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CAMBRIDGE
INTERNATIONAL EXAMINATIONS

NOVEMBER 2002

GCE Advanced Level

MARK SCHEME

MAXIMUM MARK : 50

SYLLABUS/COMPONENT :9700 /6

BIOLOGY
(OPTIONS (A2))

UNIVERSITY of CAMBRIDGE
Local Examinations Syndicate

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

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

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

(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; **max 6**

(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; **max 6**
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 8**

Total: 20

OPTION 2: BIOTECHNOLOGY

1. **(a)** **(i)** lactic acid;
CO_2;
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_2 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

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

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 *Baccillus / 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 baccili;
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

(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

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

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; **1**
AVP;

Total: 15

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;
(A) 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

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 sensitve 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

(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

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**

(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

3 **(b)** **(i)** trisomy 21;
non-disjunction;
usual origin / 95%, of Down's;
in, meiosis;
I/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)

amniocentesis;	chorionic villus sampling CVS);	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;	9 - 12 weeks pregnancy;	
results 2 - 3 weeks later;	results quicker than amnio;	results in hours;
cells cultured to divide;	cells cultured to divide;	DNA fragmented with restriction enzymes;
exploded by putting into water;	(rest as amniocentesis)	electrophoresis;
karyotyped;		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