



MARKSCHEME

November 2004

BIOLOGY

Higher Level

Paper 3

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General Marking Instructions

Subject Details: Biology HL Paper 3 Markscheme

Mark Allocation

Candidates are required to answer **ALL** questions in each of **TWO** Options (total **[20 marks]**). Maximum total = **[40 marks]**.

General

A markscheme often has more specific points worthy of a mark than the total allows. This is intentional. Do not award more than the maximum marks allowed for part of a question.

When deciding upon alternative answers by candidates to those given in the markscheme, consider the following points:

- ◆ Each marking point has a separate line and the end is signified by means of a semicolon (;).
- ◆ An alternative answer or wording is indicated in the markscheme by a “/”; either wording can be accepted.
- ◆ Words in (...) in the markscheme are not necessary to gain the mark.
- ◆ The order of points does not have to be as written (unless stated otherwise).
- ◆ If the candidate’s answer has the same “meaning” or can be clearly interpreted as being the same as that in the mark scheme then award the mark.
- ◆ Mark positively. Give candidates credit for what they have achieved, and for what they have got correct, rather than penalising them for what they have not achieved or what they have got wrong.
- ◆ Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.
- ◆ Occasionally, a part of a question may require a calculation whose answer is required for subsequent parts. If an error is made in the first part then it should be penalized. However, if the incorrect answer is used correctly in subsequent parts then **follow through** marks should be awarded.
- ◆ Units should always be given where appropriate. Omission of units should only be penalized once. Ignore this, if marks for units are already specified in the markscheme.
- ◆ Do not penalize candidates for errors in significant figures, unless it is specifically referred to in the markscheme.

Option D – Evolution

- D1.** (a) (i) Malawi
(ii) Mauritius [1]
Both needed for [1].
- (b) 40 (± 2) % (*units are not needed*) [1]
- (c) high detection rate combined with high cure rate will slow down spread of TB;
high detection rate combined with high cure rate will have positive effect on the general health of the population;
high cure rate / above 85 % is essential for reducing pool of infectious people;
high detection rate will help prevention of TB / slow down spread of TB; [2 max]
- (d) patients do not complete their prescribed course of anti-TB drug(s);
no medicinal drug is ever 100 % effective in killing the infectious organism;
transfer of plasmids with resistance against these drugs;
(spontaneous) mutations in *M. tuberculosis*;
selective pressure on *M. tuberculosis* favours survival of drug resistance;
natural variation in *M. tuberculosis* favours those bacteria with drug resistance; [3 max]
- D2.** (a) endosymbiosis / endosymbiont theory [1]
- (b) double membrane;
no histones / naked DNA;
circular DNA;
protein synthesis;
small size of the mitochondrial ribosomes;
similar size to bacteria;
reproduction by binary fission / independently; [2 max]

- D3.** (a) ring species;
subspecies may be isolated in niches / minor differences in gene pool / potentially able to interbreed but do not;
some species reproduce asexually / parthenogenesis;
interspecific hybridization / artificial methods / IVF technology;
species definition cannot be applied to bacteria;
species still evolve / cannot be applied to fossils;
difficult to know if geographically separated populations can interbreed;
some individuals are infertile;

[4 max]

- (b) gradualism;
slow, continuous change over a long period of time;
gradual accumulation of (neutral) mutations / variations;

punctuated equilibrium;
long periods of stability followed by sudden changes;
fossil record supports this;
natural selection can be intense and can cause rapid change / evolution;
rapid evolution due to major environmental changes / volcanic eruptions / meteor impact / other example;
only advantageous alleles ultimately survive;

some mutations had no morphological effects so not visible in the fossil record;
rate of evolution could have fluctuated over time;

[6 max]

Award [4 max] if only one idea is discussed.

Option E – Neurobiology and Behaviour

- E1.** (a) (i) 0.75 s (± 0.5) (*unit required*) **[1]**
- (ii) concurrent application of two negative stimuli;
rats afraid of the dark; **[1 max]**
- (b) (i) escape time decreases in both groups;
larger decrease in escape time in group Esc;
1.5 s versus 0.6/0.7 s;
between sessions 1 and 2 only group Esc shows a decrease / EscD constant; **[2 max]**
- (ii) group Esc because it shows consecutive decreases in escape time; **[1]**
- (c) mean escape time for group Esc would (likely) stay the same / 1.2 s (± 0.2) **[1]**
- E2.** (a) I: dorsal root ganglion;
II: grey matter;
III: cell body of motor neurone; **[2 max]**
Three correct [2], two or one correct [1].
- (b) use cranial / pupil reflex;
tests for minimal / basic brain activity / no response indicates brain death; **[2]**
- E3.** (a) allows animal to gain a competitive advantage;
e.g. grizzly bears catching salmon through operant conditioning / other example;
help animal to recognize dangerous situations / toxic food;
e.g. birds learning to avoid brightly coloured caterpillars / other example;
leads to more efficient energy use;
can improve the survival rate of the group / population and thus of the individual;
e.g. warning calls in vervet monkeys / other example;
learning of cooperative behaviour increases chances of survival;
e.g. hunting behaviour of dolphins / other example; **[4 max]**
- (b) unconscious/involuntary control;
antagonistic;
sympathetic system correlates with fight-flight responses / energy generation;
parasympathetic system is correlated with calming effect / emphasis on self-maintenance / return to normal state;
heart:
sympathetic system: heart rate speeds up / more blood is pumped to the muscles;
parasympathetic system: heart rate slows down / less blood is pumped to the muscles;
iris:
sympathetic system: radial muscles contract / pupil is dilated;
parasympathetic system: circular muscles contract / pupil constricts to protect retina; **[6 max]**
*Responses must include reference to both heart and iris to achieve full marks.
Award [5 max] if reference to heart or iris is omitted.*

Option F – Applied Plant and Animal Science

- F1.** (a) $0.29 (\pm 0.01) \mu\text{mol maltose min}^{-1}$ (*units needed*) **[1]**
- (b) no substantial increase in activity in the 20 % treatment over the five days of the experiment / 30 % sample reaches maximum activity two days after start of treatment; higher level of activity at all times for 30 % treatment compared with 20 % treatment; activity approximately six times higher for 30 % treatment than for 20 % treatment on day two;
any other appropriate numerical example; **[2 max]**
- (c) 30 % treatment will have greater amount of free sugars (maltose) than 20 % treatment **[1]**
- (d) water stress will trigger synthesis of proteins / β -amylase;
maltose and other free sugars attract water so will reduce the effect of water stress;
maltose and other free sugars may prevent water loss (by osmosis);
starch exerts less osmotic pressure / solute potential than free sugars;
30 % PEG creates an optimum environment for β -amylase activity; **[2 max]**
- F2.** (a) mass of plant dry weight / wet weight / fresh weight / harvestable biomass;
biomass per unit area of cultivated land;
relative growth rate;
net assimilation rate; **[2 max]**
- (b) CO_2 can limit rate of photosynthesis (at high light intensity and high temperature);
increasing CO_2 concentration increases plant growth (up to a certain point);
increasing CO_2 concentration increases carbon fixation / Calvin cycle; **[2 max]**

- F3.** (a) small piece of plant removed;
tissue is placed on sterile nutrient agar gel containing high auxin concentration;
callus growth / tissue cut into smaller pieces with same treatment;
callus growth / tissue is transferred to agar gel containing cytokinin;
gibberellin is sometimes added;
plantlets are separated and transferred to soil; **[4 max]**
- (b) *Answers must include arguments for and against antibiotics and growth hormone.*
for: [4 max]
increase growth rates / milk production;
antibiotics help control infection;
humans seem not to be affected by eating meat treated / milk containing growth hormones;
eating natural foods containing estrogen compounds has no known adverse effects;
- against: [4 max]*
increase the rate of antibiotic resistance in bacteria;
cause allergy problems in humans;
food may taste different to humans;
hormones may enter the water supply system;
hormones may alter development of children;
hormones may increase the rate of breast cancer;
hormones may cause developmental changes in aquatic organisms;
animals forced to secrete high levels of milk may suffer; **[6 max]**

Option G – Ecology and Conservation

- G1.** (a) proportion of rats in diet decrease with length / inversely proportional / negative correlation **[1]**
- (b) (i) no/little difference **[1]**
Do not award marks to responses just stating values.
- (ii) proportion of rats in diet of females is lower than for males **[1]**
- (c) larger snakes eat larger prey;
feeding frequency can be reduced if larger prey is eaten;
females shift earlier to larger prey to prepare for gestation;
larger snakes move to different habitats;
larger snakes may not be able to catch rats; **[2 max]**
- (d) sample is biased / 22 females versus 13 males, so results not reliable;
small sample size;
no males collected above 400 cm;
time and date of capture not known;
seasonal change in feeding patterns;
smaller males more active in foraging therefore greater chance of capture;
not all snakes had full stomachs at the time of capture / prey availability not known;
some snakes may have been kept in captivity / artificial or forced diet;
larger prey takes longer to digest / rats are digested more quickly;
snakes collected or captured in different habitats; **[2 max]**

- G2.** fish conservation requires accurate data to determine fish quota;
fish migration difficult to monitor;
notification of catches by fishermen often biased as it directly interferes with their income;
fish migration (patterns) influenced by climatic effects (*e.g.* El Niño);
observation and counting of fish / determining fish population is difficult;
tagging / other population estimation techniques are not efficient for very large numbers;
not all nations have ratified international fishing treaties / commercial interests interfere;
fish populations migrate in and out of international waters;

[3 max]

- G3. (a)** *Rhizobium* / nitrogen-fixing bacteria lives in root nodules / symbiotic relationship with legumes;
fixes nitrogen into ammonia;
using energy from ATP;

Azotobacter / nitrogen-fixing bacteria lives free in soil;
fixes nitrogen into ammonia;

Nitrosomonas / nitrifying bacteria converts ammonia to nitrite;

Nitrobacter / nitrifying bacteria converts nitrite to nitrate;

Nitrosomonas and *Nitrobacter* live in well aerated soil / require good supply of oxygen;

Pseudomonas denitrificans / denitrifying bacteria converts nitrate to nitrogen;
nitrate is used as terminal electron acceptor instead of oxygen;
carries this out in low oxygen / badly aerated soil;

[6 max]

*Responses must include at least three types of bacteria to achieve full marks.
Award [0] for responses with just the name of bacterium.*

- (b)** in food webs organisms often occupy two levels / eat at different trophic levels;
some organisms eat prey from different trophic levels;
not all feeding habits of all organisms are known;
feeding habits may vary seasonally / during life cycle;
e.g. chimpanzees feed on fruit, termites and monkeys / other examples;
second example;
as you move up the food chain, less energy is available / only 10–20 % of energy is passed to the next trophic level;
broad diet to ensure adequate energy intake;

[4 max]

Option H – Further Human Physiology

- H1.** (a) $5.3 (\pm 0.3) \text{ pmol dm}^{-3}$ (*unit needed*) **[1]**
- (b) a positive correlation;
no data below $280 \text{ mOsmol kg}^{-1}$; **[1 max]**
- (c) after drinking water, blood plasma / solute concentration decreases;
plasma ADH concentration decreases;
osmoreceptors in the hypothalamus monitor blood solute / blood plasma / plasma concentration;
impulses passed to ADH neurosecretory cells to reduce / limit release of ADH;
drop in ADH decreases the effect of this hormone on the kidneys;
blood solute concentration returns to normal; **[2 max]**
- (d) vomiting / diarrhoea / blood loss;
increase salt intake;
drink alcohol / coffee;
certain drugs / morphine / nicotine / barbiturates;
excess sweating / lack of water intake;
diabetes as it increases glucose in blood; **[2 max]**
- H2.** (a) endopeptidases hydrolyse peptide bonds within polypeptides and exopeptidases do so at the ends of polypeptide chains **[1]**
- (b) pepsin digests proteins;
pepsin could digest cells that secrete it;
pepsinogen is the inactive form of pepsin;
pepsinogen is activated by hydrochloric acid / HCl / pepsinogen is converted into pepsin (active form) by HCl;
different cells in the stomach wall secrete pepsinogen and HCl; **[3 max]**

H3. (a) *Responses must include reference to both steroid and peptide hormones.*

Award [3 max] for:

enter target cells via receptors / pass through plasma / cell membrane;
steroid hormones bind to (receptor) proteins in the cytoplasm;
steroid hormones hormone receptor complexes affect genes;
steroid hormones control activity and development of target cells;

Award [3 max] for:

peptide hormones do not enter cells;
peptide hormones bind to receptors in the plasma membrane;
peptide hormones act via secondary messengers inside the cell;
peptide hormones secondary messenger causes changes in / inhibit enzyme activity; **[4 max]**

(b) microvilli increase the surface of the plasma membrane exposed to the digested food;
increased surface area allows for increased absorption of foods (by diffusion);
lipids are absorbed by simple diffusion;
hydrophilic food substances / *e.g.* fructose are absorbed by facilitated diffusion;
channel proteins help hydrophilic food substances to pass though the hydrophobic core of plasma membrane;
mitochondria produce the ATP required for active transport;
pump proteins in the plasma membrane actively transport glucose / amino acids / mineral ions;
pinocytic vesicles are formed by endocytosis;
each vesicle contain small droplets of fluid from the lumen of the ileum;
membranes from these vesicles originate from plasma membrane;
these vesicles contain channels for facilitated diffusion and pumps for active transport;
digested foods can be absorbed from these vesicles into the cytoplasm; **[6 max]**
