



# **MARKSCHEME**

**November 2010**

**BIOLOGY**

**Standard Level**

**Paper 3**

1. Follow the markscheme provided, award only whole marks and mark only in **RED**.
2. Where a mark is awarded, a tick/check (✓) **must** be placed in the text at the **precise point** where it becomes clear that the candidate deserves the mark. **One tick to be shown for each mark awarded.**
3. Sometimes, careful consideration is required to decide whether or not to award a mark. In these cases write a brief annotation to explain your decision. You are encouraged to write comments where it helps clarity, especially for moderation and re-marking. It should be remembered that the script may be returned to the candidate.
4. Unexplained symbols or personal codes/notations are unacceptable.
5. Record marks in the right-hand margin against each mark allocation shown in square brackets *e.g.* [2]. The total mark for a question must equal the number of ticks for the question.
6. Do **not** circle sub-totals. **Circle the total mark** for the question in the right-hand margin **at the end of the question.**
7. Where an answer to a part question is worth no marks, put a zero in the right-hand margin next to the square bracket.
8. Where work is submitted on additional sheets the marks awarded should be shown as ticks and a note made to show that these marks have been transferred to the appropriate square bracket in the body of the script.
9. For each Option: Add the totals for each question in the Option and write it in the Examiner column on the cover sheet.  
Total: Add the marks awarded and enter this in the box marked TOTAL in the Examiner column on the cover sheet.
10. After entering the marks on the cover sheet check your addition to ensure that you have not made an error. Check also that you have transferred the marks correctly to the cover sheet. **All scripts are checked and a note of all clerical errors will be given in feedback to examiners.**
11. If an answer extends over more than one page and no marks have been awarded on a section draw a diagonal line through that section to indicate that it has been marked.
12. If a candidate has attempted more than the required number of questions within a paper or section of a paper, mark all the answers and use the marks of those answers that have the highest mark, **unless the candidate has indicated the question(s) to be marked on the cover sheet.**
13. A mark should not be awarded where there is contradiction within an answer. Make a comment to this effect in the left-hand margin.

## Subject Details: Biology SL Paper 3 Markscheme

### Mark Allocation

Candidates are required to answer questions from **TWO** of the Options [**2 % 18 marks**].

Maximum total = [**36 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 A — Human nutrition and health**

- A1. (a) *with vitamin D*: (from 0.0 to)  $1.7\ \mu\text{mol}$   $\left\{ \begin{array}{l} \text{(units required – allow answers in} \\ \text{the range of } 1.65 \text{ to } 1.75\ \mu\text{mol)} \end{array} \right.$
- without vitamin D*: (from 0.0 to)  $1.1\ \mu\text{mol}$   $\left\{ \begin{array}{l} \text{(units required – allow answers in} \\ \text{the range of } 1.05 \text{ to } 1.15\ \mu\text{mol)} \end{array} \right.$  **[1]**

*Both needed to award the mark.*

- (b) both increase with time;  
 normal mice have a greater increase in blood calcium levels than mutant mice (after ten minutes);  
 normal mice have a maximum change of  $1.1\ \mu\text{mol}$  while mutant mice have a maximum change of  $0.6\ \mu\text{mol}$ ;  
 mutant mice show gradual increase while normal mice show rapid increase followed by a plateau; **[2 max]**

- (c) mice with low calcium diets have a greater increase in blood calcium levels (after calcium administration) because their body absorbs more calcium;  
 if they have had a high calcium diet they do not need to absorb so much calcium / *vice versa*;  
 probably receptors are all occupied/inhibited / less receptors; **[2 max]**

- (d) hypothesis supported as blood calcium levels increased in mutant mice after intake of calcium (graph A);  
 but less than in normal mice / perhaps not enough to cure disease/rickets;  
 administering vitamin D also shows an increase in blood calcium levels (graph A);  
 but no good administering vitamin D as the receptor is defective;  
 in a high calcium diet, less absorption occurs (graph B), so might not be the solution;  
 should have tested mutant mice with different diets; **[2 max]**

- A2.** (a) (i) causes sensation of being full/having eaten too much (when receives messages);  
stimulated by hormones (insulin, CCK) produced by pancreas/small intestine after eating;  
stretch receptors in stomach after eating;  
hormones (leptin) produced by adipose tissue in response to fat storage;  
send message to appetite control centre in brain;

[3 max]

- (ii) BMI of  $16 \text{ (kg m}^{-2}\text{)}$  is underweight so there is a health risk;  
underweight so may be taking in insufficient nutrients;

[1 max]

(b)

<i>Component</i>	<i>Human milk</i>	<i>Artificial milk</i>
<i>sugar</i>	<i>lactose</i>	lactose / glucose;
<i>protein</i>	human whey / casein / albumin / human milk protein;	<i>soya protein</i>
<i>antibodies</i>	<i>present</i>	absent/not present;

[3]

- A3.** food miles are a measure of how far food is transported to consumption site;  
high food miles cause pollution/greenhouse gas emissions/increased fuel consumption for transport;  
traffic congestion / road damage;  
allows continuity of supply / increase in choice;  
maintenance of subsistence crop production (in undeveloped/developing countries);  
high food miles do not support local communities;  
food may not be as fresh as local produce / use more preservatives;

[4 max]

**Option B — Physiology of exercise**

- B1.** (a) positive/direct correlation / as mitochondrial concentration increases so does HAD activity [1]
- (b) fur seal has greater mitochondrial concentration / *vice versa*;  
fur seal has greater HAD activity / *vice versa*;  
lowest value of HAD for fur seal equal to/slightly above highest sea lion value/  
no overlap of data points; [2 max]
- (c) swimming muscle has a greater mitochondrial concentration than non-swimming muscle;  
the range in HAD activity is similar in both / non-swimming has slightly larger range;  
mitochondrial concentration overlaps in the middle range of values / low mitochondrial concentration only in non-swimming muscle / highest mitochondrial concentration only in swimming muscle; [2]
- (d) more mitochondria means more aerobic respiration;  
more mitochondria in swimming muscles;  
products of fatty acid oxidation could be used in respiration (so hypothesis could be supported);  
increase in HAD activity would mean an increase in fatty acid oxidation;  
little/no increase in HAD activity in swimming muscles (so hypothesis not supported);  
during diving low oxygen/hypoxic conditions so high HAD activity/  
mitochondrial concentration allows aerobic metabolism to continue; [3 max]
- B2.** (a) I. thick filament / myosin;  
II. Z line;  
III. A/dark band; [3]
- (b) vital capacity may increase slightly/appears to be unaffected by training; [1]  
*Do not award the mark for increase that is unqualified.*
- B3.** (a) moderate-intensity exercise stimulates development (in size) of slow muscle fibres whilst high-intensity exercise stimulates development (in size) of fast muscle fibres;  
both decrease heart rate at rest; [2]
- (b) *benefits:*  
more red blood cells after transfusion so more transport of oxygen by hemoglobin;  
enhances endurance; OWTTE  
*risks:*  
foreign blood could cause rejection / own blood banks to avoid rejection/  
disease transmission;  
excess of red blood cells causes clots;  
bigger volume of blood increases blood pressure;  
unethical/unfair advantage to athlete results in banning/disqualification; [4 max]  
*To award [4 max] at least one risk and one benefit must be addressed.*

**Option C — Cells and energy**

- C1.** (a) *without inhibitor:*  $5.2 \mu\text{mol min}^{-1} \text{mg}^{-1}$  (*units required*)  
*with inhibitor:*  $1.4 \mu\text{mol min}^{-1} \text{mg}^{-1}$  (*units required*) [1]  
*Both needed to award the mark.*
- (b) wild-type enzyme has greater activity than the mutant enzymes [1]
- (c) inhibitor is similar in shape/structure to malonyl-ACP which is a substrate of the reaction;  
inhibitor is competing for the active site / competitive inhibition;  
attaches to active site and does not let reaction occur;  
if more substrate is added then the inhibition will be less; [3 max]
- (d) activity of mutant enzymes without the inhibitor is always lower than wild-type;  
activity of mutant enzymes with the inhibitor is always less than without;  
but the differences are not as great as in the wild-type enzyme / the mutant enzymes were less sensitive to the inhibitor;  
the activity of the mutant enzymes with the inhibitor are always higher than the activity of the wild-type enzyme with the inhibitor;  
the data does not indicate whether these differences are significant or not / difference between wild-type enzyme and M1 enzyme not great; [3 max]
- C2.** (a) (i) pyruvate;  
ATP;  
 $\text{NADH} + \text{H}^+$ ; [2 max]
- (ii) energy (from electron transport chain) used to pump  $\text{H}^+$  across inner mitochondrial membrane;  
into space between inner and outer membrane;  
 $\text{H}^+$  move from intermembrane space down the concentration gradient;  
through ATP synthase/synthetase;  
producing energy used to produce ATP; [3 max]
- (b) light intensity;  
temperature;  
carbon dioxide concentration; [2 max]
- C3.** hemoglobin is a globular protein while keratin is a fibrous protein;  
hemoglobin folds into rounded structures while keratin remains linear;  
hemoglobin is a soluble protein while keratin is not;  
hemoglobin consists of four peptides/subunits while keratin does not;  
hemoglobin has prosthetic/heme groups while keratin does not;  
hemoglobin functions as transport molecule while keratin is a structural molecule/  
part of hair/nails; [3 max]

**Option D — Evolution**

- D1.** (a) 11 [1]
- (b) Ile and Glu (*need both to award the mark*) [1]
- (c) share 17 (out of 29) amino acids in common / more amino acids similar than different;  
both have Mn in the enzyme (as cofactor);  
greatest difference between them is from amino acid 18 to 22;  
mitochondrial has Gly (position 12) while *E. coli* (Mn) never has Gly;  
Leu is most common amino acid in both appearing four times / other valid comparison; [2 max]
- (d) divergent (evolution) as the cytoplasmic dismutase shows a greater number of differences (than the other three enzymes);  
divergent as convergent (evolution) implies existence of analogous structures and there are none here; [1 max]
- (e) endosymbiotic theory states bacteria were engulfed by organisms to become mitochondria;  
sequence comparison between mitochondrial and bacterial dismutase supports this hypothesis;  
more similarity in the amino acid sequence between mitochondrial and bacterial dismutase than between mitochondrial and cytoplasmic dismutase; [2 max]
- D2.** (a) time taken for the radioactivity/% parental isotope to fall to half of its original level/for half of the atoms in a given mass to decay;  
after 28 years there is 50% of previous reading of strontium-90 isotopes; [2]
- (b) 4 to 2.5 million years ago;  
in East Africa;  
most complete skeleton Lucy;  
Lucy dated to 3.2/3.6 million years ago; (*accept any date within this range*)  
other part-fossils found; [2 max]
- D3.** (a) two alleles in a gene pool/polymorphic;  
one allele gradually replacing another;  
due to strong selection pressure;  
example; (*e.g. melanic moths/industrial melanism*) [3 max]
- (b) periods of stability/little evolution/stasis, followed by periods of sudden major change/lot of evolution/rapid speciation;  
in periods of stability organisms become well-adapted to environment;  
natural selection acts to maintain characteristics;  
equilibrium punctuated by rapid environmental change;  
such as volcanic eruption / meteor impact / change in sea level;  
directional selection leads to rapid evolution; [4 max]



**Option E — Neurobiology and behaviour**

- E1.** (a) from 60 to 105 minutes (post-sunset) / 45 minutes [1]
- (b) to increase the possibilities of fertilization [1]
- (c) to avoid interspecific/cross-fertilization;  
cross-fertilization usually not successful/non-productive;  
some overlap of species spawning occurs so temporal separation is not completely successful;  
example of overlap (*e.g. D. strigosa* overlaps with *M. cavernosa/M. franksi*); [2 max]
- (d) the phase of the moon / time of sunset / season/time of year / (water) temperature [1]
- (e) females always spawned after males suggesting hypothesis correct;  
for example in *M. cavernosa* or *S. intercepta*;  
difficult to tell for hermaphrodites;  
chemical analysis of water should be undertaken after males spawned / other chemical signals / further evidence required to support cause and effect; [2 max]
- E2.** (a) I. dorsal root ganglion;  
II. grey matter;  
III. motor neuron; [3]
- (b) decision-making involves synapses / pre and postsynaptic neurons are required;  
some presynaptic neurons are excitatory and some are inhibitory;  
interaction between excitatory and inhibitory presynaptic neurons with the postsynaptic neuron;  
excitatory and inhibitory produce different neurotransmitters;  
the impulses from presynaptic neurons are generally summative;  
decision-making is a (mental) process leading to the selection of alternatives/  
strategies / frontal cortex/lobes are brain regions involved in decision-making processes; [3 max]
- E3.** (a) classical conditioning;  
Pavlov sounded a bell before food / conditioned stimulus;  
dogs salivated when they heard the bell / conditioned response;  
the amount of salivation after the bell was as great as when the food alone was presented;  
dogs had learnt to associate the two external stimuli; [3 max]
- (b) sound waves reaching eardrum cause it to vibrate;  
vibrations passed to bones of middle ear/oval window/fluid in cochlea;  
detected by mechanoreceptors/hair cells (in cochlea of ear); [2 max]

**Option F — Microbes and biotechnology**

- F1.** (a) turkeys: 33/32.6/32.56%  
egg laying hens: 0% { Both needed to award the mark. [1]
- (b) none of the egg laying hens have bacteria resistant to 5 or more antibiotics while (10) chickens have bacteria resistant to 5 or more antibiotics;  
13/65% of the egg laying hens have no resistant bacteria while 9/20% of the chickens have no resistant bacteria;  
both have approximately same percentage/number of *E. coli* resistant to 1 or 3 antibiotics;  
egg laying hens have less incidence of antibiotic-resistant bacteria than chickens; [2 max]
- (c) hypothesis supported for poultry raised for meat but not for egg-laying;  
turkeys and chickens always have bacteria resistant to more antibiotics than egg laying hens;  
antibiotic-resistant bacteria are still found in egg laying hens even though antibiotics are rarely given;  
antibiotic-resistant strains (of bacteria) may have arisen by other means/other than by poultry being given oral antibiotics; [2 max]
- (d) from fecal matter to man handling the chickens / by accidental hand to mouth contact / contaminated dust / eating raw meat; [1 max]
- F2.** (a) membrane-bound organelles present in Eukarya but absent in Archaea;  
70S ribosomes in Archaea whereas 80S ribosomes in (cytoplasm of) Eukarya;  
nuclear envelope in Eukarya, not in Archaea;  
introns are present in Eukarya but only in some genes of Archaea;  
histone proteins present in all Eukarya but only in a few Archaea;  
the membrane lipid structure is unbranched in Eukarya but branched in Archaea;  
Archaea can inhabit extreme habitats while Eukarya cannot; [2 max]
- (b) I. peptidoglycan;  
II. outer membrane/layer of lipopolysaccharide and protein;  
III. peptidoglycan; [3]
- F3.** (a) main ingredients are salt, soybeans and water;  
*Aspergillus oryzae/A. oryzae* (or *A. sojae*) added;  
carbohydrate/starch broken down to glucose/lactic acid/alcohol;  
(batch) fermentation;  
proteins broken down to peptides and amino acids;  
a mash/koji is obtained;  
pasteurized / preservatives; [3 max]
- (b) eutrophication;  
algal bloom deprives other organisms of light;  
death of organisms;  
microorganisms/decomposers increase oxygen demand/BOD;  
causing deoxygenation of river;  
formation of hydrogen sulphide/ammonia/nitrites;  
which are toxic to some organisms;  
pathogenic organisms released into water; [4 max]

**Option G — Ecology and conservation**

- G1.** (a) (highest HBR for *Anopheles gambiae*/*A. gambiae* week) 107/108 [1]
- (b) 35 (accept answers in the range of 34 to 37) [1]
- (c) both species show relationship between elevated precipitation and higher HBR (e.g. between week 0 and week 8 / week 100 and week 108);  
there is a lag between the period of precipitation and the increase in HBR;  
sometimes elevated precipitation does not lead to peaks of HBR (e.g. week 27);  
precipitation has a greater effect on *Anopheles gambiae*/*A. gambiae*; [3 max]
- (d) spraying insecticides just before rainy seasons;  
draining swamps before (and after) rain;  
providing (endangered) population with repellents/mosquito nets before rainy season; [1 max]
- (e) temperature / breeding site / food supply / predators / other reasonable answer [1]  
*Do not accept global warming.*
- G2.** (a) fundamental niche is the potential mode of existence whereas realized niche is the actual mode of existence;  
adaption/competition/predation/powers of distribution are important in determining the realized niche; [2]
- (b) named type of habitat; { (e.g. land left after lava flow/glacier retreat / sand dune)  
primary succession occurs on bare/lifeless substrate;  
organisms move into an area and change its nature/pioneers colonize;  
pioneers are simple autotrophs; (e.g. lichens grow first)  
break down substrate; (e.g. to form organic soil)  
leads to an eventual climax ecosystem; (e.g. forest)  
stages in the succession follow a set sequence; [3 max]  
*Award [2 max] if no named type of habitat given or if example is of secondary succession such as after a forest fire.*
- G3.** (a) X: tertiary consumers;  
Y: secondary consumers;  
Z: producers; [3]
- (b) (interspecific) competition with native species;  
does not have natural predators so may survive more;  
can be a predator difficult to control;  
reproduce faster/more;  
may cause the extinction of native species;  
most are benign/some may be beneficial (e.g. honeybee introduced to the Americas from Europe in the 1600s); [3 max]
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