

**CAMBRIDGE**  
INTERNATIONAL EXAMINATIONS

**NOVEMBER 2002**

**GCE Advanced Level**

<b>MARK SCHEME</b>
<b>MAXIMUM MARK : 50</b>
<b>SYLLABUS/COMPONENT : 9700 /6</b> <b>BIOLOGY</b> <b>(OPTIONS (A2))</b>

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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<sup>-2</sup>;  
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

Page 2	Mark Scheme	Syllabus	Paper
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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	www.dynamicpapers.com	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

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## OPTION 2: BIOTECHNOLOGY

1. (a) (i) lactic acid;  
CO<sub>2</sub>;  
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) CO<sub>2</sub> 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;  
*Actinomycetes*;  
 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 <b>both</b> 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 <u>fetal</u> 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 <u>higher</u> 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
					<b>Total: 15</b>



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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;  
 //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>	<u>DNA profile;</u>
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