UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2006 question paper

9700 BIOLOGY

9700/06 Paper 6 (Options), maximum raw mark 40

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes must be read in conjunction with the question papers and the report on the examination.

The grade thresholds for various grades are published in the report on the examination for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses.

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OPTION 1 – MAMMALIAN PHYSIOLOGY

1 **(a)** **(i)** **A** mitochondrion ;
B myofibril ;
C Z line ;
D sarcomere ;

½ marks rounded up [2]

(ii) it/**D**, would be longer/Z lines further apart ;
light area on each side of Z line/I band, longer ;
H band longer/wider ; [max 2]

(b) correct use of X with superscript *and* allele symbols stated ;
parents' genotypes X^FX^f and X^FY ;
correct gamete genotypes ;
possible offspring genotypes X^FX^F, X^FX^f, X^FY, X^fY ;
boy with muscular dystrophy identified ; [max 4]

(c) myosin (heads) pulls on actin ;
no pull on/not transmitted to, muscle membranes/rest of muscle fibre ;
no force generated/no pull overall ;
muscle will not contract; [max 3]

(d) tropomyosin lies along the actin ;
troponin found at intervals along actin ;

calcium binds with troponin (when action potential arrives) ;
troponin changes shape ;
tropomyosin moves ;
(myosin) binding sites uncovered ;
allows myosin to bind with actin/formation of cross-bridges ; [max 4]

[Total: 15]

2 **(a)** change in level of blood cholesterol/stimulation of a receptor, (causes) ;
action/effector, to bring level back to, normal/set point ; [2]

(b) **(i)** as a control/to compare with the statin group ; [1]

(ii) 1500 – 1300 = 200 ;
(200 ÷ 1500) × 100 = 13% ; (13.3%) [2]

(iii) they do (just about) support it/they do not support it/no significant difference ;
but no direct link is shown between cholesterol levels and statins ;
the link is only shown to be between statins and deaths ;
ref. assumption of link between reduced no. of heart attacks and reduced conc. of cholesterol in blood ;
further, tests/evidence, required ; [max 2]

(c) ref. to negative feedback effect ;
if less cholesterol in diet then liver will make more ;

statins inhibit the enzyme responsible for synthesising cholesterol ;
(statins) not affected by cholesterol level in blood/inhibition still takes place (even if blood cholesterol is low) ; [max 3]

[Total: 10]

3 **(a)** mechanical digestion breaks large pieces of food to small ones ;
by teeth/mastication/churning of stomach ;
chemical digestion breaks (large) molecules ;
ref. to solubility ;
ref to hydrolysis ;
by enzymes ;
ref. emulsification of lipids ; [max 3]

(b) **(i)** allows up and down movement/not sideways movement ;
great force to/canines can, pierce prey/grip prey (to prevent escape) ;
allows wide opening (of mouth to catch prey) ; [max 2]

(ii) sharp edges/many points/jagged ;
act like scissor blades/slice past each other ;
molars, slice flesh/cut meat into pieces/crush bones ; [max 2]

[Total: 7]

4 **(a)** **(i)** semicircular canals/membranous labyrinth/ampulla/utriculus/macula ; [1]

(ii) cerebellum ; [1]

(b) **(i)** *beginning rotation*
number of impulses per second increases ;
from 200 to 800/4 times greater;

stopping rotation
number of impulses per second, decreases/stops ;
from below base level/from 190, to 0 ;
returns to base level within 20 (22) seconds of stopping ; max 2 [max 3]

(ii) (surrounded by), fluid/endolymph ;
changing rate of movement/acceleration ;
inertia of fluid/relative difference in movement, of fluid or hair cell (c.f. to head) ;
hair cells/cupula, bends/moves ;
alters permeability of cell membrane ;
depolarisation/generates an action potential ;
ref. to explanation of drop of impulses sec^{-1} to zero when rotation stops ; [max 3]

[Total: 8]

OPTION 2 – MICROBIOLOGY AND BIOTECHNOLOGY

1 (a) (i) increases (throughout);
(mostly) 30 tonnes per year every 5 years ;
increase less between years, 15 and 25/30 and 40 ;
comparative figs. ; (2 quantities + 2 years) [max 3]

(ii) (originate by) mutation ;
pre existing/random/spontaneous (mutation) ;
increased use of antibiotics increases selection ;
reference to antibiotics as the selective agent ;
ref. natural selection ;
susceptible bacteria die/resistant bacteria survive ;
resistant bacteria pass resistance to offspring ; [max 4]

(iii) meat/eggs, contain bacteria that cause diseases in humans ;
these bacteria may become resistant to antibiotics used in medicine ;
disease treatment using the same antibiotic as used in animal feed will not be effective ; [max 1]

(b) (i) ampicillin (B) more effective than tetracycline (C) ; ORA
fewer bacteria are resistant to ampicillin ; ORA
comparative figs. ; [max 2]

(ii) $\frac{150}{250} \times 100$;

= 60% ; [2]

(c) inhibits enzyme ;
prevents bonds forming, between peptidoglycan molecules/in bacterial cell wall ;
cell wall, weakens/breaks down ;
bursts cells ; [max 3]

[Total: 15]

2 (a) A protein coat/capsid
B nucleic acid/DNA
C (tail) sheath
D (tail) fibres/pins

half marks rounded up [2]

(b) phage has only one type of nucleic acid/DNA, bacteria has both DNA and RNA ;
phage has protein outer covering/AW, bacteria has cell wall/murein outer surface ;
phage has no, organelle/cytoplasm/membranes;
bacteria have, ribosomes/organelles/cytoplasm/cell (surface) membrane ;
ref. mesosomes in bacteria ; [max 1]

(c) binary fission ;
(circular) DNA replicates ;
ref. attachment to mesosomes ;
cell membrane/septum/invagination, separates the, chromosomes/DNA strands ;
new cell wall material laid down between the cells ; [max 3]

(d) 1 to 2:
phage attaches to, a binding site/receptors, on the bacterial cell ;
injects, nucleic acid/DNA ;

2 to 3:
phage, nucleic acid/DNA joins host DNA ;

3 to 4:
(host cell divides) copying phage DNA along with host DNA / phage DNA passed on to daughter cells ; [max 3]

3 **(a)** **(i)** to sterilise/kill any microorganisms present ;

(ii) to double the chromosome number/to make the embryoids diploid ;

(b) cells from callus of two different anther cultures ;
fused by, osmotic shock/heat treatment ;
colchicine not added, cells are diploid following cell fusion ; [max 2]

(c) *max 2 for 2 named nutrients*

carbon source/named C source ;
used for, respiration/production of ATP/release of energy ;
to build, organic/named, molecules ;

nitrogen source/named N source;
synthesis of, amino acids/proteins/enzymes ;
synthesis of, nucleotides/nucleic acids ;

mineral salts/named mineral salt ;
used as cofactors for enzymes/component of cell
structures/example, related to a named salt ; [max 4]

[Total: 8]

4 **(a)** **(i)** reaction with/damage to, skin proteins less likely;
allergies less likely ; ORA
inhaled less easily ;
enzymes are more thermostable ; [max 2]

(ii) rate of reaction slowed down/AW ; [1]

(b) **(i)** reactants/nutrients, are supplied throughout the process ;
products are removed throughout the process ;
maintained in, log/exponential/rapid growth, phase ; [max 2]

(ii) (stirring) might physically damage the immobilising system/AW ; [1]

(c) enzymes can be re-used ;
enzyme does not have to be separated from the products ;
cost of emptying and sterilising is less as fermenter runs for a long time ; [max 2]

[Total: 8]

OPTION 3 – GROWTH, DEVELOPMENT AND REPRODUCTION

1 (a)

Kingdom	Method of asexual reproduction	Named example
Prokaryotae	**Binary fission**	**E.coli/suitable e.g. ;**
Protoctista	**Binary fission**	**Amoeba/suitable e.g. ;**
Animalia	**Budding Fragmentation**	**Hydra/suitable e.g. ribbon worms ;**

R parthenogenesis/accidental fragmentation of starfish/flatworms etc. [3]

(b) (i) **A** lag (phase) ;
B log / exponential, (phase) ; [2]

(ii) reached carrying capacity ;
death rate = reproduction rate ;

(rate of) mitosis/division, limited ;

nutrients, in short supply/used up ;
oxygen, in short supply/used up ;
waste products, build up/toxic/change pH ;

AVP ;
e.g. shading ; [max 4]

(c) respiration/metabolism, increases ;
releases more heat;

enzyme activity increases ;
enzymes denature;
unicell, activity falls/dies ; [max 3]

(d) method ;
details ;; R haemocytometer [3]

e.g. turbimetry/dry mass sampling/measure product of metabolism such as CO_2 or acid

[Total: 15]

2 (a) (i) $\frac{70}{10} \times 12$ or $\frac{70}{1} \times 1.2$;
84(μm) ; [2]

(ii) corpus luteum/yellow body ;
secretes progesterone; *ignore ref. to oestrogen* [2]

(b) (i) mitosis ; R. miosis [1]

(ii) 46/23 pairs/2n ; [1]

(iii) (primary oocyte divides by)
meiosis (I);
products, haploid/secondary oocyte and polar body ;
meiosis II ;
forms, ovum/egg, and polar body ;
AVP;
e.g. time delays (meiosis I or II) [max 3]

3 **(a)** **(i)** delays germination in 'freak' conditions ; (short favourable spell in prolonged unfavourable spell)
allows, dispersal/maturation;
germination linked to time of rainfall/survives when no, rainfall/water ;
prevents germination when seeds, not buried in soil/too deep in soil ;
prevents germination until after fire/survives fire ;
prevents germination when seed still in fruit ;
AVP ;
e.g. stops germination when inhibition from parent present/
germination linked to suitable season [max 2]

(ii) growth inhibitors in, seed coat/testa/embryo ;
named inhibitor ; e.g. ABA/abscisic acid;
in high concentration ;
low concentration of, GA/gibberellin/gibberellic acid, allows action of inhibitor ; [max 2]

(iii) (availability of), water/rainfall ;
fire; [2]

(b) switching on genes/AW ;
GA, stimulates synthesis of, enzymes/named enzyme/protein ;
hydrolytic/hydrolysis ;
named enzyme breaks down named food reserve ;
AVP ;
e.g. detail of use of product [max 3]

[Total: 9]

4 **(a)** **(i)** **A** anther/stamen
B style
C ovule *half marks rounded up*
D stigma [2]

(ii) protandry/anther releases pollen before stigma receptive ;
R if ref made to relative positions of stigma and, anther/pollen [1]

(b) **(i)** insect visits not necessary/percentages not significantly different ;
if no/few, visits then self-pollination occurs ;
stigma bends back to touch pollen on style ; [max 2]

(ii) many visits likely to result in greater variation; ora
cross pollination/AW, more likely ; ora
OR
little/no, difference in variation ;
if insects transfer pollen within the same plant ;

detail of, source/lack of, genetic variation ; [max 2]

[Total: 7]

OPTION 4 – APPLICATIONS OF GENETICS

1 (a) (i) explant/meristematic (AW) tissue ;
surface sterilised ;
sterile nutrient medium ;
named nutrient ; e.g. sucrose/amino acid/inorganic ion/minerals/vitamins
pgs to stimulate, mitosis/cell division ;
callus formed ;
pgs/cytokinin/auxin, to stimulate differentiation ;
then subdivided;
plantlets hardened off ;
plantlets transferred to sterile soil ; [max 4]

(ii) 3 sets chromosomes/3n ;
meiosis fails ;
cannot form (homologous) pairs/synapsis fails ;
in prophase 1 ; [max 2]

(iii) all genetically identical ;
so all susceptible to same, pathogen/edaphic factor/climatic factor ; [2]

(b) *sinensis x sinensis* ;

offspring selected ;
for harvestable dry mass and ability to withstand winter ;
need to be fertile ;
need to flower early ;

idea, time/several generations, needed for selection ;
idea backcrossing to parent species ;
to increase contribution re trait ;
ref. background genes ;
detail ; e.g. viable way of starting with hybrid/
emasculation/bagging before and after pollination [max 4]

(c) artificial selection/selective breeding ;
man selective agent ;
mutations (give different traits) ;
(different) people have selected for different traits ;
different plants, suited to different conditions/seen to be attractive/in fashion ; [max 3]

[Total: 15]

2 (a) (i) 100 000, base pairs/bases long/nucleotides long ; [1]

(ii) horizontal transmission ;
conjugation ;
detail of conjugation ; e.g. c. tube/single strand DNA transferred/made double stranded in recipient /ref. to plasmid DNA
'transformation ;
DNA released from one bacterium is picked up by another;

transduction ;
transfer DNA by, bacteriophage/'phage/virus ; [max 3]

(b) (i) $10^{-2} - 10^{-4}$;
$\times$ $100/10^2$; [2]

(ii) antibiotic increases transfer in both donors ;
both antibiotics have same effect on both donors ;
greater effect on *E. coli* than on *V. cholerae* ;
10 x greater/10^2v. 10^1/x 100 v. x 10 ; [max 3]

(iii) increase in, number of resistant bacteria/frequency of resistant alleles ; [1]

3 **(a)**

CF		*HD*	
recessive (allele)	v.	dominant (allele) ;	
chromosome 7	v.	chromosome 4 ;	
sufferer homozygote recessive	v.	sufferer heterozygote ;	
heterozygote carrier	v.	heterozygote sufferer ;	
needs two carrier parents	v.	one parent with allele ;	
deletion/substitution,	v.	stutter / triplet repeat ;	
effect unchanged each generation	v.	effect increased each generation ;	[max 3]

(b) **(i)** the longer the fragment length the earlier the onset/inversely proportional;
ref. shorter fragments moving further/ora ; [2]

(ii) **C** has (two), normal/recessive, alleles ;
ref. homozygote ;

A, **B** and **D** have one normal and one mutant allele ;
ref. heterozygotes/dominance ;

stutter gets longer, from **A** to **B** to **D**/with each generation ; [max 3]

[Total: 8]

4 **(i)** low temperature/–20°C ;
seeds dehydrated/ref. 5% water content/stored in 5-10% humidity ;
periodic germination tests ;
when germination falls below 85% seeds grown and fresh seed stored ; [max 3]

(ii) maintain genetic diversity/store of alleles ;
to prevent extinction;
ref. future use ;
to use in selective breeding ;
in changed circumstances ; A e.g. of change

ref: endemic species unique ;
ref. unknown traits ;
ref. possible source of drug ;

argument re numbers ; [max 4]

[Total: 7]