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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Level

MARK SCHEME for the November 2005 question paper

9700 BIOLOGY

9700/06 **Paper 6 (Options), maximum raw mark 40**

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OPTION 1 – MAMMALIAN PHYSIOLOGY

1 (a) May need revising in light of the micrograph obtained

A matrix / lamella

B blood vessel / (Haversian) canal

C osteocyte / lacuna

D Haversian system

One mark for two correct, round up ;; **2**

(b) outside of shaft / ends / at joint / AW ; **1**

(c) (i) (cartilage) no calcium (phosphate) in matrix;

no blood vessels;

has chondrocytes / does not have osteocytes; **2 max**

(ii) cartilage is very smooth ;

reduces friction ;

cartilage protects bone surface ;

prevents it wearing away / prevents roughening ; **2 max**

(d) (i) *as a control / to reduce variables ;* **1**

(ii) bone strength is reduced (when ovaries are removed) ;

Use of figures, e.g. drops by 25% in femur / by 17% in vertebra ; **2**

(iii) ovaries produce oestrogen / no ovaries so no oestrogen ;

numbers of osteoblasts compared to osteoclasts decreases ;

remove e.g. as figs incorrect and alternatives poss. for osteoblasts v osteoclasts

use of figures, e.g. osteoblasts 4 x without ovaries and osteoclasts nearly 7 times with ovaries; **2 max**

(iv) both increase bone strength;

but neither return it to normal (after ovaries removed) / neither completely compensates for loss of ovaries;

there is a greater increase with estren than with oestrogen ;

use of comparative figures ; **3 max**

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2 **(a) (i)** {difference is 138 – 122 = 16

so percentage difference is 16 ÷ 138 x 100 = 11.6% 10.9%}

correct and understandable working ;

answer ; **2**

(ii) glucose does not need digestion but starch does ;

so glucose is more quickly absorbed ;

glucose absorption from starch continues over a longer period than glucose ; **2 max**

(b) insulin secreted when blood glucose rises above normal ;

insulin concentration follows pattern of changes in blood glucose concentration ;

more insulin secreted after 30 minutes (for glucose than rice) because more glucose in blood at that time ;

as blood glucose falls insulin secretion falls ;

reference to negative feedback mechanism ;

use of comparative figures ; **3 max**

(c) insulin binds to receptors on cell surface membranes (of liver cells) ;

increases absorption of glucose (by liver cells) ;

(stimulates) conversion of glucose to glycogen ;

glycogen stored in liver cells ; **3 max**

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3 **(a)** control of body temperature ;

receptors (in hypothalamus) measure blood temperature ;

if too high stimulates neurones of autonomic nervous system ;

controls secretions from pituitary gland ;

neurones (of hypothalamus) secrete, ADH / oxytocin ;

released from (neurone endings in) posterior pituitary ;

neurones (of hypothalamus) secrete, releasing hormones / named releasing hormone (into blood) ;

which affect secretions from anterior pituitary ; **3 max**

(b) **(i)** cerebrum / cerebral hemisphere / occipital lobe ; **1**

(ii) ref generator potential ;

as action potentials in neurones ;

detail of action potential ;

in optic nerve ;

different pathways (in the brain) / parallel processing ;

correct detail about how different information transmitted (e.g. colour, shape, movement) ;; **3 max**

4 **(a)** ethanol dehydrogenase ;

ethanoate / acetate ; **2**

(b) mitochondrion ; **1**

(c) Krebs cycle requires oxidised NAD ;

to pick up hydrogen ;

as a coenzyme for dehydrogenases ; **2 max**

(d) fatty acids not oxidised ;

as little (oxidised) NAD available ;

fatty acids converted to fats ;

stored in liver cells ;

surplus fat converted to LDPs ;

passed from liver into blood to adipose tissue ;

if liver cells damaged excess fat not converted to LDPs ;

therefore accumulates in liver ; **3 max**

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OPTION 2 – MICROBIOLOGY AND BIOTECHNOLOGY

1 (a) (i) air added must be sterile / fermenter must be sealed / add airlock ;

avoids contamination by other microorganisms / contamination costly ;

cooling jacket needed / heater not needed ;

mixer / respiration, produces heat ;

surface area : volume ratio less so less heat lost ;

immobilised microbes ;

reduces loss of microbes / reduces contamination ;

change to continuous culture ;

maintains microbe at, exponential / optimum, growth ;

(greater production) more cost effective ;

AVP ;; (e.g. sparger ; small bubbles forced through culture so all microbes in contact with O_2)

each alteration 1 + explanation max 1 **4**

(ii) Ph / temperature ;

ref. enzyme denaturation ;

oxygen concentration / nutrient / substrate concentration ;

ref. microbe respiration ;

end product concentration ;

ref. inhibition ;

factor 1, explanation 1. **max 2**

(b) (i) $\frac{27+32+28}{3} = 29$ **1**

(ii) 29×10^7 working 1, answer 1 **2**

(iii) 10^{-7} too few colonies to be reliable ;
10^{-5} colonies may overlap / 10^{-6} colonies clearly separated ;
10^{-5} too many colonies to count accurately ; **max 2**

(c) turbidity / haemocytometry ;
dead cells are included in measurement ; **2**

(d) initial, slow increase from point above 0 (lag phase) ;
rapid increase (exponential phase) ;
plateau (stationary phase) ;
decreasing number (death phase) ; **max 2**

[Total: 15]

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2 **(a)** able to survive at high temperatures ;

enzymes with high optimum temperatures / do not denature at high temperatures ; **max 1**

(b) has a high optimum temperature / optimum temperature of 85-90°C ;

works well at pH range of 6-8 ;

cooling of reaction mixture after first stage unnecessary ;

reduction of pH unnecessary ;

saves time / energy ; **max 2**

(c) enzymes can be recovered and used again ;

product will not be contaminated by enzyme ;

enzyme more stable to temperature and pH changes ;

enzyme activity more easily controlled ; **max 2**

(d)

batch	continuous
closed fermenter	open fermenter ;
fixed amount of substrate	substrate added continuously ;
nutrients added at start	
large vessels used	small vessels used ;
product harvested after set period of time / when sufficient product has been made	product harvested continuously ;
less cost-effective	more cost-effective
culture harvested when in stationary phase	culture kept in exponential phase ;

max 3

[Total: 8]

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3 **(a)** **A** conidium / conidiospore ;

B conidiophore ;

C septum / cross wall ;

D hyphal wall ; **2**

(b) wash off conidia / any other feasible method ;

use aseptic conditions, ref. to sterile water, loops, flaming ;

inoculation by loop or spreader ;

spread 0.1 / 0.5 cm^3 ;

nutrient medium containing cadmium ;

ref. to range of cadmium concentrations ;

incubation conditions ;

isolate spores / conidia from any colonies that grow ;

check with Fig. 3.1 that they are *Aspergillus* ; **max 4**

(c) extract metals from low grade ores / treat raw ore before final processing / idea of microbial mining ;

detoxifying wastes ;

use to accumulate precious metals ; **max 2**

[Total: 8]

4 **(a)** increases ;

use of figures / figure calculated from data ; **max 2**

(b) ref. vector / plasmid / viral, DNA ;

ref. Agrobacterium

other method of getting the gene into cells e.g. projectiles / electroporation ;
Accept refs to role of calcium ions / protoplast ; **max 2**

(c) (i) X – so that you know it is the Bt toxin / AW having the effect ;

Y – so you know that the X hybrid is growing normally / AW ; **2**

(ii) Bt cotton reduces the amount of insecticide used ;

BT cotton almost doubles / dramatically increases / Aw, the yield / cost effectiveness ;
Bt toxin / AW is only found in the cells not in the sap ; **max 3**

[Total: 9]

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OPTION 3 – GROWTH, DEVELOPMENT AND REPRODUCTION

1 (a) <u>transcription</u>:

only when gene switched on ;

more RNA = gene, on longer/more active/used more ;

ref. promoter/AW ; **max 3**

(b) (i) activity/mRNA, rises in light and falls in dark in both regimes ;

maximum, activity/mRNA, at end of light period in both ;

decreases in dark in both ;

much more, activity/mRNA, in 16h light ;

higher production at, 8/12/15h, in 16h light ;

comparative figures ; **max 4**

(ii) long day plant ;

more FT mRNA in longer light ; **2**

(ii) phytochrome ;

in leaves ;
two forms/P_R and P_{FR}/P_{660} and P_{730} ;

P_R/P_{660}, absorbs, red/660nm, light and P_{FR}/P_{730}, absorbs, far red/730nm, light ;

absorption of light by one form converts it into the other ;

P_{FR}/P_{730} builds up during daylight ;

P_{FR}/P_{730}, converted into P_R/P_{660} at night ; **max 4**

(ii) daylength more reliable trigger than temperature/humidity ;

ensures plants flower at same time for cross pollination ;

ensures plants flower when pollinators available ;

ensures seeds, produced/dispersed, in optimum conditions ; **max 2**

[Total: 15]

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2 **(a) (i)** sperm trains faster than single sperm ;

at all viscosities ;

single sperm cannot swim at highest viscosity ;

ref. comparative figures ; **max 2**

(ii) sperm reach egg faster ;

sperm able to swim through viscous mucus/AW ;

ref. cervical mucus ;

ref. sperm competition ; **max 3**

(b) (i) acrosome swells ;

acrosome membrane fuses with plasma membrane ;

release of acrosome enzymes ;

digestive/hyaluronidase/esterase ;

digest path through, follicle cells/zona ; **max 3**

(ii) acrosome enzymes digest cell-cell molecules/AW ;

acrosome reaction destroys hooks ;

ref. figures ; **max 1**

(iii) some sperm must be able to fertilise ;

sperm with no acrosome cannot fertilise ; **1**

[Total: 10]

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3 **(a)** flexible filament ;

anther hangs outside flower ;

anther versatile / AW ;

produce light pollen grains ;

pollen, smooth/dry/aerodynamic ; **max 3**

(b) (i) peaks at 1100 on both days ;

comparative figures (44,8) ;

(many) more on day 1 at all times ;

lowest 1700 both days ;

falls to 0 1700 day 2 ; **max 3**

(ii) *62 flies v. 8 flies*

62 – 8 = 54;

54/62 x 100 ;

= 87% **max 2**

[Total: 8]

4 **(a) (i)** time/energy, not wasted seeking mate ;

no wastage of gametes ;

rapid production of large numbers of offspring ;

offspring of well-adapted parent also well adapted ;

(if in wild) effective, dispersal/spread/colonisation ; **max 2**

(ii) no <u>genetic</u> variation ;

other than by mutation ;

which is rare ;

no ability to adapt to changed environment ;

no ability to adapt to 'new' pathogen ; **max 3**

(iii) one released animal could found a population ;

rapid colonisation ;

outcompete native species ;

affect food chain ;

AVP ;; **max 2**

[Total: 7]

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OPTION 4 – APPLICATIONS OF GENETICS

1 (a) initiate heart beat ;

no external nervous stimulation / myogenic ;

control, heart rate / rhythm ;

detail of wave of excitation ;

ref. autonomic nervous system / adrenaline ; **3**

(b) (i) altering natural genotype ;

to treat (genetic) disease ;

by repairing defective gene ;

by replacing defective gene ;

by adding normal gene, leaving defective in place ;

ref. germ cell/somatic cell therapy ; **max 3**

(ii) protein/channel different, shape/3° structure ;

no longer accepts ion/ion no longer fits/receptor site different ;

no longer binds ATP ; **max 2**

(c) (i) normal cells show no activity / treated cells show action potentials ;

resting potential of –75 mV ;

treated cells have, smaller resting potential/resting potential of –60 mV/no stable RP ;

+38/39/40 mV ;

regular / repeated 550/560 ms ; **max 3**

(ii) functioning ion channels in normal cells gives, v. negative/stable, resting potential ;

channels in treated cells inactive ;

cannot transport potassium ions ;

less negative/unstable, resting potential ;

threshold to fire can be reached ; **max 3**

(iii) atrium/ventricle/heart, cells treated *in vitro* (AW) and placed in right atrium ;

cells of right atrium treated *in vivo* (AW) ; **max 1**

[Total: 15]

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2 **(a)** hydrolyse / break down, Ach/transmitter, to allow further transmission across synapse ; **1**

(b) **(i)** resistant Ach-ase slight affected v. susceptible strongly affected/ AW ;

resistant drop from 95% to 75% activity/9.5-7.5 au/susceptible from 90% to 2%/9-0.2 au ;

ref. effect higher concentrations on susceptible ;

ref. to specific concs. of propoxins in dm^{-3} ;

(ii) $\frac{8.5-1.5}{8.5}\times 100$;

= 82.35 / 82.4 (%) ; **2**

(c) mutation ;

chance / random / pre-existing / spontaneous ;

substitution ;

change in a-acid alters shape of active site;

cannot be blocked by Propoxur ;

selective advantage/natural selection ;

Propoxur selective agent ;

resistants survive longer and pass allele to offspring ; **max 4**

[Total: 10]

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3 **(a) (i)** to act as a, gene bank/genetic resource ;

of traits for future selective breeding ;

in changed climate/in case of new pathogen ;

in counteract, inbreeding/loss genetic diversity ;

known but presently unfashionable traits / unknown traits ; **max 3**

(ii) sperm checked for, abnormalities/motility/genetic disease ;

may be sexed / X and Y sperm separated ;

diluted, with extender medium/albumin/citrate buffer ;

frozen, in liquid nitrogen / at –196° C ;

in 'straws'/long thin tubes ; **max 3**

(b) different sires used ;

progeny testing to establish best sires ;

sire chosen to, maintain genetic diversity/minimise inbreeding ;

sperm sexed to guarantee sex of offspring ;

AVP ; **max 2**

[Total: 8]

4 **(a) (i)** idea of interaction of, genes / loci ;

idea effect from dominant allele / recessive allele inactive ; **2**

(ii) *AaBb* white (flowers/petals) and *Aabb* yellow (flowers/petals) ; **1**

(b) *parents* AaBb x aabb and both white ;

gametes AB Ab ab x ab ;

offspring genotypes and phenotypes ;

ratio 3 white ; 1 yellow ; **4**

gametes	AB	Ab	aB	ab
ab	AaBb white	Aabb yellow	aaBb white	aabb white

[Total: 7]

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