CAMBRIDGE
INTERNATIONAL EXAMINATIONS

JUNE 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) **A** – Chordata / chordates *and*
myotomes / segmented muscle blocks / notochord / dorsal nerve cord / post-anal tail / visceral/pharyngeal clefts/slits ;

B – Echinodermata / echinoderms *and*
pentamerous symmetry / tube feet /spines ;

C – Cnidaria *and*
radial symmetry / tentacles ; **3**

(b) (i) annelid triploblastic, cnidarian diploblastic ;
annelid has double body openings, cnidarian single ;
annelid has CNS / nerve cord, cnidarian nerve net ;
annelid bilaterally symmetrical, cnidarian radially ;
annelid has mesoderm, cnidarian has mesogloea ;
annelid segmented (cnidarian not) ;
annelid has coelom (cnidarian not) ;
annelid has blood vessels / pseudo heart (cnidarian not) **3 max**

(ii) **P** / chaetae, for grip / anchorage ;
ref retraction when moving / protrusion when stationary ;
Q and **R** are antagonistic muscles ;
Q / circular muscles create long, thin segments (contracted) ;
R / longitudinal muscles create short, fat segments (contracted) ;
waves of contraction (run from back to front) ;
muscles work against, coelom / **S** / coelom / **S**, acts as hydrostatic skeleton ;
4

(c) (i) heterotrophs / eat organic material ;
in / on, soil ;
eat humus / dead leaves ;
ref to prostomium (gripping food) ;
ref to (muscular) pharynx (swallowing) ; **2 max**

(ii) earthworms, feed selectively / do not eat all soil ;
more of each element (in casts) because these are present in leaves (in higher concentration than soil) ;
calcium from calcium pectate / in cell walls ;
magnesium from chlorophyll ;
carbon from, organic compounds (in leaves) /named organic compound ;
earthworms may bring up leached material which has been deposited in lower layers of the soil ; **3 max**

Total: 15

2 (a) to provide land for agriculture ;
space for housing / industry ;
road building ;
wood for, building / fuel ;
timber (for sale / export) ;
mining activity ; **3 max**

(b) (i) greater mortality at edge than at centre ;
above 60 cm / larger / older, trees most affected ;
uniform percentage mortality up to 60 cm ;
use of figures (% + diameter) ; **2 max**

conditions at edge less suitable for trees ;
(ii) more wind (at edge) ;
larger trees more susceptible to wind damage ;
lower humidity (at edge) ;
more intense grazing (at edge) ;
ref erosion / nutrient loss at edges ;
damage from logging activities ;
accept converse throughout **3 max**

(c) (i) fewer seedlings in smaller areas ;
always most seedlings at interior (applies to both) ;
less variation in 10 ha than 100 ha / steady decrease in 100 ha (interior to corner) ;
similar number throughout 10 ha fragment and at corners of 100 ha fragment ; **2 max**

(ii) higher proportion of 'edge' in smaller fragments ;
so more trees killed ;
especially, larger / older, ones that would be producing (most) seeds ;
trees do not, flower / set seed, so easily at edges ;
(so) fewer seeds produced in smaller fragments ;
environment in smaller fragments, not so suitable for germination / higher rate of transpiration ;
because soil is drier ;
seeds more likely to be eaten before germination in smaller fragments ; **3 max**

(d) small fragments will have lower biodiversity than large ones ;
make forest reserves as large as possible ;
corridors between fragments ; **2 max**

Total: 15

3 (a) (i) *E. coli* is a prokaryote, *Paramecium* is a eukaryote ;
E has no nucleus, P has nucleus / two nuclei ;
E has naked DNA, P has DNA associated with histones / true chromosomes ;
E DNA is loop, P DNA linear ;
E has no membrane-bound organelles / named organelles, P has ;
E has cell wall, P does not have cell wall ;
E has smaller ribosomes than P ;
E has no cilia, P has cilia ;
E has pili / fimbriae, P does not ;
E does not have contractile vacuole, P has ;
E has plasmid(s), not in P ;
P has food vacuoles, none in E ;
P has, gullet / oral groove, not in E ; **8 max**

(ii) genetic engineering / gene technology ;
DNA from other organisms inserted into bacteria ;
any example, e.g. insulin / HGH / BST ;

Agrobacterium tumefaciens ;
used as vector / to insert genes, into plants ;
detail ;
example of genes / characters used (disease resistance, resistance to herbicides) ;

Lactobacillus / Bacillus subtilis / Serratis ;
as silage inoculant ;
speeds fermentation / increases nutrient content ;

Acetobacter ;
Vinegar production ;
Converts ethanol to ethanoic / acetic acid ;

Bacillus thuringiensis ;
used as insecticide ;
sprayed onto crops (e.g. cabbages) ;
Bt toxin gene inserted into crop plants ;

blue-greens / cyanobacteria / *Spirulina* ;
grown for single cell protein ;

ref oil spills ;
e.g. bacterium ;

Streptococcus / Lactobacillus ;
cheese / yoghurt, production ;
bacteria convert sugars to lactic acid ;

thermophillic bacteria ;
as source of enzymes ;
e.g. proteases / lipases / amylases, for washing powders ; **6 max**

(iii) *Saccharomyces* used for this ;
fermentation ;
converts sugars to ethanol / alcohol ;
production of gasohol / alcoholic beverages ;

bread making ;
ref carbon dioxide production ;

antibiotic production / named antibiotic ;
detail / *Penicillium* / *Streptomyces* ;

blue cheeses ;
detail / flavour / inoculation detail ;

mycoprotein ;
detail / *Fusarium* / ref non-meat protein / low fat / high fibre ;

sources of enzymes ;
detail ; **6 max**

Total: 20

(b) (i) bryophytes have no / relatively unspecialised, vascular tissue ;
filicinophytes have xylem and phloem ;
xylem has (vessels and) tracheids ;
b have rhizoids ;
f (sporophyte) have true roots / f have rhizoids only on gametophyte ;
b have thallus ;
f have leaves / fronds ;
frond detail, e.g. rachis, pinnae ;
b have no true stem ;
f have stem with supporting tissue ;
f (often) have underground stem / rhizome ;
b have dominant gametophyte stage, f has dominant sporophyte stage ;
(some) bs have no stomata, (all) f have stomata ;
f have sporangia in clusters / sori, on leaves, b do not ;
detail sporangia structure e.g. tapetum, annulus ;
b detail of sporophyte e.g. capsule with peristome ; **8 max**

(ii) poorly adapted / confined to damp environments ;
R dark / shady
(gametophytes) have rhizoids for anchorage to substrate ;
rhizoids for absorption of, water / ions ;
some water transport tissues ;
but not well-developed ;
spores are resistant to desiccation ;
no lignin / so rely on turgor for support ;
so cannot grow very tall ;
leaves (usually) one cell thick ;
(most have) no cuticle ;
so lose water (by evaporation) easily ;
gametes require water for, fertilisation / sperm to swim ;
gametes surrounded by (sterile) cells that prevent drying out ;
some have stomata that can be closed ;
some have waxy cuticle ;
some mosses can survive long periods of desiccation /
ref Sphagnum 'wick' effect ; **6 max**

(iii) well adapted to life on land ;
coniferophyte has vascular tissue, so water is transported to all cells / provide support ;
tracheids / lignified cells / woody tissue ;
secondary growth provides more, supporting / conducting, tissue ;
so can grow large / tall ;
so can intercept more light for photosynthesis ;
has (true) roots so can obtain water from, deep in soil / over wide area / ref anchorage ;
leaf shape / cuticle reduces water loss / transpiration ;
bark / cork, resistant to fire ;
wind pollination ;
male gametes, inside pollen grains, protected / resistant to drying ;
fertilisation internal / gametes do not have to swim / gametes move down pollen tube ;
fertilisation not dependent on wet conditions ;
embryo develops in / protected in, seed ;
wind dispersal ;
seed can lie dormant through, dry / cold, conditions ; **6 max**

Total: 20

OPTION 2 - BIOTECHNOLOGY

1 (a) involves breakdown of starch by acid hydrolysis / amylase ;
to sugars / named sugar ;
anaerobic fermentation ;
named organism : *Saccharomyces cerevisiae* / *Zygomyces* / *Zygomonas*;
ref controlled conditions ;
ref distillation ;
detail e.g. sterilised apparatus / batch process / aerobic initially ; **4 max**

(b) less need to extract / transport fossil fuels ;
oil is finite / biofuels are made from renewable sources / reduces use of fossil fuels ;
biofuels produce fewer harmful emissions during production ;
biofuels produce fewer harmful emissions during combustion ; **3 max**
reduction in the build up of greenhouse gases ;

(c) *advantages*

(engine performance) - good / more powerful ;
(exhaust emissions) - less pollution / named example ;

disadvantages – ***max 3***

(maintenance costs) - parts costs more / need replacing more often ;
(fuel tank weight) - car heavier ;
(drivability) - harder to drive ;
(solvent action) - any spillage damages the paintwork more ;
(cold weather start) - harder to start car in colder climates ; **4 max**

(d) country already produces oil ;
requires a ready source of fermentable carbohydrate ;
requires a cheap power supply for distillery ;
not all countries have the appropriate technology ;
no use in cold climates ; **2 max**

(e) other fuels expensive / not available ;
uses waste materials ;
reduces deforestation ;
reduces soil erosion ;
sludge left can be used as a fertiliser / increases soil fertility ;
localised production ;
2 max

Total: 15

2 (a) oxygen consumption / rate oxygen is used up ;
pH ;
H_2O_2 production / rate H_2O_2 formed ; **2 max**

(b) (i) undernourished / stunted growth ;
fatigue / fainting / coma ;
high blood sugar levels / glucose in urine ;
excessive thirst ;
eye damage ; **2 max**

(ii) sugar consumption increases with time ;
number of cases of diabetes increases with time ;
use of figures ;
increase in sugar consumption related to increase in diabetes ; **3 max**

(iii) not a direct relationship between sugar consumption and diabetes ;
named other factor involved e.g. exercise / other dietary factors / improved diagnosis ;
genetic link ; **2 max**

(c) injections no longer needed ;
reduces the long-term chance of infection ;
cures the disease ;
leads to a better lifestyle / less need to watch diet as carefully ; **2 max**

(d) cow /pig insulin differs in structure from human insulin ;
side effects / may cause an allergic immune system reaction in some people ;
possibility of disease transmission ;
genetically engineered insulin can be produced in any quantity ;
cheaper to produce ;
some people will not / inject themselves with insulin from animals (for religious / personal reasons) ;
human insulin quicker effect ; **4 max**

Total: 15

3 (a) (i) organism *Fusarium graminearum* ;
grown at 25 - 35°C ;
looped air flow fermenter / pressure cycle fermenter ;
any named nutrient requirement eg NH_3 / glucose / minerals salts ;
choline increase hyphal length ;
cooling jacket / heat exchanger ;
continuously harvested ;
RNA reduced ;
by heating to 60 - 70°C ;
produces mycoprotein fibres / filaments ;
need to be extracted and purified ;
cut / coloured / flavoured to produce final product ; **8 max**

(ii) ref fruit ripening ;
better tasting fruit / vegetables ;
prevents fruit softening / spoilage ;
yield stability ;
locate important genetic traits and fast track them into breeding material;
e.g. stress tolerance genes to the cold / high pH tolerance ;
pest / disease control ;
modification of oils / starch / protein / fibre content ;
enhanced digestibility for forage animals ;
e.g. Canola plant producing oils for lubricants / detergents ;
potatoes with starches that absorb less fat on cooking ;
increase yield saves water in areas requiring irrigation ;
will reduce demands on the environment / less space required ;
crop digestibility may provide benefits in wood pulping ; **6 max**

(iii) enhanced / accelerated livestock improvement programmes ;
by taking advantage of genes not readily accessible ;
through normal selective breeding ;
e.g. enhanced disease resistance ;
chickens that resist infection by *Salmonella* ;
produce milk which contains therapeutic / medically important proteins ;
to alter the milk to improve nutritional value ;
achieved by inserting copies of human genes for these proteins ;
and attaching them to regulatory genes ;
so that the inserted gene only works in the mammary glands ;
leaner meat produced ; **6 max**

Total: 20

(b) (i) increases yield ;
saves water in areas requiring irrigation ;
less space required ;
plants genetically engineered able to fix nitrogen ;
external fertilisers not necessary ;
excess fertiliser no longer causing pollution ;
resistant to the attack of insects ;
resistant to disease ;
prevents fruit softening / spoilage ; **6 max**

(ii) starter culture of bacteria ;
Lactobacillus bulgaricus, / *Lactobacillus acidophilus* ;
and *Streptococcus thermophillus* / *Bifido bifidum* ;
added to milk ;
incubated at 38 - 46°C ;
Lactobacillus breaks down protein ;
releasing peptides ;
which encourage *Streptococcus* to grow ;
Streptococcus produces formic acid and CO_2 ;
which stimulate *Lactobacillus* ;
pH reduced to 4.4 - 4.6 ;
Lactobacillus produces lactic acid ;
both organisms produce acetaldehyde ;
which gives yoghurt its characteristic flavour ; **7 max**

(iii) (inject) papain ;
a protease ;
into cattle immediately before / after slaughter ;
enzyme circulates through tissues ;
begins breakdown of fibrous proteins / collagen / elastin ;
holding connective tissue together ;
releases muscle fibre ;
reduces storage time ;

may cause an allergic reaction in some people ;
public suspicious of treated meat ; **7 max**

Total: 20

OPTION 3 – GROWTH, DEVELOPMENT AND REPRODUCTION

1 **(a)** allometric ; **1**

(b) (i) baby at birth has head half as big ; (or eight week fetus has head twice as big)
adult has head one quarter as big ; (or fetus has head four times as big) **2**

(ii) hormones ;
growth hormone / thyroxin / testosterone ;
growth of brain early ;
growth of sense organs / examples of sense organs ;
ref gene switching (in different tissues) ; **3 max**

(c) (i) most birth masses around 3 kg ;
fewest deaths / lowest mortality, just above 3 kg ;
approx 3% mortality (A 2.5 – 3.5%) ;
increased mortality at lower and higher birth masses ;
ref supporting figures of extreme birth masses and mortality ; **3 max**

(ii) natural selection ;
favours birth masses close to 3 kg approx ;
heavy and light babies more likely to die ;
ref stabilising selection ;
so alleles (genes) for 3 kg birth masses passed on ; **2 max**

(d) smokers have 17 - 18% / most, babies at 3 kg ;
non smokers have 18.5 – 19.5% / most, babies above 3 kg ;
on average, smokers have lighter babies ; **2 max**

(e) IUGR / intrauterine growth retardation ;
carbon monoxide, diffuses across placenta / forms carboxyhaemoglobin / reduces oxygen to fetus ;
nicotine, affects nervous system / fetal circulation / placenta ;
birth complications / premature births ;
resistance to infection reduced ;
breathing problems / lungs immature, afterbirth ;
vitamin C uptake of mother reduced ; **2 max**

Total: 15

2 **(a)** carbohydrate – sucrose from phloem / parent plant declines ;
glucose declines, as used for synthesis / respiration ;
starch initial reserve ;
ref to amylase ;
oil – oil synthesised from carbohydrates ;
starch converted to oil ; **4 max**

(b) low density / mass, allowing easier dispersal ;
equal mass of lipid yields more energy than equal mass of carbohydrates ;
ref to higher proportion of hydrogen relative to oxygen ;
ref reduced microbial attack ; **2 max**

(c) digestion / hydrolysis ; R breakdown
ref enzymes / lipases ;
fatty acids for synthesis ;
ref respiration ;
detail of respiration ; **3 max**

(d) dry mass would fall initially ;
reserves used up ;
reserves respired ;
ref to oil / starch ;
carbon dioxide released ;
after plumule / leaves emerged ;
when photosynthesis exceeds respiration ;
dry mass would increase ; **4 max**

(e) breaks dormancy ;
acts on aleurone layer ;
amylase / hydrolytic enzymes, activity increased / starch digestion affected ;
effect on protein synthesis / RNA synthesis ;
rise during chilling / may remove need for cold period ;
ref gene switching ;
acts with IAA in elongation ; **2 max**

Total: 15

3 (a) (i) (2 different methods)
method and appropriate plant ;;
part / parts of plant involved ;;
practical detail of selected technique ;; **6**

(ii) *advantages*

only one parent needed ;
offspring genetically identical / clones ;
known growing conditions ;
known time of maturity / all together ;
known quality / characteristics / example ;
large numbers / rapid production, (from one stock plant) ;
plant diseases avoided with meristems ;
micropropagation at any time of year ;
(exotic) plants that are hard to produce from seed can be propagated ;
cloning following genetic engineering ;

5 max for advantages

disadvantages

labour intensive ;
problem of disease transmission ;
problem of disease spread through a whole crop ;
problems of harvesting at one go ; **7 max**

(iii) meiosis ;
producing pollen ; (**R** male gametes by meiosis)
producing embryo sac ; (**R** female gametes by meiosis)
independent assortment ;
detail ;
crossing-over ;
detail ;
new allele combinations ;
non-disjunction ;
random fusion of gametes ;
two parents involved ;
ref natural selection ;
ref to cross-pollination ; **7 max**

Total: 20

3 (b) (i) secretion of thyroxin / T_4 and tri-iodothyronine / T_3 ;
iodine / iodide concentrated from blood ;
thyroglobulin made / stored ;
hydrolysed / ref enzyme action ;
secretion into, blood plasma / capillaries ;
thyroxin controls BMR ;
ref oxygen / food utilisation / heat generation ;
cellular respiration / mitochondria stimulated ;
thyroxin acts on nucleus / DNA / genes ;
switches on RNA synthesis ;
protein synthesis ;
growth / development affected ;
skeleton / bone ;
mental development ;
heart rate ; **8 max**

(ii) ref cold / season / body temperature ;
hypothalamus produces TRH / TRF;
TRH / TRF stimulates anterior pituitary to produce TSH ;
low thyroxin causes anterior pituitary to secrete TSH ;
high thyroxin inhibits TSH ;
action via hypothalamus ;
ref negative feedback in right context ;
ref homeostasis ;
ref blood vessels from hypothalamus to ant pituitary ; **6 max**

(iii) ref menopause symptoms ;
ref hysterectomy / ovaries removed ;
ovaries less sensitive to FSH ;

consideration of age for HRT ;
oestrogen taken in pills / implants ;
osteoporosis / loss of calcium from bones ;
oestrogen antagonistic to parathormone ;
reduced risk of CHD ;
ref to side effects ;
example of side effects (blood clotting) ; **6 max**

Total : 20

OPTION 4 – APPLICATIONS OF GENETICS

1 (a) (i) dominant ;
epistasis ; **2**

(ii) Inhibition / suppression ;
codes for, protein/polypeptide ;
which blocks expression of banding locus ;
codes for abnormal enzyme ;
which cannot make band pigment ;
AVP ;; **3 max**

(b) *P* [BBMM] x bbmm ;
gametes BM x bm ;
F_1 BbMm unbanded ;

Allow error carried forward (ECF/consequential) marks for F_1 gametes and F_2 gametes

BM Bm bM bm x same ;

Punnett square genotypes ; ;
phenotypes ; ;

gametes	BM	Bm	bM	bm
BM	BBMM unbanded	BBMm unbanded	BbMM unbanded	BbMm unbanded
Bm	BBMm unbanded	Bbmm unbanded	BbMm unbanded	Bbmm unbanded
bM	BbMM unbanded	BbMm unbanded	bbMM midbanded	bbMm midbanded
bm	BbMm unbanded	Bbmm unbanded	bbMm midbanded	bbmm five-banded

ratio 12 unbanded : 3 midbanded : 1 five-banded ; **8 max**

(c) (i) genes on the same chromosome ; **1**

(ii) 1 unbanded pink: 1 banded yellow ; **1**

Total: 15

2 (a) Correct ref to PCR ;
cut (into fragments) ;
by enzymes ;
restriction enzyme / named restriction enzyme ;
buffered ;
loaded into wells at one end ;
of (agarose) gel ; **4 max**

(b) fragment including mutant allele shorter / lighter ;
moves further / faster (in electrophoresis) ;
[A converse points] **2**

(c) code for, tissue type / self v. not self ;
4 (6) genes ;
many alleles ;
rejection if not matched ;
some more important than others (in rejection) ;
ref haplotype / linkage / supergene ;
match, more likely in family / rare outside family ; **4 max**

(d) dominant allele added to existing genotype ;
recessive inactive so effect dominant seen ;
mutant dominant would have to be, inactivated / selectively removed ;
not, easy / feasible as yet ; **3 max**

(e) normal mouse has two normal mouse β globin alleles ;
with, switch / promoter ;
in usual place in chromosome ;
much, easier / quicker, to, express / transcribe, than added human gene ;
heterozygous mouse has one inactive allele / only one active allele ;
so human gene switched on ;
ref figures; (x2 or half) **2 max**

Total: 15

3 (a) (i) form of gene bank ;
source of genetic variation ;
source of alleles ;
of recently unfashionable traits ;
of unrecognised traits ;
for selective breeding ;
in future ;
possible resistance to, pathogens / pests / climatic conditions ;
may be needed to counteract inbreeding ; **6 max**

(ii) named animal ;
e.g. of trait selected for ;
parents chosen for trait(s) ;
and general fitness ;
ref progeny testing to identify suitable parent ;
especially for selection of sex limited trait ;
ref heritability / V_G ;
ref background genes to suit conditions ;
ref AI to maximise offspring from suitable male ;
and to allow long-distance mating ;
ref embryo transplantation to maximise offspring from suitable female ;
idea selection over many generations ;
ref avoiding inbreeding ; **8 max**

(iii) inbreeding depression ;
loss of, fitness / fertility ;
loss of genetic variation ;
loss of alleles ;
loss of heterozygosity / increase in homozygosity ;
increase in, expression of/ homozygous, deleterious recessives ;
increase in 'overdominance' ;
animals normally 'outbreeders' ;
outbreeders affected more than inbreeders ; **6 max**

Total: 20

3 (b) (i) *either*
unpredictable / spontaneous / random change ;

gene mutation – max 4
change in structure of DNA ;
change in base sequence ;
addition / deletion ;
substitution / inversion ;
detail e.g. ref frame shift ;

chromosome mutation – max 4
change in chromosome structure ;
inversion / translocation / duplication / deletion ;
change in number of chromosomes ;
change in number of sets of chromosomes ;
ref. auto / allopolyploidy ;
detail ; **6 max**

(ii)

CF – max 4	*HD – max 4*
recessive allele v.	dominant allele ; (*1 mark*)
autosomal / chromosome 7 ;	autosomal / chromosome 4 ; (*both autosomal = 1*)
deletion ;	stutter /(triplet) repeat ;
triplet missing ;	CAG ;
homozygote recessive has CF ;	heterozygote develops HD ;
heterozygote carrier ;	
2 carriers have 1 in 4 chance of producing CF child / other statement of inheritance ;	heterozygote has 1 in 2 chance of passing allele to child ;
common in Caucasians v.	rare ; (*1 mark*)

8 max

(iii) (most bacteria) reproduce rapidly ;
frequent DNA replication ;
chances for, mutation / mistake / error increased ;
no / fewer, editing enzymes ;
mutation passed to large number of descendents / ref vertical transmission ;
mutation may be on plasmid ;
transferred via horizontal transmission ;
even to different species ;
conjugation / process described ;
transformation / transduction / process described ;
ref selection ; **6 max**

Total: 20