**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**

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. This shows the basis on which Examiners were initially instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began. Any substantial changes to the mark scheme that arose from these discussions will be recorded in the published *Report on the Examination*.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

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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**

**2** **(a) (i)** {difference is 138 – 123 = 15 (122 16)

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

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**

| | | | |
| --- | --- | --- | --- |
| **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** |

## 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)** $29 \times 10^7$ 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]**

**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 ; nutrients added at start | substrate added continuously ; |
| 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]**

**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, <u>DNA</u> ;

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]**

## OPTION 3 – GROWTH, DEVELOPMENT AND REPRODUCTION

**1 (a)** transcription:

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]**

**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]**

**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]**

## 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]**

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

**(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]**

**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]**