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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UNIVERSITY of CAMBRIDGE
International Examinations

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 / <u>anterior</u> 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 <u>cervical</u> mucus to stop sperm ;

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

(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]

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]

(d) (i) 1 below 0.5 *μ*g no insects killed in either group **;**

2 at 0.5 *μ*g hybrid insects killed but resistant insects survived **;**

3 at 10 *μ*g all insects killed in hybrid group but only 80% killed in resistant group **;**

4 at 30 *μ*g 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]

(c) 1 penicillin affects (bacterial) cell wall <u>production</u> ; **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 <u>increases, cellular</u> uptake of glucose (from blood) / membrane permeability to glucose ;

2 (by), liver / muscle / adipose, cells ;

3 <u>increased</u>, respiration / metabolism, of glucose ; **A** <u>increased</u> glycolysis

4 causes conversion of glucose to, glycogen / fat ; **A** inhibits glycogenolysis

5 (blood glucose concentration maintained between) 80–120 <u>mg per 100 cm^3</u> ;
A single value between 80–120 [3 max]

(b) 1 it is <u>identical</u> 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 <u>large volume</u> / 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]

(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 / ¼ / 1 in 4, (probability) **;** *ignore ratios* [4]

(b)

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

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

[Total: 8]

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 $(½)O_2$;

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]

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]

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

(b) 17 ADH affects collecting duct **;**

18 binds to receptor on membrane **;**

19 <u>increase</u> membrane permeability (to water) / <u>more</u> 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 <u>more</u> 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]