked to 10*
- 13 (normally) all glucose reabsorbed ;
- 14 some water reabsorbed ;
- 15 some urea reabsorbed ;
- 16 AVP ; e.g. creatinine secreted into lumen

[8 max]

*accept sodium ions but reject sodium or Na
penalise once only*

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- (b) 17 ADH affects collecting duct ;
- 18 binds to receptor on membrane ;
- 19 increase membrane permeability (to water) / more water channels ;
- 20 ref. enzyme controlled reactions ;
- 21 produces (active) phosphorylase ;
- 22 (which causes) vesicles with, water channels / aquaporins ; *must be linked to 23*
- 23 to, move to / fuse with, (plasma) membrane ;
- 24 more water flows out of collecting duct ;
- 25 down / along, water potential gradient ;
- 26 (then) into blood ;
- 27 urine (more) concentrated / small volume of urine ;
- 28 ref. negative feedback ;
- 29 AVP ; e.g. role of loop of Henle in creating water potential gradient
movement of urea increases water potential gradient

[7 max]

[Total: 15]