

NOVEMBER 2002

GCE Advanced Level

MARK SCHEME

MAXIMUM MARK : 50

SYLLABUS/COMPONENT :9700 /6

**BIOLOGY
(OPTIONS (A2))**



Page 1	Mark Scheme	Syllabus	Paper
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OPTION 1: BIODIVERSITY

- 1 (a) (i) Limbs support entire body weight / diameter of limbs related to the weight supported / sensible ref. to greater weight ;
body weight increases proportionately with, volume of animal / cube of (linear) dimensions; 2
- (ii) *allow converse throughout*
dugong does not need limbs to support body weight / body weight supported by water;
dugong has streamlined shape for movement through water;
dugong has limbs modified to form flippers;
limbs / tail, with large surface area to, push against water / propel through water;
elephant has large ears, for temperature regulation / to lose heat;
(not trunk or tusks, as not related to habitat?) max 3
- (b) (i) Variable;
no relationship between human and elephant population;
below 15 humans km⁻²;
could be chance / elephants move around;
could be influenced by availability of, water / food;
elephants need areas where there are trees / not all areas have vegetation suitable for elephants; max 3
- (ii) humans use land for agriculture / buildings / industry;
drive away / kill, elephants who damage crops;
fences keep elephants out;
removal of trees; Max 2
- (c) (i) some can be killed;
population remains (approximately) the same;
as enough animals are left to breed;
over long time period; Max 2
- (ii) (natural) birth rate;
(natural) death rate;
age at which reproduction begins;
frequency with which females give birth;
age structure of population; Max 3

Total: 15

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- 2 (a) (i) flowers; 1
- (ii) 3-petalled flowers; ignore elongated leaves
parallel veins (in leaves); 2
- (iii) adventitious;
fibrous / branching;
no tap root; max 2
- (iv) bundles scattered and not in a ring; 1

(b)

	Bryophyta	Filicinophyta	Coniferophyta
dominant stage is diploid sporophyte	x	✓	✓
vascular tissue present	x	✓	✓
xylem vessels present	x	x	x

half mark per correct box, round up

5

(c) *assume statement refers to angiospermophyte unless otherwise stated*

gametophytes / male gametes, inside pollen grain;
protected from desiccation / can be dispersed over wide area;

internal fertilisation / fertilisation described;
not dependent on water / male gametes do not swim;

young sporophyte / embryo, develops within seed;
not dependent on gametophyte / can lie dormant for long periods / can
survive dry conditions;

max 4

Total: 15

Page 3	Mark Scheme	Syllabus	Paper
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- 3 (a) (i) hyphae form mycelium;
septate;
septa with central pore;
more than one nucleus per compartment;
cell walls of chitin;
and glucan;
conidiophore;
conidia / conidiospores;
detail of conidia;
sterigma / phialide;
detail of cellular structure; max 6
- (ii) heterotrophic;
saprophytic / saprotrophic;
necrotrophic;
parasitic;
suitable named substrate;
enzymes secreted / extracellular digestion;
named substrate and product;
second named substrate and product;
products / soluble substances, absorbed;
diffusion / active uptake; max 6
- (iii) non-cellular;
no(cell) membrane / cytoplasm;
nucleic acid / DNA / RNA;
(may) contain enzyme / reverse transcriptase;
protein coat / capsid / capsomers;
may have, membrane / envelope, obtained from other organism;
do not respire;
do not take in nutrients;
reproduce only inside living cell;
obligate parasite;
use cell machinery to copy viral DNA;
description of reproduction of, RNA / DNA viruses;
some attempt to put forward an argument; max 8
- Total: 20**

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- (b) (i) water has low oxygen content ;
gaseous exchange surface of fish is gill lamellae;
large surface area + thin (epithelium);
detail of gill structure;
blood in capillaries/ well vascularised ;
ventilation provides oxygen-rich water over gills;
ventilation / blood flow, maintains diffusion gradient;
ventilation mechanism described;
water and blood flow in opposite directions / countercurrent;
speeds diffusion / increases concentration gradient;
- (ii) loss of water from exchange surface is problem on land;
locust exchange surface is tracheoles;
tracheae lined with chitin;
tracheoles deep inside body;
spiracles can close to prevent water loss;
tracheoles are, very small / thin, + large surface area;
all cells are short diffusion distance from tracheole / air;
penetrate, tissues / muscles;
withdrawal of fluid (from tip of tracheole) when muscle is active;
speeds diffusion;
ventilation mechanism described;
- (iii) exoskeleton with chitin;
six jointed legs;
chitin hardened except at joints / chitin more flexible at joints;
detail of, leg / joint, structure;
muscles attached inside skeleton;
across joint;
antagonistic muscles / extensor and flexor;
three legs remain on ground while three move;
large hind legs for jumping;
leverage explained;
claws for grip;
sticky pads for adherence;

max 6

max 6

max 8

Total: 20

Page 5	Mark Scheme	Syllabus	Paper
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OPTION 2: BIOTECHNOLOGY

1. (a) (i) lactic acid;
CO₂;
lowers the pH / makes it more acidic; max 2
- (ii) amount of microbes / yeast / bacteria / inoculum small;
idea of lag phase;
initial drop in pH is slow due to, synthesis of enzymes / gene switching;
as yeast level increases/ reaches exponential phase, pH drops quicker;
levels off as, lactose is used up / too acidic;
ref. figs. eg lag phase 1-2 h / levelling off after 6h / complete after 7-8 h; max 4
- (b) CO₂ produced;
by yeast;
respiration; max 2
- (c) different amounts of lactose;
different fat content;
different protein content;
other compounds / acetaldehydes/ diacetyl / alcohols produced; max 3
- (d) Inoculate new cultures;
food for animals;
(health) food for humans;
removal of microorganisms;
AVP; max 2
- (e) (i) lactose fermented;
milk is starting substrate;
both involve bacteria; max 1
- (ii) yeast involved in fermenting kefir / only bacteria (named bacteria) in
yoghurt;
different by-products formed eg alcohol; max 1

Total: 15

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2. (a) Explant from apical dome of e.g. potato / other valid e.g.;
for disease-free plants;

embryos used as explant of e.g. soya bean / other valid e.g.;
for disease free plants;

protoplast culture of e.g. tomato/ other valid e.g.;
to facilitate genetic manipulation of crop;

AVP;; e.g. in cases of sterility

max 4

- (b) (i) Prevent microbial contamination;
culture media contains suitable nutrients for the growth of microbes;
as microbes grow faster than plant;

max 2

- (ii) (shoot / root) meristems;
leaf initials;
young flower buds;
pseudobulbs;
embryonic tissue;
any sensible named tissue;

max 2

- (c) cytokinin promotes shoot growth;
higher concentrations more shoots;
too much cytokinin and shoot size decrease;
root development only when no cytokinin present / cytokinin inhibits root
growth;
reference to comparative figs;

max 3

- (d) Each correct answer for ½ mark - marks rounded up . The use must be
linked to the correct ingredient. Maximum 2 for ingredients. Maximum 2
for uses.

Vitamin; correct use;
N / amino acids; protein synthesis;
Ca ; middle lamella formation;
P; nucleic acid synthesis / ATP synthesis;
Mg ; chlorophyll formation;
trace elements; enzyme activators;
C source; energy source / osmoticum;
S; amino acid synthesis;
Giberellins; cell elongation;
Auxin; control cell differentiation;

max 4

Total 15

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3. (a) (i) Primary effluent sprayed over (graded) stones / grit / clinker;
 Covered in thin film of, bacteria / fungi; (*trickling filter system*)
 Or passed into an aeration tank; (*activated sludge process*)
 named example of organisms involved eg *Bacillus* / *Proteus* /
Pseudomonas / *Zoogloea ramigera* ;
 together with ciliate protozoa;
 eg *Vorticella*;
 these are aerobic;
 bacteria break down organic material;
 small solid particles digested by ciliates;
Zoogloea secretes a gum;
 which flocculates particles together;
 other microbes work on the floc. To break it down;
 all the organisms involved are sensitive to poisoning with heavy metals;
- sludge (from aerobic treatment tank & settlement tank) is broken down by
 anaerobic bacteria;
 eg *Clostridium*;
 temperature is 30-35°C;
 also methanogenic bacteria;
 eg *Methanobacteria* / *Methanococcus* / *Methanobacillus* / *Methanosarcina*
 / *Methanospirillum*;
 produce methane;
 which is used as a power source;

max 8

- (ii) microorganisms break down organic matter;
 found naturally on the substrate;
 initial decomposition by mesophilic microorganisms;
 produces heat / temperature raised;
- replaced by predominantly bacilli;
 named species eg *Thermus*;
 which are thermophiles;
 accelerates breakdown of proteins / fats / complex carbohydrates;
 rise in temperature kills, many microbes / pathogens;
- compost temperature decreases and mesophilic microorganisms take
 over;
 the longer the compost left the more diverse the species;
Actinomyces;
 degrade complex organic compounds / cellulose / lignin / chitin / proteins;
 appear during the thermophilic phase;
 fungi / moulds breakdown complex plant polymers / named example;
 important in mesophilic phase;
 enables bacterial decomposition to take place;

max 6

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(iii)

unicellular algae;
 named example eg *Scenedesmus*;
 some fungi / eg mycorrhizal;
 acidophilic bacteria;
 named example eg *Thiobacillus*;
 obtains energy from oxidation;
 example eg ferrous iron / sulphides, to ferric iron / sulphates;
 aids the solubility of metals;
 take up metal ions from dilute solutions;
 named metal eg cobalt / copper / lead / zinc / uranium;
 accumulate ions against a concentration gradient;
 in non-toxic form;
 low grade metal ores, crushed / dumped, on impermeable surface;
 microorganisms already present in the ore;
 irrigated with sulphuric acid;
 metal sulphate collect in lagoons;
 metal extracted by, physical / chemical methods;
 water / acid solutions recycled;

max 6
 Total: 20

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3. (b) (i) *Monoclonal antibodies* – maximum 4

group of identical antibody molecules;
 recognise only one type of antigen;
 produced from hybridoma cells;
 formed from fusion of B-lymphocytes;
 and myeloma / tumor cells;
 hybridoma cells have culture immortality;

Biosensor – maximum 4

device for measuring chemical compounds /molecules;
 have immobilised enzyme;
 transducer;
 amplifier;
 enzymes, recognise & select only one type of molecule /specific;
 used to detect molecules at low concentrations;

max 6

- (ii) used to identify different strains of pathogens;
 eg hepatitis B;
 detection of, virus particles / microbial toxins ;
 in infected blood / tissues;
 cancer diagnosis;
 detection of tumour antigens;
 prior to development of symptoms;
 detail;
 therapy;
 carriage of cytotoxic drugs directly to tumour cells / magic bullets;
 detail;
 purification of interferon;
 affinity ligands to bind / purify compounds;
 preparation of vaccines;
 identification of immunogenic parts of, viruses / bacteria;
 for use as subunit vaccines;
 passive immunization;
 named example eg malaria / rabies /influenza;
 for immunologically compromised hosts;
 eg due to, AIDS / radiotherapy / drugs;

max 8

- (iii) Immobilised enzyme is glucose oxidase;
 in protective, gel / matrix;
 made of cellophane acetate;
 detect low levels of glucose;
 from a sample of blood;
 glucose is oxidised;
 to gluconic acid;
 and hydrogen peroxide;
 reaction causes changes;
 in a transducer;
 produces a current;
 platinum electrode;
 current directly relates to amount of glucose;

max 6

Total: 20

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OPTION 3: GROWTH, DEVELOPMENT AND REPRODUCTION

- 1 (a) (i) Fertilisation birth, must get **both** right for one mark; 1
- (ii) 18% adult 82% fetal; 1
- (iii) rapid growth / associated with placenta / need to get oxygen (from mother); 1
- (b) No nucleus;
Different Hb;
Biconcave shape; max 2
- (c) (i) S-shaped curve / sigmoid;
(very) high affinity for oxygen;
small increase in pO_2 causes large increase in oxygen carried;
oxygen released to tissues (at lower pO_2);
(steep part of curve) rapid release, with small decrease pO_2 ;
suitable comparative figs; (in relation to fetal curve)
allosteric binding described; max 4
- (ii) fetal steeper than maternal;
fetal shifted left;
fetal (remains) saturated at lower pO_2 / higher maximum saturation;
fetal carries more O_2 , at any given pO_2 ;
comparative figs % and KPa for both; max 3
- (iii) maternal haemoglobin must release oxygen at a particular pO_2 , while fetal haemoglobin picks up oxygen / fetal haemoglobin has higher affinity;
to allow O_2 transfer (from mothers blood) to fetal blood;
fetal haemoglobin has different polypeptide chains; max 2
- (iv) blood system of embryo poorly developed;
embryonic haemoglobin holds oxygen at a low pO_2 ;
AVP; 1
- Total: 15**

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- 2 (a) garden pea french bean
- hypogeal epigeal;
epicotyl elongates hypocotyl elongates;
cotyledons below soil cotyledons above soil;
testa stays below soil testa moves above soil;
Ⓐ no lateral roots many lateral roots present;
- Max 3**
- (b) (i) heat to constant mass;
at 110°C or less;
cool in a desiccator;
weigh;
- Max 3**
- (ii) nitrate - mean yield less, (than control / A)
may not be significant;
standard deviation greater;
ref figs; (must include units)
- phosphate - mean yield greater, (than control / A)
standard deviation greater;
ref figs; (must include units)
ref to significance of results;
- max 4**
- (iii) nitrate - soil might have sufficient nitrogen;
beans (are leguminous) can fix nitrogen;
via bacteria in nodules;
- phosphate - phosphate increases, growth, of beans;
since soil might be deficient;
used for, ATP / used for hexose phosphates / phospholipids;
used for, DNA / RNA;
- max 5**
- Total: 15**

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- 3 (a) (i) unspecialised cells / totipotent cells;
DNA replication;
during interphase;
mitosis;
cytokinesis;
exact replication of genetic material;
all cells form a clone;
organelles replicate;
ref mitochondria / chloroplasts;
cells enlarge / elongate;
ref vacuolation;
ref cell wall;
cells specialise / differentiate;
different genes are switched on;
example of specialised cells; max 8
- (ii) *Oestrogen*
Follicular phase;
Shedding of lining / endometrium (day 1 to 5);
Myometrium excitable / muscles sensitive to hormones;
repair;
endometrium, supplied with (straight) arteries / vascularised;
endometrium becomes glandular;
up to, ovulation / day 14; max 6
- progesterone*
secretory phase;
endometrium thickened;
ref coiled arteries;
ref coiled glands;
venous blood lakes / sinuses;
change in the cervical mucus;
secretion from uterine glands;
myometrium less excitable;
maintains endometrium;
from ovulation / day 14 to day 28;
reduction of steroid / progesterone induces menstruation; max 6

Total: 20

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- (b) (i) P_{FR} acts as inhibitor;
 ref. to photoperiod;
 (critical) dark period needed;
 that is continuous;
 to allow phytochrome to be converted;
 also far red light;
 $P_{FR} \rightarrow P_R$;
 so inhibition removed;
 leaves act as receptors;
 ref to florigen / gibberellic acid;
 transmission via phloem;
 switching of genes;
 in shoot apex / meristem;
 specialisation of cells;
 to form anthers / carpels / other named parts;
 example given;

max 8

- (ii) Gibberellin / GA, stimulates germination / breaks dormancy;
 in light requiring seeds;
 in seeds that need chilling;
 cytokinins promote germination;
 cytokinins and gibberellins may work (alone or) together;
 ethene promotes germination;
 ethene may work with, cytokinins / gibberellins;
 ABA / abscisic acid, inhibits germination / causes dormancy;
 ref to leaching of ABA;
 ABA antagonistic to, cytokinins / gibberellins;
 ABA levels decline with chilling;
 idea of different seeds responding differently;
 ref to mechanism of ABA action;
 ref to mechanism of gibberellic action;
 ref gene switching;

max 7

- (iii) fruit maturation { IAA / NAA / auxin promote fruiting;
 in pears / strawberries / tomatoes / grapes / other named example;
 ref parthenocarpy;
 no seeds;
 ethene promotes ripening;
 in bananas / other named fruit;
 idea of putting ripe fruit with unripe fruit to promote ripening;
 ref fruit drop;
 lack of pollinators;

max 5

Total: 20

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OPTION 4: APPLICATIONS OF GENETICS

- 1 (a) V_E /environment;
 V_G /genotype; 2
- (b) (i) selection for particular trait(s);
of benefit to man;
artificial selection;
choosing which individuals may breed;
assuming trait heritable;
ongoing selection/ref. time number of generations; max 3
- (ii) small number breeding individuals;
may not have all alleles;
loss of alleles linked to discarded traits;
inbreeding / backcrossing;
many generations;
increases homozygosity / decreases heterozygosity; max 3
- (c) seeds, from many sources / from many phenotypes;
dehydrated;
chilled / frozen;
ref. effect on storage life; (doubled for reduction of 5°C or 2% humidity)
labelled / packaged;
sample germinated, at intervals/every 5 years;
seed from these plants returned to bank; max 4
- (d) (i) Yes, diversity reduced;
ref. %;
but only one gene considered; max 2
- (ii) greater selection for regulatory region;
differences may alter gene switching;
difference between species is, amount of product/whether gene switched on;
switching on more important than differences in product; max 1
- Total: 15
- 2 (a) (i) chance / random;
mutation;
of, chromoneme / plasmid / DNA; max 2
- (ii) Natural selection;
Antibiotic = selective agent;
Vertical transmission;
Horizontal transmission;
Conjugation / transformation / transduction / description of process; max 3
- (b) (i) Sample sites not free from contact with antibiotic;
Allele / gene / mutation giving resistance to one gives resistance to other;
Small / common / easily achieved, mutation;
on plasmid so easily transferred;
A.V.P.; max 3

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- (ii) not closely related to other species;
less horizontal transmission;
more easily killed by antibiotic;
different enzymes/pathways;
A.V.P.; ; max 2
- (iii) affects, crucial pathway / pathway with no alternatives;
requires large mutation;
requires series of mutations;
A.V.P.; ; max 2
- (c) not supported;
except in case of antibiotic B;
bacteria supposedly not in contact with antibiotic show resistance;
up to 100% of colonies tested; max 3
- Total: 15**
- 3 (a) (i) female superovulated;
ref. FSH / brand name;
either fertilised; *or* oocytes harvested;
embryos flushed from uterus; IVF;
embryos genetically tested;
embryos sexed;
embryos, subdivided/cloned;
embryos implanted into surrogates;
treated with hormones to, prepare uteruses / synchronise cycles;
surrogate may not be same species;
surrogate may be temporary portmanteau; max 7
- (ii) explant;
sample, meristematic / totipotent / cambium, cells;
surface sterilised/treated with hypochlorite/treated with bleach;
placed in sterile medium;
with nutrients / named nutrients;
hormones / p-g-s, to promote division;
mitosis / cytokinin;
forms callus;
callus subdivided;
placed in medium with, hormones / p-g-s, to promote differentiation;
auxin / gibberellin;
plantlets;
hardening medium / sterile, sand / soil; max 7
- (iii) *Embryo transplantation*
Increases number of offspring from desirable female;
does not put female at risk from pregnancy;
subdivision / cloning, further increases number of desirable offspring;
gives, herd/flock/etc., with desired trait quickly;
plant tissue culture
all plantlets from a callus genetically identical;
multiplies desirable hybrid which will not, breed true / breed;
multiplies particular genotype for subsequent crossing;
so speeds up selective breeding; max 6
- Total: 20**

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- 3 (b) (i) trisomy 21;
non-disjunction;
usual origin / 95%, of Down's;
in, meiosis;
1/production of secondary oocyte;
chance / not inherited;
usually maternal;
increased chance with increased maternal age;
can be paternal;
also increased chance with increased paternal age;
translocation;
end of long arm of 21 onto other chromosome;
rest of chromosome 21 lost;
carrier has 45 chromosomes;
this type Down's can be inherited;

max 7

(ii)

<u>amniocentesis:</u>	<u>chorionic villus sampling (CVS);</u>	DNA profile;
tests fetus;	tests fetus;	tests, possible carrier parent/embryo;
sample amniotic fluid;	sample chorionic villi of placenta;	sample, blood / skin / hair / cell from IVF embryo / cell from amio or CVS;
13 -16 weeks pregnancy; results 2 - 3 weeks later; cells cultured to divide;	9 - 12 weeks pregnancy; results quicker than amnio; cells cultured to divide;	results in hours; DNA fragmented with restriction enzymes;
exploded by putting into water;	(rest as amniocentesis)	electrophoresis;
<u>karyotyped:</u>		radioactive gene probe / altered pattern of bands;
chromosomes, counted / examined for translocations etc.;		Autoradiography / u.v. light;
fluorescent, chromosome marker / gene probe:		

Mark from one technique or from more than one.

max 7

- (iii) give information about, severity of disorder / quality of life with disorder;
and treatment available;
components of diet to be avoided;
time of onset;
explain probability of risk of passing on condition;
explain options available;
in light, of religion / culture / ethics;
put individuals in position to make own choice;

max 6

Total: 20