

November 2003

GCE AS/A LEVEL

MARK SCHEME

MAXIMUM MARK: 50

SYLLABUS/COMPONENT: 9700/06

BIOLOGY
Paper 6 (Options (A2))



Page 1	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – NOV 2003	9700	6

Option 1 - BIODIVERSITY

- 1 (a) (i) A (spore) capsule;
B thallus / leaf;
C rhizoid; 3
- (ii) H labelled anywhere other than seta and capsule;
D labelled anywhere on seta / capsule; 2
- (iii) rhizoids / C;
no true, roots / stems / leaves or thalloid A thallus;
sporophyte composed of capsule and seta; max 1
- (b) (i) any **two** of: temperature / light intensity / air movements /
growth medium / named component of medium / CO₂ concentration; 2
- (ii) *R. loreus* grows more slowly than *D. majus* in almost all conditions;

both species grow faster in high humidity;
this effect greater for *D. majus*;
except at 1W1D;

both species grow faster, when watered for more continuous period /
in 6W6D;
this effect greater for *D. majus* / this effect decreases for *R. loreus*
as watering regime gets longer;

appropriate figs; (accept converse throughout) max 3
- (c) (bryophytes have) no cuticle;
so water (vapour) lost from surfaces (more easily);
rate of loss greater at lower humidities;

(bryophytes) do not have, vascular tissue / xylem;
(so) water transport less efficient / cannot replace lost water efficiently;

no true roots / only have rhizoids;
so cannot absorb water so effectively; max 4

Total 15

Page 2	Mark Scheme	Syllabus	Paper
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- 2 (a) (i) *feature drawn in correct position and labelled*
 cell wall **and** cell (surface) / plasma, membrane **and** nucleus;
 chloroplast;
 starch grains (in chloroplast);
 vacuole(s);
 cellulose (cell wall);
 pyrenoid; max 4
- (ii) answer in range x 2000 to x 15000;
 (A) scale line / bar, between 2mm and 15mm per 1 μm 1
- (b) (i) cilia;
 macro- and micronucleus;
 cytostome;
 (definite shape due to) pellicle; max 3
- (ii) *Vorticella* gains organic nutrients / glucose / sugar from *Chlorella* /
 C photosynthesises;
Chlorella gains nitrogen source / other named substances,
 from *Vorticella*; 2
- (c) (i) need light;
 for photosynthesis; 2
- (ii) release oxygen (from photosynthesis); 1
- (d) animal feed;
 (spread onto land as) fertiliser;
 produce, biogas / methane; 2 max
- Total 15**

Page 3	Mark Scheme	Syllabus	Paper
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- 3 (a) (i) high biodiversity;
ref to wide range of genetic variety;
(many) species / plants / animals, can only live in these forests;
danger of many species becoming extinct if habitat lost;
undiscovered species could be source of
new medicines / drugs / genes;
- loss may increase soil erosion;
as tropical rainforests grow in areas of high rainfall;
as tropical rainforests grow in areas of on thin soils;
- loss could affect (local or global) climate;
as their transpiration affects humidity of air;
if forests are lost then (may be) less rainfall;
- because they take carbon dioxide from atmosphere;
can be considered to be carbon sinks;
loss could result in global warming; max 6
- (ii) growing human populations ;
expectations of higher standard of living;
clear land for, agriculture / cash crops / raiding / AW;
slash and burn / plantations;
wood used for fuel;
logging;
tropical hardwoods have high value;
clear land for building, towns / roads; max 6
- (iii) make reserves;
qualified (e.g. description of types of reserves);
reserves need to be, large / linked;
- ecotourism;
provides money that can be used for conservation;
- international ban on trade in endangered (rainforest) species / CITES;
example of rainforest species listed in CITES;
quotas/international regulations, on use of wood from rainforests;
educate consumers (so they can choose not to buy it);
provide international aid to countries with tropical rainforests;
- find ways of making sustainable use of tropical rainforests;
allow only selective felling;
limit quantity of timber felled per time period; max 8
- Total 20**

Page 4	Mark Scheme	Syllabus	Paper
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- 3 (b) (i) diploblastic / wall composed of only two layers of cells;
acoelomate;
ectodermis + endodermis;
mesogloea;
radial symmetry;
single opening / mouth;
tentacles;
enteron / gut cavity;
lined with flagellated cells;
and enzyme-secreting cells;
nematocysts / cnidocytes;
musculo-epithelial cells;
nerve net / nerve cells (in mesogloea);
polymorphism; max 8
- (ii) heterotrophic;
is a predator / carnivorous / captures (small) animals /
feeds on zooplankton;
- nematocysts / cnidocytes, capture prey;
detail of action;
tentacles push prey into gut cavity;
digestion occurs within gut cavity;
- enzymes secreted / extracellular digestion;
detail, e.g. flagella help mixing;
intracellular digestion; max 6
- (iii) cnidarian has larger surface area to volume ratio (than fish);
cnidarian has, only two layers of cells / small body;
every cell in contact with water;
(so) O_2 / CO_2 diffuses, to / from water, directly in / out of cells;
- fish needs gills to increase area for gas exchange;
(so) O_2 / CO_2 can diffuse to / from water to / from blood;
most of fish body surface is not permeable;
- fish is more metabolically active than cnidarian;
fish moves, more / faster;
therefore greater respiration rate in fish;
needs oxygen supplied at faster rate; max 6

Total 20

Page 5	Mark Scheme	Syllabus	Paper
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Option 2 - BIOTECHNOLOGY

- 1 (a) ref reduction of disease;
specific relevant example e.g. cholera / typhoid;
reduced, pollution / eutrophication;
improved, potability / taste / smell;
AVP / e.g. fluoride to reduce tooth decay; max 3
- (b) (i) aerobic vs. anaerobic;
(R aerobic unqualified)
(R anaerobic unqualified) 1
- (ii) secondary treatment / follows sedimentation;
(aerobic) respiration;
bacteria / fungi / named e.g.;
ciliated protozoa / nematode worms / named e.g.;
remove organic matter; max 3
- (iii) methanobacterium / methanococcus / methanothrix;
(anaerobic) respiration / fermentation;
(produces) methane and carbon dioxide;
with traces of H₂S / H₂O / H₂;
AVP; max 3
- (c) (i) need light;
for photosynthesis; 2
- (ii) release oxygen (from photosynthesis) 1
- (d) animal feed / single cell protein;
(spread on land as) fertiliser;
produce biogas / methane; max 2

Total 15

Page 6	Mark Scheme	Syllabus	Paper
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- 2 (a) feeding the worlds hungry by increasing agricultural production;
making it cheaper to grow crops, so they are affordable;
making it easier to grow crops;
making new foods with desirable characteristics / e.g. improved taste /
appearance / nutritional value;;
waste used to produce a product; max 3
- unknown long term health effects e.g.allergies;
introduced for the benefit of the producer / less regard for consumer,
e.g. transportation / longevity;
- use of pesticides, qualified;
use of antibiotics, qualified;
use of growth hormones, qualified;
idea of gene leakage to other species;
reduction of genetic diversity, qualified; max 3
- (b) demonstrate that the product is safe;
compare it with its conventional counterpart;
more transparent to the public;
overcome fears; max 2
- (c) contains no genetically engineered ingredients;
not grown using inorganic / chemical fertilisers / named fertiliser;
not grown using pesticides; max 2
- (d) farmers can choose the optimal time to spray /
only need to spray once;
- less glyphosate is needed;
compared with selective weedkillers;
using fewer chemicals is beneficial for the environment;
saves energy;
lower use of farm machinery;
higher crop yield ;
improved crop quality;
efficiency in terms of manpower; max 5

Total 15

Page 7	Mark Scheme	Syllabus	Paper
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- 3 (a) (i) the pregnancy rate is high;
 experience of parenthood is shared by the couple;
 one parent has a biological link to the child;
 genetic link to the child;
- male can attend insemination;
 simple / painless procedure;
 does not require surgery / stay in hospital;
- public opinion in favour of process;
 anonymity of donor;
 some couples prefer to adoption;
 can be used if male is fertile but carries a known genetic disease;
- max 6
- (ii) some people / religious groups opposed to process;
 naturally / ethically, wrong;
 feelings of guilt / relationship to the child;
 husband has no genetic link to child;
 impact on partners relationship;
 right of child to know parents identity;
 pass on genetic disease;
 remarks about child's likeness to parents;
- max 6
- (iii) seeds collected;
 orthodox seeds;
 stored at a temperature of -18°C ;
 dried to moisture content below 7%;
- storage life doubled for every 5°C reduction;
 storage life doubled for every 2% reduction in humidity;
 may be X-rayed to check embryo present;
 sealed in moisture proof container;
- regular monitoring of viability / appropriate specified frequency;
 regeneration / recollection;
 when viability falls below an acceptable level/specified;
- recalcitrant seeds can not withstand low humidity / temperature;
 not stored by this method;
- max 8

Total 20

Page 8	Mark Scheme	Syllabus	Paper
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- 3 (b) (i) enzyme attached to insoluble material;
 physical methods;
 chemical methods;
 immobilised on ceramic / polymer gels;
 trapped behind membranes / dialysis tubing;
 or encapsulated;
- alginate solution;
 using a syringe, drop mixture on calcium chloride;
 wash with water;
 enzyme dipped into substrate / substrate run over enzyme (in column);
 which is circulated / in a continuous flow;
 giving maximum contact with enzyme;
- max 7
- (ii) immobilised enzymes can be controlled more easily;
 have a long shelf life / more stable;
 protection from proteolysis;
 protection from thermal denaturation;
- do not get washed out of the reactor/can be reused;
 not diluted by the medium;
- similar to the way they act in cells;
 attached to membranes;
 only part of the molecule exposed;
- product free from contaminating enzyme molecules;
 ideal for continuous process;
 able to operate at a wider pH range than in solution;
- max 7
- (iii) type of immobilisation e.g. entrapping in alginate;
 add to substrate;
 test e.g. Benedicts / iodine, relevant to named enzyme;
 positive/negative result, relevant to named test;
 name of cell / enzyme, e.g. yeast / sucrase;
 pack column with alginate beads;
 method of preventing beads from falling through e.g. glass wool /
 gauze bags / sieve to collect up beads (after set time);
 collect known volume / place in known volume;
 at set intervals / for a set time;
- max 6

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Option 3 - GROWTH, DEVELOPMENT AND REPRODUCTION

- 1 (a) (i) A exine R'extine'
 B intine
 C male gametes/male nuclei
 D vegetative nucleus/tube nucleus *half marks rounded up* 2
- (ii) ref. double fertilisation;
 one fuses with female gamete;
 to give diploid, embryo / zygote;
 one fuses with, the fusion nucleus/two polar nuclei;
 to give triploid endosperm nucleus; max 4
- (iii) rough/AW, exine; 1
- (b) (i) so no stigma secretion present/so only known substance(s) present; 1
- (ii) to test that lipids were responsible for effect;
 not other substances in the normal secretion;
[lipids, alone/solely, responsible = 2]
 to test that triglycerides were responsible for effect;
 not, breakdown products/products of digestion, of lipids;
 to test that, plant/stigma/pollen, does not have to break down lipids; 4
- (iii) purified lipids have, same/slightly greater (A figs), effect as normal secretion;
 so lipids responsible for pollen tubes penetrating style;
 unsaturated triglycerides responsible;
 especially triglyceride 2;
 when used alone more effective (A figs) than, normal secretion/purified lipids; max 3

Total 15

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- 2 (a) (i) anterior pituitary gland;
- (ii) anterior pituitary gland;
- (iii) interstitial cells/Leydig cells, (of testis);
- [*pituitary + pituitary + testis = 1*] 3
- (b) (i) significant rise in both at age 10 - 12 years;
plateau in both at ages 16 / 17 years;
ref. figures;
triggered by GnRF;
from hypothalamus;
steep rise triggers puberty;
LH / ICSH stimulates synthesis of testosterone;
FSH stimulates spermatogenesis; max 4
- (ii) significant rise at age 10 / 11 - 14 years;
rise less steep age 14 - 18 years;
ref. figures;
triggered by rise in LH(ICSH);
testis increases in size at the same time;
responsible for secondary sexual characteristics; max 4
- (c) (i) $\frac{28.0 - 8.0 \text{ g}}{4 \text{ y}}$ = 5; g per year; 2
- (ii) $\frac{20}{4} \times \frac{1}{8}$ or $\frac{5}{8}$; = 0.625 (0.63 s.f.); 2
- Total 15**

Page 11	Mark Scheme	Syllabus	Paper
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- 3 (a) (i) named prokaryote;
binary fission; (R mitosis)
DNA replicates;
detail replication; (e.g. enzyme/replication fork/replicates in both directions round loop)
DNA separates;
ref. role mesosomes in separation;
septum/cross-wall, forms;
clone/genetically identical;
ref. time scale;
replication of plasmids;
growth to maximum, size/length; max 7
- (ii) named microorganism;
nutrient medium;
sterile conditions;
temperature controlled;
other condition controlled; (pH/aeration)
measuring/sampling, at intervals;
way of making sure sample is homogeneous;
several repeats/averages;
colorimeter/haemocytometer/dry mass/diameter colony/number of colonies;
need for dilution;
detail 1 of method; (calibration of colorimeter/volume of haemocytometer)
detail 2 of method; (e.g. absorbance/count)
graph results; max 7
- (iii) *problems with one technique used in (ii) e.g.*
optical density
sterility/unwanted organisms;
uniformity of samples;
total count;
dead cells;
detail;;
AVP;; [e.g.dry mass only real measure]
- haemocytometry*
sterility/unwanted organisms;
uniformity of samples;
total count;
dead cells;
detail;;
AVP;; [e.g.dry mass only real measure]

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counting colonies

sterility/unwanted organisms;
uniformity of samples;
viable count;
colony diameter does not include depth;
detail;; [e.g. irregular shaped colonies]
AVP;; [e.g.dry mass only real measure]

dry massing

sterility/unwanted organisms;
uniformity of samples;
dead cells;
detail;; [e.g. separating organisms from medium]
AVP;;[e.g. counting colonies only viable measure]

max 6

Total 20

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- 3 (b) (i) suitable seed;
major factors = water, oxygen, suitable temperature;
suitable apparatus;
control with oxygen, water and suitable temperature;
experiments with only one factor altered;
unsuitable temperature experiment;
prechilling;
minus oxygen experiment;
minus water experiment;
pseudoreplicates (several seeds per control/condition);
replicates (more than one control/condition);
averages/% germination;
dark/light/different wavelengths experiment; (*A ref. to light intensity wavelength although technically not a major factor*) max 7
- (ii) immature embryo needing time for development;
needs infection by specific fungus;
testa mechanically restrictive;
testa impermeable to water;
testa impermeable to oxygen;
testa needing, scarification/digestion/microorganism action;
need fire;
inhibitor in testa needing leaching;
inhibitor in fruit needing separation of seed;
ref. ABA (as common inhibitor);
need prechilling;
need, light/dark;
need particular wavelength of light;
ref. phytochrome;
ref. GA; max 7
- (iii) germination can be linked to season;
(need for prechilling) prevents germination in short favourable spell
in prolonged unfavourable period;
some only germinate when, at/near top of, soil;
some only germinate when buried;
some only germinate when, gap in canopy/fire has cleared
vegetation;
some only germinate after sufficient rain;
prevents wasteful germination;
reduces competition / allows time for dispersal;
spreads germination time of given batch of seeds;
if first batch killed others follow;
insurance against no seed set in any one year; max 6

Total 20

Page 14	Mark Scheme	Syllabus	Paper
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Option 4 - APPLICATIONS OF GENETICS

- 1 (a) inbreeding depression;
loss of, vigour/fertility;
loss of genetic diversity;
increase in homozygosity/decrease in heterozygosity;
increased expression of deleterious recessive alleles; max 3
- (b) DNA extracted from, suitable cell/named cell;
fragmented by restriction enzyme(s);
gel electrophoresis;
smallest fragments furthest/largest fragments least far;
Southern blotting;
banding pattern visualised; max 4
- (c) shows relationships;
similar bands = genetic similarity;
most diverse chosen to breed/most similar not bred;
to maintain heterozygosity/prevent homozygosity; max 3
- (d) (i) to produce desirable change in phenotype;
for benefit of man;
by artificial selection;
of parent(s) showing desired features; max 2
- (ii) selective breeding reduces genetic diversity;
captive breeding needs to maintain maximum diversity;
selective breeding chooses parents on grounds of
particular phenotype/characteristics;
captive breeding parents should not be chosen for particular
phenotype/characteristics;
weak/unattractive, organisms may house needed alleles;
captive breeding is solely for the benefit of the species; max 3

Total 15

Page 15	Mark Scheme	Syllabus	Paper
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- 2 (a) (i) economy/efficiency;
saves waste of materials;
saves waste of, energy/ATP;
cell can be making other useful, proteins/materials; max 2
- (ii) random/chance/spontaneous;
mutation;
different, enzyme/metabolic pathway;
mutant mites survive and reproduce;
pass mutation to offspring;
fitter;
increase in resistance allele frequency;
ref. recessive mutation v. dominant mutation; max 4
- (b) measure production of mRNA;
detail;
measure production of, protein/polypeptide, coded for;
detail; max 2
- (c) (i) all (6) genes switched on in infested leaves;
compared with none in control;
switch on all bar one (5) genes in receiver leaves;
mites result in volatiles being emitted/AW; max 2
- (ii) 4 (out of 6) genes switched on by wounding;
same effect for these as mite action;
only one gene switched on in receiver leaves;
wounding does not produce volatiles in same way as mites; max 2
- (d) depends whether plants heterozygous;
advantageous in that effective alleles of all genes inherited together;
maximum protection for individuals inheriting these;
disadvantageous for individuals receiving ineffective alleles;
if plants homozygous then immaterial whether linked; max 3

Total 15

Page 16	Mark Scheme	Syllabus	Paper
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- 3 (a) (i) (complete) dominance;
 only one allele of heterozygote affects phenotype;
 phenotype of heterozygote same as one homozygote;
 recessive allele must be homozygous to appear in phenotype;
 example/symbols;
- codominance;
 both alleles of heterozygote affect, the phenotype/functional protein;
 example/symbols;
- multiple alleles;
 dominance hierarchy;
 example/symbols; max 6
- (ii) involuntary muscle movement/chorea;
 mental deterioration;
 brain cells lost;
 ventricles enlarge;
 (commonly) onsets in middle age; [max 4]
- dominant allele;
 autosomal/chromosome 4;
 most sufferers heterozygotes;
 1 in 2 chance of passing on condition;
stutter;
 CAG (triplet) repeat;
 sufferers have > 37/37 - 100, repeats;
 more repeats earlier onset;
 increased number with each generation;
 inheritance from male and female different;
 not truly Mendelian; [max 6] max 8
- (iii) *advantages*
 know have allele before having children;
 take steps not to pass on allele/gene/condition;
 test embryo and terminate if positive/test IVF embryo and do not
 implant if positive;
 appropriate, AI/donor oocyte/donor embryo;
 activity/physiotherapy to delay onset; [max 4]
- disadvantages*
 know will suffer from incurable disease in time;
 positive test on offspring means untested parent knows must have allele;
 positive test on parent means any offspring knows has 1 in 2
 chance of having allele; max 6
- Total 20**

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3	(b) (i) <i>continuous variation</i>	<i>discontinuous variation</i>	
	no discrete classes .. vary between, limits/extremes; quantitative; can be plotted as normal distribution curve; example 1; example 2;	discrete classes; [1 mark] no intermediates; qualitative; can be plotted as bar chart; example 1; example 2;	
			max 8
	(ii) <i>continuous variation</i>	<i>discontinuous variation</i>	
	> 3 genes/many genes; polygenes; many alleles; different alleles have small effects on character different genes have same effect on character additive effect; large environmental effect	v. one/few, gene(s); v. few alleles; v. different alleles have large effects on character; v. different genes have different effects on character; different genes may interact; v. small environmental effect;	
			max 6
	(iii) organism 1 + phenotypic character; environmental effect; detail;		
	organism 2 + phenotypic character; environmental effect; detail;		6
			Total 20