



MARKSCHEME

May 2011

BIOLOGY

Standard Level

Paper 3

17 pages

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General Marking Instructions

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. 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.
9. Only consider units at the end of a calculation.

Option A — Human nutrition and health

- A1.** (a) *Ascorbic acid: 2 mg (units are needed)*
Dehydroascorbic acid: 2 mg (units are needed) [1]
Both required for the mark.
- (b) 400(%) (*working not required*) [1]
- (c) more ascorbic acid (40 mg) than dehydroascorbic acid (33 mg) is released/excreted;
 more dehydroascorbic acid (16 mg) than ascorbic acid (10 mg) is released/excreted in the first three hours / dehydroascorbic acid peaks before ascorbic acid;
 from six hours onwards more ascorbic acid is released than dehydroascorbic acid;
 maximum release of dehydroascorbic acid at three hours whereas maximum release of ascorbic acid at six hours;
 ascorbic acid release rises then falls whereas dehydroascorbic release falls (until 12 hours after loading); [2 max]
- (d) genetic variability / differences in vitamin C metabolism / differences in vitamin C requirements / differences in levels of uptake into blood / size/weight of individuals [1]
- (e) both chemical forms are released/excreted so supplements need to be given regularly;
 using dehydroascorbic acid instead of ascorbic acid does not improve vitamin C retention / dehydroascorbic acid could be marginally better as less is excreted;
 study only looks at young/healthy/female subjects;
 period of vitamin C deficiency is too short / need a longer period to allow scurvy to develop; [2 max]
- A2.** (a) (i) $BMI = 74.0 \text{ kg} / (1.80 \text{ m})^2$;
 $= 22.8 \text{ kg m}^{-2}$; (*unit required*) [1 max]
- (ii) normal weight (*allow ECF*) [1]
- (b) diet rich in carbohydrate/fat;
 too much food intake / unbalanced diet / food cheap and readily available;
 sedentary lifestyle / lack of training/exercise;
 genetic disposition/disorder;
 malfunction of hunger centre; [3 max]

- A3.** (a) first milk/colostrum/breast milk of humans contains antibodies;
human milk contains lactose (rather than glucose/glucose polymers);
human milk contains more suitable fatty acids;
human milk contains human proteins / appropriate protein concentrations / more easily digested proteins; *Accept “artificial milk contains bovine/soya proteins”.*
bonding between the mother and child;
breastfeeding avoids allergies to proteins in cow’s milk;
human milk naturally sterile;
health benefits for mother e.g. loss of weight / breast cancer protection; **[2 max]**
Accept reverse arguments for any of the above points if clear.
- (b) decreasing responsiveness to insulin;
high blood glucose;
glucose in urine;
loss of weight / tiredness;
increased production of urine;
dehydration and thirst; **[1 max]**
- (c) regulate diet/total calorie intake and exercise to ensure a balanced energy budget;
low fat diet to avoid weight gain;
consume complex carbohydrates to ensure gradual release of glucose into blood/avoid sudden effect on blood glucose;
eat regular small meals to ensure a steady supply of glucose;
do not go for long periods without meals to avoid large drop in blood glucose;
consume foods (with low glycemic index) to avoid abrupt changes in blood glucose; **[3 max]**
Each statement must be justified to gain a mark.

Option B — Physiology of exercise

- B1.** (a) $12.6 \text{ cm}^3 \text{ beat}^{-1}$ (*units required*) **[1]**
- (b) muscles working harder / require more O_2 / moving the whole body;
intensity of exercise (on weight-bearing machines) is higher;
muscles supporting body weight are also active; **[1 max]**
- (c) weight-bearing machines require higher energy expenditure (than non weight-bearing);
body has highest energy expenditure and stationary cycle lowest;
large standard deviations for all machines / large range of values amongst participants / no clear trend apparent; **[2 max]**
- (d) *Advantages: [2 max]*
energy expenditure is higher so greater weight loss/greater use of carbohydrates/fats;
shorter recovery times needed due to higher oxygen supply;
heart rate is increased but not to an excessive level;
higher ventilation rate means more aerobic respiration (although lactate levels indicate more anaerobic respiration as well);
- Disadvantages:*
possible strain on joints;
body has results in very high blood lactate values;
increased heart rate potentially dangerous for obese subjects / too much stress for obese subjects (as indicated by high lactate levels); **[3 max]**
- B2.** (a) cardiac output/stroke volume increases more rapidly during exercise;
heart rate increases more gradually during exercise;
recovery to normal cardiac output after exercise is faster;
resting pulse rate is lower; **[2 max]**
- (b) lactate can be converted to pyruvate in liver;
pyruvate can then be converted into glucose (Cori cycle);
glucose/pyruvate can then be used for aerobic respiration;
additional oxygen is supplied during deep/fast ventilations after exercise; **[2 max]**
- (c) increase blood flow to muscles;
stretch tendons and ligaments;
improve flexibility of joints;
little scientific evidence for the need to warm up / strong belief amongst athletes in the effectiveness of warm up / placebo effect during scientific trials / mental preparation for intense exercise; **[2 max]**

B3. (a) *Award [1] for each structure clearly drawn and correctly labelled.*

Z lines;
actin filaments;
myosin filaments with heads;
light bands and dark bands;

[3 max]

(b) Ca^{2+} ions released when a nerve impulse arrives at the muscle;
 Ca^{2+} ions are released from the sarcoplasmic reticulum;
binding sites for myosin heads are exposed;
this allows cross-bridges between myosin and actin to form;

[2 max]

Option C — Cells and energy

- C1.** (a) 200 μM (*units required*) [1]
- (b) $(77-51)/77 \times 100 = 35\%$ (*Units required. Allow answers in the range of 32–37%.*) [1]
- (c) highest rate of photosynthesis at pH 7;
decrease (in rate of photosynthesis) between pH 7 and pH 7.5;
little change (in rate of photosynthesis) at higher pH values;
rate of photosynthesis falls again (slightly) at pH 9; [2 max]
- (d) uses hydrogen carbonate ions;
uses stored carbon dioxide / carbon dioxide from respiration; [1 max]
- (e) *pH*
optimum pH may be less than 7;
reducing the pH below 7 may lead to a higher rate (of photosynthesis);
(but) enzyme activity can be affected by low pH;
- or*
- Temperature*
optimum temperature may not be 15 °C;
enzyme activity is affected by temperature;
temperatures above (or below) 15 °C may lead to a higher rate (of photosynthesis);
- or*
- Light intensity*
light intensity may not be optimal/may be limiting;
too low light intensity produces less ATP/NADPH + H⁺ ;
higher light intensities may result in a higher rate (of photosynthesis);
as light intensity/temperature increases rate of photosynthesis may not increase as another factor becomes limiting; [2 max]
[1] for named limiting factor and [1] for effect on photosynthesis.
- C2.** (a) *Fibrous protein:*
keratin / elastin / fibroin / collagen / myosin / actin / other named example;
- Globular protein:*
hemoglobin / myoglobin / named enzyme / named peptide hormone / named antibody / albumin / other named example; [1 max]
Example of both fibrous and globular protein needed to gain the mark. Check any other answers for validity.

(b) both are polypeptides / chains of amino acids joined by peptide bonds / have primary structure;
globular proteins have tertiary structure whereas fibrous proteins do not (may have extended secondary structure);
globular proteins are rounded in shape while fibrous proteins are elongated / *OWTTE*;
globular proteins are (generally) soluble while fibrous tend to be insoluble; **[2 max]**

(c) polar amino acids are soluble/have stable interactions in water/extracellular fluid/cytoplasm;
non-polar amino acids are soluble/have stable interactions in the lipid bilayer;
polar amino acids strongly hydrophilic and non-polar amino acids are repelled by water/are hydrophobic;
(help to) retain protein in position in the membrane;
polar amino acids form hydrophilic channels/protein pores in membranes;
transmembrane proteins have polar amino acids on either side of the membrane; **[3 max]**

C3. (a) *Award [1] for each structure clearly drawn and clearly labelled.*
overall circular or cylindrical shape;
smooth outer membrane and inner folded membrane shown close together;
cristae, shown as thin folds of the inner membrane orientated towards the inside of the mitochondrion;
matrix;
ribosomes/circular DNA;
intermembrane space; **[3 max]**

(b) large inner surface area of cristae for respiratory complexes/electron transport chains;
matrix contains/encloses DNA and ribosomes for protein (enzyme) synthesis / Krebs cycle enzymes;
(double) membrane(s) isolates metabolic processes from the rest of the cytoplasm;
small IM space between inner and outer membranes for accumulation of protons; **[2 max]**
Answers must clearly link a structure to a function for a mark.

Option D — Evolution

- D1.** (a) *Highest probability: 0.58 (Allow answers from 0.57–0.59)*
Lowest probability: 0.25 (Allow answers from 0.24–0.26) [1]
Both required for the mark.
- (b) different varieties from same lake / I [1]
- (c) individuals are more likely to breed if they are the same variety / individuals of different varieties have a low probability of breeding;
the probability of breeding between individuals of the same variety shows a large range of values / narrow range if of different variety;
the probability of breeding between any two individuals is always less than 0.6/correct numerical value; [2 max]
- (d) data provides (strong) evidence for reproductive isolation between the varieties in each lake;
different sizes/feeding habits/habitat (shore versus open water) seem to contribute (strongly) to low breeding probability;
this could lead to speciation/formation of separate species in each lake;
same varieties from different lakes do not show strong reproductive isolation/geographical isolation is a weak factor in speciation / no evidence of allopatric speciation;
sympatric speciation seems to be taking place because different varieties from the same lake have a low probability of breeding; [3 max]
- D2.** (a) simple molecules must polymerize/assemble into polymers;
origin of self-replicating molecules / formation of self-replicating molecules;
simple molecules must become isolated from the surroundings/enclosed in membranes; [2 max]
- (b) in water as organic reactions are aqueous;
warm conditions/pools near geothermal vents/volcanic pools allow high reaction rates;
evaporation of water allows organic (precursor) molecules to become more concentrated;
high temperatures not desirable as organic molecules become unstable;
clay minerals/metal ions may act as catalysts / clay forms a matrix for monomers to attach; [2 max]
- (c) early atmosphere was oxygen free;
some prokaryotes could carry out chemosynthesis;
cyanobacteria (and other varieties) developed the ability to photosynthesize;
used water as hydrogen source so released oxygen;
oxygen began to accumulate in the atmosphere;
more photosynthesis than respiration; [2 max]

- D3.** (a) original concentration of the radioisotope must be established/estimated;
rate of decay/half-life of the isotope must be known;
in radiocarbon dating concentration of the surviving ^{14}C in the fossil is measured;
in potassium-argon dating ratio of ^{40}K to ^{40}Ar atoms are measured; *[2 max]*
- (b) 10 000 years *[1]*
- (c) increased bipedalism;
increased brain size/cranial capacity;
reduction of sagittal crest;
tooth size reduction;
flattening of the facial bones;
development of opposable thumb; *[2 max]*

Option E — Neurobiology and behaviour

E1. (a) in flight **[1]**

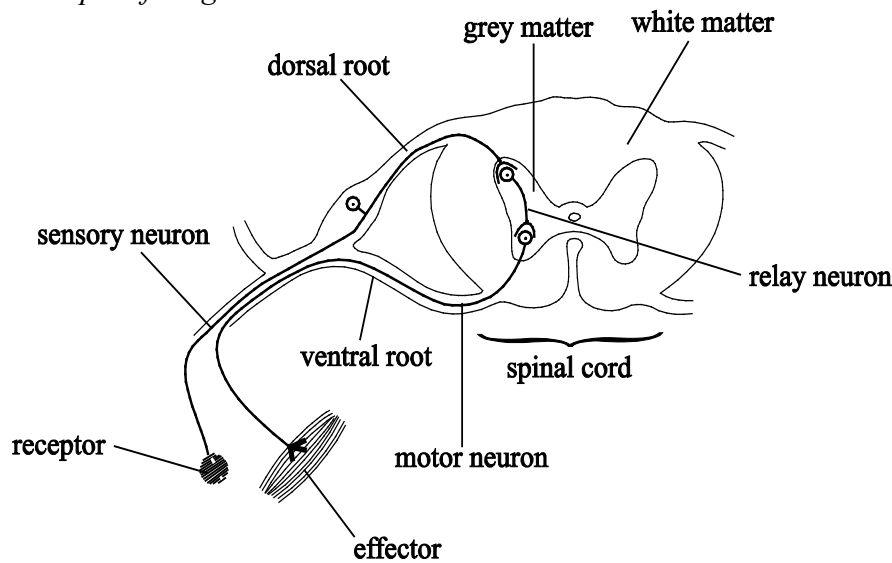
(b) $\frac{1}{4} \times \frac{1}{6} \times 100$;
4.2(%); (Allow answers from 4% to 4.2%) **[1 max]**

(c) birds spend most of time active on the water;
more or less the same time in flight, diving and resting in water; *Need all three parts for the mark.* **[2]**

(d) birds need to rest/sleep to recover energy/digest food / are inactive at night;
moulting makes them flightless;
defending territory / protection of young / other example of social behaviour; **[2 max]**

E2. (a) rapid and unconscious/automatic response (to a stimulus) **[1]**

(b) *Example of diagram.*



sensory neuron shown connecting site of stimulus/receptor to relay neuron;
relay neuron shown in grey matter, connecting sensory neuron to motor neuron;
motor neuron shown connecting relay neuron to effector/muscle / cell body of
motor neuron shown in grey matter;
cell body of sensory neuron shown outside spinal cord/in dorsal root;
spinal cord shown with grey and white matter;

[3 max]

- (c) unconditioned stimulus is smell/sight of food and unconditioned response is salivation;
conditioned stimulus is sound of a bell and conditioned response is salivation at sound of bell;
bell/other stimulus is repeatedly applied just before food;
after several repeats the response can be seen without the food/when only the bell is rung/other stimulus;

[2 max]

- E3.** (a) psychoactive drugs may increase or decrease transmission (to the post-synaptic membrane);
may increase the release/delay the breakdown/interfere with storage/uptake/reabsorption of neurotransmitters;
may mimic the action of neurotransmitters;
inhibitory drugs may reduce the effect of excitatory neurotransmitters / increase the effect/release of inhibitory neurotransmitters;
inhibitory drugs can hyperpolarize the post-synaptic neuron;

[3 max]

- (b) *taxis*:
named independent variable *e.g.* light, humidity, dissolved nutrient or other suitable example;
named example of suitable invertebrate *e.g.* Flatworm, maggots;
named dependent variable *e.g.* direction of movement / time taken to change direction;
use of choice chamber to record number or percentage of organisms in a particular environment;
use of video to monitor and then analyse movement;

or

- kinesis*:
named independent variable *e.g.* light, humidity, dissolved nutrient or other suitable example;
named example of suitable invertebrate *e.g.* woodlice;
named dependent variable *e.g.* rate of movement / rate of turning (of the head);
use of choice chamber to record percentage of active versus inactive organisms);
use of video to monitor and then analyse movement;

[3 max]

Option F — Microbes and biotechnology

- F1.** (a) 22 (%) (*Allow values between 21.5 % and 22.5 %*) **[1]**
- (b) *Aspergillus flavus* has less protease activity;
A. flavus produces more tyrosine equivalents;
A. flavus produces more nitrogen;
A. flavus produces higher glucose concentration;
Accept the converse of any of the above points. **[2 max]**
- (c) will have a sweeter taste (than soy produced with *A. oryzae*) because it has more glucose;
has an acceptable taste;
no toxicity important otherwise not sold;
locally occurring fungus may have ecological/economical advantage over imported soy sauce;
more dissolved nitrogen might be dangerous/long-term effects not known; **[3 max]**
- F2.** (a) producers
decomposers
nitrogen fixers **[1 max]**
Two needed for one mark.
- (b) bacilli/rods;
cocci/spherical;
spirilli/spiral-shaped/helical;
vibrio/comma-shaped; **[2 max]**
- (c) digest/consume organic waste;
reduce organic waste levels / reduce BOD;
produce mucous/slime which helps flocculate/remove suspended solids;
absorb heavy metals;
make nitrogen available to plants growing in reed beds; **[2 max]**

- F3.** (a) makes DNA on an RNA template / copies RNA into DNA **[1]**
- (b) used to make DNA/genes for gene transfer/gene therapy/gene libraries;
used to make DNA from mature mRNA;
make DNA without introns;
cDNA made by reverse transcriptase and double strand completed by DNA polymerase;
reverse transcriptase is obtained from retroviruses; **[3 max]**
- (c) at present, gene therapy treatment effects may be short-lived / process may need to be repeated/fails;
reintroduction of cells/introduction of viral vector to the patient risks immune response;
viral vectors may infect the patient;
insertion of DNA may lead to tumours; **[3 max]**

Option G — Ecology and conservation

- G1.** (a) 166 mg m^{-2} (*Allow answers in the range of 162–168 mg m⁻²*) [1]
- (b) rapid rise and fall between April and August;
peak in May/June;
fluctuates between August/September and December;
low December/January until February/March;
cyclical; [2 max]
- (c) negative relationship / during period of defoliation, biomass (of terrestrial invertebrates) is at its lowest;
less leaves means less food/habitats / easier for predators to see invertebrates;
defoliation occurs in winter/autumn and the cold may kill invertebrates; [2 max]
- (d) (aquatic invertebrate flux) decreases because movement to the forest has occurred (by adult forms) / fewer aquatic invertebrates left in the stream so fewer are moving;
fluctuation due to movement of different species/different life cycles/second generation;
decreases because invertebrates left at the beginning of winter/cold season;
(adult forms) move to utilize (changes in) food supply in forest; [2 max]
- G2.** (a) *Fundamental niche:*
the potential niche / the niche the organism could occupy under ideal conditions / the full mode of existence given the adaptations of the species / *OWTTE*;
- Realized niche:*
the actual niche / the niche restricted by competition and environmental variables / the niche resulting from the limits placed on the species / *OWTTE*; [2]
Responses must distinguish between the two types to gain credit.
- (b) energy transfer along the food chain is less than 100 % efficient;
10 % energy transfer between trophic levels;
nutrient transfer is less than 100 % efficient;
each carnivore needs to consume many prey organisms;
tendency for size of organisms to increase as trophic level increases; [2 max]
- (c) mercury / DDT / other named example;
biomagnification is the accumulation of chemicals through the food chain;
chemicals that undergo biomagnification are stored/not broken down (in the bodies of the organisms that consume them);
chemicals are passed (unaltered) from one trophic level to the next;
chemicals become more concentrated in the bodies of each (subsequent) trophic level;
organisms higher up the food chain consume larger amounts of the chemical; [3 max]

- G3. (a) example *e.g.* Cane Toads/*Bufo marinus*;
effect *e.g.* predation of native invertebrates;

[2]

Other possible examples:

Example	Effect
<i>Salvinia (Floating fern/Giant Salvinia/Kariba weed) or Water Hyacinths</i>	<i>blocked waterways excessive decomposition depletes oxygen and fish stocks</i>
<i>Nile Perch</i>	<i>destroyed native fish species (in Lake Victoria)</i>
<i>Yellowjackets (German wasps – North America)</i>	<i>nests in buildings and threat of stings due to aggressive behaviour</i>
<i>Rabbits (in Australia)</i>	<i>loss of native plant species erosion due to excessive herbivory</i>

Accept other suitable examples. Accept common name or systematic name. Google to check others.

- (b) UV light causes CFCs to release chlorine;
CFCs cause ozone to form oxygen (by chlorine atoms reacting);
causes a reduction in ozone concentration (allowing more UV to enter);
increases the ozone hole;
particularly effective in the Antarctic spring;
effective in very low concentrations / a small amount of CFC can destroy a large amount of ozone;

[2 max]