

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) $\frac{122 - 106}{122} \times 100 = 12.3\%$
{difference is $138 - 123 = 15$ }
so percentage difference is $16 \div 138 \times 100 = 11.6\%$
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**

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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 O₂)
- 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
fixed amount of substrate
nutrients added at start
large vessels used
product harvested after set period
of time / when sufficient product
has been made
less cost-effective
culture harvested when in
stationary phase | open fermenter ;
substrate added continuously ;

small vessels used ;
product harvested continuously ;

more cost-effective
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 cm³ ;
 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) 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]

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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*
 $62 - 8 = 54$;
 $54/62 \times 100$;
 $= 87\%$ 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 genetic 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	<i>AaBb</i> white	<i>Aabb</i> yellow	<i>aaBb</i> white	<i>aabb</i> white

[Total: 7]