

MARKSCHEME

May 2005

BIOLOGY

Higher Level

Paper 3

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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 markscheme 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. Indicate this with “**ECF**”, error carried forward.
- ◆ Units should always be given where appropriate. Omission of units should only be penalized once. Indicate this by “**U-1**” at the first point it occurs. 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) *H. sapiens* [1]

N.B. answers of (b) to (d) must be answered using data, not option content.

(b) *H. sapiens* dates back 200 000 years in Africa;
the oldest ancestor, *H. ergaster*, originated in Africa;
H. sapiens evolved from *H. rhodesiensis*, *H. antecessor/mauritanicus* and *H. ergaster*,
all in Africa; [2 max]

(c) *H. sapiens* exists today, *H neanderthalensis* does not;
they co-existed in Europe;
they co-existed for about 50 000 years;
H. neanderthalensis preceded *H. sapiens*;
H. sapiens did not evolve from *H neanderthalensis*;
both evolved from an African species, *H. antecessor/mauritanicus*; [2 max]

(d) *H. erectus* because it lived longer (1.5 million years compared to 700 000 years for
H. antecessor/mauritanicus);
H. erectus because it lived more recently;
cannot say since climate during period of either species unknown;
cannot say since population size of either species unknown;
H. erectus (existed for a longer period) so may have had a greater absolute
number of individuals therefore chance of fossilization is also greater; [2 max]

D2. (a) rocks ^{40}K / K^{40} / potassium 40 and fossils ^{14}C / C^{14} / carbon 14 [1]

(b) the amount of time taken for the radioactivity to decay to half its original level; [1]

Award [1] for any two of the following

(c) petrification / sedimentation / mineralization / preservation in tar / peat / amber / ice; [1]

D3. (a) RNA self-replicates RNA self-replication has been shown experimentally;
RNA thought to have served as first genes not DNA;
because DNA → RNA → protein mechanism too complicated to evolve all at once;
it can act as an enzyme / called a ribozyme / RNA has catalytic properties;
(recently discovered that) RNA can catalyze formation of more RNA (e.g. rRNA / tRNA / mRNA);
RNA can bind amino acids for formation of peptide linkages;
and form enzymes to help RNA replicate;
RNA can also be transcribed into DNA (using reverse transcriptase);

[6 max]

(b) natural selective pressures result in survival of advantageous alleles;
frequency of these alleles will increase through reproduction;
these alleles spread through population;
basis for microevolution;
over time many advantageous genes accumulate in a species;
when many changes occur some members of a species cannot successfully mate with others / reproductive isolation;
results in evolution of a new species;

[4 max]

Option E — Neurobiology and Behavior

- E1.** (a) all fly north / northeast / toward equator **[1]**
- (b) bird 1;
flew shortest distance between release site and island home;
least deviations in flight path;
reached home before all others;
arrived home between 15-16 hours; **[2 max]**
- (c) (i) 28 (± 5) km hr⁻¹ (*units needed*) **[1]**
- (ii) bird 2 appears to be faster / travels further in the same time;
bird 1 appears to be slower / travels less distance than bird 2 in same time; **[1 max]**
- (d) use their sense of smell;
using wind direction;
other land birds; **[1 max]**
- E2.** (a) (i) transform energy;
convert various types of stimuli into electrochemical energy; **[1 max]**
- (ii) *Award [1] for any two of the following.*
mechano (proprio);
chemo;
thermo;
photoreceptors; **[1 max]**
- (b) subconscious/involuntary control of heart / breathing rate / blood vessels / digestive system / smooth muscle / control of involuntary body functions; **[1]**
- (c) taxis is movement toward (positive) or away from (negative) a stimulus / directional stimulus and kinesis is random movement in response to a stimulus; **[1]**

- E3.** (a) provides objective data rather than opinion / greater accuracy;
allows graphical representation of data;
allows for statistical analysis / average values (so anomalies less significant);
enables comparative study;
can be used to support/refute an hypothesis / draw reliable conclusion;
can generate new questions for research;
permits the analysis of absolute data (*e.g.* presence or absence of certain substance);
establishes frequency of behaviour;

[4 max]

- (b) block/decrease synaptic transmission;
can be inhibitory to brain;
examples are benzodiazepines / cannabis / alcohol;
benzodiazepines increase effect of inhibitory neurotransmitter GABA;
causing less transfer of information to the brain;
cannabis can block cannabinoid receptors in the brain stopping transmission;
alcohol enhances effect of inhibitory neurotransmitter GABA;
also decreases activity of glutamate, an excitatory neurotransmitter;
use of psychoactive drugs can lead to dependence on them;

[6 max]

Option F — Applied Plant and Animal Science

- F1.** (a) *Vitellaria paradoxa* [1]
- (b) construction [1]
- (c) 3 species / *A. digitata*, *P. biglobosa*, *V. doniana* “very important” in both categories; 10 species ranked “very important” for edible fruits and 7 species for vegetable sauce; overall the 20 tree species were slightly more valuable for edible fruits than for vegetable sauce;
Ximenia africana more useful as edible fruit but not as vegetable sauce / *vice versa* for *Bombax costatum*;
in both categories there were no “do not know” responses; [2 max]
- (d) $\frac{3}{20} \times 100 = 15\%$ [1]
Do not need to show working.
- (e) strength;
resistance to insect attack *e.g.* termites;
attractiveness;
resistant to decay;
flexible;
not too heavy;
easy to cut;
tradition; [1 max]
- F2.** (a) large / colorful petals;
petals release scent;
nectaries secrete nectar;
sticky pollen grains;
sturdy filaments to hold anthers in position when brushed; [2 max]
- (b) net increase in plant biomass per unit area of leaf per unit time [1]
- (c) it will not flower/bloom [1]

- F3.** (a) named animal and name/description of gene transferred;
role of named animal after gene transfer;
specific advantage / purpose of transgenic technique in chosen example;

Award [3 max] for one example. e.g.

salmon are given a foreign growth hormone gene;
which makes them grow in one year what normally takes two or three years;
fish production increases leading to an increase in income;

cows clone to have casein transgene;
transgene leads to milk with high levels of casein;
casein is major protein in milk for nutritional value;

cows cloned to have lysostaphin transgene;
transgene leads to production of milk with lysostaphin protein;
lysostaphin provides protection against mastitis in cows;
mastitis is caused by a bacteria which destroys milk-secreting cells in cows;
mastitis reduces milk production in cows;

cows cloned to have myelin basic protein (MBP) transgene;
transgene leads to production of milk with large amounts of MBP;
MBP in milk thought to help sufferers of multiple sclerosis (MS);

[3 max]

Award other accurate specific examples.

- (b) *positive aspects:*
monoculture involves planting and raising only one type of crop;
however, crop selection dependent on local climate, soil and amount of land;
one crop allows for one type of harvesting technique;
predictable harvest time;
requires less variety of equipment/less expense in harvesting;
specialization allows for greater overall efficiency;
resulting in more profit per unit of biomass/per unit of land;
farmer can choose the crop that seems to be the most profitable;
pesticides / fungicides / herbicides must be applied at correct time;

negative aspects:

monoculture often requires use of fertilizers;
fertilizers are expensive / contaminate;
pesticides are often required to protect crop against specific insects;
single type of crop can be eliminated by disease;
farmers with one crop are more vulnerable to price changes on domestic/world markets;

genetic variability of crop has been compromised;

[7 max]

For full marks answer must include at least one positive aspect and one negative aspect. Award [6 max] if only one aspect presented.

Option G — Ecology and Conservation

- G1.** (a) NY / urban **[1]**
- (b) 37 (± 1):16 (± 1) / 2.3:1 (± 0.1) **[1]**
Do not need to show working. Accept percentages.
- (c) shoot biomass is always greater than root biomass in all three years;
 shoot biomass was greatest for rural and urban sites in the first year;
 root biomass was greatest for rural and urban sites in last year;
 second year shows lowest increase in shoot and root biomass for rural and urban sites / first and third years with greatest increase;
 HV rural site had greater shoot and root biomass than LI site in first and third years;
 urban site always has the highest biomass / greatest shoot / root biomass; **[3 max]**
- (d) some bacteria (*e.g.* Nitrobacter) can convert NO_2 from car emissions into NO_3^- (nitrates) which can be used by plants;
 more predation / herbivores / plagues in rural areas;
 no information given of the location of one compared to the other / of the types of pollution;
 extra care given (fertilizer / insecticides) by urban residents; **[1 max]**
- G2.** (a) (i) *Award [1] for name and factor but accept only examples of recent extinctions within the last 4,000-5,000 years.*
e.g. Miss Waldron’s red colobus monkey, habitat destruction / hunting;
 Tasmanian Tiger/Wolf (*do not accept Tasmanian Devil*) due to habit loss / hunting / competition with other animals;
 Dusky Seaside Sparrow, habitat fragmentation / habitat degradation;
 Guam Flycatcher, introduction Brown Tree Snake; **[1 max]**
- (ii) *Award [1] for any two of the following.*
 captive breeding of animals/zoos;
 botanic gardens;
 seed banks; **[1 max]**
- (b) *Award [1] for any two of the following.*
 ammonium ions in soil;
 nitrite ions in soil;
 aerated soils / abundant supplies of oxygen;
 high humidity;
 high temperature; **[1 max]**
- (c) methane / ethanol **[1]**

- G3.** (a) limits plant (tree) growth / kills plants (trees);
by making soil less fertile;
trees show premature leaf fall / dieback of branches / wax cuticle destroyed so
infections/disease can enter;
low pH of water can kill most aquatic organisms;
preventing eggs from hatching;
preventing young fish from developing normally;
destroys shells of animals;
acid rain leaches aluminium from soil, damaging/killing aquatic organisms; **[4 max]**
- (b) nitrogen-fixing bacteria in pioneer plants/lichen can introduce nitrate to soil;
taller plants provide shelter from lower temperatures/frost;
humus resulting from pioneer plants / lichens adds organic matter to soil;
increased soil structure enables soil to retain moisture;
enabling new species to grow;
new species contribute more nitrogen to soil;
leaves and fallen trees can acidify alkaline soils;
low acid and higher nitrate levels in soil allow another species (spruce) to grow;
larger trees with deeper root systems can reduce soil erosion;
acid secretion of lichens help break down rock;
presence of plants lead to greater recycling of nutrients (fundamental in phosphorous
cycle); **[6 max]**

Option H — Human Physiology

- H1.** (a) (i) $0.25 (\pm 0.05) \mu\text{mol dm}^{-3} \text{ min}^{-1}$ (*units needed*)
or
 $15.0 (\pm 1.0) \mu\text{mol dm}^{-3} \text{ h}^{-1}$ **[1]**
- (ii) $215 (\pm 15) \text{ min}$ **[1]**
- (b) β -carotene and lycopene concentrations high initially;
 β -carotene and lycopene concentrations decrease steadily / all three decrease;
lutein concentration initially increases slightly;
lutein concentration relatively constant for first 120 minutes;
lutein concentration decreases after 120 minutes; **[2 max]**
- (c) removal of carotenoids by absorption in duodenum is balanced by new additions from stomach;
cannot be broken down by small intestine enzymes/no enzyme to digest lycopene;
higher pH stabilizes the compound / acidic conditions of stomach favour its absorption while neutral / basic conditions of the small intestine favour the reverse / digested well in stomach but not in small intestine;
break down products of β -carotene and lutein stabilize lycopene in small intestine; **[1 max]**
- H2.** (a) (i) estrogen / progesterone / testosterone / aldosterone / cortisol / *etc.* **[1]**
- (ii) ADH (vasopressin) / TRH / TSH / insulin/GH / FSH / LH / prolactin / HCG / oxytocin / glucagons / gastrin / secretin / *etc.* **[1]**
- (b) secretory cells arranged in layer one cell thick;
cells contain secretory vesicles;
cells are grouped in acini;
surrounded by basement membrane;
cells adjacent to duct/lumen; **[3 max]**

- H3.** (a) produced in liver;
by hepatic cells/hepatocytes;
because of stimulation by secretin;
released into ducts /canaliculi;
flows into hepatic / bile common duct;
stored in gall bladder;
travels down common / bile duct;
enters duodenum/small intestine where duct joins;
release triggered by cholecystokinin;

[4 max]

- (b) oxygen dissociation curves describe saturation of hemoglobin by oxygen;
over a narrow range of partial pressure of oxygen;
which typifies oxygen pressures surrounding cells under normal metabolism;
increased metabolism results in greater release of CO₂ into blood;

CO₂ lowers pH of blood;

increased acidity shifts oxygen dissociation curve to right;

results in release of oxygen from hemoglobin;

at the same partial pressure of oxygen;

ensuring that respiring tissues have enough oxygen;

when their need for oxygen is greatest;

also, saturation of hemoglobin occurs at higher partial pressures of oxygen;

so that it can release oxygen at higher partial pressures;

Credit may be given to a suitably annotated diagram.

N.B. *The Bohr shift only occurs in tissues.*

[6 max]
