



# **MARKSCHEME**

**May 2010**

**BIOLOGY**

**Higher Level**

**Paper 3**

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## Subject Details Biology HL Paper 3 Markscheme

### Mark Allocation

Candidates are required to answer questions from **TWO** of the Options [**2 × 20 marks**].

Maximum total = [**40 marks**]

1. A markscheme often has more marking points than the total allows. This is intentional. Do **not** award more than the maximum marks allowed for part of a question.
2. Each marking point has a separate line and the end is signified by means of a semicolon (;).
3. An alternative answer or wording is indicated in the markscheme by a slash (/). Either wording can be accepted.
4. Words in brackets ( ) in the markscheme are not necessary to gain the mark.
5. Words that are underlined are essential for the mark.
6. The order of marking points does not have to be as in the markscheme, unless stated otherwise.
7. If the candidate's answer has the same "meaning" or can be clearly interpreted as being of equivalent significance, detail and validity as that in the markscheme then award the mark. Where this point is considered to be particularly relevant in a question it is emphasized by writing **OWTTE** (or words to that effect).
8. Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.
9. Occasionally, a part of a question may require an answer that is required for subsequent marking points. If an error is made in the first marking point then it should be penalized. However, if the incorrect answer is used correctly in subsequent marking points then **follow through** marks should be awarded. Indicate this with **ECF** (error carried forward).
10. Only consider units at the end of a calculation. Unless directed otherwise in the markscheme, unit errors should only be penalized once in the paper. Indicate this by writing **-1(U)** at the first point it occurs and **U** on the cover page.

**Option D — Evolution**

- D1.** (a) as latitude increases so does wing size / direct relationship / positive correlation  
*Do not accept directly proportional as line does not pass through the origin.* [1]
- (b) (i) at higher latitudes/above 45° European species have larger wings than American species/largest wing sizes seen in European flies;  
 European flies show more variation than American flies (steeper curve);  
 at lower latitudes/below 45° North American flies have larger wings than European species;  
 South American flies have smaller wing size than European/N. American flies; [2 max]
- (ii) American species show less variation because they have had less time to diverge / evolve;  
 size of American flies closer to that of flies recently introduced/founder effect / European founder population from low latitudes;  
 American flies exposed to different selective pressures; [1 max]
- (c) isolated populations diverge (genetically) / separation of gene pools;  
 may become a new species / allopatric speciation;  
 wing size will follow same trend as in Europe as population spreads (to higher latitudes because larger size favored by higher latitudes/colder climate);  
 wing size may stay small due to smaller gene pool/different climate; [2 max]
- D2.** (a) self-replicating and catalytic activities of RNA;  
 short sequences of RNA have been able to duplicate/copy other RNA molecules accurately;  
 RNA enzyme/ribozyme (able to synthesize other molecules);  
 3-dimensional structure of ribosome catalytic sites (for peptide formation) are composed of RNA;  
 able to store information in sequence of (4) nucleotides (similar to DNA); [2 max]
- (b) all living organisms use DNA as genetic/hereditary material;  
 genetic code is (almost) universal;  
 idea that mutations accumulate gradually in DNA; [2 max]
- (c) A is most similar to B;  
 A is equally similar to C and D;  
 A is least similar to both C and D; [2 max]
- (d) methods used to prepare cladograms use a different approach from traditional classification/taxonomy;  
 show ancestral relationships;  
 reflect how recently two groups shared a common ancestry;  
 cladograms are (objective/accurate because they are usually) based on molecular differences;  
 they should be considered as a good complement to traditional classification; [2 max]

- D3.** cultural evolution based on skills / information passed from one generation to another;  
new methods can be transmitted between different groups;  
cultural evolution is learned/taught/language dependent;  
large brains of *Homo* species allow more learning;  
cultural evolution allows more rapid evolution / most recent changes are cultural;  
genetic evolution is dependent on/controlled by genes;  
genetic evolution is limited by the genetic composition/genotypes of the populations;  
*e.g.* of human genetic evolution (such as increase in cranial capacity);  
*e.g.* of human cultural evolution (such as tool making/religion/art);

**[6 max]**

**Option E — Neurobiology and behaviour**

- E1.** (a) downwind approach distance increases with increasing nest-feeder distances / the closer the feeder to the nest the shorter the downwind approach distance / direct/positive relationship [1]
- (b) feeder at 5 m has smaller downwind approach distances than feeder at 60 m / *vice versa*;  
 feeder at 5 m has peak frequency at 50 % whereas at 60 m peak/plateau at 20 %;  
 narrower range of approach distances for 5 m while wider range of approach distances for 60 m;  
 feeder at 5 m has peak approach distance at 1 m downwind while feeder at 60 m has peak/plateau 4 m – 4.5 m; [3 max]
- (c) difficulty handling ants / size of ants;  
 variation of wind;  
 other odours;  
 path of trail not easy to measure accurately; [1 max]  
*Accept any other reasonable suggestions.*
- (d) *EITHER*  
 innate behaviour / taxis;  
 because all walking at same angle to constant wind / all turn and follow odour trail when they detect smell;  
*OR*  
 learned behaviour;  
 because of repetition/training / following other ants; [2]
- E2.** (a) I. cornea;  
 II. lens;  
 III. vitreous humour;  
 IV. choroid; [2 max]  
*Two correct for [1] and four correct for [2].*
- (b) both retinas receive information/stimuli from left and right fields of vision;  
 left and right optic nerves cross in optic chiasma;  
 neurons from both eyes carrying impulses from left field of view go to right hemisphere / *vice versa* / right field of vision is processed in left side of brain / *vice versa*;  
 neurones from the optic nerve synapse (in the lateral geniculate nucleus) with neurones to the (primary) visual cortex;  
 allowing brain to have perception of depth, distances and sizes; [3 max]  
*Accept any of these points made on an annotated diagram.*
- (c) *Excitatory drug*: amphetamines/nicotine/caffeine;  
*Inhibitory drug*: alcohol/benzodiazepines/THC;  
 (no brand names accepted, do not accept marijuana / heroin/other opiates) [2]

- E3.** it is a legal/medical definition of death;  
some cases of coma are irreversible / some cases of coma may recover;  
damage in the medulla (oblongata) is generally permanent;  
doctors have to diagnose damage to decide treatment;  
use tests of brain stem function to decide whether to preserve patient's life / without  
brain stem function life cannot continue;  
test pupil reflex / shine light into eye;  
if pupils do not constrict with light this suggests brain death;  
more than one test used to diagnose brain death;  
no response to pain or cranial reflexes;  
legal/ethical definition needed for organ donation / long term use of life-support  
machines may be inappropriate / bioethical considerations;

*[6 max]*

**Option F — Microbes and biotechnology**

**F1.** (a) 28 hours after untreated sewage added (*Allow answers in range 27–29 hours*) [1]

(b) (i) sunlight reduces counts of fecal coliform bacteria significantly;  
fecal coliform bacteria fall below 1 count per 100 ml on day 2;  
no reduction during dark period;  
significant drop on day 1 / bacteria count drops from  $10^5$  per 100 ml to less than  $10^2$  per 100 ml on day 1; [2 max]

(ii) sunlight causes small reduction of coliphage viruses;  
coliphage virus counts never fall below  $10^2$  counts per 100 ml;  
no reduction during dark period; [2 max]

(c) coliphage viruses because they are less affected by the sun / numbers do not decrease much in two days [1]

(d) water becomes deoxygenated (killing organisms);  
cause eutrophication;  
odours;  
spread of diseases/pathogens; [1 max]

**F2.** (a) (i) organism that uses energy from chemical reactions to generate ATP and obtains organic compounds from other organisms; [1]

(ii) *e.g. Clostridium/Lactobacillus/name of a pathogenic bacterium;*  
*Allow any correct example.* [1]

(b)

<i>Endotoxins</i>	<i>Exotoxins</i>
toxin is present in outer membrane	toxin released ;
(toxin is a) Lipopolysaccharide	protein;
less toxic/cause fever	very toxic/fatal;
localized effect/not mobile	cause damage away from area of infection/mobile;

[2]

*Award [1] for each pair.*

(c) antibiotics interfere with some aspects of microbial metabolism;  
inhibits (enzymes in) formation of bacterial cell wall (cross-links);  
*e.g. penicillin;*  
inhibition of protein synthesis / binds to bacterial ribosomes;  
*e.g. streptomycin/erythromycin/tetracycline;*  
inhibition of synthesis of nucleic acids;  
*e.g. rifampicin;* [3 max]  
*Award [2 max] if no example linked to correct mechanism provided. Mark for name of antibiotic can only be awarded if it is linked to the correct mechanism.*



**F3.** somatic cell therapy methods alter the genetic material of somatic cells/non-gametes;  
could cure the individual treated but disease can still be passed to offspring;  
germ-line therapy methods alter the genetic material of sex-cells/gametes/sperm/eggs;  
disease would be absent in future offspring;  
retroviruses/viruses are used (as vectors);  
to insert (normal) gene/allele (in host cells);  
verified application, *e.g.* treatment of SCID (severe combined immunodeficiency);  
no fully successful cases since relatively new / technical issues need to be solved  
*e.g.* ensure correct amount of gene product/at the right time/in the right place;  
cases of gene therapy causing cancer in patients / infect healthy cells causing  
illness / harm other cell functions / *e.g.* (two) children treated for SCID developed  
leukaemia;  
immune system may attack newly introduced viruses causing  
inflammation/toxicity/organ failure;

**[6 max]**

**Option G — Ecology and conservation**

- G1.** (a) arsenic accumulates in leaves;  
 arsenic concentration (in leaves) increases rapidly in the first 7 weeks;  
 arsenic (in leaves) increases from 0 to approximately  $6000 \text{ mg kg}^{-1}$  at 7 weeks;  
 maximum arsenic level (in leaves) is about  $7500 \text{ mg kg}^{-1}$  at end of experiment / valid numerical example;  
 after week 7 arsenic concentration in plant increases more slowly/begins to plateau;  
 arsenic concentration in roots remains relatively unchanged throughout the experiment; **[3 max]**  
*(Accept range of 7–10 weeks in all of above points)*
- (b) (i) 77 weeks *(Allow answers in range 70 – 80 weeks)* **[1]**
- (ii) Chinese brake fern could be used to remove arsenic from soil;  
 after 20 weeks about 25 % of soil arsenic removed by fern;  
 arsenic concentration increases (rapidly) in fern (tissue) in 20 weeks;  
 eventually/longer periods may reach toxic levels for plant; **[2 max]**
- (c) plants may become toxic for consumers;  
 arsenic may accumulate in the food chain / biomagnification; **[1 max]**
- G2.** (a) tertiary consumer / fourth trophic level **[1]**
- (b) capture – mark – release – recapture method;  
 marked unit area;  
 apply a paint spot/ear tag/leg ring/radio transmitter to the captured rabbits;  
 sufficient time must elapse to allow mixing of population to occur;  
 second capture must be from same marked area;  
 calculate the Lincoln index / population size =  $\frac{n_1 \times n_2}{n_3}$  ;  
 $n_1$ =first capture,  $n_2$ = second capture,  $n_3$ = number marked in second capture; **[4 max]**
- (c)  $N$  = total number of organisms of all species found;  
 $n$  = number of individuals of a particular species/per species; **[2]**

- G3.** indicator species sensitive to/need specific environmental conditions to survive;  
monitor population size of indicator species over time;  
biotic index can be calculated;  
low overall score when abundance of tolerant species / lack of indicator species / *vice versa*;  
represent summation of factors/overall assessment of environmental conditions;  
time consuming / species not easy to identify (need keys) / species may not be present for other reasons such as season / another disadvantage;  
methodology is simple / minimum equipment needed;  
needs a reference study/guide to compare;  
example of variable *e.g.* oxygen level / temperature / heavy metals / sulphur dioxide in air / other;  
example of appropriate indicator species *e.g.* *Tubifex* to heavy metals / *Chironomis* to low oxygen levels / lichens to sulphur dioxide / other;

**[6 max]**

**Option H — Further human physiology**

**H1.** (a) both  $P_{O_2}$  and  $P_{CO_2}$  fall with increasing altitude;  
 above certain altitude there is little change in alveolar  $P_{O_2}$  /  $P_{O_2}$  remains close to 37 mmHg over a wide range of altitudes;  
 $P_{CO_2}$  changes over the entire range of altitudes;  
 the  $P_{O_2}$  is always higher than  $P_{CO_2}$ ; [2 max]

(b) the rate of ventilation would increase;  
 expelling large quantity of  $CO_2$  / causing fall in blood  $CO_2/P_{CO_2}$ ;  
 rise in blood pH hampers ventilation/inhibits chemoreceptors; [2 max]

(c) (i)  $\left(\frac{32.5}{40} \times 100\right) = 81.3\%$  (Allow answers in the range 81–81.5%) [1]

(ii) low partial pressure/level of carbon dioxide in the air;  
 hyperventilation/high rate of ventilation; [1 max]

(d) high lung capacity;  
 larger tidal volumes;  
 high proportion of hemoglobin / high red blood cell count;  
 hemoglobin with higher affinity for oxygen; [1 max]

**H2.** (a) (i) chemical messengers secreted by endocrine glands/specialized cells directly into the blood/body fluid (and transported to specific target cells); [1]

(ii) steroid hormone *e.g.* testosterone / peptide/protein hormone *e.g.* insulin / tyrosine derivatives *e.g.* thyroxine; [1]

(b)

<i>Gastric juice</i>	<i>Pancreatic juice</i>
produced by glands in stomach wall	produced by pancreas;
low pH / acidic	high pH / alkaline;
contains hydrochloric acid	contains $HCO_3^-$ ;
pepsinogen	trypsinogen;
no enzymes for lipid/starch digestion	lipase/amylase;
contains mucus	no mucus;
both contain protease;	

[3 max]

*Award [1] for each pair.*

(c) cellulose / lignin;  
 cellulase not present / no enzymes for digesting lignin; [2]  
*Accept any other reasonable substance.*

- H3.** SA node is located in the wall of right atrium of heart muscle;  
has characteristics of both nerve and muscle tissue;  
SA node initiates each impulse;  
acts as pacemaker of the heart;  
no nerve impulses needed for contraction / myogenic;  
connected to nerves which slow/accelerate heart rate;  
impulses spread out in all directions through walls of atria;  
stimulates atrial systole/contraction;  
fibres in walls of atria prevent impulses from reaching ventricles;  
impulses reach AV node (after atrial contraction);

*[6 max]*

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